

Trends of racial disparities in assisted reproductive technology outcomes in black women compared with white women: Society for Assisted Reproductive Technology 1999 and 2000 vs. 2004–2006

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Objective: To determine trends in assisted reproductive technology (ART) in black and white women by comparing Society for Assisted Reproductive Technology (SART) database outcomes for 2004–2006 with previously reported outcomes for 1999 and 2000.

Design: Retrospective, cohort study.

Setting: The SART member clinics that performed at least 50 cycles of IVF and reported race in more than 95% of cycles.

Patient(s): Women receiving 158,693 IVF cycles.

Intervention(s): In vitro fertilization using nondonor embryos.

Main Outcome Measure(s): Live birth rate per cycle started.

Result(s): Reporting of race increased from 52% to 60%. The proportion of black, non-Hispanic (BNH) women increased from 4.6% to 6.5%. For BNH women using fresh embryos and no prior ART, significant increasing trends were observed for older age, male factor, uterine factor, diminished ovarian reserve, and ovulation disorders. The BNH women were 2.5 times more likely to have tubal factor for those cycles with no prior ART. The proportion of live births per cycle started increased across all groups over time, although greater increases occurred for white women.

Conclusion(s): There seems to be widening disparities in IVF outcomes between BNH and white women, perhaps attributable to poor prognostic factors among black women. Race continues to be a marker for prognosis for ART outcomes and should be reported. (Fertil Steril® 2009; ■: ■–■. ©2009 by American Society for Reproductive Medicine.)

Key Words: IVF, ART, black women, race, ethnicity, African American, racial disparities, delivery of health care, SART

A retrospective examination of the Society for Reproductive Assisted Technology (SART) database of more than 80,000 cycles for 1999 and 2000 demonstrated lower pregnancy and higher miscarriage rates among black as compared with white women after controlling for age (1). When considering factors that may have been responsible for these findings, it was noted that black women generally had a longer duration of infertility before they presented for treatment. Of particular interest was the fact that when black women did seek treatment, they went more often than their white counterparts to ART clinics that performed fewer cycles per year and to clinics with lower overall pregnancy rates. Furthermore, black women underwent only 4.6% of the total cycles in this period. By comparison, the United States Cen-

sus data for the year 2000 general population showed that 12.9% of people were black (2, 3), and black women composed up to 7.8% of married, reproductive-aged women in the United States during 2002. Thus, black women seemed to be underrepresented among those receiving ART during 1999 and 2000.

This disproportionately low representation of black women having ART raises the issue of accessibility to advanced reproductive care. The issue is of particular relevance because the prevalence of infertility among black women seems to be increasing, whereas it is concomitantly decreasing among white women (4, 5). The issue of accessibility to specialized, high-technology–based medical care for minority individuals has been noted across a range of illnesses and diseases (6–12). A disparity in access to care for infertility has been documented by the National Survey of Family Growth, which noted that in 1995 the percentage of black women who received any service for infertility was 13%, compared with 16.3% of white women (13). Illustrating the widening of this gap in delivery of infertility services among

Received December 30, 2008; revised and accepted February 25, 2009. D.B.S. has nothing to disclose. R.Z. has nothing to disclose. D.A.G. has nothing to disclose.

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women with one or more previous births surveyed in 2002 was the fact that 10% of black women compared with 18.8% of white women received such care (5). The objective of this study was to examine the most recent SART database for the period 2004–2006 to investigate whether the trends noted in our initial study of the 1999 and 2000 SART database (1) had continued or changed. Furthermore, we wanted to better understand what some of the possible underlining causes could be that are responsible for the continuation or changes of such trends.

MATERIALS AND METHODS

Data Source and Inclusion Criteria

This study was approved by the institutional review board of the University of Kansas School of Medicine at Wichita and the SART Research Committee. A retrospective, cohort study was conducted using 2004–2006 data and compared with an analysis previously performed and published using the 1999 and 2000 data (1). De-identified data from the SART national registry of ART treatment cycles performed by member clinics in the United States during 2004–2006 were analyzed. This registry contributes approximately 92% of all cycles contained in the complete Centers for Disease Control and Prevention (CDC) ART registry (described in detail elsewhere (14–16)). The SART registry contains data collected by SART and submitted to the CDC, in compliance with the Fertility Clinic Success Rate and Certification Act of 1992 (Pub. L. 102-493, October 24, 1992). Clinics submitted information about ART treatment cycles and outcomes according to a standardized protocol that included prompts for designating Hispanic ethnicity and for indicating race as white, Asian, black, Native American, or other. Samples of the data reported by ART clinics were validated independently by medical record review (14, 15). More than 90% of clinics complied with the mandate to report data, and it is believed that nonreporting centers were smaller-than-average practices (16).

To create the study data set, the SART data vendor selected the 367,445 IVF cycles reported by SART member clinics during the study period and then excluded 2,598 cycles (0.7%) to limit the study data set to clinics providing 50 or more cycles in a given year. Clinics with 50 or fewer cycles were excluded to avoid skewing data because of small sample sizes and outcomes not representative of larger SART clinics. Clinic and patient identifiers were then deleted from the study data set.

To minimize the likelihood of selection bias because of missing data on race, we excluded 145,362 cycles (39.8%) from the remaining 364,847 cycles to limit the study data set to clinics that reported race in all cycles. We compared the 145,362 cycles excluded because of missing data on race with the remaining 219,485 cycles and found that the clinical pregnancy rate per cycle started was essentially the same for the excluded and included cycles (34.9% and 35.6%, respectively), whereas live birth rates were 28.5%

and 29.3%, respectively. Race was reported more frequently in cycles during 2004–2005 as compared with 1999 and 2000 (60.2% vs. 51.6%). Overall clinical pregnancy rates and live birth rates were also higher during the later study period and not different between the included and excluded cycles (30.8% vs. 30.6% for clinical intrauterine gestation rate, and 25.2% for both live birth groups).

From the 219,485 cycles in the final study data set provided by the CDC, we also excluded the following: 1,670 cycles with missing data on whether a clinical intrauterine gestation occurred, 3,065 cycles that used a gestational carrier, and 24,188 cycles that used embryos created with donor oocytes, which left 190,562 cycles for analysis.

Statistical Analysis

Data were analyzed using commercial software (SPSS 15.0; SPSS, Chicago, IL). The treatment cycle was the unit of analysis because personal identifiers were not included and cycles were not linked, precluding analysis by individual patient. Data among women with no prior ART were examined separately because these cycles represent individual women. Diagnoses were examined individually to avoid obscuring relationships by using mutually exclusive categories, such as multiple female factors or multiple male and female factors (16). Extreme values of FSH dosage (>80 ampules) that may have been coding errors were replaced by missing values. The implantation rate was calculated by dividing the number of fetal heartbeats on first-trimester ultrasound in a given cycle by the number of embryos transferred in that cycle. Clinical pregnancy was defined as the presence of a gestational sac by ultrasound during the first trimester. A live birth was defined as the birth of one or more living infants. Rates of both of these outcomes were calculated per cycle started.

Categorical variables were compared using χ^2 tests. Where distributions were skewed, continuous variables were compared using Mann-Whitney tests. Similar to previously reported data, and to facilitate comparisons, 95% confidence intervals were calculated using the formula $p \pm z_{\alpha/2} \sqrt{p(1-p)/n}$, where p represents the proportion with the outcome, and n represents the total number of cycles.

To estimate the independent contribution of race to treatment outcomes, multivariable logistic regression analyses were performed. To compare differences between previously reported results the same confounders (where appropriate) were used as in the 1999 and 2000 models. Some confounders, such as FSH ratios, were omitted in the models because of incomplete reporting and limitations of the 2004–2006 dataset. To derive approximate relative risks (RRs) the adjusted odds ratios (Adj. ORs) were corrected using this formula: Adj. RR = Adj. OR / [(1 × p₀) + (Adj. OR × p₀)] (17). All statistical tests were two-tailed and used $\alpha = 0.05$. Percentages in specific analyses did not total to 100 because of rounding, and there were different numbers of cycles in some analyses because of missing data.

RESULTS

There were 190,562 nondonor cycles of ART during 2004–2006 that met study inclusion criteria. To facilitate comparisons with the United States population, the distribution of these ART cycles was examined by race and Hispanic origin. There were 12,287 cycles (6.5%) among black, non-Hispanic women (an increase from the 4.6% reported in 1999 and 2000) and 146,406 cycles (76.8%) among white, non-Hispanic women. We excluded from further analysis 17,529 cycles (9.2%) among Asian, non-Hispanic women, 11,897 cycles (6.2%) among Hispanic women of any race, 337 cycles (0.2%) among American Indian or Alaska Native women, and 2,105 cycles (1.1%) among women of other races. This left a final study population of 158,693 cycles among black, non-Hispanic women and white non-Hispanic women (referred to as black women and white women for the rest of this discussion).

The baseline characteristics, treatment factors, and outcomes are provided in Table 1 for fresh, nondonor cycles (10,354 cycles among black women and 120,994 cycles among white women) and Table 2 for cycles using cryopreserved embryos (1,933 cycles among black women and 25,412 cycles among white women). Race was reported with increasing frequency per cycle with each successive year that was reviewed specifically: 56.9% in 2004, 61.2% in 2005, and 62.2% in 2006, with a mean of 60.2% over the 3-year period of 2004–2006. This compared favorably with 51.6% for which race was recorded in 1999 and 2000 ($P < .001$). Cycles in black women showed an increase between 1999 and 2000 and 2004–2006 in their representation of the total number of ART cycles, compared with a decrease in the representation of white women. Of those women with no prior history of ART in 1999 and 2000 who underwent ART for their first time, 5.4% were black, as compared with 8.4% in 2004–2006 ($P < .001$). Similar findings were noted for women who had previously undergone ART and were doing another cycle: 4.6% of those women were black in 1999 and 2000, compared with 7.1% in 2004–2006 ($P < .001$). The woman's race was the same as the man's race 90.5% of the time (143,612 of 158,694).

The overall age distribution in fresh, nondonor embryo cycles differed by a woman's race if there had been no prior ART ($P < .001$) compared with if there had been prior ART ($P < .001$; Table 1). When specific age strata were examined, a smaller percentage of black women had their initial fresh embryo treatment cycle before age 35 years, compared with white women (42.1% vs. 50.1%, respectively; $P < .001$). In contrast, a greater percentage of black women who first pursued ART were over 37 years old compared with their white counterparts (35.4% vs. 27.5%, respectively; $P < .001$). Among women with prior ART, the proportion of black women less than 35 years old was 31%, compared with 36.8% for white women; for women older than 37 years these proportions were 46.3% and 38.5%, respectively; $P < .001$. To place this in additional perspective, the percentage of black women who were undergoing ART and were less than 35 years decreased between 1999 and 2000 and 2004–

2006. Of black women who underwent IVF for the first time in 1999 and 2000, 50.1% were less than 35 years old, compared with 42.1% in 2004–2006 ($P < .001$). Similarly, 38.9% of black women who underwent ART with a previous history of IVF were less than 35 years old in 1999 and 2000, in contrast to 31% in 2004–2006 ($P < .001$). A similar trend was noted among white women, with a general decrease in the percentage of women younger than 35 years undergoing ART. Thus, regardless of race, women who underwent ART in 2004–2006 tended to be older than those in 1999 and 2000. However, the difference between black and white women in the percentage of women less than 35 years old undergoing ART widened significantly between 1999 and 2000 and 2004–2006, with 50.1% black women vs. 53.6% white women with no prior ART in 1999 and 2000, compared with 42.1% vs. 50.1%, respectively, in 2004–2006 ($P < .001$).

Nulliparity characterized 68.8% of black women who underwent ART for their first time in 1999 and 2000, compared with 58% of black women in 2004–2006 ($P < .001$). More dramatically, 77.7% of white women in 1999 and 2000 who underwent ART for the first time in 1999 and 2000 were nulliparous, compared with 58% of white women in 2004–2006 ($P < .001$). Despite black and white women having the same percentage (58%) of nulliparity in 2004–2006, the decrease in nulliparity was greater among white than black women ($P < .001$). A similar finding was noted in women with a previous history of ART for both 1999 and 2000 and 2004–2006. Thus, it seems that fewer women had undergone ART to treat primary rather than secondary infertility in 2004–2006 as compared with 1999 and 2000 ($P < .001$).

When examining the etiology of infertility, women who underwent fresh, nondonor embryo cycles demonstrated several differences between races (Table 1). Among women with no prior ART, black women were 2.5 times (compared with 2 times in 1999 and 2000) more likely than white women to have tubal factor (45% vs. 17.9%; $P < .001$). Of black women who underwent ART for the first time, 62.8% had tubal factor in 1999 and 2000, compared with 45% in 2004–2006 ($P < .001$). Of white women, 28.2% had the diagnosis of tubal factor in 1999 and 2000, compared with 17.9% in 2004–2006 ($P < .001$). Again, similar trends were evident among black and white women with a previous history of ART. Although tubal factor decreased among all women between 1999 and 2000 and 2004–2006, the difference between blacks and whites significantly widened (data not shown; $P = .015$) between these intervals. Black women continued to be 3 times more likely to have uterine factor infertility than white women (12.4% vs. 3.9%, respectively, for black and white women undergoing their initial ART cycle and 13.1% vs. 4.7% for women with a history of prior ART; $P < .001$).

The diagnoses of diminished ovarian reserve and unexplained infertility both increased between the datasets of 1999 and 2000 and 2004–2006 among all women but to a greater extent among black women. Of black women who underwent ART for the first time, 7.5% had a diagnosis of diminished ovarian reserve in 1999 and 2000, compared with

TABLE 1

Baseline characteristics, treatment, and outcomes for fresh, nondonor cycles among black and white women.

Characteristic (% reporting)	No prior ART						Prior ART					
	Black (n = 6,815)			White (n = 74,390)			Black (n = 3,539)			White (n = 46,604)		
	%	95% CI	Change ^a	%	95% CI	P	%	95% CI	Change ^a	%	95% CI	P
Woman's age (y)												
<35	42.1	(40.9–43.3)	–	50.1	(49.7–50.5)	<.001	31.0	(29.5–32.5)	–	36.8	(36.4–37.2)	<.001
35–37	22.5	(21.5–23.5)	+	22.3	(22–22.6)		22.7	(21.3–24.1)	+	24.8	(24.4–25.2)	
38–40	21.8	(20.8–22.8)	+	17.1	(16.8–17.4)		27.0	(25.5–28.5)	+	22.2	(21.8–22.6)	
41–42	8.8	(8.1–9.5)	+	7.0	(6.8–7.2)		11.7	(10.6–12.8)	+	10.2	(9.9–10.5)	
>42	4.8	(4.3–5.3)	+	3.4	(3.3–3.5)		7.6	(6.7–8.5)	+	6.1	(5.9–6.3)	
Nulliparous (59.1)	58.0	(56.6–59.4)	–	58.0	(57.5–58.5)	.946	53.0	(51.1–54.9)	–	44.7	(44.1–45.3)	<.001
Past spontaneous abortion	34.1	(32.7–35.5)	NC	25.2	(24.8–25.6)	<.001	28.5	(26.7–30.3)	–	33.8	(33.3–34.3)	<.001
Diagnosis												
Tubal factor	45.0	(43.8–46.2)	–	17.9	(17.6–18.2)	<.001	47.5	(45.9–49.1)	–	18.8	(18.4–19.2)	<.001
Tubal ligation	6.1	(5.5–6.7)		3.2	(3.1–3.3)	<.001	4.6	(3.9–5.3)		2.2	(2.1–2.3)	<.001
Hydrosalpinx	4.3	(3.8–4.8)		1.5	(1–1.6)	<.001	4.0	(3.4–4.6)		1.5	(1–1.6)	<.001
Other	33.2	(32.1–34.3)		12.9	(12.7–13.1)	<.001	37.3	(35.7–38.9)		14.7	(14.4–15)	<.001
Male infertility	32.2	(31.1–33.3)	+	37.4	(37.1–37.7)	<.001	35.9	(34.3–37.5)	+	40.2	(39.8–40.6)	<.001
Uterine factor	12.4	(11.6–13.2)	+	3.9	(3.8–4)	<.001	13.1	(12–14.2)	+	4.7	(4.5–4.9)	<.001
History of endometriosis	7.5	(6.9–8.1)	–	14.6	(14.3–14.9)	<.001	8.9	(8–9.8)	–	15.9	(15.6–16.2)	<.001
Diminished ovarian reserve	14.4	(13.6–15.2)	+	15.9	(15.6–16.2)	.001	21.3	(20–22.6)	+	23.0	(22.6–23.4)	.020
Ovulation disorders (PCOS)	11.2	(10.5–11.9)	+	16.2	(15.9–16.5)	<.001	9.4	(8.4–10.4)	–	13.8	(13.5–14.1)	<.001
Other	12.2	(11.4–13)	+	13.9	(13.7–14.1)	<.001	14.0	(12.9–15.1)	+	15.4	(15.1–15.7)	.019
Unexplained	7.3	(6.7–7.9)	+	13.4	(13.2–13.6)	<.001	4.2	(3.5–4.9)	+	9.9	(9.6–10.2)	<.001
FSH dose ≥ 37 ampules (88.5)	48.6	(47.3–49.9)	+	45.7	(45.3–46.1)	<.001	59.4	(57.7–61.1)	+	57.9	(57.4–58.4)	.115
High ovarian response (88.1)	56.7	(55.4–58)	+	57.2	(56.8–57.6)	.474	48.1	(46.3–49.9)	–	50.6	(50.1–51.1)	.009
Cycle canceled	15.5	(14.6–16.4)	–	12.3	(12.1–12.5)	<.001	13.5	(12.4–14.6)	–	11.1	(10.8–11.4)	<.001
Due to low response	73.8	(71.1–76.5)	–	83.8	(83–84.6)	<.001	78.7	(75–82.4)	+	85.4	(84.4–86.4)	<.001
ICSI	51.3	(50–52.6)	+	53.7	(53.3–54.1)	<.001	55.8	(54–57.6)	+	60.6	(60.1–61.1)	<.001
No. of embryos transferred (81.3)												
1	8.8	(8–9.6)	+	8.6	(8.4–8.8)	<.001	9.7	(8.6–10.8)	+	8.8	(8.5–9.1)	.003
2	47.6	(46.3–48.9)	+	51.1	(50.7–51.5)		30.2	(28.5–31.9)	+	33.3	(32.8–33.8)	
3+	43.6	(42.3–44.9)	–	40.3	(39.9–40.7)		60.1	(58.3–61.9)	–	57.9	(57.4–58.4)	
Implantation rate (%), mean ± SD (35.1)	56.2 ± 29.8		+	58.9 ± 30.7		<.001	47.8 ± 30.3		+	50.8 ± 29.9		.003

Seifer. Racial disparities: SART 1999 and 2000 vs. 2004–2006. Fertil Steril 2009.

TABLE 1

Continued.

Characteristic (% reporting)	No prior ART						Prior ART					
	Black (n = 6,815)			White (n = 74,390)			Black (n = 3,539)			White (n = 46,604)		
	%	95% CI	Change ^a	%	95% CI	P	%	95% CI	Change ^a	%	95% CI	P
Treatment outcome												
Clinical intrauterine gestation (CIG)	29.3	(28.2–30.4)	+	38.3	(38–38.6)	<.001	25.0	(23.6–26.4)	+	32.4	(32–32.8)	<.001
Spontaneous abortion	19.9	(18.1–21.7)	–	13.6	(13.2–14)	<.001	26.3	(23.4–29.2)	+	16.8	(16.2–17.4)	<.001
Live birth per CIG	76.9	(75–78.8)		84.8	(84.4–85.2)	<.001	71.0	(68–74)		81.6	(81–82.2)	<.001
Biochemical pregnancy	4.3	(3.8–4.8)	+	6.2	(6–6.4)		4.4	(3.7–5.1)	NC	6.7	(6.5–6.9)	
Ectopic or heterotopic	0.7	(0.5–0.9)	–	0.7	(0.6–0.8)		0.7	(0.4–1)	+	0.7	(0.6–0.8)	
Not pregnant	65.7	(64.6–66.8)	–	54.7	(54.3–55.1)		69.9	(68.4–71.4)	–	60.1	(59.7–60.5)	
Live births per cycle started	22.2	(21.2–23.2)	+	32.3	(32–32.6)	<.001	17.5	(16.2–18.8)	+	26.3	(25.9–26.7)	<.001
Plurality of birth (29.3)												
Singleton	71.3	(69–73.6)	+	67.6	(67–68.2)	.013	73.3	(69.8–76.8)	+	68.8	(68–69.6)	.064
Twins	27.0	(24.8–29.2)	–	30.4	(29.8–31)		24.3	(20.9–27.7)	–	28.2	(27.4–29)	
Triplets or more	1.8	(1.1–2.5)	–	2.0	(1.8–2.2)		2.4	(1.2–3.6)	–	2.9	(2.6–3.2)	

Note: CI = confidence interval; NC = no change; PCOS = polycystic ovary syndrome.

^a Change in black women from 1999 and 2000 dataset; “+” indicates percentage increase, “–” indicates percentage decrease.

Seifer. Racial disparities: SART 1999 and 2000 vs. 2004–2006. *Fertil Steril* 2009.

TABLE 2

Baseline characteristics, treatment, and outcomes for cryopreserved, nondonor cycles among black and white women.

Characteristic (% reporting)	Black (n = 1,933)			White (n = 25,412)		P
	%	95% CI	Change ^a	%	95% CI	
Woman's age (y)						
<35	45.4	(43.2–47.6)	–	51.4	(50.8–52)	<.001
35–37	26.4	(24.4–28.4)	+	25.5	(25–26)	
38–40	18.8	(17.1–20.5)	+	15.3	(14.9–15.7)	
41–42	5.1	(4.1–6.1)	+	4.9	(4.6–5.2)	
>42	4.3	(3.4–5.2)	+	2.8	(2.6–3)	
Nulliparous (73.1)	53.3	(50.7–55.9)	–	38.7	(38–39.4)	<.001
Past spontaneous abortion	42.4	(40.2–44.6)	+	34.7	(34.1–35.3)	<.001
Diagnosis						
Tubal	45.4	(43.2–47.6)	–	20.4	(19.9–20.9)	<.001
Tubal ligation, not reversed	5.8	(4.8–6.8)		2.7	(2.5–2.9)	<.001
Hydrosalpinx (in place)	3.9	(3–4.8)		1.8	(1–2)	<.001
Other tubal disease (no hydrosalpinx)	34.1	(32–36.2)		15.4	(15–15.8)	<.001
Male infertility	31.6	(29.5–33.7)	+	38.0	(37.4–38.6)	<.001
Uterine factor	10.7	(9.3–12.1)	–	4.0	(3.8–4.2)	<.001
History of endometriosis	8.1	(6.9–9.3)	–	15.5	(15.1–15.9)	<.001
Diminished ovarian reserve	8.0	(6.8–9.2)	+	7.5	(7.2–7.8)	.383
Ovulation disorders/polycystic ovaries	16.3	(14.7–17.9)	+	20.3	(19.8–20.8)	<.001
Other	12.0	(10.6–13.4)	+	12.1	(11.7–12.5)	.858
Unexplained	5.9	(4.8–7)	+	11.9	(11.5–12.3)	<.001
Cycle canceled	7.1	(6–8.2)	–	7.6	(7.3–7.9)	.423
No. of embryos transferred (90.1)						
1	10.6	(9.2–12)	+	14.5	(14–15)	<.001
2	41.4	(39.1–43.7)	+	41.3	(40.7–41.9)	
3+	48.0	(45.7–50.3)	–	44.2	(43.6–44.8)	
Implantation rate (%), mean ± SD		49.4 ± 29.1	+		51.0 ± 30.1	.191
Treatment outcome						
Clinical intrauterine gestation (CIG)	31.8	(29.7–33.9)	+	31.8	(31.2–32.4)	.426
Spontaneous abortion per CIG	25.9	(22.4–29.4)	+	18.5	(17.7–19.3)	<.001
Live birth per CIG	71.8	(68.2–75.4)		80.3	(79.4–81.2)	
Biochemical pregnancy	8.1	(6.9–9.3)	+	9.1	(8.7–9.5)	
Ectopic or heterotopic	0.6	(0.3–0.9)	–	0.4	(0.3–0.5)	
Not pregnant	59.5	(57.3–61.7)	–	58.6	(58–59.2)	
Live births per cycle started	22.6	(20.7–24.5)	+	25.4	(24.9–25.9)	.006
Plurality of birth (25.2)						
Singleton	74.1	(70–78.2)	+	76.5	(75.5–77.5)	.246
Twins	22.9	(19–26.8)	–	21.6	(20.6–22.6)	
Triplets or more	3.0	(1.4–4.6)	–	2.0	(1.7–2.3)	

Note: CI = confidence interval.

^a Change in black women from 1999 and 2000 dataset; “+” indicates percentage increase, “–” indicates percentage decrease.

Seifer. Racial disparities: SART 1999 and 2000 vs. 2004–2006. Fertil Steril 2009.

14.4% of black women in 2004–2006 ($P<.001$). Of white women who underwent ART for the first time in 1999 and 2000, 10.2% had the diagnosis of diminished ovarian reserve, compared with 15.9% of white women in 2004–2006 ($P<.001$). Similar trends were noted among those women with a prior history of ART. Of black women who underwent

their initial cycle of ART, 3.2% had the diagnosis of unexplained infertility in 1999 and 2000, compared with 7.3% of black women in 2004–2006 ($P<.001$). Of white women who underwent ART for the first time in 1999 and 2000, 9% had the diagnosis of unexplained infertility, compared with 13.4% of white women in 2004–2006 ($P<.001$). Similar

trends, though not as obvious, were noted among women with a previous history of ART. Polycystic ovarian syndrome, endometriosis, and male factor continued to display a greater percentage among white than among black women ($P < .001$) in 2004–2006 as in 1999 and 2000, both in women who underwent ART for the first time and in those with a previous history of ART.

The clinical practices of single embryo transfer and the application of intracytoplasmic sperm injection (ICSI) increased, whereas the transfer of three or more embryos decreased between 1999 and 2000 and 2004–2006 for all women, regardless of race. For black women, 5.3% of transfers were single embryo transfers in 1999 and 2000, as compared with 8.8% in 2004–2006 ($P < .001$) for those undergoing their first ART cycle. For white women, 4.6% of transfers were single embryo transfers in 1999 and 2000, compared with 8.6% in 2004–2006 ($P < .001$) for those undergoing their initial cycle. A similar trend was noted in women with a history of a prior cycle. Of black women who underwent their first ART cycle, 70.8% had three or more embryos transferred in 1999 and 2000, compared with 43.6% in 2004–2006 ($P < .0001$). Of white women in their first cycle, 69% had three or more embryos transferred in 1999 and 2000, compared with 40.3% in 2004–2006 ($P < .001$). Again, these trends were also evident among women with a previous history of ART. Intracytoplasmic sperm injection accounted for 37.1% of ART cycles in black women in 1999 and 2000, compared with 51.3% in 2004–2006 ($P < .001$); for white women these figures were 42.1% in 1999 and 2000, compared with 53.7% in 2004–2006 ($P < .001$). Similar trends were noted in women with a prior history of ART.

Treatment outcomes among cycles using fresh, nondonor embryos continued to be worse for black compared with white women. A clinical intrauterine gestation occurred less often: 29.3% for black women vs. 38.3% for white women per cycle started, respectively ($P < .001$). This occurred despite the fact that the number of embryos transferred was not substantially different overall. If clinical pregnancy occurred, spontaneous abortion continued to be more common among black women (19.9% vs. 13.6% among white women; $P < .001$). The difference in spontaneous abortion rates between black and white women did not change appreciably between 1999 and 2000 and 2004–2006, with black women continuing to have an approximately 50% increase over white women. Live births per cycle started continued to be less common among black vs. white women (22.2% vs. 32.3% per cycle started, respectively; $P < .001$). Similar findings occurred in fresh, nondonor embryo cycles for women who had received prior ART (Table 1).

It is worth noting that clinical intrauterine gestations and live births per cycle started increased in representation among white but not among black women between the two datasets of 1999 and 2000 and 2004–2006. Of white women trying ART for their first time, 33.6% had a clinical intrauterine gestation in 1999 and 2000, compared with 38.3% in 2004 and 2006 ($P < .001$). This represents a 14% increase, in contrast to no significant change among black women: 27.7%

in 1999 and 2000 vs. 29.3% in 2004–2006 ($P = .185$). Similar differences between the two datasets were noted among women with a previous history of ART, with an increase among white women (28.9% vs. 32.4%; $P < .001$) but less of a significant change among black women (22.1% vs. 25%; $P = .04$) for clinical intrauterine gestation. Of white women attempting their initial cycle of ART, 28.4% had a live birth per cycle start in 1999 and 2000, compared with 32.3% in 2004–2006 ($P < .001$). This represents a 13.7% increase, in contrast to no significant change among black women: 20.7% in 1999 and 2000 vs. 22.2% in 2004–2006 ($P = .185$). Similar differences between the two datasets were noted among women with a previous history of ART, with an increase among white women (23.7% vs. 26.3%; $P < .001$) but no change among black women (15.7% vs. 17.5%; $P = .160$) for live births per cycle started.

The distribution of plurality of births differed between black and white women ($P = .013$) for the dataset for 2004–2006. This difference is in contrast to a similar distribution of plurality of births in the dataset for 1999 and 2000. The distribution of plurality of births changed significantly between the 1999 and 2000 and 2004–2006 datasets. Overall, births of twins decreased and births of triplets or more dramatically decreased, whereas singleton births increased. Of all births among black women who attempted their initial ART cycle, 32% were twins in 1999 and 2000, compared with 27% in 2004–2006 ($P < .05$), whereas 32.4% of all births among white women were twins in 1999 and 2000, compared with 30.4% in 2004–2006 ($P < .001$). A similar decrease in the birth of twins was noted among white women who reported a previous history of ART (30.1% vs. 28.2%; $P = .008$) but was unchanged among black women (25.9% vs. 24.3%; $P = .65$) between 1999 and 2000 and 2004–2006. Of all births among black women who had their first ART cycle, 5.8% were triplets or more in 1999 and 2000, compared with 1.8% in 2004–2006 ($P < .001$), representing a 69% decrease. Of all births among white women who had their initial cycle, 5.3% were triplets or more in 1999 and 2000, compared with 2% in 2004–2006 ($P < .001$), representing a 62% decrease. A similar decrease was noted in the birth of triplets or more among white women who reported a previous history of ART (5.3% vs. 2.9%; $P < .001$) but not among black women (3.5% vs. 2.4%; $P = .42$). Singleton births increased among all women, regardless of race, between 1999 and 2000 and 2004–2006: 62.2% of all births were singletons among black women who had their initial ART cycle in 1999 and 2000, compared with 71.3% in 2004–2006 ($P < .001$); for white women these figures were 62.3% in 1999 and 2000 vs. 67.6% in 2004–2006 ($P < .001$). For women with a prior history of ART, similar differences were noted for white women (64.6% vs. 68.8%; $P < 0.001$) but not for black women (70.6% vs. 73.3%; $P = .46$) between 1999 and 2000 and 2004–2006.

When examining the outcomes between black and white women in cycles using cryopreserved embryos (Table 2), neither implantation rates nor clinical intrauterine gestation rates differed between races; however, black women had fewer live births per cycle started than white women (22.6% vs. 25.4%;

$P=.006$) in 2004–2006. This finding is in contrast to there having been no difference between races for implantation rates, clinical intrauterine gestation rates, or live births per cycle started for cryopreserved embryos in 1999 and 2000.

Similar to the 1999 and 2000 data study, the present logistic regression controlled for potential confounding by medical factors, such as age, parity, and certain diagnoses (Table 3) (1). Comparing the two periods, the 2004–2006 regression models showed more of a tendency toward increased risk for not achieving live births among black women (with no prior ART), and for women's age, prior spontaneous abortion, other ovarian disorders, and ICSI. Particularly among fresh, nondonor cycles, multivariable adjustment for differences in prognostic factors revealed an independent effect of race on live birth. Adjusted RRs revealed that the magnitude of the independent effect associated with black women not achieving a live birth was 31%–33%, whereas in 1999 and 2000 this risk was 24%–38%. When comparing age of women who were less than 35 years old, the previous study reported an adjusted RR of 18%–21%, whereas for the pres-

ent study the adjusted RR increased to 24% for this age group. Also in contrast to the prior study, which found no significant difference in race for those with cryopreserved cycles, the present models, adjusted for confounding, revealed a 10% increased risk of not achieving live birth among black women when compared with white women.

DISCUSSION

Concerning trends have been identified by our comparison of the 1999 and 2000 and 2004–2006 SART data sets. Because this is the largest reported study examining trends in racial disparities between black and white women for ART outcomes and reviews 3 years of SART data from 2004–2006 compared with SART data from 1999 and 2000, these findings deserve attention. Similar to our original study (1), these data demonstrate several interesting findings and changing trends relating to differences between black and white women undergoing ART. It is noted that even though race was reported with increasing frequency per cycle with each successive year from 2004 through 2006 compared with 1999 and 2000, 40% of

TABLE 3

Independent predictors of not achieving a live birth.

Factor	Fresh, nondonor cycles								
	No prior ART			Prior ART			Cryopreserved cycles		
	Adj. RR	(95% CI)	<i>P</i>	Adj. RR	(95% CI)	<i>P</i>	Adj. RR	(95% CI)	<i>P</i>
Race									
White	Reference			Reference			Reference		
Black	1.31 +	(1.26–1.37)	<.001	1.33	(1.24–1.42)	<.001	1.10 +	(1.00–1.21)	.048
Woman's age (y)									
<35	Reference			Reference			Reference		
35–37	1.24 +	(1.20–1.27)	<.001	1.24 +	(1.19–1.30)	<.001	1.17	(1.11–1.24)	<.001
38–40	1.60	(1.56–1.65)	<.001	1.65 +	(1.59–1.71)	<.001	1.43	(1.34–1.52)	<.001
41–42	2.10	(2.02–2.16)	<.001	2.23	(2.13–2.33)	<.001	1.65	(1.49–1.82)	<.001
>42	2.66	(2.56–2.74)	<.001	2.97	(2.83–3.10)	<.001	1.92	(1.68–2.16)	<.001
Nulliparous	1.09	(1.05–1.12)	<.001	1.20	(1.15–1.24)	<.001	1.05	(1.00–1.11)	.054
Prior spontaneous abortion	—			0.96 +	(0.92–1.00)	.060	1.04	(0.99–1.09)	.136
Tubal disorder	1.00	(0.97–1.04)	.806	1.04	(1.00–1.09)	.070	—		
Male factor	1.04	(1.00–1.07)	.025	1.03	(0.98–1.07)	.222	—		
Uterine factor	1.10	(1.02–1.17)	.013	—			1.19	(1.05–1.34)	.006
Diminished ovarian reserve	1.33	(1.27–1.38)	<.001	1.31	(1.25–1.38)	<.001	1.15	(1.03–1.26)	.010
Other ovarian disorder (e.g., PCOS)	—			—			0.94 +	(0.89–1.00)	.065
Endometriosis	—			—			1.03	(0.96–1.10)	.454
ICSI	0.83 +	(0.80–0.86)	<.001	0.81 +	(0.77–0.85)	<.001	NA		

Note: CI = confidence interval; PCOS = polycystic ovary syndrome. “+” indicates increased adjusted relative risk over 1999 and 2000.

Seifer. Racial disparities: SART 1999 and 2000 vs. 2004–2006. *Fertil Steril* 2009.

cycles still remain unreported for race. It is believed that as the general awareness regarding race as a prognostic factor for ART outcomes grows, such voluntary reporting is likely to continue to improve in the years ahead.

A greater percentage of black women underwent ART in 2004–2006 than in 1999 and 2000. However, black women still remained underrepresented in proportion to the number of women of reproductive age who may have had infertility and may have benefited from ART during this study period. Whether this underrepresentation is due to an issue of access, health education/motivation, or is economically driven remains unclear. It is interesting to note that fewer women, regardless of race, underwent ART to be treated for primary rather than secondary infertility in 2004–2006 than in 1999 and 2000. It may be that more women are resorting to undergoing ART after having had their first child. It is speculated that women are waiting longer to have their second child, and this decision may be a factor in contributing to the increasing number of women who are of advanced reproductive age by the time they have their initial cycle of ART to treat secondary infertility.

Black women were older than white women who underwent ART in 2004–2006 compared with 1999 and 2000. This observation is highlighted by the decrease in black women less than 35 years old and the increase in black women older than 37 years old who underwent ART in 2004–2006 compared with 1999 and 2000. Thus, the difference in age between black and white women undergoing ART for the treatment of infertility seems to be increasing in a disadvantageous direction for black women. This is consistent with the observation that the diagnosis of diminished ovarian reserve increased between the two datasets among all women but to a greater extent among black women. This is further supported by a recent observation that black women have lower levels of serum Müllerian inhibiting substance/anti-Müllerian hormone, a surrogate marker of ovarian aging, over time compared with white women after controlling for age, body mass index, smoking, and HIV status (18).

Although tubal factor did decrease among all women between 1999 and 2000 and 2004–2006, the difference between black and white women significantly increased between these time intervals. It is speculated that some percentage of these cycles with tubal factor had hydrosalpinges that may have not been detected or surgically treated before ART, thus further widening potential differences in pregnancy rates between black and white women. Thus, the increase in poor prognostic factors of older age, diminished ovarian reserve, uterine factor, and suspected untreated tubal factor among black women may in part have contributed to the widening disparity of clinical outcomes between black and white women for clinical intrauterine gestations and live births per cycle of initial ART started in 2004–2006 (22.2% vs. 32.3%, a 31% difference) in contrast to 1999 and 2000 (20.7% vs. 28.4%, a 27% difference).

Other notable findings included the increase in the clinical practices of single embryo transfer and application of ICSI,

whereas the transfer of three or more embryos decreased between 1999 and 2000 and 2004–2006 for all women, regardless of race. This was reflected in the decreased births of twins and the dramatic decrease in triplets, whereas singleton births increased particularly among black women, who demonstrated a greater increase in singletons and decrease in twins or more compared with white women. These findings are consistent and are evidence of the probable effectiveness of the recent American Society for Reproductive Medicine guidelines encouraging the transfer of fewer embryos to preclude high-order multiple births (19).

The lower live births per cycle started among black women who had thawed cryopreserved embryos transferred may indicate that these thawed embryos were more likely to abort after initial implantation, given that implantation and clinical intrauterine gestation rates were similar between black and white women. It is speculated that in the interim between 1999 and 2000 and 2004–2006 cryopreserving and thawing techniques improved, resulting in higher national rates for all women while concomitantly revealing a small disparity in live births for black women. However, this 10% disparity for live birth rate with cryopreserved embryos is less remarkable than the 31% disparity for live birth rate between black and white women for fresh embryo transfer during the same interval.

Estimates of determining access to high-quality ART care have not yet been well defined. As such, we could not examine issues of access in this dataset. It is noted that unlike the 1999 and 2000 SART databases, duration of infertility before the time of presentation for treatment was not available in the present dataset, and thus it was not possible to determine whether black women had a longer duration of infertility before they presented for treatment as compared with white women. Previous studies suggest that specific ART care received by patients and treatment outcomes are affected by state insurance mandates (20–24); however, we did not have access to such information in this dataset. Our previous study (1) suggested that black women were more often treated at low-volume clinics, corroborating the findings of a study of cardiovascular procedures that noted that black patients in the United States may disproportionately receive surgery at centers with lower volume (25). Although volume is a relatively crude measure of care, high-volume centers have been linked to better outcomes for some medical problems (26, 27). However, in other studies no effect of volume persisted after controlling for case mix (23, 28). Thus, the question of medical access for IVF treatment remains a challenging issue to be addressed.

On the basis of the observations of this study it is possible to suggest several approaches that may have a future impact in narrowing the disparity between black and white outcomes for women undergoing ART but would require further investigation to show efficacy. Education regarding the negative influence of age on reproduction may encourage some to consider having children before the rapid progression of diminished ovarian reserve that occurs in the mid-30s for most women. Removal of hydrosalpinges and submucosal fibroids could be of benefit for those women choosing to undergo ART

because both, left untreated, have been linked to decreasing success rates. Finally, the disparity in outcomes may continue to widen with time unless further studies are designed to specifically uncover those differences in treatments or outcomes and clinicians are proactive in considering race as a significant prognostic factor when making ART decisions.

Acknowledgments: The Society for Assisted Reproductive Technology wishes to thank all of its members for providing clinical information to the SARTCORS database for use by patients and researchers. Without the efforts of our members, this research would not have been possible.

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