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The effect of donor and recipient race on outcomes of assisted reproduction

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Abstract

Background: A growing literature suggest that minority races, particularly Black women, have lower probability of live birth and higher risk of perinatal complications after autologous ART. However, questions still remain as to whether these racial disparities have arisen due to associations between race and oocyte/embryo quality, the uterine environment, or a combination of the two. Oocyte donation ART represents a unique approach to examine this question.

Objective: To evaluate the associations between the race of female oocyte donors and recipients and live birth rates following vitrified donor oocyte assisted reproductive technologies (ART).

Study Design: This was a retrospective study conducted at a single, private fertility clinic that included 327 oocyte donors and 899 recipients who underwent 1601 embryo transfer cycles (2008–2015). Self-reported race of the donor and recipient were abstracted from medical records. Live birth was defined as the delivery of at least one live born neonate. We used multivariable cluster weighted generalized estimating equations with binomial distribution and log link function to estimate the adjusted risk ratios (aRR) of live birth adjusting for donor age and BMI, recipient age and BMI, tubal and uterine factor infertility, and year of oocyte retrieval.

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Results: The racial profile of our donors and recipients were similar: 73% White, 13% Black, 4% Hispanic, 8% Asian, and 2% Other. Women who received oocytes from Hispanic donors had a significantly higher probability of live birth (aRR 1.20, 95% CI 1.05, 1.36) compared with women who received oocytes from White donors. Among Hispanic recipients, however, there was no significant difference in probability of live birth compared with White recipients (aRR 1.07 95% CI 0.90, 1.26). Embryo transfer cycles using oocytes from Black donors (aRR 0.86, 95% CI 0.72, 1.03) and Black recipients (aRR 0.84, 95% CI 0.71, 0.99) had a lower probability of live birth compared to White donors and White recipients, respectively. There were no significant differences in the probability of live birth among Hispanic, Asian, and Other race recipients compared with White recipients.

Conclusions: Black female recipients had lower probability of live birth following ART even when using vitrified oocytes from healthy donors. Female recipients who utilized vitrified oocytes from Hispanic donors had higher probability of live birth regardless of their own race.

Keywords

ethnicity; in vitro fertilization; live birth; oocyte donor; oocyte recipient; pregnancy; race

Introduction

The use of assisted reproductive technology (ART) has become increasingly prevalent in the United States and now accounts for 2% of all infants born.[1, 2] Using national data from the Society for Assisted Reproductive Technology (SART) Clinical Outcome Reporting System, multiple studies have documented the existence of racial disparities in live birth rates and pregnancy outcomes among women undergoing autologous ART.[3] In these analyses, White women consistently had the highest probability of live birth, followed by Hispanic, Asian, and Black women.[4–8] While the ability to leverage this large nationwide database is a clear strength of the SART based studies, firm conclusions on racial disparities in ART outcomes are challenging to make since over 35% of cycles lacked data on race/ethnicity. In agreement with the SART findings, though, there are several clinic-specific studies documenting these same racial disparities.[9–11]

Although a growing body of evidence suggests that race is associated with differences in fertility treatment and obstetric outcomes, questions still remain as to whether the racial disparities observed in ART studies are related to oocyte/embryo quality, an impaired uterine environment, or a combination of the two. Oocyte donation ART represents a unique approach to examine this question. Research on the association between race and ART outcomes in the context of oocyte donation is sparse. In an analysis of 17,030 third party ART cycles from SART (2004–2013), non-Hispanic Black, Asian/Pacific Islander, and Hispanic recipients had significantly lower live birth rates following oocyte donation compared to non-Hispanic White recipients.[13] However, the authors were not able to adjust for potential confounding and, similar to the SART studies in autologous IVF, they had to exclude 37% of patients due to missing race information.[13] A matched cohort study performed at a private fertility clinic in Spain (2003–2008) found that Black recipients (n=280) had a lower probability of achieving an ongoing pregnancy after oocyte donation compared to matched White recipients, but there were no significant difference in outcomes

between South-East Asians and White recipients.[12] Neither of these previous studies had information on the oocyte donor's race.

This study intended to provide new insights to the knowledge on racial disparities in ART outcomes by utilizing a unique cohort of oocyte donors and recipients where the associations between race, oocyte quality, and uterine environment can be better delineated. Our aim was to evaluate whether race of oocyte donors and recipients are independently associated with ART outcomes using data from a large, racially diverse vitrified donor oocyte bank.

Materials and Methods

This was a retrospective study using data from a national oocyte bank based at Reproductive Biology Associates (RBA) in Atlanta, GA (2008–2015). The data collection project was approved through the institutional review board (IRB) of Emory University (IRB00080463). Prior to 2012, when oocyte cryopreservation was still labelled as experimental, there was also IRB approval at RBA for donor oocyte vitrification. Cycles included in this study were those in which oocytes were cryopreserved via vitrification for use in an oocyte bank and later thawed for recipients' use. Cycles were further limited to those in which both the donor and recipient were patients at RBA. Of the 1,772 embryo transfer cycles initially eligible for analysis, we excluded cycles where agonist protocols were used for ovarian stimulation (n=25), information on donor (n=47) or recipient (n=98) race was missing, or pregnancy outcome was missing (n=1). After exclusions, there were 327 oocyte donors and 899 oocyte recipients who underwent 1601 embryo transfer cycles.

At the patient's initial visit, data was collected on age, self-identified race/ethnicity (i.e. White, Black, Asian, Hispanic, South Asian/Southeast Asian, American Indian, or Other), and reproductive history. Height and weight were measured using standardized procedures to calculate body mass index (BMI). The antagonist protocol was employed for the oocyte donors' ovarian stimulation and, approximately 39–40 hours after trigger injection, mature oocytes were cryopreserved using minimum volume vitrification.[14] For each retrieval, ovarian reserve data and ovarian stimulation data were recorded.

Oocyte recipients were administered leuprolide acetate, estrogen, and progesterone for endometrial preparation. Recipients received a cohort of vitrified oocytes (most commonly in batches of 6–8) and 2–3 hours after warming the oocytes were fertilized using intracytoplasmic sperm injection (ICSI).[15] The resulting embryo(s) were then cultured in the lab to cleavage stage (day 3) or blastocyst stage (day 5/6). In standard fashion, the highest quality embryo(s) were transferred into the recipient's uterus first and remaining embryos were cryopreserved. Some recipients subsequently underwent frozen embryo transfers using these cryopreserved embryos.

Our main outcome was live birth, defined as the delivery of at least one live born neonate in a given embryo transfer cycle. Secondary outcomes included a positive pregnancy test (PPT), defined as a serum β- human chorionic gonadotropin (hCG) level >6 mIU/mL, and miscarriage, defined as the loss of a pregnancy before 20 weeks. Additional outcomes included the proportion of oocytes that survived warming, fertilized, and developed into

usable embryos. The delivery date and birthweight were recorded among all live born infants. Gestational age was calculated using the American College of Obstetricians and Gynecologists guidelines: (delivery date − transfer date) + 14 + cycle day of transfer. Preterm delivery was defined as a birth prior to 37 weeks gestation and low birthweight was defined as the birth of a neonate <2,500 grams.

Among the oocyte donors, we compared demographic, reproductive, and ovarian stimulation parameters at their first retrieval across categories of donor race. In addition, we also compared characteristics of the oocyte recipients at the time of their first embryo transfer by categories of their race. Chi-square or Kruskal-Wallis tests were used to compute the differences across categories.

To estimate the association between donor race, recipient race, as well as the joint effect of donor and recipient race on the probability of live birth, we used cluster weighted generalized estimating equations with binomial distribution and log link function. These models accounted for the correlation between multiple embryo transfer cycles within a woman and non-ignorable cluster size. Our weight was equal to the inverse of the cluster size, which helped down-weigh the women with more severe infertility who tended to undergo a greater number of embryo transfer cycles. We calculated the risk ratios (RRs) of live birth comparing the risk in a specific race category with the risk in the reference race category (e.g. White). We also obtained the covariate-adjusted marginal mean probability of live birth for each race category at the mean level of continuous covariates and most common level of categorical covariates. For the outcomes of PPT and miscarriage we used the same analytic approach; however, for miscarriage, the analysis was restricted to only cycles that resulted in a PPT. Sensitivity analyses were conducted stratifying on the number of embryos transferred and restricting the analyses to only blastocyst transfers, only first embryo transfers, and only recipients without uterine factor infertility.

For the analyses of birth outcomes, we only considered singleton live births with known gestational age at delivery. The association between the length of gestation and oocyte donor and recipient race was analyzed using a cluster weighted Cox proportional hazard model with a robust sandwich covariance estimate. For the outcome of pre-term birth, we used cluster weighted GEE with binomial distribution and log link. The association between donor and recipient race and birthweight were computed using cluster weight GEE with normal distribution and identity link function. For low birthweight, a cluster weighted GEE with binomial distribution and logit link function was used. Our additional outcomes following oocyte warming (e.g. % survived, % fertilized, % usable embryos) were analyzed using GEE with binomial distribution and logit link function. Data are presented as back transformed marginal percentages at the mean level of continuous covariates and most common level of categorical covariates.

Confounding was evaluated based on prior knowledge and descriptive statistics from our cohort via the use of directed acyclic graphs. We adjusted for donor age, donor BMI, recipient age, recipient BMI, tubal factor infertility, uterine factor infertility, and the year of the retrieval in our final model. All tests of statistical significance were two-sided with a

significance-level of 0.05. All data were analyzed using SAS 9.4 (SAS Institute Inc, Cary, NC).

Results

Our 327 oocyte donors, on average, were young (median 25 years), of normal weight (median BMI 22.3 kg/m^2), and most commonly White (75%) and nulliparous (78%) (Supplemental Table 1). The peak estradiol was significantly higher among Black, Hispanic, Asian, and Other races compared with White women. There were also slight differences in year of retrieval, BMI, parity, and total gonadotropin dose across race categories; however, all other characteristics of the donors were similar. Among our 899 donor oocyte recipients, the median age and BMI was 42 years and 23.4 kg/m^2, respectively (Supplemental Table 2). On average, the recipients who were Black, Hispanic, and of Other races tended to be older compared with White women, while Asian oocyte recipients tended to be younger. Recipient BMI also varied across races, being significantly higher for Black recipients and lower for Asian recipients compared with White recipients. Uterine and tubal factor infertility were more common among Black recipients compared with other race groups. Specifically, 13% of Black recipients had a history of fibroids compared to only 4% of White recipients. All other characteristics were similar across recipient race categories.

The mean (standard deviation) number of oocytes warmed among recipients was 6.3 (1.7) and this was similar across races. The adjusted percentage of oocytes that survived warming was significantly higher for donors of Asian (94.7%) and Other races (94.9%) compared with White donors (91.4%), although differences were small (Table 1). There were no differences in the percentage of oocytes that fertilized across donor race categories. The proportion of warmed oocytes that developed into usable embryos was significantly higher for Black (56.9%) and Hispanic (64.5%) donors in comparison with White donors (40.9%).

Donor oocyte recipients underwent a total of 1 (50.3%), 2 (31.4%), 3 (11.5%), or 4+ (6.9%) embryo transfer cycles. Most often these transfers contained a single embryo (61%) at the blastocyst stage (90%). There was a high concordance of race between oocyte donors and recipients (Supplemental Table 3). For instance, 96% of White recipients received oocytes from White donors, 73% of Black recipients received oocytes from Black donors, and 62% of Asian recipients received oocytes from Asian donors. There was less concordance among Hispanic donors and recipients (32%). Among the 1601 embryo transfer cycles, 1119 (70%) resulted in a PPT and 777 (49%) resulted in a live birth.

After multivariable adjustment, cycles with oocytes from Hispanic donors had a significantly higher probability of live birth (aRR 1.20 95% CI 1.05–1.36) compared with oocytes from White donors (Table 2). Among Hispanic recipients, however, there was no significant difference in probability live birth compared with White recipients. There was a suggestion of a lower probability of live birth if the donor was Black (aRR 0.86 95% CI 0.72–1.03); however this failed to reach conventional levels of statistical significance. Cycles initiated by Black recipients had a significantly lower probability of live birth (aRR 0.84, 95% CI 0.71–0.99) compared with cycles initiated by White recipients. There was no statistically significant difference in the probability of live birth among Hispanic, Asian, and Other races

recipients compared with White recipients. Results were similar after stratifying on the number of embryos transferred and restricting the analyses to blastocyst transfers, first embryo transfers, and only recipients without uterine factor infertility (Supplemental Table 4).

To further isolate the independent effect of donor and recipient race on live birth, we analyzed the joint effect, with a particular focus on donor-recipient pairs that were discordant on race (Table 3). Recipients who used oocytes from Hispanic donors had higher probability of live birth and this effect was similar in Hispanic (aRR 1.19 95% CI 0.99–1.43) and non-Hispanic recipients (aRR 1.17 95% CI 0.99–1.38) compared to White recipients using oocytes from White donors. Hispanic recipients who received oocytes from non-Hispanic donors did not have a higher probability of live birth compared to White recipients using oocytes from White donors. Black recipients had a lower probability of live birth compared to White recipients using oocytes from White donors regardless of whether their oocyte donor was Black (aRR 0.86 95% CI 0.72–1.02) or non-Black (aRR 0.79 95% CI 0.56–1.11). Although numbers were small (n=21), the lowest live birth rates were observed for non-Asian recipients who utilized oocytes from Asian donors (aRR 0.54 95% CI 0.34–0.87).

Finally, we evaluated the association between donor and recipient race and birth outcomes among the 640 singleton live births in our cohort (Table 4). Overall, there were no associations between donor or recipient race and gestational age, although many of the effect estimates were imprecise. Singleton live births resulting from Asian donors and from Asian recipients had lower birthweights compared to White donors and recipients. All other comparisons with regard to birthweight were not significantly different.

Comment

Principal Findings.

Among our large cohort of oocyte donors and recipients at a vitrified donor oocyte bank, we found that the highest probability of live birth was among recipients utilizing oocytes from Hispanic donors, while Black recipients had the lowest probability of live birth regardless of oocyte donor race. Our results add to the mounting evidence from autologous ART cycles documenting racial disparities in ART outcomes between Black and White women even after adjusting for demographic and clinical characteristics.

Results of the study in the context of other observations.

Despite Black donors in our study having a significantly higher percentage of usable embryos following fertilization, cycles using oocytes from Black donors had a lower probability of live birth compared to ART cycles using oocytes from White donors. However, virtually all of the oocytes from Black donors included in our analysis went to Black recipients, limiting our ability to examine outcomes in cycles with Black donors and non-Black recipients. Similar to findings from previous autologous and third party ART studies, Black recipients in our study had a consistently lower probability of live birth.[10, 12, 16] Moreover, this lower success with oocyte donation ART persisted whether Black

recipients used oocytes from Black or non-Black donors. In some studies, the lower success rates among Black recipients could be partially attributable to a higher prevalence of tubal and uterine factor infertility[5, 7, 17] and increased BMI.[10, 18, 19] Yet in our study, the association between Black race and lower probability of live birth persisted after adjustment for these variables, suggesting alternate pathways. As our study was not designed to evaluate potential mechanisms underlying these racial disparities, additional research is warranted.

Although we did not observe any significant differences in ART outcomes for Asian donors and recipients compared to White women, due to low numbers we cannot rule out small, clinically meaningful effects. For example, previous studies utilizing SART data found that Asian women have significantly lower live birth rates following autologous ART compared to White women with effect estimates similar in magnitude to ours.[5, 13] In concordance with our findings is a previous study that compared anonymous Asian and White donors and found no differences in pregnancy rates between the two.[20] Our finding that singleton live births resulting from Asian donors and recipients had lower birthweights is in line with previous research from both spontaneous conceptions and autologous ART cycles.[21] An unexpected finding was that non-Asian recipients who received oocytes from Asian donors had the lowest probability of live birth in our study. While this analysis was limited by sample size, it is worthy of further study.

Contrary to findings from prior published work in autologous[5, 12] and third party ART cycles,[13] Hispanic recipients in our study did not have lower success with ART. In fact, embryo transfer cycles that used oocytes from Hispanic donors were found to have higher live birth rates independent of recipient race. We also found that oocytes from Hispanic donors resulted in a larger percentage of useable embryos, which indicates that superior gamete quality could be mediating this association. Our findings of greater success rates among women utilizing oocytes from Hispanic donors may provide further insight into the Hispanic paradox- a finding that Latina mothers tend to have more favorable pregnancy outcomes despite a higher prevalence of social disadvantages.[22–24] To date, the prevailing hypothesis underlying the Hispanic paradox is that Latino women have stronger community networks, which creates a protective environment and results in healthier pregnancy outcomes.[22, 23] Whether this same rationale underlies the association with better quality oocytes is unclear.

Strengths and Limitations.

Our study was strengthened by the relatively large sample size and a relatively high proportion of Black women represented among donors (11%) and recipients (13%), which is similar to national averages. Moreover, race was known on the majority our women, which decreased the likelihood of selection bias. All of our cycles came from an anonymous, vitrified donor oocyte bank, which ensured that none of our donors and recipients were biologically related and all patients were treated with a similar protocol. Our findings were subject to several limitations. We only included women from a single ART clinic which may decrease the generalizability of our findings, given that treatments, success rates, and the racial distribution of donors and recipients may differ between clinics. Because this was a retrospective cohort based on data from the medical record, information on lifestyle and

socioeconomic factors were not uniformly collected, which likely resulted in unmeasured confounding. Of note, it is reasonable to speculate that the socioeconomic status of recipients was controlled for by design due to the high cost of ART procedures in a state without mandated fertility coverage. However, there may still be substantial variation among oocyte donors. While one of our primary interests was evaluating ART outcomes among race-discordant oocyte donor/recipient pairs, these analyses were often limited by sample size. Small numbers were also the reason why we combined all Asian races into one category; however, there still may be interesting regional differences to explore. We also had limited information on Hispanic origin and acculturation which could play an important role in the observed associations.[23] Finally, we did not collect information on societal factors that likely contribute to the less favorable ART outcomes among minority women. For instance, there is substantial evidence that racism experienced at the individual, interpersonal, community, and societal level, is associated with adverse health outcomes independent of socioeconomic status.[25, 26] Moreover, the common finding of larger racial disparities among the non-poor than the poor, and among women than men, suggests that persistent racial differences in health may be particularly relevant to our population.[27]

Conclusions and future research directions.

Our study corroborates and extends previous literature showing that Black women tend to have less favorable ART outcomes even when using oocytes from young, healthy donors. In contrast, women who utilized Hispanic oocytes tended to have better ART outcomes regardless of recipient race. Further research- particularly prospective cohort studies with targeted recruitment of minorities from a larger geographic catchment- is needed to confirm our findings and explore the potential mechanisms which may underlie these racial disparities in ART outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Condensation:

Black female recipients had lower probability of live birth even when using vitrified oocytes from young, anonymous donors.

AJOG at a Glance:

A. Why was this study conducted?

- Previous research has shown that Black women have a lower probability of live birth and a higher risk of perinatal complications after autologous assisted reproductive technology (ART); however, questions still remain as to whether racial disparities are associated with differences in gamete quality, an impaired uterine environment, or a combination of the two.

B. What are the key findings?

- Black female recipients had lower probability of live birth following ART even when using vitrified oocytes from young, anonymous donors. Female recipients who utilized vitrified oocytes from Hispanic donors had higher probability of live birth regardless of their own race.

C. What does this study add to what is already known?

- Our study corroborates and extends previous literature showing that Black women have less favorable ART outcomes even in the setting of vitrified donor oocyte ART, where all recipients are utilizing vitrified oocytes from young, healthy donors.

Table 1.

Association between donor race and early outcomes following oocyte warming and fertilization.

	Adjusted Percentage (95% CI)*		
	Surviving Oocytes	**Fertilized Oocytes**	**Usable Embryos**
Donor Race			
White	91.4 (89.9–92.7)	77.0 (75.1–78.7)	49.8 (47.6–52.1)
Black	93.8 (91.5–95.6)	78.8 (73.0–83.6)	56.9 (51.4–62.3)†
Hispanic	95.0 (86.2–98.3)	84.3 (73.3–91.3)	64.5 (51.0–76.1)†
Asian	94.7 (92.7–96.1)†	80.3 (75.1–84.6)	54.2 (48.1–60.2)
Other	94.9 (92.1–96.7)†	79.2 (75.4–82.6)	52.6 (45.4–59.6)

*Models are adjusted for donor age, donor BMI and the year of the retrieval.

†P-value for comparison with reference group (White) is <0.05.

Table 2.

Association between donor and recipient race and probability of positive pregnancy test, live birth, and miscarriage.

	Positive Pregnancy Test		Live Birth		Miscarriage	
	PPT/Transfer Cycles (%)	Adjusted Risk Ratio (95% CI)*	Live Births/Transfer Cycles (%)	Adjusted Risk Ratio (95% CI)*	Miscarriages/PPTs(%)	Adjusted Risk Ratio (95% CI)*
Donor Race						
White	874/1213 (72.1)	Reference	611/1213 (50.4)	Reference	253/874 (29.0)	Reference
Black	96/167 (57.5)	0.85 (0.75–0.96)	67/167 (40.1)	0.86 (0.72–1.03)	27/96 (28.1)	1.02 (0.62–1.70)
Hispanic	32/44 (72.7)	1.10 (1.01–1.20)	24/44 (54.6)	1.20 (1.05–1.36)	7/32 (21.9)	0.72 (0.34–1.50)
Asian	63/95 (66.3)	0.91 (0.82–1.02)	43/95 (45.3)	0.92 (0.81–1.06)	18/63 (28.6)	1.00 (0.70–1.43)
Other	54/82 (65.9)	0.93 (0.82–1.06)	32/82 (39.0)	0.88 (0.69–1.11)	22/54 (40.7)	1.41 (0.87–2.28)
Recipient Race						
White	840/1168 (71.9)	Reference	591/1168 (50.6)	Reference	240/840 (28.6)	Reference
Black	135/226 (59.7)	0.85 (0.77–0.95)	90/226 (39.8)	0.84 (0.71–0.99)	42/135 (31.1)	1.12 (0.71–1.76)
Hispanic	43/59 (72.9)	1.07 (0.97–1.17)	29/59 (49.2)	1.07 (0.90–1.26)	13/43 (30.2)	1.05 (0.59–1.86)
Asian	83/120 (69.2)	0.95 (0.86–1.04)	55/120 (45.8)	0.94 (0.80–1.10)	26/83 (31.3)	1.09 (0.72–1.65)
Other	18/28 (64.3)	0.88 (0.69–1.14)	12/28 (42.9)	0.88 (0.63–1.24)	6/18 (33.3)	1.11 (0.54–2.26)

PPT, positive pregnancy test.

*Adjusted for donor age, donor BMI, recipient age, recipient BMI, tubal factor infertility, uterine factor infertility, and the year of the retrieval.

Table 3:

Joint association between donor and recipient race and live birth.

Race Categories		Live Births/Transfer Cycles (%)	Adjusted Risk Ratio (95% CI)*
Donor	**Recipient**		
White	White	577/1123 (51.4)	Reference
White	Non-White	34/90 (37.8)	0.80 (0.62–1.02)
Black	Black	67/166 (40.4)	0.85 (0.72–1.02)
Black	Non-Black	0/1 (0.0)	-
Hispanic	Hispanic	11/19 (57.9)	1.19 (0.99–1.43)
Hispanic	Non-Hispanic	13/25 (52.0)	1.17 (0.99–1.38)
Asian	Asian	38/74 (51.4)	0.98 (0.83–1.16)
Asian	Non-Asian	5/21 (23.8)	0.54 (0.34–0.87)
Recipient	**Donor**		
White	White	577/1123 (51.4)	Reference
White	Non-White	14/45 (31.1)	0.75 (0.53–1.05)
Black	Black	67/166 (40.4)	0.86 (0.72–1.02)
Black	Non-Black	23/60 (38.3)	0.79 (0.56–1.11)
Hispanic	Hispanic	11/19 (57.9)	1.20 (1.01–1.43)
Hispanic	Non-Hispanic	18/40 (45.0)	0.99 (0.78–1.25)
Asian	Asian	38/74 (51.4)	0.98 (0.82–1.17)
Asian	Non-Asian	17/46 (37.0)	0.83 (0.61–1.12)

*Adjusted for donor age, donor BMI, recipient age, recipient BMI, tubal factor infertility, uterine factor infertility, and the year of the retrieval.

Table 4.

Association between donor and recipient race and gestational length and birthweight among donor-oocyte recipient singleton live births.

		Length of Gestation			Birthweight		
	No. of Live Births	Mean Weeks / % <37 wks	Adjusted HR (95% CI)*	Adjusted RR of Pre-term (95% CI)*	Mean Grams / % <2500g	Adjusted β (95% CI)	Adjusted OR of Low Birthweight (95% CI)*
Donor Race							
White	504	38.5 / 14.2	Reference	Reference	3325.1 / 8.4	Reference	Reference
Black	54	38.4 / 9.3	0.92 (0.71–1.21)	0.45 (0.17–1.20)	3142.9 / 7.4	−163.6 (−370.7–43.6)	0.71 (0.26–1.95)
Hispanic	17	37.7 / 23.5	1.36 (0.96–1.92)	1.16 (0.49–2.76)	3066.0 / 11.8	−215.3 (−489.8–59.3)	0.97 (0.19–5.09)
Asian	37	38.0 / 27.0	1.15 (0.82–1.63)	1.26 (0.58–2.74)	2988.4 / 24.3	−266.5 (−472.3–−60.6)	2.25 (0.92–5.48)
Other	28	37.5 / 21.4	1.12 (0.61–2.05)	0.94 (0.34–2.55)	3076.8 / 11.1	−138.8 (−342.7–65.1)	0.37 (0.08–1.70)
Recipient Race							
White	486	38.5 / 13.5	Reference	Reference	3330.6 / 7.7	Reference	Reference
Black	75	38.0 /14.7	0.98 (0.76–1.26)	0.85 (0.41–1.77)	3152.3 / 9.5	−112.4 (−284.6–59.7)	0.63 (0.26–1.52)
Hispanic	24	38.1 / 20.8	1.01 (0.77–1.32)	0.73 (0.27–2.01)	3103.3 / 20.8	−147.1 (−399.4–105.3)	1.45 (0.44–4.84)
Asian	48	37.9 / 29.2	1.01 (0.67–1.51)	1.70 (0.94–3.09)	2998.7 / 20.8	−259.6 (−433.9–−85.2)	1.89 (0.78–4.56)
Other	7	38.0 / 14.3	0.74 (0.48–1.16)	0.47 (0.08–2.69)	2994.4 / 14.3	−203.6 (−603.3–196.2)	0.80 (0.10–6.50)

β, beta coefficient; HR, hazard ratio; RR, risk ratio; OR, odds ratio; No, number.

*Adjusted for donor age, donor BMI, recipient age, recipient BMI, tubal factor infertility, uterine factor infertility, and the year of the retrieval.