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Neighborhood deprivation and adverse birth outcomes among diverse ethnic groups

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Abstract

Purpose—Living in a socioeconomically deprived neighborhood has been associated with an increased risk of adverse birth outcomes. However, variation in the effect of neighborhood deprivation among diverse ethnic groups has not been studied.

Methods—Using linked hospital discharge and birth data for 517,994 singleton live births in New York City from 1998–2002, we examined the association between neighborhood deprivation, preterm birth (PTB), and term low birthweight (TLBW)(≥37 weeks and <2500g). Adjusted odds ratios (aOR) for PTB (<32 and 33–36 weeks) and TLBW were estimated using logistic regression.

Results—The aOR for PTB <32 weeks for the highest quartile of deprivation compared to the lowest was 1.24 (95% Confidence Interval (CI)=1.13, 1.36), for PTB 33–36 weeks was 1.06 (95%CI=1.01, 1.11), and for TLBW was 1.19 (95%CI=1.11, 1.27). Measures of association varied by ethnicity; AORs of the greatest magnitude for PTB were found among Hispanic Caribbean women (PTB<32weeks: aOR=1.63, 95%CI=1.27, 2.10; PTB 33–36 weeks: aOR=1.32, 95%CI=1.02, 1.70), and for TLBW among African women (aOR=1.47, 95%CI=1.02, 2.13).

Conclusions—The mechanisms linking neighborhood deprivation to adverse birth outcomes may differ depending on individual ethnicity and/or cultural context and should be investigated in future research.

MeSH Headings

Residence characteristics; pregnancy; ethnic groups

Introduction

Numerous studies have shown that women who live in more deprived neighborhoods are at a higher risk for adverse birth outcomes, including preterm birth(1–6), low birthweight(7–

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11), and small for gestational age(2;12;13), than those in wealthier neighborhoods, after controlling for individual socioeconomic status. Among studies that examined the effects of neighborhood deprivation and racial/ethnic groups separately, most have only examined Non-Hispanic Whites and African Americans. The majority showed effects of neighborhood deprivation only in African Americans(3;6;7;10;14), although several found little difference among groups(5;13;15), or a stronger effect in Non-Hispanic Whites.(4) If neighborhood deprivation affects ethnic groups differently, it might help explain the disparities in birth outcomes found consistently between ethnic groups.(16)

A few studies of neighborhood deprivation and adverse birth outcomes have looked at other ethnic groups. One study in California found an association among African Americans and Asians, but not among Non-Hispanic Whites or Hispanics.(9) Another study using a U.S. wide sample reported an association of neighborhood poverty level in African Americans, and found other neighborhood sociodemographic variables associated with an increased risk of preterm birth among Hispanics and Non-Hispanic Whites.(17)

Increasing migration to cities globally has resulted in “EthniCities,”(18) making it timely to examine neighborhoods and urban health within the context of various ethnic groups. New York City, with its ethnic diversity, is an opportune setting in which to do so. The purpose of this analysis was to examine the association between neighborhood deprivation and preterm birth and term low birthweight among nine ethnic groups in New York City from 1998–2002.

Methods

Individual-level data

Linked hospital and birth data for the years 1998–2002 were obtained from the New York State Department of Health.(19) Of 623,601 live singleton births from for the years 1998–2002, 591,983 (94.9%) birth records had been successfully linked to the mother’s hospital discharge record. Of these 591,983 births, 517,994 had information on the mother’s census tract of residence and were to residents of New York City. Births with missing information on gestational age (n=2953, 0.6%) or on covariates (n=22,709, 4.4%) were excluded, leaving a total of 492,332 births for analysis.

Gestation in weeks as estimated by the attendant at birth was obtained from the birth certificate and categorized into three groups: <32 completed weeks, 33–36 completed weeks, 37–44 completed weeks. Additionally, we created a dichotomous variable indicating birthweight <2500g, restricting the analysis to term births (≥37 completed weeks) to better address fetal growth directly.

Ethnicity was based on the question on the birth certificate, “What is your ethnic ancestry?”, which most women answered with a country. The following ethnic categories were created based on geographical regions: African, East Asian, South Asian, Non-Hispanic Caribbean, Hispanic Caribbean, Mexican, Central/South American and Other. Women who did not report their ethnic ancestry as from a Hispanic region (Hispanic Caribbean, Mexican, Central/South American) and reported their race as White were categorized as “Non-Hispanic White”. The “Other” category was not included in this analysis. Greater detail on the categorization of ethnicity using these data has been reported previously.(19)

Individual level covariates were obtained from the birth certificate and categorized as follows: parity (0, 1, ≥2), pre-pregnancy weight (in quartiles), maternal education (<12 years, 12 years, > 12 years), maternal age (continuous), smoking (yes/no), and nativity (foreign born vs. US-born).

Neighborhood-level data

Census tract was used as a proxy for neighborhood to measure neighborhood deprivation. The birth data from 1998–1999 were geocoded to 1990 census tracts, and the data from 2000–2002 to 2000 census tracts by the New York City Department of Health and Mental Hygiene. Since there were some changes to census tracts between 1990 and 2000, we devised a method to use these years simultaneously. For those tracts that were collapsed from two tracts to one tract from 1990 to 2000 (n=12), we used the 2000 tract boundaries in our analysis. For those tracts that were split from 1990 to 2000 (n=15), we used the 1990 boundaries in our analysis. The result was 2154 census tracts with at least one birth in the years 1998–2002.

Neighborhood deprivation was measured using an index derived from a principal components analysis replicating the method by Messer et al(20) and used previously in studies of neighborhood deprivation and preterm birth.(4;13) Twenty-one variables from the 2000 U.S. census from the domains of education, employment, housing, occupation, poverty, and residential stability were entered in the principle component analysis. Using the criterion of retaining variables with factor loadings >0.25, 17 variables were retained (minimum loading=0.53, maximum =0.91, see Table 1 for list of variables). One component was selected *a priori* to serve as the index. This component explained 53% of the variance in the 17 socioeconomic variables. All variables were standardized and as necessary reverse coded so that a high score represented highest level of deprivation. The resulting deprivation scores ranged from −3.14 to 2.47.

Statistical analysis

Multinomial logistic regression was used to estimate the ratio of relative risks, also interpreted as the odds ratio,(21) for each quartile of neighborhood deprivation relative to the lowest for the 3-level outcome of preterm birth (birth <32 weeks, birth 33–36 weeks, ≥ 37 weeks). The variance was calculated using the Huber-White method to account for the clustering of births within census tracts.(22) Potential confounders were selected based on their theoretical association with neighborhood deprivation and adverse birth outcomes, and were introduced to the model in the following way. First we included maternal education, a measure of individual socioeconomic position, in order to consider the relative contributions of individual and neighborhood socioeconomic status. We then included all potential confounders simultaneously in the final adjusted model.

In an analysis restricted to term births (n=454,677), the association between quartile of neighborhood deprivation and term low birthweight was estimated using logistic regression with the Huber-White variance using the same variable selection strategy. Interaction terms for level of neighborhood deprivation by ethnicity were tested in models for preterm birth and term low birthweight. All adjusted models were then repeated within each stratum of ethnicity. A test for trend for the coefficients relating quartile of neighborhood deprivation to each birth outcome was conducted. Analyses were performed using Stata v.10.

Results

Hispanic Caribbean mothers lived in the most deprived neighborhoods (average deprivation score of neighborhoods = 0.9), followed by African Americans (0.8), Mexicans (0.7), and Africans (0.6) (Table 1). Non-Hispanic whites lived in the least deprived neighborhoods (deprivation score = −0.5), followed by South Asians (−0.1). The overall risk for preterm birth <32 weeks was 1.3%, and for preterm birth from 33–36 weeks was 6.3%. Among term infants, the risk for low birthweight was 2.7% (data not shown). An analysis comparing the risk of these outcomes across ethnic groups is reported elsewhere.(23)

In unadjusted analyses, women living in neighborhoods in the highest quartile of deprivation had twice the risk of early preterm birth relative to those in the lowest quartile (Table 2). These measures were slightly attenuated after adjusting for individual socioeconomic position (maternal education), and then more considerably attenuated after adjusting for all individual-level covariates, primarily ethnicity (Adjusted OR (aOR) for 4th quartile=1.24, 95% CI=1.13, 1.36; aOR for 3rd quartile=1.21, 95%CI=1.11, 1.33; aOR for 2nd quartile=1.14, 95%CI=1.04, 1.24), but retained a monotonic relationship with preterm birth (Test for trend, $p<0.001$). Adjusted odds ratios for moderate preterm birth were of lower magnitude than those for early preterm birth (Table 2).

The magnitude of the measures of association relating neighborhood deprivation to preterm birth varied somewhat by ethnic group (p=0.07) (Figure 1). The association for preterm birth was of greatest magnitude among Hispanic Caribbean women, with an aOR of 1.63 for delivery <32 weeks for women living in neighborhoods in the highest quartile of deprivation relative to the lowest (95% CI= 1.27, 2.10), and an aOR for delivery 33–36 weeks of 1.32 (95% CI=1.02, 1.70). Among Hispanic Caribbean women there also was a significant trend with increasing level of deprivation for both early ($p<0.001$) and moderate preterm birth (p=0.03). Neighborhood deprivation was also associated with both levels of preterm birth among Central/South Americans (aOR for delivery <32 weeks, 4th quartile versus 1st quartile=1.39, 95% CI=1.04, 1.87, test for trend p=0.07); aOR for delivery 33-36 weeks, 4th quartile versus 1st quartile=1.18, 95% CI=1.02, 1.36, test for trend p=0.02). Among East Asian and African American women, living in the most deprived neighborhoods was associated with preterm birth at 33–36 weeks only, (aORs for 4th quartile versus 1st quartile =1.29, 95% CI = 1.05, 1.57, and 1.12, 95% CI=1.02, 1.22, among East Asian and African American women, respectively) with a significant trend with increasing level of deprivation (p=0.01 for both groups).

In unadjusted analyses, neighborhood deprivation was associated with term low birthweight; this association was attenuated but still significant after adjusting for individual-level covariates, primarily ethnicity (aOR for 4th quartile = 1.19, 95% CI = 1.11, 1.27, aOR for 3rd quartile = 1.09, 95% CI = 1.02, 1.16, aOR for 2nd quartile = 1.14, 95% CI = 1.07, 1.21, Test for trend $p<0.001$)(Table 2). This association varied in magnitude by ethnic group ($p<0.001$) (Figure 2). Living in a neighborhood in the highest quartile of deprivation was significantly associated with term low birthweight among African, Mexican, African American, and Hispanic Caribbean women, and for each of these groups there was a significant trend with increasing level of deprivation (p=0.01,p=0.01, p=0.001, $p<0.001$, respectively). African women living in the most deprived neighborhoods had an adjusted odds of delivering a term low birthweight infant 1.47 times that of those living in the least deprived neighborhoods (95% CI = 1.02, 2.13). Odd ratios of similar magnitude were found among Mexican women (aOR for 4th quartile versus 1st quartile= 1.46, 95% CI=1.02, 2.10). Associations of slightly lower magnitude were found among Hispanic Caribbean women (aOR for 4th quartile=1.30, 95% CI=1.11, 1.52), and among African American women (aOR for 4th quartile = 1.25, 95% CI = 1.09, 1.44). No association was found among either of the Asian groups. Among non-Hispanic whites, while there was no association for the 4th quartile of deprivation (aOR= 0.96, 95% CI=0.76, 1.21) there was a significant association for the 3rd and 2nd quartiles of deprivation (aOR=1.18, 95% CI=1.02, 1.37, aOR=1.15, 95%CI=1.02, 1.37, respectively).

Most of the ethnic groups in our study were comprised of over 90% foreign-born women, making it impractical to study whether the magnitude of the odds ratios relating neighborhood deprivation to birth outcomes varied by nativity status. However, a sufficient percentage of Non-Hispanic white women (71.5%), Hispanic Caribbean women (47.0%), and African American women (88.8%) were U.S.-born, allowing us in a post-hoc analysis to test an interaction term for neighborhood deprivation by nativity status within each of these groups. (Note that since ethnicity was self-reported, most women who reported their ethnicity as African were foreign-born (98.3%), whereas few women who reported their ethnicity as African American were foreign-born (11.2%)). There was no evidence of effect modification by nativity among Hispanic Caribbean women or African American women for either outcome. There was evidence of effect modification among Non-Hispanic White women (p=0.01); among foreign-born Non-Hispanic White women, there was a positive association between neighborhood deprivation and delivery 33–36 weeks, where as there was no association among native-born Non-Hispanic White women.

Discussion

In our analysis of New York City births, we found that women living in deprived neighborhoods were at a higher risk of preterm birth and term low birthweight relative to those living in the least deprived neighborhoods. When we examined diverse ethnic groups separately, we found substantial variation in the magnitude of the measures of association. One pathway linking neighborhood deprivation to birth outcomes that has been proposed in the literature is via psychosocial factors such as stress or lack of social support, which may impact birth outcomes by neuroendocrine, immune or vascular mechanisms. A second pathway proposed is via health behaviors known to increase the risk of adverse birth outcomes, such as smoking. The variation we observed among ethnic groups suggests that deprivation may operate by different mechanisms depending on individual ethnicity and/or cultural context.

Our finding that neighborhood deprivation is associated with adverse birth outcomes is consistent with two previous studies examining this question in New York City. Rauh et al found an association in New York City from 1987–1993 between percent below poverty level, and birthweight 1500–2499g among African Americans, but not <1500 g.(10) No association was found for Non-Hispanic Whites. Since the majority of moderately low birthweight infants are term, this is consistent with our findings among African American women that adjusted odds ratios were of the greatest magnitude for term low birthweight. Grady et al also found a significant association between neighborhood-level percent of households below poverty level and birthweight <2500g among African Americans and non-Hispanic whites in New York City for births in 2000, but did not present results stratified by race or ethnicity.(24) Our research adds to these findings by reporting an association between neighborhood deprivation and preterm birth, and by identifying neighborhood deprivation as an important risk factor for adverse birth outcomes for other ethnic groups in New York City in addition to African Americans.

It has been argued that viewing New York City through a racial framework ignores complex relationships among ethnic groups.(25) The diversity of our results among ethnic groups underscores the importance of utilizing an ethnicity framework rather than a racial one in multi-ethnic cities. For example, for both preterm birth and term low birthweight, we found a significant association for African American and African women but not for non-Hispanic Caribbean women, all groups often categorized as “Black”. The same is true for Asian groups with regards to preterm birth, with an association found among East Asian women but not South Asian women. Among Hispanic groups, an association was found among Hispanic Caribbean women for both preterm birth and term low birthweight, and among Central/South American women only for preterm birth, and for Mexican women only for term low birthweight. However, this point is not to negate the potential value of additionally studying the impact of neighborhood poverty on categories based on race, since the perceived race of a group may impact exposure to racial discrimination, which may exacerbate the effects of neighborhood poverty.

The ethnic groups we studied have many varying individual and neighborhood-level sociodemographic and cultural characteristics, which may explain the diversity in results. Ethnic groups in New York City tend to be segregated, residing in ethnic enclaves. Deprived neighborhoods in these enclaves may have negative or positive characteristics that may act as enhancers or buffers of neighborhood deprivation. An example of a negative characteristic might be housing quality. The measures of association of greatest magnitude and with the strongest dose-response relationship in our study were found among Hispanic Caribbean women, a group composed primarily of Puerto Rican and Dominican women. Relative to other ethnic groups in New York City, a high percentage of Puerto Rican families, and increasingly Dominican families, live in public housing, a factor that has previously been associated with low birthweight.(26) An example of a positive characteristic that might buffer the effects of neighborhood deprivation might be found among Non-Hispanic Caribbean women. Despite facing levels of racial segregation similar to African Americans in New York City, it has been suggested that Non-Hispanic Caribbean neighborhoods have more favorable characteristics due in part to utilization of ethnic resources and ethnic solidarity.(27) To explore such hypotheses more detailed research on specific ethnic groups is needed.

Many of the ethnic groups we examined were made up of mostly foreign-born women, within whom we found a diversity of results. Among ethnic groups with both U.S.-born and foreign-born women, we found no effect modification by nativity for term low birthweight, and effect modification by nativity for preterm birth only for Non-Hispanic White women. Thus there was no consistent pattern in our data regarding whether the effects of neighborhood deprivation on birth outcomes differ by nativity.

Our analysis of neighborhood deprivation and adverse birth outcomes had various strengths. First, we categorized women based on self-reported ethnic ancestry, which is recorded on the birth certificate independent of race. Therefore we were able to investigate for the first time the effects of neighborhood deprivation using an ethnic framework instead of a racial one. Next, the use of a neighborhood deprivation score derived specifically for New York City allowed us to examine many dimensions of neighborhood socioeconomic status simultaneously. This may be especially important when studying diverse ethnic groups, since the many dimensions of the construct of neighborhood deprivation may have different meaning in different cultural contexts, and thus exploring any one dimension singularly may overlook the importance of others. Finally, by isolating term low birthweight infants, and therefore separating the phenomena of being born too early and being born too small, we identified groups for which neighborhood deprivation was a risk factor for one outcome but not the other. Among East Asian and Central/South American women, neighborhood deprivation increased the risk of preterm birth but not term low birthweight. Conversely, among Mexican women, neighborhood deprivation increased the risk of term low birthweight but not preterm birth. These differences argue for caution in examining birthweight alone in research on the effects of the neighborhood environment on birth outcomes.

Several limitations to our study should be noted. Our analysis did not include measures of ethnic or racial segregation. Neighborhood deprivation may be on the causal pathway between ethnic or racial segregation and adverse birth outcomes. According to such a model, segregation is an antecedent factor to neighborhood deprivation, and failure to control for it in our models would not bias our reported measures of association. However, to the extent that segregation has an effect on birth outcomes independent of neighborhood deprivation, it could act as an unmeasured confounder. In the analysis by Grady, the effect of neighborhood deprivation on African Americans and Non-Hispanic Whites in New York City was attenuated by the addition of racial segregation into the model.(24) Thus unmeasured confounding by racial or ethnic segregation limited to some ethnic groups could partially explain the variation in our results by ethnic group.

This analysis also faces limitations common to the literature on neighborhood effects on health, including not accounting for neighborhood characteristics of the workplace, length of time at residence, and the characteristics of near-by neighborhoods. We also may have over-adjusted our measures of association by controlling for individual-level characteristics that might be on the causal pathway from neighborhood deprivation to birth outcomes, such as smoking status.(11) Additionally, although using birth certificate data provided sufficient numbers to examine specific ethnic groups, certain variables such as gestational age and smoking status may be less accurately reported on the birth certificate than in primary data collection. Finally, although by examining nine ethnic groups in stratified analyses we were able to demonstrate the need to incorporate ethnicity when studying neighborhood context, the large number of ethnic groups explored does not allow for a nuanced discussion of the socio-historical context of any one ethnic group in New York City.

Neighborhood deprivation was associated with preterm birth and low birthweight in New York City. However, the associations varied by ethnic group. These findings underscore the importance of taking into consideration the "EthniCities" within cities in research on neighborhood context and health. Future research should investigate causal mechanisms linking neighborhood deprivation to adverse birth outcomes within specific ethnic groups, with a priority given to those ethnic groups for whom living in a deprived neighborhood is associated with the highest increased risk of adverse outcomes.

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Abbreviations

OR	odds ratio
aOR	adjusted odds ratio
CI	confidence interval

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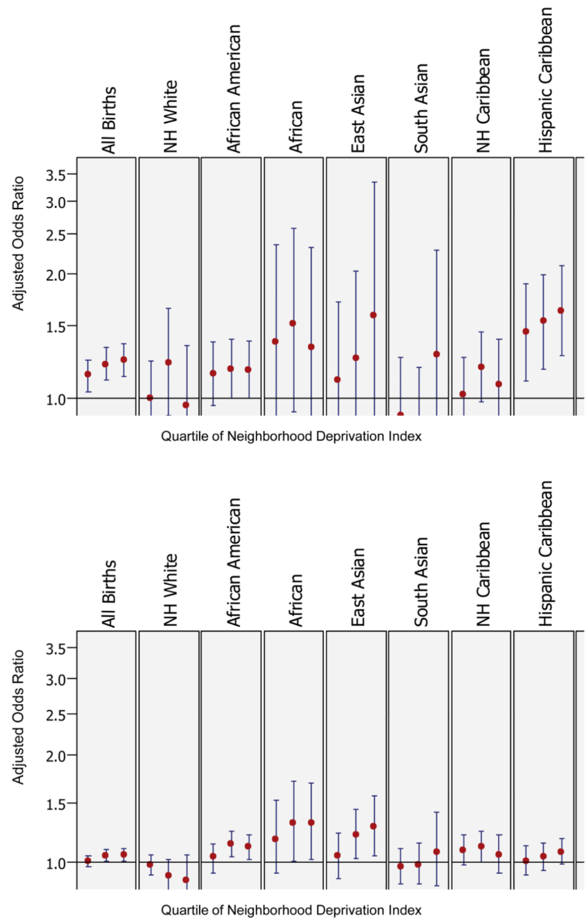

Figure 1.

Adjusted odds ratios of preterm birth <32 weeks (top panel) and preterm birth 33–36 weeks (bottom panel) with 95 confidence intervals for quartile of neighborhood deprivation index by ethnic group, New York City, 1998–2002 (n=492,332). Odds ratios were adjusted for maternal age, maternal education, parity, ethnicity, nativity, and smoking during pregnancy. Test for heterogeneity of the odds ratios (p=0.07).

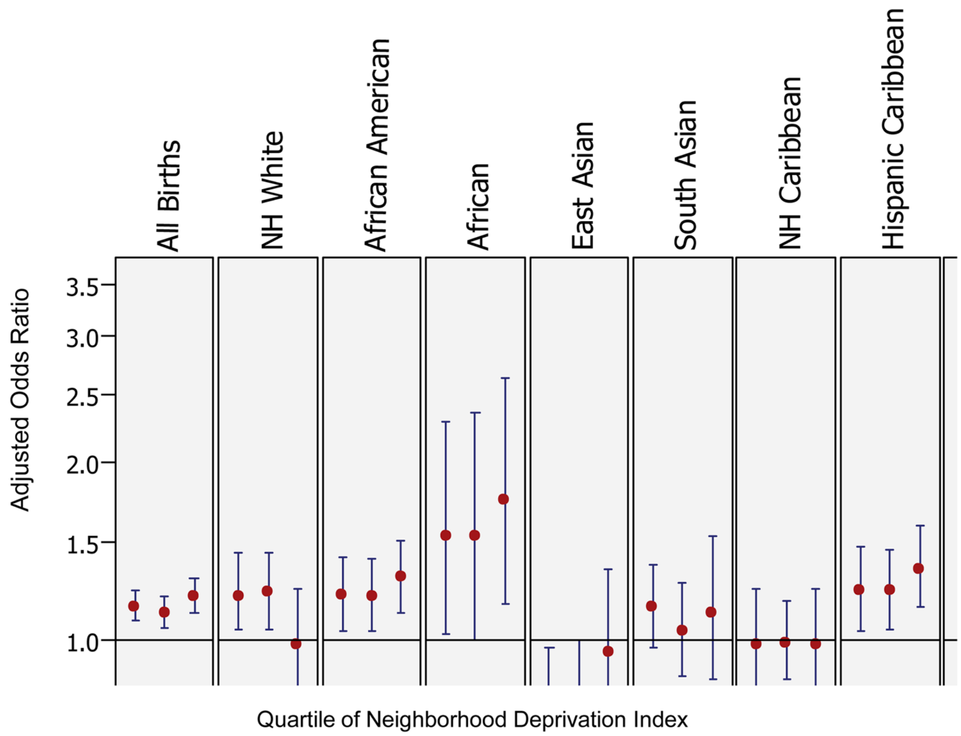

Figure 2.

Adjusted odds ratios of birthweight <2500g among term births (≥37 weeks) with 95 confidence intervals for quartile of neighborhood deprivation index by ethnic group, New York City, 1998-2002 (n=454,677). Odds ratios were adjusted for maternal age, maternal education, parity, ethnicity, nativity, smoking during pregnancy, and pre-pregnancy weight. Test for heterogeneity of the odds ratios (p<0.001).

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Table 1

Neighborhood deprivation index* by study characteristics in New York City, 1998–2002 (n=492,332).

	Neighborhood Deprivation Index			Birth outcomes		
	# births	**Mean**	**SD**	**Delivery <32 weeks (%)**	**Delivery 32–36 weeks (%)**	**Term low birthweight** ** **(%)**
Ethnic Group						
Non-Hispanic White	121,081	−0.5	1.0	0.6	4.5	1.8
African American	81,395	0.8	0.9	2.6	8.7	4.3
African	14,323	0.6	0.9	1.3	5.4	2.7
East Asian	30,426	0.1	0.9	2.2	3.8	1.8
South Asian	26,952	−0.1	0.7	3.4	5.3	4.1
Non-Hispanic Caribbean	38,866	0.3	0.7	2.0	7.9	3.0
Hispanic Caribbean	100,039	0.9	0.8	1.4	7.2	2.8
Mexican	29,464	0.7	0.8	0.8	5.7	2.1
Central/South American	49,786	0.4	0.8	1.2	6.3	2.7
Maternal age						
≤25 years	157,200	0.7	0.9	1.2	6.4	3.1
26–30	121,627	0.3	1.0	1.2	5.7	2.4
31–35	107,878	0	1.1	1.3	6.3	2.5
36–40	55,391	−0.1	1.1	1.7	7.3	2.7
≥41	12,581	−0.1	1.1	1.9	8.7	3.5
Maternal education						
<12 years	127,129	0.8	0.8	1.4	7.1	3.3
12	164,361	0.5	0.9	1.4	6.3	2.8
13–15	96,808	0.3	0.9	1.4	6.5	2.5
≥16	104,034	−0.6	1.0	0.9	5.3	2.2
Parity						
0	219,382	0.2	1.1	1.4	6.4	3.3
1	148,504	0.3	1.0	1.1	5.8	2.2
≥2	124,446	0.5	0.9	1.4	6.9	2.5
Nativity						

	Neighborhood Deprivation Index			Birth outcomes		
	# births	**Mean**	**SD**	**Delivery <32 weeks (%)**	**Delivery 32–36 weeks (%)**	**Term low birthweight** ** **(%)**
U.S.-born	215,732	0.2	1.2	1.5	6.9	3.0
Foreign-born	276,600	0.4	0.9	1.1	5.9	2.6
Smoked ever during pregnancy						
Yes	15,622	0.7	1.0	3.0	10.7	6.2
No	476,710	0.3	1.0	1.3	6.2	2.6
Total	**492,332**	**0**	**1**	**1.3**	**6.3**	**2.7**

[*] Higher score indicates greater deprivation; index is composed of the following variables from the 2000 U.S. census: less high school education, unemployed, males not in workforce, housing >1 person per room, renter occupied housing, males professional occupation, females professional occupation, males management occupation, females management occupation, individuals below poverty level, households female headed with children, households income <$30,000/yr, households on pub assist, households no car, median household income, median income-individuals >=16 w/earnings, median value of owner-occupied units

[**] Analysis restricted to term births (n=454,677)

Table 2

Unadjusted and adjusted odds ratios for neighborhood deprivation, preterm birth, and term low birth weight, New York City, 1998–2002 (n=492,332).

Neighborhood deprivation index in quartiles	Unadjusted OR	95 CI	Adjusted for maternal education	95 CI	Adjusted for all covariates*	95 CI
Delivery <32 weeks						
Q1	1.00		1.00		1.00	
Q2	1.41	(1.27, 1.56)	1.30	(1.17, 1.44)	1.14	(1.04, 1.24)
Q3	1.73	(1.56, 1.92)	1.57	(1.41, 1.75)	1.21	(1.11, 1.33)
Q4	1.99	(1.80, 2.19)	1.79	(1.61, 1.98)	1.24	(1.13, 1.36)
Delivery 32–36 weeks						
Q1	1.00		1.00		1.00	
Q2	1.12	(1.07, 1.17)	1.07	(1.02, 1.12)	1.01	(0.97, 1.05)
Q3	1.26	(1.20, 1.32)	1.18	(1.13, 1.24)	1.05	(1.01, 1.10)
Q4	1.37	(1.30, 1.44)	1.27	(1.21, 1.34)	1.06	(1.01, 1.11)
Term Low Birth Weight**						
Q1	1.00		1.00		1.00	
Q2	1.30	(1.22, 1.38)	1.22	(1.15, 1.30)	1.14	(1.07, 1.21)
Q3	1.32	(1.24, 1.40)	1.19	(1.12, 1.28)	1.09	(1.02, 1.16)
Q4	1.55	(1.45, 1.65)	1.37	(1.28, 1.47)	1.19	(1.11, 1.27)

*Adjusted for maternal age, maternal education, parity, ethnicity, nativity, and smoking during pregnancy; Term low birthweight model additionally adjusted for pre-pregnancy weight

**Analysis restricted to term births (n=454,677)