

Barriers to Living Donor Kidney Transplantation among Black or Older Transplant Candidates

Francis L. Weng,^{*†} Peter P. Reese,[‡] Shamkant Mulgaonkar,^{*} and Anup M. Patel^{*}

^{*}Renal and Pancreas Transplant Division and Department of Medicine, Division of Nephrology, Saint Barnabas Medical Center, Livingston, New Jersey; [†]Department of Epidemiology, School of Public Health, University of Medicine and Dentistry of New Jersey, Piscataway, New Jersey; and [‡]Center for Clinical Epidemiology and Biostatistics, and Department of Medicine, Renal-Electrolyte and Hypertension Division, University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania

Background and objectives: Lower rates of living donor kidney transplant (LDKT) among transplant candidates who are black or older may stem from lower likelihoods of (1) recruiting potential living donors or (2) potential donors actually donating (donor “conversion”).

Design, setting, participants, & measurements: A single-center, retrospective cohort study was performed to determine race, age, and gender differences in LDKT, donor recruitment, and donor conversion.

Results: Of 1617 kidney transplant candidates, 791 (48.9%) recruited at least one potential living donor, and 452 (28.0%) received LDKTs. Black transplant candidates, *versus* non-blacks, were less likely to receive LDKTs (20.5% *versus* 30.6%, relative risk [RR] = 0.67), recruit potential living donors (43.9% *versus* 50.7%, RR = 0.86), and receive LDKTs if they had potential donors (46.8% *versus* 60.3%, RR = 0.78). Transplant candidates ≥ 60 years, *versus* candidates 18 to < 40 years old, were less likely to receive LDKTs (15.1% *versus* 43.2%, RR = 0.35), recruit potential living donors (34.0% *versus* 64.6%, RR = 0.53), and receive LDKTs if they had potential donors (44.5% *versus* 66.8%, RR = 0.67). LDKT and donor recruitment did not differ by gender. Race and age differences persisted in multivariable logistic regression models. Among 339 candidates who recruited potential donors but did not receive LDKTs, blacks (*versus* non-blacks) were more likely to have potential donors who failed to donate because of a donor-related reason (86.9% *versus* 72.5%).

Conclusions: Black or older kidney transplant candidates were less likely to receive LDKTs because of lower likelihoods of donor recruitment and donor conversion.

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Living donor kidney transplant (LDKT) is usually the best treatment option for kidney failure (1) but occurs less frequently among persons who are black or older (2–4). In 2007, blacks comprised only 13.8% of LDKT recipients in the United States—a percentage that has remained unchanged for 10 years (1). In contrast, blacks make up 30% to 40% of the dialysis population (5), active deceased donor kidney transplant (DDKT) waiting list, and DDKT recipients (1). LDKTs also occur less frequently among older patients (2–4), whose anticipated waiting time for a DDKT often exceeds their life expectancy (6). In addition, several studies have reported decreased access to LDKTs among women (4,7–9), although other studies have found no gender differences (2,3).

Kidney transplant candidates who are black or older may receive fewer LDKTs because of barriers at two steps in the LDKT process. First, black or older candidates may be less

likely to “recruit” potential living donors (10). Second, black or older candidates may be less likely to “convert” their potential donors into actual donors. Better knowledge of the relative importance of these two steps would enable targeted interventions to increase rates of LDKT.

Unfortunately, the relative importance of donor recruitment and donor “conversion” as barriers to LDKT remains unclear. Examination of these two steps requires a cohort of transplant candidates and recipients linked with their potential and actual living donors. One smaller study examined transplant candidates with their potential living donors and found that older age, but not race or gender, was associated with a lower likelihood of donor recruitment (3). Further studies are needed to determine whether donor recruitment impedes LDKT among certain subgroups.

Studies are also needed to determine whether donor conversion serves as a barrier to LDKT. Obesity and possibly hypertension exclude a higher proportion of black, *versus* non-black, potential donors (11–13), reflecting the higher prevalence of diabetes, obesity, and hypertension among blacks in general (14,15). However, the lower likelihood of donation by black potential donors does not necessarily demonstrate that the donor conversion step prevents LDKT among black transplant

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Correspondence: Dr. Francis L. Weng, Renal and Pancreas Transplant Division, Saint Barnabas Health Care System, Saint Barnabas Medical Center, East Wing, Suite 305, 94 Old Short Hills Road, Livingston, NJ 07039. Phone: 973-322-2361; Fax: 973-322-8930; E-mail: fweng@sbhcs.com

candidates. After all, transplant candidates whose initial potential donors fail to donate may later receive LDKTs from subsequent donors. Without information about the transplant candidates, prior studies of potential living donors (11–13) have been unable to fully characterize the donor conversion step.

Among kidney transplant candidates, we sought to determine (1) the barriers to receipt of LDKTs and (2) race, age, and gender differences in these barriers. We hypothesized that blacks were less likely than non-blacks to receive LDKTs because of a lower likelihood of donor recruitment and donor conversion.

Materials and Methods

Study Design and Population

We performed a retrospective cohort study of adults evaluated for a kidney-alone transplant at Saint Barnabas Medical Center in Livingston, New Jersey. We included persons who were ≥ 18 years old; evaluated between January 1, 2000 and December 31, 2005; and deemed medically suitable for transplant. We excluded persons previously evaluated for kidney transplant, persons already listed for DDKT at another center, and recipients of prior kidney transplants. Study patients were followed until they died; were removed from our waiting list; transferred to another transplant center; received a LDKT; received a DDKT; or December 31, 2007, whichever came first.

The study protocol was approved by the human subjects Institutional Review Board at Saint Barnabas Medical Center.

Study Outcomes

Our main outcomes were (1) recruitment of potential living kidney donors, (2) receipt of LDKTs among all candidates, and (3) receipt of LDKTs among candidates who recruited potential donors (donor conversion).

Recruitment of a potential living donor occurred if a person contacted our center to express interest in donating to a specific transplant candidate and then appeared for education and evaluation (2000 to 2004) or completed the living donor referral form over the phone or via mail (2004 to 2007). Transplant candidates stop recruiting donors if an earlier donor actually donates, so the number of recruited, potential living donors may be misleading. Instead, we categorized donor recruitment dichotomously (any potential living donors *versus* none).

Receipt of a LDKT occurred only after the transplant candidate's potential donor successfully completed the living donor evaluation (16–18). Regarding criteria that may vary between centers, we excluded persons from living kidney donation for repeated creatinine clearance < 80 ml/min per 1.73 m²; repeated proteinuria > 300 mg/d; age > 75 years or < 18 years; diabetes mellitus, impaired fasting glucose (glucose > 100 mg/dl), or abnormal oral glucose tolerance test; and body mass index > 35 . We excluded persons with high blood pressure (BP), defined as use of any antihypertensive medications or BP $> 135/85$ during the physician evaluation (usually confirmed by 24-hour ambulatory BP monitoring). Donor nephrectomies were performed laparoscopically, with $< 0.5\%$ requiring open donor nephrectomy.

Kidneys from live nondirected (*i.e.*, altruistic) donors were transplanted into the next suitable candidates on the DDKT waiting list. We reclassified the six recipients of kidney transplants from live nondirected donors as recipients of DDKTs because these transplant candidates did not recruit their living donors.

Study Variables

Transplant candidates' demographic and medical data were abstracted from their medical records. The transplant candidate's zip code

at the time of evaluation was linked to median household income for that zip code tabulation area, according to the 2000 U.S. Census Bureau.

Among potential living donors to transplant candidates who did not receive LDKTs, we determined the reasons for nondonation. The number of potential donors who were unable to donate for a given reason can be misleading, so we determined the number of transplant candidates who could not receive a LDKT because of each reason. For example, ten potential donors who could not donate because of blood group incompatibility may have intended to donate to only seven transplant candidates (several donors were recruited by the same candidate). Blood group incompatibility would be the reason for nondonation in ten donors but prevent LDKTs in only seven candidates. The transplant candidate, not the potential living donor, was the unit of all analyses, except where indicated.

Statistical Analyses

Analyses were performed using Stata software, version 9.1 (Stata Corporation, College Station, TX). Two-sided P values < 0.05 were considered statistically significant.

Categorical variables were expressed as proportions, and their values across groups (*e.g.*, race) were compared using χ^2 testing. Continuous variables were expressed as medians (with 25% to 75% interquartile ranges) and compared using Wilcoxon rank-sum tests. Our outcomes were common, so we calculated relative risks (RRs) and odds ratios.

We used logistic regression to model associations between covariates and our three outcomes (19). Candidate variables with $P < 0.20$ in the unadjusted analyses were eligible for the multivariable model. The multivariable model for each outcome was generated using a stepwise, backward elimination method. The significance of each variable in the nested models was assessed using the likelihood ratio test and the Wald statistic. Variables with adjusted $P < 0.10$ were retained in the final model. Goodness-of-fit was confirmed using the Hosmer–Lemeshow test with ten deciles of risk.

We also used Cox proportional hazards models to estimate associations with time until LDKT and recruitment of the first potential living donor, calculated from the dates of initial evaluation and medical suitability for transplant. Given the similarity of the hazard and odds ratios, we present only the results of the logistic regression models.

Results

Study Cohort

The baseline characteristics of the 1617 kidney transplant candidates in our study differed according to race (Table 1) as well as sex and age. Compared with younger candidates, older transplant candidates were more likely to have Medicare as primary insurance ($P < 0.001$) and reside in a higher income zip code ($P < 0.001$).

Recruitment of Potential Living Donors and Receipt of LDKTs

Transplant candidates were followed for a median of 2.5 years after evaluation (25% to 75% range, 1.1 to 3.8 years). Overall, 791 (48.9%) kidney transplant candidates recruited at least one potential living donor (1194 total potential donors). By the end of follow-up, 452 transplant candidates received LDKTs, corresponding to 28.0% of the entire cohort and 57.1% of the candidates who recruited potential living donors.

Transplant candidates who were black or older were significantly less likely to receive LDKTs (Table 2). Compared with non-blacks, black transplant candidates were one third less

Table 1. Baseline characteristics of 1617 kidney transplant candidates

Characteristic	Non-Black	Black	P	Total
N	1193 (73.8%)	424 (26.2%)		1617
Male	749 (62.8%)	242 (57.1%)	0.04	991 (61.3%)
Age at evaluation			<0.001	
18 to <40 years	230 (19.3%)	129 (30.4%)		359 (22.2%)
40 to <50 years	260 (21.8%)	97 (22.9%)		357 (22.1%)
50 to <60 years	340 (28.5%)	105 (24.8%)		445 (27.5%)
≥60 years	363 (30.4%)	93 (21.9%)		456 (28.2%)
Age at evaluation, median (25% to 75%), in years	53.4 (42.8 to 61.8)	48.5 (38.3 to 58.9)	<0.001	52.5 (41.2 to 61.2)
Etiology of renal disease			<0.001	
diabetes	478 (40.1%)	136 (32.1%)		614 (38.0%)
hypertension	155 (13.0%)	146 (34.4%)		301 (18.6%)
cystic	114 (9.6%)	12 (2.8%)		126 (7.8%)
glomerulonephritis	278 (23.3%)	89 (21.0%)		367 (22.7%)
interstitial	30 (2.5%)	7 (1.7%)		37 (2.3%)
obstruction	30 (2.5%)	0 (0%)		30 (1.9%)
unknown	48 (4.0%)	19 (4.5%)		67 (4.1%)
Married	766 (64.2%)	190 (44.8%)	<0.001	956 (59.1%)
Dialysis status			<0.001	
not on dialysis	246 (20.6%)	38 (9.0%)		284 (17.6%)
hemodialysis	819 (68.7%)	361 (85.1%)		1180 (73.0%)
peritoneal dialysis	128 (10.7%)	25 (5.9%)		153 (9.5%)
Medical insurance			0.07	
private	703 (58.9%)	225 (53.1%)		928 (57.4%)
Medicare	429 (36.0%)	169 (40.0%)		598 (37.0%)
Medicaid and other public insurance	61 (5.1%)	30 (7.1%)		91 (5.6%)
Highest education level			<0.001	
up to high school diploma	571 (47.9%)	193 (45.5%)		764 (47.3%)
any college or technical school	276 (23.1%)	134 (31.6%)		410 (25.4%)
associate, bachelor, or higher degree	296 (24.8%)	68 (16.0%)		364 (22.5%)
unknown	50 (4.2%)	29 (6.8%)		79 (4.9%)
Median household income of zip code, in U.S. dollars				
median (25% to 75%)	\$59,611 (43,850 to 72,839)	\$41,566 (33,418 to 57,479)	<0.0001	\$53,375 (38,733 to 68,709)
median income of each quartile			<0.001	
quartile 1	\$32,569 (17.8%)	\$31,269 (45.5%)		\$31,949 (25.1%)
quartile 2	\$46,646 (24.4%)	\$47,308 (26.9%)		\$46,833 (25.1%)
quartile 3	\$61,433 (28.3%)	\$60,748 (15.6%)		\$61,321 (24.9%)
quartile 4	\$87,121 (29.6%)	\$79,438 (12.0%)		\$86,151 (25.0%)
Initial panel reactive antibody			0.07	
0%	715 (59.9%)	225 (53.1%)		940 (58.1%)
1% to 19%	27 (2.3%)	14 (3.3%)		41 (2.5%)
20% to 79%	39 (3.3%)	20 (4.7%)		59 (3.7%)
≥80%	29 (2.4%)	9 (2.1%)		38 (2.4%)
missing	383 (32.1%)	156 (36.8%)		539 (33.3%)
ABO blood type			<0.001	
O	543 (45.5%)	229 (54.0%)		772 (47.7%)
A	390 (32.7%)	93 (21.9%)		483 (29.9%)
B	184 (15.4%)	81 (19.1%)		265 (16.4%)
AB	76 (6.4%)	21 (5.0%)		97 (6.0%)

likely to receive LDKTs. Compared with candidates <40 years old, candidates in older age categories were less likely to receive LDKTs ($P < 0.001$). Among the 96 candidates who were ≥70 years, the RR of receiving a LDKT was especially low (RR = 0.19, 95% confidence interval [CI] 0.10 to 0.38, $P < 0.001$).

Transplant candidates who were black or older were significantly less likely to (1) recruit at least one potential living donor and (2) receive LDKTs if they had potential living donors (Table 3).

There were no gender differences in the likelihoods of

receiving LDKTs and recruiting potential living donors (Tables 2 and 3).

At the end of follow-up, 279 (17.3%) transplant candidates had received DDKTs, 258 (16.0%) had died or been removed from the waiting list because of medical reasons, 433 (26.8%) remained on the waiting list, and 195 (12.1%) had transferred their waiting time or received transplants elsewhere. The proportion of patients who received DDKTs was similar across race ($P = 0.78$), gender ($P = 0.89$), and age categories ($P = 0.07$).

Table 2. Counts and unadjusted RRs of receipt of LDKT according to race, gender, and age category of kidney transplant candidates

Transplant Candidate Characteristic	Received a LDKT		
	N (%)	RR (95% CI)	P
Race			
non-black	365 (30.6)	Reference	
black	87 (20.5)	0.67 (0.55 to 0.82)	<0.001
Gender			
male	285 (28.8)	Reference	
female	167 (26.7)	0.93 (0.79 to 1.09)	0.36
Age			
18 to <40 years	155 (43.2)	Reference	
40 to <50 years	115 (32.2)	0.75 (0.62 to 0.90)	0.003
50 to <60 years	113 (25.4)	0.59 (0.48 to 0.72)	<0.001
≥60 years	69 (15.1)	0.35 (0.27 to 0.45)	<0.001

Univariable and Multivariable Models

In univariable models, black race and older age were associated with lower odds of receipt of a LDKT, recruitment of potential living donors (donor recruitment), and receipt of a LDKT if the candidate had potential living donors (donor conversion). Diabetes, not being married, requiring maintenance dialysis, having nonprivate insurance, lower median zip code income, panel reactive antibodies ≥ 20%, and recipient blood type O were associated with lower odds of receipt of a LDKT (data not shown).

In a multivariable model, black race ($P = 0.001$) and older age ($P < 0.001$) remained associated with lower odds of receiving a LDKT (Table 4). Among candidates who were black and ≥60

years old, the adjusted odds ratio for receipt of a LDKT was 0.13 (95% CI 0.08 to 0.21).

In separate multivariable models, black race and older age remained associated with lower odds of (1) donor recruitment and (2) donor conversion (Table 4). Among transplant candidates who were black and ≥60 years old, the adjusted odds ratio for donor recruitment was 0.18 (95% CI 0.12 to 0.28), and the adjusted odds ratio for donor conversion was 0.21 (95% CI 0.12 to 0.38).

In multivariable models, female sex was not associated with receipt of a LDKT, donor recruitment, or donor conversion. There were no interactions between race and the following: sex, age category, medical insurance type, or median income of the transplant candidate's zip code. There were no interactions between sex and age category.

Candidates Who Recruited Potential Living Donors but Did Not Receive LDKTs

There were 339 transplant candidates who recruited at least one potential living donor (530 total donors) but did not receive LDKTs. Among these candidates, the number of recruited donors differed according to candidate gender ($P = 0.02$) but not according to candidate race ($P = 0.43$) or age category ($P = 0.27$) (Figure 1).

For 260 (76.7%) of these candidates, at least one potential donor did not donate because of one of the three donor-related reasons: blood group or crossmatch incompatibility (167 donors to 113 candidates), medical contraindication to donation (119 donors to 101 candidates), and lack of further donor interest in donation (117 donors to 101 candidates). More black (*versus* non-black) transplant candidates had at least one potential donor who failed to donate because of any of the three donor-related reasons (86.9% *versus* 72.5%, $P = 0.004$). However, racial differences in each of the three donor-related reasons were not statistically significant (Figure 2). Nondonation because of do-

Table 3. Counts and unadjusted RRs of recruitment of potential living donors (donor recruitment) and receipt of a LDKT among candidates who recruited potential living donors (donor conversion) according to race, gender, and age category

Transplant Candidate Characteristic	Recruited One or More Potential Living Donors			Received LDKT, among Candidates Who Recruited Potential Living Donors		
	N (%)	RR (95% CI)	P	N (%)	RR (95% CI)	P
Race						
non-black	605 (50.7)	Reference		365 (60.3)	Reference	
Black	186 (43.9)	0.86 (0.77 to 0.98)	0.015	87 (46.8)	0.78 (0.66 to 0.92)	0.001
Gender						
male	475 (47.9)	Reference		285 (60.0)	Reference	
female	316 (50.5)	1.05 (0.95 to 1.17)	0.32	167 (52.9)	0.88 (0.78 to 1.00)	0.047
Age						
18 to <40 years	232 (64.6)	Reference		155 (66.8)	Reference	
40 to <50 years	190 (53.2)	0.82 (0.73 to 0.93)	0.002	115 (60.5)	0.91 (0.78 to 1.05)	0.19
50 to <60 years	214 (48.1)	0.74 (0.66 to 0.84)	<0.001	113 (52.8)	0.79 (0.68 to 0.92)	0.003
≥60 years	155 (34.0)	0.53 (0.45 to 0.61)	<0.001	69 (44.5)	0.67 (0.55 to 0.81)	<0.001

Table 4. Multivariable models of factors associated with receipt of LDKT, recruitment of potential living donors, and receipt of a LDKT among candidates who recruited potential living donors

Transplant Candidate Characteristic	Receipt of LDKT		Recruitment of Potential Living Donor(s)		Receipt of a LDKT, among Candidates Who Recruited Potential Living Donor(s)	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
Black race (<i>versus</i> non-black)	0.61 (0.45 to 0.81)	0.001	0.78 (0.62 to 1.00)	0.047	0.57 (0.40 to 0.82)	0.002
Female (<i>versus</i> male)	0.94 (0.74 to 1.21)	0.64	1.16 (0.93 to 1.44)	0.18	0.78 (0.58 to 1.07)	0.12
Age (<i>versus</i> 18 to <40 years)		<0.001		<0.001		<0.001
40 to <50 years	0.52 (0.37 to 0.72)		0.52 (0.38 to 0.72)		0.64 (0.42 to 0.97)	
50 to <60 years	0.34 (0.25 to 0.47)		0.40 (0.29 to 0.54)		0.47 (0.31 to 0.71)	
≥60 years	0.21 (0.14 to 0.30)		0.23 (0.17 to 0.32)		0.37 (0.24 to 0.58)	
Married (<i>versus</i> not married)	1.38 (1.06 to 1.81)	0.02	1.69 (1.33 to 2.13)	<0.001	NS	—
Not on dialysis (<i>versus</i> already on dialysis)	2.52 (1.89 to 3.36)	<0.001	2.16 (1.62 to 2.87)	<0.001	2.21 (1.53 to 3.22)	<0.001
Insurance status (<i>versus</i> private insurance)		<0.001		0.002	NS	—
Medicare	0.66 (0.50 to 0.87)		0.73 (0.58 to 0.92)			
Medicaid	0.41 (0.22 to 0.77)		0.49 (0.31 to 0.80)			
Initial panel reactive antibody (<i>versus</i> <20%)		0.001	NS	—		<0.001
20% to 100%	0.35 (0.18 to 0.69)				0.29 (0.14 to 0.62)	
missing	1.22 (0.95 to 1.56)				1.34 (0.97 to 1.85)	
Blood type (<i>versus</i> type O)		0.04	NS	—		0.07
A	1.47 (1.12 to 1.92)				1.52 (1.07 to 2.14)	
B	1.35 (0.97 to 1.89)				1.52 (0.99 to 2.34)	
AB	1.11 (0.67 to 1.84)				1.23 (0.64 to 2.35)	

NS, not significant.

nor-related reasons was distributed evenly across transplant candidates' gender ($P = 0.85$) and age categories ($P = 0.78$).

For 103 (30.4%) of the 339 candidates, at least one potential donor did not donate because of one of the three recipient-related reasons: transplant candidate death or medical ineligibility for transplant (57 donors to 44 candidates), transplant candidate received a DDKT (37 donors to 30 candidates), and miscellaneous reasons (33 donors to 31 candidates). Nondonation because of recipient-related reasons was less common among black (*versus* non-black) candidates (22.2% *versus* 33.8%, $P = 0.04$) but was distributed evenly across transplant candidates' gender ($P = 0.86$) and age categories ($P = 0.59$).

Among these 530 potential donors to 339 transplant candidates who did not receive LDKTs, the specific reasons for nondonation are listed in Table 5. Among the 119 potential donors who had medical contraindications to donation, potential donors to black transplant candidates (*versus* to non-black candidates) were more likely to be excluded because of hypertension (43.6% *versus* 22.5%). However, overall the specific medical contraindications did not differ according to the race of the transplant candidate ($P = 0.13$) (Table 5). These 530 potential donors, *versus* the 452 actual living donors, were similar in age (median 40.9 *versus* 41.2 years old, $P = 0.80$) and sex (42.3% *versus* 37.2% male, $P = 0.10$) but more likely to be black (24.2% *versus* 16.4%, $P = 0.003$).

Discussion

In this retrospective cohort study of 1617 kidney transplant candidates, black or older transplant candidates had lower likelihoods of donor recruitment and donor conversion. Barriers at both of these steps in the LDKT process resulted in significantly lower likelihoods of LDKT in blacks (RR = 0.67, *versus* non-blacks) and in candidates ≥60 years (RR = 0.35, *versus* candidates 18 to <40 years old). These race- and age-based differences in LDKT, donor recruitment, and donor conversion persisted in multivariable models that adjusted for many potential confounders.

The lower likelihood of donor recruitment by black or older transplant candidates is potentially addressable. Educational and behavioral interventions can increase the proportion of transplant candidates who bring forth potential living donors (20–22). Such interventions have been especially effective among blacks (21,22).

To eliminate race- and age-based differences in LDKT, donor conversion by black or older transplant candidates also must improve. Otherwise, donor conversion may serve as the rate-limiting barrier to LDKT. Persistent differences in donor conversion would cause black or older transplant candidates to receive fewer LDKTs, even if differences in donor recruitment disappeared. Unfortunately, decreasing

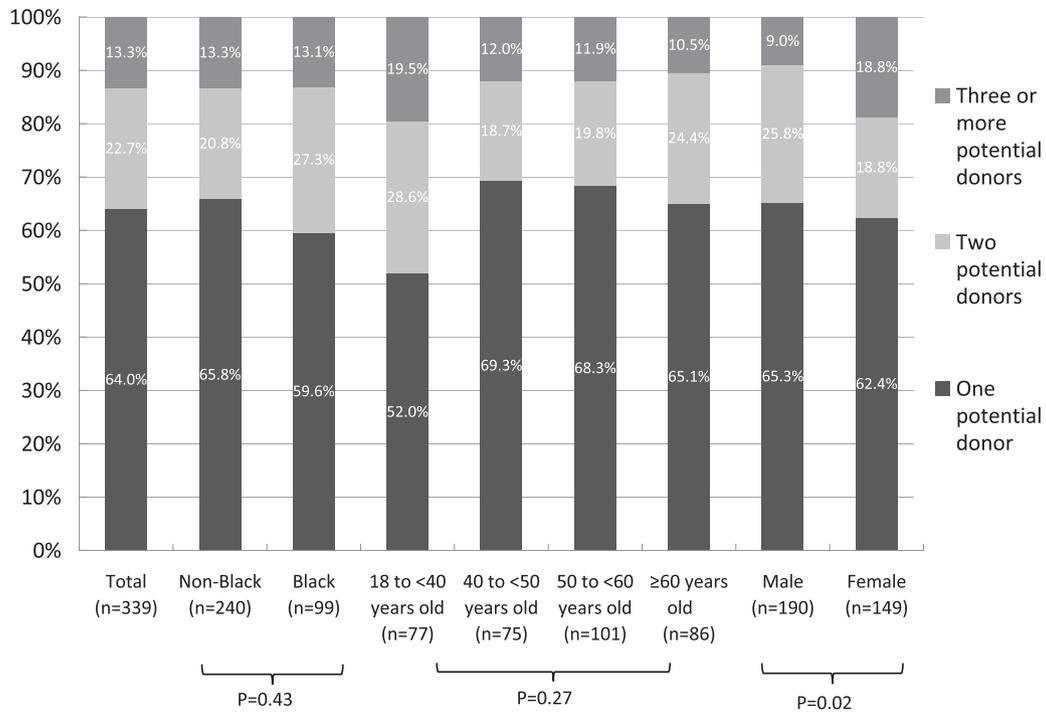


Figure 1. Number of potential donors recruited by 339 transplant candidates who recruited donors but did not receive LDKTs, stratified by race, age, and gender of the transplant candidate.

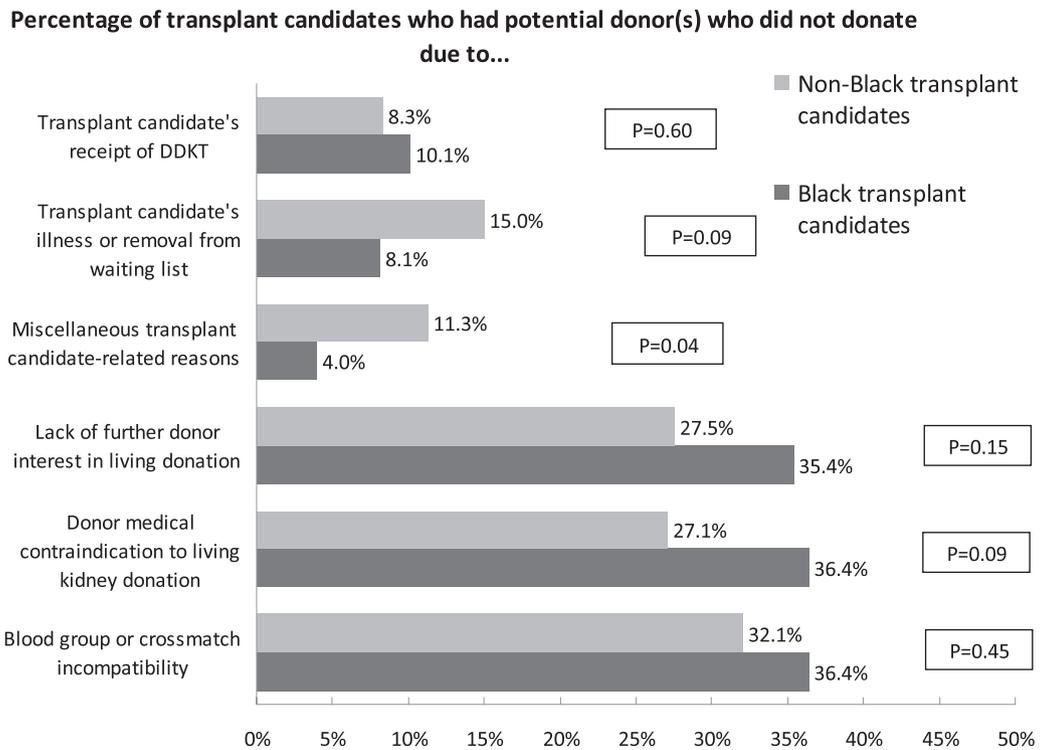


Figure 2. Transplant candidates who had potential living donors and did not receive LDKTs, categorized by reasons for nondonation and stratified by race of the transplant candidate.

race- and age-based differences in donor conversion may prove to be difficult.

Many candidates did not receive LDKTs because their re-

cruited donors had medical contraindications to living kidney donation. These medical contraindications are not easily amenable to interventions. Current medical criteria for living kid-

Table 5. Reasons for nondonation by 530 potential living donors recruited by 339 transplant candidates who did not receive LDKTs

	Total Number of Potential Donors	Potential Donors to Non-Black Transplant Candidates	Potential Donors to Black Transplant Candidates
N	530	376	154
Donor-related reasons for nondonation	403	276	127
blood group and/or crossmatch incompatible	167 (31.5%)	120 (31.9%)	47 (30.5%)
lack of further donor interest in donation	117 (22.1%)	76 (20.2%)	41 (26.6%)
medical contraindication to kidney donation	119 (22.5%)	80 (21.3%)	39 (25.3%)
hypertension ^a	35 (29.4%)	18 (22.5%)	17 (43.6%)
obesity ^a	17 (14.3%)	11 (13.8%)	6 (15.4%)
diabetes mellitus ^a	10 (8.4%)	6 (7.5%)	4 (10.3%)
low GFR ^a	7 (5.9%)	6 (7.5%)	1 (2.6%)
proteinuria ^a	8 (6.7%)	5 (6.3%)	3 (7.7%)
hematuria ^a	2 (1.7%)	2 (2.5%)	0 (0%)
nephrolithiasis ^a	2 (1.7%)	2 (2.5%)	0 (0%)
psychosocial ^a	10 (8.4%)	7 (8.8%)	3 (7.7%)
renal cysts ^a	4 (3.4%)	4 (5.0%)	0 (0%)
other anatomic (renal mass, vascular) ^a	4 (3.4%)	3 (3.8%)	1 (2.6%)
hepatitis C or other hepatic abnormality ^a	7 (5.9%)	3 (3.8%)	4 (10.3%)
cardiac ^a	6 (5.0%)	6 (7.5%)	0 (0%)
other medical contraindication (pulmonary, pregnancy, cancer, hypercoagulable state) ^a	7 (5.9%)	7 (8.8%)	0 (0%)
Recipient-related reasons for nondonation	127	100	27
transplant candidate death or medical ineligibility for transplant	57 (10.8%)	48 (12.8%)	9 (5.8%)
transplant candidate received DDKT at our center	37 (7.0%)	24 (6.4%)	13 (8.4%)
miscellaneous transplant candidate-related reasons	33 (6.2%)	28 (7.5%)	5 (3.3%)
transplant candidate transferred time or transplanted elsewhere ^b	15 (45.5%)	12 (42.9%)	3 (60.0%)
transplant candidate refused LDKT ^b	13 (39.4%)	12 (42.9%)	1 (20.0%)
LDKT scheduled and pending ^b	5 (15.2%)	4 (14.3%)	1 (20.0%)

^aThe denominator for the calculation of these percentages is the number of potential donors who did not donate because of donor medical contraindications.

^bThe denominator for the calculation of these percentages is the number of potential donors who did not donate because of miscellaneous transplant-candidate-related reasons.

ney donation are appropriately stringent given that donation has short-term (23,24) and possibly long-term (25,26) risks. Obesity, which occurs more commonly among black potential donors (11–13), has uncertain long-term risks for living donors (27,28). The medical criteria for accepting living donors should not be relaxed given the ethical imperative to protect the welfare of potential and actual donors (29).

Many candidates did not receive LDKTs because their recruited donors lacked further interest in living donation. Potential living donors who are black are more likely to be lost to follow-up and lose interest in living donation (12,13). Thus, efforts to decrease donor “dropout” may especially increase donor conversion and LDKT among black transplant candidates. However, transplant centers must tread carefully in any efforts to decrease living donor dropout. Potential donors should feel neither pressured nor coerced into donating given

the risks (23,25,26) and voluntary nature (29) of living kidney donation.

Many transplant candidates did not receive LDKTs because they were blood group or crossmatch incompatible with their recruited donors. Desensitization and donor exchange programs now enable transplant candidates with immunologically incompatible living donors to receive LDKTs (30–32). However, in our study, incompatible potential donors occurred with equal frequency among black *versus* non-black candidates and among older *versus* younger candidates. Therefore, desensitization and donor exchange may increase overall rates of LDKT (33) but fail to reduce race- or age-based differences in LDKT rates (34). Future studies should determine the effect of desensitization and donor exchange (including chains and dominos that use nondirected donors) on demographic disparities in LDKT.

To examine the donor recruitment and conversion steps, we linked kidney transplant candidates with their potential, as well as actual, living donors. Prior studies could not examine these steps because they examined transplant candidates but lacked data on candidates' potential living donors (2,4,7), examined recipients of LDKTs but lacked data on candidates who did not receive LDKTs (2,7–9,35), or examined potential living donors but lacked data on donors' intended recipients (11–13,36). Several recent studies have reported reasons for non-donation by recruited, potential living donors (11–13,36). Although informative, these donor-based studies lacked information about donors' associated transplant candidates, preventing examination of donor recruitment and conversion. Compared with the steps in the DDKT process (37), the steps in the LDKT process remain poorly characterized (38).

Our study has important limitations. First, our results may not necessarily apply to other U.S. transplant centers. Other centers may select their transplant candidates and living donors using different criteria (39). Nevertheless, our results are likely generalizable. Demographically, our center's waiting list closely resembles the national waiting list. Furthermore, most centers evaluate and select their transplant candidates (40) and living donors (16,18) using similar, albeit not identical, criteria. In any case, studies of the barriers to LDKT are almost necessarily single-center studies because large registry data sets lack the granularity of information needed to examine donor recruitment and conversion.

Second, we did not collect and adjust for psychosocial and health services factors that may influence donor recruitment and conversion (3,41). These factors include poorly understood provider and system factors (42); candidates' self-efficacy, social support, and networks (43); and prior discussions of LDKT (44), timing of nephrology referral (45), and knowledge and attitudes regarding ESRD and LDKT (46). Future, prospective studies should collect and adjust for these factors to better determine the root causes of LDKT disparities (47). Subsequent interventions can then target these factors to increase rates of LDKT.

In conclusion, black or older kidney transplant candidates were less likely to receive LDKTs because of lower likelihoods of donor recruitment and donor conversion. These dual barriers to LDKT underscore the difficulty of increasing rates of LDKT in transplant candidates who are black or older. Decreasing race- and age-based differences in LDKT will require interventions to address both barriers in the LDKT process.

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Disclosures

None.

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