Racial Residential Segregation and Low Birth Weight in Michigan's Metropolitan Areas

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Objectives. We examined the influence of racial residential segregation, independent of neighborhood economic factors, on the overall and specific etiological risks of low birth weight.

Methods. We geocoded all singleton births in Michigan metropolitan areas during 2000 to census tracts. We used hierarchical generalized linear models to investigate the association between low birth weight (<2500 g) and neighborhood-level economic and racial segregation, controlling for individual and neighborhood characteristics. We analyzed competing risks of the 2 etiologies of low birth weight: intrauterine growth restriction and preterm birth.

Results. Living in a Black segregated area was associated with increased odds (odds ratio [OR]=1.15; 95% confidence interval [CI]=1.03, 1.29; $P<.05$) of low birth weight after adjusting for individual- and tract-level measures. The analysis suggested that the association between low birth weight and racial segregation was attributable primarily to increased risk of intrauterine growth restriction (OR=1.19; 95% CI=1.03, 1.37; $P<.05$).

Conclusions. Odds of low birth weight are higher in racially segregated Black neighborhoods in Michigan's metropolitan areas, independent of economic factors. The association appears to operate through intrauterine growth restriction rather than preterm birth. (*Am J Public Health.* 2011;101:1714–1720. doi: 10.2105/AJPH.2011.300152)

As the leading cause of death among non-Hispanic Black infants and second-leading cause of death among non-Hispanic White infants, complications related to short gestation and low birth weight represent a significant clinical and public health issue.[1–3] Low birth weight also leads to long-term health consequences through increased rates of childhood and adult chronic diseases.[3–6] Racial disparities in rates of low birth weight have persisted even as total infant mortality has declined and prenatal care utilization among women of color has increased.[1–3] Because differences in individual-level risk factors cannot completely explain the differences in outcomes for White and Black mothers,[3,7] researchers have begun investigating contextual influences on racial disparities in birth outcomes.[3,8]

Racial segregation is a contextual factor that might contribute to racial disparities in low birth weight by isolating Blacks from the resources and opportunities found more frequently in White communities.[9–13] Residents in Black segregated neighborhoods accumulate less home equity,[14,15] have decreased access to quality primary education,[16] and are exposed to greater residential and economic instability than are residents of nonsegregated communities.[9] The accumulation of disadvantages in racially isolated neighborhoods could lead to negative birth outcomes for women by limiting opportunities associated with improved health (e.g., educational opportunities or access to quality medical care) and by exposing them to increased stress from neighborhood-level factors.

Evidence from a small number of studies suggests that low birth weight is associated with racial residential segregation.[17–24] With few exceptions,[17,25,26] studies link metropolitan-level segregation or the percentage of Black residents in a community to low birth weight. However, because isolation is inherently spatial, to understand how the racial isolation of an individual mother's neighborhood affects her pregnancy outcomes, isolation is most appropriately measured by considering her neighborhood along with its immediate surroundings (e.g., bordering neighborhoods) rather than by the metropolitan area or a single neighborhood.[17]

Some authors have argued that racial segregation simply serves as a proxy for economic segregation.[27,28] By contrast, we posit that racial segregation is a distinct form of neighborhood-level disadvantage that presents an increased risk for low birth weight beyond that caused by economic segregation. Sociologists have shown that, even in the presence of economic segregation, the circumstances of racially segregated Black neighborhoods differ from those of White neighborhoods at similar socioeconomic levels.[29–32] This means that although residents of Black middle-class neighborhoods may live in residential areas that are separate from poor Black neighborhoods, they have greater exposure than do middle-class Whites to negative contextual factors and have fewer resources in their vicinity. This also suggests that any attempt to distinguish between the effects of racial and economic segregation on low birth weight requires that economic segregation also be measured spatially, taking a mother's neighborhood and its immediate surroundings into account.

It is also important to consider that the drivers of low birth weight—preterm birth and intrauterine growth restriction—have distinct physiological mechanisms.[33–35] Assessing the degree to which racial isolation is associated with each can provide important insight into the etiological mechanisms relating racial segregation to low birth weight. Spontaneous preterm birth is commonly precipitated by an infection,[36–40] which could be associated with racial segregation if, for instance, racial segregation reduces access to quality care.[25] Intrauterine growth restriction, on the other hand, typically stems from a chronic deficiency in oxygen and nutrient delivery to the fetus.[41–46] Chronic stress associated with the circumstances of racially isolated neighborhoods might affect placental vasculature function, creating an oxygen–nutrient insufficiency that leads to intrauterine growth restriction.[47] We know of no research that has considered the competing risks of growth restriction and preterm birth in the relationship of neighborhood environments with low birth weight.

We examined births to mothers living in Michigan metropolitan areas to ascertain whether neighborhood racial segregation was associated with low birth weight independent of economic factors. We explicitly captured the spatial nature of both racial and economic segregation through a localized segregation index. We also analyzed the degree to which racial segregation was associated with different etiologies of low birth weight.

METHODS

We obtained birth certificate data from the Michigan Department of Community Health for the 136 287 singleton births in the state in 2000. Available birth data were mother's age, race, and census tract, and infant's race, gestational age, and weight in grams. Other maternal characteristics (e.g., education and prenatal smoking) were not provided. We selected Michigan because it has multiple metropolitan areas with high levels of Black–White segregation and relatively low impact of other racial or ethnic groups on segregation indices.

We restricted our analysis to 109 238 births to Black and White mothers who had census tract identifiers and resided in 1 of 2230 census tracts in Michigan's 9 metropolitan statistical areas at the time of delivery (96% of births in our data were to Black or White mothers). These restrictions concentrated the analysis on the births for which racial segregation was likely to be a significant issue. We excluded records missing census tract identifiers (n=2563); we detected no systematic differences in birth outcomes between these births and those with tract identifiers.

Measures

We defined low birth weight as less than 2500 grams, regardless of gestational age. To examine the influence of residential segregation on different etiologies, we also subdivided all infants with low birth weight (i.e., <2500 g) into 2 mutually exclusive subcategories—intrauterine growth restriction and preterm birth—according to standard clinical definitions.[33] Standard definitions allow for infants heavier than 2500 grams to be considered preterm or growth restricted; however, we focused solely on birth weights of less than 2500 grams because low birth weight contributes heavily to infant mortality and has known implications for longer-term morbidity.[1,4,48] We classified infants with birth weight of less than 2500 grams as growth restricted if their weight was lower than the 10th percentile for the infant's gestational age (regardless of the number of weeks of gestation), a clinical cutoff derived from fetal growth curves.[49] We defined infants with birth weights less than 2500 grams as preterm if the infant's gestational age was less than 37 weeks and their weight was appropriate for the length of gestation (i.e., weight ≥10th percentile for gestational age). We categorized infants born preterm but weighing less than the 10th percentile for age as growth restricted because the physiological mechanisms leading to growth restriction were the most likely cause of their low weight (Figure 1).[50,51]

We used mother's race, as reported on the birth certificate, as a binary variable. Maternal age was a continuous variable, mean centered in all analyses.

We obtained tract-level variables for each census tract in Michigan's 9 metropolitan statistical areas from Summary File 3 of the 2000 census. We used total (Black–White) population and Black population per tract to calculate racial segregation scores for each tract as described; similarly, we used the population in poverty to calculate economic segregation scores for each tract.

In addition to race and poverty data, we obtained the percentage of vacant nonseasonal housing units per tract as a measure of structural disadvantage. In models, we log transformed this measure to ease interpretability. Finally, we obtained the percentage of women with less than 1 year of college education in each tract as an indicator of social affluence.

Segregation Index

The local isolation index we used to measure local racial and economic segregation was developed by Krivo et al.[52] The Krivo index provides a neighborhood-specific measure of the probability of interaction between individuals in 2 groups compared with what would be

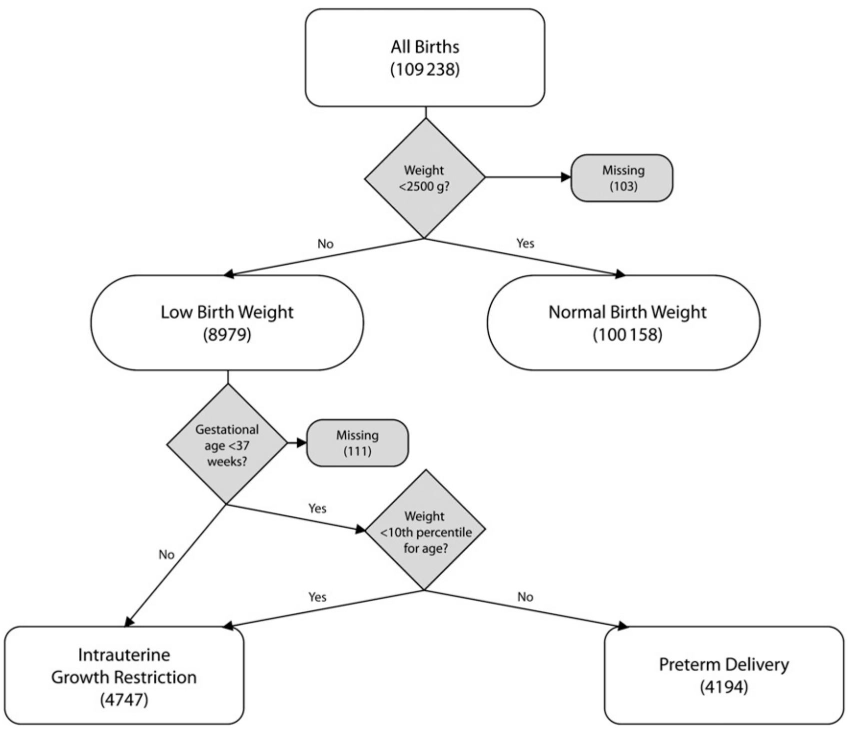

FIGURE 1—Birth record classification derived from weight and gestational age: Michigan Metropolitan Areas, 2000.

expected in the metropolitan area as a whole if residents were not spatially clustered within tracts.[52–55] Such local measures provide a better approximation of isolation than do neighborhood racial or economic composition because they position each areal unit within the context of neighboring areal units.[56]

We calculated the local isolation measure as

$$(1)\quad LS_{i*xy}\quad 1 - \frac{\left(\Sigma_j c_{ij} y_j\right)/\left(\Sigma_j c_{ij}\left(x_j + y_j\right)\right)}{\left(\Sigma_j y_j\right)/\left(\Sigma_j\left(x_j + y_j\right)\right)},$$

where x and y represent the number of people in group X and Y, respectively (i.e., Blacks and Whites or poor and nonpoor), that lived in census tracts i and j; c_{ij} is the value of cell ij in a spatial weights matrix, which equals 1 if tracts i and j share a border or if $i=j$ (i.e., the index includes the focal neighborhood) and zero otherwise. Positive values of this index are bounded between 0 and 1 and represent a proportionate decrease in the chance of interaction of group X with group Y compared with the probability of random interaction in the region as a whole. Negative values of this index are unbounded, with higher absolute values indicating greater separation of group Y from group X.

Because of the asymmetric nature of the values on the index, we created categorical measures from the continuous segregation scores. Scores on the Black (B)–White (W) racial segregation index fell between –0.30 and 0.98 and were divided into 4 categories: Black segregated ($LS_{i*BW}>0.60$), Black nonsegregated ($0<LS_{i*BW}\leq 0.60$), White nonsegregated ($-0.2<LS_{i*BW}\leq 0$), and White segregated ($LS_{i*BW}\leq -0.2$). Theoretical and empirical work suggests that a score of 0.60 or greater indicates hypersegregation; we determined other cutoffs according to natural breaks in the distribution.[54,55] The range of the economic segregation index (i.e., Poor [P]–Nonpoor [N] segregation) was much narrower (–0.12–0.43), and we divided scores into only 2 categories according to the distribution: poor segregated ($LS_{i*PN}>0.2$) and economically integrated ($LS_{i*PN}\leq 0.2$). Analyses were robust to alternative cutoffs for racial and economic segregation.

The history of intense racial segregation in Detroit, MI, gives reason to suspect that the effects of local segregation might operate differently there than in Michigan's other metropolitan areas. To account for this, we created a dummy variable for each census metropolitan statistical area, and we estimated each of the statistical models with fixed effects for metropolitan area using Detroit as the reference group. Including these fixed effects did not alter our results.

Statistical Analysis

To measure the influence of neighborhood covariates on low birth weight, we used 2-level hierarchical generalized linear models with a logit link function to predict low birth weight as a function of individual- and neighborhood-level characteristics.[57]

To examine the differential risks of low birth weight via intrauterine growth restriction and preterm birth, we fit a multinomial logistic hierarchical generalized linear model, treating normal birth weight (reference), low birth weight attributable to preterm delivery, and low birth weight attributable to intrauterine growth restriction as competing risks. We used HLM version 6.06 (Scientific Software International, Lincolnwood, IL) to predict the models.

RESULTS

In Michigan's metropolitan areas, 8.2% of all infants had low birth weight, slightly higher than the national average in 2000.[1] Low birth weights affected 14.7% (n=3477) of infants born to Black mothers (nearly 2 percentage points higher than the national average) and 6.9% (n=5502) of infants born to White mothers (similar to the national average).[1] Of the low-weight births, 52.9% (n=4747) were growth restricted, and 47.2% (n=4194) were preterm. Figure 1 is a diagram of the data by analytical categories: normal weight, preterm birth, and intrauterine growth restriction.

Spatially Measured Racial and Economic Segregation

Table 1 shows descriptive statistics of the frequency of low birth weight across the 4 levels of racial segregation along with the number of tracts in each category and the percentage of tracts within each category that were also poor segregated tracts. In White segregated areas, we found significant overlap between economic and racial segregation; less than 1% of White segregated tracts were also categorized as economically segregated. However, approximately half of Black segregated tracts were economically segregated, indicating that racial and economic segregation were distinct entities in Black neighborhoods. Overall, Black infants were likelier than were White infants to have low birth weights across all

TABLE 1—Distribution of Births by Level of Racial and Economic Segregation in Census Tracts, Birth Weight, and Maternal Race: Michigan Metropolitan Areas, 2000

	Black Segregated Tracts (n = 291), No. (%)	Black Nonsegregated Tracts (n = 425), No. (%)	White Nonsegregated Tracts (n = 670), No. (%)	White Segregated Tracts (n = 815), No. (%)
Poor segregated tracts	136 (46.74)	34 (7.98)	18 (2.69)	4 (0.49)
Infants of White mothers				
Normal birth weight	715 (90.28)	13 631 (92.95)	32 690 (93.75)	32 880 (93.69)
Low birth weight	77 (9.72)	1034 (7.05)	2178 (6.25)	2213 (6.31)
Infants of Black mothers				
Normal birth weight	11 407 (84.76)	6661 (85.73)	1387 (87.18)	784 (87.40)
Low birth weight	2051 (15.24)	1109 (14.27)	204 (12.82)	113 (12.60)

neighborhood types, but the percentage of low birth weights was highest in Black segregated neighborhoods (15.2%) and lowest in White segregated neighborhoods (12.6%). White infants had higher rates of low birth weight in Black segregated tracts than in White nonsegregated and White segregated tracts, suggesting that the structural effects of racial segregation might also affect births to White mothers.

Table 2 presents the odds ratios (ORs) from the hierarchical generalized linear models predicting low birth weight, adjusted for metropolitan statistical area. As expected, both maternal race and age were significant predictors of low birth weight. A Black mother had approximately twice the odds of having a low-weight infant as a White mother across all models (OR=2.12–2.35). Each additional year of maternal age increased the odds of a low birth weight by approximately 1.01 across all models. Model 1 showed that, absent other neighborhood-level covariates, mothers living in a Black segregated tract were nearly 26% likelier to have a low-weight infant than were mothers living in a White nonsegregated tract (OR=1.26; 95% confidence interval [CI]=1.13, 1.40; $P<.001$). Mothers living in a Black nonsegregated tract were 15% likelier to have a low-weight infant (OR=1.15; 95% CI=1.06, 1.24; $P<.01$). Model 2 showed that living in a poor segregated tract, absent other neighborhood-level covariates, predicted a 21% increase in the odds of a low-weight birth (OR=1.21; 95% CI=1.12, 1.31; $P<.001$) compared with living in an economically integrated tract.

In model 3, we examined racial and economic segregation together. The relationship between racial segregation and low birth weight remained significant after we controlled for economic segregation: odds of low birth weight were higher among residents of Black segregated (OR=1.19; 95% CI=1.06, 1.32; $P<.01$) and Black nonsegregated (OR=1.14; 95% CI=1.06, 1.23; $P<.01$) areas than among residents of White nonsegregated neighborhoods. Economic segregation was also associated with increased odds of low birth weight (OR=1.16; 95% CI=1.07, 1.27; $P<.01$).

In model 4, we added vacancy, a measure of structural disadvantage, and women's college education, a measure of social affluence, to the covariates from model 3. Both vacancy and women's college education were related to low birth weight in the expected direction. However, these additional measures of socioeconomic advantage did not completely explain the effect of racial segregation; living in a Black segregated or Black nonsegregated area remained a statistically significant predictor of increased odds of low birth weight. Compared with residence in a White nonsegregated tract, living in a Black nonsegregated area was related to an 11% increase in the odds of low birth weight (OR=1.11; 95% CI=1.03, 1.20; $P<.01$), and living in a Black segregated area was related to a 15% increase in the odds of low birth weight (OR=1.15; 95% CI=1.03, 1.29; $P<.05$).

Etiologies of Low Birth Weight

We next examined how these neighborhood characteristics were related to the underlying etiologies of low birth weight. The ORs from the multinomial logistic model predicting the impact of racial and economic segregation on the competing risks of preterm low birth weight, growth-restricted low birth weight, and normal weight are presented in Table 3. The effects of maternal and census tract characteristics on the odds of low birth weight compared with normal birth weight are shown separately for the 2 mechanisms leading to low birth weight.

Several neighborhood characteristics, including racial segregation, predicted growth-restricted low birth weight but not preterm low birth weight. Living in a Black segregated (OR=1.19; 95% CI=1.03, 1.37; $P<.05$) or Black nonsegregated (OR=1.21; 95% CI=1.10, 1.33; $P<.001$) neighborhood significantly increased the odds of having an infant with low birth weight caused by growth restriction rather than a normal-weight infant. In addition, both the percentage of vacant housing units and the percentage of college-educated women were statistically significant predictors of growth-restricted low birth weight. No neighborhood-level covariates predicted a change in the odds of having a preterm infant with low birth weight at the 95% confidence level.

TABLE 2—Hierarchical Generalized Linear Models Predicting Low Birth Weight: Michigan Metropolitan Areas, 2000

	Model 1, OR (95% CI)	Model 2, OR (95% CI)	Model 3, OR (95% CI)	Model 4, OR (95% CI)
Maternal characteristics				
Age	1.014* (1.010, 1.018)	1.015* (1.011, 1.019)	1.014* (1.010, 1.018)	1.014* (1.010, 1.018)
Race	2.143* (1.991, 2.305)	2.349* (2.225, 2.479)	2.138* (1.987, 2.300)	2.121* (1.971, 2.282)
Census tract characteristics				
White segregated	1.002 (0.919, 1.093)	...	1.010 (0.926, 1.101)	1.046 (0.959, 1.141)
Black nonsegregated	1.148** (1.064, 1.237)	...	1.140** (1.057, 1.229)	1.111** (1.030, 1.199)
Black segregated	1.257* (1.132, 1.395)	...	1.187** (1.064, 1.324)	1.151*** (1.030, 1.285)
Poor segregated	...	1.213* (1.120, 1.314)	1.163** (1.067, 1.267)	1.056 (0.963, 1.157)
Vacancies, %	...	...	...	1.070*** (1.015, 1.128)
Women with college education, %	...	...	...	0.996* (0.994, 0.998)

Note. CI = confidence interval; OR = odds ratio. Models included fixed effects for metropolitan statistical area. Ellipses indicate variables not included in the model.
*$P<.05$; **$P<.01$; ***$P<.001$.

TABLE 3—Hierarchical Multinomial Logistic Regression Estimating Competing Risk of Low Birth Weight by Cause: Michigan Metropolitan Areas, 2000

	Intrauterine Growth Restriction, OR (95% CI)	Preterm Birth, OR (95% CI)
Maternal characteristics		
Age	1.010* (1.005, 1.015)	1.019* (1.014, 1.025)
Race	1.923* (1.746, 2.119)	2.372* (2.136, 2.635)
Census tract characteristics		
White segregated	1.102 (0.984, 1.234)	0.988 (0.871, 1.119)
Black nonsegregated	1.208* (1.095, 1.333)	0.998 (0.893, 1.115)
Black segregated	1.187*** (1.029, 1.370)	1.106 (0.944, 1.294)
Poor segregated	1.066 (0.950, 1.196)	1.042 (0.913, 1.189)
Vacancies, %	1.157* (1.078, 1.242)	0.973 (0.901, 1.051)
Women with college education, %	0.995* (0.993, 0.998)	0.996** (0.993, 0.999)

Note. CI = confidence interval; OR = odds ratio. Models included fixed effects for metropolitan statistical area.
*P < .05; **P < .01; ***P < .001.

DISCUSSION

We characterized the relationship between racial segregation and low birth weight in Michigan's metropolitan areas and examined whether that relationship could be explained by economic segregation. Our results indicated that infants born to mothers living in Black segregated and Black nonsegregated areas were more likely to have low birth weights than were infants born to mothers living in White nonsegregated tracts. This relationship persisted after we controlled for measures of economic well-being, including concentrated poverty.

Although the use of racial segregation as a health indicator has been criticized as a simple proxy for the spatial concentration of poverty, our analysis suggested that—at least for Michigan metropolitan areas—racial and economic segregation operated independently. The spatial concentration of poverty attenuated but did not eliminate the relationship between Black segregated areas and low birth weight. In addition, local measures of structural disadvantage and social affluence attenuated, but did not fully explain, the relationship between racial segregation and low birth weight. This finding suggests that in racially segregated areas, structural or institutional sources of disadvantage may deserve additional attention as potential mediators of the relationship between racial segregation and low birth weight.

Furthermore, we found evidence that the effects of racial residential segregation and tract-level socioeconomic factors on low birth weight were driven by intrauterine growth restriction, not preterm birth. This pattern could result from 2 possible pathways. First, mothers in racially segregated neighborhoods could have a higher prevalence of medical conditions or health behaviors related to intrauterine growth restriction.[58] However, individual-level factors such as smoking or nutrition depend to some degree on structural factors that contribute to vulnerability in segregated neighborhoods, such as targeted tobacco advertising or a lack of healthy food options.[59–64] These structural elements create and maintain additional health risks for residents of segregated Black neighborhoods suggesting that health behaviors may mediate the relationship between racial segregation and low birth weight.

A second possibility that deserves further attention is that women living in segregated neighborhoods could be subject to chronically stressful circumstances that stem from systematic disinvestment in racially segregated areas.[9,65] Chronic exposure to stress may be more likely than acute exposure to change placental and vascular physiology, which could result in intrauterine growth restriction; acute stressors may increase vulnerability to preterm delivery. If chronic maternal stress theoretically links segregation and low birth weight, it seems plausible that neighborhood-level factors could have a stronger relationship with intrauterine growth restriction than with preterm delivery.

Limitations

Our analysis lacked individual-level data such as prenatal care, insurance coverage, marital status, education, and tobacco and alcohol use. Because we controlled for maternal race, our results suggest that individual-level factors that vary systematically by race are not likely to have a substantial impact on neighborhood-level results. However, neighborhood effects may be overestimated if models do not control for spatially clustered individual-level factors. For example, the incidence of growth restriction is related to maternal tobacco exposure,[45,66] and smoking is known to be spatially clustered.[9,58,67] Without access to individual-level data, we were unable to explore the possibility that tobacco exposure or other maternal characteristics (e.g., education, nutrition) may serve as mediators in the relationship between segregation and low birth weight. Our findings suggest, however, that living in a segregated neighborhood has implications for pregnancy outcomes and that future studies should test hypotheses about mediating and confounding factors in the relationship between segregation and low birth weight, particularly those related to intrauterine growth restriction, and should collect detailed data about mothers and the neighborhoods in which they live.

The cross-sectional nature of our study and of others that linked racial segregation and health outcomes also poses a significant limitation. One suggested mechanistic link between racial segregation and birth outcomes is chronic stress, but cross-sectional data cannot provide evidence of chronic exposure to the stressful circumstances of segregation. Although costly, a longitudinal study following adolescent girls prior to childbearing, and continuing throughout their reproductive lives, with a focus on pregnancy, childbirth, and child health; objective neighborhood quality measures; biological and behavioral risk factors; and participants' subjective estimations of stress from personal and contextual sources could provide the detailed data needed to characterize the relationship between neighborhood-level stressors and pregnancy outcomes.

The high degree of overlap between racial segregation and economic segregation may also have created some instability in the estimates of racial segregation's impact on low birth weight and warrant some caution. However, our results were robust to different cut points in the creation of both the racial and the economic segregation measures, and the consistency of standard errors across models gives us confidence that racial segregation presents a risk of low birth weight independent of economic segregation.

Our results were specific to the economic and racial circumstances of Michigan's metropolitan areas. However, we believe that studying segregation in Michigan conferred several advantages. First, Detroit and other Michigan metropolitan areas have a long history of segregation and some of the highest metropolitanwide segregation indices in the United States,[55,68] providing a striking setting in which to assess the impact of segregation on birth outcomes. Furthermore, our data encompassed all of Michigan's metropolitan statistical areas, with their diverse urban and suburban populations. All other studies of racial segregation and low birth weight, to our knowledge, have concentrated on a single metropolitan area or on multiple large cities across the United States. Finally, the low percentage of other racial groups in Michigan made it reasonable to focus solely on Black–White segregation. A limitation of other studies of Black–White segregation and low birth weight is the unobserved impact of other racial/ethnic groups not included in the analyses.

Conclusions

Our findings illustrate a meaningful relationship between racial residential segregation and low birth weight and suggest that intrauterine growth restriction is a potential etiological link between them. Although we could not determine the proximal causes of the relationship between low birth weight and racial segregation, our identification of intrauterine growth restriction as a likely pathway suggests that future research should examine both the physiological consequences of stressful environments for expectant mothers and structural factors such as tobacco advertising and food environments that could mediate the relationship between segregation and low birth weight.

Public health interventions that aim to reduce disparities in low birth weight should take racial segregation and its consequences into account as an aspect of women's social environment that may drive this pregnancy outcome. Future research into segregation and other neighborhood-level circumstances and their relationship to low birth weight should attempt to disentangle intrauterine growth restriction and preterm delivery, which may permit the development of cause-specific interventions to prevent low birth weight. ■

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Contributors

M. Precourt Debbink originated the study, performed the analysis, and led the writing. M. D. M. Bader contributed methodological expertise and assisted with the analysis and writing. Both authors conceptualized ideas, interpreted findings, and reviewed drafts of the article.

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This project was reviewed and approved by the University of Michigan institutional review board.

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