Influence of Donor Race and Donor-recipient Race-matching on Pediatric Kidney Transplant Outcomes

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Background. Existing literature has demonstrated the significant relationship between race and kidney transplant outcomes; however, there are conflicting and limited data on the influence of donor race or donor-recipient race-matching on pediatric kidney transplant outcomes. **Methods.** Analysis included kidney-only transplant recipients between ages 2 and 17 from 2000 to 2017 enrolled in the Organ Procurement and Transplantation Network and their associated donors. Multivariable regression models were used to compare outcomes by donor race and donor-recipient race-matched status. **Results.** Of the total 7343 recipients, 4458 (60.7%) recipients received a kidney from a White donor, 1009 (13.7%) from a Black donor, 1594 (21.7%) from Hispanic donor, and 169 (4.1%) from an Asian donor; 4089 (55.7%) were race-matched. No donor races were significantly associated with transplant outcomes (all $P > 0.05$). Race-matched status was not associated with graft failure (hazard ratio, 1.03; 95% confidence interval [CI] = 0.89-1.2; $P = 0.68$), mortality (hazard ratio, 1.1; 95% CI, 0.79-1.53; $P = 0.56$), acute rejection at 1 y (odds ratio, 0.94; 95% CI, 0.77-1.15; $P = 0.53$), or delayed graft function (odds ratio, 1.02; 95% CI, 0.80-1.29; $P = 0.91$). **Conclusions.** Neither donor race nor race-matched status is associated with better transplant outcomes. Further studies are necessary to confirm the impact of donor race and race-matching more fully on pediatric kidney transplant outcomes.

(*Transplantation Direct* 2022;8: e1324; doi: 10.1097/TXD.0000000000001324).

INTRODUCTION

Racial and ethnic disparities pervade healthcare delivery and transplant surgery outcomes for adult and pediatric patients.[1-3] Specifically in the context of kidney transplant outcomes, the role of race is well understood. Adult African American/Black transplant recipients tend to experience worse outcomes, including increased graft failure and shorter half-life.[4,5] In studies on pediatric patients, the same trend is apparent, with Black patients experiencing poorer outcomes, including higher rejection rates and higher mortality risk.[6,7] It has been postulated that socioeconomic factors may serve as a mediating variable to explain this discrepancy[8]; however, some studies have found counterevidence of this explanation by demonstrating that Black recipients still experience worse kidney transplant outcomes in populations with access to universal health care.[9] Although universal healthcare access does not alleviate poverty or dissolve systemic disparities, this research does indicate that understanding racial differences requires additional research.

In kidney transplantation, characteristics of the donor and recipient, including race, are highly relevant because the compatibility between donors and recipients can have a significant positive influence on transplant outcomes.[10,11] The current literature, though, focuses mainly on the race of the recipient. Findings show that adult and pediatric Black recipients suffer worse outcomes, whereas the effects resulting from donor race are not yet fully understood.[12,13] Previous studies have indicated that Black donor race is associated with higher all-cause and cardiovascular mortality and graft loss following adult kidney transplants.[14-16] Other research has indicated that Black and non-Black donors produce similar transplant outcomes in the recipient.[17] Furthermore, research related to race and kidney

transplants in pediatric populations is limited. Therefore, this study aims to provide additional information about the effects of donor race on kidney transplant outcomes in children.

Moreover, in the previous studies exploring the effects of donor race on kidney transplant, outcomes have demonstrated that donor race differentially affects transplant outcomes according to recipient race as well.[16] These findings are relevant to another aspect of race and transplant outcomes: donor-recipient race-matching. Studies have begun to explore race-matching of donors and recipients in organ transplants, and findings thus far are mixed but encouraging. Data from LeClaire et al[18] suggest that race-matching of organ transplant donors and recipients does not confer significant improvement in transplant outcomes for any race, whereas Silva et al[19] found that donor-recipient race-matching of patients undergoing liver transplants resulted in significantly improved outcomes for those with hepatocellular carcinoma. Studies are beginning to examine race-matching in pediatric transplant patients, and data have shown that race-matching predicts increased graft survival in pediatric heart transplant patients.[20] Therefore, this study aims to further current understanding of the influence of donor race and donor-recipient race-matching on kidney transplant outcomes in pediatric patients. We hypothesized that transplant outcomes, such as graft loss, acute rejection, and mortality, would differ by donor race. Additionally, we hypothesized that transplant outcomes would improve for race-matched donor-recipient pairs.

METHODS

Study Population and Data Source

The study population was derived from the Organ Procurement and Transplantation Network (OPTN) database,[21] a nonprofit, mandatory national registry of all solid organ transplants performed in the United States since October 1987. Data are collected pretransplant and posttransplant at 6 mo and 1 y posttransplant and then on an annual basis. Participants included from the OPTN database were pediatric patients, ages 2 to 17, at the time of kidney transplant between 2000 and 2017. Patients were excluded if they did not contain information about race or diagnosis if they received a multiorgan transplant or history of any other transplant. The final study population included 7343 recipients who met the criteria (Figure 1). This study did not meet the criteria for human subjects research and was exempt from review by the Institutional Review Board of Northwell Health.

Exposure

The exposures of interest included donor race and donor-recipient race-matching. Within the OPTN database, race/ethnicity categories were self-reported. Race was categorized as White, Black, Hispanic, Asian, and Other (includes American Indian/Alaska Native, Native Hawaiian/other Pacific Islander, or Multiracial). The aforementioned categories include both races and ethnicities; for the purposes of this study, donor or recipient race will be referred to with the understanding that some of the race categories are ethnicities, namely, Hispanic. Recipients who received a kidney transplant from a donor of the same race were considered race-matched.

Transplant Outcomes

Primary outcomes of this study included delayed graft function (DGF), acute rejection, death-censored graft failure,
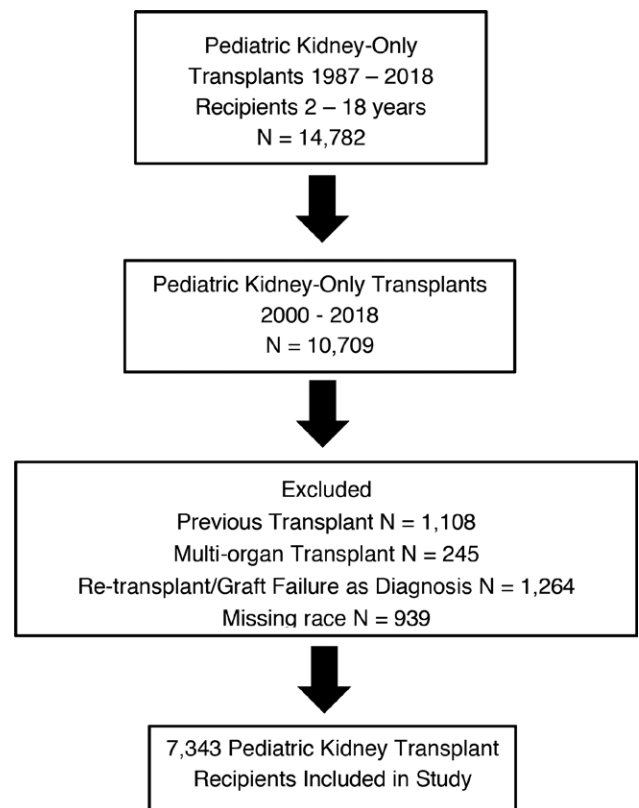

FIGURE 1. Flow chart of the study population.

and mortality. DGF was defined as the need for dialysis within the first week of transplantation. Acute rejection was defined as rejection reported within 1 y of transplant. Death-censored graft failure was calculated from date of transplantation to date of irreversible graft failure signified by return to long-term dialysis, retransplantation, or date of last follow-up during which the transplant was still functioning. In the event of death with a functioning transplant, the follow-up period was censored at date of death. Patient survival (mortality) was calculated from date of transplantation to date of death or date of last follow-up. Analysis was limited to those with a minimum follow-up time of 1 y, as time to rejection data was not available. Due to large underreporting of causes of graft failure and mortality, data were not reliably ascertained and thus excluded from analysis.

Demographic and Clinical Variables

Recipient and donor demographic information included age, sex, age, body mass index (BMI), and HLAs. Regarding recipients, the study also analyzed dialysis before transplant, kidney cold ischemic time, and graft survival time in years. Further demographic information included percentage of deceased donor kidney transplants, percentage with public insurance, donor-recipient ABO match, and HLA mismatch. Weight and height at time of transplant were used to calculate age and sex-specific Z scores for BMI. BMI-for-age percentile for growth charts from the Centers for Disease Control and Prevention were used to define weight categories. Public insurance was defined as participants with Medicaid, Medicare Fee for Service, Medicare and Choice, Children's Health Insurance Program, Department of Veterans Affairs, or US/State Government Agency.

Statistical Analysis

Descriptive statistics included medians with interquartile range for continuous variables and frequencies with percentages for categorical variables. Demographic and clinical characteristics of recipients were compared among donor race categories using χ^2 and Kruskal-Wallis tests. To determine whether there were differences in transplant outcomes by race and race-matching, regression analyses were carried out. Specifically, for mortality and graft failure, Kaplan-Meier curves and the Cox proportional hazards regression model were used to generate survival plots and hazard ratios (HRs), respectively. For DGF and acute rejection, multivariate logistic regression was used to generate an odds ratio (OR). Crude and adjusted models were generated for each outcome using donor race or race-matching status as the primary variables of interest. Models were adjusted for the following variables, chosen a priori based on previous literature review: recipient age, recipient gender, recipient race, recipient BMI Z score, recipient kidney diagnosis, if the recipient had received prior dialysis, donor age, donor type (living or deceased), HLA mismatch level, ABO match level, and cold ischemic time. All assumptions for the regression models were met. Multiple imputation using the Markov chain Monte Carlo method was used for missing values. A P value of <0.05 was considered statistically significant, and 2-sided tests of hypotheses were

used throughout. SPSS 26.0 (IBM SPSS) statistical software was used to conduct the analyses.

RESULTS

Clinical and Demographic Data

Among the 7343 pediatric kidney transplant recipients, 60.7% received a transplant from a White donor, 13.7% from a Black donor, 21.7% from a Hispanic donor, and 2.3% from an Asian donor. Of the total population, 55.7% were race matched. Several significant differences were observed based on donor race (Table 1) and race-matched status. Among the donor clinical and demographic information, there were significant differences based off donor race in donor age, sex, height, weight, and BMI. Other significant differences in recipient factors based on donor race included deceased donor, kidney cold ischemic time, recipient BMI Z score, prior dialysis, public insurance, ABO mismatch level, and HLA mismatch level. Of the total population, 55.7% of recipients were race-matched. Significant differences were also identified based on race-matched status (Table S1, SDC, http://links.lww.com/TXD/A421).

Several significant differences were observed in transplant outcomes among different donor races (Table 2) and race-matched statuses. There were significant differences in graft

TABLE 1.

Baseline demographic and clinical characteristics by donor race

Median (IQR) or n (%)	Overall	White	Black	Hispanic	Asian	Other	P
	7343	4458 (60.7)	1009 (13.7)	1594 (21.7)	169 (2.3)	113 (1.5)	
Donor							
Age, y	25 (19 to 34)	26 (19–36)	22 (18–29)	24 (18–33)	26 (20–37)	23 (19–30)	<0.0001
Female, %	2592 (40.3)	1663 (42.3)	278 (32.4)	534 (38.2)	77 (52.4)	40 (39.2)	<0.001
Height, cm	170 (163–178)	173 (163–180)	173 (165–180)	168 (157–174)	165 (157–171)	170 (163–179)	<0.0001
Weight, kg	73 (61.4–85)	73.6 (61.9–85.5)	74.9 (64–86.3)	71.7 (60–82.2)	64.9 (56–74.8)	74.8 (62.9–87.5)	<0.001
BMI, kg/m^2	24.7 (21.7–28.5)	24.6 (21.6–28.2)	24.7 (21.8–28.6)	25.5 (22.1–29.9)	23.3 (21.4–26.6)	24.6 (21.6–30)	<0.001
Recipient							
Age, y	13 (8 to 16)	13 (8–16)	13 (7–16)	13 (8–16)	14 (8–16)	14 (8.75–16)	0.57
Deceased donor, %	4601 (71.5)	2751 (70.1)	667 (77.8)	1013 (72.5)	94 (63.9)	76 (74.5)	<0.001
Female, %	2630 (40.9)	1591 (40.5)	351 (41.0)	594 (42.5)	59 (40.1)	35 (34.3)	0.15
Kidney cold ischemic time, h	9.75 (3.59–15.1)	9.5 (3–15.1)	10.4 (5–16)	9.8 (4.5–15)	9 (2.3–13)	10 (4–18)	0.02
Height, cm	145 (118–160)	146 (118–160.8)	144 (115–160)	145 (119–160)	145 (122–163)	149 (119–160)	0.57
Weight, kg	40.1 (23.1–55.5)	40.8 (23.1–56.7)	40 (22.3–54.6)	39 (23.5–54)	41.5 (23.2–54.4)	40.6 (22.9–55.8)	0.44
BMI, kg/m^2	18.6 (16.7–22.2)	18.9 (16.7–22.3)	19 (16.9–22.6)	18.7 (16.6–21.8)	18.5 (16.5–21.6)	18.4 (16.6–21.5)	0.07
BMI Z score	0.209 (–0.685 to 1.17)	0.20 (–0.65 to 1.19)	0.34 (–0.59 to 1.3)	0.19 (–0.78 to 1.1)	0.1 (–1.1 to 1.2)	–0.08 (–1.0 to 0.75)	0.002
Follow-up times, y	4.7 (2–8)	4.5 (2.0–8.0)	4.8 (2.5–7.9)	4.9 (2.0–8.1)	5.0 (1.9–9.0)	4.1 (1.9–8.0)	0.28
Prior dialysis	4716 (73.4)	2750 (70.1)	678 (79.1)	1113 (79.6)	103 (70.5)	72 (70.6)	<0.001
Public insurance, %	3936 (61.3)	2234 (57.0)	564 (65.8)	991 (70.9)	79 (54.1)	68 (66.7)	<0.001
Graft time, y	4 (1.9–7.5)	4.0 (1.9–7.5)	4.0 (2.0–7.1)	4.1 (1.9–7.7)	4.4 (1.3–8.0)	4.0 (1.7–7.3)	0.86
Donor-recipient ABO match, %							0.02
Identical	5873 (91.3)	3549 (90.4)	799 (93.2)	1301 (93.1)	131 (89.1)	93 (91.2)	
Compatible	545 (8.5)	368 (9.4)	58 (6.8)	94 (6.7)	16 (10.9)	9 (8.8)	
Incompatible	13 (.2)	10 (.25)	0 (0)	3 (.21)	0 (0)	0 (0)	
HLA mismatch, %							<0.0001
0	142 (2.2)	99 (2.5)	2 (.2)	34 (2.4)	5 (3.4)	2 (2.0)	
1–3	1942 (30.3)	1213 (31.0)	182 (21.4)	464 (33.3)	54 (36.7)	29 (28.4)	
4–5	3321 (51.8)	2023 (51.7)	487 (57.3)	692 (49.7)	66 (44.9)	53 (52.0)	
6	1002 (15.6)	581 (14.8)	179 (21.1)	202 (14.5)	22 (15.0)	18 (17.6)	

BMI, body mass index; IQR, interquartile range.

n (%)	Overall	White	Black	Hispanic	Asian	Other	*P*
Mortality	206 (2.8)	133 (3)	38 (3.8)	32 (2)	1 (.6)	2 (1.8)	0.09
Death-censored graft failure	988 (15.9)	586 (15.4)	161 (19.7)	217 (15.9)	11 (7.5)	13 (13.0)	0.002
Acute rejection at 1 y	670 (14.3)	409 (14.3)	86 (13.6)	148 (14.4)	13 (13.4)	14 (18.9)	0.8
Delayed graft function	417 (6.5)	272 (6.9)	63 (7.4)	76 (5.4)	3 (2.1)	3 (2.9)	0.02

failure and DGF based on donor race. There were significant differences in graft failure (*P* < 0.001), acute rejection at 1 y (*P* < 0.001), and DGF (*P* = 0.001) based on race-matched status (Table S2, SDC, http://links.lww.com/TXD/A421).

DGF
Donor Race
The proportion of recipients who experienced DGF with a White donor was 6.94%, with a Black donor was 7.35%, with a Hispanic donor was 5.44%, and with an Asian donor was 2.05%. In the crude regression model, donor race was associated with DGF (*P* = 0.04). Asian donor race had a lower likelihood of DGF (OR, 0.31; 95% confidence interval [CI], 0.1-0.96; *P* = 0.042; reference: White donor), and Hispanic donor race also had a lower likelihood of DGF (OR, 0.77; 95% CI, 0.6-0.99; *P* = 0.046; reference: White donor). In the adjusted model, no donor races were associated with a lower likelihood of DGF (All *P* > 0.05). The differences in outcomes of DGF by individual recipient races are described in Table S3, SDC, http://links.lww.com/TXD/A421.

Race Matched
Of those with DGF, 201 (48.2%) were race-matched. Of the nonrace-matched pairs, 7.61% experienced DGF; of the race-matched pairs, 5.61% experienced DGF. In the crude regression model, the OR for race-matched was 0.667 (95% CI, 0.550-0.808; *P* < 0.001, reference not race-matched). In the adjusted model, race-matched was not associated with DGF (OR, 1.02; 95% CI, 0.80-1.29; *P* = 0.91).

Acute Rejection
Donor Race
The proportion of recipients who experienced acute rejection with a White donor was 12.4%, with a Black donor was 13.6%, with a Hispanic donor was 14.5%, and with an Asian donor was 12.6%. The crude model, which only included donor race and acute rejection, was not significant (*P* = 0.66). In the adjusted model, donor race was not significant (all *P* > 0.05).

Race Matched
Of those with acute rejection, 327 (48.8%) were race-matched. Of those who were not race-matched, 16.9% experienced acute rejection; of those who were race-matched, 12.5% experienced acute rejection. Regression analysis was limited to those with a minimum follow-up time of 1 y post-transplant because time to rejection data was not available. In the crude regression model, which only included race-matched status and acute rejection, the OR was 0.66 (95% CI, 0.57-0.77; *P* < 0.001, reference not race-matched). In the adjusted model, race-matched status was not significantly associated with acute rejection (OR, 0.94; 95% CI, 0.77-1.15; *P* = 0.53).
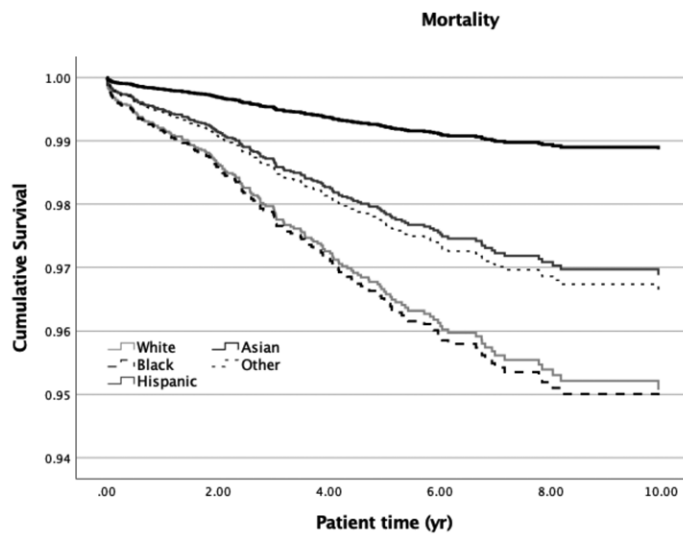
Graft Failure
Donor Race
A survival plot was generated to estimate the probability of graft failure over time between donors of different races (Figure 2). The proportion of recipients who experienced graft failure with a White donor was 15.4%, with a Black donor was 19.7%, with a Hispanic donor was 15.9%, and with an Asian donor was 7.53%. In the crude Cox proportional hazards model, donor race was statistically significant (*P* = 0.007) for graft failure. Asian donor race had a lower likelihood of graft failure (HR, 0.51; 95% CI, 0.28-0.93; *P* = 0.03; reference: White donor), Black donor race had a higher likelihood of graft failure (HR, 1.29; 95% CI, 1.08-1.54; *P* = 0.004; reference: White donor). In the adjusted model, donor race was not associated with graft failure; however. Asian donor race approached significance for being protective against graft failure (HR, 0.56; 95% CI, 0.31-1.02; *P* = 0.057). The differences in outcomes of DGF by individual recipient races are described in Table S3, SDC, http://links.lww.com/TXD/A421.

Moreover, we analyzed differences in cases of graft failure within the first year or after the first year by donor race. For those who experienced early graft failure, in the crude Cox proportional hazards model, Black donor race was associated with higher incidence of early graft failure (HR, 1.68; 95% CI, 1.04-2.71; *P* = 0.035; reference: White donor). In the adjusted model, no donor race was associated with early graft failure (all *P* > 0.1)

For the cases of late graft failure, in the crude model, Hispanic donor race was associated with higher risk of late graft failure (HR, 1.34; 95% CI, 1.09-1.67; *P* = 0.007). In the adjusted model, no donor races were associated with late graft failure (all *P* > 0.085).

Race Matched
A survival plot for graft failure with life tables comparing donor-recipient pairs who were race-matched or not race-matched is presented in Figure 3. Of those who experienced graft failure, 465 (47.1%) were race-matched. Of those who were not race-matched, 19.1% experienced acute rejection; of those who were race-matched, 13.4% experienced acute rejection. To assess the association between race-matched status and incidence of graft failure, the data were fit to a Cox proportional hazards regression model. In the crude model, race-matched status was associated with less hazard of graft failure (HR, 0.63; 95% CI, 0.551-0.708; *P* < 0.001). In the adjusted model, race-matched status was not significant (HR, 1.03; 95% CI, 0.89-1.2; *P* = 0.68). We also analyzed differences in cases of early and late graft failure by race-matched status. For those with early graft failure, in the crude model, race-matched status was significant (HR, 0.68; 95% CI, 0.47-0.98; *P* = 0.041). In the adjusted model, race-matched status was not significant (HR, 1.08; 95% CI, 0.71-1.66; *P* = 0.72). In the crude model for late graft loss, race-matched status was

Mortality

FIGURE 2. Kaplan-Meier survival plot and life table for graft failure based on donor race. The recipient survival rate depending on the race of donor was graphed as a function of patient time (in years), which was defined as the time from the day of transplant to last follow-up or death. Log-rank *P* = 0.027. The table outlines hazard rates and proportions of recipients who survived for 1, 3, 5, and 10 y after the kidney transplant. Tx, transplant.

	Year post-tx	Patients	Patients who have died	Patients still at risk	Proportion surviving	Cumulative proportion surviving at end of interval	Hazard rate	Standard error of hazard rate
White	0	4452	34	4148	.99	.99	.01	.00
	1	3809	24	3579	.99	.99	.01	.00
	3	2858	21	2633	.99	.97	.01	.00
	5	1995	7	1825	1.00	.96	.00	.00
	10	679	1	340	1.00	.95	.00	.00
Black	0	1009	12	951	.99	.99	.01	.00
	1	880	5	843	.99	.98	.01	.00
	3	685	4	630	.99	.97	.01	.00
	5	462	4	420	.99	.95	.01	.00
	10	144	0	72	1.00	.94	.00	.00
Hispanic	0	1594	11	1493	.99	.99	.01	.00
	1	1381	4	1300	1.00	.99	.00	.00
	3	1064	3	986	1.00	.98	.00	.00
	5	747	2	692	1.00	.98	.00	.00
	10	239	0	120	1.00	.96	.00	.00
Asian	0	168	0	155	1.00	1.00	.00	.00
	1	141	0	131	1.00	1.00	.00	.00
	3	106	0	100	1.00	1.00	.00	.00
	5	83	0	76	1.00	1.00	.00	.00
	10	30	0	15	1.00	.98	.00	.00

associated with lower hazard of late graft failure (HR, 0.63; 95% CI, 0.55-0.72; *P* = 0.000). In the adjusted model, though, race-matched status was not significant (HR, 1.04; 95% CI, 0.90-1.22; *P* = 0.61).

Mortality
Donor Race

A Kaplan-Meier curve with life table for mortality is presented in Figure 4 based on donor race. Of the 206 recipients who died during the study period, 133 (64.6%) were White, 38 (18.4%) were Black, 32 (15.5%) were Hispanic, and 1 (0.5%) was Asian. The proportion of recipients who died with a White donor was 2.98%, with a Black donor was 3.77%, with a Hispanic donor was 2.00%, and with an Asian donor was 0.59%. To assess the relationship between donor race and recipient mortality, data were fit into a Cox proportional hazards regression model. In the crude model, donor race was associated with mortality (*P* = 0.04). Recipients who received

a kidney from a Hispanic donor had a lower likelihood of mortality (HR, 0.65; 95% CI, 0.44-0.96; *P* = 0.03). In the adjusted model, none of the donor races were significant. The differences in outcomes of DGF by individual recipient races are described in Table S3, SDC, http://links.lww.com/TXD/A421.

Race Matched

There were 206 recipients who died during the study period, 107 (51.9%) of which were race matched; the Kaplan-Meier curve is presented in Figure 5. Of those who were not race-matched, 3.04% experienced acute rejection; of those who were race-matched, 2.62% experienced acute rejection. The crude model only factored in race-matched status, and the HR was 0.83 (95% CI, 0.63-1.09; *P* = 0.18). In the adjusted model, no significant association was identified between race-matched status and mortality (HR, 1.1; 95% CI, 0.79-1.53; *P* = 0.56).
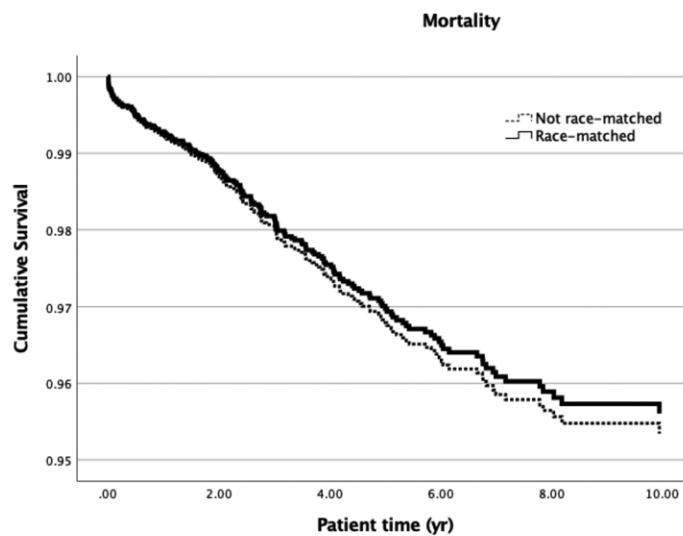
	Year post-tx	Patients	Patients who have died	Patients still at risk	Proportion surviving	Cumulative proportion surviving at end of interval	Hazard rate	Standard error of hazard rate
Race-matched	0	4087	29	3816	.99	.99	.01	.00
	1	3516	17	3322	.99	.99	.01	.00
	3	2699	14	2502	.99	.98	.01	.00
	5	1920	11	1770	.99	.97	.01	.00
	10	660	1	331	1.00	.96	.00	.00
Non-race-matched	0	3249	28	3032	.99	.99	.01	.00
	1	2786	16	2617	.99	.98	.01	.00
	3	2086	15	1914	.99	.97	.01	.00
	5	1415	3	1286	1.00	.96	.01	.00
	10	445	0	223	1.00	.95	.00	.00

FIGURE 3. Kaplan-Meier survival plot and life table for graft survival based on race-matched status. The recipient survival rate depending on the race of donor was graphed as a function of patient time (in years), which was defined as the time from the day of transplant to last follow-up or death. Log-rank *P* < 0.0001. The table outlines hazard rates and proportions of recipients who survived for 1, 3, 5, and 10 y after the kidney transplant. Tx, transplant.

DISCUSSION

Using the OPTN national registry of pediatric transplant recipients, results indicated that donor race and race-matched status are not significantly associated with various kidney transplant outcomes, except for the protection against graft failure after the 1-y mark for those who are race-matched. There was no indication that donor race or race-matched status affected acute rejection, DGF, or mortality. Contrary to our expectations, donor race was not associated with worse outcomes, and race-matching did not confer advantages.

In previous studies, the relationship between race and kidney transplant outcomes has largely been limited to analyzing the race of the recipient. In these studies, there is a vast amount of data demonstrating that adult Black recipients suffer worse outcomes, including shorter graft function and increased higher rate of graft failure compared with Whites and Hispanics.[12,22,23] These differential outcomes are also observed in pediatric populations, as Black pediatric kidney transplant recipients experience decreased survival rates.[7] Contrastingly, we did not identify a relationship between Black donor race or any other donor race and transplant outcomes.

Although less extensively studied, studies thus far have associated Black donor race with worse outcomes in the recipient as well, including higher all-cause mortality, cardiovascular mortality, and death-censored graft loss.[14-16,24] A study from Brown et al[25] identified no differences in recipient survival depending on if the donor was Black, but Black donor race was associated with higher incidence of acute rejection and decreased graft survival. There is a lack of research exploring the influence of donor race on pediatric kidney transplant outcomes. Our study did not identify any differences in kidney transplant outcomes depending on Black donor race. These findings support the notion that donor race should not be considered when determining the best characteristics for the kidney donor; specifically in the United States, this research suggests that the United States kidney allocation system should not consider donor race as a significant predictor of kidney transplant outcomes.

Studies thus far have shown mixed outcomes associated with donor-recipient race-matched pairs for organ transplants. Our results indicated that race-matched status was not significant to DGF, graft failure, acute rejection, or mortality. LeClaire et al[18] conducted a study that also explored the effects of race-matching using the OPTN database, and their study included
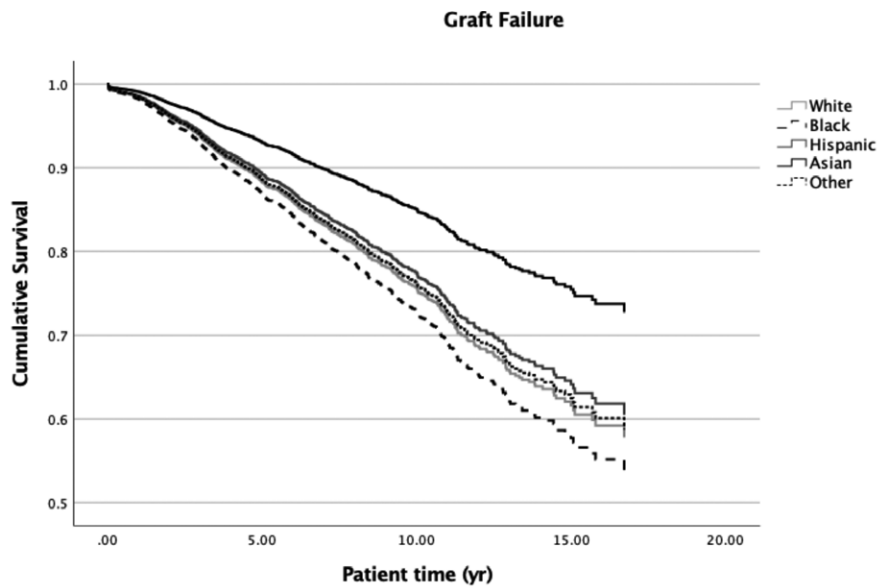
Graft Failure

	Year post-tx	Patients	Patients who have died	Patients still at risk	Proportion surviving	Cumulative proportion surviving at end of interval	Hazard rate	Standard error of hazard rate
White	0	3921	76	3650	.98	.98	.02	.00
	1	3302	83	3115	.97	.95	.02	.00
	3	2406	91	2231	.96	.88	.02	.00
	5	1611	59	1492	.96	.81	.04	.01
	10	529	70	300	.77	.53	.00	.00
Black	0	857	29	809	.96	.96	.04	.01
	1	732	23	707	.97	.93	.03	.01
	3	554	24	515	.95	.84	.05	.01
	5	361	16	332	.95	.76	.05	.01
	10	101	18	59	.70	.44	.00	.00
Hispanic	0	1398	24	1306	.98	.98	.02	.00
	1	1190	33	1129	.97	.95	.03	.01
	3	892	38	838	.95	.88	.05	.01
	5	603	22	564	.96	.82	.04	.01
	10	181	18	100	.82	.56	.00	.00
Asian	0	146	0	134	1.00	1.00	.00	.00
	1	121	0	111	1.00	1.00	.00	.00
	3	87	2	82	.98	.94	.02	.02
	5	65	0	59	1.00	.94	.00	.00
	10	20	3	12	.74	.62	.00	.00

FIGURE 4. Kaplan-Meier survival plot and life table for mortality based on donor race. The recipient survival rate depending on the race of donor was graphed as a function of patient time (in years), which was defined as the time from the day of transplant to last follow-up or death. Log-rank $P = 0.006$. The table outlines hazard rates and proportions of recipients who survived for 1, 3, 5, and 10 y after the kidney transplant. Tx, transplant.

adults who underwent heart, lung, liver, kidney, and pancreas transplants.[18] There were slight variations in some organ transplant outcomes due to race-matching, but the results were not strong enough to suggest race-matching should be considered when matching donors and recipients. Contrary findings resulted from Allen et al's study,[26] which also used the OPTN database and found that race-matching of adult liver transplant pairs resulted in improved long-term survival but did not confer any advantages for decreased rejection after 1 y. These mixed findings from initial race-matching studies indicate the need for further research; our research suggests that race-matching does not significantly affect kidney transplant outcomes, except for graft failure.

It is understood that early graft loss, within the first year of transplant, occurs for different reasons than later graft loss.[27-29] Accordingly, we analyzed if donor race or race-matching played a role in the early and late stages of graft failure and identified that race-matching conferred protection against late graft failure. Although other studies have explored clinical and pathologic factors that influence early versus late graft failures, such as donor-specific antibodies and interstitial fibrosis, these studies have not considered race as a potentially influential factor.[30] Our results, however, did not show any significance of either donor race or race-matched status and early or late graft failure.

Other potentially relevant factors influencing racial differences in kidney transplant outcomes are postulated to include

Graft Failure

	Year post-tx	Patients	Patients who have died	Patients still at risk	Proportion surviving	Cumulative proportion surviving at end of interval	Hazard rate	Standard error of hazard rate
Race-matched	0	3585	65	3342	.98	.98	.02	.00
	1	3033	68	2878	.98	.96	.02	.00
	3	2269	67	2115	.97	.90	.03	.00
	5	1560	50	1453	.97	.84	.04	.00
	10	517	55	286	.81	.59	.00	.00
Non-race-matched	0	2839	65	2649	.98	.98	.02	.00
	1	2393	71	2261	.97	.94	.03	.00
	3	2057	90	1609	.94	.85	.06	.01
	5	1120	49	1030	.95	.77	.05	.01
	10	323	55	189	.71	.44	.00	.00

FIGURE 5. Kaplan-Meier survival plot and life table for mortality based on race-matched status. The recipient survival rate depending on the race of donor was graphed as a function of patient time (in years), which was defined as the time from the day of transplant to last follow-up or death. Log-rank $P = 0.144$. The table outlines hazard rates and proportions of recipients who survived for 1, 3, 5, and 10 y after the kidney transplant. Tx, transplant.

unequal access and quality of care, variation among individual transplant centers, and income disparities.[3,31] In this study, we used insurance status as an indicator of socioeconomic status; however, this does not fully reflect differences in access and quality of care. Basiri et al[32] found that better outcomes were associated with living donors and that those of higher socioeconomic and educational status had higher likelihood of living donors. Patzer et al[12] also demonstrated significant racial disparities in preexisting risk factors for poorer allograft survival, such as low socioeconomic status; however, evidence has been found that, in settings where all patients have equal access to and quality of care, Black recipients still suffer worse outcomes than non-Blacks.[9] It has also been shown that poorer kidney graft outcomes are correlated with lower socioeconomic status in pediatric populations as well.[33]

It is important to note the limitations of this study. These include lack of or missing clinical data such as kidney donor profile index, disease severity, medications before transplant, cause of death, and the inability to account for changes in clinical covariates after the transplant. We used insurance status as a measure of participants' socioeconomic status, but this likely was not a completely accurate indicator of socioeconomic status. Because insurance status was the only indication

of socioeconomic status, this was included a priori in all of the adjusted models to verify that race is independent of this cofactor. As a result of the retrospective nature of this study, we were unable to incorporate other potentially relevant variables that were not part of the OPTN database, such as parental income or employment status. It is also possible that there was incomplete reporting of variables, such as acute rejection, that were not marked as missing in the dataset. Self-reporting of race was also a limitation, and although we refer to race throughout this study, the race categories included Hispanic ethnicity. This study did not analyze further details about White or non-White Hispanic self-identity. Hispanic ethnicity took precedence over all other listed races/ethnicities, according to OPTN conventions. The results of this study are important for the United States population; however, the results are not necessarily generalizable to populations in other countries.

This study adds to the growing literature more broadly exploring the relationship between race and renal transplant outcomes, expanding beyond only recipient race. Our findings suggest that donor race is not significantly associated with pediatric renal transplant outcomes. Like some of the existing mixed findings about race-matching, we did not find that race-matching confers significant protection against graft failure,

mortality, acute rejection, or DGF. Studies thus far analyzing the effects of donor race and race-matching on organ transplant outcomes largely study adults; we have contributed information that specifically focuses on the effects in the pediatric population. Based on existing literature and our analyses, there are many additional factors that might have influenced racial and race-matching disparities in outcomes. Future studies are necessary to better understand the influence of donor race and race-matching in pediatric organ transplant patients.

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