Original Contribution

Neighborhood Deprivation and Preterm Birth among Non-Hispanic Black and White Women in Eight Geographic Areas in the United States

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Disparities in preterm birth by race and ethnic group have been demonstrated in the United States. Recent research has focused on the impact of neighborhood context on racial disparities in pregnancy outcomes. The authors utilized vital-record birth certificate data and US Census data from eight geographic areas in four states (Maryland, Michigan, North Carolina, and Pennsylvania) to examine the relation between neighborhood deprivation and preterm birth among non-Hispanic White and Black women. The years covered by the data varied by site and ranged from 1995 to 2001. Results were adjusted for maternal age and education, and specific attention was paid to racial and geographic differences in the relation between neighborhood deprivation and preterm birth. Preterm birth rates were higher for non-Hispanic Blacks (10.42–15.97%) than for non-Hispanic Whites (5.77–9.13%), and neighborhood deprivation index values varied substantially across the eight areas. A significant association was found between neighborhood deprivation and risk of preterm birth; for the first quintile of the deprivation index versus the fifth, the adjusted summary odds ratio was 1.57 (95% confidence interval: 1.41, 1.74) for non-Hispanic Whites and 1.15 (95% confidence interval: 1.08, 1.23) for non-Hispanic Blacks. In this study, deprivation at the neighborhood level was significantly associated with increased risk of preterm birth among both non-Hispanic White women and non-Hispanic Black women.

ethnic groups; premature birth; residence characteristics; social class; social environment; United States

Abbreviation: CI, confidence interval.

Despite efforts to reduce the gap between Blacks and Whites, racial disparities in adverse birth outcomes—specifically infant mortality, low birth weight, and preterm birth—continue to persist in the United States. National infant

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mortality data from 2002 demonstrate rates for non-Hispanic Black mothers (13.9 per 1,000 births) that are 2.4 times higher than those for non-Hispanic Whites (5.8 per 1,000 births) (1). Preliminary data for 2004 showed that 13.7 percent of infants born to non-Hispanic Black mothers were low birth weight, 3.1 percent were very low birth weight, and 17.9 percent were preterm. In comparison, 7.2 percent of infants born to non-Hispanic White mothers were low birth weight, 1.2 percent were very low birth weight, and 11.5 percent were preterm (2).

Preterm birth, defined as delivery before 37 weeks' completed gestation, is responsible for two thirds of infant deaths and approximately half of subsequent childhood neurologic problems in the United States (3). The wide gap in preterm birth rates by racial and ethnic group has been the subject of numerous studies over the past few decades (4–8). The failure of individual-level characteristics (e.g., maternal behaviors) to fully account for racial disparities in preterm birth has led to a resurgent interest in macro-level factors (9, 10). Growing attention is being paid to the impact of residential neighborhood environment on racial disparities in pregnancy outcome (11–19). Current research indicates that racial and ethnic minorities generally have a lower socioeconomic position than Whites (20–22) and reside in neighborhoods with more economic deprivation and social disorder and differential access to health-enhancing resources (23–26). Such differential neighborhood environments may be partly responsible for the Black-White racial differences in health generally and preterm birth specifically (9).

A small set of studies across North America and the United Kingdom have specifically examined the impact of neighborhood-level factors on preterm birth (12, 14–16, 18, 27–30). Ahern et al. (16) found that, even when controlling for maternal cigarette smoking, neighborhood-level unemployment status was significantly associated with an increased risk of preterm delivery. Additional research focused on two provinces in Canada (11, 14) found lower neighborhood socioeconomic status, as measured by income level, to adversely affect birth outcomes, including preterm birth. Recent research by Janghorbani et al. (28) found that women living in the most deprived neighborhoods in Plymouth, United Kingdom, as compared with the least deprived neighborhoods, were at increased risk of giving birth preterm.

In this analysis, we aimed to examine the relation between neighborhood deprivation and preterm birth across a range of geographic areas and to explore what happened to the relation after controlling for maternal age and education. To our knowledge, no previous studies have examined multiple geographic areas simultaneously to determine whether associations are similar across sites. Because previous research on pregnancy outcomes has demonstrated substantial effect modification for neighborhood and race (16, 18, 31–33), we stratified our analyses by maternal race and examined the relation between neighborhood deprivation and preterm birth separately for non-Hispanic White women and non-Hispanic Black women.

MATERIALS AND METHODS

The MODE-PTD Project (Multilevel Modeling of Disparities Explaining Preterm Delivery) is a collaborative partnership between researchers at four universities and their government health departments, with the purpose of studying contextual influences on disparities in adverse birth outcomes. A total of eight geographic areas are represented in this study: Philadelphia, Pennsylvania; Baltimore City, Maryland; Baltimore County, Maryland; Montgomery County, Maryland; Prince George's County, Maryland; 16 combined cities in Michigan (hereafter called "16 Cities, Michigan"); Durham County, North Carolina; and Wake County, North Carolina. The 16 cities in Michigan were combined after exploratory work revealed homogeneity of several contextual characteristics and no notable differences in the results when the cities were analyzed together versus separately; statistical power was increased by pooling the smaller cities into a single area. The four Maryland counties and the two North Carolina counties were analyzed separately because of sociodemographic and birth outcome heterogeneity among them.

Individual-level data

Data for singleton births were obtained from the vital statistics records of each study site's government health department. The years covered by the data varied by site (as noted in the table titles) depending on data availability and the years of interest, as negotiated with each government health department partner. Categorical outcome and adjustment variables were constructed from vital-record birth certificate data (see table 1). Preterm birth was defined as delivery of an infant weighing less than 3,888 g at less than 37 completed weeks of gestation (34). Records with missing data on variables of interest (e.g., census tract, preterm birth, maternal education, and maternal age) comprised less than 5 percent of the overall sample and were excluded.

Neighborhood-level data

Census tract data from the 2000 US Census were used to characterize neighborhoods. Census tracts are designed to be small areas comprising a relatively economically homogeneous population containing approximately 4,000 residents (35). Maternal addresses from the birth certificate records were geocoded to identify residential census tracts. Geocoding was successful for at least 95 percent of the records. Birth record data were then linked to census data using the unique residential census tract identifiers.

A neighborhood deprivation index was created using census variables. The development of the neighborhood deprivation index is described in detail elsewhere (29). In brief, eight census variables representing five sociodemographic domains previously associated with health outcomes, including income/poverty, education, employment, housing, and occupation, were empirically summarized using principal-components analysis (see table 1). Census data from all sites were pooled, and principal-components analyses were used to create the index. The all-site deprivation index was then standardized to have a mean of 0 and a standard deviation of 1, by dividing the index by the square of the eigenvalue

TABLE 1. Individual and neighborhood variables included in a study of neighborhood deprivation and preterm birth in eight study areas in four US states (Maryland (1999–2001), Michigan (1995, 1998–1999), North Carolina (1999–2001), and Pennsylvania (1999–2000))

Level and variable	Categories
Individual-level variables from vital records	
Gestational age (weeks)	≤37 (preterm)*
	≥38
Maternal age (years)	<20
	20–24
	25–29
	30–34
	≥35
Maternal race	Non-Hispanic Black
	Non-Hispanic White
Maternal education	<20 years and less than high school
	≥20 years and less than high school
	High school completion or equivalent
	More than high school
Neighborhood-level variable from 2000 US Census	
Deprivation index†	A single index comprising the following census variables: percentage of males in management and professional occupations; percentage of residents living in crowded housing; percentages of households in poverty, female-headed households with dependents, households on public assistance, and households earning <$30,000 per year; percent with less than a high school education; and percent unemployed

* Preterm infants had to weigh less than 3,888 g (34).
† Lower values indicate less deprivation, while higher values represent greater deprivation (range, −1.85 to 3.72) (29).

(36). Lower values on the neighborhood deprivation index (range, −1.85 to 3.72) indicate less deprivation, while higher values represent greater deprivation (29).

Statistical analyses

The use of race-stratified models was informed by previous research which showed that risk factors vary across racial groups (12, 31, 33, 37). First, unadjusted multilevel (random-intercept) logistic regression models for preterm birth containing neighborhood deprivation were fitted. Next, multivariate models that controlled for the individual-level potential confounders of maternal age and education were used to estimate the adjusted relation. Because our primary emphasis was on examination of neighborhood effects, we sought to avoid overadjustment for individual characteristics. We chose maternal age and maternal education because they were thought to be the major confounders and they are reliably reported on the birth certificate. While other individual-level variables were initially considered for inclusion, they were found either to be in the causal pathway (e.g., maternal smoking), to suffer from poor reporting (e.g., maternal health conditions) (38–40), or to be unavailable across all of our study sites.

To assess the possibility of nonlinear relations between deprivation and preterm birth, we fitted quartiles of neighborhood deprivation as well as a model with a quadratic term. The site-specific regressions estimated fixed-effect slope coefficients by assuming that each of the estimates was a more or less precise estimate of a single underlying value. The summary estimate is a precision-weighted average of the site-specific estimates. To test the null hypothesis of homogeneity of study results, we computed a homogeneity test statistic, Cochran's Q. The random-effects summary estimate assumes a "population of populations," each of which has its own slope value. The statistical model is that the slope values from all populations have a normal distribution and that a random sample of the populations was chosen in our study. The target of the summarization is an estimate of the mean of the distribution of population values (41). Analyses were conducted using Stata software (42) at three of the sites (Maryland, North Carolina, and Pennsylvania) and HLM software (43) at one site (Michigan).

RESULTS

Demographic and birth characteristics

There was a large number of births for each geographic area, and there was variability by age and education (tables 2 and 3). Among non-Hispanic Whites (table 2), 16 Cities, Michigan, had the fewest births (9.63 percent) to women aged ≥35 years, while Montgomery County, Maryland, had the highest proportion (34.21 percent). Among non-Hispanic Blacks (table 3), the percentage of births to women aged 35 ≥35 years was also lowest in 16 Cities, Michigan (7.48 percent), and Montgomery County, Maryland, had the highest proportion (22.94 percent). Among non-Hispanic Whites, Baltimore City, Maryland, and 16 Cities, Michigan, had the highest proportions of births to women with less than a high school education and women aged 20 years or more: 14.51 percent and 15.71 percent, respectively (table 2). This pattern was similar for non-Hispanic Blacks (table 3); Baltimore City, Maryland, and 16 Cities, Michigan, had 18.33 percent and 18.41 percent of births to women with less than a high school education and women aged 20 years or more, respectively.

The preterm birth rates were substantially higher for Blacks than for Whites. There was substantial geographic-area variability in rates of preterm birth. For non-Hispanic Whites (table 2), preterm birth rates were highest in Baltimore City, Maryland (9.13 percent) and lowest in Montgomery County, Maryland (5.77 percent); for non-Hispanic Blacks, these two areas had the highest and lowest rates of preterm birth as well: 15.97 percent and 10.42 percent, respectively.

TABLE 2.   Individual-level maternal demographic characteristics, birth characteristics, and neighborhood-level deprivation index values for non-Hispanic White women in eight study areas in four US states (Maryland (1999–2001), Michigan (1995, 1998–1999), North Carolina (1999–2001) and Pennsylvania (1999–2000))

	Baltimore City, Maryland	Baltimore County, Maryland	Montgomery County, Maryland	Prince George's County, Maryland	16 Cities, Michigan	Durham County, North Carolina	Wake County, North Carolina	Philadelphia, Pennsylvania
Individual-level variables								
Total no. of births	5,707	12,625	14,222	4,224	31,730	3,822	17,983	12,064
Maternal age in years (%)								
<20	10.88	6.58	1.92	7.01	12.66	3.98	3.06	8.75
20–24	23.22	16.01	5.91	18.99	27.56	10.83	10.73	20.37
25–29	23.71	26.03	17.99	24.50	30.01	28.47	27.40	28.77
30–34	25.34	31.55	39.98	28.43	20.14	36.24	37.49	26.64
≥35	16.86	19.83	34.21	21.07	9.63	20.49	21.33	15.48
Maternal education (%)								
<20 years and less than high school	7.76	3.25	0.83	3.22	8.83	2.64	1.75	4.81
≥20 years and less than high school	14.51	5.61	2.05	5.40	15.71	4.37	2.84	8.45
High school or equivalent	25.48	29.42	10.88	29.24	35.24	13.03	13.64	38.61
More than high school	52.25	61.72	86.24	62.14	42.22	79.96	81.77	48.13
Preterm birth (%)	9.13	7.16	5.77	6.87	7.25	7.56	6.88	6.83
Neighborhood-level variables*								
No. of census tracts	174	166	177	154	567	51	105	338
Neighborhood deprivation index								
Median value	−0.27	−0.81	−1.24	−0.87	0.57	−1.09	−1.08	0.08
25th percentile	−0.63	−1.15	−1.38	−1.00	−0.16	−1.24	−1.41	−0.51
75th percentile	0.20	−0.54	−0.83	−0.69	1.18	−0.62	−0.87	0.99
Minimum value	−1.35	−1.59	−1.71	−1.37	−1.65	−1.63	−1.85	−1.78
Maximum value	2.59	1.59	0.68	1.38	3.72	2.55	3.68	3.68

* Neighborhood data were derived from the 2000 US Census.

Neighborhood-level deprivation characteristics

Figure 1 exhibits the range of neighborhood deprivation by geographic area based on the census data only. Neighborhood deprivation varied substantially in the three urban regions (16 Cities, Michigan; Baltimore City, Maryland; and Philadelphia, Pennsylvania) at the more deprived end of the scale, as indicated by their medians and distributions within the positive range of the index. Particularly noteworthy is Montgomery County, Maryland, with deprivation index values ranging from −6 to −1, suggesting that this area has very low levels of deprivation. Along with Montgomery County, the majority of tracts in Durham, Prince George's, Baltimore, and Wake counties were at the affluent end of the all-site deprivation continuum, as compared with the three most densely urban study areas (16 Cities, Baltimore City, and Philadelphia), which were clearly at the more deprived end of the range.

We also examined the distribution of neighborhood deprivation for the women in our sample. Tables 2 and 3 exhibit five deprivation index values—the median, the 25th and 75th percentiles, and the minimum and maximum values—for each study site for births to non-Hispanic White women and non-Hispanic Black women. Among non-Hispanic Whites, the median deprivation index values for all sites except two (16 Cities, Michigan, and Philadelphia, Pennsylvania) were less than 0; negative values indicate that a site has lower levels of deprivation than the mean. The least deprived (wealthiest) areas were Montgomery County, Maryland (median, −1.24), Durham County, North Carolina (median, −1.09), and Wake County, North Carolina (median, −1.08) (table 2). For non-Hispanic Blacks, many but not all of the areas had positive deprivation index values, indicating higher levels of deprivation. Baltimore City, Maryland (median, 0.74) and 16 Cities, Michigan (median, 0.64) were the most deprived areas. Montgomery County, Maryland (median, −0.79) and Wake County, North Carolina (median, −0.67) were the least deprived areas among non-Hispanic Blacks (table 3).

Neighborhood-level deprivation and preterm birth

Table 4 presents results from the regression analyses. The table shows odds ratios that compare the highest quintile of neighborhood deprivation with the lowest, similar to comparisons made in previous work (e.g., see Zhong-Cheng et al. (11) and Luo et al. (14)). When neighborhood deprivation was entered into the regression models alone, a change in

TABLE 3. Individual-level maternal demographic characteristics, birth characteristics, and neighborhood-level deprivation index values for non-Hispanic Black women in eight study areas in four US states (Maryland (1999–2001), Michigan (1995, 1998–1999), North Carolina (1999–2001), and Pennsylvania (1999–2000))

	Baltimore City, Maryland	Baltimore County, Maryland	Montgomery County, Maryland	Prince George's County, Maryland	16 Cities, Michigan	Durham County, North Carolina	Wake County, North Carolina	Philadelphia, Pennsylvania
Individual-level variables								
Total no. of births	18,038	4,599	4,934	16,568	54,862	4,373	6,304	19,845
Maternal age in years (%)								
<20	26.77	12.92	7.11	11.75	23.06	16.21	13.12	21.61
20–24	31.88	26.55	16.68	22.78	32.12	30.48	28.76	32.16
25–29	20.19	26.74	24.94	25.28	23.69	25.77	25.98	22.04
30–34	12.98	21.42	28.33	24.03	13.65	18.18	20.00	14.67
≥35	8.19	12.37	22.94	16.15	7.48	9.35	12.14	9.53
Maternal education (%)								
<20 years and less than high school	16.32	5.26	2.94	5.02	15.42	10.98	7.96	12.57
≥20 years and less than high school	18.33	5.59	4.82	4.59	18.41	13.95	9.88	14.68
High school or equivalent	41.99	35.88	29.71	37.51	37.55	29.02	31.88	42.96
More than high school	23.36	53.27	62.53	52.89	28.62	46.06	50.27	29.79
Preterm birth (%)	15.97	12.74	10.42	11.29	13.55	15.28	12.44	13.48
Neighborhood-level variables*								
No. of census tracts	191	147	166	183	592	51	103	343
Neighborhood deprivation index								
Median value	0.74	−0.52	−0.79	−0.34	0.64	0.02	−0.67	0.30
25th percentile	0.08	−0.74	−1.06	−0.84	−0.06	−0.68	−0.98	−0.40
75th percentile	1.19	−0.33	−0.27	0.06	1.23	0.93	0.13	1.11
Minimum value	−1.28	−1.59	−1.71	−1.37	−1.65	−1.63	−1.76	−1.53
Maximum value	2.59	1.17	0.68	1.38	3.72	2.55	2.65	3.68

* Neighborhood data were derived from the 2000 US Census.

neighborhood deprivation from the lowest quintile to the highest was significantly associated with increased risk of preterm birth among non-Hispanic White women for all

eight areas. There was variability across areas in the magnitude of the effect, with the odds ratios for neighborhood deprivation for non-Hispanic White women ranging from
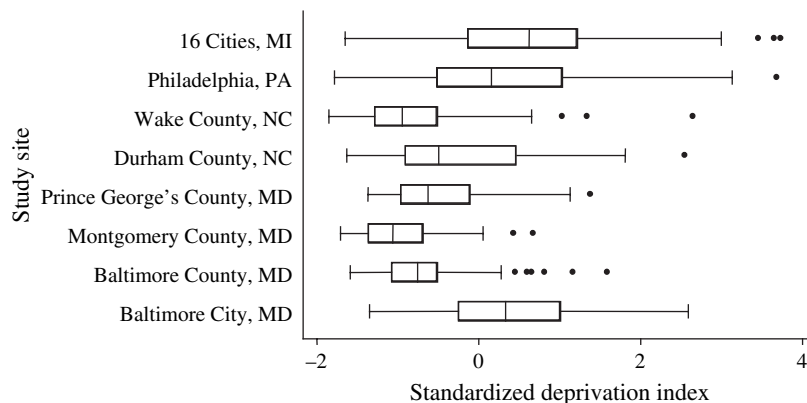
FIGURE 1. Deprivation index values for eight areas in four US states (Maryland (MD) (1999–2001), Michigan (MI) (1995, 1998–1999), North Carolina (NC) (1999–2001), and Pennsylvania (PA) (1999–2000)). The figure shows box plots of the standardized deprivation index for each of the eight sites. The smallest (non-outlier) value is represented by the leftmost vertical line (whisker); the interquartile range (quartile 1–quartile 3) is represented by the box; the vertical line in each box marks the median standardized deprivation value for each site; and the rightmost whisker represents the largest (non-outlier) value. The dots represent any outliers in the distribution.

a low of 1.64 (95 percent confidence interval (CI): 1.51, 1.77) for 16 Cities, Michigan, to a high of 3.14 (95 percent CI: 2.72, 3.56) for Baltimore County, Maryland. Cochran's Q statistic for homogeneity of the effect of neighborhood deprivation did not reject the null hypothesis that neighborhood deprivation estimates were the same across areas ($p = 0.064$). Therefore, we were able to calculate a summary measure across all areas for non-Hispanic Whites; the odds ratio was 1.83 (95 percent CI: 1.65, 2.01). Among non-Hispanic Blacks, the odds ratios for neighborhood deprivation across the eight areas were more varied. The highest odds ratio for non-Hispanic Blacks was for the Durham, North Carolina, site (odds ratio = 1.48, 95 percent CI: 1.24, 1.71). Cochran's Q statistic for homogeneity was not significant ($p = 0.07$). The odds ratio for the summary effect across all areas for non-Hispanic Blacks was 1.25 (95 percent CI: 1.18, 1.33).

When controlling for the individual-level variables, maternal age, and education, the estimates of neighborhood deprivation were attenuated but remained significant for several of the racially stratified areas (table 4). For non-Hispanic Whites, the largest changes from the unadjusted models occurred in Baltimore City, Maryland, Baltimore County, Maryland, and Durham, North Carolina. For non-Hispanic Blacks, the odds ratios were also attenuated but to a smaller degree than was seen for non-Hispanic Whites. Cochran's Q statistic for homogeneity was not significant for either non-Hispanic Whites ($p = 0.83$) or non-Hispanic Blacks ($p = 0.50$). For the summary effect measure, the odds ratio for non-Hispanic Whites was 1.57 (95 percent CI: 1.41, 1.74), and for non-Hispanic Blacks it was 1.15 (95 percent CI: 1.08, 1.23).

Figure 2 presents a graphic representation of the adjusted slopes for non-Hispanic Whites and Blacks by site. For Whites, the slopes are steep and quite similar across the sites. For Blacks, the slopes are generally flatter than those for Whites and also similar across sites.

Our finding of different effect sizes between non-Hispanic Whites and non-Hispanic Blacks for the relation between neighborhood deprivation and preterm birth has been reported previously (16, 18, 32), and we sought to explore the reasons for this observation. One hypothesis we explored was that the association between neighborhood deprivation and preterm birth was not linear. We fitted a categorical variable for neighborhood deprivation in our model and subsequently added a quadratic term to the model. The results of these analyses did not support the presence of a nonlinear relation between neighborhood deprivation and preterm birth (data not shown).

DISCUSSION

In this analysis, we examined the relation between neighborhood deprivation and preterm birth across a broad spectrum of diverse geographic areas in the United States that exhibit significant racial disparities in preterm birth. We used a deprivation index comprising a wide set of neighborhood characteristics that were identified as being highly relevant for pregnancy risk and preterm birth (29).

We found a significant but moderate-to-weak association between neighborhood deprivation and risk of preterm birth

TABLE 4. Odds ratios comparing the first quintile of a neighborhood deprivation index with the fifth quintile among non-Hispanic White and Black women in eight study areas in four US states (Maryland (1999–2001), Michigan (1995, 1998–1999), North Carolina (1999–2000), and Pennsylvania (1999–2000))

	Baltimore City, Maryland		Baltimore County, Maryland		Montgomery County, Maryland		Prince George's County, Maryland		16 Cities, Michigan		Durham County, North Carolina		Wake County, North Carolina		Philadelphia, Pennsylvania	
	OR*	95% CI*	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Non-Hispanic White women																
Unadjusted	2.79	2.30, 3.08	3.14	2.72, 3.56	1.82	1.38, 2.26	2.07	1.29, 2.85	1.64	1.51, 1.77	2.18	1.69, 2.68	1.82	1.48, 2.16	1.68	1.45, 1.92
Adjusted†	1.87	1.42, 2.31	2.24	1.77, 2.71	1.56	1.09, 2.02	1.68	0.90, 2.46	1.48	1.32, 1.63	1.68	1.14, 2.23	1.52	1.15, 1.88	1.52	1.28, 1.75
Non-Hispanic Black women																
Unadjusted	1.37	1.24, 1.50	1.37	0.74, 1.99	0.86	0.36, 1.35	1.20	0.97, 1.43	1.14	1.06, 1.22	1.48	1.24, 1.71	1.33	1.02, 1.64	1.40	1.27, 1.53
Adjusted†	1.23	1.08, 1.39	1.40	0.78, 2.03	0.88	0.38, 1.37	1.14	0.90, 1.37	1.05	0.95, 1.16	1.20	0.97, 1.43	1.20	0.89, 1.51	1.26	1.13, 1.39

* OR, odds ratio; CI, confidence interval.
† Adjusted for maternal age and education.
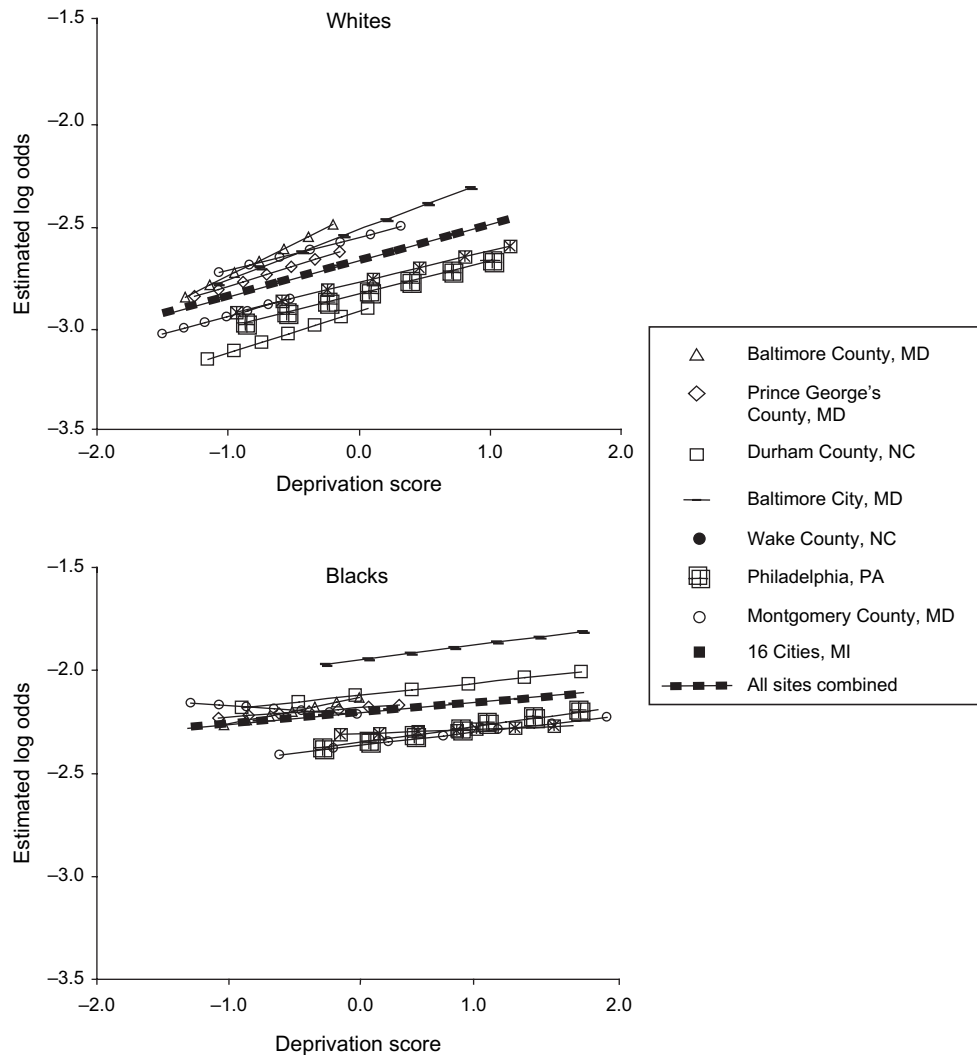
FIGURE 2.   Estimated adjusted log odds of preterm delivery by neighborhood deprivation score for women aged 20 years or more in eight study areas in four US states (Maryland (MD) (1999–2001), Michigan (MI) (1995, 1998–1999), North Carolina (NC) (1999–2001), and Pennsylvania (PA) (1999–2000)).

among both non-Hispanic White women and non-Hispanic Black women. The adjusted summary odds ratio for the effect of neighborhood deprivation on risk of preterm birth was 1.57 (95 percent CI: 1.41, 1.74) for non-Hispanic Whites and 1.15 (95 percent CI: 1.08, 1.23) for non-Hispanic Blacks. Adjusting for individual-level variables attenuated the strength of the association only slightly; neighborhood deprivation remained significantly associated with preterm birth among non-Hispanic Whites at seven of the eight study sites. The geographic areas represented included a range of urbanicity in the eastern and midwestern regions of the United States, and the effect of neighborhood deprivation on preterm birth varied across the areas. While the effect of neighborhood deprivation varied by area, the odds ratios were homogeneous, such that summary estimates can be used to describe the relation between neighborhood deprivation and preterm birth.

Although, to our knowledge, no previous studies on preterm birth have examined a neighborhood deprivation index similar to ours, prior research does support associations between neighborhood economic characteristics (e.g., household income) and preterm birth. For example, Kaufman et al. (15) reported significant associations between high (greater than the sample median) average household income (versus low income) and preterm birth for African-American women but not for White women; the odds ratio for high average neighborhood income among African-American women was 0.59. Pickett et al. (18) also reported a significant nonlinear association between median neighborhood household income and preterm birth for African-American women but not White women. Our finding that the association between neighborhood deprivation and preterm birth is weaker for non-Hispanic Blacks than for non-Hispanic Whites contrasts with the findings of Kaufman et al. (15)

and Pickett et al. (18), who found weaker associations among Whites compared with Blacks. Differences in study design (e.g., our sample was population-based), sample size, and statistical power (e.g., our large study population had ample statistical power to detect smaller effects) and our use of an index of deprivation versus those investigators' use of a single indicator of average or median household income not only make it difficult to compare the three studies but also may have contributed to the differences observed.

Other studies that have examined the relation between neighborhood economic factors and preterm birth include two Canadian studies. While Luo et al. (14) and Zhong-Cheng et al. (11) did not stratify their models by race, they reported adjusted odds ratios comparing the highest quintiles of neighborhood income with the lowest (the odds ratios were 1.26 and 1.14, respectively). These two studies were closest to ours in design (i.e., large population-based samples) and in the use of quintiles to categorize neighborhood economic factors.

We found differential effects between non-Hispanic White women and non-Hispanic Black women, with the latter group exhibiting a weaker association between neighborhood deprivation and preterm birth. We sought to investigate this further. In particular, we subsequently examined whether the neighborhood deprivation index distribution for non-Hispanic Whites was wider than that for non-Hispanic Blacks. A narrower range of neighborhood deprivation for Blacks as compared with Whites might explain the weaker effect of deprivation on preterm birth. We first observed the full range of neighborhood deprivation values shown separately for Whites and Blacks in tables 2 and 3. The average difference between the maximum and minimum neighborhood deprivation values for Blacks was 3.86, while for Whites it was slightly larger at 4.09. To eliminate extreme values that might influence the range, we examined the values between the 10th and 90th percentiles, separately, for Whites and Blacks for each site (data not shown). We now found in this case that non-Hispanic Blacks had wider ranges. On average, the differences between the 10th and 90th percentiles of neighborhood deprivation values were 1.81 for non-Hispanic Blacks and 1.46 for non-Hispanic Whites. We conclude, therefore, that a weaker effect among non-Hispanic Blacks is not explained by a narrow deprivation range for that group.

The limitations associated with this study should be noted. First, our use of vital-record data limited our ability to adjust for individual-level confounders, as the breadth and quality of maternal data on US birth certificates is limited. However, our findings were not likely to have been significantly affected. Adjusting for age and education in our study resulted in only small changes in the crude odds ratios for neighborhood deprivation. Further adjustment in our study for maternal hypertension and smoking produced only minimal changes to the findings we reported (data not shown). In a study similar to ours that examined average levels of household income and preterm birth (14), minimal changes in the crude estimates occurred upon adjustment for infant sex, plurality, parity, ethnicity, maternal age, marital status, abortion history, mode of delivery, maternal illness, community size, and distance to the nearest hospital. Another limitation is associated with our use of multiple years of data and the

likelihood that a substantial portion of women had more than one pregnancy in our data set. We conducted sensitivity analyses to determine whether this may have affected our findings. We reanalyzed our data after limiting the data to a single year (1999) and found very little change in parameter estimates in the reduced sample versus the full sample. Odds ratios comparing the first and fifth quintiles for non-Hispanic Whites (odds ratio = 1.23, 95 percent CI: 1.13, 1.33) and non-Hispanic Blacks (odds ratio = 1.08, 95 percent CI: 0.98, 1.20) were very comparable to the estimates obtained using data for all years. Thus, it is unlikely that our analyses were biased because of the presence of more than one pregnancy per woman in our data set.

Other limitations include the lack of information in vital records concerning length of residence in the current neighborhood. Women who had resided at their current residence for a short period of time may have been misclassified in terms of the level of neighborhood deprivation they were exposed to just prior to and during their pregnancies. The extent to which this misclassification occurred and the impact it had on our findings cannot be determined. One final issue is that our study did not have geographic representation from the Southwest or West Coast of the United States, and this may limit the generalizability of our findings to those regions.

In conclusion, results from our analysis are consistent with past research and demonstrate that an indicator of neighborhood deprivation based on a broad set of area-level characteristics is useful, even after accounting for individual-level factors, for understanding risk of preterm birth in different racial groups and a wide variety of geographic settings. Furthermore, while variation in this effect may be observed across geographic areas, this effect may be similar across diverse settings. In future research, investigators should use this same index to determine whether it is useful for other adverse pregnancy outcomes. Researchers investigating the pathways connecting neighborhood environment to preterm birth should seek to include individual-level data missing from the current analysis (e.g., data on material health conditions).

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