Poverty, Education, Race, and Pregnancy Outcome

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Few studies have considered the differing impact of socioeconomic factors on pregnancy outcomes among racial subgroups. We assessed pregnancy outcome by race, education, and income (poverty index), using data from the Pregnancy, Infection, and Nutrition Study, a cohort study of preterm birth in central North Carolina, using binomial regression. Poverty was associated with an increased risk of preterm birth only among African Americans with 12 or more years of education (RR=1.6, 95% CI: 1.1, 2.2). White participants with both a low level of education and an income below the poverty line were at increased risk of preterm birth (RR=1.7, 95% CI: 1.1, 2.7). White women with 12 or more years of education had increased risk of small-for-gestational-age birth (SGA, defined as <10th percentile of birth weight for gestational age) associated with poverty status (RR=1.7, 95% CI: 1.1, 2.7). Socioeconomic indicators appear to have complex joint effect patterns among racial subgroups, perhaps because the material and psychological implications of education and income status differ between groups. (*Ethn Dis*. 2004;14:322–329.)

Key Words: Ethnic Groups, Premature Infant, Small for Gestational Age Infant, Social Class, Socioeconomic Factors

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Introduction

Studies have consistently demonstrated that African Americans experience a greater risk of preterm birth than Whites,[1–2] with the increased risk most pronounced for the more severe, early preterm births.[3–4] Socioeconomic, psychosocial, behavioral, biomedical, and healthcare influences have been studied as possible sources of this disparity.[5–9] Some aspect of "socioeconomic status" is often invoked as an underlying cause of this inequality, given the marked socioeconomic differences between African Americans and Whites resulting from America's long history of racial segregation and discrimination. However, among the most ostensibly comparable groups of highly educated women, substantial racial disparities in outcome remain.[2,10,11] Although direct comparisons between African Americans and Whites are often problematic on both substantive and methodologic grounds,[12,13] understanding the causes of, and reducing the incidence of, adverse outcomes among recognized high-risk groups, including African Americans, is an urgent public health goal.

Lower social class, income, and education are generally associated with increased risks of spontaneous preterm birth.[14–16] However, the impact of socioeconomic factors appears to differ across racial groups,[17,18] with little research to directly evaluate why markers of socioeconomic status do not appear to convey the same implications for African Americans and Whites. Presumably, this would occur if the relationships between markers of socioeconomic status, and behavioral, healthcare, and biological mediators of the effect on pregnancy outcome, differ across these groups. African Americans and Whites at equal levels of common social indicators remain profoundly unequal in other, often unmeasured, dimensions of material advantage,[19] unequal in medical treatment,[20] and with differential access to other beneficial environments and experiences.[21] Thus, having a given level of education or even family income does not have the same implication for life circumstances, health care, and, quite possibly, for health behaviors.

We analyzed data from the Pregnancy, Infection, and Nutrition (PIN) Study, a prospective cohort study of preterm birth in central North Carolina,[22] to assess patterns of preterm birth and fetal growth restriction by race, educational attainment, and annual household income, as well as to evaluate socioeconomic status, race, and pregnancy outcome among women residing in the area. We were particularly interested in the joint effects of low educational status and poverty, in relation to pregnancy outcome, among African-American and White women. To better understand the extent to which these patterns among PIN study participants may reflect patterns unique to the study cohort, we also evaluated the relationships using vital records for women in the same geographic area. We were thus able to consider the influence of socioeconomic factors on pregnancy outcome by race, for both area and PIN study women.

Methods

The PIN study was conducted at prenatal care clinics affiliated with the University of North Carolina Hospitals, with Wake County Human Services, and the Wake Area Health Education

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Center. As described in detail elsewhere,[22] women were recruited at 24–29 weeks' gestation, and were interviewed by telephone in the subsequent 2 weeks to collect information on health behaviors, symptoms of infection during pregnancy, levels of physical exertion, employment, and other potential risk factors for preterm birth. Participants reported educational attainment, annual household income, and the number of adults and children supported by that income (for calculating the poverty index).[23] Given the clinic locations, most patients resided in central North Carolina.

Recruitment began in August 1995 at University of North Carolina Hospital clinics, and in February 1996 at the Wake County sites, ending at the Wake sites in June 1998, and has continued at University of North Carolina Hospital clinics. The analyses presented here include women whose last menstrual periods occurred between January 26, 1995 and April 30, 2000, restricted to those who self-identified as White or Black/African-American. During that time, 4,673 women were identified as eligible, by having come to the participating clinic prior to 30 weeks' gestation with a singleton pregnancy, having access to a telephone, being able to communicate in English, and planning to continue care and deliver at a study hospital. The exclusion based on language effectively resulted in our inability to recruit most Hispanic women in the participating clinics. Therefore, "White" refers to "non-Hispanic Whites" in this analysis.

Among those eligible, 2,958 (61.4%) were successfully recruited, based on willingness to provide genital tract specimens, with approximately 28% lost due to patient refusal, 5% due to an inability to make contact at the time of their clinic visit, 4% due to physician refusal, and 1% for other reasons.

Among the 2,958 women recruited during this period of the study, 2,685 women (91%) completed the telephone interview. Patterns of participation were analyzed in detail,[22] and suggest that those recruited were generally similar to those eligible, but not recruited, particularly with respect to adverse pregnancy outcome. For the analyses comparing the PIN study participants to the area population based on vital records, the PIN study group was further restricted to the 2,169 women with delivery dates from 1996 to 2000, from Alamance, Orange, and Wake counties, the 3 counties from which the majority of PIN study participants were recruited. We then excluded the 68 African-American and 49 White women, aged 16–17, whose high school education would potentially be incomplete, leaving 2052 women in the final analysis. Vital records were similarly restricted.

Three measures of socioeconomic position were considered: mother's years of education (excluding women with $<$12 years of education who were still in school at the time of pregnancy); total annual household income (including parents if part of the mother's household); and poverty index, incorporating the number of adults and children supported by the household income,[23] and expressed as a percent of the level that defined poverty in 1996.

Gestational age was assigned using an algorithm that combined last menstrual period with ultrasound dating. If both were available, and the dates were within 14 days of each other, the last menstrual period was used to assign gestational age, whereas if the disparity was more than 14 days, the ultrasound dating was used. If a reliable last menstrual period date was not available, we used the earliest available ultrasound. For this cohort, 80% of women had both last menstrual period dates and ultrasound, 11% ultrasound only, and 9% last menstrual period only. Most of the ultrasounds were taken prior to the 20th week of gestation (89%). Where both were available, gestational age was assigned based on last menstrual period in 84% of women, and based on ultrasound in 16%. Preterm birth was defined as delivery prior to the completion of 37 weeks' gestation. Fetal growth restriction was measured by identifying those infants below the 10th percentile of birth weight for gestational age, race, gender, and parity, using national norms,[24] referred to as small for gestational age (SGA).

We first examined the social and demographic characteristics of study participants relative to a full census of births from vital records in the 3 counties from which most of the patients were recruited. We compared the distribution by race, education, marital status, and age for women giving birth in those counties during the time period of the study, to the distributions of women who were recruited, and those who were eligible but not recruited. We also compared risks of preterm and SGA births for women in the PIN study relative to all women who resided in the area.

Next, we examined the relation between socioeconomic status indicators and pregnancy outcome for area women, and for study participants. Because the only available socioeconomic status indicator from vital records is educa-

tional level, which is reliably reported,[17] proportions of preterm and SGA births among PIN women and area women were compared in strata of educational level (<12 years, 12 years, >12 years) and race. In addition, for all PIN study participants (regardless of county of residence), we examined the risk of preterm delivery and SGA in African-American and White women by categorized educational level and poverty index. Exploratory analyses led to the decision to collapse the 12 years and >12 years education categories into a single category of ≥12 years, to enhance precision in light of the homogeneity in risk across the 2 strata. Based on evaluation of potential confounding factors, we adjusted for maternal age (at 24 weeks' gestation) and parity (first births vs second or later births). We found minimal confounding of these socioeconomic exposures by marital status and mother's prepregnancy body mass index (BMI). Multivariate models of race-specific risk of preterm birth, adjusted for maternal age and parity, showed that odds ratios moderately overstated the relative risks (RR), so we estimated adjusted relative risks directly with binomial regression (a generalized linear model with binomial error distribution and log link).

RESULTS

Relative to the population of women giving birth in the geographic area, the PIN study substantially over-represented African-American women compared to Whites women (43% vs 21%, respectively) (Table 1). Among both Whites and, especially, African Americans, PIN study participants had lower educational attainment than area women, due to both clinic composition and refusals to participate from college graduates. Participants of both races were much less likely to be married, and much more likely to be younger than 30 years, compared with area women. Limited recruitment of private patients in the area, and the participation of a large public health clinic, appear to account for much of this pattern.

Among Whites, participants would be expected to have higher risk compared to area women, but the risk of preterm birth was very similar for PIN participants and area women (10.8% vs 9.9%, respectively) (Table 2). The demographic profile of African-American participants would, likewise, predict higher risk of adverse outcomes for participants compared to area women, but the opposite was found (Table 2). Only 12.7% of African-American study participants had preterm deliveries, compared to 17.5% of area women, with a comparably decreased risk of birth prior to completing 34 weeks' gestation (3.7% vs 6.9%, respectively, data not shown). The favorable outcomes of African-American women in the study lessened racial differences among study participants, compared to the community. The risk ratio for preterm birth comparing African Americans and Whites was 1.8 in the area population, vs 1.2 among study participants, and 2.6 vs 1.3 for birth <34 weeks' gestation in the 2 groups, respectively (data not shown). The association between education and preterm birth by race differed in the area population, compared to study participants (Table 2). Among area African-American women, more education was predictive of lower risk, whereas among study participants, little difference was observed in relation to education. Among White women, both in the area and among PIN participants, there was a clear inverse gradient for risk of preterm birth with advancing education.

For White women, a similar inverse risk gradient for SGA was observed in both study participants and women residing in the area. Among African-American women in the area, there was a clear inverse gradient in risk of SGA with rising education; however, that pattern was not nearly as pronounced among PIN participants, due to an anomalous absence of high risk in the lowest education group. Considering poverty index and education jointly among PIN participants (Table 3), White participants who were disadvantaged on both (low income and <12 years education) were at greatest risk for preterm delivery (21.3%). Among Whites, being poor was associated with increased risk for SGA births, regardless of education. Risk for preterm birth among African Americans *increased* with advancing education, weakly among women living above the poverty line, but rather markedly among women living below the poverty line. Equivalently, among African-American women with 12 or more years of education, poverty was associated with increased risk of preterm birth, compared to those with more than 12 years of education (22.0% vs 12.8%, respectively). Incidence of small-for-gestational-age (SGA) births tended to be higher among African-American women living below the poverty line, but exhibited an irregular relationship with education, higher among women living above the poverty line with 12 years of education.

Linear contrasts of coefficients from multivariate models are shown in Table 4 for preterm birth and SGA among PIN study women, with education dichotomized at <12 vs 12+ years. For White women, taking the most favored group as the referent (12+ years of education, income at or above the poverty index), only jointly disadvantaged women showed appreciably elevated risk of preterm birth (RR=1.7, 95% CI: 1.1, 2.7). For African-American women, using the same referent category (12 or more years of education, living above the poverty line), low education level, alone, was not associated with increased risk (RR=1.1, 95% CI: 0.5, 2.3), whereas poverty, especially in combination with more education, was associated with increased risk (RR=1.6, 95% CI: 1.1, 2.2). Therefore, for African-American women, higher income was

Table 1. Sociodemographic characteristics of eligible and recruited African-American and White women in the Pregnancy, Infection, and Nutrition Study and the African-American and White women giving birth in the geographic study area: Central North Carolina, 1996–2000

	Area Population (*N*=59,979) %	Recruited into Pregnancy, Infection and Nutrition Study (*N*=2289) %	Eligible for Pregnancy, Infection and Nutrition Study, Not Recruited (*N*=1530) %
White	70	52	44
African American	21	43	48
Other	9	5	8
White	(*N*=41,887)	(*N*=1172)	(*N*=672)
Education (years)			
<9	6	2	2
9–<12	8	17	18
12	18	29	25
12–<16	20	19	12
16+	48	33	43
Marital status			
Not married	15	38	45
Married	85	62	52
Unknown	—	—	3
Age			
<18	2	3	4
18–19	4	9	9
20–29	44	53	49
30–34	32	21	23
35+	18	14	15
African American	(*N*=12,356)	(*N*=997)	(*N*=743)
Education (years)			
<9	2	3	4
9–<12	19	24	22
12	33	37	30
12–<16	25	26	17
16+	21	10	27
Marital status			
Not married	59	81	80
Married	41	18	19
Unknown	—	1	1
Age			
<16	6	5	4
16–19	9	15	11
20–29	55	63	63
30–34	19	12	15
35+	11	5	7

found to be beneficial largely among women with 12 or more years of education.

Again taking those with 12 or more years of education, and with an income at or above the poverty index as the referent group, adjusted relative risk estimates for SGA ranged from 1.0 to 1.7 for White women (Table 4), suggesting no influence of educational attainment, but an adverse effect of poverty among women with 12 or more years of education. For African-American women, adjusted relative risk estimates ranged from 0.7 (lower education and income at or above the poverty index) to 1.1 (income below the poverty index, regardless of educational level), indicating little variation in risk in relation to either education or poverty, or their combination.

DISCUSSION

The opportunity to examine patterns of education and pregnancy out-

Table 2. Comparison of education, race, and pregnancy outcome of Pregnancy, Infection, and Nutrition (PIN) Study participants (*N*=2052) and area population (*N*=52,602): Central North Carolina, 1996–2000

Mother's Race & Data Source		Preterm Delivery (<37 wks) Maternal Education (yrs)					Small for Gestational Age Maternal Education (yrs)				
		<12	=12	>12	Missing	Total	<12	=12	>12	Missing	Total
White											
Area population	%	12.4	10.6	9.2	15.0	9.9	9.5	8.3	6.5	9.7	7.2
	N	5011	7317	28,554	113	40,995	5011	7317	28,554	113	40,995
PIN Study	%	14.1	12.2	9.0	—	10.8	11.4	10.4	6.6	—	8.5
	N	185	328	610	—	1123	185	328	610	—	1123
African American											
Area population	%	20.2	19.3	15.3	21.4	17.5	13.1	8.8	7.0	21.4	8.6
	N	1825	4061	5693	28	11,607	1825	406	5693	28	11,607
PIN Study	%	13.1	12.3	12.9	—	12.7	9.2	9.3	5.9	—	8.0
	N	206	365	358	—	929	206	365	358	—	929

come among African-American and White women in the area population, as well as among the study participants, provides an informative contrast. Analyses of the area population provide an accurate summary description, but include substantial heterogeneity, due to diversity in prenatal care setting (ranging from private clinics to no care at all), and preclude incorporation of information on income, which is unavailable. In the area population, we found clear indications of a reduced risk of both preterm and SGA births, with education of 12 years or more, among both Whites and African Americans. However, among the PIN participants, the patterns of association with education and income were more complex, with less of an overall effect among African Americans, compared to Whites, and with an elevated risk of preterm birth for African-American women with 12 or more years of education and lower income.

The literature on socioeconomic gradients in pregnancy outcome is quite extensive, particularly in the United Kingdom, with most[14–16,25–27] but not all[28,29] indicating lower risk among the more advantaged. In the United States, the magnitude of socioeconomic gradients varies across studies, but most studies report relative risks of 1.5 or less, contrasting lower to higher socioeconomic groups.[30–33] Focusing specifically on the socioeconomic gradient in risk among African Americans in the United States, there is some evidence that the inverse gradients in risk for preterm birth are reduced,[5,34] and, in one case, reversed to a modest extent.[35] Analysis of the 1988 National Maternal and Infant Health Survey yielded disparate results for the relation between socioeconomic indicators and pregnancy outcome by race.[33] However, the pattern was dissimilar to what we observed, with low education and low income predictive of preterm birth among African Americans, but not among Whites, and predictive of SGA among Whites, but not among African Americans. This same pattern of a greater, not lesser, effect among African Americans was recently reported in a study of very low birth weight deliveries in Georgia,[36] and in a study of preterm birth in California,[37] at least with respect to education. These findings are inconsistent with our observation of more modest risk gradients among African-American, as compared to White, participants in central North Carolina.

Whites may more readily obtain the benefits associated with advanced education than African Americans, eg, income, medical care, housing opportunities.[38] In addition, the behavioral correlates of advancing education may differ across ethnic groups.[39] The inconsistency between the area and study populations in regard to the risk of preterm birth and the effects of education among African-American women can be viewed as a form of selection bias in which the clinic population is peculiar. On the other hand, the results accurately characterize a well-defined subset of African-American women, who received prenatal care at the county health department and university medical center clinics. Perhaps their more favorable outcomes are a reflection of their enrollment in prenatal care, in general, or, specifically, at these clinics. What is less readily explained is the absence of a reduced risk of preterm birth and SGA with advancing education for African-American mothers, in contrast with results from several previous reports. This is driven largely by a lack of increased risk among the lowest education group in the study, relative to the lowest education group in the area, perhaps simply reflecting a more substantial selection effect in this subset of women. Among the lowest education group, those who attend prenatal care, keep their appointments, and agree to participate in a rather demanding research protocol, may be more distinctive from their counterparts than from those in other education and race strata.

Race-specific multivariate analyses of

Table 3. Preterm delivery (<37 weeks) and small for gestational age births in relation to poverty status, education, and race

	Preterm Delivery (<37 wks) Maternal Education (yrs)								Small for Gestational Age Maternal Education (yrs)							
	<12		12		>12		Total		<12		12		>12		Total	
	N	% Preterm	*N*	% Preterm	*N*	% Preterm	*N*	% Preterm	*N*	% SGA	*N*	% SGA	*N*	% SGA	*N*	% SGA
White*																
<100% of poverty	94	21.3	112	12.5	70	10.0	276	14.9	81	12.4	103	14.6	64	10.9	248	12.9
≥100% of poverty	91	12.1	266	14.3	767	9.8	1124	11.0	77	7.8	244	10.7	721	7.5	1042	8.3
Total	185	16.8	378	13.8	837	9.8	1400	11.8	158	10.1	347	11.8	785	7.8	1290	9.2
African American†																
<100% of poverty	110	14.6	190	17.4	132	22.0	432	18.1	104	8.7	183	7.7	132	7.6	419	7.9
≥100% of poverty	57	12.3	198	12.6	289	12.8	544	12.7	55	5.5	193	10.4	283	4.6	531	6.8
Total	167	13.8	388	15.0	421	15.7	976	15.1	159	7.6	376	9.0	415	5.5	950	7.3

Note: This table represents the PIN cohort (deliveries span 1995–2000).

* For White women delivering preterm, there were 155 missing poverty status, 1 missing education, and 3 missing both. For White women delivering SGA, there were 146 missing poverty status, 1 missing education, 3 missing both, and 110 without SGA status.

† For African-American women delivering preterm, there were 243 missing poverty status and 4 missing both poverty status and education. For African-American women delivering SGA, there were 235 missing poverty status, 4 missing both poverty status and education and 26 without SGA status.

preterm and SGA outcomes demonstrated that jointly disadvantaged (ie, low level of education and low income) White women were at elevated risk of preterm birth, but this effect was not true for White women who were singly disadvantaged by either of these variables. Perhaps only the 2 conditions together accurately define deprivation. In contrast, the overall impact of education and income on pregnancy outcomes among African-American women was more modest and less readily interpreted. The effect of poverty seemed stronger among African-American women with 12 or more years of education, and, likewise, the adverse effect of low education was only apparent among women living above the poverty line. Perhaps the incongruity and sense of inequality associated with more education and poverty is somehow more detrimental than the more predictable combinations of lower education and poverty, or more education with adequate income. Small-for-gestational-age (SGA) birth showed a different pattern than preterm birth, with poverty (but not low education) associated with increased risk among Whites, and with little effect of either income or education observed among African Americans.

The complex and disparate patterns across race, and for the different outcomes, serve as a useful reminder of how non-specific and indirect these indices of education and income actually are.[40] The concern is not with the presence of a high school diploma, per se or the actual figure on a paycheck, but the consequences of life experiences. The inconsistency of patterns among African Americans across study populations may well reflect variability in the impact of educational attainment and income on actual deprivation or disadvantage. Clearly, African-American and White women with equal levels of reported education and income differ in their average socioeconomic origins and lifetime social exposures,[41] and with respect to non-material and psychosocial expo-

Table 4. Results of binomial regression of education, poverty status, and preterm delivery (<37 wks) and small-for-gestational-age births: risk ratios and 95% confidence intervals stratified by race: Pregnancy, Infection, and Nutrition Study, 1995–2000

	Preterm Delivery			
	White Women (*N*=1395)		African-American Women (*N*=972)	
	<12 yrs	>12 yrs	<12 yrs	≥12 yrs
<100% of poverty level	1.7	1.0	1.3	1.6
95% CI	(1.1, 2.7)	(0.6, 1.5)	(0.8, 2.1)	(1.1, 2.2)
≥100% of poverty level	1.0	Reference*	1.1	Reference*
95% CI	(0.5, 1.8)		(0.5, 2.3)	
	Small-for-Gestational-Age Births			
	White Women (*N* = 1286)		African-American Women (*N*=946)	
	<12 yrs	≥12 yrs	<12 yrs	≥12 yrs
<100% of poverty level	1.6	1.7	1.1	1.1
95% CI	(0.8, 3.0)	(1.1, 2.7)	(0.6, 2.3)	(0.6, 1.8)
≥100% of poverty level	1.0	Reference*	0.7	Reference*
95% CI	(0.4, 2.3)		(0.2, 2.3)	

* ≥12 years education and ≥100% of poverty level is referent; interaction term for education by poverty included; adjusted for parity (0, 1+) and maternal age quartiles; women ages 18 and older only.

What is less readily explained is the absence of a reduced risk of preterm birth and SGA with advancing education for African-American mothers, in contrast with results from several previous reports.

sures that are patterned by racial stratification in American society, and by culturally mediated behavioral strategies.[42,43] It would not be surprising if the reproductive health consequences of education and income also differed across racial groups, as suggested in a recent analysis of socioeconomic status and maternal and infant health among multiple race/ethnic groups in California.[17]

Direct comparison of risk in African-American and White women by social class indicators is generally impossible, because the social factor measures are incommensurate across groups.[12] Therefore, although it may be informative for surveillance purposes to assess racial disparity, it is generally not helpful for etiologic inference to attempt adjusted contrasts, when the adjustment factors are social variables that suffer from severe differential misclassification.[44] It is conceivable that with more detailed information on housing, savings, discrimination, and other dimensions of socioeconomic status and psychosocial interaction, these associations would be stronger and more consistent across racial groups, as shown in other populations[37] and under evaluation in the PIN study.

An important limitation of this study was imprecision of results in subgroups, particularly for combinations of income and education. The search for more subtle and complex patterns of risk was incomplete and subject to error as a result. Gestational age is measured with uncertainty, and although we applied an algorithm that combines information from last menstrual period and ultrasound dating in the PIN study, the analyses of vital record data are subject to greater uncertainty, due to reliance on last menstrual period information, alone. Finally, the generalizability of these findings to other settings is susceptible to error and uncertainty. That is, the meaning of indices of education, income, and race in other parts of the United States, or during other time periods, let alone other parts of the world, is likely to differ in ways that affect pregnancy outcome. By starting with observations from multiple, diverse populations using the conventional indices of socioeconomic status, a more universal understanding of the interplay between race and social class and health may ultimately be formulated and evaluated. Only by gathering such information will we be able to appreciate the commonalities and unique ways in which socioeconomic status and race jointly influence pregnancy outcomes.

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