Does Neighborhood Risk Explain Racial Disparities in Low Birth Weight among Infants Born to Adolescent Mothers?

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Abstract:

Study Objective

To test associations and interactions between racial identification, neighborhood risk, and low birth weight disparities between infants born to African-American and white adolescent mothers.

Design

Retrospective cross-sectional study. Birth cases were geocoded and linked to census tract information from the 2010 US Census and the 2007-2011 American Community Survey. A "neighborhood risk" index was created using principal component analysis, and mothers were grouped into 3 neighborhood risk levels (low, medium, high). Multilevel models with cross-level interactions were used to identify variation in racial differences in low birth weight outcomes across neighborhood risk levels when controlling for maternal demographic characteristics and pregnancy behaviors (smoking, prenatal care use).

Setting

North Carolina, United States.

Participants

Singleton infants (n = 7923 cases) born to non-Hispanic African American and white adolescent mothers from the North Carolina State Center of Health Statistics for 2011.

Main Outcome Measures

Low birth weight.

Results

African American mothers were significantly more likely to have infants of low birth weight than white mothers in this sample (odds ratio = 1.89; 95% confidence interval, 1.53-2.34). Mothers that resided in areas of high neighborhood risk were significantly more likely to have infants of low birth weight than mothers residing in areas of low neighborhood risk (odds ratio = 1.55; 95% confidence interval, 1.25-1.93). Even when controlling for confounding factors, racial disparities in low birth weight odds did not significantly vary according to neighborhood risk level.

Conclusion

Racial disparities can remain in low birth weight odds among infants born to adolescent mothers when controlling for maternal characteristics, pregnancy behaviors, and neighborhood risk.

Keywords: Adolescent pregnancy | Low birth weight | Racial disparities | Health disparities | Socioeconomic status | Neighborhood | African-American

Article:

Introduction

Adolescent mothers experience greater levels of low birth weight (LBW), preterm birth, and neonatal mortality outcomes compared with mothers of older age groups,[1 and 2] and racial disparities in adverse birth outcomes persist in all age groups, including adolescent mothers.[3] Preterm birth as an independent adverse outcome is the most important factor associated with LBW, but studies have consistently identified other factors, such as individual characteristics and prenatal behaviors, as contributors to LBW. Studies on racial disparities in LBW have examined individual characteristics of mothers with limited consideration of neighborhood and structural factors. Previous findings demonstrated that women who reside in deprived neighborhoods have higher rates of adverse birth outcomes than women in more affluent neighborhoods[4, 5, 6, 7 and 8]; however, this research has focused on adult mothers or general samples of women of childbearing age rather than a focus exclusively on adolescent mothers. Because adolescents could have heightened vulnerability toward neighborhood stress factors,[9] more studies on neighborhood socioeconomic factors and racial disparities in LBW among infants of adolescent mothers are needed to clarify these associations.

Testing the role of neighborhood factors on birth outcomes among adolescent populations brings additional challenges. For example, neighborhood factors examined in previous studies[4, 5, 6, 7 and 8] were focused on income and educational demographic characteristics that have been deemed more problematic for assessment of social class among adolescents compared with adults.[10] Further examinations of new neighborhood variables or more sensitive ways of clarifying existing variables that have greater relevance for adolescent mothers are therefore needed. To address this need, in this study we examined neighborhood risk (defined according to multiple socioeconomic indicators from census tract data) as a potential explanation of racial disparities in LBW outcomes among infants born to African American and white adolescent mothers.

This study was designed to answer the following questions: (1) do racial disparities in LBW outcomes persist between African American and white adolescent mothers' infants after controlling for neighborhood risk? (2) Does neighborhood risk moderate the racial disparities in LBW outcomes between African American and white adolescent mothers' infants? With the recognition of intersectional and socioecological frameworks of maternal and infant health outcomes,[11 and 12] this examination stemmed from the rationale that individual and neighborhood factors can intersect to influence distribution of resources, household income, access to health resources, employment, and education, and subsequently affect birth weight outcomes and disparities between racial groups of adolescent mothers.

With the exception of 2 studies,[13 and 14] previous investigations did not examine the contribution of neighborhood risk factors in explaining racial disparities in birth weight outcomes for infants born to adolescent mothers. This study extends these previous studies by using birth record data from a large statewide sample of almost 8000 adolescent mothers to test the interdependent relationship of multiple neighborhood risk characteristics and the association with racial disparities in LBW. Moreover, this study contributes to the growing literature on neighborhood risk factors and associations with racial disparities in birth outcomes.

Materials and Methods

Data Sources

In this study we used a cross-sectional design to examine birth record data from the North Carolina State Center of Health Statistics for 2011. Neighborhood was defined as census tracts delineated according to 2010 US Census boundaries. Mothers' street addresses were geocoded to census tract identification numbers using ArcGIS 10.0 (Environmental Systems Research Institute, Redlands, CA) and the US Federal Financial Institutions Examination Council geocoder. These adolescent birth cases were subsequently linked to census tract statistics from the 2010 US Census and the 2007-2011 American Community Survey. This study was deemed exempt by the authors' institutional review board because no interactions with human subjects occurred in these secondary data analyses of existing birth record data.

Study Sample

This study focused on 8302 adolescent mothers who matched the following criteria: African American or white racial identification, non-Hispanic ethnic status, born in the United States, age younger than 20 years, North Carolina residency, and delivery of single live births at gestational ages of 20 weeks or more. The study's gestational age cutoff at 20 weeks stemmed from the national use of the 20-week cutoff to compare fetal deaths between states and previous research recommendations for consistency in studies on birth outcomes across geographic locations.[15, 16 and 17] Cases that could not be geocoded at the street address level were excluded from analyses, resulting in a final study sample of 7923 adolescent mothers (95.4% of all eligible cases) who resided in 1803 census tracts across the state.

Study Variables and Measures

LBW (defined as infant birth weight <2500 grams) was used as the dependent variable because of the extensive literature of LBW as an adverse birth outcome. Maternal racial identification was dichotomized (African American or white) and other racial categories were excluded from these analyses. Specifically, adolescent mothers of Hispanic and foreign-born status were excluded to avoid potential confounding of ethnicity in the comparison of racial groups, and mothers of other racial groups (ie, Asian, Native American) were excluded because of the small proportion of adolescent mothers in these groups.

A neighborhood risk index was created from selected census tract variables because multiple socioeconomic factors interact at the community level to affect health outcomes. The potential variables to include in the index were chosen based on previous research[13, 18, 19, 20, 21, 22, 23 and 24] to assess how interactions of multiple characteristics could explain the effect of socioeconomic status rather than to solely rely on income and educational factors. Principal component analysis[25] was used to develop this index. This approach, similar to the creation of neighborhood context indices in previous research,[13, 18, 19 and 26] helps to summarize the pattern of relationships explained by the intersection of census-level socioeconomic factors. The neighborhood risk index was based on one principal component which accounted for 60.1% of the total variance. The final index included the following census tract variables: median household income, poverty proportion, unemployment rate, percentage of people 25 years old and older with a high school diploma or more advanced education, percentage of households headed by single women with children younger than age 18, percentage of households that receive public assistance, the Gini inequality index (a standardized measurement of inequality within census tracts), and percentage of households residing in rental housing. Analyses for the neighborhood risk index indicate that the census tract neighborhood risk for these adolescent mothers' residences ranged between −3.12 (low risk) and 4.54 (high risk).

Next, this index was used to divide adolescents into 3 levels of neighborhood risk following guidelines on research for adolescent samples and assessments on birth outcome disparities among adult mothers involving examination of socioeconomic factors.[27 and 28] The “low neighborhood risk” level included adolescents who resided in the neighborhoods in the lowest quartile of neighborhood risk; adolescents in this level represented the referent group with the assumption that these adolescents would have more access to resources for optimal birth outcomes. The “medium neighborhood risk” level included adolescents in the middle 50% quartiles, and the “high neighborhood risk” level included adolescents in the highest quartile of neighborhood risk.

Most examinations of adverse birth outcomes and associated disparities controlled for mothers' demographic and medical risk characteristics[15 and 29]; therefore, these characteristics were included in these analyses as potential confounders. Data on all demographic and medical risk characteristics came from the birth records data set. Demographic variables included age (younger than 17 years or 17-19 years of age), marital status (single or married), and education (high school graduate or no high school graduate). Separate dichotomous indicators for each of the following medical risk factors were included as confounders[15, 29, 30, 31, 32 and 33]: prepregnancy hypertension, gestational hypertension (pregnancy-induced hypertension and preeclampsia), prepregnancy diabetes, gestational diabetes, eclampsia, previous preterm births, and previous

poor obstetric outcomes (small for gestational age or intrauterine growth-restricted birth, perinatal death). Because of the increased probability of shortened interconception periods among adolescent mothers who have previous children,[34] previous pregnancy status (no previous pregnancies or 1 or more previous pregnancies) was also included as a risk factor.

Behaviors such as inadequate prenatal care utilization, poor nutrition, smoking, and other substance use have also been associated with increased risk in adverse birth outcomes.[15 and 29] Therefore, our analyses controlled for prenatal care utilization and tobacco use history; data were unavailable for other prenatal behaviors. Prenatal care utilization was measured with the Adequacy of Prenatal Care Utilization Index.[35] Dummy variables for inadequate, intermediate, and adequate with prenatal care categories were included (adequate prenatal care was used as the reference category). Because of the greater risk associated with smoking during pregnancy compared with smoking before pregnancy, tobacco use was assessed using 2 separate dichotomous variables: (1) smoked at any point 3 months before pregnancy (yes or no); and (2) smoked at any point during pregnancy (yes or no).

Because of the strong association between preterm birth (births that occurred before 37 weeks' gestation) and LBW,15 preterm birth was included as a confounding birth outcome. LBW included preterm and full-term births because the proportion of full-term LBW cases was too small to run separate analyses for each group. Because of these circumstances, preterm birth was assessed as a confounder in lieu of analyses with full-term LBW births. Periviable birth (births occurring at 25 weeks' gestation or earlier) was also included as a confounding birth outcome because of its association with extreme LBW and other comorbid conditions.[36 and 37]

Statistical Analyses

Racial differences in maternal characteristics, census tract variables, and LBW outcomes were tested with $\chi 2$ and independent sample t tests using SPSS version 21 (IBM, Armonk, NY).[38] Preliminary regression models were also run using SPSS 38 and 39 to test for multicollinearity between maternal characteristics. All tolerance values were greater than 0.3, which indicates that multicollinearity among the predictor variables was not a problem in any of the models. To answer questions about cross-level associations between neighborhood factors and individual outcomes, multilevel modeling[40] was used. This approach also accounted for the nesting of adolescent mothers (level 1) within census tracts (level 2). Neighborhood risk was tested as a level 2 moderator variable 40 and 41 in these models to determine whether racial disparities in birth outcomes varied across different levels of neighborhood risk. HLM 7.01 (Scientific Software International, Inc, Skokie, IL)[42] was used for all multilevel analyses. Two-sided P less than .05 determined significance for all analyses.

A series of binomial hierarchical generalized linear models was completed for determination of whether neighborhood risk was significantly associated with odds of LBW in context of racial identification and confounding variables. A description of each model follows:

> Model 1: Only included racial identification, to identify racial differences in LBW.
> Model 2: Added neighborhood risk to test if racial differences persisted when controlling for neighborhood risk.

Model 3: Added the racial identification by neighborhood risk interactions to test whether neighborhood risk moderated the relationship between racial identification and LBW.
Model 4: Tested whether the significant associations or moderating effects of neighborhood risk changed after controlling for demographic and medical risk factors.
Model 5: Added the prenatal care and smoking variables to test whether significant associations or moderating effects of neighborhood risk changed after controlling for these health behaviors. These variables were added to address current advocacy for prenatal care and smoking abstinence as protective behaviors in reducing risk of adverse birth outcomes.
Model 6: Controlled for preterm birth and periviable birth as confounding birth outcomes to test whether differences related to racial identification and neighborhood risk changed after controlling for these strong predictors of LBW births.

Results

Table 1 provides descriptive statistics for the maternal characteristics of this sample and birth outcomes. Results from bivariate $\chi 2$ analyses indicated that LBW outcomes, maternal characteristics, behavioral characteristics, and preterm and periviable birth outcomes significantly differed between the 2 racial groups ($P < .01$), and medical risk factors (other than 1 or more previous pregnancies) did not. African American mothers had a higher proportion of LBW infants than white mothers, and a higher proportion of African American mothers were younger than 17 years of age, single, had 1 or more previous pregnancies, and had inadequate prenatal care use. However, significantly fewer African American mothers smoked before and during pregnancy.

	Total (n = 7923)	African-American (n = 3782)	White (n = 4141)	χ^2
LBW proportion	772 (9.7)	483 (12.8)	289 (7.0)	50.88*
Maternal age younger than 17 years	930 (11.7)	546 (14.4)	384 (9.3)	50.87*
Less than high school graduate education	3962 (50.0)	2031 (53.7)	1931 (46.6)	39.40*
Single status	6989 (88.2)	3703 (97.9)	3286 (79.4)	679.70*
Medical risk factors				
Prepregnancy hypertension	77 (1.0)	44 (1.2)	33 (0.8)	2.78
Gestational hypertension	449 (5.7)	219 (5.8)	230 (5.6)	0.21
Prepregnancy diabetes	20 (0.3)	6 (0.2)	14 (0.3)	2.53
Gestational diabetes	170 (2.1)	71 (1.9)	99 (2.4)	2.48
Eclampsia	31 (0.4)	17 (0.4)	14 (0.3)	0.63
Previous PTB	57 (0.7)	31 (0.8)	26 (0.6)	1.02
Previous poor obstetric outcomes	32 (0.4)	18 (0.5)	14 (0.3)	0.94
1 or more previous pregnancies	1819 (23.0)	976 (25.8)	873 (20.4)	34.35*
APNCU index†				
Inadequate	1886 (24.4)	1156 (31.4)	730 (18.0)	186.45*
Intermediate	577 (7.5)	288 (7.8)	289 (7.1)	1.29
Adequate	2388 (30.9)	1020 (27.7)	1368 (33.8)	33.61*
Adequate plus	2880 (37.3)	1219 (33.1)	1661 (41.0)	51.94*
Smoking				
3 Months before pregnancy	1510 (19.1)	323 (8.5)	1187 (28.7)	518.95*
During pregnancy	1147 (14.5)	229 (6.1)	918 (22.2)	414.54*
PTB	740 (9.3)	392 (10.4)	348 (8.4)	9.03‡
Periviable births	52 (0.7)	35 (0.9)	17 (0.4)	8.04‡

Table 1. Demographic Characteristics of the Study Sample

APNCU, Adequacy of Prenatal Care Utilization Index; LBW, low birth weight; PTB, preterm birth.

Data are presented as n (%). *P* values without a footnote were nonsignificant (*P* > .05).

∗ *P* < .001.

† Missing data comprise less than 5% for the variable.

‡ *P* < .01.

Table 2, which provides the census tract characteristics for these mothers' residencies stratified according to racial identification, highlights the presence of significant racial disparities across all measures of census tract characteristics and the composite neighborhood risk index (P < .001). A significantly greater proportion of African American mothers resided in areas of high neighborhood risk than white mothers (40.9% vs. 10.1%), whereas fewer African-American

mothers resided in areas of low and medium neighborhood risk than White mothers (15.0% vs 34.1% for low risk; 44.1% vs 55.7% for medium risk).

	African-American (n = 3782)	White (n = 4141)	Test statistic*†
Median household income	$36,781	$43,738	−22.56
Poverty proportion, %	25.3	16.9	−32.43
Unemployment rate, %	13.8	10.6	−25.10
Percentage of people 25 years old and older who graduated high school	78.2	81.4	−15.61
Gini inequality index	0.43	0.41	−10.85
Percentage of households receiving public assistance	20.5	12.4	−34.93
Percentage of households headed by single women with children age 17 and younger	12.6	7.7	−37.45
Percentage of households residing in rental housing	44.0	30.3	−33.05
Neighborhood risk index	0.39	−0.36	−35.50
Neighborhood risk levels			
Percentage of adolescents in low-risk neighborhoods	15.0	34.1	384.71
Percentage of adolescents in medium-risk neighborhoods	44.1	55.7	107.95
Percentage of adolescents in high-risk neighborhoods	40.9	10.1	1003.64

Table 2. Comparison of Census Tract Characteristics According to Racial Identification
∗ Statistics reflect *t* values for tests comparing means and χ^2 values for comparing neighborhood level proportions.
† All differences significant at $P < .001$.

Table 3 provides the χ2 tests of LBW proportions stratified according to racial identification and neighborhood risk. Significant racial disparities in LBW outcomes were identified across all neighborhood risk levels, but larger racial disparities in LBW outcomes were present among mothers who resided in low- and medium-risk neighborhoods. Separate χ2 analyses (results not shown) indicated that although African American mothers in high-risk neighborhoods had the greatest proportion of LBW outcomes in the overall sample, this proportion was not significantly greater than for African American mothers who lived in low- and medium-risk neighborhoods (P > .05).

	African-American (n = 3782)	White (n = 4141)	χ^2
Low-risk neighborhood	11.6%	6.9%	12.10*
Medium-risk neighborhood	12.9%	6.6%	44.77*
High-risk neighborhood	13.1%	9.3%	4.51†

Table 3. χ^2 Tests for Racial Differences in LBW Rates Stratified According to Neighborhood Risk

LBW, low birth weight.
∗ $P < .001$.
† $P < .05$.

The multilevel results summarized in Table 4 were consistent with the bivariate results. A null model (results not shown) confirmed that significant variance in LBW odds were present across census tracts (P < .001). In model 1, African American mothers had significantly greater odds of LBW than white mothers (odds ratio = 1.89; 95% confidence interval, 1.53-2.34). In model 2, mothers who lived in high-risk neighborhoods had greater odds of LBW than mothers in low-risk neighborhoods (odds ratio = 1.55; 95% confidence interval, 1.25-1.93). However, racial disparities in LBW odds remained significant. In model 3, the racial identification by neighborhood risk interactions were not significant, indicating that racial disparities in LBW odds do not vary according to the level of neighborhood risk (P > .05). According to the results in Table 5, the main effects of racial identification and high neighborhood risk remained significantly associated with odds of LBW after controlling for demographic characteristics and medical risk factors (model 4), maternal behaviors (model 5), and preterm and periviable birth (model 6). The racial identification by neighborhood risk interactions remained nonsignificant in models 4-6.

Independent Variable	Model 1	Model 2	Model 3
AA*	1.89 (1.53-2.34)†	1.98 (1.57-2.50)†	2.09 (1.62-2.67)†
Medium-risk neighborhood‡	–	1.13 (0.93-1.38)	1.14 (0.93-1.40)
High-risk neighborhood	–	1.55 (1.25-1.93)†	1.59 (1.27-1.99)†
AA by medium-risk neighborhood	–	–	0.85 (0.47-1.56)
AA by high-risk neighborhood	–	–	0.65 (0.33-1.29)

Table 4. Binomial Hierarchical Generalized Linear Model Analyses for LBW Odds, Models 1, 2, and 3

AA, African American; LBW, low birth weight.
Data are presented as odds ratio (95% confidence interval); fixed effects only.
∗ White is the referent category.
† $P < .001$.
‡ Low-risk neighborhood is the referent category.

Independent Variable	Model 4	Model 5	Model 6
AA*	1.88 (1.51-2.34)†	2.06 (1.64-2.58)†	1.99 (1.57-2.52)†
Medium-risk neighborhood‡	1.14 (0.96-1.37)	1.13 (0.95-1.36)	1.12 (0.93-1.35)
High-risk neighborhood	1.59 (1.30-1.94)†	1.59 (1.30-1.95)†	1.58 (1.28-1.96)†
AA by medium-risk neighborhood	0.84 (0.50-1.40)	1.01 (0.60-1.72)	1.07 (0.62-1.84)
AA by high-risk neighborhood	0.65 (0.35-1.20)	0.75 (0.40-1.42)	0.87 (0.46-1.64)
Demographic covariates			
Maternal age younger than 17 years	1.05 (0.82-1.35)	1.10 (0.85-1.42)	0.92 (0.70-1.22)
Less than high school graduate education	1.16 (0.99-1.37)	1.15 (0.97-1.36)	1.20 (1.01-1.43)§
Single status	0.85 (0.67-1.11)	0.91 (0.70-1.19)	1.00 (0.75-1.32)
Medical Risks			
Prepregnancy hypertension	2.37 (1.19-4.71)§	2.43 (1.23-4.80)§	2.58 (1.29-5.13)‖
Gestational hypertension	3.38 (2.52-4.53)†	3.06 (2.27-4.13)†	3.36 (2.43-4.66)†
Prepregnancy diabetes	0.87 (0.20-3.81)	0.78 (0.21-2.93)	0.37 (0.15-0.90)§
Gestational diabetes	1.01 (0.62-1.67)	0.88 (0.52-1.50)	0.90 (0.49-1.64)
Eclampsia	8.92 (3.99-19.92)†	10.21 (4.35-23.95)†	2.28 (0.75-6.96)
Previous PTB	4.77 (2.42-9.38)†	4.32 (2.10-8.90)†	0.76 (0.38-1.52)
Previous poor obstetric outcomes	3.22 (1.35-7.68)‖	2.76 (1.14-6.68)‖	1.69 (0.47-6.06)
Previous pregnancy status	0.99 (0.81-1.22)	0.94 (0.77-1.15)	0.83 (0.68-1.02)
Tobacco Use			
Smoking before pregnancy	–	0.72 (0.49-1.06)	0.77 (0.53-1.12)
Smoking during pregnancy	–	2.02 (1.35-3.04)†	1.97 (1.32-2.95)†
APNCU variables¶			
Inadequate	–	1.49 (1.20-1.85)†	1.10 (0.88-1.38)
Intermediate	–	1.02 (0.74-1.41)	0.87 (0.63-1.21)
Adequate-plus	–	2.62 (2.18-3.16)†	1.33 (1.10-1.62)‖
PTB	–	–	34.73 (27.01-44.67)†
Periviable birth	–	–	33.53 (16.98-66.23)†

Table 5. Binomial Hierarchical Generalized Linear Model Analyses for LBW Odds, Models 4, 5, and 6

AA, African American; APNCU, Adequacy of Prenatal Care Utilization Index; LBW, low birth weight; PTB, preterm birth.

Data are presented as odds ratio (95% confidence interval); fixed effects only.

∗ White is the referent category.

† $P < .001$.

‡ Low-risk neighborhood is the referent category.
§ $P < .05$.
‖ $P < .01$.
¶ Adequate is the referent category.

Taking all analyses into account, racial differences in odds of LBW persisted regardless of neighborhood risk as shown by the greater odds of LBW among African American mothers in all models. Neighborhood risk was also significantly associated with differences in LBW odds after controlling for maternal characteristics and behaviors. Notably, the racial disparities in LBW outcomes did not significantly vary according to levels of neighborhood risk. Therefore, racial disparities remained in odds of LBW when controlling for individual characteristics, pregnancy behaviors, neighborhood risk, preterm birth and periviable birth.

Discussion

Overall, these results indicate that racial disparities in LBW outcomes persist across all levels of neighborhood risk for adolescent mothers. Therefore, African American adolescent mothers, like their adult counterparts, experience unique health burdens on the basis of racial identification that contribute to health disparities across all types of neighborhoods. Our descriptive results (Table 3) suggest that the intersection of racial identification and neighborhood risk might affect LBW outcomes. Although African American and white mothers in the high neighborhood risk areas had the greatest proportions of LBW outcomes in their respective racial groups, the racial disparities were greater in the medium and low neighborhood risk communities. These results are consistent with previous findings in which greater disparities in LBW and preterm birth were found between African American and white adult mothers of higher socioeconomic status than between mothers of lower socioeconomic status.[28 and 43] However, in our multilevel analyses (Table 4 and Table 5) we did not find statistically significant differences in disparities across levels of neighborhood risk, as indicated by the nonsignificant racial identification by neighborhood risk interactions.

The current study builds on past studies that tested neighborhood characteristics and their associations with birth weight outcomes among infants born to adolescent mothers in the United States.[13 and 14] In 1 study[14] it was found that adolescents who resided in lower income neighborhoods had significantly greater odds of LBW after controlling for maternal race, but African American adolescents still experienced greater odds of LBW when controlling for income. However, the study focused on LBW among mothers with repeat pregnancies in 1 Midwestern city and only included median household income as a neighborhood predictor with mothers' educational and marital status as socioeconomic predictors at the individual level. In the other study[13] it was found that neighborhood risk was not significantly associated with odds in LBW for African American and white adolescents when controlling for individual factors. Although the research team used a robust neighborhood variable that incorporated multiple census characteristics to examine contextual effects on LBW among a national sample of adolescent mothers, they did not directly test if neighborhood risk moderated racial disparities. Therefore, this study contributes to this scarce research in testing moderating effects using a multifaceted neighborhood socioeconomic index, and future studies can build on these findings

by further testing the effect of neighborhood circumstances on racial disparities in birth outcomes among adolescent mothers.

These results also illustrate how the etiology of LBW can differ from preterm birth even though their influential factors often overlap. Findings from a recent North Carolina study[44] indicated that racial disparities in preterm birth existed in high income (ie, potentially low neighborhood risk) neighborhoods but not in low income neighborhoods (ie, potentially high neighborhood risk). In the previous study, African American adolescent mothers residing in high income neighborhoods were twice as likely to have preterm births as white mothers in similar neighborhoods, but there were no significant racial differences in preterm birth odds in low income neighborhoods. Notably, African American adolescent mothers in high income neighborhoods had the highest rates of preterm birth among all racial and income groups whereas white adolescent mothers in similar neighborhoods had the lowest rates of preterm birth. In contrast, this current study found racial disparities in LBW did not depend on neighborhood risk; African American adolescent mothers had the highest rates of LBW regardless of their neighborhood risk level even after controlling for preterm and periviable births. One potential explanation for differences across outcomes is that African American adolescents who reside in neighborhoods of high socioeconomic status might be at increased risk of preterm birth because of unique neighborhood stressors, such as less social support resulting from fewer proportions of African American residents in higher income neighborhoods.[45] However, these same neighborhoods do provide the advantage of better resources that could improve factors such as nutritional status and subsequently decrease the risk of LBW for African American adolescents compared with what would be expected from their increased risk of preterm birth. Future research is needed to test these assertions.

The current results also indicated that neighborhood risk was associated with LBW outcomes even when controlling for racial identification. These results contrast study findings from a national sample of adolescent mothers[13] that showed neighborhood disadvantage was no longer significantly associated with infant birth weight in context of racial identification. Although using national data sets can yield valuable information in health trends, national data trends can overshadow socioeconomic differences in relationships with birth outcomes within local and state populations. The 2010 US Census46 reported that North Carolina's proportion of African American residents (21.5%) exceeded the national average (12.6%). Taking into account these differences in racial composition, results from this study indicate that the associations between birth outcomes, racial disparities in these outcomes, and neighborhood factors could vary according to geographic region. Future exploration therefore requires further testing of relationships between neighborhood characteristics and birth outcomes across different geographic regions.

Regarding the multilevel results for medical risk factors and maternal behaviors, these results also indicated that prepregnancy hypertension, gestational hypertension, and smoking during pregnancy were significant risk factors for greater LBW odds among adolescent mothers when controlling for racial identification, neighborhood risk, and all other factors. Although the rates of these risk factors were low in this sample, addressing hypertension and smoking abstinence might reduce differences in LBW odds between African American and white adolescents across all levels of neighborhood risk. These risks could be addressed through preconception health

initiatives, prenatal care, and other pregnancy support interventions for adolescent mothers. For pinpointing potential areas of intervention, future analyses could further examine associations of these risk factors in context of racial identification and neighborhood risk with other samples of adolescent mothers.

This study had several limitations which suggest future opportunities for research on birth outcome disparities among adolescent mothers. One limitation stemmed from the lack of data on social support variables; marital status was the only variable available for operationalizing social support. Although previous research consistently documented adolescent mothers' positive relationships with their mothers as beneficial for birth outcomes,[47 and 48] current research also identified associations between the presence of paternal support and favorable birth outcomes among adolescent parents.[49 and 50] Moreover, data were not available for stress-related factors such as violence and abuse which could also affect adolescent mothers during pregnancy. Another limitation came from the inability to account for other individual factors (body mass index and obesity) and behavioral variables as confounders (eg, alcohol and other substance use) because of the lack of data on these variables. Third, the low number of adolescent mothers younger than 15 years old (less than 1% of the sample) hindered the further separation of age groups for analyses. Adolescents younger than 15 years have a greater risk for adverse birth outcomes than older adolescents,[51 and 52] but the interaction between maternal race and younger maternal age on birth outcomes needs to be further explored. Finally, no information was available on the length of time that adolescents lived at the residence reported in birth records. Because of the transient circumstances of adolescent mothers, variations in these mothers' length of residency could explain differences in the influence of neighborhood factors on these adolescents' maternal health and subsequent differences in LBW rates. In addition, reliance on census data at the census tract level instead of the smaller census block level might have caused inaccuracies in assessment of the neighborhood context of these adolescent mothers. Because of these limitations and previous research findings, future studies are still needed to examine how racial differences in these factors might further explain the racial differences in birth weight outcomes.

Conclusion

Despite the limitations, this study builds on previous research[53 and 54] on birth outcome disparities in illustrating that racial disparities between African American and white adolescent mothers can remain in LBW outcomes after controlling for demographic, medical risk, prenatal behaviors, and neighborhood factors. The results indicate that African American adolescent mothers are at greater risk of LBW outcomes regardless of the extent of neighborhood socioeconomic status, and future intervention efforts are needed to reduce this increased risk. This study is among the first to examine associations of neighborhood factors on LBW disparities across a statewide population of infants born to adolescent mothers. Because all states are required to collect birth records data, this study also shows the utility that can come from using state birth records data to examine racial disparities in birth outcomes to identify potential subgroups for intervention planning at the state and local levels. As another benefit, this study builds on existing literature that found significant associations between characteristics of neighborhood context and health outcomes[23, 55 and 56] by expanding the findings from adult mothers to adolescent mothers. Overall, these results support the need for more research regarding disparities in adverse birth outcomes

to identify risk factors that can be modified through intervention and to subsequently reduce these outcomes and risk of infant mortality among infants born to adolescent mothers.[48] Future studies can incorporate analyses of neighborhood factors with other samples of adolescent mothers, and these future analyses could provide more information to explain differences in birth outcomes and associated disparities.

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