A Multilevel Analysis of Low Birth Weight and Black-White Interaction

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Extended Abstract

Introduction

The most prevalent and dominate risk factor for infant mortality and developmental disorders is low birth weight, making the study of birth weight extremely important in trying to reduce poor infant health outcomes not only in the first few months of life but also later in the life course (Thompson, Goodman, Chang, & Stukel, 2005). Measures capturing the health status of surviving infants and children, such as birth weight, may be more useful in understanding the persistence of disparities in health. Much like variation in infant mortality rates across places in the United States, Thompson and colleagues (2005) has found that regional variation in the rates of low birth weight exist in the U.S. Rates of low birth weight were found to vary from 3.8 to 10.6 per 100 live births across regions in the United States. This variation lends support for more targeted interventions at the individual and aggregate level to help eliminate disparities in birth weight.

While studies indicate that variation in birth weight exists, complexities arise when trying to account for this variation. Individual-level risk factors for birth weight have been researched extensively and produced consistent relationships between individual-level characteristics and birth weight (Aber, Bennett, Conley, & Li, 1997; Almond, Clay, & Lee, 2002; Gorman, 1999; Shiono & Behrman, 1995; Shiono, Rauh, Park, Lederman, & Zuskar, 1997; Sparks, 2009). One criticism of this work may be that certain components of these relationships (socioeconomic, behavioral, biological) have been given too much attention in individual studies without fully explaining why disparities in this outcome, particularly by race/ethnicity, remain.

More recent research highlights the importance of the environment and communities in contributing to the risk of low birth weight (Aber, et al., 1997; J.W. Collins & David, 1990; Coulton & Pandey, 1991; Gould & LeRoy, 1988; Hummer, 1993; O'Campo, Xue, Wang, & Caughy, 1997)with particular attention given to the association between segregation and infant health outcomes (Baker & Hellerstedt, 2006; Bell, Zimmerman, Almgren, Mayer, & Huebner, 2006; J. W. Collins, et al., 1998;

Grady, 2006; Grady & McLafferty, 2007; Grady & Ramirez, 2008; Lukusa, Holvoet, Vermeesch, Devriendt, & Fryns, 2003; Metcalfe, Lail, Ghali, & Sauve, 2011; Osypuk, Bates, & Acevedo-Garcia, 2010; Roberts, 1997; Schempf, Strobino, & O'Campo, 2009; Shaw, Pickett, & Wilkinson, 2010; Urquia, et al., 2009; Wallace, 2011). Results from this line of research suggest that many measures of racial and economic segregation, measured in multiple ways, have an impact, both positive and negative depending on the measure used, on individual low birth weight status.

To date, the research literature on the multilevel association between residential segregation and low birth weight has been limited to specific cities or large metropolitan areas. Likewise no studies have used a measure of racial segregation that captures the interaction between black and white residents of an area. This research helps to fill these gaps, and asks: does racial interaction influence a infant's birth weight one individual level determinants for birth weight are controlled for in a multilevel framework? Since more current work assumes that racial residential segregation has a negative impact on infant health outcomes, this research argues that more interaction between individuals of different races/ethnicities in their local environment will lead to better investment in resources, which will promote better health outcomes for infants (Bell, et al., 2006; Debbink & Bader, 2011).

Data and Methods

The Early Childhood Longitudinal Study – Birth Cohort (ECLS-B) is an ideal data source to analyze individual and structural level determinants of birth weight. The rich detail provided on the infant's birth certificate and accompanying parental surveys create a strong basis for understanding individual level mechanisms as they relate to birth weight. The ECLS-B follows a nationally representative probability sample of children born between January and December 2001, with over sampling of Asian, Pacific Islander, Chinese, and American Indian children, twins, as well as very low and moderately low birth weight infants. A cross-section of the data is used in this analysis and consists of measures collected from the child's birth certificate and when they were nine months of age. The inclusion of state and county fips codes in the restricted files of the ECLS-B then allows for this dataset to be merged with other datasets at a higher level of aggregation in order to assess the impact of structural level characteristics on this outcome. For this research, the ECLS-B was merged with 2000 U.S. Census of Population and Housing, Summary File 3 (SF3) data. Taken together these data sources allow for the use of multilevel modeling techniques which allow for a better understanding of how both individual characteristics and racial segregation impact birth weight outcomes.

Measurement

Data collected in the first wave (infant nine months of age) include batteries of questions about the infants themselves including physical measurements and developmental tests appropriate for nine months of age, and their families, both mothers and fathers, resident and non-resident. Information taken directly from the birth certificates is part of the restricted data file from the ECLS-B and contains sensitive information about infants and their parents. Information included on the birth certificates include such things as detailed birth weight in grams, gestational age of the infant, plurality status, weight gain during pregnancy, infant and maternal health complications, maternal educational levels, marital status, smoking and drinking behaviors, prenatal care use, and state and county of residence. The detail included on the birth certificates about both infants and their mothers make the data an ideal source for this analysis.

Variables

Birth weight is used as the dependent variable in this analysis. On the infant's birth certificate, birth weight in grams is reported. This continuous measure of birth weight will be used to indicate how individual and structural level characteristics raise or lower birth weight.

In order to have a diverse set of **race/ethnicity** classifications in this analysis, three separate variables taken from the infant's birth certificate were used to specify if the mother was: 1) Hispanic or non-Hispanic; 2) US- or foreign-born; and 3) the mother's race. This classification scheme allowed seven categories of race/ethnicity to be created. These include non-Hispanic whites (NHW), foreign-born Mexican origin Hispanics (FBMO), US-born Mexican origin Hispanics (USMO), non-Hispanic blacks (NHB), Native Americans, Asians (of all ethnicities), and other Hispanics, which includes Puerto Ricans and Cubans. A variety of health complications are combined to make a measure of **maternal health complications** during pregnancy. These include the following risk factors included on the infant's birth certificate: anemia, cardiac disease, acute/chronic lung disease, diabetes, genital herpes, (oligo)hydramnios, hemoglobinopathy, chronic hypertension, hypertension during pregnancy, eclampsia, incompetent cervix, previous birth weighing 4,000 or more grams, previous preterm or small birth, renal disease, rh sensitization, uterine bleeding, and other medical risk factors. These measures were combined into one variable capturing the mother's health risk factors during pregnancy (U.S. Department of Education, 2005). Variables used to measures social characteristics of the mother and infant are taken from the birth certificate data and mother's survey. **Poverty status** assesses whether the household was below the federally designated poverty threshold at the time of the nine-month interview or not. **Maternal age** was grouped into three variables: less than 20, 20-34 years of age, or 35 and older. **Mother's education** was measured as less than a high school education, high school completion, and some college or more. **Health insurance** was constructed dummy variable that measures whether or not the mother had private health insurance during her pregnancy. Private health insurance includes plans from employers, the workplace, private purchase, or through as state or local government program or community based program. **Marital status** was taken from the infant's birth certificate and indicates if the mother was married or not at the time of birth.

A measure of **prenatal care** usage was constructed based on a question in the parental survey using an adequacy of prenatal care usage index. Based on the number of prenatal care visits and the timing of the start of visits mothers could have received: 1) no care, 2) inadequate care, 3) intermediate care, 4) adequate care, or 5) adequate plus care. **Weight gain** during pregnancy was reported on the infant's birth certificate in pounds. Three weight gain variables were constructed from this measure. Mothers gaining between 0 and 15 pounds were assigned a value of 1 for low weight gain, 0 otherwise; weight gain between 16 and 40 pounds was assigned a value of 1 for normal weight gain, 0 otherwise; and mothers gaining 41 or more pounds were assigned a value of 1 for high weight gain, and 0 otherwise. In the parental survey, mothers were asked if they used the supplemental **WIC** program during their pregnancy. This is a dichotomous measures coded 1 for yes and 0 for no. **Smoking**, **drinking,** and **prenatal vitamin use** behaviors during pregnancy were reported on this infant's birth certificate. Dichotomous measures for whether the mother smoked cigarettes, drank alcohol, or took prenatal vitamins during her pregnancy were used.

To measure whether white and black residents of a county had interaction with one another, data from the 2000 Census was used to construct the racial interaction index. Residential exposure refers to the possibility of interaction between black and white residents within a county. Indexes of exposure measure the extent to which residents of different races/ethnicities come into contact with one another simply by sharing a common residential area. The interaction index, a basic measure of residential exposure, measures the extent to which white residents are exposed to black residents in their residential space. It has been denoted as ${}_xP_y{}^*$ (Lieberson & Carter, 1982a, 1982b):

$$ {}_xP_y^* = \sum_{i=1}^{n} \left[\frac{x_i}{X} \frac{y_i}{t_i} \right] $$

where x_i , y_i , and t_i are the number of black residents in the block group, the number of white residents in the block group, and the total population of block group i within a county, respectively. X represents the total number of black residents in the county. The index varies between 0.0 and 1.0 and can be interpreted as the probability a black resident shares an area with a white resident. Quartiles of this measure were also created for bivariate analyses. A total of 8,500 infants nested in 167 counties were used in this analysis.

Methods

In order to get a better understanding of how the individual level variables were distributed across the range of racial segregation, chi-square tests of significance for all variables were estimated based on the quartile distribution of the interaction index for each infant's county of residence. Due to the complex sample design of the ECLS-B, adjustments were made to the calculation of the standard errors for the chi-square statistics. Second, multilevel model were estimated to assess the impact of racial interaction on individual birth weight. Due to the clustering of infants within counties, a more common method of analysis, such as ordinary least squares (OLS) regression, would not be appropriate. OLS regression assumes independence among observations and normally distributed random errors. The clustered nature of the data in this analysis violates these assumptions. Observations within clusters tend to be more similar on unobserved measures than observations chosen randomly, making the errors within these clusters correlated. Without taking into consideration the clustering of infants within counties in this analysis, standard errors will be biased downward and statistical significance will be overestimated.

With the inclusion of individual- and county-level measures, hierarchical linear modeling, using SAS 9.2 software was used to more robust standard errors and unbiased estimates of the relationship with individual birth weight because a random component is added to the intercept (u_0). Essentially, this random component estimates a separate intercept for each county, allowing the fixed effect portion of the equation to completely control for between-county differences in the average level of the outcome, birth weight in grams. All level-I (individual-level) covariates were centered about their county means, so that true within-county estimates are obtained. At level-II, the interaction index was centered about the grand-mean for ease of interpretation.

Preliminary Findings

Significant differences were noted across the interaction index quartiles for low birth weight status, maternal race/ethnicity, maternal health complications, mother's age at the time of the infant's birth, maternal education, prenatal care adequacy, and pregnancy weight gain (see Table 1). Interestingly there were no significant differences in poverty status, WIC usage, or the various maternal behavioral measures, including smoking, drinking, or taking prenatal vitamins during pregnancy, based on the level of interaction among racial/ethnic groups in blocks within counties across the US.

Results from the full multilevel model in Table 2 indicate that more interaction among racial/ethnic groups at the higher level increases individual birth weight. This result holds with the inclusion of all other individual level variables in the model. Some disparities at the individual level remain for birth weight based on maternal race/ethnicity and poverty status. However, no differences based on maternal education are found once the interaction index is included in the multilevel model.

Discussion

Research examining the role of structural level characteristics on individual infant health outcomes has grown considerably; however there is still a need to better understand how stratification and segregation impact individuals in their local environment. This research starts to examine this issue by using a different measure of racial segregation than previous research, the interaction index, and argues that more interaction between different racial/ethnic groups leads to better investment in resources and more positive experiences with diversity. Preliminary results presented here indicate that increased interaction among racial/ethnic groups leads to higher birth weights for infants.

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Table 1. Weighted Percentages of Birth Weight and Other Individual-Level Variables by Interaction Index Quartile				
	Interaction Index Quartile			
	First (Lowest Interaction)	Second	Third	Fourth (Highest Interaction)
Low Birth Weight Status ***				
Normal Weight	24.06	24.24	25.61	26.08
Low Weight	25.37	26.44	24.84	23.35
Very Low Weight	33.52	34.44	18.99	13.06
Maternal Race/Ethnicity ***				
Non-Hispanic White	15.26	22.80	26.03	35.91
Non-Hispanic Black	39.58	36.57	16.73	7.13
US-Born Mexican-Origin Hispanic	22.57	26.72	36.38	14.33
Foreign-Born Mexican-Origin Hispanic	26.53	25.47	33.90	14.09
Asian	39.16	22.31	23.84	14.69
Native American	5.62	18.93	30.85	44.60
Other Hispanics	36.44	26.22	18.42	18.92
Maternal Health Complications *				
No Health Risks	25.14	26.68	24.10	24.09
Low Health Risk	25.53	21.88	25.89	26.71
High Health Risk	22.21	25.65	29.76	22.37
Family Poverty Status				
Live Below Poverty Threshold	24.12	27.24	25.28	23.35
Live Above Poverty Threshold	25.33	24.81	24.83	25.04
Mother's Age **				
Less than 20	21.66	27.28	25.33	25.73
20-34	24.42	25.72	24.37	25.49
More than 34	29.16	23.37	27.17	20.30
Mother's Education ***				
Less than High School	24.49	27.80	26.66	21.05
High School Diploma	21.63	26.47	22.26	29.64
Some College or More	27.42	23.53	25.70	23.35
Health Insurance				
Private or Public Coverage	25.23	24.56	25.03	25.18
No Coverage	24.79	26.40	24.84	23.96
Marital Status at Birth				
Married	25.45	25.36	24.45	24.74
Not Married	24.15	25.59	25.95	24.31
Prenatal Care Adequacy ***				
No Care	28.09	26.05	32.34	13.52
Inadequate Care	26.96	21.93	26.16	24.96
Intermediate Care	25.93	22.33	23.09	28.65
Adequate Care	22.85	25.48	24.85	26.82
Adequate Plus Care	26.17	27.73	24.44	21.66
Pregnancy Weight Gain **				
Weight Gain Low	26.30	28.17	22.21	23.32
Weight Gain Normal	25.14	25.46	25.98	23.42
Weight Gain High	23.80	23.59	23.82	28.80
WIC Usage				
Yes	25.22	25.59	25.67	23.52
No	24.89	25.33	24.46	25.32
Pre-pregnancy Vitamin Usage				
Yes	24.87	25.73	24.97	24.44
No	26.50	22.65	24.68	26.17
Drank During Pregnancy				
Yes	22.00	32.42	20.60	24.99
No	25.04	25.40	24.96	24.60
Smoked During Pregnancy				
Yes	25.07	23.67	25.15	26.11
No	25.02	25.65	24.92	24.42

Weight: W1R0; *p≤ 0.05, **p≤ 0.01, ***p≤ 0.0001

Table 2. Multilevel Regression Model of Birth Weight

Early Childhood Longitudinal Study – Birth Cohort, n~8,500	
	b (Standard Error)
Interaction Index	398.65 (75.2588)***
Race/Ethnicity (ref = Non-Hispanic White)	
Foreign-Born Mexican Origin	20.1217 (39.8209)
U.S.-Born Mexican Origin	99.1103 (50.2799)*
Non-Hispanic Black	-260.25 (29.0480)***
Native American	289.93 (43.8899)***
Asian	120.00 (29.2441)***
Other Hispanics	-57.4086 (44.6418)
Female Infant	7.1829 (18.5216)
Maternal Health Complications (ref = No Health Risk)	
Low Health Risk	-240.45 (22.3448)***
High Health Risk	-492.35 (37.6292)***
Family Lives Below Poverty Threshold	-86.6639 (22.7806)***
Mother's Age (ref = 20-34 years)	
Less than 20	-74.8318 (34.7272)*
More than 34	30.5737 (25.0596)
Mother's Education (ref = Some College or More)	
Less than High School	13.5212 (28.0215)
High School Diploma	-14.8208 (22.9741)
Private or Public Health Insurance Coverage	-4.9981 (21.5776)
Married at Child's Birth	2.1727 (23.4785)
Prenatal Care Adequacy (ref = Adequate Care)	
No Care	163.81 (49.3677)***
Inadequate Care	-4.4277 (33.0946)
Intermediate Care	-16.5679 (28.7999)
Adequate Plus Care	-53.9447 (21.9303)*
Pregnancy Weight Gain (ref = Weight Gain Normal)	
Weight Gain Low	-5.2614 (32.5023)
Weight Gain High	-72.2609 (25.4115)**
WIC Usage	-0.7493 (22.4911)
Pre-Pregnancy Vitamin Usage	-45.6768 (31.7597)
Smoked During Pregnancy	-58.0602 (30.8601)
Drank During Pregnancy	109.04 (142.11)
-2 Log Likelihood	144307.1
AIC	144367.1

*$p \leq 0.05$, **$p \leq 0.01$, ***$p \leq 0.0001$