Adverse Perinatal Outcomes Among Interracial Couples in the United States

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Objective: We examined the association between parental race and stillbirth and adverse perinatal and infant outcomes.

Methods: We conducted a retrospective cohort analysis using the 1995–2001 linked birth and infant death files that are composed of live births and fetal and infant deaths in the United States. The study included singleton births delivered at 20 or more weeks of gestation with a fetus weighing 500 g or more (N = 21,005,786). Parental race was categorized as mother white–father white, mother white–father black, mother black–father white, and mother black–father black. Multivariable logistic regression analysis was performed to examine the association between parental race and risks of stillbirth (at ≥ 20 weeks), small for gestational age (defined as birth weight < 5th and < 10th percentile for gestational age), and early neonatal (< 7 days), late neonatal (7–27 days), and postneonatal (28–364 days) mortality. All analyses were adjusted for the confounding effects of maternal age, education, trimester at which prenatal care began, parity, marital status, and smoking during pregnancy.

Results: Although risks varied across parental race categories, stillbirth was associated with a higher-than-expected risk for interracial couples: mother white–father black, relative risk (RR) 1.17 (95% confidence interval [CI] 1.10–1.26) and mother black–father white, RR 1.37 (95% CI 1.21–1.54) compared with mother white–father white parents. The RR for stillbirth was even higher among mother black–father black parents (RR 1.67, 95% CI 1.62–1.72). The overall patterns of association for small for gestational age births (< 5th and < 10th percentile) and early neonatal mortality were similar to those seen for stillbirth.

Conclusion: There is an increased risk of adverse perinatal outcomes for interracial couples, including stillbirth, small for gestational age infants, and neonatal mortality.
(Obstet Gynecol 2005;106:81–8)

Level of Evidence: II-2

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Drs. Getahun and Ananth are partially supported through a grant (R01-HD038902) from the National Institutes of Health awarded to Dr. Ananth.

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ISSN: 0029-7844/05

Reducing untoward pregnancy outcomes has been a main public health objective in the United States and in several other Western societies.[1,2] Stillbirth and infant mortality are major forms of adverse pregnancy outcomes. Although the reported incidence of stillbirth gradually declined from 7.6 per 1,000 births in 1995 to 7.0 per 1,000 births in 2002, and infant mortality rates declined from 7.0 per 1,000 births in 1995 to 6.5 per 1,000 births in 2001 in the United States,[3–5] stillbirths continue to account for a vast proportion of overall perinatal mortality.[6,7] In 1990 the reported number of fetal deaths was 29,345 (42% of all perinatal deaths) and increased to 27,003 (49% of all perinatal deaths) in 2000.[7] In addition, substantial racial disparity in stillbirth and infant deaths in the United States persist.[8]

The proportion of infants born to mixed race (black and white) parents increased gradually from 3.3 in 1968 to 17.7 per 1,000 pregnancies in 1996,[9] corresponding to a 4-fold to 5-fold increase. Although assessment of risks for an array of adverse pregnancy outcomes with respect to maternal characteristics has been the object of scores of studies, little is known about the influence of paternal characteristics on risks of adverse pregnancy outcomes.

Studies that have examined the influence of paternal characteristics on adverse pregnancy outcomes

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have found pregnancies of mixed parental race to have higher risk of low birth weight and very low birth weight birth in comparison with same-race parents.[10] A recent study reported higher infant mortality rate among twins when parents were either both black or mixed race when compared with both white parents.[11] The purpose of this study was to examine the contributions of parental race to adverse perinatal and infant outcomes among singleton births in the United States.

MATERIALS AND METHODS

Data for this study was obtained from the National Centers for Health Statistics Linked Birth/Infant Death files collected from 1995–2001.[12] National Centers for Health Statistics links birth certificates to infant deaths with the help of data made available by the individual states and the District of Columbia. The database comprises more than 26 million births for which records were available. The Linked Birth/Infant Death data files (perinatal mortality data) includes information on live birth and fetal and infant death as well as maternal sociodemographic and behavioral characteristics, medical history, and complications during labor and delivery associated with these outcomes. Gestational age is defined as the period from the first day of the last normal menstrual period to the day of birth. When last normal menstrual period data were unavailable, or when the calculated gestational age was inconsistent with reported birth weight, a clinical estimate of gestational age was instead used.[13,14] Information on the father that was included in these data files was paternal age and race.

We conducted a retrospective cohort analysis to examine the association between parental race and the risk of adverse pregnancy outcomes (stillbirth, preterm birth, small and large for gestational age birth, and infant death) in a cohort of 21,005,786 singleton pregnancies delivered in the United States from 1995 to 2001. Self-reported maternal and paternal race were grouped as white and black, irrespective of Hispanic origin. Furthermore, we grouped parental race into 2 similar race categories ("WW" for white mother and white father, "BB" for black mother and black father) and two mixed race categories ("WB" for white mother and black father, and "BW" for black mother and white father).

The study was approved by the ethics committee of the Institutional Review Board of the University of Medicine & Dentistry of New Jersey–Robert Wood Johnson Medical School, New Brunswick, New Jersey. The analyses were performed using SAS 9.1 (SAS institute, Cary, NC).

Independent variables that were considered to be potential confounders included maternal age (<20, 20–24, 25–29, 30–34, ≥35 years), marital status (married or unmarried), parity (primiparity or multiparity), trimester at which prenatal care began (1st trimester, 2nd trimester, 3rd trimester, and no prenatal care), maternal education (<9, 9–11, 12, 13–15, 16–17 years of completed schooling), and maternal smoking during pregnancy (yes or no).

The outcomes that were examined included risks of fetal death at 20 weeks or more, early neonatal (< 7 days), late neonatal (7–27 days), and postneonatal (28–364 days) mortality. Among all live births, we examined risks of preterm birth including less than 37, less than 34, and less than 32 completed weeks of gestation, small for gestational age (SGA), and large for gestational age (LGA) births. Small for gestational age births were defined as gestational age–specific birth weight less than 10th and less than 5th percentile, and LGA births as gestational age-specific birth weight more than 90 percentile. Small for gestational age and LGA births were estimated based on the 1995 gender-specific normogram.

Of all singleton live births and stillbirths in the United States between 1995 and 2001 (N = 26,544,378), we excluded the following categories: births at less than 20 weeks and less than 500 g birth weight, women aged less than 15 years, missing paternal race or "other" races, mothers with missing maternal race or "other" race, and implausible birth weight and gestational age[15] (Table 1). The exclusion of births at less than 20 weeks of gestation and fetuses weighing less than 500 g was done in an attempt to minimize errors in gestational age estimation and to minimize interstate differences in reporting live births that were at borderline viability.[13] Also, women aged less than 15 years were excluded due to insufficient numbers.

We examined the distribution of maternal characteristics, pregnancy complications, and fetal and infants outcomes by four parental race categories (WW, WB, BW, and BB). We also calculated the crude gestational age–specific mean birth weight, and gestational age–specific cumulative rate of delivery for the 4 parental race categories. Time trends were then examined by comparing event rates in the earliest (1995) compared with most recent periods (2001) for parental race specific singleton births.

To examine the association between outcome variables and the independent variables, a logistic regression model was fitted after controlling for potential confounding variables (maternal age, maternal education, trimester at which prenatal care began, parity, marital status, and smoking during pregnancy). Risks associated with the independent variable (WW, WB, BW, and BB) were estimated using relative risk

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Table 1. Data Exclusions by Maternal Race Categories: United States 1995–2001

	Maternal Race	
	Blacks	Whites
Singleton live birth and fetal death (N)	4,199,841	21,468,461
Exclusions		
Gestational age < 20 wk or birth weight < 500 g	114,309 (2.7)	473,391 (2.2)
Maternal age < 15 y	7,120 (0.2)	5,352 (< 0.01)
Nonblack or nonwhite paternal races	10,753 (0.3)	223,497 (1.0)
Missing data on paternal race	1,576,185 (37.5)	2,188,317 (10.2)
Implausible birth weight or gestational age[15]	7,429 (0.2)	56,163 (0.3)
Total exclusions	1,715,796 (40.9)	2,946,720 (13.7)
Final data set (n)	2,484,045	18,521,741

Values are n (%) unless otherwise specified.

(RR) and 95% confidence interval (CI). The WW risk group served as a reference group in this comparison.

RESULTS

After all exclusions, we were left with 21,005,786 pregnancies that resulted in singleton stillbirth and live birth for analyses (Table 1). The rate of singleton births among WB and BW parents increased from 1.66% and 0.48% in 1995 to 2.14% and 0.64% in 2001, respectively, which accounts for a relative increase of 28.9% and 33.3% (Table 2). The rate of singleton births to BB parents showed a modest relative increase of 5.2% from 10.86% in 1995 to 11.42% 2001. Demographic characteristics showed a higher proportion of women of early child bearing age (< 20 and 20–24 years) to pregnancies of mixed or both black race parents as compared with pregnancies of both white parents (Table 3). The proportion of mothers who failed to complete high school was higher among WB, BW, and BB parents as compared with WW parents. More women in WW category sought prenatal care earlier in the pregnancy, were multiparous, and were twice as likely to be married, in comparison to women of other race-combinations. Among white mothers, the proportion of smoking was much higher when the father was black (WB) as compared with when the father was white (WW). The proportion of smoking during pregnancy was the least among mothers of both black parents.

Table 4 outlines the proportion of fetal and infant outcomes by parental race categories. The proportion of stillbirth was 3.1 per 1,000 births in pregnancies of WW parents, compared with 3.9, 4.7, and 5.8 per 1,000 births in pregnancies of WB, BW, and BB parents, respectively. Preterm (< 37 weeks) and SGA births were more common in pregnancies of mixed-race parents and both black parents as compared with both white parents, whereas the reverse was true for large for gestational age births. Risks of infant death were 3.9, 6.0, 5.9, and 7.6 per 1,000 births among pregnancies of WW, WB, BW, and BB parents, respectively. The risks of early neonatal, late neonatal, and postneonatal mortality were also higher among pregnancies of WB, BW, and BB parents, as compared with WW parents.

Crude mean birth weight and cumulative rate of deliveries by gestational age among the 4 parental race categories are shown in Figures 1 and 2, respectively. The mean birth weight difference by gestational age between WW parents and BB parents

Table 2. Proportion of Birth and Relative Percent Changes by Parental Race Categories: United States, 1995–2001

	Mother White–Father White	Mother White–Father Black	Mother Black–Father White	Mother Black–Father Black
Number of births	18,110,223	411,518	118,811	2,365,234
Births (%)				
1995	87.00	1.66	0.48	10.86
1996	86.80	1.79	0.50	10.91
1997	86.40	1.91	0.53	11.16
1998	86.02	2.01	0.58	11.39
1999	85.86	2.07	0.59	11.47
2000	85.67	2.11	0.64	11.57
2001	85.79	2.14	0.64	11.42
Relative % change*	−1.39 (−1.40, −1.38)	28.90 (28.89, 28.91)	33.33 (33.28, 33.35)	5.15 (5.15, 5.16)

* Relative % change from 1995 to 2001.

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Table 3. Maternal and Paternal Characteristics by Parental Race Categories: United States, 1995–2001

Characteristics	Mother White–Father White (n = 18,110,223)	Mother White–Father Black (n = 411,518)	Mother Black–Father White (n = 118,811)	Mother Black–Father Black (n = 2,365,234)
Maternal age (y)				
< 20	8.6	17.6	15.2	14.9
20–24	22.5	36.5	28.5	28.9
25–29	29.2	24.3	25.0	25.7
30–34	25.8	13.7	19.4	19.1
≥ 35	14.0	7.9	11.9	11.3
Paternal age (y)				
< 20	3.7	7.3	8.5	7.5
20–24	16.8	26.7	25.4	23.9
25–29	26.9	27.6	24.6	25.2
30–34	28.0	19.9	19.8	20.7
≥ 35	24.7	18.5	21.7	22.7
Maternal education (y)				
< 9	6.2	2.1	1.9	1.8
9–11	12.6	20.7	15.4	16.6
12	30.9	40.7	35.6	38.9
13–15	22.7	24.5	28.7	27.1
≥ 16	27.6	12.1	18.4	15.5
Unmarried status	18.1	56.6	42.8	52.0
Primiparity	32.7	32.5	33.7	28.0
Prenatal care began				
1st trimester	85.3	78.4	79.2	76.3
2nd trimester	10.4	15.3	14.1	15.8
3rd trimester	1.9	2.8	2.7	3.0
No care	0.6	1.0	1.1	1.3
Missing	1.8	2.4	3.0	3.6
Smoking during pregnancy				
Yes	9.8	16.0	8.9	6.3
No	71.7	66.6	73.0	83.0
Missing	18.4	17.4	18.1	10.7

Values are %. All differences in proportions are statistically significant ($P < .001$, χ^2 test).

increased gradually from 30 weeks, and at term the disparity increased to 137–176 grams. The gestational age specific mean birth weight of the various parental race categories were significantly different from one another at term ($P < .001$). The cumulative rate of delivery (Fig. 2) shows that the frequency of preterm births was considerably higher in both black and mixed race parents as compared with both white parents.

Table 5 presents the adjusted relative risks for fetal and infant outcomes by parental race categories relative to both white parents. As compared with both white parents, the RR for all adverse pregnancy outcomes was significantly higher, with the exception of LGA births, among mixed-race parents and both black parents. The relative risks for stillbirth were higher among WB, BW and BB parents relative to pregnancies among WW parents. The relative risks for preterm birth at less than 32 weeks, less than 34 weeks, and at less than 37 weeks of gestation and SGA births at less than 5 centile and less than 10 centile showed similar patterns for every parental race category. The relative risks of LGA births were marginally significant for pregnancies of WB parents, relative to WW parents. In contrast, risks of LGA births in pregnancies of BW and BB parents were lower in comparison to WW parents. Finally, risks of early, late, and post-neonatal mortality among pregnancies of other-race combinations were higher relative to pregnancies of both white parents.

DISCUSSION

The number of interracial married couples has more than doubled since 1980. The number of black/white interracial married couples in the U.S. increased from about 167,000 in 1980 to 395,000 in 2002.[16] In parallel to this increase, there has been an increasing trend in births to mixed race parents in the United States.[9] Our data show increasing trend in birth among white mother/black father from 1.66% in 1995 to 2.14% in 2001 corresponding to a 28.9% relative increase and among black mother/white father the increase was from 0.48% in 1995 to 0.64% in 2001, a relative increase of 33.3%.

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Table 4. Fetal and Infant Outcomes by Parental Race Categories: United States, 1995–2001

Perinatal Outcomes	Mother White–Father White	Mother White–Father Black	Mother Black–Father White	Mother Black–Father Black
Stillbirths (per 1,000 births)	3.1	3.9	4.7	5.8
Preterm birth (%)				
< 37 wk	8.6	10.4	12.5	14.8
< 34 wk	2.0	2.9	3.9	5.1
< 32 wk	1.1	1.7	2.4	3.1
Small for gestational age (%)				
< 5th percentile	4.0	5.2	6.2	7.7
< 10th percentile	8.3	10.4	12.4	14.9
Large for gestational age (%)				
(> 90th percentile)	12.2	10.7	8.5	7.0
Infant mortality (per 1,000)	3.9	6.0	5.9	7.6
Early neonatal mortality	1.6	2.0	2.5	2.8
Late neonatal mortality	0.6	0.9	0.9	1.3
Postneonatal mortality	1.6	3.1	2.6	3.5

Infant mortality (< 1 year), early neonatal (< 7 days), late neonatal (7–27 days), and postneonatal (28–364 days). All differences in proportions are statistically significant ($P < .001$, χ^2 test).

Previous studies examining potential risk factors for adverse pregnancy outcomes have not taken this fast growing mixed racial parenthood into account, therefore the evidence remains inconclusive as to whether mixed race parents are, in fact, at a higher risk for adverse pregnancy outcomes.

The results of this large population-based study reveal differences in fetal and infant outcomes between pregnancies of same race and mixed race parents. As compared with pregnancies of both white parents, pregnancies of other race-combinations pose a higher risk for adverse pregnancy outcomes and the risks for both fetal and infant outcomes worsened.

Previous studies using animal models documented that paternal genes play an important role in hypertensive disorders of pregnancy, and eclampsia.[17–19] Similarly, fetal inheritance of paternal gene is also found to be associated with hypertensive disorders during pregnancy in human.[20] Scott et al described that paternal gene play an important role in the development and function of the placenta. Furthermore, studies give further credence to paternal contribution in fetal development. A study that examined the association between paternal characteristics and maternal and infant outcomes in twin pregnancies showed substantial differences in pregnancy outcomes among twin births of both mixed and similar race parents.[11] In that study, the relative risks for infant mortality to parents of black mother-black father, black mother-white father, and white mother-black father were 1.84 (95% CI 1.73, 1.95), 1.39 (95% CI 1.03, 1.51), and 1.49 (95% CI 1.26, 1.77), respectively, and stillbirth rates also showed similar patterns. The findings of the current study strengthen the results of the aforementioned papers by using a very large population based dataset. Although the overall RR for infant mortality was much higher in pregnancies of both black parents, late neonatal and post neonatal infant mortalities have been found to be the greatest contributors to this risk, whereas, in pregnancies of BW parents, the contribution of early neonatal mortality to the overall infant mortality was much higher.

The gestational age-specific relative mean birth weight difference for BW parents was twice that of BB parents at 32 and 33 weeks of gestations, whereas for WB parents these relatives mean-birth weight difference were lower by half. This suggests that although maternal factors may, in most part, influence birth weight, there is some evidence that paternal race may play an important role as well.

The contribution of paternal race to the mean birth weight is the least when the mother was white as compared with when the mother was black. The higher relative mean-birth weight difference noted among BW parents as compared with BB parents could partly be suggestive of paternal contribution to fetal birth weight. The risk of stillbirth among BB parents was also 1.67 times higher than that of their white counterparts. On the other hand, as compared with BW parents, the RR for stillbirth among WB was lower. These differences in stillbirth rates and all other investigated adverse pregnancy outcomes between the various parental races may have been the result of paternal genetic contribution.

Adverse perinatal outcomes are commonly reported in fetuses and infants of black mothers. The finding that rates of adverse perinatal outcomes are higher in BW and WB compared with WW parents could partly be attributed to socioeconomic disparities.[8,21] In fact, the proportions of teen mothers (and fathers), unmarried women, and those that did not

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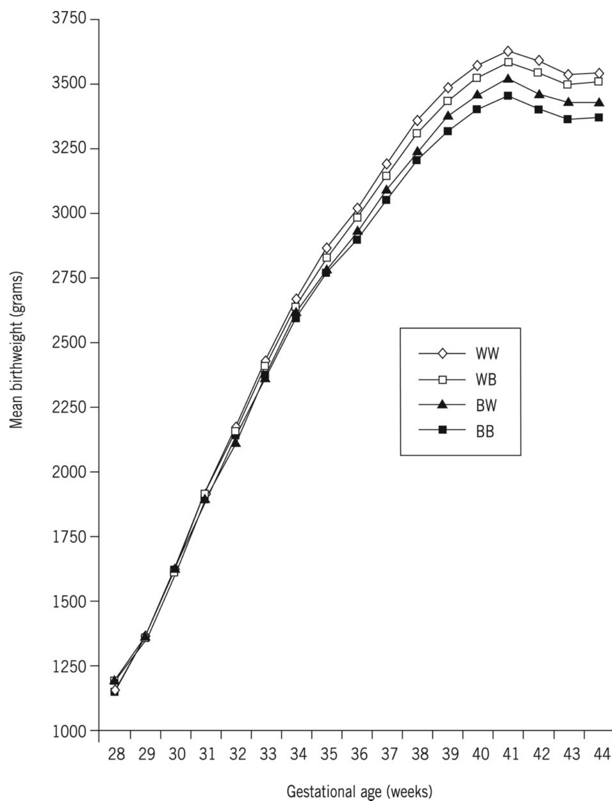

Fig. 1. Gestational age–specific crude mean birth weight based on parental race: United States, 1995–2001. WW, mother white–father white; WB, mother white–father black; BW, mother black–father white; BB, mother black–father black.

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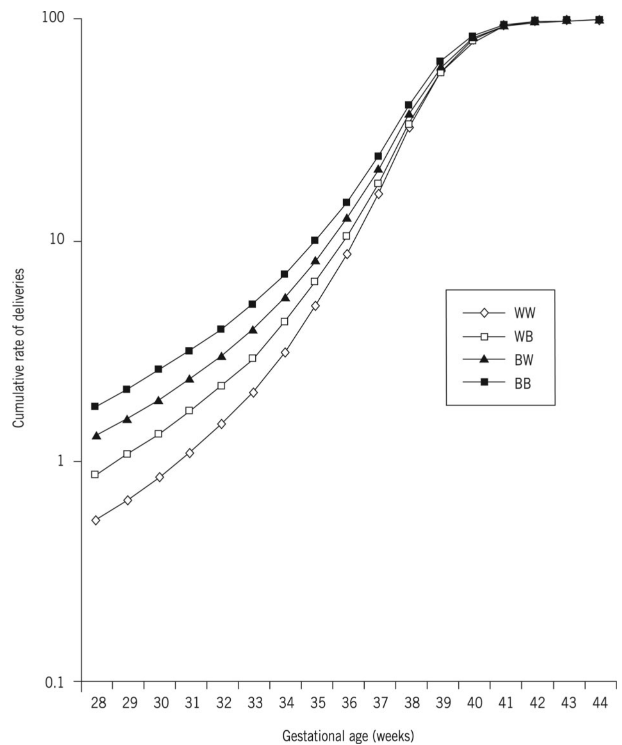

Fig. 2. Cumulative rate of delivery based on parental race: United States, 1995–2001. WW, mother white–father white; WB, mother white–father black; BW, mother black–father white; BB, mother black–father black.

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seek prenatal care was higher in the BW, WB, and BB race groups (Table 1). Although the contributions of social disparities in our study cannot be overlooked completely, the lack of congruence in proportions of these factors (i.e., teen birth, unmarried status, and lack of prenatal care) and the risk of adverse outcomes by paternal race categories may suggest the importance of genetic factors. In addition, while the contribution of paternal race to adverse pregnancy outcomes is evident, our analysis underscores a strong influence of maternal race on perinatal outcomes. It is likely that complex social and behavioral factors are at interplay; given the limited data on such social factors available on the vital statistics data files, results from our study must be interpreted with caution.

A few potential shortcomings of our analysis using birth certificate data must be recognized. Some degree of underreporting of paternal race and maternal smoking during pregnancy that could introduce random errors in the vital statistics data cannot be overlooked.[22,23] Given the higher proportion of missing paternal race data noted in this study, future studies must carefully examine the impact of missing paternal race on adverse pregnancy outcomes, as well as the extent to which such missing data may bias overall patterns of associations. On the other hand, the strength of this study is that it is population-based study with a large number of births, and arguably perhaps the largest to examine the association between parental race and fetal and infant outcome.

We limited the analysis to black/white parenthood for the reason that in examining the available data on other race, the yearly individual race count was not to the level of confidence to do this analysis and may potentially affect comparability. The justification for limiting the analysis to singleton births was that multiple pregnancies inherently present with different risks of adverse pregnancy outcomes. A study that includes multiple births with singleton births without taking into account their inherent differences obscures this underlying association between parental race and pregnancy outcomes. Future studies should consider examining the socio-demographic profile of couples of mixed race, as well as the

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Table 5. Adjusted Relative Risk and 95% Confidence Interval for Perinatal Outcomes by Parental Race Categories Relative to White Mother–White Father Parents: United States 1995–2001

Perinatal Outcomes	Mother White–Father Black	Mother Black–Father White	Mother Black–Father Black
Stillbirth	1.17 (1.10–1.26)	1.37 (1.21–1.54)	1.67 (1.62–1.72)
Preterm birth (wk)			
< 37	1.11 (1.10–1.13)	1.43 (1.41–1.46)	1.71 (1.70–1.72)
< 34	1.25 (1.23–1.28)	1.79 (1.74–1.85)	2.32 (2.30–2.34)
< 32	1.34 (1.31–1.38)	2.02 (1.94–2.10)	2.70 (2.68–2.73)
Small for gestational age			
< 5th percentile	1.11 (1.09–1.13)	1.51 (1.47–1.55)	1.98 (1.97–1.99)
< 10th percentile	1.09 (1.08–1.10)	1.49 (1.46–1.51)	1.92 (1.91–1.93)
Large for gestational age (> 90 percentile)	1.01 (1.00–1.02)	0.71 (0.70–0.72)	0.56 (0.55–0.57)
Infant mortality (overall)	1.34 (1.29–1.40)	1.38 (1.27–1.50)	1.78 (1.74–1.81)
Early neonatal	1.20 (1.11–1.30)	1.46 (1.28–1.66)	1.65 (1.59–1.70)
Late neonatal	1.34 (1.20–1.49)	1.13 (0.91–1.40)	1.87 (1.79–1.96)
Postneonatal	1.44 (1.36–1.53)	1.41 (1.25–1.59)	1.86 (1.80–1.91)

Values are relative risk and (95% confidence interval). Relative risks are adjusted for maternal age, paternal age, maternal education, trimester at which prenatal care began, parity, marital status, and smoking during pregnancy.

association between parental race and adverse pregnancy outcomes among multiple births.

In conclusion, we have demonstrated that there is a higher risk of adverse perinatal outcomes among BW, WB, and BB parental categories. Although many factors are likely to be responsible for the various adverse perinatal outcomes, both maternal and paternal races are important components of fetal and infant outcomes. Identifying high-risk obstetric groups based on maternal and paternal races may help clinicians in designing interventions at an earlier stage in pregnancy.

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