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Maternal Racial and Ethnic Disparities in Neonatal Birth Outcomes With and Without Assisted Reproduction

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Abstract

OBJECTIVE—To explore disparities in prematurity and low birth weight (LBW) by maternal race and ethnicity among singletons conceived with and without assisted reproductive technology (ART).

METHODS—We performed a retrospective cohort study using resident birth certificate data from Florida, Massachusetts, and Michigan linked with data from the National ART Surveillance System from 2000 to 2010. There were 4,568,822 live births, of which 64,834 were conceived with ART. We compared maternal and ART cycle characteristics of singleton liveborn neonates using χ^2 tests across maternal race and ethnicity groups. We used log binomial models to explore associations between maternal race and ethnicity and LBW and preterm birth by ART conception status.

RESULTS—The proportion of liveborn neonates conceived with ART differed by maternal race and ethnicity ($P<.01$). It was smallest among neonates of non-Hispanic black (0.3%) and Hispanic women (0.6%) as compared with neonates of non-Hispanic white (2.0%) and Asian or Pacific Islander women (1.9%). The percentages of LBW or preterm singletons were highest for neonates of non-Hispanic black women both for non-ART (11.3% and 12.4%) and ART (16.1% and 19.1%) -conceived neonates. After adjusting for maternal factors, the risks of LBW or preterm birth for singletons born to non-Hispanic black mothers were 2.12 [95% confidence interval (CI) 2.10–2.14] and 1.56 (95% CI 1.54–1.57) times higher for non-ART neonates and 1.87 (95% CI 1.57–2.23) and 1.56 (95% CI 1.34–1.83) times higher for ART neonates compared with neonates of

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non-Hispanic white women. The adjusted risk for LBW was also significantly higher for ART and non-ART singletons born to Hispanic (adjusted relative risk [RR] 1.26, 95% CI 1.09–1.47 and adjusted RR 1.15, 95% CI 1.13–1.16) and Asian or Pacific Islander (adjusted RR 1.39, 95% CI 1.16–1.65 and adjusted RR 1.55, 95% CI 1.52–1.58) women compared with non-Hispanic white women.

CONCLUSION—Disparities in adverse perinatal outcomes by maternal race and ethnicity persisted for neonates conceived with and without ART.

In the United States, disparities in perinatal outcomes by maternal race and ethnicity are well documented.[1] Approximately 13% of neonates born to non-Hispanic black women have low birth weight (LBW) and 13% are premature compared with 7% and 9%, respectively, of neonates born to non-Hispanic white women.[2] The rate of neonatal mortality is more than twice as high for non-Hispanic black compared with non-Hispanic white women (11.11 compared with 5.06 per 1,000 live births in 2013).[3]

Assisted reproductive technology (ART) is associated with increased perinatal morbidity primarily as a result of increased risk of multiple births. However, ART singletons also demonstrate modestly increased risks for preterm birth and LBW.[4] In studies of ART cycles using the National ART Surveillance System and the Society for Assisted Reproductive Technology Clinic Outcome Reporting System, non-Hispanic black maternal race has been associated with LBW, prematurity, severe growth restriction, and decreased rates of pregnancy and live birth[5–9]; however, maternal race and ethnicity are not reported for approximately 30–40% of cycles.[10] Additionally, it is unclear whether racial disparities in ART birth outcomes are comparable with those in the non-ART population given that a greater proportion of women undergoing ART are married, college-educated, privately insured, and initiating prenatal care in the first trimester.[11]

In this study, we investigated the association between maternal race and ethnicity and perinatal outcomes in neonates conceived with and without ART using a population-based data set. We hypothesized that racial disparities would exist for both ART and non-ART neonates, but would be smaller among ART neonates.

MATERIALS AND METHODS

We performed a retrospective cohort study using data obtained from Florida, Massachusetts, and Michigan state resident birth certificates and the National ART Surveillance System, a national surveillance system capturing approximately 95% of all ART cycles performed in U.S. clinics.[12] Assisted reproductive technology is defined as any procedure involving the laboratory handling of oocytes or embryos; the majority are in vitro fertilization procedures. National ART Surveillance System data are ART cycle-specific and include patient demographics, obstetric and medical history, infertility diagnosis, clinical parameters of the ART procedure, and information regarding resultant pregnancies and births. States were selected for this study based on participation in the States Monitoring ART Collaborative, a group focused on state-based surveillance of ART and neonatal and maternal health outcomes.[13] The birth certificate and National ART Surveillance System data sets were

linked using a previously described probabilistic linkage method for the States Monitoring ART Collaborative.[14] Linkage rates average 90%.[15]

We examined the distribution of maternal race and ethnicity among all neonates born to residents of Florida, Massachusetts, and Michigan (N=4,568,822) and among all neonates conceived with ART (n=64,834) from 2000 to 2010. Conception with ART was determined from linkage between the birth certificate and National ART Surveillance System data. Information on maternal race and ethnicity was derived from the birth certificate and based on maternal report. We classified maternal race and ethnicity into the following mutually exclusive categories: non-Hispanic white, non-Hispanic black, Hispanic, Asian or Pacific Islander, and other. We excluded 15,145 neonates (0.3% of all neonates) missing information on maternal ethnicity. We compared the proportion of neonates conceived with ART among all neonates and the proportion of singleton ART neonates among all ART neonates using χ^2 tests across race and ethnicity groups, excluding an additional 31 ART neonates missing information on plurality (less than 0.1%).

Because multiple gestations are at increased risk for adverse perinatal outcomes, further analyses were restricted to 33,523 ART and 4,358,029 non-ART singleton liveborn neonates with known maternal race. In addition, as a result of difficulty in interpretation, singletons were further restricted to 33,198 ART and 4,301,941 non-ART neonates with a maternal race and ethnicity classification that was not other. Assisted reproductive technology singletons were then restricted to those conceived with fresh autologous cycles (n=25,338) to ensure homogeneity of the ART population. We compared the distribution of maternal characteristics for ART and non-ART singletons and ART cycle characteristics for ART singletons using χ^2 tests across maternal race and ethnicity groups. Maternal characteristics, ascertained from the birth certificate, included: state of residence, age, education, marital status, nativity, smoking during pregnancy, diabetes history (pregestational or gestational), chronic hypertension history (pregestational), gravidity, parity, and initiation of prenatal care in the first trimester. Some of these variables changed over time as a result of state adoption of the 2003 birth certificate revision. Assisted reproductive technology cycle characteristics included: infertility diagnosis (multiple diagnoses possible), history of prior ART cycles, use of intracytoplasmic sperm injection, use of assisted hatching, number of days of embryo culture, number of embryos transferred, availability of supernumerary embryos for freezing, and the number of fetal hearts on 6-week ultrasonography.

Log binomial models were used to model preterm delivery (any delivery occurring before 37 weeks of gestation) and LBW (the birth of any neonate weighing less than 2,500 g) against maternal race and ethnicity. We used birth weight and clinical estimate of gestational age as reported on the birth certificate. All models included an indicator for whether the neonate was conceived with ART and the interaction between maternal race and ethnicity and the ART indicator. We calculated unadjusted and adjusted relative risks and accompanying 95% confidence intervals (CIs). The adjusted models included all maternal characteristics listed previously, which were all statistically significant. An additional adjusted model restricted only to ART-conceived singletons was considered to explore the inclusion of ART cycle characteristics.

We performed two secondary analyses, each modeling preterm delivery and LBW. First, we restricted the analysis to singletons of nulliparous mothers to eliminate the effect of a mother having more than one delivery during the 11-year study period. Second, we explored models among singletons born to women of all parity by state of residence to explore differences in disparities by state. All statistical analyses were conducted using SAS 9.3 with α=0.05. The institutional review boards of the Centers for Disease Control and Prevention and the Massachusetts Department of Public Health approved this study; the Michigan Department of Health and Human Services institutional review board and the Florida Department of Health institutional review board determined that their institutions were not engaged in human subjects research. Table cells with counts less than 20 were suppressed to protect patient confidentiality. Cells allowing for calculation of counts less than 20 also were suppressed.

RESULTS

Among all neonates born to residents of Florida, Massachusetts, and Michigan from 2000 to 2010 (N=4,568,822), 1.4% were conceived with ART (n=65,449), and 0.7% were singletons conceived with ART (n=33,523). The percentage of ART neonates among all neonates born differed by maternal race and ethnicity (P<.01) with a lower percentage for neonates born to non-Hispanic black women (0.3%), Hispanic women (0.6%), and women of other race–ethnicity (1.1%) than for neonates born to non-Hispanic white (2.0%) and Asian or Pacific Islander women (1.9%). Approximately half (51.7%) of all ART neonates were singletons; the percentage was slightly higher among neonates of Asian or Pacific Islander mothers (55.4%) (P<.01). Among non-ART neonates, 58.1% were born to non-Hispanic white, 17.8% to non-Hispanic black, 19.2% to Hispanic, 3.6% to Asian or Pacific Islander, and 1.3% to other race and ethnicity women. Comparatively, among neonates conceived with ART, 81.5% were born to non-Hispanic white, 4.0% to non-Hispanic black, 8.7% to Hispanic, 4.8% to Asian or Pacific Islander, and 1.0% to other race and ethnicity women.

Across all maternal race and ethnicity groups, for both ART (n=25,338) and non-ART (n=4,301,941) singletons, the majority had mothers who were born in the United States, were nonsmokers, had no history of diabetes or chronic hypertension, and received first-trimester prenatal care (Table 1). The majority of ART singletons were born to mothers who were 30 years or older, had at least some college education, were married, and had no prior pregnancies or births. In comparison, the majority of non-ART singletons were born to mothers who were younger than 30 years old and had one or more prior pregnancies and births.

Regardless of conception with or without ART, the highest percentage of singletons born to women younger than 30 years old occurred among neonates of non-Hispanic black mothers (Table 1). A higher percentage of ART and non-ART singletons born to non-Hispanic black and Hispanic women had unmarried mothers and mothers with no college education. A lower percentage of ART and non-ART singletons born to Hispanic women had mothers born in the United States. Although maternal smoking was uncommon across all maternal race and ethnicity groups, ART and non-ART singletons born to non-Hispanic white and non-Hispanic black women were more likely to have mothers who smoked. Assisted

reproductive technology and non-ART singletons born to Asian or Pacific Islander women were most likely to have mothers with a history of diabetes and no prior pregnancies or births, whereas singletons born to non-Hispanic black women were most likely to have mothers with a history of chronic hypertension. Prenatal care was initiated in the first trimester for more than 90% of ART singletons and more than 73% of non-ART singletons. The percentages were slightly higher for ART singletons of non-Hispanic white and Hispanic mothers and non-ART singletons of non-Hispanic white and Asian or Pacific Islander mothers.

Among ART singletons, those born to non-Hispanic black women were most likely to have mothers diagnosed with tubal factor (47.1%) and uterine factor (8.6%) infertility and least likely to have mothers diagnosed with endometriosis (8.4%) (Table 2). Assisted reproductive technology singletons born to Hispanic women were most likely to have parental infertility diagnoses of diminished ovarian reserve (10.8%) and male factor infertility (48.1%) and to have mothers who had no prior ART cycles (65.5%), used intracytoplasmic sperm injection (70.4%), and transferred blastocysts (45.3%). The highest percentage of singletons born after single embryo transfer occurred among neonates of Asian or Pacific Islander mothers (12.4%). Neonates of non-Hispanic black mothers were most likely to have come from pregnancies with two or more heartbeats on the 6-week ultrasonogram (11.4%).

Among non-ART singletons, the percentage born with LBW was highest among neonates of non-Hispanic black women (11.3%) followed by neonates of Asian or Pacific Islander (6.6%), Hispanic (5.8%), and non-Hispanic white (5.0%) women (Table 3). Non-ART singletons born to non-Hispanic black women also had the highest percentage of preterm birth (12.4%) compared with singletons of Hispanic (7.8%), non-Hispanic white (7.2%), or Asian or Pacific Islander (7.0%) women. After adjusting for maternal characteristics, non-ART singletons born to non-Hispanic black women were 2.12 (95% CI 2.10–2.14) and 1.56 (95% CI 1.54–1.57) times more likely to have LBW or preterm births, whereas non-ART singletons born to Hispanic and Asian or Pacific Islander women were 1.15 (95% CI 1.13–1.16) and 1.55 (95% CI 1.52–1.58) times more likely to have LBW births as compared with singletons of non-Hispanic white women. Non-ART singletons of Hispanic and Asian or Pacific Islander women also were more likely to be born preterm compared with singletons of non-Hispanic white women, but adjusted relative risks and CIs were close to 1.

Patterns were similar among ART singletons (Table 3). The percentage of ART singletons born with LBW was highest among neonates of non-Hispanic black women (16.1%) followed by neonates of Asian or Pacific Islander (10.3%), Hispanic (10.0%), and non-Hispanic white (7.6%) women. The percentage of ART singletons born preterm also was highest among non-Hispanic black women (19.1%) followed by Hispanic (12.2%), Asian or Pacific Islander (11.3%), and non-Hispanic white (10.5%) women. After adjusting for maternal characteristics, ART singletons born to non-Hispanic black women were 1.87 (95% CI 1.57–2.23) and 1.56 (95% CI 1.34–1.83) times more likely to have LBW or preterm births, whereas ART singletons born to Hispanic and Asian or Pacific Islander women were 1.26 (95% CI 1.09–1.47) and 1.39 (95% CI 1.16–1.65) times more likely to have LBW births as compared with singletons of non-Hispanic white women.

Although the percentages of singletons with LBW or preterm birth were higher for ART neonates than for non-ART neonates, the differences in risk of LBW or preterm birth by maternal race and ethnicity did not differ significantly for ART singletons compared with non-ART singletons, as indicated by the interactions (P=.13 and P=.98, respectively) (Table 3). The magnitudes and significance of the relative risks for ART neonates were similar even when adjusting for ART cycle characteristics (results not shown). When analysis was restricted to singletons born to nulliparous women, results were similar to those of singletons born to women of all parity (Table 4). Analysis of singletons born to women of all parity by state of residence showed similar results by state (results not shown). Notable differences in disparities by state included no significant increase in LBW risk for singletons of Asian or Pacific Islander women in Florida, a larger increased risk of LBW for singletons born to Hispanic women than for singletons born to non-Hispanic black women in Michigan, and no increase in preterm birth risk for singletons born to non-Hispanic black women in Michigan, all compared with singletons born to non-Hispanic white women. However, some sample sizes were small.

DISCUSSION

This analysis showed that non-ART singletons of non-Hispanic black women had the greatest increase in risk of LBW and preterm births as compared with non-ART singletons born to non-Hispanic white women. Non-ART singletons born to Hispanic and Asian or Pacific Islander mothers also had increased risk of LBW and preterm births compared with singletons of non-Hispanic white mothers, although the adjusted relative risks and CIs for preterm birth were close to 1, suggesting findings of limited clinical significance. Although ART singletons were at an increased risk for LBW and preterm birth compared with non-ART singletons, the disparities in LBW and preterm birth by maternal race and ethnicity did not significantly differ for ART and non-ART singletons.

This analysis also confirmed disparities by maternal race and ethnicity in the proportion of ART-conceived neonates among all neonates, differences that persisted for neonates of nulliparous women, suggesting differences in ART use. Similarly, the National Survey of Family Growth found that ever use of medical help to get pregnant was nearly twice as common among non-Hispanic white women aged 25–44 years (15%) as among Hispanic (7.6%) or non-Hispanic black women (8.0%).[16]

Disparities in perinatal outcomes by maternal race and ethnicity are supported by other studies.[5–8,17–19] Our study showed differences in maternal and ART characteristics such as education, marital status, chronic hypertension, prenatal care, diabetes, and tubal factor diagnosis by maternal race and ethnicity that are consistent with other studies.[2,20–23] However, elevated risks in this study persisted after statistical adjustment, suggesting that maternal and ART characteristics captured here explain little of the variation in LBW and preterm birth risk by maternal race and ethnicity. In addition, the majority of ART singletons were born to mothers who were older, college-educated, married, nonsmokers, and who received first-trimester prenatal care, regardless of maternal race and ethnicity. Even so, the racial and ethnic disparities in perinatal outcomes observed in non-ART neonates persisted in the more homogenous group of ART neonates. However, other factors not explored in this

study may play a role in explaining maternal racial and ethnic disparities in perinatal outcomes. For example, maternal characteristics such as pregnancy weight gain, genetics, poverty and income, health insurance, maternal stress, and racial discrimination have all been explored as contributors to disparities in preterm birth.[24]

Using a large, population-based surveillance system linked with birth certificate data, we conducted a highly powered analysis with more than 99% complete and reliable data for maternal race and ethnicity.[25] However, this study is subject to limitations. First, the number of non-ART neonates is large, allowing for statistical detection of findings of questionable clinical significance. Second, consistency of certain variables such as infertility diagnosis reported to the Centers for Disease Control and Prevention through the National ART Surveillance System and sensitivity of uncommon birth certificate variables may vary.[12,26–28] For example, diabetes and hypertension are underreported on the birth certificate.[29] Third, the collection of several variables changed during the 2003 birth certificate revision, including maternal education, tobacco use during pregnancy, and prenatal care, and study results could be affected by combining data from two different versions of the birth certificate.[30] In addition, we controlled for a limited number of variables in our analysis. Also, this neonate-level analysis may be influenced by the average number of neonates born per woman because women could have multiple singleton births during the study period. However, secondary analysis of neonates born to nulliparous women did not alter the major study findings. Finally, the results of this study of only three states may not be generalizable to the United States.

Relative to singletons of non-Hispanic white mothers, singletons of non-Hispanic black mothers had increased risk of preterm birth and LBW, regardless of whether conceived with or without ART. Both ART and non-ART singletons of Hispanic and Asian or Pacific Islander mothers also had increased risk of LBW. Controlling for differences in maternal characteristics did not explain these disparities in adverse neonatal outcomes. An important step in documenting these disparities is accurate and complete reporting of race and ethnicity in national surveillance systems such as the National ART Surveillance System. An additional important step in understanding these disparities is to look for sources beyond those maternal characteristics explored in this study, including maternal behaviors, socioeconomic indicators, and maternal stressors.

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Table 1

Maternal Characteristics of Singletons Conceived With and Without Assisted Reproductive Technology Among Florida, Massachusetts, and Michigan Residents, by Maternal Race and Ethnicity, 2000–2010

	ART Singletons*					Non-ART Singletons†				
Maternal Characteristic	**Non-Hispanic White (n=20,831)**	**Non-Hispanic Black (n=991)**	**Hispanic (n=2,123)**	**Asian or Pacific Islander (n=1,393)**	***P***	**Non-Hispanic White (n=2,533,657)**	**Non-Hispanic Black (n=766,078)**	**Hispanic (n=841,542)**	**Asian or Pacific Islander (n=160,664)**	***P***
State of residence					<.01					<.01
Florida	25.2	44.3	75.0	25.1		41.6	60.9	77.3	38.2	
Massachusetts	54.9	36.4	19.2	60.6		21.9	8.6	12.9	35.4	
Michigan	19.9	19.3	5.8	14.3		36.5	30.5	9.8	26.5	
Age (y)					<.01					<.01
Younger than 30	10.8	16.5	13.5	10.7		56.0	73.3	65.7	44.4	
30–34	36.0	31.7	35.2	36.4		27.3	16.3	21.3	35.8	
35–39	39.2	37.8	39.8	41.9		13.8	8.3	10.6	16.6	
40–44	13.9	__‡	__‡	11.1		2.8	2.0	2.3	3.0	
45 or older	0.1	__‡	__‡	0.0		0.1	0.1	0.1	0.1	
Education§					<.01					<.01
High school or less	12.2	23.8	22.2	9.9		39.4	64.2	65.0	28.6	
At least some college	87.8	76.2	77.8	90.1		60.6	35.8	35.0	71.4	
Marital status					<.01					<.01
Married	96.8	84.3	91.1	97.9		71.7	28.9	51.8	86.8	
Not married	3.2	15.7	8.9	2.1		28.3	71.1	48.2	13.2	
Nativity					<.01					<.01
U.S.-born	99.9	__‡	92.8	__‡		99.4	99.3	92.4	99.6	
Foreign-born	0.1	__‡	7.2	__‡		0.6	0.7	7.6	0.4	
Smoking§					<.01					<.01
Smoker	1.3	__‡	__‡	__‡		13.2	6.7	2.5	1.5	
Nonsmoker	98.7	__‡	__‡	__‡		86.8	93.3	97.5	98.5	
Diabetes history					<.01					<.01
Yes	5.7	10.5	6.9	14.0		3.9	4.1	4.2	7.5	
No	94.3	89.5	93.1	86.0		96.1	95.9	95.8	92.5	

Maternal Characteristic	ART Singletons*					Non-ART Singletons†				
	Non-Hispanic White (n=20,831)	Non-Hispanic Black (n=991)	Hispanic (n=2,123)	Asian or Pacific Islander (n=1,393)	*P*	Non-Hispanic White (n=2,533,657)	Non-Hispanic Black (n=766,078)	Hispanic (n=841,542)	Asian or Pacific Islander (n=160,664)	*P*
Chronic hypertension history					<.01					<.01
Yes	2.0	4.8	__≠	1.4		1.6	2.3	0.8	0.8	
No	98.0	95.2	__≠	98.6		98.4	97.7	99.2	99.2	
Gravidity					<.01					<.01
0	53.2	52.1	54.9	63.0		35.6	31.3	34.6	41.7	
1	27.1	20.7	22.7	24.3		30.6	25.1	29.8	33.6	
2 or greater	19.7	27.2	22.4	12.7		33.8	43.6	35.5	24.8	
Parity					<.01					<.01
0	66.9	66.3	70.5	75.4		43.2	38.5	40.9	48.4	
1	25.4	19.8	18.0	21.4		33.7	28.2	32.5	36.0	
2 or greater	7.7	13.9	11.5	3.2		23.1	33.3	26.6	15.7	
1st-trimester prenatal care§					<.01					<.01
Yes	93.1	90.4	93.5	91.4		87.0	73.9	78.2	83.5	
No	6.9	9.6	6.5	8.6		13.0	26.1	21.8	16.5	

ART, assisted reproductive technology.

Data are % unless otherwise specified.

*For ART singletons, there are no missing data for state of residence, age, or marital status; 1% or less of data are missing for education, nativity, smoking, diabetes, chronic hypertension, gravidity, and parity; less than 4% of data are missing for prenatal care.

†For non-ART singletons, there are no missing data for state of residence; 1% or less of data are missing for age, education, marital status, smoking, diabetes, chronic hypertension, gravidity, and parity; less than 2% of data are missing for nativity; less than 5% of data are missing for prenatal care.

≠Percentages are suppressed if they allow for the calculation of counts less than 20.

§Collection of variables changed over time as states adopted the 2003 birth certificate revision.

Table 2

Assisted Reproductive Technology Cycle Characteristics of Singletons Conceived With Assisted Reproductive Technology Among Florida, Massachusetts, and Michigan Residents, by Maternal Race and Ethnicity, 2000–2010

ART Cycle Characteristic*	Non-Hispanic White (n=20,831)	Non-Hispanic Black (n=991)	Hispanic (n=2,123)	Asian or Pacific Islander (n=1,393)	*P*
Infertility diagnosis					
Tubal factor	18.5	47.1	27.3	17.0	<.01
Endometriosis	14.5	8.4	14.5	13.2	<.01
Uterine factor	3.6	8.6	3.9	2.7	<.01
Ovulatory disorder	14.5	14.0	12.9	16.1	.06
Diminished ovarian reserve	8.0	6.9	10.8	7.5	<.01
Male factor	40.2	37.8	48.1	40.5	<.01
No. of prior ART cycles					<.01
0	55.2	61.9	65.5	56.6	
1	19.8	18.8	18.4	18.8	
2 or greater	25.0	19.4	16.2	24.6	
ICSI					<.01
Yes	57.8	60.9	70.4	57.3	
No	42.2	39.1	29.6	42.7	
Assisted hatching					.24
Yes	29.0	26.9	27.4	29.2	
No	71.0	73.1	72.6	70.8	
No. of days of oocyte culture					<.01
Blastocyst (5–6)	21.5	—†	—†	—†	
Cleavage (2–3)	77.0	67.1	53.9	79.1	
Other	1.4	—†	—†	—†	
No. of embryos transferred					<.01
1	9.4	8.3	7.6	12.4	
2	47.8	54.6	57.5	50.4	
3 or greater	42.7	37.1	34.9	37.2	
No. of embryos cryopreserved					<.01
0	61.7	55.2	64.5	63.9	

ART Cycle Characteristic*	Non-Hispanic White (n=20,831)	Non-Hispanic Black (n=991)	Hispanic (n=2,123)	Asian or Pacific Islander (n=1,393)	*P*
1 or greater	38.3	44.8	35.5	36.1	
No. of fetal hearts on 6-wk ultrasonography					.04
1	91.2	88.6	90.8	91.7	
2 or greater	8.8	11.4	9.2	8.3	

ART, assisted reproductive technology; ICSI, intracytoplasmic sperm injection.

Data are % unless otherwise specified.

*There are no missing data for infertility diagnosis; less than 1% of data are missing for number of prior ART cycles, ICSI, assisted hatching, number of days of oocyte culture, number of embryos transferred, number of embryos cryopreserved, and number of fetal hearts on 6-week ultrasonography.

†Percentages are suppressed if they allow for the calculation of counts less than 20.

Table 3

Low-Birth-Weight and Preterm Births Among Singletons Conceived With and Without Assisted Reproductive Technology Among Florida, Massachusetts, and Michigan Residents, by Maternal Race and Ethnicity, 2000–2010

	LBW (Less Than 2,500 g)			Preterm Birth (Less Than 37 wk of Gestation)		
	n (%)	RR* (95% CI)	Adjusted RR† (95% CI)	n (%)	RR* (95% CI)	Adjusted RR† (95% CI)
ART singletons						
Non-Hispanic white	1,574 (7.6)	Reference	Reference	2,191 (10.5)	Reference	Reference
Non-Hispanic black	159 (16.1)	**2.12 (1.83–2.47)**	**1.87 (1.57–2.23)**	189 (19.1)	**1.81 (1.59–2.07)**	**1.56 (1.34–1.83)**
Hispanic	213 (10.0)	**1.33 (1.16–1.52)**	**1.26 (1.09–1.47)**	259 (12.2)	**1.16 (1.03–1.31)**	1.01 (0.88–1.16)
Asian or Pacific Islander	143 (10.3)	**1.36 (1.16–1.60)**	**1.39 (1.16–1.65)**	157 (11.3)	1.07 (0.92–1.24)	1.09 (0.92–1.28)
Non-ART singletons						
Non-Hispanic white	126,545 (5.0)	Reference	Reference	183,085 (7.2)	Reference	Reference
Non-Hispanic black	86,781 (11.3)	**2.27 (2.25–2.29)**	**2.12 (2.10–2.14)**	94,828 (12.4)	**1.71 (1.70–1.73)**	**1.56 (1.54–1.57)**
Hispanic	48,629 (5.8)	**1.16 (1.14–1.17)**	**1.15 (1.13–1.16)**	65,714 (7.8)	**1.08 (1.07–1.09)**	**1.02 (1.01–1.03)**
Asian or Pacific Islander	10,523 (6.6)	**1.31 (1.29–1.34)**	**1.55 (1.52–1.58)**	11,172 (7.0)	**0.96 (0.95–0.98)**	**1.05 (1.03–1.07)**

LBW, low birth weight; RR, relative risk; CI, confidence interval; ART, assisted reproductive technology.

Bold indicates statistically significant results.

*Interaction term between maternal race and ART conception status was not significant in unadjusted models for LBW (*P*=.17) or preterm birth (*P*=.36).

†Adjusted for maternal characteristics: state of residence, age, education, marital status, nativity, smoking during pregnancy, diabetes history (pregestational or gestational), chronic hypertension history (pregestational), gravidity, parity, initiation of prenatal care in the first trimester, and conception with ART. Also included an interaction term between maternal race and ART conception status. Interaction term was not significant in adjusted models for LBW (*P*=.13) or preterm birth (*P*=.98).

Table 4

Low-Birth-Weight and Preterm Births Among Singletons Conceived With and Without Assisted Reproductive Technology Among Nulliparous Florida, Massachusetts, and Michigan Residents, by Maternal Race and Ethnicity, 2000–2010

		LBW (Less Than 2,500 g)		Preterm Birth (Less Than 37 wk of Gestation)		
	n (%)	RR* (95% CI)	Adjusted RR† (95% CI)	n (%)	RR* (95% CI)	Adjusted RR† (95% CI)
ART singletons						
Non-Hispanic white	1,195 (8.6)	Reference	Reference	1,525 (11.0)	Reference	Reference
Non-Hispanic black	113 (17.3)	**2.02 (1.69–2.40)**	**1.84 (1.50–2.25)**	129 (19.8)	**1.81 (1.54–2.12)**	**1.65 (1.37–1.99)**
Hispanic	154 (10.3)	**1.20 (1.02–1.41)**	1.16 (0.97–1.38)	181 (12.1)	1.10 (0.96–1.28)	0.98 (0.84–1.16)
Asian or Pacific Islander	106 (10.1)	1.18 (0.98–1.42)	**1.24 (1.01–1.52)**	112 (10.7)	0.97 (0.81–1.17)	1.00 (0.82–1.22)
Non-ART singletons						
Non-Hispanic white	66,174 (6.1)	Reference	Reference	86,303 (7.9)	Reference	Reference
Non-Hispanic black	36,991 (12.7)	**2.08 (2.06–2.11)**	**2.01 (1.98–2.04)**	35,172 (12.0)	**1.52 (1.50–1.54)**	**1.44 (1.42–1.47)**
Hispanic	23,786 (6.9)	**1.14 (1.13–1.16)**	**1.13 (1.11–1.15)**	27,942 (8.2)	**1.03 (1.02–1.04)**	0.99 (0.98–1.01)
Asian or Pacific Islander	5,929 (7.7)	**1.26 (1.23–1.29)**	**1.45 (1.41–1.49)**	5,516 (7.1)	**0.90 (0.88–0.92)**	**0.95 (0.93–0.98)**

LBW, low birth weight; RR, relative risk; CI, confidence interval; ART, assisted reproductive technology.

Bold indicates statistically significant results.

*Interaction term between maternal race and ART conception status was not significant in unadjusted models for LBW (*P*=.78) or preterm birth (*P*=.17).

†Adjusted for maternal characteristics: state of residence, age, education, marital status, nativity, smoking during pregnancy, diabetes history (pregestational or gestational), chronic hypertension history (pregestational), gravidity, parity, initiation of prenatal care in the first trimester, and conception with ART. Also included an interaction term between maternal race and ART conception status. Interaction term was not significant in adjusted models for LBW (*P*=.40) or preterm birth (*P*=.56).