

Disparity in assisted reproductive technologies outcomes in black women compared with white women

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Objective: To compare success rates in black and white women undergoing IVF.

Design: Retrospective cohort study.

Setting: Society for Assisted Reproductive Technology member clinics in 1999–2000 that performed ≥ 50 cycles of IVF and reported race/ethnicity in $>95\%$ of cycles.

Patient(s): Women receiving 80,309 IVF cycles.

Intervention(s): IVF using nondonor embryos.

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

Result(s): Black, white, and other race/ethnicity women underwent 3666 (4.6%), 68,607 (83.5%), and 8036 (11.9%) IVF cycles, respectively. Spontaneous abortions were more common among black women. The live-birth rate was 26.3% (95% confidence interval [CI], 25.9%–26.7%) among white women compared with 18.7% (95% CI, 17.5%–20.1%) among black women (rate ratio, 1.41). After controlling for increased tubal and uterine factor infertility among blacks and other characteristics, black race was an independent risk factor for not achieving a live birth (adjusted relative risk, 1.21; 95% CI, 1.12–1.36 if no prior ART, and RR, 1.38; 95% CI, 1.20–1.57 if prior ART). For cryopreserved embryo cycles, live-birth rates were equivalent.

Conclusion(s): Black women, who represented 7.8% of married reproductive-age women in the United States at that time, were underrepresented among IVF recipients. Race is a marker for prognosis that is not explained by characteristics available in the registry data set. (Fertil Steril® 2007; ■: ■–■. ©2007 by American Society for Reproductive Medicine.)

Key Words: Infertility, in vitro fertilization, assisted reproductive techniques, African Americans, black women, race, ethnic groups, socioeconomic factors, delivery of health care

Black women in the United States have experienced an increase in the prevalence of infertility at the same time that infertility is decreasing among white women (1). The population-based rates of 12-month infertility determined by the National Survey of Family Growth in 1982 and 2002 were 7.8% and 11.6%, respectively, for black women and 11.6% and 7.1%, respectively, for white women. Although 1% of all births now originate from some form of assisted reproductive technology (ART), few studies have evaluated differences in ART outcomes between black and white women (1–6).

Differences in clinical outcomes between blacks and whites have been assessed for a variety of other medical tech-

nologies in the United States. Cardiovascular procedures, renal transplantation, knee arthroplasty, and cancer surgery are examples of treatments that have been examined (7–13). Such analyses may help determine whether there are racial or ethnic variations in the severity of disease at presentation, while the research results could help improve the accessibility and delivery of medical technologies.

There is no consensus among the existing research that compares the ART outcomes of black women with white women. Some studies have identified racial differences (2, 3, 6), while others have not (4, 5). Previous studies are limited by relatively small sample sizes, and this may explain the discrepant results. In an effort to help resolve this controversy, we examined the hypothesis that there may be racial differences in ART outcomes between black and white women in the United States by analyzing the Society for Assisted Reproductive Technology (SART) database for the years 1999–2000 (14–16). This time period is at the midpoint of the two most recent National Survey of Family Growth years,

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1995 and 2002 (1, 17, 18). Analysis of the extensive SART database for possible racial disparities may also serve as a baseline for comparison at the beginning of the 21st century with future ART outcome studies.

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. A retrospective cohort study was conducted. Deidentified data from the national registry of ART treatment cycles in the United States during 1999–2000 were analyzed. This registry, described in detail elsewhere (14–16), contains data collected by SART and maintained by the Centers for Disease Control and Prevention (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. Clinics reported the woman's maximum historic cycle day 3 FSH level (in mIU/mL) and the laboratory's upper limit of normal. 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, CDC selected the 184,173 IVF cycles reported by SART member clinics during the study period and then excluded 2755 (1.5%) cycles to limit the study data set to clinics providing 50 or more cycles in a given year. CDC used clinic identifiers to create an annual clinic volume variable in two categories split by the median volume and a variable in four quartiles representing the clinic's overall clinical intrauterine gestation (CIG) rate for fresh nondonor cycles among women <35 years old. Then clinic identifiers were deleted from the study data set. To minimize the likelihood of selection bias because of missing data on race, CDC excluded 87,836 (48.4%) cycles from the remaining 181,418 cycles to limit the study data set to clinics that reported race in $\geq 95\%$ of cycles. CDC compared the 87,836 cycles excluded because of missing data on race to the remaining 93,582 cycles and found that the clinical pregnancy rate per cycle started was essentially the same for the excluded and included cycles (30.8% and 30.6%, respectively) and that the live-birth rates were identical (25.2%).

From the 93,582 cycles in the final study data set provided by CDC, we excluded 241 cycles with missing data on whether a CIG occurred, 1027 cycles that used a gestational carrier, 10,117 cycles that used embryos created with donor oocytes, and 1888 cycles with missing data on race, which left 80,309 cycles for analysis.

Statistical Analysis

Data were analyzed using SPSS (ver. 14.0; SPSS Inc., Chicago). The treatment cycle was the unit of analysis because

personal identifiers were not available and cycles were not linked, precluding analysis by individual patient. Data among women with no prior ART were examined separately because these cycles most likely 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 (6, 16). FSH ratios were obtained by dividing the FSH level by the upper limit of normal for the laboratory. 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 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. For continuous variables, groups were compared using Mann-Whitney tests because of skewed distributions. For our data and when using published data used for comparison purposes (14, 15), 95% confidence intervals (CIs) were calculated using the formula

$$p \pm Z_{1-\alpha/2} \sqrt{p(1-p)/n}$$

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. Potential confounders found to be statistically significant in univariate analyses were included in the models. Backward conditional elimination was used to generate the most parsimonious models. If race was eliminated from the model, then results were presented for the last regression step that included race. To derive approximate relative risks (RRs) for outcomes that had a prevalence of 10% or greater, the adjusted odds ratios (Adj. ORs) were corrected using the formula, $\text{Adj. RR} = \text{Adj. OR} / [(1 - p_0) + (\text{Adj. OR} \times p_0)]$ (19). 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 80,309 nondonor cycles of ART during 1999–2000 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 3666 (4.6%) cycles among black non-Hispanic women and 68,607 (85.4%) cycles among white non-Hispanic women. We excluded from further analysis 3585 Asian non-Hispanic women, 4338 (5.4%) cycles among Hispanic women of any race, 66 (0.08%) cycles among Native American women, and 47 (0.06%) cycles among women of other

racers. This left a final study population of 72,273 cycles among white non-Hispanic women and black non-Hispanic women (referred to as white and black for the rest of this paper).

The baseline characteristics, treatment factors, and outcomes are provided in Table 1 for fresh nondonor cycles (3116 cycles among black women and 58,459 cycles among white women) and in Table 2 for cycles using cryopreserved embryos (550 cycles among black women and 10,147 cycles among white women). The woman's race was the same as the man's race 99.3% of the time. The overall age distribution in fresh nondonor embryo cycles differed by the woman's race if there had been no prior ART ($P=.023$) compared with if there had been prior ART ($P=.007$; Table 1). When specific age strata were examined, a smaller percentage of black women had their initial fresh embryo treatment cycle before age 35 compared with white women (50.1% vs. 53.6%, respectively; $P=.004$). In contrast, a greater percentage of black women who first pursued ART were >37 years old compared with their white counterparts (27.6% vs. 25.1%, respectively; $P=.017$). Among women with prior ART, the proportion of black women >37 years old was 37.4% versus 34.2% for white women ($P=.019$). The duration of infertility was longer for black women when analyzed by prior ART status and by whether the embryo was fresh or cryopreserved (Tables 1 and 2) and also when analyzed within age and parity strata (data not shown).

When examining the etiology of infertility, black women who underwent fresh nondonor embryo cycles had a different pattern of diagnoses as white women (Table 1). For example, among women with no prior ART, black women were twice as likely as white women to have tubal disorders (62.8% vs. 28.2%, respectively; $P<.001$). Black women were also more likely to have uterine factor infertility, whereas white women were more likely to have male factor infertility, endometriosis, and other ovulation disorders such as polycystic ovarian syndrome (PCOS). The diagnosis of diminished ovarian reserve was made less often in black women with no prior ART (7.6% vs. 10.2%, respectively; $P<.001$), and their canceled cycles were less often due to low response (74.3% vs. 84.6%, respectively; $P<.001$). However, these findings were not substantiated with other evidence of better ovarian response, that is, reduced FSH ratios or lower gonadotropin dosage (Table 1).

Treatment outcomes among cycles using fresh nondonor embryos were worse for black compared with white women, for instance, among women with no prior ART (Table 1). CIGs occurred less often (e.g., 27.7% vs. 33.6% per cycle started, respectively; rate ratio, 0.82; $P<.001$). This occurred despite the fact that the number of embryos transferred was not substantially different overall (Table 1) or when comparing the proportion of cycles in which at least three embryos were transferred (70.8% vs. 69.0%, respectively; $P=.162$). If clinical pregnancy occurred, spontaneous abortion was more common among these black women (20.4% vs. 13.2%, respectively; rate ratio, 1.5, among women who

achieved CIG; $P<.001$). Live births per cycle started were less common among black women (20.7% vs. 28.4% per cycle started, respectively; $P<.001$). Similar findings occurred in fresh nondonor embryo cycles for women who had received prior ART (Table 1).

Combining the groups with and without prior ART, the overall live-birth rate per cycle started using fresh nondonor embryos was 18.7% (95% CI, 17.5%–20.1%) among black women, compared with 26.3% (95% CI, 25.9%–26.7%) among white women ($P<.001$; rate ratio, 0.71). Reduced live births among black women occurred in each age category (rate ratios, 0.75, 0.77, 0.55, and 0.67 for ages <35 years, 35–37 years, 38–40 years, and >40 years, respectively; P values <.001, <.001, <.001, and .059, respectively).

In contrast, outcomes were not worse for black women in cycles using cryopreserved embryos. Overall, treatment outcomes were similar ($P=.337$; Table 2). When CIG was examined separately, the rate was slightly higher among black women (22.7% vs. 20.2%; rate ratio, 1.12), although the difference was not statistically significant (95% CI, 19.2–26.2 vs. 19.4–21.0, respectively; $P=.145$; Table 2). The live-birth rate per cycle started was 16.5% (95% CI, 13.4%–19.6%) among black women, compared with 16.0% (95% CI, 15.3%–16.7%) among white women ($P=.718$; Table 2; rate ratio, 1.03).

Black women received treatment at a clinic that provided more than the median number of ART cycles per year less often than white women (e.g., 39.5% vs. 47.3%, respectively; $P<.001$ for women with no prior ART; Table 3). Black women were somewhat more likely to be treated at clinics that had lower success rates overall (Table 3).

Multivariable adjustment for differences in prognostic factors revealed an independent effect of race on live birth among cycles using fresh nondonor embryos. The logistic regressions controlled for potential confounding by medical factors such as age, parity, and diagnosis as well as clinic factors such as ART volume and overall pregnancy rate (Table 4). Adjusted RRs revealed that the magnitude of the independent effect associated with black race was a 24%–38% increase in risk of not achieving a live birth. Adjustment for confounding did not reveal an independent effect of race on live births among cycles with cryopreserved embryos.

DISCUSSION

This is the largest reported study examining racial disparity in ART outcomes, and it demonstrates that black women undergoing ART using fresh nondonor embryos were less successful at achieving a live birth than white women. The CIG rates were lower for black women, and the pregnancies of black women were more likely to result in miscarriage than were the pregnancies of white women. The overall live-birth rate per fresh nondonor cycle started for blacks was below the lower 95% CI for the rate among all races in the United States during 1999–2000 (18.7%; 95% CI, 17.5%–20.1%,

TABLE 1**Baseline characteristics, treatment, and outcomes for cycles using fresh nondonor embryos among black and white women.**

Characteristic	No Prior ART			Prior ART		
	Black (n = 1839)	White (n = 32,049)	P	Black (n = 1277)	White (n = 26,410)	P
Woman's age, years:						
<35	50.1 (47.8, 52.4)	53.6 (53.1, 54.1)	.023	38.9 (36.2, 41.6)	41.1 (40.5, 41.7)	.007
35–37	22.2 (20.3, 24.1)	21.2 (20.8, 21.6)		23.6 (21.3, 25.9)	24.7 (24.2, 25.2)	
38–40	18.1 (16.3, 19.9)	16.1 (15.7, 16.5)		25.3 (22.9, 27.7)	21.2 (20.7, 21.7)	
>40	9.5 (8.2, 10.8)	9.0 (8.7, 9.3)		12.1 (10.3, 13.9)	13.0 (12.6, 13.4)	
Duration of infertility in months, median, mean ± SD:	40.0, 51.6 ± 36.7	34.0, 41.0 ± 29.4	<.001	48.0, 55.5 ± 36.9	36.0, 44.6 ± 30.3	<.001
Nulliparous	68.6 (66.5, 70.7)	77.7 (77.2, 78.2)	<.001	67.3 (64.7, 69.9)	69.4 (68.8, 70.0)	.129
Past spontaneous abortion	34.1 (31.9, 36.3)	25.4 (24.9, 25.9)	<.001	41.3 (38.6, 44.0)	33.3 (32.7, 33.9)	<.001
Diagnosis:						
Tubal factor	62.8 (60.6, 65.0)	28.2 (27.7, 28.7)	<.001	62.3 (59.6, 65.0)	28.5 (28.0, 29.0)	<.001
Male factor	30.4 (28.3, 32.5)	36.9 (36.4, 37.4)	<.001	32.3 (29.7, 34.9)	40.0 (39.4, 40.6)	<.001
Uterine factor	11.4 (9.9, 12.9)	4.8 (4.6, 5.0)	<.001	13.6 (11.7, 15.5)	4.8 (4.5, 5.1)	<.001
Endometriosis	10.6 (9.2, 12.0)	22.1 (21.6, 22.6)	<.001	10.5 (8.8, 15.5)	21.5 (21.0, 22.0)	<.001
Diminished ovarian reserve	7.6 (6.4, 8.8)	10.2 (9.9, 10.5)	<.001	10.6 (8.9, 12.3)	14.3 (13.9, 14.7)	<.001
Other ovulation disorders (e.g., PCOS)	9.2 (7.9, 10.5)	14.6 (14.2, 15.0)	<.001	10.1 (8.4, 11.8)	14.0 (13.6, 14.4)	<.001
Other factors	11.4 (9.9, 12.9)	12.6 (12.2, 13.0)	.116	12.1 (10.3, 13.9)	13.4 (13.0, 13.8)	.210
Idiopathic	3.2 (2.4, 4.0)	9.0 (8.7, 9.3)	<.001	3.1 (2.1, 4.1)	7.5 (7.2, 7.8)	<.001
FSH ratio, cycle day 3:						
<0.5	40.3 (37.5, 43.1)	40.0 (39.3, 40.7)	.971	35.3 (32.1, 38.5)	37.3 (35.0, 39.6)	.429
0.5–1.0	52.1 (49.3, 54.9)	52.4 (51.7, 53.1)		55.7 (52.4, 59.0)	53.4 (51.0, 55.8)	
>1.0	7.7 (6.2, 9.2)	7.6 (7.2, 8.0)		8.8 (6.9, 10.7)	9.4 (8.0, 10.8)	
FSH dose ≥ 35 ampules ^a	45.7 (43.3, 48.1)	44.8 (44.2, 45.4)	.446	53.4 (50.4, 56.4)	55.3 (54.6, 56.0)	.232
High ovarian response (>10 oocytes retrieved)	55.8 (53.3, 58.3)	55.8 (55.2, 56.4)	.956	51.0 (48.0, 54.0)	49.8 (49.2, 50.4)	.448
Cycle canceled	16.9 (15.2, 18.6)	14.3 (13.9, 14.7)	.002	16.4 (14.4, 18.4)	12.8 (12.4, 13.2)	<.001
Canceled because of low response	74.3 (69.4, 79.2)	84.6 (83.6, 85.6)	<.001	77.5 (71.8, 83.2)	85.7 (84.5, 86.9)	.001
ICSI	37.1 (34.9, 39.3)	42.1 (41.6, 42.6)	<.001	43.1 (40.4, 45.8)	49.0 (48.4, 49.6)	<.001
Embryo(s) available for cryopreservation	34.3 (30.6, 38.0)	33.1 (32.2, 34.0)	.556	22.5 (18.5, 26.5)	22.5 (21.7, 23.3)	.997

Seifer. ART outcomes in black women. *Fertil Steril* 2007.

TABLE 1

Continued.						
Characteristic	No Prior ART			Prior ART		
	Black (n = 1839)	White (n = 32,049)	P	Black (n = 1277)	White (n = 26,410)	P
No. of embryos transferred:						
1	5.3 (4.1, 6.5)	4.6 (4.3, 4.9)	.080	6.7 (5.1, 8.3)	5.9 (5.6, 6.2)	.502
2	23.9 (21.7, 26.1)	26.4 (25.9, 26.9)		18.5 (16.1, 20.9)	18.4 (17.9, 18.9)	
≥3	70.8 (68.4, 73.2)	69.0 (68.4, 69.6)		74.8 (72.1, 77.5)	75.8 (75.2, 76.4)	
Implantation rate ^b , mean ± SD	48.2 ± 28.1	50.2 ± 28.4	.121	41.0 ± 28.3	43.9 ± 26.8	.073
Treatment outcome ^c :						
CIG	27.7 (25.7, 29.7)	33.6 (33.1, 34.1)	<.001	22.1 (19.8, 24.4)	28.9 (28.4, 29.4)	<.001
Biochemical pregnancy	4.2 (3.3, 5.1)	5.4 (5.2, 5.6)		4.4 (3.3, 5.5)	5.5 (5.2, 5.8)	
Ectopic or heterotopic	0.9 (0.5, 1.3)	0.8 (0.7, 0.9)		0.6 (0.2, 1.0)	0.7 (0.6, 0.8)	
Not pregnant	67.2 (65.1, 69.3)	60.3 (59.8, 60.8)		72.9 (70.5, 75.3)	64.9 (64.3, 65.5)	
Spontaneous abortion ^d	20.4 (16.9, 23.9)	13.2 (12.6, 13.8)	<.001	25.4 (20.3, 30.5)	15.2 (14.4, 16.0)	<.001
Live birth ^c	20.7 (18.8, 22.6)	28.4 (27.9, 28.9)	<.001	15.7 (13.7, 17.7)	23.7 (23.2, 24.2)	<.001
Plurality of birth:						
Singleton	62.2 (57.3, 67.1)	62.3 (61.3, 63.3)	.908	70.6 (64.3, 76.9)	64.6 (63.4, 65.8)	.178
Twins	32.0 (27.3, 36.7)	32.4 (31.4, 33.4)		25.9 (19.8, 32.0)	30.1 (29.0, 31.2)	
Triplets or more	5.8 (3.5, 8.1)	5.3 (4.8, 5.8)		3.5 (1.0, 6.0)	5.3 (4.7, 5.9)	
<i>Note:</i> Data are % (95% CI) unless otherwise indicated.						
^a FSH dosage above the median.						
^b Percentage of embryos that implanted per cycle.						
^c Rate per cycle started.						
^d Rate among women with a CIG.						
<i>Seifer. ART outcomes in black women. Fertil Steril 2007.</i>						

TABLE 2

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

Characteristic	Black (n = 550)	White (n = 10,147)	P
Woman's age, years:			
<35	53.6 (49.4, 57.8)	55.4 (54.4, 56.4)	.333
35–37	22.4 (18.9, 57.8)	23.6 (22.8, 24.4)	
38–40	17.3 (14.1, 20.5)	14.5 (13.8, 15.2)	
>40	6.7 (4.6, 8.8)	6.5 (6.0, 7.0)	
Duration of infertility in months, median, mean \pm SD:	48.0, 53.5 \pm 33.7	36.0, 42.8 \pm 29.7	<.001
Nulliparous	67.5 (63.6, 71.4)	58.6 (57.3, 59.9)	<.001
Past spontaneous abortion	40.0 (35.9, 44.1)	34.0 (33.1, 34.9)	.004
Diagnosis:			
Tubal factor	60.2 (56.1, 64.3)	31.6 (30.7, 32.5)	<.001
Male factor	30.2 (26.4, 34.0)	34.6 (33.7, 35.5)	.034
Uterine factor	11.6 (8.9, 14.3)	4.3 (3.9, 4.7)	<.001
Endometriosis	10.7 (8.1, 13.3)	20.2 (19.4, 21.0)	<.001
Diminished ovarian reserve	4.7 (2.9, 6.5)	4.4 (4.0, 4.8)	.687
Other ovulation disorders (e.g., PCOS)	10.5 (7.9, 13.1)	18.0 (17.3, 18.7)	<.001
Other factors	6.9 (4.8, 9.0)	11.1 (10.5, 11.7)	.002
Idiopathic	3.3 (1.8, 4.8)	7.6 (7.1, 8.1)	<.001
FSH ratio, cycle day 3:			
<0.5	55.2 (49.4, 61.0)	47.3 (45.8, 48.8)	.036
0.5–1.0	41.6 (35.8, 47.4)	48.9 (47.4, 50.4)	
>1.0	3.2 (1.1, 5.3)	3.8 (3.2, 4.4)	
Cycle canceled	10.9 (8.3, 13.5)	9.5 (8.9, 13.5)	.281
No. of embryos transferred:			
1	6.2 (4.0, 8.4)	8.8 (8.1, 9.5)	.083
2	23.5 (19.7, 27.3)	25.1 (24.0, 26.2)	
≥ 3	70.3 (66.2, 74.4)	66.1 (64.9, 67.3)	
Implantation rate ^a , mean \pm SD	42.8 \pm 23.5	41.9 \pm 26.4	.738
Treatment outcome ^b :			.337
CIG	22.7 (19.2, 26.2)	20.2 (19.4, 21.0)	
Biochemical pregnancy	4.4 (2.7, 6.1)	5.4 (5.0, 5.8)	
Ectopic pregnancy only	0.7 (0, 1.4)	0.5 (0.4, 0.6)	
Not pregnant	72.2 (68.5, 75.9)	73.9 (73.0, 74.8)	
Spontaneous abortion ^c	19.7 (12.6, 26.8)	18.5 (16.8, 20.2)	.745
Live birth ^b	16.5 (13.4, 19.6)	16.0 (15.3, 16.7)	.718
Plurality of birth:			
Singleton	68.1 (58.5, 77.7)	73.1 (70.9, 75.3)	.070
Twins	24.2 (15.4, 33.0)	23.7 (21.6, 25.8)	
Triplets or more	7.7 (2.2, 13.2)	3.2 (2.3, 4.1)	

Note: Data are % (95% CI) unless otherwise indicated.

^a Percentage of embryos that implanted per cycle.

^b Rate per cycle started.

^c Rate among women with a CIG.

Seifer. ART outcomes in black women. *Fertil Steril* 2007.

compared with 25.5%; 95% CI, 25.3%–25.7%, respectively) (14, 15). This is in contrast to the live-birth rate among whites, which was slightly above the upper 95% CI for all races nationally (26.3%; 95% CI, 25.9%–26.7%, compared with 25.5%; 95% CI, 25.3%–25.7%, respectively).

Multivariate logistic regression, which controlled for factors known to affect ART outcome such as age of the woman, cycle day 3 FSH ratio, etiology of infertility, parity, and number of embryos transferred, demonstrated that black women had a 24%–38% increased risk of not achieving a live birth

TABLE 3

Characteristics of clinics where treatment cycles among black and white women occurred.

Clinic characteristics	No prior ART, % (95% CI)		Prior ART, % (95% CI)		P
	Black (n = 1839)	White (n = 32,049)	Black (n = 1277)	White (n = 26,410)	
Clinic's volume (cycles per year) ^a :					
50–311	60.5 (58.3, 62.7)	52.7 (52.2, 53.2)	53.3 (50.6, 56.0)	46.1 (45.5, 46.7)	<.001
>311	39.5 (37.3, 41.7)	47.3 (46.8, 47.8)	46.7 (44.0, 49.4)	53.9 (53.3, 54.5)	<.001
Clinic's pregnancy rate among women <35 years old ^b :					
<30.8%	33.7 (31.5, 35.9)	24.4 (23.9, 24.9)	38.5 (35.8, 41.2)	27.1 (26.6, 27.6)	
30.8%–37.3%	24.6 (22.6, 26.6)	23.7 (23.2, 24.2)	25.8 (23.4, 28.2)	26.0 (25.5, 26.5)	
37.4%–43.9%	21.9 (20.0, 23.8)	25.0 (24.5, 25.5)	19.5 (17.3, 21.7)	22.9 (22.4, 23.4)	
>43.9%	19.7 (17.9, 21.5)	26.9 (26.4, 27.4)	16.2 (14.2, 18.2)	24.0 (23.5, 24.5)	

Note: Results are for fresh nondonor ART cycles. Findings were similar for cycles using thawed embryos (data not shown).

^a Clinic's volume, below and above the median, for all ART cycles among women of any race.

^b Clinic's overall rate, in quartiles, of ClG per cycle started using fresh nondonor embryos among women of any race.

Seifer. ART outcomes in black women. *Fertil Steril* 2007.

in fresh nondonor embryo cycles when compared with white women (Table 4). To put the magnitude of risk conveyed by race in perspective, risk associated with other clinical factors can be reviewed. Considering women with no prior ART, for example, being 35–37 years old (compared with being younger than 35 years) increases risk by about the same amount as black race (i.e., an adjusted RR of 1.21 for age 35–37 years, and an adjusted RR of 1.24 for black race; Table 4).

Possible explanations for racial disparity between blacks and whites in ART outcomes may be a combination of biological or social differences between races. Black women were noted to have increased pelvic pathology (i.e., diagnosis of tubal disorders or uterine factor). Hydrosalpinx and leiomyomata are known to reduce implantation and increase the risk of spontaneous abortion (20, 21). Black couples were less likely to have male factor infertility, a diagnosis that can often be successfully treated by intracytoplasmic sperm injection (ICSI).

Black women appeared to have pursued ART at a later age than white women, had prior ART less frequently, and had a longer duration of infertility by the time they were treated (Tables 1 and 2). Black women may have been more proactive in pursuing ART during the well-publicized period of diminishing ovarian reserve between the critical ages of 38 and 40 (Table 1). Black women were less likely to be nulliparous, suggesting they had less primary infertility and more secondary infertility at the time they underwent their first ART cycle.

The proportion of ART cycles provided for black and white women indicate there was a disparity in use of ART services in the United States at the beginning of the 21st century. There were 3666 (4.6%) cycles among black women and 68,607 (85.4%) cycles among white women after excluding clinics with incomplete data on race and a small number of other cycles. United States census data for the general population in the year 2000 showed 12.9% of the population to be black and 75.1% to be white (22, 23). Black and white women made up 7.8% and 72.1%, respectively, of married, reproductive-age women in the United States during 2002 (1). Clearly, blacks were under-represented in this national data set of ART treatment during 1999–2000, because the fraction of cycles for women of black race was much less than their proportionate representation within the U.S. population.

Supporting our findings are other studies among IVF patients that have documented delayed care seeking among black women (2, 24). The National Survey of Family Growth also found that in 1995, having received any infertility service was less common among black than among white women (13.0% and 16.3%, respectively) (17). In 2002, similar patterns were found—among nulliparous women, infertility services were received by 5.5% of black women and 7.6% of white women (18). Among women with one or more previous births surveyed in 2002, infertility services were received by 10.1% of black women compared with 18.8% of white women. This disparity in service use occurred at the same time that the prevalence of infertility was growing among blacks while it was decreasing among whites (1).

TABLE 4

Independent predictors of not achieving a live birth.

Predictor	Fresh nondonor embryo cycles, adjusted RR (95% CI), <i>P</i>		Cryopreserved embryo cycles, adjusted RR (95% CI), <i>P</i>
	No prior ART	Prior ART	
Race			
White	Reference	Reference	Reference
Black	1.24 (1.12, 1.36), <.001	1.38 (1.20, 1.57), <.001	0.944 (0.704, 1.25), .695
Woman's age, years			
<35	Reference	Reference	Reference
35–37	1.21 (1.14, 1.28), <.001	1.18 (1.11, 1.25), <.001	1.17 (1.01, 1.34), .032
38–40	1.66 (1.56, 1.76), <.001	1.55 (1.46, 1.64), <.001	1.50 (1.24, 1.80), <.001
>40 years	3.39 (3.04, 3.76), <.001	2.94 (2.70, 3.17), <.001	1.79 (1.26, 2.49), .001
Nulliparous	1.09 (1.03, 1.15), .003	1.29 (1.22, 1.36), <.001	1.11 (0.963, 1.27), .153
Prior spontaneous abortion	—	0.943 (0.888, 1.00), .053	1.13 (0.979, 1.29), .094
Tubal disorder	1.05 (1.00, 1.11), .048	1.09 (1.02, 1.16), .009	—
Male factor	1.23 (1.16, 1.29), <.001	1.21 (1.14, 1.29), <.001	—
Uterine factor	1.11 (1.00, 1.22), .042	—	1.25 (0.913, 1.67), .160
Diminished ovarian reserve	1.46 (1.36, 1.58), <.001	1.53 (1.41, 1.65), <.001	1.17 (0.814, 1.64), .384
Other ovarian disorder (e.g., PCOS)	—	—	0.869 (0.727, 1.03), .114
Endometriosis	—	—	1.12 (0.944, 1.32), .191
ICSI	0.801 (0.755, 0.849), <.001	0.728 (0.678, 0.781), <.001	NA
FSH ratio			
<0.5	Reference	Reference	—
0.5–1.0	1.05 (1.02, 1.08), .002	1.04 (1.01, 1.08), .019	
>1.0	1.58 (1.36, 1.78), <.001	1.50 (1.31, 1.72), <.001	
Clinic's volume ^a (cycles per year)			
50–311	1.08 (1.03, 1.12), .001	1.06 (1.00, 1.12), .058	1.03 (0.900, 1.18), .661
>311	Reference	Reference	Reference
Clinic's pregnancy rate among women <35 years old ^b			
<30.8%	1.87 (1.77, 1.97), <.001	1.82 (1.70, 1.94), <.001	1.67 (1.40, 1.96), <.001
30.8%–37.3%	1.43 (1.36, 1.51), <.001	1.48 (1.39, 1.58), <.001	1.50 (1.30, 1.71), <.001
37.4%–43.9%	1.28 (1.21, 1.35), <.001	1.21 (1.13, 1.29), <.001	1.13 (0.972, 1.30), .111
>43.9%	Reference	Reference	Reference

^a Clinic's volume, below and above the median, for all ART cycles among women of any race.

^b Clinic's overall rate, in quartiles, of CIG per cycle started using fresh nondonor embryos among women of any race.

Seifer. ART outcomes in black women. *Fertil Steril* 2007.

The analysis of ART clinic-specific factors suggests that more black women sought treatment at smaller centers that had somewhat lower overall success rates during 1999–2000. These associations need confirmation in prospective studies that can provide more detail on care provided before any conclusions about specific ART care practices are warranted. Studies in other fields have sometimes found that blacks in the United States are more likely to receive surgery at centers with lower volume (8, 13). This relatively crude measure has linked high volume to better outcomes for

some medical problems (13, 25), but in other studies no effect of volume persisted after controlling for case mix (8, 26, 27).

Our differences in diagnoses and outcomes are consistent with other published studies. Sharara and McClamrock (2) were the first to report poorer ART outcomes in a relatively small number of black women ($n = 37$) when compared with whites ($n = 95$) from an urban program in Baltimore. Feinberg and colleagues (6) found comparable results in a retrospective cohort study of black ($n = 253$) and white

($n = 974$) women undergoing their first fresh, nondonor ART cycle at Walter Reed Army Medical Center. Their clinic was an “equal access to care” setting under the authority of the Department of Defense during 1999–2003. The increased rates of uterine factor (reported as leiomyoma) and tubal factor and the decreased rates of male factor that they found among blacks were similar to the findings in our study. Furthermore, they also found a reduced live-birth rate among black women, although the comparison did not reach statistical significance (29.6% for black women vs. 35.8% for white women; $P=.06$). They noted a greater rate of spontaneous miscarriage among blacks (25.0% and 15.9% in blacks and whites, respectively, a 1.6-fold difference; $P=.03$), and the magnitude of the increased risk was similar to what we found (20.4% and 13.2% in blacks and whites, respectively, a 1.5-fold difference; $P<.001$). Thus despite improved access to care, racial differences in ART outcomes persisted, and the investigators attributed this to an increased prevalence of leiomyomas in black women (6).

The difference in live-birth rates between races for fresh transfers was not seen in our study after transfer of thawed embryos. As the SART database did not provide the information to determine the reasons for this, we can only speculate. Perhaps live-birth rates were equalized by selection of only the best-appearing embryos for transfer during the initial fresh cycle. By the time cryopreservation was initiated, the remaining nontransferred fresh embryos may have been of similar quality regardless of race. Whether or not there are inherent differences in the effects of cryopreservation and thawing as a function of race remains to be investigated.

Limitations of our study include the fact that it was retrospective. We used the SART registry, and it does not include information on confounders known to worsen live-birth rates such as body mass index, history of recurrent miscarriages, or direct measures of poor embryo quality. No information was available to assess differences in severity within a given diagnosis, in insurance coverage, and in socioeconomic status (24, 28, 29). Other factors that may contribute to reduced live-birth rates among black women for which there was no information include comorbidity from diabetes, chronic hypertension, or other medical problems. It was not possible to assess cumulative pregnancy rates. Some women were probably represented more than once in the deidentified data set in which the cycle was the unit of analysis, but similar findings when analyzing the first cycle and repeat cycles of ART separately (Tables 1, 3, 4) suggest that this limitation probably had minimal impact.

The recording of race in the SART registry data set is an interesting consideration. Mixed race could not be examined because there is no code for it in the data set. Hispanic ethnicity is recorded, but its interaction with race could not be studied because there were only 78 treatment cycles among black Hispanic women (0.1% of the 80,309 cycles meeting the initial study inclusion criteria). The proportion of cycles in which race was determined through self-report by the patient versus observation by a caregiver are unknown. The distribu-

tion of diagnoses we found is consistent with other studies on the prevalence of infertility pathology by race (6), which suggests that miscoding of race had minimal impact.

It is interesting that in the registry data set overall, a large proportion of cycles did not include information on race. Among the SART member clinics that conduct 50 or more ART cycles per year, 87,836 cycles occurred at clinics with missing race data for up to 95% of cycles, compared with 93,582 cycles from clinics that had nearly complete information on race. Incomplete reporting of race suggests that clinics may not view race as a prognostically important factor, but the results of our study suggest otherwise. The findings of our study underscore the importance of reporting race as a defining demographic factor that is a marker for prognosis. The disproportionately low representation of black women among those receiving infertility services also highlights the need to address access to care.

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