INTERGENERATIONAL EFFECTS OF HIGH SOCIOECONOMIC STATUS ON LOW BIRTHWEIGHT AND PRETERM BIRTH IN AFRICAN AMERICANS

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As socioeconomic status (SES) increases, the incidence of low birthweight and preterm birth decreases irrespective of social class. However, low birthweight remains twice as high for African-American women as for white women even when SES is controlled. This study examines to what extent second generation high SES African-American women experience improvement in birthweight and gestational age. One hundred eighty-nine former Meharry students were surveyed. Identified were 934 births that are the children and grandchildren of these students who matriculated at Meharry. These infants are compared with a cohort of white mothers from a study in the School of Public Health at Yale University. Low birthweight was reduced in the third generation high SES African-American children (6.9%) from the second generation (11.4%) but remained higher than white children (3.3%). Results showed that African-American third generation children remained at higher risk for low birthweight than were white children (relative risk [RR], 1.78; 95% confidence interval [CI], 1.03, 3.09). Similar results were observed for preterm delivery where the increased risk to third generation African-American children was 3.16 (1.89, 5.27). Persistent strong ethnic differences in birthweight in this high SES cohort (OR = 3.16, 95% CI, 1.89–5.27) support a conclusion that African-American women have birthweight distributions that are somewhat lighter than white women. This may explain a portion of current ethnic differences in birthweight. It is also possible that persistent psychosocial and behavioral factors continue to negatively influence birthweight, even in second generation high SES African-American mothers. This explanation will require identification of powerful risk factors, which are largely unrelated to those presently under investigation. (*J Natl Med Assoc.* 2000;92:213–221.)

Key words: low birthweight ♦ socioeconomic status ♦ intergenerational perinatal outcomes ♦ ethnicity

Low birthweight, particularly resulting from preterm delivery, is the primary antecedent of infant mortality in America. Consistently, studies have shown a twofold higher rate of infant mortality in African-American populations than in white populations.[1–19] The infant mortality rate is inversely associated with socioeconomic status (SES) for both African-American and white populations; it is well established that as SES improves so does birthweight and other perinatal outcomes.[13,15–17] Nonetheless, prevailing data show that African-American women, when compared with white women, irrespective of SES, continue to have approximately twofold higher risk of giving birth to low birthweight infants (<2500 g) and a threefold higher risk of delivering very low birthweight infants (<1500 g). In studying the problem of infant mortality, we focus on birthweight and preterm delivery because they are the

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most important correlates of infant mortality and, therefore, critical indicators of risk for infant death.[20–23]

Intergenerational effects on birthweight and gestational age have been shown to exist.[24–28] However, nearly all studies on the effect of ethnicity and SES on perinatal outcome have been cross-sectional; the length of time in social position or the effect of sustained high SES on second generation African Americans has not been measured. It is unknown whether second generation high SES African-American women will have perinatal outcomes, which are similar to those of high SES white women. Data on this question will help inform us as to whether the persistent difference in birthweight between African-American and white women are primarily SES-related or whether some difference due to ethnicity persists.

At Meharry Medical College, a unique 45-year cohort exists that begins to address this gap in study design.[29] We examine whether an African-American population, with sustained high SES and similar risk factors to a similar white cohort, will experience a narrowing of the differential in low birthweight and gestational age between African-American and white mothers.

METHODS

The Meharry Cohort

In 1954 John Thomas, MD, initiated the Meharry Cohort Study to obtain sociodemographic information and baseline cardiovascular assessments on Meharry students who were then followed longitudinally and compared with a matched group of white students at Johns Hopkins University.[30–32]

In 1991, contact was made with 430 of the African-America students who had matriculated at Meharry in the 1950s and 1960s and were participants in the Cohort study. From this original cohort group we identified 484 children and 450 grandchildren for a total of 934. This was achieved by using a questionnaire that included an informed consent statement and medical release form, inquired about offspring birth certificate data, obtained spouse and former spouse addresses if different, and elicited notification of any impending births. This questionnaire was mailed to 592 of the original cohort members, and 449 responses were returned. Of the 449 respondents, 189 (42%) were ultimately included in the study; some had no children, and others responded no further because of the complexity of the study. For these 189 participants who completed the process there were 484 singleton births. We consider this response rate of 42% realistic given the fact that some of the individuals were octogenarians who had entered the study some four and a half decades earlier.

These 484 children of the original cohort were then sent the same questionnaire, and 292 replies (60%) were returned. Of these, 265 participated in the study and yielded 450 singleton births (grandchildren of the original cohort) for a combined total of 934 offspring for inclusion in the study.

To help ensure the quality of the data, a national advisory committee was formed to assist in directing the study and a professional data collection agency, Survey Research Associates, Inc., was retained. Socioeconomic status was established using criteria set forth by the U.S. Bureau of the Census[33] and others.[34] This afforded the development of a questionnaire consisting of demographics, pregnancy history, reproductive information, labor and delivery experience, and lifestyle questions.

The Yale Cohort

Ideally, we would have followed the cohort of white students from Hopkins that was part of the original cardiovascular study. We requested this group but it was not made available to us. However, we were able to obtain a similar group for comparison from a sample of women in a Yale study.[35] The Yale cohort is comprised of women obtaining their antenatal care in private medical practices and HMOs. Only the 2714 women delivering singleton births are included, and the analysis is restricted to the 2450 (90.3%) of women who are white. Women in the Yale cohort were all interviewed prior to their 16th week of pregnancy by trained interviewers during 1988 through 1992, which is approximately the time of the third generation Meharry births who form the major focus of this analysis. Information on other risk factors associated with birthweight and gestational age were collected during the prenatal interview.

The Yale study obtained birthweight within 24 h of birth. All deliveries were in hospitals with standardized protocols for umbilical cord clamping, use of scales, and scale calibration. Gestational age was calculated by direct examination of newborns within 6 to 24 h of delivery by study nurses trained to use the Ballard examination, which estimates gestational age within 95% confidence limits of ±2 weeks. If a Ballard examination was not completed (5.7%), gestational age was estimated from the date of last menstrual period.

Statistical Analysis

To compare pregnancy outcomes between the Meharry and Yale cohorts under circumstances where all other potentially determinant variables are equal, we employed multiple regression analyses. The common logistic regression model assumes that the response variable consists of independent observations of study outcome in the study participants. However, 295 Meharry parent participants (65%) had more than one birth, and repeated births by the same study subject may exhibit within-person correlation. To address this, the generalized estimating equation (GEE) was used for the analysis of longitudinal data using extensions (marginal, random effects, and transition models) of generalized linear models (GLMs).[36] GEE solved the problem of within- person correlation and gave unbiased regression parameter estimates for data with this characteristic. Because of the binomial distribution of the response variables (low birthweight and preterm delivery), we use logistic regression models with parameter estimates derived from GEE. The software used for the GEE analysis was the GENMOD procedure in the SAS program.[37]

RESULTS

Table 1 compares demographic and socioeconomic characteristics of the Meharry and Yale cohorts. The percentage of younger maternal age (<30 years) among Meharry's women was higher than the Yale cohort (relative risk [RR], 1.81; 95% confidence interval [CI] 1.64 to 2.01). The Meharry subjects were more highly educated: 93% and 86% for the original Meharry Cohort and their children, respectively, compared with 58% of Yale subjects who received 16 years or more of education. Yale women weighed more prior to birth than Meharry women (75% vs. 68% weighed >120 lbs) but they were not as tall (38% vs. 43% were >65 inches in height). The birth genders for the two groups were similar. Yale mothers did not smoke cigarettes as much as the Meharry second generation. There was little meaningful difference in the consumption of alcohol and no difference in caffeine consumption between the two groups. The Meharry second generation was less likely to have a chronic medical condition than the Yale mothers (RR = 0.5; 95% CI, 0.32 to 0.75), although these were defined somewhat differently in the two cohorts (Table 1).

The rate of low birthweight was twice as high in children of second generation Meharry mothers as it was in the Yale cohort (6.9% vs. 3.3%; RR = 2.08; 95% CI, 1.39 to 3.11), and there was a 296-g differential in mean birthweight (3183 vs. 3479 g; t = 10.5; $p < 0.001$). The second generation Meharry mothers had children with a mean birthweight 146.8 g (3183.2 vs. 3036.4g, t = 4.1, $p < 0.001$) heavier than the mean for the first generation Meharry mothers who had a low birthweight rate of 11.4% and mean birthweight of 3036.4 g. The first generation mothers had a preterm delivery rate of 11.2%, which was reduced in Meharry second generation mothers but who still showed a significantly greater percentage of births at gestational ages less than 37 completed weeks (8.2% vs. 2.9%) than the Yale cohort (RR = 2.86; 95% CI, 1.93 to 4.24) (Table 2). Cesarean delivery occurred almost twice as frequently in second generation Meharry mothers as in the Yale cohort and six times more frequently as in the first Meharry generation.

After adjusting for several potentially confounding variables (Table 3), the odds of low birthweight are reduced but remain significantly different between third generation Meharry African-American and Yale white newborns (OR = 1.78; 95% CI, 1.03 to 3.09). Mothers' height and weight before pregnancy, cigarette smoking, and alcohol consumption during pregnancy and chronic medical status were all significant additional independent predictors of low birthweight.

The increased risk of preterm birth of the third generation Meharry offspring remained three times that of the Yale cohort (OR = 3.16; 95% CI, 1.89 to 5.27) (Table 4). Other independent risk factors were cigarette smoking and alcohol consumption during pregnancy.

Finally, we modeled relative risks for low birthweight and preterm delivery between the first and second generation Meharry mothers. The actual rates are shown in Table 2, and adjustment was made for the covariates shown in Tables 3 and 4. Meharry first generation mothers had significantly higher rates of low birthweight than their daughters

Table 1. Selected Demographic and Socioeconomic Characteristics of Yale White Cohort and Meharry Black Cohorts*

	Yale cohort, number (%) or mean (SD)	Meharry first generation, number (%) or mean (SD)	Meharry second generation, number (%), or mean (SD)	RR(95% CI) or *t*-test, (Meharry second generation vs. Yale cohort)
Total births	2450	484	450	
Maternal age				
<30	695 (31.5)	289 (63.3)	241 (57.1)	18.1 (1.64–2.01)
≥30	1513 (68.5)	168 (36.7)	181 (42.9)	Reference
Years of education				
<16	1032 (42.1)	32 (6.8)	58 (13.6)	0.32 (0.25–0.41)
≥16	1418 (57.9)	436 (93.2)	369 (86.4)	Reference
Gender of births				
Male	1195 (49.2)	258 (53.3)	238 (52.9)	1.08 (0.98–1.18)
Female	1236 (50.8)	226 (46.7)	212 (47.1)	Reference
Mother's weight before pregnancy				
≤120 lb	618 (25.5)	223 (50.6)	131 (32.2)	1.26 (1.08–1.47)
>120 lb	1803 (74.5)	218 (49.4)	276 (67.8)	Reference
Mean in pounds (SD)	136.4 (24.0)	124.4 (19.2)	133.8 (22.5)	$t = 2.1$ $p = 0.03$
Mother's height				
≤65 inches	1524 (62.2)	272 (61.1)	228 (56.9)	0.91 (0.83–1.00)
>65 inches	926 (37.8)	173 (38.9)	173 (43.1)	Reference
Mean in inches (SD)	64.6 (2.7)	65.0 (2.2)	65.1 (2.5)	$t = 3.4$, $p = 0.01$
Cigarette smoking				
Not at all	2217 (91.3)	329 (95.6)	318 (89.6)	Reference
Yes	211 (8.7)	15 (4.4)	37 (10.4)	1.20 (0.86–1.67)
1–10/day	135 (5.6)	12 (3.5)	34 (9.6)	1.68 (1.18–24.1)
10+	76 (3.1)	3 (0.9)	3 (0.8)	0.28 (0.09–0.65)
Alcohol drinking				
No	1785 (73.5)	248 (54.7)	301 (73.5)	Reference
Yes	644 (26.5)	205 (45.3)	109 (26.5)	1.00 (0.84–1.19)
≤1/month	458 (18.7)	171 (37.7)	99 (24.1)	1.22 (1.01–1.47)
1–4/week	181 (7.5)	28 (6.2)	10 (2.4)	0.35 (0.19–0.65)
>4/week	8 (0.3)	6 (1.3)	0 (0)	
Caffeinated beverage consumption				
No	1059 (43.6)	79 (17.3)	173 (42.9)	Reference
Yes	1372 (56.4)	378 (82.7)	230 (57.1)	1.01 (0.92–1.11)
Chronic medical conditions†‡				
No	217 (89.2)	438 (96.3)	380 (94.8)	Reference
Yes	262 (10.8)	17 (3.7)	21 (5.2)	0.49 (0.32–0.75)

*The Meharry cohorts refer to the mothers. The births to the second generation mothers are the third generation.
†Defined in Yale cohort as self-report of being treated for heart or circulation or kidney problems, diabetes, high blood pressure, sickle cell anemia, or other chronic medical conditions.
‡Defined in Meharry cohort as self-report of being treated for anemia, placenta previa, hypertension, or other chronic medical conditions.

did (RR 1.73; 95% CI, 1.07 to 2.82); however, this difference decreased after adjustment for confounders (RR = 1.39; 95% CI, 0.80 to 2.39). The respective adjusted and unadjusted risks for preterm delivery were 1.41 (95% CI, 0.88 to 2.27) and 1.19 (95% CI, 0.65 to 2.18).

DISCUSSION

This study accords with others that show persistent negative differences in preterm birth and low birthweight among African-American women after adjustment for a wide range of socioeconomic vari-

Table 2. Pregnancy and Obstetrical Outcomes of Yale and Meharry Cohorts*

	Yale cohort, number (%) or mean (SD)	Meharry first generation, number (%) or mean (SD)	Meharry second generation, number (%), or mean (SD)	RR(95% CI) or *t*-test, (Meharry second generation vs. Yale cohort)
Birth weight				
<2500 g	81 (3.3)	55 (11.4)	31 (6.9)	2.08 (1.39–3.11)
≥2500 g	2369 (96.7)	429 (88.6)	419 (93.1)	Reference
Mean (SD)	3479.1 (530.9)	3036.4 (535.3)	3183.2 (555.7)	$t = 10.5$, $p < 0.001$
Gestational weeks				
<37	70 (2.9)	52 (11.2)	35 (8.2)	2.86 (1.93–4.24)
≥37	2380 (97.1)	413 (88.8)	393 (91.8)	Reference
Cesarean delivery				
No	2036 (83.8)	435 (95.0)	290 (68.4)	Reference
Yes	395 (16.2)	23 (5.0)	134 (31.6)	1.95 (1.65–2.30)

*The Meharry cohorts refer to the mothers. The births to the second generation mothers are the third generation.

ables,[4,8,9,12,16,26,38] specifically prenatal care[39] and college education.[40] Persistently worse pregnancy outcome in African-American women is noteworthy in the present study, because it occurs in third generation offspring born to second generation African-American women who are themselves children of first generation mothers with high SES. Second generation Meharry mothers show improved low birthweight and preterm delivery rates over those experienced by their mothers; however, these reductions were relatively modest, and poor pregnancy outcomes remained significantly higher than those observed in a comparable group of middle class white women with somewhat lower education.

A possible weakness of the present study is that the Meharry cohort was largely defined by the SES of the male spouse, all of whom had necessarily completed a college degree. However, the high level of the mother's education (93.2% had more than 16 years of education) suggests little tendency of the male cohort to marry spouses of lower SES. All of the second generation mothers were, by definition, born into upper middle class families, and their slight reduction in education (86.4% with more than 16 years) is expected because of regression to the mean effects. Moreover, they remain significantly better educated than the white cohort (57.9% with more than 16 years). The Yale cohort is comprised of white women seeking antenatal care at private medical practices; however, their lower level of education suggests that the African-American women would tend to be of higher SES and any study bias would be against finding differential reproductive outcomes in the two groups.

The Yale data were collected in similar but not identical ways. For most variables these are unlikely to affect the conclusions of the study in a meaningful way. Medical conditions were reported differently and were less prevalent in the Meharry cohort making it likely that they were under-reported. This would explain some of the ethnic differential in reproductive outcomes but is unlikely to account for most of it, because a large cohort difference persists after control for prior medical conditions.

The findings from this study neither suggest nor refute a genetic basis for the outcomes that were observed, but they raise intriguing questions that warrant further research. Our results, and those of others, challenge the notion that excessive rates of poor perinatal outcome observed in African-American women is largely due to low SES and lack of education.[40] Low SES and education are strongly associated with poorer reproductive outcome; however, our data indicate they can not fully explain ethnic differences. Other lines of evidence support this view. Native American and Hispanic women have low birthweight rates, which are similar to those of American white women[3,8,12–14] despite sharing many of the low SES characteristics widely found in the African-American population.

Two general and noncompeting hypotheses might explain the results of this study: 1) persistent stress from institutionalized racism and 2) a differential birthweight distribution in African-American

Table 3. Association of Yale and Meharry Second Generation Cohorts with Low Birthweight Adjusted for Potential Confounding Factors*

	Adjusted OR (95% CI)	*p* value
Cohort		
Yale (white)	Reference	
Meharry (African-American)†	1.78 (1.03–3.09)	0.04
Maternal age		
<30	Reference	
≥30	1.01 (0.77–1.32)	0.95
Years of education		
<16	Reference	
≥16	0.99 (0.62–1.58)	0.96
Mother's weight before pregnancy		
>120 lb		
≥120 lb	1.54 (1.01–2.43)	0.05
Mother's height		
>65 inches	Reference	
≤65 inches	5.17 (2.34–11.43)	<0.001
Cigarette smoking		
No	Reference	
Yes	2.80 (1.64–4.80)	<0.001
Alcohol drinking		
No	Reference	
Yes	1.73 (1.07–2.79)	0.02
Caffeinated beverage consumption		
No	Reference	
Yes	0.80 (0.52–1.23)	0.96
Chronic medical conditions‡		
No	Reference	
Yes	2.58 (1.47–4.53)	<0.001

*Modeled using the GEE from GENMOD in SAS.[32]
†Refers to birthweights of Meharry third generation.
‡Defined in Meharry cohort as self-report of being treated for anemia, placenta previa, hypertension, or other chronic medical conditions.

women that is shifted to the left of that for white women. Each hypothesis is reviewed briefly.

Several authors have argued that traditional methods of operationalizing stressors in epidemiologic studies do not capture the effect of stress due to racism experienced by African-American women. Coping styles and psychological resources and support networks needed to understand their negative impact have not been fully explored.[41,42] Recent work has suggested that the negative perception of African-American mothers to their environmental stressful life events increases their rate of very low birthweight.[43]

Although most subjects in that study were of low SES, too often there are unique environmental stressors that affect African Americans and from which even high SES does not exempt them. Unequal protection by law enforcement and restricted access to the housing market are two very common examples.[44]

Evidence that some of the discrepancy in birthweight may be owed to a differential birthweight distribution also comes from a variety of indirect sources. It is well known from national and other data that birthweight-specific mortality is slightly lower for African-American babies under 3000 g than for white babies. This would be expected if small African-American babies were more mature than small white babies of the same weight, which would follow a shift to the left in the normal birthweight and gestational age distributions. This is precisely what is observed in the birthweight specific

Table 4. Association of Yale and Meharry Second Generation Cohorts with Preterm Births Adjusted for Potential Confounding Factors*

	Adjusted OR (95% CI)	*p* value
Cohort		
Yale (White)	Reference	
Meharry (African-American)	3.16 (1.89–5.27)	<0.001
Mother's weight before pregnancy		
>120 lb	Reference	
≤120 lb	1.05 (0.65–1.70)	0.85
Mother's height		
>65 inches	Reference	
≤65 inches	1.51 (0.86–2.65)	0.15
Cigarette smoking		
No	Reference	
Yes	2.30 (1.24–4.26)	0.008
Alcohol drinking		
No	Reference	
Yes	2.41 (1.54–3.78)	<0.001
Chronic medical conditions‡		
No	Reference	
Yes	1.48 (0.76–2.88)	0.24

*Modeling using the GEE from GENMOD in SAS.[32]
†Refers to birthweights of Meharry third generation.
‡Defined in Meharry cohort as self-report of being treated for anemia placenta previa, hypertension, or other chronic medical conditions.

mortality of baby girls who are born with lighter weights than baby boys (average of 100 g) but are of the same maturity.[45]

Data from high SES groups in Scandinavia and elsewhere also provide strong evidence that birthweight is familial and that mothers who themselves were of low birthweight have a higher risk of delivering a low birthweight baby despite the benefit of high SES and excellent prenatal care.[9,12,24–27] Recently, David and Collins showed that a 97-g difference in birthweight persisted between low risk white women and better educated African-born African-American women living in the United States, all of whom were married to men with a least 12 years of education.[46] In that study, the occurrence of low birthweight for African-American women was significantly higher than that for white women (RR = 1.5; 95% CI, 1.0 to 2.4), but the difference in very low birthweight (<1500 g) was reduced (RR = 1.3; 95% CI, 0.4 to 4.2), further providing some support for an unexplained, modest left shift in birthweight in African-American middle class women.

Analysis of very low birthweight will be informative, because these newborns have the greatest impact on perinatal mortality. Ethnic differences in this extreme low birthweight group is unlikely to reflect an underlying biological likelihood for African-American babies to have lower birthweight or be born at earlier gestational ages than white babies. Such extreme effects are implausible when they decrease the risk of survival. Thus, greater improvement in very low birthweight, relative to low birthweight, would be expected from first to second generation high SES African-American births if the left-shifted birthweight distribution hypothesis is correct.

Additional support for the hypothesis is provided by research, which examined the relative maturity of newborns of different ethnic groups but with the same birthweight. Some evidence exists that the Dubowitz neonatal exam of physical and neurologic development shows more maturity in African-American than white babies of the same birthweight and other work suggests that diseases of the immature newborn, such as respiratory distress syndrome, are also less common in African-American than white babies of the same birthweight.[47,48] But these studies are far from definitive and more work with other measures of maturity is needed.

As a contributing factor to low birthweight and preterm delivery, the social structure of African Americans must be analyzed in much greater depth. Meharry's Cohort of two and a half generations of high SES mothers may not be of long enough duration to show a significant improvement in perinatal outcome. Past and current effects of social deprivation on African-American families may be contributory and warrant continued examination. If this hypothesis is correct, the birthweight of the fourth generation, who remain in high SES families, should exhibit further reductions in low birthweight.

To ultimately explain additional variance in the African-American and white birthweight disparity, it will be necessary to identify quite powerful new risk factors, which are largely unrelated to those already under study.

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