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Race and ethnic differences in determinants of preterm birth in the USA: broadening the social context

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Abstract

Preterm births occur in 9.7% of all US singleton births. The rate for blacks is double that of whites and the rate is 25% higher for Hispanics than for whites. While a number of individual correlates with preterm birth have been identified, race and ethnic differences have not been fully explained. Influenced by a growing body of literature documenting a relationship among health, individual income, and neighborhood disadvantage, researchers interested in explaining racial differences in preterm birth are designing studies that extend beyond the individual. No studies of adverse birth outcomes have considered contextual effects beyond the neighborhood level. Only a handful of studies, comparing blacks and whites, have evaluated the influence of neighborhood disadvantage on preterm birth.

This study examines how preterm birth among blacks, whites and Hispanics is influenced by social context, broadly defined to include measures of neighborhood disadvantage and cumulative exposure to state-level income inequality, controlling for individual risk factors. Neighborhood disadvantage is determined by Census tract data. Cumulative exposure to income inequality is measured by the fraction of the mother's life since age 14 spent residing in states with a state-level Gini coefficient above the median. The results for neighborhood disadvantage are highly sensitive across race/ethnicities to the measure used. We find evidence that neighborhood poverty rates and housing vacancy rates increased the rate of very preterm birth and decreased the rate of moderately preterm birth for blacks. The rate of very preterm increased with the fraction of female-headed households for Hispanics and decreased with the fraction of people employed in professional occupations for whites. We find direct effects of cumulative exposure to income inequality only for Hispanics. However, we do find indirect effects of context broadly defined on behaviors that increased the risk of preterm birth.

Keywords: Preterm; Social context; Income inequality; Racial differences

Introduction

Preterm births, defined as deliveries of less than 37 completed weeks of gestation, occurred in more than 9.7% of all US singleton births during 1996. The rate for non-Hispanic blacks was 16%, for non-Hispanic whites was 8%, and for Hispanics was 10% (CDC, 1999). The causes of preterm birth are thought to be multifactorial (Von Der Pool, 1998). Roughly 20% of preterm deliveries in the US result from medical intervention, 40% result from idiopathic preterm labor (IPL), and 40% result from premature rupture of the membranes (PROM) (Mattison, Damus, Fiore, Pertrini, & Alter, 2001; Lockwood & Kuczynski, 2001). The physiological pathways that result in IPL and PROM are not well

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understood. Maternal risk factors associated with preterm births include the number of pregnancies, short interpregnancy interval (Basso, Olsen, Knudsen, & Christensen, 1998), maternal age (Anath, Misra, Demissie, & Smulian, 2001), maternal smoking (Walsh, 1994), use of marijuana and cocaine (Kliegman, Madura, Kiwi, Eisenberg, & Yamashita, 1994), intrauterine infections, bacterial vaginosis, some extrauterine infections (Goldenberg & Culhane, 2003), hypertension (Samadi, & Mayberry, 1998), and occurrence of a previous preterm birth (Mattison et al., 2001). The prevention of preterm births has been associated with the availability of and access to prenatal care (Vintzileos, Ananth, Smulian, Scorza, & Knuppel, 2002).

While a number of individual correlates with preterm birth have been identified, race and ethnic differences in preterm birth rates have not been fully explained. Influenced by a growing body of literature that documents a relationship among health, individual poverty, and neighborhood segregation (by class or race), researchers interested in explaining racial differences in preterm birth are designing studies that extend beyond the individual. Pickett, Ahern, Selvin, and Abrams (2002) found that Census tract measures of disadvantage, including proportion of unemployed males, median household income and the change over the sample period in the fraction of the population that is black were significant predictors of preterm birth for blacks. For whites, only the change in male unemployment over the sample period was significant. Other evidence is mixed. Dole et al. (2003) found that perceived neighborhood safety was not a significant predictor of preterm birth, controlling for pregnancy anxiety, negative life events and perceived discrimination.

Neighborhood disadvantage may increase psychosocial stress and directly influence the occurrence of preterm birth through neuroendocrine and immune pathways that affect susceptibility to infection and hypertension (Wadhwa, Dunkel-Schetter, Chiez-DeMet, Porto, & Sandman, 1996; Culhane et al., 2001; Culhane, Rauh, McCollum, Elo, & Hogan, 2002). Other effects of neighborhoods may be indirect through their influence on maternal behaviors, such as drug use and short interpregnancy interval, and on access to prenatal care (Hogan & Ferre, 2001; Buekens & Klebanoff, 2001). But the potential influence of social context on preterm birth may not end at the neighborhood boundary. Income inequality, especially as it cumulates over time, can increase psychosocial stress, particularly for those who are relatively deprived. States with greater income inequality may be less willing to provide social services such as income maintenance and health care for poor women, which can also increase the risk of preterm birth. However, there has not been a study to date that evaluated whether or not there is a broader social context operating through cumulative exposure to income inequality for preterm birth, or any other adverse birth outcome.

This study evaluates the quantitative importance of social context, broadly defined, in explaining differences among blacks, whites and Hispanics in moderately preterm (gestation between 33 and 36 weeks), very preterm (gestation less than 33 weeks) and full-term births. We estimate a multilevel, multinomial logit model of the risk of very preterm and moderately preterm birth relative to term birth controlling for neighborhood contextual variables. We broaden the scope for social context to include a measure of cumulative exposure to income inequality.

Background

Explaining racial and ethnic differences in preterm birth rates remains a high priority. Studies over the last 15 years have focused on elucidating individual risk factors associated with adverse birth outcomes and assessing their importance across racial and ethnic subgroups. But these results have generally been unsuccessful in explaining the large racial and ethnic disparities in preterm births and other adverse birth outcomes. Because of the lack of progress in explaining these differences, researchers have reconceptualized the problem and have begun to explore psychological and biological mechanisms within a social context. By introducing social context, it may be possible to account for differences in exposure to psychological and physical stressors. These differences can arise from both the place in which people live and their relative social position.

In the early 1990s, the Centers for Disease Control (CDC) hypothesized that chronic stress was a major contributor to preterm births in blacks. Since then there has been progress in identifying the physiological pathways between chronic stress and preterm birth. Researchers have investigated the relationship between preterm birth, maternal stress and hormones that control the onset of labor, especially corticotropin and catecholamines. The neuroendocrine system is viewed as a possible mediating pathway between psychosocial factors and preterm birth (McCubbin et al., 1996; Wadhwa et al., 1996; Sandman, Wadhwa, Chiez-DeMet, Dunkel-Schetter, & Porto, 1997). Chronic stress and stress hormones also affect immune functions, influencing a mother's susceptibility to disease. In addition, there is a large body of research that links stress and increased risk for cardiovascular disorders, including hypertension (Wadhwa, Culhane, Rauh, & Barve, 2001). This link is key because chronic hypertension, pregnancy-induced hypertension and pregnancy-aggravated hypertension are associated with a greater risk for preterm delivery (Samadi & Mayberry, 1998).

Neighborhood disadvantage can be a source of psychosocial stress. Culhane et al. (2001) reported that high levels of chronic stress were associated with bacterial vaginosis among pregnant women. Culhane et al. (2002) found significant racial differences in stress at the community level and demonstrated a link between one neighborhood stressor, measured by the rate of homelessness, and bacterial vaginosis among pregnant women. Black women lived in less advantaged neighborhoods than white women and experienced higher rates of bacterial vaginosis.

Variation in neighborhood economic conditions can also influence preterm birth through differences in access to health care, the quality and type of food available in grocery stores, the amount of green space, the number of safe places for exercise, and the amount of environmental pollutants (Diez Roux, 2003; MacIntyre & Ellaway, 2000). Women living in disadvantaged neighborhoods have diminished access to material resources, which can influence preterm birth directly and indirectly through constraints on women's choice sets, reflected in behaviors such as timely utilization of prenatal care. Finally, higher-neighborhood socioeconomic status (SES) has been linked to increased levels of social capital. At the community level, social capital operates through established relationships and positive norms (Kawachi, 1999). Individuals residing in neighborhoods with high social capital are more likely to have effective channels of communication, to have reciprocal relationships providing mutual support, and to be influenced by positive social norms, all increasing the likelihood that healthy behaviors, such as abstention from drug use, will be adopted (Berkman, 1995; Kawachi, Kennedy & Glass, 1999).

A number of studies have linked neighborhood disadvantage to low birthweight, an adverse outcome that is related to preterm birth, among blacks but not among whites (Buka, Brennan, Rich-Edwards, Raudenbush, & Earls, 2003; Geronimus, 1996; O'Campo, Xue, Wang, & Caughy, 1997; Rauh, Andrews, & Garfinkel, 2001). One study reported no effect of Census tract poverty on low birthweight among Hispanics (Pearl, Braveman, & Abrams, 2001). In contrast, Shiono, Rauh, Park, Lederman, and Zuskar (1997) found that living in public housing and believing that chance has a major role in determining one's health had negative impacts on birthweight across an ethnically diverse sample.

Cumulative exposure to income inequality may also have an influence on preterm birth. Greater exposure to income inequality may increase the risk of preterm birth by increasing psychosocial stress through perceptions of relative deprivation (Wilkinson, 1997). But the influence of income inequality on health may go beyond the direct effects of psychosocial stress. The hypothesis has been advanced that income inequality at the state-level may be negatively related to material resources by creating political environments that are less conducive to spending on education and healthcare for poor women that are protective of health (Kawachi, Kennedy, & Wilkinson, 1999). Poor women residing in states with weak social safety nets are less likely to obtain timely prenatal care and eat nutritious diets because their choice sets are constrained by lack of services and low levels of income maintenance. Finally, increased income inequality, like neighborhood disadvantage, has been hypothesized to reduce social capital, thereby increasing the risk of unhealthy behaviors.

There is by no means a consensus that income inequality has adverse consequences for health outcomes. Several recent studies have reported no effect of contemporaneous income inequality on health. (Muller, 2002; Osler et al., 2002; Shibuya, Hashimoto, & Yano, 2002; Sturm & Gresenz, 2002). Other studies have argued that the effects of income inequality on health, if they exist at all, probably occur with a lag. But here too the results are mixed. Several studies reported that lagged measures of state-level income inequality were negatively related to self-reported health, controlling for individual income, for at least some income groups (Subramanian, Kawachi, & Kennedy, 2001; Subramanian, Blakely, & Kawachi, 2003). Mellor and Milyo (2003) report no effect of lagged income inequality on self-reported health after adjustment for individual characteristics and dummy variables for the five Census regions. These studies did not have longitudinal data and used lagged values of inequality to proxy for cumulative effects. No study has examined the potential effect of cumulative exposure to income inequality on adverse birth outcomes.

Methods

Study population

We use data from the 1979–1998 waves of the National Longitudinal Survey of Youth 1979 cohort (NLSY79) to test the hypotheses that the risks of very and moderately preterm birth increase relative to term birth with increases in neighborhood disadvantage and cumulative exposure to income inequality. The NLSY79 surveys were conducted annually between 1979 and 1994 and biennially thereafter. The NLSY79 is a longitudinal survey that includes a national sample of civilian women born between 1957 and 1964, residing in the US at the end of 1978, with oversamples of Hispanic and black women. Individuals who reported Asian ethnicity comprised less than 2% of the sample. They were excluded because the sample size was too small for a separate analysis. This study included all singleton births occurring in the US to native-born women who delivered between 1979 and 1998. We further restricted the sample to observations with valid length of gestation and maternal interview in the year of birth of the child. In 1979, the mothers ranged in age from 14 to 21; by 1998, they ranged in age from 34 to 41. Thus, our study sample is not representative of all children who are ever born to this cohort; it under-represents births to mothers under the age of 21 and over the age of 34. The final analyses were conducted on 1917 births to 1033 black mothers, 2842 births to 1664 white mothers, and 1133 births to 602 Hispanic mothers.

Data construction and measures

Our outcomes of interest are moderately preterm birth (between 33 and 36 weeks gestation) and very preterm birth (less than 33 weeks) based on mother-reported length of gestation. We chose to work with moderately preterm and very preterm birth instead of low birthweight because low birthweight is a heterogeneous variable that includes preterm birth, small for gestational age and births that are both preterm and small for gestational age. Since these outcomes may have different etiologies, the current study advances understanding by focusing on the effects of social context on very preterm and moderately preterm birth for three race/ethnic groups. While accuracy in self-reported measures is a concern, research on maternal reporting of length of gestation indicates that these reports are generally accurate (McCormick & Brooks-Gunn, 1999). We cannot verify the accuracy of our self-reported measures against a nationally representative sample because we observe births over a limited span of these mother's childbearing years. In our study sample, the rates of preterm births to blacks and Hispanics are below the national average for women of all ages, whereas the rates of preterm births to whites are above the national average.

All individual-level data on length of gestation and bio-behavioral risk factors were collected biennially beginning in 1986 from the child supplements and matched back to maternal characteristics at the time of the child's birth from the main files of the NLSY79. Data on individual SES, measured by marital status, maternal education and family income, were collected annually until 1994 and biennially thereafter. Preliminary studies showed that the protective benefits of family income declined with increases in the level of family income. Therefore, in the analysis we used the natural log transformation of family income. We exploited the longitudinal data to construct a variable to indicate whether the mother had a previous preterm birth. We also constructed a variable to indicate whether the birth occurred within 12 months of a prior birth. Since evidence suggests that preterm birth is a greater problem for young mothers and older mothers, we use both the mother's age and the square of her age in the regressions. This specification allows for a U-shaped relationship between maternal age and risk of preterm birth. Other risk factors considered in this study are prenatal care during the first trimester, prepregnacy BMI, and use of marijuana, cocaine, alcohol and cigarettes during pregnancy.

Individual-level data were linked to neighborhood characteristics from the 1980, 1990 and 2000 Census of Population, Summary Tape Files 3a. The neighborhood was defined as the Census tract of residence. Inter-Census years were linear interpolations of the decennial characteristics. We report results that used the tract poverty rate as a measure of neighborhood conditions because this is the measure most widely used in other multilevel birth outcome studies. However, we reestimated the model using other measures of neighborhood disadvantage including housing vacancy rate, fraction of female-headed households and the fraction of workers in professional occupations, a measure of neighborhood advantage.

In each year, we compared the Gini coefficient in the mother's current state of residence with the median state Gini coefficient for that year. We then computed the fraction of her life since age 14 that she had spent in states with a Gini coefficient above the yearly median. Gini coefficients are calculated from the decennial Census. Yearly state-level Gini coefficients are linearly interpolated between Census years. We chose to measure this exposure from age 14 because it is the first age for which we have residential information for all mothers. When information on state of residence was missing between consecutive interviews, we assumed that the mother spent equal time in the two states in which she reported living.

Between 1969 and 1999 the mean state Gini coefficient rose from 0.359 to over 0.416 and the standard deviation rose from 0.026 to 0.031. In 1969, the states with the highest Gini coefficients were Mississippi, the District of Columbia, Arkansas, Louisiana and Florida. In 1999, the states with the highest Gini coefficients were the District of Columbia, New York, California, Louisiana and Texas. Variation in the measure of cumulative exposure to income inequality comes from variation over time and across states in the Gini coefficients; it does not directly reflect variation in the mothers' ages.

Data analysis

The analysis proceeded first with basic descriptive comparisons of variable means for blacks, whites and Hispanics. We then estimated multinomial logit model with three outcomes: very preterm, moderately preterm and term births. We report relative risk ratios that represent the effect of a one-unit change in the explanatory variable on the risk of being very or moderately preterm relative to the term births. Since relative risk ratios in multinomial models are difficult to interpret, we also report difference between the predicted probabilities for a series of counter-factuals. For discrete variables we calculate the predicted probabilities assuming the discrete variable takes a value of 1, holding all other explanatory characteristics at their observed levels, and subtract from the predicted probabilities assuming the discrete variable takes a value of 1. For continuous variables, we compare the predicted probabilities adding a constant increment to the variable, holding all other explanatory characteristics at their observed values. We report robust standard errors clustered on the mother's identifier to control for the non-independence of observations on the same mother, i.e. multiple births per mother. Estimates were obtained using Stata. The models were estimated both separately by race/ethnicity and pooled.

In addition to the individual risk factors and behavioral risk factors, all models have dummy variables for four regions of residence (northeast, midwest, south and west) and urban residence. These fixed factors control for unobserved regional differences in welfare, rurality and regional differences in the organization of public health services that may affect preterm birth. The models also include parameters for missing explanatory variables.

Results

Table 1 presents the variables used in this analysis by race and ethnicity. While the only statistically significant race/ethnic difference in preterm birth in this sample was the black/white difference in very preterm, there were large race/ethnic differences in the risk factors for preterm. Black and Hispanic mothers were younger, less likely to be nulliparous as a consequence of having more children, more likely to have had a short interpregnancy interval, and less likely to have received prenatal care in the first trimester than white mothers. In addition, blacks were more likely than whites to have had a previous preterm birth and to drink or use drugs during pregnancy. Black and Hispanic mothers had lower individual SES than whites as measured by marital status, education and family income. Their mean poverty rate in Census tract of residence was more than twice as high as that for whites. Black and Hispanic mothers had greater cumulative exposure to income inequality than white mothers. Given the secular rise in Gini coefficients and the fact that black and Hispanic mothers were younger than white mothers, we would expect these two groups to have a lower cumulative exposure to income inequality. The higher exposure of black and Hispanic mothers to income inequality must, therefore, be explained by race/ethnic differences in states of residence.

Table 1
Variable means and definitions

	Definition	Blacks	Whites	Hispanics
Very	<33 weeks gestation	0.03[a] (0.17)	0.02 (0.14)	0.03 (0.16)
Moderate	33–36 weeks gestation	0.10 (0.30)	0.10 (0.30)	0.09[b] (0.28)
Term	$\geqslant 37$ weeks gestation	0.87 (0.34)	0.88 (0.32)	0.89 (0.31)
Age	Age of mother	24.16[a] (4.71)	25.92 (4.65)	24.67[a] (4.67)
Parity	Nulliparous mother	0.38[a] (0.48)	0.47 (0.50)	0.40[a] (0.49)
Interval 12	Interval between births $\leqslant 12$ months	0.04 (0.20)	0.03 (0.17)	0.05[b] (0.21)
Prevpre	Previous preterm birth	0.10[a] (0.30)	0.08 (0.27)	0.08 (0.27)
Firstri	Prenatal visit in first trimester	0.79[a] (0.41)	0.85 (0.36)	0.77[a] (0.42)
Under	Prepregnancy maternal BMI <18.5	0.08 (0.28)	0.09 (0.29)	0.08 (0.27)
Obese	Prepregnancy maternal BMI $\geqslant 30$	0.11[a] (0.31)	0.08 (0.26)	0.07 (0.26)
Smoke	Smoked during pregnancy	0.28[b] (0.45)	0.32 (0.46)	0.16[a] (0.37)
Drink	Drank alcohol $\geqslant 3$ times per month during pregnancy	0.07[a] (0.25)	0.04 (0.20)	0.02[b] (0.16)
Drug	Used cocaine or marijuana during pregnancy	0.05[a] (0.21)	0.03 (0.16)	0.02 (0.14)
Msp	Married spouse present	0.33[a] (0.47)	0.84 (0.37)	0.68[a] (0.47)
Educ	Highest grade completed	12.11[a] (1.93)	12.86 (2.23)	11.60[a] (2.39)
Income	Family income in 1990 dollars	22346.87[a] (58996.7)	43953.84 (87413.16)	28067.86[a] (60142.95)
Tractpov	Poverty rate in census tract of residence	0.26[a] (0.15)	0.10 (0.08)	0.20[a] (0.13)
Cum_Gini	Fraction of years spent in states with Gini above median since age 14	0.42[a] (0.29)	0.33 (0.30)	0.46[a] (0.28)
Sample size	Number of births	1917	2842	1133
Mothers	Number of mothers	1033	1664	602

[a,b]Denote a statistically significant difference in the mean from the White sample at 1%, 5% and 10% levels, respectively.

The estimates in Table 2 are the exponentiated coefficients from a multinomial logit model of the probabilities of very preterm and moderately preterm birth relative to term birth, known as relative risk ratios. The base category is term birth. To aid in interpreting these relative risk ratios, we report the differences in the predicted probabilities for a series of counterfactuals in Table 3.

The age variables were statistically significant only in the pooled sample. We considered the case in which each mother was 5 years older than she actually was at the time of the birth, without changing her other characteristics, and compared the predicted probabilities under this scenario with the predicted probabilities generated by her actual age. We found that the risk of moderately preterm birth would have increased by 1% and the risk of term decreased by 1%. Nulliparity was significant for the white, Hispanic and pooled samples. We compared the situations in which all births were assumed to be first births with that in which no birth was assumed to be a first birth. The counterfactuals would have resulted in a decrease in very preterm birth of between 3% and 4%, a decrease in moderately preterm birth of between 5% and 8% and an increase in term births of between 8% and 11%. The magnitudes in absolute value were slightly higher for white mothers than for Hispanic mothers and in the pooled sample.

Table 2
Estimated relative risk ratios from a multinomial logit model of preterm birth

	Black	95% CI	White	95% CI	Hispanic	95% CI	Pooled	95% CI
Very preterm								
Black							1.24	0.76–2.01
Hispanic							1.42	0.81–2.49
Age	1.27	0.71–2.26	0.71	0.39–1.29	0.76	0.33–1.78	0.91	0.63–1.30
AgeSq	1.00	0.99–1.01	1.01	1.00–1.02	1.00	0.99–1.02	1.00	1.00–1.01
Firstb	0.31[c]	0.09–1.12	0.22[a]	0.08–0.57	0.20[b]	0.05–0.82	0.26[a]	0.13–0.51
Interval12	3.58[b]	1.31–9.79	9.67[a]	3.74–25.02	8.95[a]	2.32–34.60	6.10[a]	3.35–11.10
Prevpre	6.73[a]	3.27–13.86	7.25[a]	3.48–15.08	7.78[a]	2.75–22.01	7.13[a]	4.54–11.19
Firstri	0.60	0.32–1.12	0.99	0.47–2.07	0.48[c]	0.22–1.04	0.71[c]	0.48–1.04
Under	1.99[c]	0.91–4.32	0.73	0.25–2.16	4.49[a]	1.61–12.54	1.86[b]	1.13–3.09
Obese	0.29	0.07–1.28	0.43	0.10–1.86	2.79	0.77–10.11	0.61	0.27–1.35
Smoke	1.13	0.60–2.15	1.24	0.61–2.53	1.46	0.57–3.75	1.29	0.86–1.94
Drink	1.67	0.67–4.14	1.27	0.32–5.00	2.52	0.44–14.49	1.63	0.82–3.23
Drug	1.46	0.29–7.30	4.61[b]	1.17–18.24	7.26	0.61–86.05	3.04[b]	1.17–7.89
Msp	0.45[b]	0.21–0.95	0.68	0.31–1.49	1.16	0.62–2.17	0.65[b]	0.44–0.98
Educ	1.05	0.89–1.25	1.00	0.86–1.17	1.21[c]	1.00–1.48	1.07	0.97–1.18
LogIncome	1.16	0.81–1.66	1.29[c]	0.96–1.75	0.85[c]	0.71–1.02	1.02	0.88–1.18
Tractpov	7.64[b]	1.01–57.65	0.42	0.01–24.31	1.29	0.03–51.28	3.14	0.61–16.17
Cum_Gini	0.60	0.24–1.50	0.98	0.33–2.86	2.06	0.38–11.17	0.93	0.49–1.77
Moderately preterm								
Black							0.94	0.73–1.19
Hispanic							0.88	0.67–1.15
Age	0.80	0.59–1.10	0.82	0.62–1.07	0.72	0.44–1.19	0.78[a]	0.66–0.94
AgeSq	1.00	1.00–1.01	1.00[c]	1.00–1.01	1.01	1.00–1.02	1.00[a]	1.00–1.01
Firstb	1.07	0.38–3.07	0.37[a]	0.18–0.78	0.43	0.16–1.18	0.58[b]	0.36–0.93
Interval12	1.39	0.48–4.01	5.25[a]	2.49–11.09	2.67[c]	0.99–7.25	2.97[a]	1.84–4.81
Prevpre	8.07[a]	5.01–13.00	7.08[a]	4.82–10.40	7.95[a]	4.35–14.51	7.55[a]	5.84–9.77
Firstri	0.83	0.57–1.22	0.69[b]	0.49–0.97	0.64[c]	0.38–1.08	0.72[a]	0.57–0.90
Under	1.33	0.84–2.13	1.63[b]	1.10–2.41	1.95[c]	0.94–4.07	1.56[a]	1.19–2.04
Obese	0.97	0.59–1.62	0.84	0.53–1.35	1.75	0.83–3.70		0.80–1.48
Smoke	0.88	0.59–1.31	1.07	0.80–1.42	0.83	0.42–1.65	1.02	0.83–1.26
Drink	0.97	0.50–1.91	0.87	0.44–1.74	0.93	0.22–3.86	0.89	0.58–1.37
Drug	2.78[b]	1.16–6.69	0.92	0.33–2.58	6.42[b]	1.52–27.06	1.92[b]	1.08–3.41
Msp	0.74	0.50–1.09	0.85	0.59–1.21	1.04	0.58–1.85	0.86	0.68–1.09
Educ	1.1[b]	1.01–1.24	1.05	0.97–1.13	1.16[b]	1.03–1.30	1.07[a]	1.02–1.13
LogIncome	1.12	0.96–1.30	0.92	0.84–1.02	1.01	0.86–1.18	0.99	0.93–1.06
Tractpov	0.30[c]	0.08–1.09	0.62	0.07–5.58	1.03	0.14–7.67	0.72	0.30–1.74
Cum_Gini	0.97	0.50–1.89	1.10	0.69–1.77	0.40[b]	0.17–0.95	0.92	0.65–1.31

[a,b,c]Denote statistical significance at 1%, 5% and 10% levels, respectively.

Table 3
Predicted changes in length of gestation, based on multinomial logit model in Table 2

Counterfactuals	Black			White			Hispanic			Pooled		
	Very preterm	Mod. preterm	Term	Very preterm	Mod. preterm	Term	Very preterm	Mod. preterm	Term	Very preterm	Mod. preterm	Term
Age + 5 vs. Age										0.00	0.01	−0.01
Firstb = 1 vs. Firstb = 0				−0.03	−0.08	0.11	−0.04	−0.05	0.09	−0.03	−0.05	0.08
Interval12 = 1 vs. Interval12 = 0	0.04	0.01	−0.05	0.03	0.10	−0.13	0.04	0.05	−0.09	0.04	0.07	−0.11
Prevpre = 1 vs. Prevpre = 0	0.05	0.15	−0.20	0.02	0.12	−0.14	0.03	0.14	−0.17	0.03	0.17	−0.20
Firstri = 1 vs. Firstri = 0				0.00	−0.02	0.02				0.00	−0.02	0.02
Under = 1 vs. Under = 0				0.00	0.04	−0.04				0.02	0.04	−0.06
Drug = 1 vs. Drug = 0	0.01	0.11	−0.12	0.06	−0.02	−0.04	0.07	0.20	−0.27	0.03	0.08	−0.11
Hcg + 1 vs. Hgc	0.00	0.01	−0.01				0.00	0.01	−0.01	0.00	0.01	−0.01
Msp = 1 vs. Msp = 0	−0.02	−0.02	0.04							−0.01	−0.01	0.02
Log(faminc + $10,000) vs. Log(faminc)				0.001	−0.002	0.001						
Tractpov + 0.1 vs. Tractpov	0.01	−0.01	0.00									
Cum_gini*1.1 vs. Cum_gini							0.001	−0.003	0.002			

Changes reported only on coefficients statistically significant at the 5% level.

An interval between pregnancies of 1 year or less was significant for all samples. We compared the predicted probabilities assuming that all pregnancies beyond the first pregnancy were short interval with the predicted probabilities assuming that no pregnancy beyond the first was short interval. The average predicted effect was smallest in absolute value for black mothers, who would have been 4% more likely to have had a very preterm birth, 1% more likely to have had a moderately preterm birth and 5% less likely to have had a term birth. White mothers would have been 3% more likely to have a very preterm birth and 10% more likely to have had a moderately preterm birth. Hispanic mothers would have been 4% and 5% more likely to have had, respectively, a very preterm and a moderately preterm birth. The results for the pooled sample showed that the average effect of short interpregnancy interval was an increase of 4% and 7% for very and moderately preterm birth, respectively.

Previous preterm birth was significant for all samples. We compared the predicted probabilities assuming that all pregnancies beyond the first had been preceded by a previous preterm birth with the predicted probabilities assuming that no birth beyond the first had been preceded by a previous preterm birth. The difference in the predicted probabilities in absolute value was greatest for black mothers. Black mothers would have had 5% more very preterm births and 15% more moderately preterm births if all multiparous women had had a previous preterm birth than if no multiparous woman had had a previous preterm birth. White mothers would have had, respectively, 2% and 12% more very preterm and moderately preterm births. Hispanic mothers would have had 3% and 14% more very and moderately preterm births. In the pooled sample, the average effect of previous preterm was 3% more very preterm and 17% more moderately preterm births.

Receipt of prenatal care during the first trimester was significant only for white women and in the pooled sample. We compared the hypothetical situation where every mother received first trimester prenatal care with the one in which no mother received first trimester prenatal care. For whites and in the pooled sample the average effect of first trimester prenatal care was a 2% decrease in moderately preterm birth and a 2% increase in term births.

Drug use was significant for all samples. We compared the counterfactuals in which all mothers used marijuana and cocaine during pregnancy with the one in which no mother used marijuana or cocaine during pregnancy. Hispanic mothers had the greatest response. The counterfactuals increased very preterm birth by 7% and increased moderately preterm birth by 20% among Hispanic mothers. Among black mothers, the average effect of drug use was an increase of 1% in very preterm birth and an 11% increase in moderately preterm birth. Among white mothers, the average effect of drug use by all mothers was an increase in very preterm birth of 6%, a reduction in moderately preterm birth of 2% and an increase in term birth of 4%. For the pooled sample, drug use by all compared to drug use by none would have increased very perterm birth by 3% and increased moderately preterm birth by 8%.

Education was significant for blacks, Hispanics and in the pooled sample. We compared the predicted probabilities under the assumption that each mother had one more year of education than she actually had with the predicted probabilities using her actual education. In all cases, an additional year of education would have resulted in 1% more moderately preterm births and 1% fewer term births. Marital status was significant only for black mothers and in the pooled sample. We compared the case in which all mothers were married with the case in which no mother was married. For black mothers, the average effect of being married was a 2% decrease in both very and moderately preterm births and a 4% increase in term births. For the pooled sample, the average effect was to reduce both very and moderately preterm births by 1% and increase term births by 2%.

Family income was significant only for white mothers. We compared the predicted probabilities under a counterfactual where each mother had $10,000 higher family income than she actually had with the predicted probabilities given her actual income. This would have resulted in an increase of a 0.1% increase in very preterm and term births and a 0.2% decrease in moderately preterm births.

Neighborhood poverty rates were significant only for black mothers. We compared the predicted probabilities under a counterfactual in which each mother lived in a neighborhood with a poverty rate 10% higher than the poverty rate in her actual neighborhood with the predicted probabilities given her actual neighborhood poverty rate. This counterfactual would have resulted on average in a 1% increase in very preterm births and a 1% decrease in moderately preterm births. The cumulation of exposure to income inequality was significant only for Hispanic mothers. We compared the predicted probabilities of a counterfactual in which each mother spent 10% more time since age 14 in states with a yearly Gini coefficient above the yearly US median with the actual predicted probabilities of the model. (The fraction of time that any mother can spend in state with above-average Gini coefficients was capped at 1.) Spending 10% more time in high Gini states would have resulted in a 0.2% increase in very preterm birth, a 0.3% decrease in moderately preterm birth and a 0.1% increase in term births. No effect of contemporaneous exposure to income inequality on preterm birth was found.

We tested alternative measures of neighborhood disadvantage. The housing vacancy rate in the Census tract of residence was statistically significant only for black mothers. Housing vacancy rates that were 10% higher than the vacancy rate in black mothers' actual neighborhood of residence would have increased very preterm births by 2%, decreased moderately preterm births by 1% and decreased term births by 1%. The fraction of workers in professional occupations, a measure of neighborhood advantage, was statistically significant only for whites. Neighborhoods in which the fraction of workers in professional occupations was 10% higher than the rate in white mother's actual neighborhood of residence would have decreased very preterm birth by 0.3% and increased term birth by 0.3%. The fraction of female-headed households was statistically significant only for Hispanics. Neighborhoods in which the fraction of female-headed households was 10% higher than the rate in Hispanic mothers' actual neighborhood would have increased very preterm births by 1% and decreased term births by 1%.

Finally, we investigated the hypothesis that neighborhood poverty rates and exposure to income inequality had indirect effects on preterm birth through their effects on behaviors. We estimated a series of random effect probit models with different behaviors as the endogenous variable and the full complement of explanatory variables used in the preterm birth equations. We report only results that were statistically significant at the 5% level. We found that probability of short interval pregnancy increased with the neighborhood poverty rate for blacks and whites. The probability of receiving prenatal care during the first trimester of pregnancy decreased with increased exposure to income inequality for blacks and whites. Drug use increased with both neighborhood poverty and exposure to income inequality for blacks and whites. The models were rerun using contemporaneous exposure to income inequality and no indirect effects on behavior were found.

Discussion

In this paper, we examined the effect of social context in explaining racial/ethnic differences in preterm births. We found a significant direct association between neighborhood poverty and very preterm births for blacks but not for whites and Hispanics. This finding is consistent with studies on neighborhood context and low birthweight that found a similar relationship between neighborhood poverty and low birthweight. An increase in neighborhood poverty exacerbated the problem of preterm birth for blacks by reducing the length of gestation for some births that would have moderately preterm and shifting them into the very preterm category. While neighborhood poverty was not associated with preterm births for whites and Hispanics, we found that for whites the fraction of workers in professional occupations and for Hispanics the fraction of female-headed households was associated with preterm birth. The magnitude of the neighborhood effect for Hispanics was comparable to that for blacks, but the effect for whites was less than 1/3 of the effects for the two minority groups.

Pickett et al. (2002) also found that blacks and whites differed in the particular measure of neighborhood disadvantage that affected preterm birth. Together, these findings raise the question of how neighborhood disadvantage may be defined more appropriately within the particular culture and social circumstances of different groups. There are also differences across groups in the levels of different measures of neighborhood advantage and disadvantage. If there are threshold effects, such a minimum concentration of poverty above which concentrated poverty becomes a neighborhood disadvantage, then different race/ethnic groups may be observed to respond differently to different measures although if they had similar circumstances they would respond in the same manner. There is as yet no theoretical reason to measure disadvantage or advantage along any one particular dimension. Studies such as this one that use Census tract data to proxy for neighborhood disadvantage can at best run a horse race between the different measures and provide directions that more detailed neighborhood surveys might pursue in developing theoretically appropriate measures of disadvantage relevant to different populations.

The Public Health Disparities Geocoding Project (Kreiger, Chen, Waterman, Rehkopf, & Subramanian, 2003) has made progress in determining the appropriate level of geography at which to measure neighborhood disadvantage and which measures of neighborhood disadvantage best explain child health. They found that measures at the tract or block group level performed about equally well, but measures at the zip code level tended to detect smaller differences in children's health. They also found that measures pertaining to income and poverty were more predictive than those relating to education, occupation or wealth. However, their work to date does not address why some measures are more predictive for one race/ethnic group than for others. While the Geocoding Project has advanced our understanding of the appropriate geographic level and provided information on how measures compare in the general population, still unanswered is whether measures of disadvantage may be culturally sensitive or related to aggregate group circumstances and, if so, why these differences occur.

We found direct effects of cumulative exposure to income inequality on preterm birth only for Hispanics. The results were not unidirectional, because greater exposure to income inequality decreased moderately preterm birth while it increased both very preterm and term births. These findings do not provide strong support for a direct pathway from income inequality to preterm birth. However, for blacks and whites we found indirect effects of cumulative exposure to income inequality on two behaviors, short-interval pregnancies and drug use, which had a significant impact on very and moderately preterm birth. These are two behaviors that may be affected by receipt of prenatal and postnatal care. We also found that the probability that black and white women received prenatal care during the first trimester was reduced by increases in cumulative exposure to income inequality. One possible explanation for this finding is that black and white women with greater exposure to income inequality either have reduced access to timely prenatal care or a more tenuous relationship with medical providers and are less likely to seek prenatal care. The authors have calculated that the average correlation between yearly state-level Gini's and state uninsured rates, as reported by the US Census Bureau Historical Health Insurance Tables (http://www.census.gov/hhes/hlthins/historic/hihistt4.html), between 1987 and 1999 was 0.59. Women residing in states with higher income inequality were more likely to be uninsured. Thus, it is plausible that poor, pregnant women who have spent more of their lives residing in states with high income inequality have faced a lifetime of reduced access to healthcare which, for reasons of experience or reduced contemporaneous access to prenatal care, resulted in lower rates of first trimester prenatal care.

It should be stressed that the indirect effect of exposure to income inequality on behavior was found only for cumulative exposure and not for contemporaneous exposure to income inequality. Both direct and indirect effects of context on birth outcomes may accrue gradually. Geronimus (1996) first formalized this argument with the weathering hypothesis. More recently, Lu and Halfon (2003) suggested that racial disparities in birth outcomes should be examined in terms of cumulative exposures over the life course.

There are a number of limitations to the current study. First, we had self-reports of length of gestation. Second, the observation window for our sample provided a non-representative sample of all births that ever occurred to women of the 1957–1964 birth cohort. Consequently, the rates of preterm birth in our sample did not conform to the national statistics reported for cross-sections of women of all ages. Third, we observed births over a 20-year period between 1979 and 1998. There have been significant practice changes during this time for which we cannot account. One of the largest practice changes has been in the rise in scheduled preterm deliveries. This may be reflected in our finding that moderately preterm birth rises with education or income for some groups. Older mothers, giving birth in the later years of the observation window, tend to have both higher education and higher income than younger mothers giving birth in the early years of the observation window. Women with higher individual SES may also have had greater access to medical care and may have avoided a very preterm delivery by delaying the onset of labor and having a moderately preterm delivery instead.

Our results suggest that there are multiple levels at which social context affects preterm birth. The effects can occur through cumulative exposure to income inequality as well as contemporaneous exposure to neighborhood disadvantage. Furthermore, the effects of context are not confined to direct effects. There are also important indirect channels through which context may alter behavior by changing access to material resources, attitudes towards healthy behaviors and social norms. Studies to date have examined only the direct effects of neighborhood context. Our findings highlight the importance of broadly defining social context, considering cumulative as well as point-in-time effects, and examining indirect influences on behaviors as well as direct effects on birth outcomes. Examination of the indirect effects of social context on availability of material resources and maternal choice may be a fruitful direction for future research on social context and health.

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