Residence and teenage birth rates: A potential non-stationary process in US counties

Carla Shoff, Ph.D. Candidate

Department of Agricultural Economics and Rural Sociology
and The Population Research Institute
The Pennsylvania State University
13 Armsby Building
University Park, PA 16801, USA
email: carlashoff@gmail.com
Tel: +1-814-341-5380

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Abstract

A geographically weighted regression (GWR) approach was used to examine how the relationships between a set of predictors and teenage birth rates (TBR) vary across the US. The findings from the global (OLS) model show metropolitan counties have higher TBR than nonmetropolitan counties. The GWR model confirmed this association and showed that the magnitude of the estimated association between metropolitan status and the TBR varies across space, but this spatial variation is not large enough to be considered non-stationary. Additionally, as the rate of family planning clinics increases in a county, the TBR decreases. The GWR results provide evidence for location-specific teenage pregnancy prevention programs and policy.

1. Introduction

The United States (US) has the highest teenage pregnancy rate among all developed countries (P.C.P.T.P., 2004), with 75 per 1,000 females ages 15–19 who become pregnant each year (The Alan Guttmacher Institute, 2006). America's teenage pregnancy rate is twice as high as England and Wales and eight times as high as in Japan and the Netherlands (The Alan Guttmacher Institute, 2006), despite the fact that US levels of teenage sexual activity are comparable to other developed countries (Skatrud et al., 1998). Thirty four percent of US teenage girls become pregnant at least once before they are twenty years old (P.C.P.T.P., 2004), resulting in approximately 750,000 women who are ages 15–19 who become pregnant each year (Eshbaugh et al., 2006; The Alan Guttmacher Institute, 2006).

There is very limited information available about teenage pregnancy and childbearing in rural areas (Loda et al., 1997), even though approximately 20 percent of the nation's youth live in rural areas (Economic Research Service, 2005). Most of the previous research that focuses on teenage pregnancy has concentrated on teenage pregnancy prevention, with very little research that has compared teenage birth rates across states (Crosby & Holtgrave, 2006), and no nationally representative studies that provide pregnancy or birth rates for teenagers from nonmetropolitan[1] areas (Skatrud et al., 1998). Finding differences in teenage birth rates across metropolitan and nonmetropolitan areas is important, because these differences may reflect ecological-level influences that could be changed in efforts to reduce teenage birth rates (Crosby & Holtgrave, 2006).

Skatrud et al. (1998) wrote the most comprehensive overview of the literature on teenage pregnancy in nonmetropolitan areas. Of the 500 citations the authors reviewed, they indentify

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[1] The definitions of the terms "rural" and "metropolitan" are not the same, but are often used interchangeably.

only six published articles that focus on teenage pregnancy in nonmetropolitan areas. However, these six published articles focused specifically on one or a few states and the samples were not racially or ethnically diverse, and one of the articles only focused on sexual activity among rural teenagers, rather than teenage pregnancy or births.

By compiling this comprehensive literature review, Skatrud et al. (1998) identified that there is a genuine need for a thorough examination of comparative data for representative samples of rural and urban teenagers. The authors conclude their synthesis with a recommendation for future research that examines the impact of health services on teenage pregnancy in rural areas. The authors suggest that this research has not yet been conducted because of the lack of data availability due to data restrictions to protect rural teenagers' confidentiality. Thirteen years after the Skatrud et al. (1998) review, the authors' recommendation for future research is finally being addressed in this paper. More specifically, this paper will employ both a conventional ordinary least squares (OLS) regression model and a geographically weighted regression (GWR) approach to identify whether there are metropolitan/nonmetropolitan differences in teenage birth rates across counties in the lower 48 states. Due to the variation in health care service availability across metropolitan and nonmetropolitan areas, this study will also examine how the existence of family planning clinics in an area affects the teenage birth rate.

2. Research Framework

2.1 Rurality and the Presence of Family Planning Clinics

Rural areas in the US tend to be characterized by high rates of poverty, high unemployment rates, and low educational levels. People living in rural areas are commonly affected by geographical isolation, have limited access to medical services, and poorer health status (Darroch & Singh, 1999; Loda et al., 1997). Walker et al. (1990) found that rural teenagers were just as likely to be sexually active and are at equally high risk for pregnancy as their urban counterparts; however, this study was limited to middle and high school students living in Minnesota. The results of this study imply that levels of sexual activity and risk of teenage pregnancy are similar among adolescents in rural and urban areas, however access to family planning services is more restricted for rural teenagers (Walker et al., 1990).

Family planning services are a critical component to making the changes needed to reduce the teenage birth rate (Santelli et al., 2007); however, rural teenagers face certain restrictions when trying to obtain contraceptives because of their geographic location (Skatrud et al., 1998). Most importantly, there is a lack of multiple forms of health services available in rural areas (Loda et al., 1997). In addition, when compared to urban teenagers, rural teenagers have more confidentiality concerns, have minimal public transportation options, and have to travel long distances to family planning clinics (Skatrud et al., 1998).

Even if contraceptive services and supplies are available in an area, this does not mean that all minors are able to receive the contraceptives or reproductive health care they need. Rising medical costs, such as those associated with new contraceptive methods and treatment options, have forced family planning clinics to restructure their administration resulting in clinic consolidation (Frost et al., 2004). This restructuring has made it more difficult for teenagers who live far from open clinics or in places where clinics have closed. A clinic opening further away not only causes transportation and contraceptive availability problems, but also causes problems for women and teenagers to receive stable and continuous reproductive healthcare.

Clinic consolidation can be especially problematic for teenagers who live in rural areas, where increasingly rural hospitals are no longer providing family planning services and there is a lack of public transportation available to get to the more distant clinics (Bennett, 2002). Teenagers may be forced to seek more expensive contraceptive services through private physicians located close by, settle for using a less effective contraceptive methods, or use no contraceptive method or receive no reproductive healthcare at all (Frost et al., 2004). Using local private physicians can also cause problems for rural teenagers because of common characteristics of rural life such as lack of anonymity and fears of confidentiality regarding matters such as contraceptive use or sexual activity before marriage (Skatrud et al., 1998).

2.2 Race, Ethnicity, and Religiosity and Their Relationship with Teenage Childbearing

Most of the research on teenage pregnancy has focused on behavioral and socioeconomic variables that are associated with teenage pregnancy, while limited research has focused on the differences in pregnancy and birth rates across racial and ethnic groups (Berry et al., 2000). There has been some research that has compared teenage birth rates among Whites, African American, and Hispanic teenagers, and even fewer studies that include American Indians. This is usually due to the small sample sizes of American Indian teenage populations (Berry et al., 2000).

Teenage pregnancy and birth rates are higher among racial and ethnic minority groups (Manlove et al., 2000b; Maynard & Rangarajan, 1994; Santelli et al., 2000; Zavodny, 2001). American Indian teenagers experience higher rates of teenage pregnancy than their white counterparts (Corcoran et al., 2000; Garwick et al., 2008). In the US, the American Indian teenage birth rate is 69 per 1,000 teenagers compared to the national teenage birth rate of 49 per 1,000 teenagers (Garwick et al., 2008). African American and Hispanic teenagers have higher rates of teenage births than white teenagers (Blake & Bentov, 2001; Corcoran et al., 2000). In their study on birth rates among teenagers in California, Kirby et al. (2001) found that the proportion of the population who were black and the proportion of the population who were Hispanic to be significantly related to the teenage birth rate.

Some research suggests that a communities' racial composition is a better predictor of teenage births than a community's socioeconomic status (Driscoll et al., 2005). This is suggested because black teenagers in highly segregated neighborhoods are more likely to experience a teenage birth than black teenagers who are living in a racially mixed neighborhood. The authors continue by suggesting "racial segregation heightens the risk of nonmarital childbearing of black adolescents by restricting access to mainstream social and economic opportunities" (Driscoll et al., 2005:p. 36).

There is a need for more extensive empirical research on the possible association between religiousness and adolescent pregnancy (Miller & Gur, 2002), because little is known about the influence of religious affiliation or practice on teenage pregnancy and childbearing (Brewster et al., 1998). We do know that teenage women with an established religious affiliation are less likely to become sexually active prior to marriage than their nonreligious counterparts (Brewster et al., 1998). In addition, teenage females involved with fundamentalist religions experience their first sexual intercourse at a later age; however, they are substantially less likely to use contraceptives during their first sexual intercourse (Brewster et al., 1998).

Miller and Gur (2002) examined the relationship between religiousness and adolescent pregnancy through unprotected sexual intercourse and found that three out of the four dimensions of religiousness were associated with a decrease in the number of sexual partners in the last year. The authors also identified that planned and responsible use of birth control methods was significantly related with frequent attendance at religious events. Surprisingly, the authors found that no aspect of religiousness in adolescents was associated with a decrease in the likelihood of sexual activity or sexual abstinence (Miller & Gur, 2002). In another study on religiosity and teenage childbearing, Zavodny (2001) found that women's religious background does not affect the likelihood of a nonmarital teenage pregnancy. In addition, O'Connor (1999) found that membership in a school religious organization was associated with a lowered odds (0.3) of having a child as a teenager, however significant findings were only identified for white teenagers.

Because there are very limited studies that look at the relationship between religiousness and teenage childbearing, it is difficult to understand why there are differences in levels of sexual activity, contraceptive use, pregnancy, and childbearing among teenagers from different religious affiliations. Differences in levels of pregnancy and childbearing among teenagers from different religions may be related to different beliefs regarding sexual activity before marriage or contraceptive use. Differences in birth rates among teenagers with different religious affiliations could also be attributed to different beliefs about abortions. Other possible explanations for these differences could be the types of sexual education teenagers are exposed to or differences in parents' willingness to communicate with their teenager about sexual activity and teenage pregnancy.

2.3 Socioeconomic Status and Teenage Childbearing

Socioeconomic status has been found to be a significant factor contributing to teenage childbearing (Berry et al., 2000; Corcoran et al., 2000; Manlove et al., 2000a; Santelli et al., 2000). The risk of teenage pregnancy and births is higher in more disadvantaged communities (Driscoll et al., 2005; Skatrud et al., 1998). When a community has economic resources available, this is associated with lower rates of teenage pregnancy (Driscoll et al., 2005). High socioeconomic status in a community usually leads to more services and opportunities available for teenagers and other members of the community (Driscoll et al., 2005). When teenagers are exposed to these services and opportunities, they are more likely to delay childbearing. Teenagers who live in disadvantaged areas have fewer opportunities, which may provide less of an incentive for avoiding a birth as a teenager (Driscoll et al., 2005).

Poverty has been found to be one of the strongest indicators of unintended teenage childbearing (Blake & Bentov, 2001; East & Jacobson, 2000; Manlove et al., 2000a; Santelli et al., 2000). While there are no studies that examine the relationship of the poverty rate in an area to the teenage birth rate that use a representative sample of rural and urban teenagers (Skatrud et al., 1998), using data for all the zip code areas in the state of California, Kirby et al. (2001) found that the proportion of households living below the poverty line is highly positively correlated with the teenage birth rate. The birth rate among poor teenagers ages 15 to 19 is almost 10 times the rate among higher-income teenagers (Santelli et al., 2000).

High levels of unemployment are related to higher levels of teenage pregnancy (Corcoran et al., 2000; Young et al., 2004). Kirby et al. (2001) found that among the non-Hispanic white population, both male and female unemployment rates were highly and positively related to the teenage birth rate. Among the black population, neither male employment or male unemployment rates were significantly related to the teenage birth rate; however, the Black female unemployment rate was even more highly related to the Black teenage birth rate than the white female unemployment rate was to the white teenage birth rate (Kirby et al., 2001). For the Hispanic population in the study, neither male or female unemployment rates were significantly related to the teenage birth rate (Kirby et al., 2001).

Living in an area with low levels of formal education is a significant risk factor for teenage pregnancy. Blake and Bentov (2001) found that the higher the percentage of adults with less than 12 years of education, the higher the unmarried teenage birth rate. Also, Kirby et al. (2001) found that the higher the adult population with a college degree, the lower the teenage birth rate.

Teenagers who grow up in communities with high unemployment rates and inferior schools perceive that they have more limited educational and employment opportunities. They may have less of an incentive to delay early childbearing (Blake & Bentov, 2001; Corcoran et al., 2000; Driscoll et al., 2005; SmithBattle, 2007). This previous research shows how poverty, unemployment, and limited education in an area are associated with teenage pregnancy and childbearing.

2.4 Hypotheses

As discussed, teenagers from nonmetropolitan areas face certain restrictions when trying to obtain contraceptives that are created by their geographic location (Skatrud et al., 1998) and the lack of multiple forms of health services available (Loda et al., 1997). Also, teenagers living in nonmetropolitan areas face more concerns with confidentiality than other teenagers, have minimal public transportation options, have to travel long distances to family planning clinics, and sometimes have no telephone in their homes (Skatrud et al., 1998). Because of these restrictions in obtaining contraceptive services, I hypothesize that (1) *teenage birth rates in nonmetropolitan counties may be higher than the teenage birth rates in metropolitan counties* and (2) *those counties with higher rates of family planning clinics will have lower rates of teenage births*. In addition, due to the conditions of employment and the structure of local economies where racial/ethnic minorities tend to be concentrated, I anticipate the racial/ethnic composition of the county to be associated with the teenage birth rate; therefore, I predict that (3) *counties with higher percentages of black, Native American, and Hispanic populations to have* *higher teenage birth rates*. I also expect to find that (4) *these relationships are stronger in some counties in the US than in others*. These predictions are guided by findings in the recent literature that focus on factors that are associated with teenage pregnancy and childbearing.

3. Data and Methodology

3.1 Dependent variable—Teenage birth rate

The data that will be used in this analysis comes from multiple data sources. The National Center for Health Statistics (NCHS) provided the non-public use 1999, 2000, and 2001 micro-data detailed natality files (NCHS, 1999-2001). This individual-level data set is based on information abstracted from birth certificates filled in the vital statistics offices in every state. Because the data from NCHS is at the individual level, the birth data used for this analysis was aggregated to the county-level using the mother's county of residence at the time of birth. This is a 100 percent sample that consists of all births that occurred during the 1999, 2000, and 2001 calendar years to women of all ages. This data was used to calculate the dependent variable *teenage birth rate*. In order to minimize the fluctuation in the birth rates, the three-year (1999-2001) average teenage birth rates were calculated for all counties in the continental US. In order to create this measure, the births to mothers that were ages 15–17 at the time their birth took place were extracted using SAS 9.2. The birth counts from each of the three data files were averaged and this number was divided by the total population of females ages 15-17 according to the 2000 census and multiplied by 1,000 (US Census Bureau, 2000). The 15–17 year age range was chosen because there are very few births that occur to girls who are under the age of 15. Teenage birth rates are regularly reported for women ages 15–17 or 15–19 years old. Births to those teenagers who were 18 or 19 years of age were not included in the analysis because these teenagers may already be married, especially those girls who live in nonmetropolitan areas, where marriage at earlier ages is more common (Heaton et al., 1989).

This analysis focuses on the continental US for two reasons. First, because the unit of analysis of this study is the county-level and Alaska and Hawaii are not made up of counties in the same way the other 48 states are, the analysis is restricted to counties in the lower 48 states in order to avoid inconsistencies in the comparisons. All counties in the lower 48 states are included in this analysis with the exception of Loving County, Texas, which had limited data available due to its small population. Second, because GWR uses kernel density to place weights on different observations covered by the density shape, only including counties in the lower 48 states in the analysis would fit the adaptive bandwidth selection better than also including the distant counties located in Hawaii and Alaska.

3.2 Independent variables—Metropolitan status and family planning clinic availability

The Economic Research Service 2003 Urban Influence Codes were used to classify the metropolitan status of counties. The 2003 Urban Influence Codes classify counties into urban influence categories that capture some of the differences in economic opportunities among the counties (Economic Research Service, 2003). The 2003 Urban Influence Codes divide the counties into 12 groups that fall within one of three separate types of counties: metropolitan, nonmetropolitan micropolitan, and nonmetropolitan noncore. The *metropolitan* variable is a dichotomous variable that is coded as 1 if the counties are in large metro areas with at least 1 million residents or a small metro area with fewer than 1 million residents. If the county is classified as a nonmetropolitan micropolitan or nonmetropolitan noncore county then they are coded as 0 for the *metropolitan* variable.

The Directory of Family Planning Grantees, Delegates, and Clinics was used to identify each state's Title X funded clinics' contact information (Office of Population Affairs, 2005). To identify the *rate of clinics* per 1,000 females ages 15–17, the street addresses for each of the publicly funded family planning clinics was entered into a database. These addresses were then geocoded and matched to the other data in ArcGIS 9.3. The clinic shape file was joined to a 2000 Census county boundary shape file to identify the number of clinics in each county. The number of clinics in each county was then divided by the female population ages 15–17, and multiplied by 1,000.

3.3. Independent variables—Racial/ethnic composition, religiousness, and socioeconomic status

Data from the summary files (SF) 1 and 3 of the 2000 US Decennial Census (US Census Bureau, 2000) were used calculate the following independent variables. The following independent variables are measures of county-level racial/ethnic composition. The *percentage black* is the percentage of the total population who only identified themselves as black, which means they only chose one race/ethnicity, which in this case is black. The *percentage Native American* is measured as the percentage of the total population who only identified themselves as Native American. The *percentage Asian* is the percentage of total population who only chose one race/ethnicity, Asian. The Hispanic population divided by the total population, and then multiplied by 100, is the *percentage Hispanic* measure. This measure combines Hispanics reporting white race and Black race in this category.

The *percentage of the population in poverty* (the percentage of persons for whom poverty status is determined with income below the poverty level), the *percentage unemployed* (the percentage of the civilian population ages 16 years and over and in the labor force), and the *percentage less than high school* (the percentage of the total population 25 years old and older with less than a high school or equivalent degree) measures were highly correlated: poverty and unemployment (0.68); poverty and less than high school (0.71); and unemployment and less than high school (0.428) and all three bivariate correlations were significant at the $p \leq 0.001$ level. In order to avoid potential problems with multicollinearity, factor analysis was used to create one composite measure, *socioeconomic disadvantage index*, from the three census variables.

Data from The Association of Religion Data Archives (ARDA, 2000) was used to create a composite measure of *religiosity*. The 2000 ARDA county files were used to extract data on the rate of adherence per 1,000 population for Mainline Protestant, Catholic, and Evangelical adherence. These rates of adherents were calculated by ARDA using the 2000 US Census SF1 files. The rates of adherence for these three religions were included in a factor analysis to create one composite measure of *religiosity* using the regression method.

3.4 Methodological Advantages of GWR

In order to test the above stated hypotheses, both a conventional OLS regression model and GWR model were estimated. One of the assumptions of OLS regression is the assumption of stationarity. This assumption is also referred to as the constancy assumption, where the "slope of a regression line (or average association among all units) applies to separate units that comprise the whole (Freedman et al., 1991:678). This assumption means that all parameter estimates are the same everywhere in the study area and that there is no differentiation in the magnitude and nature of the relationships across the spatial region. When an OLS regression model is applied to spatial data, we assume a stationary process. This means that a one-unit change in *X* provokes the same change in *Y* in all parts of the study region and that the parameter estimates that are obtained from the regression model are constant over space. The problem with the stationarity assumption when using spatial data is that the relationships being tested may vary spatially. Relationships may vary spatially for a number of reasons including sampling variation or model misspecification. These relationships may also vary spatially because the relationships are intrinsically different across space (Fotheringham et al., 2002). Researches can avoid violating the stationarity assumption all together by addressing the issue of spatial non-stationarity directly and allowing the relationships being measured to vary over space, which is the heart of GWR (Fotheringham et al., 1998, 2002).

Because the conventional OLS regression model is unable to detect potential spatially varying associations, GWR was used to examine spatial varying coefficients over space by generating a set of location-specific parameter estimates. The best approach to summarizing the information generated by GWR is to map and show the distributions of the local estimates (Fotheringham et al., 2002). The GWR 3.0 software also allows you to perform tests to assess the significance of the spatial variation in the local parameter estimates and perform tests to determine whether the local model performs better than the global model after accounting for the differences in the degrees of freedom (Fotheringham et al., 2003). GWR is a beneficial methodological tool for testing the hypotheses outlined in this paper, because it not only allows for the identification of how teenage birth rates vary across metropolitan and nonmetropolitan areas, but also shows where these relationships vary across space.

4. Analytic Results

4.1 Descriptive Results

The mean, standard deviation, and minimum and maximum values for each of the variables included in the analysis are presented in Table 1. On average, the US has a teenage birth rate of approximately 26 births per 1,000 females ages 15-17 years of age. The minimum and maximum teenage birth rates vary from 0.00 to 101.27, revealing the variability in the teen birth rates across counties in the continental US. This variability is also apparent in Figure 1.

The map in this figure was created in ArcMap 9.3 to show the distribution of the teenage birth rates across counties. As shown in the map, the counties in the southern half of the United States tend to have higher teenage birth rates, especially along the Black Belt and the US-Mexico border, with additional pockets of high teenage birth rates in the Midwest. Given the variability of teenage birth rates across the United States, it is crucial to determine the factors contributing to this variation in teenage birth rates in local populations. Even though counties are not considered actual communities, they are a valid spatial and decisional unit of analysis for the purposes of determining the factors corresponding to the variability in conditions across the continental US (McLaughlin et al., 2007).

Table 1. Descriptive Statistics for the Births per 1,000 Females Ages 15-17 and the Independent Variables (N=3,107)

	Mean	Std. Dev.	Minimum	Maximum
Births per 1,000 Females Ages 15-17	25.82	14.58	0.00	101.27
Metropolitan Status (1=Metro, 0=Nonmetro)	0.35	0.47	0.00	1.00
Clinics per 1,000 Females Ages 15-17	1.88	3.13	0.00	58.82
Percentage Black	8.83	14.54	0.00	86.49
Percentage Native American	1.58	6.25	0.00	93.68
Percentage Asian	0.77	1.56	0.00	30.89
Percentage Hispanic	6.21	12.05	0.08	97.54
Religiosity Index	0.00	1.00	-3.65	3.55
Socioeconomic Disadvantage Index	0.00	1.00	-2.16	6.45

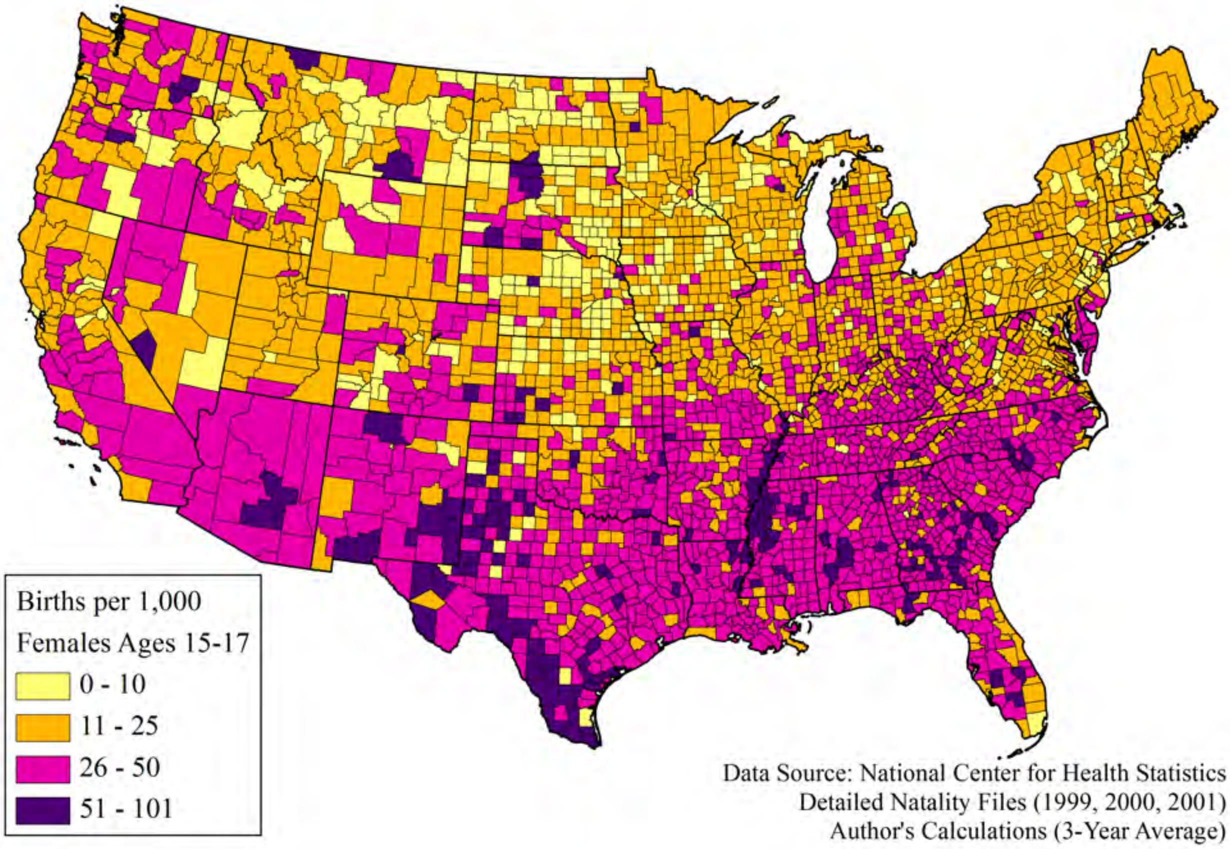

Figure 1. Map of 3-year average (1999-2001) births per 1,000 females ages 15-17 by county

Thirty-five percent of counties in the lower 48 states are classified as metropolitan counties. There is an average of 1.88 publicly funded family planning clinics per 1,000 females 15–17 years of age. There are 938 counties with no publicly funded family planning clinics located within the county and 743 of these (or 79 percent) are nonmetropolitan counties (x^2=118.08; $p \leq 0.001$).

As for the racial/ethnic composition of US counties, on average, US counties have a 8.83 percent black, 1.58 percent Native American, 0.77 percent Asian, and 6.21 percent Hispanic population. Because the socioeconomic disadvantage and religiosity indices were created using factor analysis, these measures have a mean of 0 and a standard deviation of 1.

4.2 Global Regression Results

The OLS regression results for models 1 and 2 are provided in Table 2. These are the results of the global models. Collinearity diagnostics were estimated, and no problems of multicollinearity were found among the independent variables. The collinearity diagnostics used were the variance inflation factors (VIF) and tolerances for individual variables in SPSS 19.0 in the regression command. Multicollinearity is said to exist if the VIF is 10 or higher (or equivalently, tolerances of .10 or less) (Williams, 2011). The highest VIF in this analysis was 2.179 and the lowest tolerance was 0.459 for the socioeconomic disadvantage index.

In model 1, only metropolitan status was included in the model; however, no significant relationship between metropolitan status and teenage birth rates was identified. Nevertheless, when adding the other covariates in model 2, the teenage birth rate in metropolitan counties is 1.46 births per 1,000 teenagers higher than it is in nonmetropolitan counties. As expected, with every additional clinic per 1,000 teenagers, the teenage birth rate decreases by 0.30 births per 1,000 females. Clearly, the availability of family planning clinics has a significant impact on the teenage birth rate.

Table 2. OLS Regression Models Predicting Births per 1,000 Females Ages 15-17
(Global Regression Models 1 & 2) N=3,107

	Model 1		Model 2	
	Estimate	Std. Error	Estimate	Std. Error
Intercept	26.11***	0.32	19.98***	0.28
Metropolitan Status (1=Metro, 0=Nonmetro)	-0.81	0.55	1.46***	0.38
Clinics per 1,000 Females Ages 15-17			-0.30***	0.05
Percentage Black			0.34***	0.01
Percentage Native American			0.30***	0.03
Percentage Asian			-0.55***	0.11
Percentage Hispanic			0.46***	0.02
Religiosity Index			-4.64***	0.18
Socioeconomic Disadvantage Index			3.85***	0.24
Adjusted R-Squared		0.00		0.63
Akaike Information Criterion (AIC)		25,473.09		22,436.06

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

As for how the racial/ethnic composition is associated with the teenage birth rate, the findings are consistent with the previously stated hypotheses. Increases in the percentage of black, American Indian, and Hispanic populations are associated with an increase in the teenage birth rate by 0.34, 0.30, and 0.46 births per 1,000 teenagers, respectively. As expected, the socioeconomic disadvantage and religiosity indices are significantly related to the teenage birth rate. Specifically, with every one point increase in county religiosity the teenage birth rate decreases by 4.64 births per 1,000 teenagers. Socioeconomic disadvantage also had a substantial effect on the teenage birth rate, with every one point increase in disadvantage results in an increase in the teenage birth rate of 3.85 births per 1,000 teenagers.

The OLS full model (model 2) explains 63 percent of the total variance in the teenage birth rate and has an AIC value of 22,436.06. Although the OLS regression model provides some evidence for the above stated hypotheses, it is still not clear whether spatial non-stationarity is a concern in the analysis. The homoskedastic assumptions underlying the OLS regression will be investigated in the following section by using local modeling.

4.3 Local Regression Results

The GWR 5-number parameter summary and Monte Carlo significance tests for spatial variability of parameter estimates for models 1 and 2 are displayed in Table 3. The Monte Carlo significance tests indicated that the associations between the independent and dependent variables are non-stationary across space, with the exception of the metropolitan status measure in the full model. Therefore, the associations identified in the OLS models could not be generalized to anywhere in the US except for in the case of the association between metropolitan status and teenage birth rates. Compared to the OLS full model that explained 63 percent of the total variance in teenage birth rates, the GWR full model explains 72 percent of the total variance. The AIC value of the GWR full model is 21,762.43 compared to the AIC value of OLS model of 22,436.06; these diagnostics suggest that the GWR local model is statistically preferable to the OLS global model.

Table 3. GWR 5-Number Parameter Summary Results and Monte Carlo Significance Test for Spatial Variability of Parameters for Model 1 and Model 2 (N=3,107)

	Model 1					
	Min	LQ	Med	UQ	Max	Monte Carlo
Intercept	10.33	17.25	24.05	36.22	50.19	***
Metropolitan Status	-14.00	-3.82	-0.93	1.67	14.72	***
	Model 2					
	Min	LQ	Med	UQ	Max	Monte Carlo
Intercept	2.91	16.13	19.42	24.18	36.29	***
Metropolitan Status	-3.36	-0.75	0.18	1.28	5.13	
Clinic Rate	-1.80	-0.57	-0.24	0.00	0.87	**
Percentage Black	0.06	0.24	0.40	0.63	2.90	***
Percentage Native American	-2.22	0.10	0.39	0.61	5.73	***
Percentage Asian	-4.28	-1.70	-0.84	-0.16	4.69	***
Percentage Hispanic	-0.25	0.51	0.91	1.34	2.97	***
Religiosity Index	-10.65	-3.29	-2.23	-1.32	0.84	***
Socioeconomic Disadvantage Index	-4.35	2.39	4.40	5.65	10.67	***
	Model 1		Model 2			
Adjusted R-Square		0.48		0.72		
Akaike Information Criterion		23,565.03		21,762.43		

Note: **p*≤0.05; ***p*≤0.01; ****p*≤0.001

Maps of the local R-squared for models 1 and 2 are included in Figure 2-1. As shown in the local R-squared map for model 1, the total variance explained by the local model ranges from 0 percent to 46 percent. After adding all the other controls in model 2, the total explained variance of the local model ranges from 22 to 78 percent, indicating that the model fits the data well in many areas of the US, including the Northwest, Midwest, and parts of the Great Lakes and Northeast regions. This model did not fit the data as well in the Appalachia region and the South. One of the benefits of the GWR approach is that it allows for the identification of areas that may benefit from a model that includes additional covariates that may help explain the reason for high teenage birth rates.

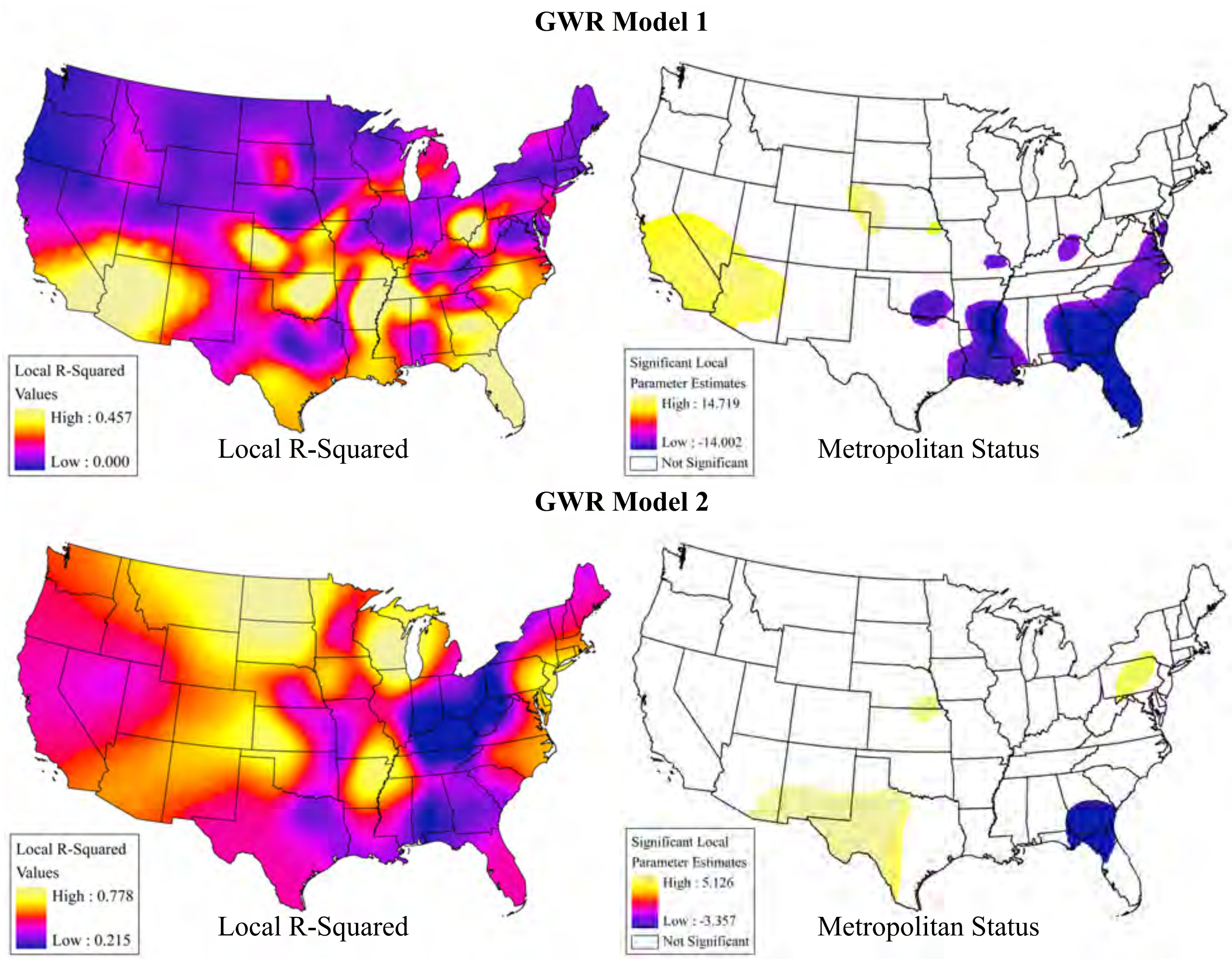

Figure 2-1. Map of local R-squared estimates and GWR estimates for metropolitan status
Note: Significant areas at $\pm$1.96

Also included in Figure 2-1 are maps of the significant local GWR parameter estimates for metropolitan status for models 1 and 2. While the OLS model revealed no significant relationship between metropolitan status and the teenage birth rate in model 1, the GWR results show areas of the US were a significant relationship does exist. Metropolitan counties in California, Arizona, Nevada, and Nebraska have higher teenage birth rates than nonmetropolitan counties, while metropolitan counties located in the South have lower teenage birth rates.

After adding the additional covariates to the model (model 2), the results show a similar pattern; however, the significant relationship between metropolitan status and the teenage birth rate covers a smaller area. The magnitude of the estimated association between metropolitan status and the teenage birth rate varies across space, but this spatial variation is not large enough to be considered non-stationary, as indicated by the non-significant Monte Carlo test. This example illustrates why a local modeling approach is appropriate for this type of analysis, because without the use of GWR, the varying relationship between metropolitan status and the teenage birth rate would remain hidden.

Figure 2-2 displays the spatially varying associations between the racial/ethnic composition measures and the teenage birth rate. Consistent with the above stated hypotheses, increases in the percentage of black, Native American, and Hispanic populations are associated with increases in the teenage birth rate in the majority of the significant areas. Significant associations for these measures cover a large portion of the US, especially for the percentage Hispanic measure. This indicates that the racial ethnic composition of a county is an important predictor of the teenage birth rate in most areas; however, the results do reveal that the strength of the relationship does vary, and even changes direction in some areas for the percentage Native American measure. The GWR model results challenge the OLS results by showing that the relationship between percentage Native American and the teenage birth rate can vary across space. The literature was not clear about how the composition of the Asian population would be associated with the teenage birth rate. The OLS results of this study showed that with every percentage point increase in the Asian population that the teenage birth rate decreased by approximately one birth per 1,000 females. The GWR results reveal the same (negative) relationship in the majority of the significant areas; however, a larger Asian population is associated with higher teenage birth rates in counties located in Texas, Oklahoma, Kansas, Colorado, and New Mexico. These are areas that may benefit from culturally sensitive teenage pregnancy prevention efforts.

GWR Model 2

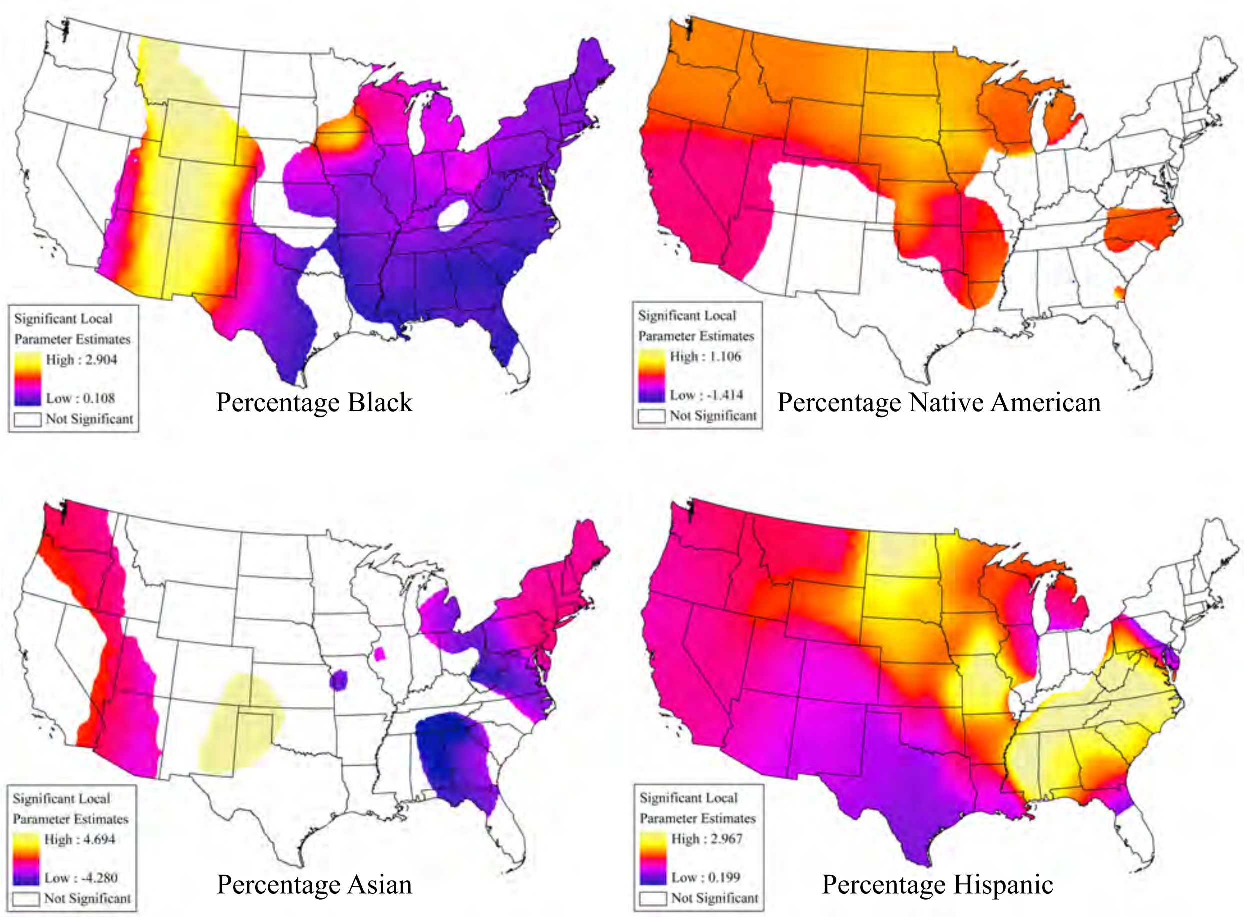

Figure 2-2. Map of GWR estimates for percentage black, percentage Native American, percentage Asian, and percentage Hispanic
Note: Significant areas at ±1.96

The spatially varying association between the rate of clinics per 1,000 females and the teenage birth rate are displayed in Figure 2-3. As shown, as the clinic rate increases the teenage birth rate decreases across most of the Western US, in a large portion of the South, and in Michigan. A positive association between the clinic rate and the teenage birth rate is significant in a small area of the central US. While this result may make it seem as if family planning clinics are not effective in this area, it may be that these clinics were put in place to address an already high teenage birth rate. The findings displayed in this map are very important—they not only show areas that could benefit from efforts to reduced the teenage birth rate, but they also show areas that can be targeted to make improvements in family planning clinic availability, which can in turn, reduce the teenage birth rate.

GWR Model 2

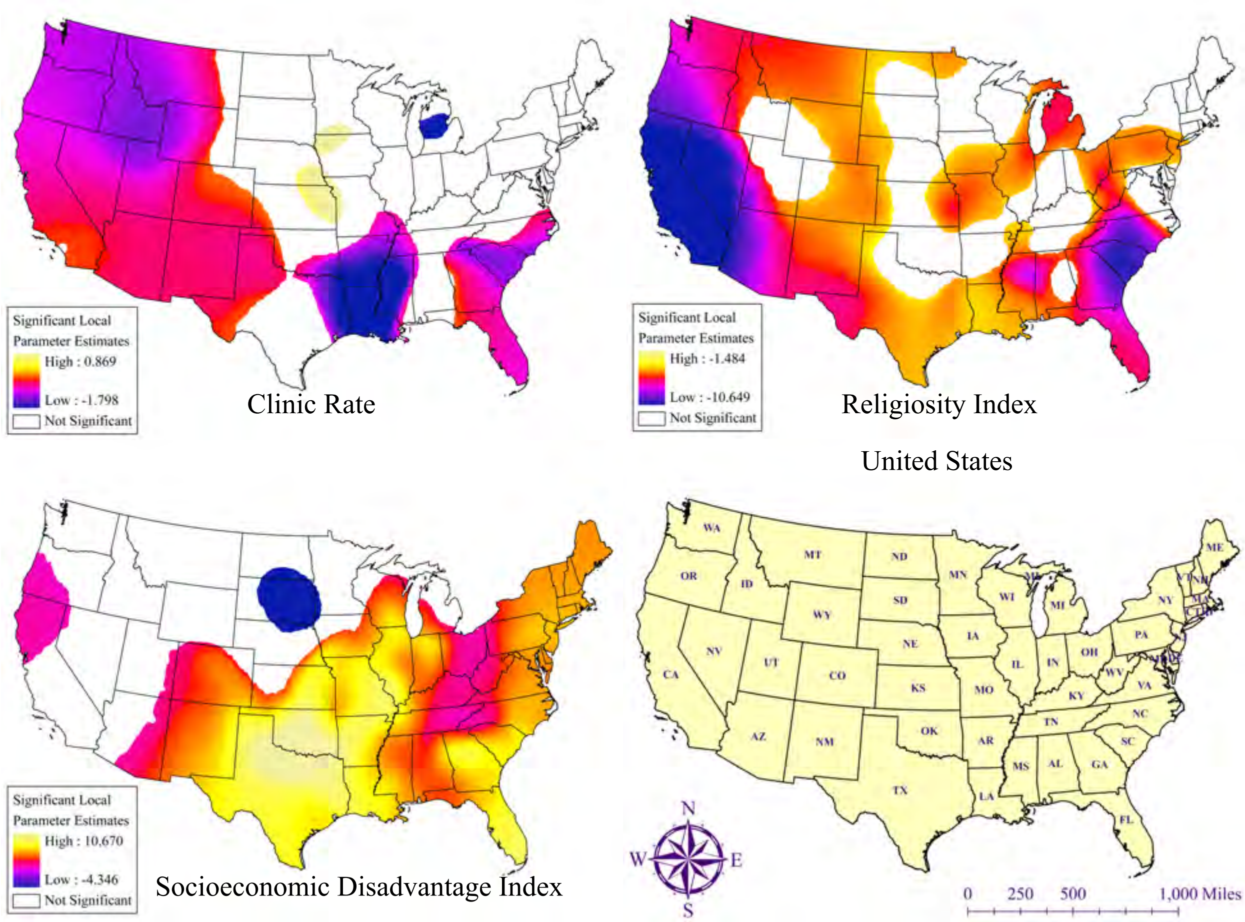

Figure 2-3. Map of GWR estimates for clinic rate, religiosity index, socioeconomic disadvantage index and map of US states
Note: Significant areas at ±1.96

Figure 2-3 also displays the effect of the religiosity index on the teenage birth rate. As you may recall, the OLS results revealed that with every one point increase in the religiosity index, the teenage birth rate decreases by approximately 5 births per 1,000 females. The GWR results also show a negative relationship between the religiosity index and the teenage birth rate. The reduction in the teenage birth rate across counties ranges from an approximately 1 to 11 birth reduction per 1,000 females. The largest decreases in the teenage birth rate can be found along the west coast and in Georgia. These are areas where a greater religious adherence has a larger impact on reducing the teenage birth rate compared to counties in Texas, Louisiana, and the central US where a higher religiosity score is associated with a decrease in the teenage birth rate; however, the effect is not as strong.

As found in the OLS model, as socioeconomic disadvantage increases in a county, the teenage birth rate also increases. This strong relationship was found in many counties across the US including most counties located in the eastern and south central portions of the US and parts of the northern west coast. There is a strong negative association between socioeconomic disadvantage and the teenage birth rate located in North and South Dakota and Nebraska. These are areas where efforts to improve the county's socioeconomic status could also reduce the teenage birth rate.

5. Conclusions

5.1 Discussion of Findings

The empirical results of this study allowed me to answer my original research questions and come to some interesting conclusions. With this study, I wanted to find if there were differences in teenage birth rates across metropolitan and nonmetropolitan counties and determine whether the availability of family planning clinics was associated with the teenage birth rate. In addition, I wanted to investigate other predictors of teenage birth rates that have had less attention in the literature when using a nationally representative sample of teenagers (racial/ethnic composition, religiosity, and socioeconomic status).

Although the results of the OLS global model were not consistent with my hypothesis that nonmetropolitan counties would have higher teenage birth rates than metropolitan counties, I did find evidence of this when using the GWR local modeling approach (see Figure 2-1). Specifically, metropolitan counties located in the southeastern portion of the US had significantly lower teenage birth rates compared to nonmetropolitan counties. However, metropolitan counties located in states along the US-Mexico border, the central US, and in Pennsylvania had higher teenage birth rates than nonmetropolitan counties. While there is no agreement in the literature on the best way to measure rural, the use of a measure other than metropolitan/nonmetropolitan dichotomy may yield different results.

With over 6 million clients each year, publicly funded family planning clinics play a vital role in meeting American contraceptive needs (Frost et al., 2004). The results of the OLS model showed that counties with higher rates of family planning clinics had lower teenage birth rates. The GWR results revealed this relationship in the majority of counties located in states in the western half of the US, the South, and in Michigan (see Figure 2-3). However, the inverse relationship was found in counties in the central US. This finding may seem contradictory; however, these clinics may have been specifically placed in these counties due to the fact the counties already had a high teenage birth rate. With this study, there is no way of knowing why the family planning clinics were opened in specific areas. These clinics may have been opened in order to maintain a low teenage birth rate; or they may have been established to help in lowering an existing high teenage birth rate.

5.2 Policy and Practice Implications

Helping young women avoid an unwanted teenage birth is an important public policy goal (Darroch & Singh, 1999). Programs need to continue to be developed to address the unique needs of adolescents, whether they are sexually active, pregnant, or parenting (Casserly et al., 2001). Adequate information about sexual behavior and its consequences, as well as confidential and affordable contraceptive services and supplies, need to be easily accessible to all teenagers (Darroch & Singh, 1999), regardless of their residential location.

With this research, I found that in areas with more socioeconomic disadvantage there are higher teenage birth rates. Since greater educational and employment opportunities are associated with lower teenage birth rates (Darroch & Singh, 1999), these findings should be taken into account when developing strategies to reduce the teenage birth rate. If academic success is associated with a lower teenage birth rate, then finding ways to keep teenagers in school, receive higher grades, and promote higher educational attainment should be incorporated into teenage pregnancy prevention programs.

In addition to funds designated specifically for teenage pregnancy programming or family planning clinics, efforts to address teenage pregnancy prevention can be assisted through policies directed at other areas. For example, efforts to lower the poverty rate may be just as essential to lowering the teenage birth rate. Herein lies one of the advantages of the GWR approach. From examining the results of the local parameter estimates, one can determine where policies directed at specific social problems such as increasing socioeconomic status can at the same time reduce the teenage birth rate. For example, the results of this study (see Figure 2-3) reveal that efforts to improve the socioeconomic status in counties located in the south and southwest could also reduce the teenage birth rate.

Efforts to reduce the teenage birth rate cannot only be made through teenage pregnancy prevention programs, but also by improving our schools and communities in order to give teenagers realistic goals. Simply encouraging teenagers to stay in school and receive high grades will not be successful if the teenager is attending an inferior school or has no plans for further education or career options. The educational system as well as the employment opportunities in a community must be worthwhile, in order for teenagers to take these suggestions seriously and work hard to reach these future goals.

The majority of the programs that are currently in use are modeled after pregnancy prevention efforts in urban areas (Skatrud et al., 1998). However, teenagers need pregnancy prevention programs to be specifically tailored to focus on issues that are specific to the areas and situations in which they live (Skatrud et al., 1998). Pregnancy prevention programs that are made available to rural teenagers need to address issues that are particular to rural areas such as social and cultural isolation, high rates of unemployment and poverty, poor housing, family disruption, confidentiality concerns, and lack of economic opportunities (Loda et al., 1997; Skatrud et al., 1998). In addition, rural communities typically do not have the wide range of resources and funding sources that are often found in urban areas (Loda et al., 1997; Skatrud et al., 1998). Therefore, special attention will need to be paid to finding creative ways to raise money for these efforts, as well as to find ways to work with the resources that are already available in rural communities. This study found that higher rates of religiosity are associated with lower teenage birth rates. Working with churches or other religious institutions may be a way to reach out to teens in an effort to reduce teenage pregnancy.

In addition, this study found that counties with higher concentrations of black, Native American, and Hispanic populations have higher teenage birth rates. Because of the differences in teenage birth rates across race/ethnicity, class, and location, teenagers are at varying risks of experiencing a teenage birth (Berry et al., 2000). Teenagers need contraceptive services and pregnancy prevention interventions to be specific according to their particular needs (Santelli et al., 2006). The programs implemented must also take into account racial, ethnic, and cultural differences, as well as regional differences (Berry et al., 2000).

5.3 Limitations of the Current Study and Directions for Future Research

This study has some limitations. First, as an ecological and cross-sectional analysis, the findings cannot be used to make causal inferences about individual behaviors. Second, while the data used in this study are maintained by Federal agencies and are of high quality, sampling error in the data collection design may be a concern. Third, because of the racial/ethnic disparities in the teenage birth rates, it may have been more beneficial to examine the teenage birth rates for specific racial/ethnic groups. This data could be used to perform this type of analysis; however, it was not done in this study due to the terms of the restricted data access agreement with the NCHS. A study using teenage birth rates by race/ethnicity using a nationally representative sample that included both rural and urban teenagers would allow for an examination of how local (county) characteristics differ in their relationship with teen birth rates for different racial and ethnic groups and would fill additional gaps in the rural teenage pregnancy literature.

Further research needs to be done on teenage pregnancy, childbearing, and contraceptive use in rural areas, including work on placement and effectiveness of family planning clinics. Family planning clinic providers need to know the extent to which rural teenagers need improved access and availability of contraceptive methods and services, as well as ways to create flexibility in the programming that allows for easy adaptation to local community needs.

Teenage pregnancy and childbearing have significant economic costs, and investing in resources that can lower the teenage pregnancy rate can lower these economic costs and the number of unintended births to teenagers. This investment can improve the well being of children and teenagers, their health, education, and social prospects, as well as reduce the cost for taxpayers associated with teenage pregnancy and childbearing. Finding ways to lower the teenage birth rate will benefit the well being of our youth, our economy, and our nation.

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