Income diversity and neighborhood variation in low birth weight rates, Chicago, 1990-2006: Results using longitudinal and cross-sectional measures

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ABSTRACT

Although increased risk for adverse birth outcomes has been associated with neighborhood socioeconomic disadvantage, most studies have used cross-sectional measures to account for neighborhood context. Consequently, dynamic neighborhood processes that may influence adverse birth outcomes are not fully understood. In this study, a longitudinal measure of socioeconomic change was used to explore variation in low birth weight (LBW) rates between 1990 and 2006 in Chicago neighborhoods. A cross-sectional measure of neighborhood socioeconomic characteristics was then used to compare the LBW rates across Chicago neighborhoods during the same time frame to determine whether the cross-sectional measure would capture the same nuances in LBW variation as the longitudinal measure. Consistent with previous studies, both measures identified higher low birth weight rates in neighborhoods entrenched in poverty during the study period. However, the longitudinal measure showed that mothers residing in low income neighborhoods with high concentrations of immigrants had LBW rates that were lower than mothers residing in high income neighborhoods. Our results suggest that while cross-sectional measures of neighborhood socioeconomic context may capture global variations in low birth weight rates, longitudinal measures may illuminate subtleties between neighborhoods that might provide an opportunity for targeted policies to reduce adverse maternal and child health outcomes.

1. INTRODUCTION

In the United States (US), low birth weight (LBW), defined as the percentage of babies weighing <2500 grams (5.5 lbs) at birth, persists as a major public health problem [1,2]. Between 1970 and 2008, LBW prevalence in the US increased from 7.93% to 8.18% [1,2]. During this time frame, racial disparities in LBW also persisted, with African-American LBW rates consistently almost twice that of Whites [1]. Several studies have demonstrated that socioeconomic characteristics of neighborhoods may mediate these observed disparities [3-9]. In addition, higher levels of neighborhood deprivation, usually measured using constructs of education, income, poverty, or unemployment, have been found to be predictive of LBW and other adverse birth outcomes [3-7, 9-11].

Notwithstanding the fact that these studies do capture variations in birth outcomes, a major limitation is the use of single decennial census estimates to measure neighborhood context. Although several studies demonstrate that longitudinal measures of neighborhood context may better explain variations in health [12,13], most studies examining neighborhood influences on LBW and other adverse birth outcomes use cross-sectional measures [5, 6,14-17]. In a study by Do [12], results suggest that longitudinal measures of neighborhood context are particularly salient for disentangling health disparities between Blacks and Whites. As such, using cross-sectional measures to investigate differences in birth outcomes between Blacks and Whites in neighborhoods in the US may underestimate or misestimate the gap in LBW rates, par-

ticularly given dynamic neighborhood processes that might change over time. Neighborhood disinvestment, for example, may impact social networks or access to health service agencies that conceivably influence maternal stress, and as a consequence, increase poor birth outcomes. Conversely, neighborhood revitalization may improve access to better quality foods, and a higher tax base for resources that could result in a more supportive environment for health-promoting behaviors for expectant mothers, thus, reducing LBW risk. In the context of public health planning and surveillance, these neighborhood processes are critical for targeting and tracking interventions, particularly in major metropolitan areas of the US that have experienced substantial changes in socioeconomic composition over the last three decades [18,19]. Thus, incorporation of a longitudinal assessment metric of neighborhood processes could provide a more complete picture in understanding LBW risk.

In this study, we use a longitudinal measure of neighborhood socioeconomic change in the city of Chicago to examine associations with trends in LBW rates. Time trends in LBW are examined as well as mean LBW over the study period 1990-2006. We compare the longitudinal measure of neighborhood characteristics to a cross-sectional measure of neighborhood characteristics based on quintiles of income categories from the US 2000 census.

2. METHODS

2.1. Low Birth Weight

Publically available de-identified vital statistics data from the Illinois Project for Local Assessment of Needs (IPLAN) website was used for this study. The IPLAN website serves as a repository for 102 health indicators used to assist health departments with community assessments and five-year planning goals [20]. The Center for Health Statistics at the Illinois Department of Public Health maintains the IPLAN website, updating vital statistics data based on birth certificate records reported by local health departments across the state. Total counts of live births and LBW infants born to Black and White women in each of Chicago's 77 community areas (*i.e.*, neighborhoods) between 1990 and 2005 were abstracted from the IPLAN database. IPLAN defines low birth weight using the conventional definition of weight at birth of less than 2500 grams [21]. The final sample size consisted of 804,289 births; 350,681 to Black mothers, and 453,428 to White mothers.

2.2. Neighborhood Socioeconomic Context

2.2.1. Definition of Neighborhoods

The administrative unit used for public health planning

in the city of Chicago is the community area, which is used as a proxy for neighborhoods in this study [22]. Designated in the 1920's by the Social Science Research Council at the University of Chicago, these 77 areas were intended to reflect the cultural and social history of Chicago [23]. On average, community areas in Chicago consist of 3 to 4 census tracts and the population count may range from approximately 3000 to 120,000. On average, each community area has 37,000 residents [22].

2.2.2. Measure of Socioeconomic Change

An income diversity index of neighborhood socioeconomic context developed by the Metro Chicago Information Center (MCIC), an official census center, was used to characterize neighborhoods. To develop the income diversity index, the MCIC used data available from the Neighborhood Change Database (NCDB), a commercially available database of social, demographic, economic and housing data on census tracts in the US for 1970, 1980, 1990, and 2000 [24]. The purpose for developing the index was to examine trends in the socioeconomic composition of neighborhoods over time in order to develop sound community development policies [25].

Neighborhoods were categorized as *stable diversity*, *emerging low income*, *emerging high income, desertification*, and *emerging bipolarity* based on patterns of economic change in Chicago community areas over 30 years [25]. Briefly, *stable diversity neighborhoods* (n = 19) consist of community areas that have maintained a socioeconomically diverse population between 1970 and 2000. *Emerging low income neighborhoods* (n = 11) have experienced a loss of high income families, while the reverse occurred with *emerging high income* neighborhoods (n = 21), where the number of low income families is decreasing. *Desertification* neighborhoods (n = 11) show patterns of entrenched levels of poverty with a predominantly African-American population. Finally, *emerging bipolarity* neighborhoods (n = 15) show an increase in both high and low income residents. Table 1 summarizes the characteristics of each type of neighborhood based on the index using US Census 2000 data. (For detailed methodology on the MCIC income diversity index, see http://www.mcic.org).

2.2.3. Quintiles of Low Income Families

The percent of families considered to be low income in 2000 was obtained from the MCIC database for each of the 77 Chicago neighborhoods. These percentages were used to divide the 77 neighborhoods into quintiles. The first quintile, which contains the lowest percentage of low income families, has 17 neighborhoods. The second has 16, the third 15, the fourth 14, and the fifth 15.

2.2.4. Neighborhood Demographics

Census 2000 data was obtained for the 77 Chicago neighborhoods from the Chicago Metropolitan Agency for Planning (http://www.cmap.illinois.gov/). Race/ethnicity, percent college educated, percent foreign born, median income, percent in poverty, median property value, percent female-headed households, and percent unemployment were calculated using neighborhood-level data and aggregated by each set of indices used—the IDI and low income quintiles.

2.3. Statistical Analyses

Race-stratified mean LBW rates were calculated using counts of LBW and total live births for each neighborhood type based on the income diversity index and for each quintile of low income families in 2000. Simple linear regression was performed for each income diversity index category and each quintile of low income. The year (1990-2006) was used as the predictor, with percent of LBW as the response. R^2 values from simple linear regression, as well as estimates and p-values of the intercept and predictors are reported. All analyses were performed using SAS 9.1 (SAS Institute Inc., Cary, NC).

3. RESULTS

Demographics from the 2000 census were compared for neighborhoods aggregated using both index methods (IDI and low-income quintiles) in **Table 1**. It is observed that the range of median incomes in thousands of dollars is lower (28.7 versus 34.4) when using the IDI than when using income quintiles. Desertification neighborhoods are 96.2% Black (quintiles range from 12.2 in 0 - 20th quintile to 80.7 in 80 - 100th quintile). Also, while the 60 - 80th quintile is 61.7% Black, emerging low income neighborhoods are 37.9% Black.

Between 1990 and 2006, mean LBW rates for Whites ranged from 6.38% (95% CI, 6.05, 6.71) in emerging low income neighborhoods to 7.82% (95% CI, 7.07, 8.57) in desertification neighborhoods (**Table 2**). Linear regression (**Table 3**) indicates significant increases in LBW rates in emerging low income, emerging bipolarity, stable diversity, and emerging high income neighborhoods during the study period. LBW ranged from 6.61% (95% CI, 6.18, 7.04) in the 0 - 20 quintile to 6.83% (95% CI, 6.47, 7.20) in the 80 - 100 quintile during the study period. Linear regression results show a significant increase in LBW for all quintiles at the 95% level of significance.

The mean LBW rates for Black mothers ranged from 13.9% (95% CI, 13.5, 14.3) in emerging low income neighborhoods to 16.3% (95% CI, 15.9, 16.7) in desertification neighborhoods (**Table 2**). Overall, LBW rates for this demographic showed a downward trend between

Table 1. Selected demographic characteristics of neighborhood socioeconomic context using the US Decennial Census 2000 estimates.

Income Diversity Index	% foreign born	% of adults with a college education	% White non-Hispanic	% Black non-Hispanic	% Hispanic	Median property value in $1000s	Median household income in $1000s	% of families below poverty rate
Desertification N = 11	1.9	13%	1.6	96.2	1.6	105.6	18.9	39.1
Emerging Low Income N = 11	28.2	16%	31.9	37.9	44.8	104.9	34.0	18.4
Emerging Bipolarity N = 15	22.5	26%	50.0	30.0	23.0	160.0	39.2	13.6
Stable Diversity N = 19	21.8	27%	33.9	45.0	20.9	147.8	40.2	13.6
Emerging High Income N = 21	19.1	39%	63.6	18.9	20.2	222.6	47.6	10.7
US Census 2000 Income Quintile	% foreign born	% of adults with a college education	% White non-Hispanic	% Black non-Hispanic	% Hispanic	Median property value $	Median household income	% of families below poverty rate
80 - 100 N = 17	8.8	13%	8.4	80.7	15.5	102.0	21.4	35.0
60 - 80 N = 16	17.0	24%	19.1	61.7	18.3	129.1	31.5	21.5
40 - 60 N = 15	27.8	23%	39.3	28.9	41.4	159.9	37.3	16.4
20 - 40 N = 14	25.8	27%	51.9	28.8	23.0	150.8	41.3	10.5
0 - 20 N = 15	16.7	43%	75.6	12.2	11.7	238.3	55.8	4.9

Table 2. Mean low birth weight rate by income diversity index and US Census 2000 quintile of income families for White, Black and combined mothers.

	White	Black	Combined
All Neighborhoods	6.78 (6.48, 7.08)	15.27 (14.93, 15.61)	10.44 (10.12, 10.76)
Income Diversity Index	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)
Desertification	7.82 (7.07, 8.57)	16.30 (15.87, 16.73)	15.75 (15.41, 16.10)
Emerging Low Income	6.38 (6.05, 6.71)	13.89 (13.51, 14.27)	8.11 (7.84, 8.39)
Emerging Bipolarity	7.15 (6.76, 7.55)	15.27 (14.93, 15.61)	10.86 (10.56, 11.16)
Stable Diversity	6.66 (6.34, 6.99)	14.55 (14.17, 14.93)	10.41 (10.04, 10.77)
Emerging High Income	6.85 (6.53, 7.18)	15.27 (14.83, 15.72)	8.99 (8.71, 9.26)
	White	Black	Combined
US Census 2000 Income Quintile	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)
80 - 100	6.83 (6.47, 7.20)	15.97 (15.56, 16.38)	13.26 (12.90, 13.61)
60 - 80	6.83 (6.50, 7.17)	14.92 (14.55, 15.29)	11.43 (11.10, 11.75)
40 - 60	6.87 (6.57, 7.17)	15.08 (14.64, 15.52)	9.24 (8.93, 9.55)
20 - 40	6.76 (6.43, 7.09)	14.60 (14.07, 15.13)	8.61 (8.25, 8.96)
0 - 20	6.61 (6.18, 7.04)	14.37 (13.89, 14.84)	7.86 (7.53, 8.20)

Table 3. Results of linear regression of low birth weight rates on years for White, Black, and combined mothers.

	White		Black		Combined	
All Neighborhoods	0.0007	<0.0001	−0.0006	0.0127	−0.0007	0.0004
Income Diversity Index	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Desertification	0.0012	0.3967	−0.0012	0.0009	−0.0005	0.0362
Emerging Low Income	0.0007	0.0029	−0.0001	0.7692	0.0003	0.0636
Emerging Bipolarity	0.0011	0.0002	−0.0002	0.5674	−0.0002	0.4448
Stable Diversity	0.0006	0.0032	−0.0002	0.5168	−0.0007	0.0203
Emerging High Income	0.0007	0.0009	−0.0004	0.3986	−0.0004	0.0302
	White		Black		Combined	
US Census 2000 Income Quintile	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
80 - 100	0.0006	0.0474	−0.0008	0.0146	−0.0007	0.0075
60 - 80	0.0006	0.0102	−0.0004	0.2330	−0.0003	0.1360
40 - 60	0.0004	0.0254	0.0001	0.8527	−0.0002	0.2588
20 - 40	0.0006	0.0035	−0.0006	0.3283	−0.0004	0.1227
0 - 20	0.0014	<0.0001	−0.0007	0.1502	0.0007	0.0014

1990 and 2006 ($P < 0.05$), with significant decreases in LBW rates for desertification neighborhoods. Black LBW rates ranged from 14.4% (95% CI, 13.9, 14.8) in the 0 - 20 quintile to 16.0 (95% CI, 15.6, 16.4). A non-significant increase in LBW rates was noted for the 40 - 60 quintile; non-significant decreases occurred in the 0 - 20, 20 - 40, and 60 - 80 quintile. Neighborhoods in the 80 - 100 quintile experienced a significant decrease in LBW rates.

Regression results for White mothers were significant for all quintiles, however, for desertification neighborhoods no significant time trend was observed. For Black

mothers only the 80 - 100 quintile with the highest percentage of low income families had significant regression results; similarly, using the IDI only desertification neighborhoods had significant time trends. Combined results also showed a difference in the two index methods—for Black and White mothers, desertification, stable diversity, and emerging high income had significant time trends; only the 0 - 20 and 80 - 100 quintiles had significant time trends. Further, the 0 - 20 quintile with the least percentage of low income families had a positive slope; emerging high income neighborhoods had a negative slope.

4. DISCUSSION

Consistent with other studies exploring adverse birth outcomes and neighborhood context using cross-sectional measures, we found that Black and White women residing in neighborhoods entrenched in poverty, with high concentrations of Blacks, were more likely to have higher LBW risk [3,4]. Additionally, consonant with national estimates, LBW rates for Blacks were consistently double those of Whites for the study period. Notwithstanding, it is interesting to note that emerging low income neighborhoods have the lowest LBW rates of all neighborhoods and seem to confer some protection against LBW risk for both Black and White mothers. This finding may be due to high concentrations of Latino immigrants in these neighborhoods (**Table 1**), where some studies have suggested that better social support may attenuate the impact of limited material resources on health [26]. Higher LBW risk for Black and White mothers residing in emerging high income neighborhoods may be due to more highly educated women residing in these neighborhoods who tend to be older at first birth [27]. As a consequence of being older at first birth, these women may also be more likely to use assisted reproductive technology that has also been shown to be associated with higher LBW risk [28].

Comparing the two classification schemes, aggregated demographics over 77 neighborhoods using the US census 2000 estimates shows an increasing gradient of percent Black, percent in poverty and proportion of female headed households and a decreasing gradient of median income from the lowest quintile of low income households to the highest. The IDI, on the other hand, shows desertification neighborhoods in stark contrast with other indices for these measures. The IDI as a longitudinal measure appears to better capture the entrenched poverty of the desertification neighborhoods, while the method of income quintiles misses this in the quintile with the highest low income families.

To our knowledge, few studies have undertaken investigations of neighborhood influences on birth outcomes using a longitudinal measure of socioeconomic context.

The income diversity index is particularly unique as it allows us to examine patterns in LBW risk in Chicago neighborhoods while accounting for the influence of neighborhood revitalization and immigration patterns, thus providing a more nuanced view of neighborhood influences on LBW. In addition, the income diversity index was specifically designed to address issues related to community development for the city of Chicago, thus it may serve as a more practical tool for public health planning to address LBW risk.

This study was not without its limitations. First, the use of vital statistics data at the neighborhood level without individual level covariates limited our ability to account for potential confounders. For example, information on mothers' length of residence would have improved our ability to better quantify the influence of neighborhoods on LBW risk. Second, while we had data on racial categories of the mothers in our study, we did not have data on ethnicity. As such, some of the women in our population may be misclassified as Black or White, when their ascribed status was Hispanic. This could account for the lower LBW rates for both Blacks and Whites in the emerging low income neighborhoods in our study. Third, while our measure of neighborhood context accounts for socioeconomic change over a thirty-year period, it is primarily based on a measure of family income, which is only one aspect of neighborhoods that may influence health.

The goal of this study was to use a longitudinal measure of neighborhood context based on population-based data for LBW in the city of Chicago. While our results corroborate previous findings [8,10] that neighborhoods with high concentrations of African-Americans and high levels of poverty have higher rates of LBW, it also provides a nuanced view of the impact of neighborhood immigrant and revitalization patterns on the birth outcomes of Black and White residents. Thus, measures that seek to capture socioeconomic characteristics of neighborhoods over time may provide better insight for targeted policies to reduce adverse health outcomes as part of city-wide public health planning efforts.

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