# An Exploratory Spatial Data Analysis of Preterm Birth Prevalence in Georgia, USA, 1995-2010

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#### 1. Introduction

Preterm births are defined as births occur before the 37th week of pregnancy. In the United States, the rate of preterm birth was 12.8 percent in 2006, a more than 20 percent increase compared to that in 1990. The rate has since been decreasing slowly but continuously but preterm births still represented 11.7 percent of all the live births in 2011 (CDC 2012). In the State of Georgia (Figure 1), 14.2 percent of live births were preterm births in 2006, compared with 11.9 percent in 1995 (GDPH 2012). The rate has lowered to 12.2 percent in 2010, showing a similar pattern with the national trend. Preterm births are the number one predictor of infant mortality and it is also believe to be closely related to some severe health problems and lifelong disabilities of premature babies. In addition, these health problems have become significant financial burden to society and families.

The exact etiology of preterm delivery remains elusive. Aside from a maternal history of previous preterm delivery, other widely studied risk factors include mother's socioeconomic status (SES), behavioral and demographic factors, environmental exposures, and neighborhood characteristics (e.g., Wilhelm 2011). In addition, preterm births consistently demonstrate the inequity among different social and economic groups (e.g., Miranda et. al 2012). Evidence of associations between low SES and preterm births exists across and within many countries, especially for groups with economic deprivation. Because of its potential importance in the elimination of poverty, reduction of health inequalities, and improvements in life quality, reduction in the prevalence of preterm births again identified as one of the reproductive health goals in the Millennium Development Goals Report by the United Nations (2012). In addition, a pronounced and persistent race/ethnic disparity in the rate of preterm birth has been consistently reported in the literature (e.g., Bloch 2011).

The intent of this research was to investigate the patterns of preterm prevalence in the State of Georgia. Unadjusted preterm rates were examined at both the state level and county level, while spatial clusters of high preterm rates were detected using Moran I statistics. Analyses were performed on race and sex groups to discover disparities.



Figure 1. A locational map of the state of Georgia, USA

### 2. Data

The preterm births data used to complete this study were collected from the Online Analytical Statistical Information System (OASIS) administered by the Georgia Department of Public Health (GDPH 2012). The annual rates of preterm births (Number of live births with gestational age less than 37 weeks /number of live births \* 100) were acquired for all the Georgia counties (n = 159) over a 16 year study period (1995 – 2000). Due to privacy concerns, the OASIS system does not provide rates in counties with less than five events of preterm cases occurring in a single year. Data were also segmented by race (e.g., black or white) for disparity analysis. County boundary shapefiles were obtained from the U.S. Census Bureau and used for mapping and spatial cluster detection.

### 3. Methods

A two-step analytical process was followed to visualize and analyze data. The first step was mapping the spatial distribution of averaged unadjusted preterm rates for all births, births to black mothers, and births to white mothers at the county (n=159) level for the years of 1995-2000, 2001-2006, and 2007-2010, and 1995-2010.

The second step was computing global and local spatial autocorrelation of preterm births rates for the above time intervals. The Moran's I statistic was measured and assessed by testing the null hypothesis that the spatial pattern of these data were random. Rooks case adjacency was used to define neighbor relationships, which considers that all counties/census tracts with common borders are neighbors (Anselin, 1995). All data analyses, including data processing, mapping, and statistical testing, were conducted using the ArcGIS Desktop 10.0 software package.

## 4. Results

#### 4.1 Descriptive statistics

From 1995 to 2010, there were 2,128,264 live births in Georgia, among which 269,450 were preterm births, representing 12.7 % of the total live births. As illustrated in

Table 1, the yearly state preterm rates were significantly higher in black births (mean=16.4%) as compared to white births (mean=10.7%). The racial disparity remains evident when the same statistics were calculated using subgroups of the data, i.e., 1995-200, 2001-2006, and 2007 to 2010. Visually examining the annual preterm rates over time, the overall trend was that the rates continued to increase until they peaked at 2007 and then decreased notably in 2008. In addition, the rates of preterm births between 1995 and 2000 changed 2.5%, 10.5%, and -6.1% for all births, white births, and black births, respectively (Figure 2).

	Min (%)	Max (%)	Mean (%)	Stdev (%)
White	9.4	12.2	10.7	0.90
Black	15.2	18.5	16.4	1.05
All	11.6	14.2	12.6	0.82

 Table 1. Average unadjusted preterm birth by race in Georgia, 1995-2010



Figure 2. Unadjusted preterm birth rates in Georgia, 1995-2010

#### 4.2 Spatial Patterns of Preterm Rates

Figures 3-6 illustrates the spatial distribution of county-level unadjusted preterm birth rates for all, white, and black births for the periods of 1995-2000, 20011-2007, 2007 to 2010 and 1995-2010. Overall, the higher rates appeared in the southwest and central counties while lower rates occurred in the northern and eastern counties. For black births, data were masked in several northern counties due to the small size of preterm births. There was a large high rate county cluster in the south and southwest part of the state. For white births (F, the high rate counties seemed to be relatively scattered across the state, two more obvious clusters seems to be in the central south and northwest of the state.

Table 2 illustrates spatial correlation statistics and corresponding p-values as estimated by the Moran's I statistic. The level of spatial autocorrelation is 0.29 (p < 0.001) for all the live births occurring in Georgia between 1995 and 2010. Moran's I statistics for black and white births were to 0.12 (p < 0.01) and 0.18 (p < 0.01), respectively. The Moran's I statistics and corresponding p-values suggest overall non-randomness in the spatial pattern of preterm births in Georgia. This non-randomness has been consistent across black and white births and over three sub-periods from 1995 to 2010.

Groups	Periods	Moran's I	p-Value	
	1995-2000	0.32	0.0000	
Black	2001-2006	0.47	0.0000	
DIACK	2007-2010	0.37	0.0000	
	1995-2010	0.12	0.002	
	1995-2000	0.12	0.0096	
\//bito	2001-2006	0.33	0.0000	
VVIILE	2007-2010	0.33	0.0000	
	1995-2010	0.18	0.002	
	1995-2000	0.44	0.0000	
A II	2001-2006	0.51	0.0000	
All	2007-2010	0.37	0.0000	
	1995-2010	0.29	0.0000	

Table 2: Moran's I statistic o	f county-level	preterm birth	rates in	Georgia,
	1995-2010			



Figure 3. Unadjusted preterm birth rates in Georgia counties, 1995-2010



Figure 4. Unadjusted preterm birth rates in Georgia counties, 1995-2000



Figure 5. Unadjusted preterm birth rates in Georgia counties, 2001-2006



Figure 6. Unadjusted Preterm birth rates in Georgia Counties, 2007-2010

County-level LISA significant clusters (HH, LL, HL, and LH) were observed for all, black, and white births for the study periods of 1995-2000, 2001-2006, 2007 to 2010, and 1995-2010 (Figures 6-8). Looking at the pattern of 1995-2010, three small hot spot (HH) clusters were detected in the central and southwest counties. One large cool spot (LL) was observed in the northern central region of Georgia. For white births, three small hot spot (HH) were found in several central west and southwest counties. One cool spot (LL) appeared in central northern part of the state. For black births, one hot spot was detected in the northern part of the state including two counties, Murray and Gilmer. No cool spot was detected. In addition, dispersed pattern of cluster (HL or LH) were also observed mainly in counties in the south and southwest.



Figure 7. County-level LISA cluster map of unadjusted preterm birth rates: all births Red: High/High, Pink: High/Low, Light Green: Low/High, Green: Low/Low, White: Not significant (P<0.05)



Figure 8. County-level cluster map of unadjusted preterm birth rates: white births Red: High/High, Pink: High/Low, Light Green: Low/High, Green: Low/Low, White: Not significant (P<0.05)



Figure 9. County-level LISA cluster map of unadjusted preterm birth rates: black births Red: High/High, Pink: High/Low, Light Green: Low/High, Green: Low/Low, White: Not significant (P<0.05)

#### 5. Summary and Discussion

The preterm birth rates in the State of Georgia have been increasing for black births (1995-2007) and for white births (1995 to 2006). The rates were then decreased but 3-4 years of data were insufficient to be used to detect the overall trend of change. A marked racial and geographic variability of preterm birth rates were also observed in this study. Preterm rates were significantly higher in black than those of white rates. Geographically, several counties in south and southwestern Georgia stood out as clusters of high preterm rates while a few counties in northern and northeastern part of the state appeared to be the area with lower preterm rates. Moran I statistics further confirmed the above observation. Furthermore, the preterm rates seem to be was lower in urban areas than in rural regions. The elevated county-level rates in rural Georgia may partially be related to the lower overall socioeconomic status of rural Georgia, although further research needs to be done to thoroughly understand the multi-faceted risk factors behind the racial and geographic disparities behind preterm birth.

The research present here provides a critical first step in more clearly understanding the epidemiology of preterm birth and better informing the practice of public health care in the state. In particular, the spatial characteristics of preterm birth prevalence uncovered in this research can help develop heath initiatives including, but not limited to, educational prevention programs to target high-risk population groups and geographic regions.

### 6. Acknowledgements

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