

## Transplantation/Vascular Surgery

# The Socioeconomic Status of Donors and Recipients of Living Unrelated Renal Transplants in the United States

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### Abbreviations and Acronyms

LRRT = living related renal transplantation

LURT = living unrelated renal transplantation

SES = socioeconomic status

SESI = SES index

UNOS = United Network for Organ Sharing.

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**Purpose:** We evaluated unrelated living kidney donation in the United States and examined the characteristics of unrelated donor-recipient pairs.

**Materials and Methods:** We accessed United Network for Organ Sharing files to identify adult living donor renal transplant recipients who received a transplant between 1997 and 2007. We evaluated factors associated with unrelated donation and compared a composite index of the socioeconomic characteristics of donor and recipient ZIP Codes between living unrelated and living related renal transplantation pairs. Spousal pairs were categorized as living related.

**Results:** Of 39,168 adult renal transplant recipients 19% underwent living unrelated renal transplantation. These recipients were more likely white (vs black, Hispanic and other race OR 0.77–0.82,  $p < 0.05$ ) and more highly educated (college vs less than high school OR 0.66, 95% CI 0.54–0.77), and more commonly received care at high volume transplant centers (vs lowest volume centers OR 0.89, 95% CI 0.82–0.95). Living unrelated renal transplantation recipients and donors lived in higher socioeconomic status index ZIP Codes than living related recipients (mean  $\pm$  SD recipients and donors  $0.62 \pm 3.74$  and  $0.44 \pm 3.63$  vs  $0.03 \pm 3.85$  and  $0.10 \pm 3.87$ , respectively, each  $p < 0.001$ ).

**Conclusions:** Living unrelated renal transplantation donors and recipients are generally of higher socioeconomic status than their living related renal transplantation counterparts. There is restricted access to unrelated donors among underserved populations.

**Key Words:** kidney, kidney transplantation, living donors, socioeconomic factors, health services accessibility

SOON after the first successful living donor kidney transplant in 1954, living donor transplantation from first-degree relatives became commonplace. In the 1980s the first transplants from spouses were performed and with advances in immunosuppression the need for close human leukocyte antigen matching was overcome.<sup>1</sup> Living donation from donors who were not biologically related and yet were

closely related emotionally became more frequent.

With time the closeness of the emotional bond between donor and recipient that was deemed appropriate for donation became more tenuous. By the 1990s transplants from donors with no relationship to the recipients were done in some programs. The identification, evaluation and protection of donors with limited relation-

ships to the recipient became subject to intense scrutiny.<sup>2-4</sup>

The last decade has seen remarkable changes in the relationship between living donors and their recipients in the United States. Nationally unrelated kidney donation now accounts for almost 40% of all living donor transplants.<sup>5</sup> This trend has occurred in a legal environment that prohibits financial gain for donors with reports showing excellent donor psychosocial outcomes and long-term medical safety.<sup>2,6,7</sup> In this respect the United States has taken the lead among developed countries, of which some prohibit biologically unrelated donation even from spouses.<sup>8</sup>

We describe LURT trends in the United States. We sought to understand the associated donor, recipient and transplant center characteristics. To evaluate the SES of unrelated donors and their recipients we compared SES differences of unrelated living kidney donor-recipient pairs with those of biologically related or spousal donor-recipient pairs performed between 1997 and 2007.

## MATERIALS AND METHODS

### Study Sample

We accessed UNOS Standard Transplant and Research files based on Organ Procurement and Transplant Network data as of August 6, 2007. We identified all American citizens who underwent renal transplantation from July 1, 1997 through June 30, 2007. We restricted our sample to recipients and donors at least 25 years old to focus on donor-recipient pairs in which each party had attained socioeconomic maturity.<sup>9</sup> Study exclusion criteria included multi-organ transplantation, missing donor or recipient age and missing ZIP Code of residence.

We categorized living donor relationship type as related or unrelated. For this analysis spousal donation was grouped with LRRT to separate spousal pairs from the socioeconomically independent donors and recipients who are more characteristic of unrelated donor-recipient pairs. The remaining unrelated categories were specified by UNOS, including extended family, friends and other or unknown relationships.

Of the covariates race/ethnicity was subdivided into white, black, Hispanic and other. Educational achievement of recipients and donors ranged from less than a high school education to at least a college degree. We classified those with a high school diploma who attended college but did not obtain a degree as having some college. Primary payer at transplantation registration was categorized as private, Medicare, Medicaid and other, eg self-pay and veteran benefits.

The etiology of renal failure corresponded to the causes of end stage renal disease according to UNOS. Recipient panel reactive antibody indicated the percent of the American population against whom the recipient has preexisting anti-human leukocyte antigen antibodies. A higher panel reactive antibody connotes a lower likelihood of

receiving a renal allograft secondary to the increased risk of early antibody mediated rejection.

We examined transplant center characteristics known to influence the use of living donor renal transplantation.<sup>10</sup> We categorized transplant center volume into terciles and examined low—fewer than 50, moderate—50 to 99 and high volume centers—100 or greater kidney transplants annually. Centers were considered to have a high laparoscopy volume when more than 95% of living donor nephrectomies were done laparoscopically.

### Recipient and Donor SES

At the individual level we evaluated recipient and donor SES by educational achievement. At the neighborhood level we evaluated recipients and donors by linking their residential ZIP Code to 2000 United States Census Bureau data. We measured neighborhood characteristics previously shown by factor analysis to correlate closely with individual level SES,<sup>11</sup> including median household income, median housing value, percent of households with investment income, percent high school educated, percent with a college degree and percent with a professional occupation. These values were standardized to z-scores, such that 0 indicated a median neighborhood and each unit above or below 0 represented an SD from the median. These z-scores were summed to create the neighborhood composite SESI.

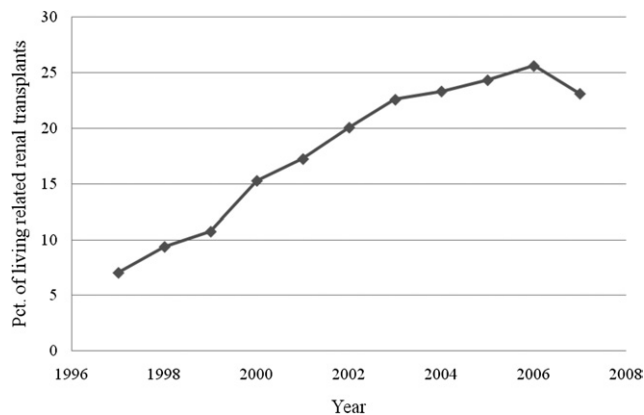
### Statistical Analysis

We analyzed data as pooled cross-sectional observations. We compared LURT recipients and donors with LRRT recipients and donors using chi-square analysis for categorical variables and the independent sample t test for continuous variables. We constructed backward stepwise multivariate logistic regression models to identify factors associated with LURT. We focused on recipient and transplant center characteristics since we identified substantial collinearity between recipient and donor demographic characteristics regardless of donor-recipient relationship. Since our response variable LURT was common, we performed post-estimation predictions for each covariate to determine the relative likelihood of LURT with all other variables held constant. We bootstrapped with 1,000 repetitions to determine the 95% CI for the relative likelihood.

We compared the individual level SES characteristic, educational achievement, between recipients and donors by donor-recipient relationship status with chi-square analysis. We compared neighborhood level SESI between recipients and donors by donor-recipient relationship with the independent samples t test. The difference in recipient and donor neighborhood SESI was calculated, such that positive differences indicated that the recipient had a higher neighborhood SESI. Statistical analysis was done using SAS®, version 9.2.

## RESULTS

We identified 39,168 living donor-recipient pairs in which the recipient and the donor were at least 25 years old and underwent surgery between 1997 and 2007. Of these pairs 31,597 (81%) underwent LRRT



LURT time trend, excluding spousal donors, as proportion of living donor renal transplants in United States from 1997 to 2007.

and 7,571 (19%) underwent LURT. The proportion of living donor renal transplant recipients with an unrelated donor exclusive of spousal pairs increased from 7% in 1997 to 26% in 2006 (see figure).

Recipients and donors involved in LURT pairs were older and more commonly white than LRRT recipients and donors (each  $p < 0.001$ ). LURT recipients and donors were more highly educated than LRRT recipients and donors ( $p < 0.001$ ). LURT recipients were more likely to have private insurance than LRRT recipients ( $p < 0.001$ ). A disproportionate number of LURT recipients had polycystic kidney disease as the etiology of renal failure (20% vs 11%,  $p < 0.001$ ). More unrelated recipients were transplanted preemptively or had a prior kidney transplant (each  $p < 0.001$ ). LURT pairs more commonly received transplant care at centers with greater laparoscopic donor nephrectomy availability and at high volume kidney transplant centers (each  $p < 0.001$ ).

Table 1 shows the results of our multivariate model of factors associated with LURT. Independent of other covariates middle-aged recipients (ages 40 to 59 years) had a higher likelihood of LURT than younger recipients (ages 25 to 39). Recipient female gender was associated with a higher likelihood of LURT than male gender. Compared with white recipients black, Hispanic and other race/ethnicity recipients had a statistically significant 18% to 25% lower likelihood of LURT. With all other variables held constant lower education was associated with a lower likelihood of LURT. Compared with recipients with Medicare as the primary payer those with Medicaid were less likely to undergo LURT. A history of renal transplantation was independently associated with LURT. Lastly care at transplant centers where laparoscopic donor nephrectomy was prioritized conferred a 26% increased likelihood of LURT compared

with other centers. Care at high volume centers was likewise associated with an increased likelihood of LURT independent of other covariates.

Table 2 shows donor and recipient education by donor-recipient relationship. More highly educated donors more commonly donated to more highly educated recipients regardless of the donor-recipient relationship. Of 10,305 LRRT donors who had attended some college 58% donated to recipients who had attended at least some college. Of 3,146 LURT donors who had attended some college 61% donated to recipients who had attended at least some college. Of 6,282 LRRT donors with at most a high school education 32% donated to recipients who had attended at least some college. Of 1,514 LURT donors with at most a high school education 42% donated to recipients who had attended at least some college.

Table 3 lists neighborhood SES characteristics. Unrelated recipients resided in higher SES neighborhoods than related recipients for all neighborhood categories. The mean neighborhood SESI was significantly higher among unrelated than related recipients. Similarly unrelated donors resided in

**Table 1.** Multivariate model of recipient and transplant center factors associated with LURT

	Relative Likelihood (95% CI)
<i>Recipient</i>	
Age (vs less than 40):	
40–49	1.17 (1.09–1.25)
50–59	1.20 (1.12–1.28)
60–69	1.04 (0.95–1.12)
70 or Greater	0.89 (0.74–1.04)
Female gender	1.06 (1.01–1.11)
Race/ethnicity (vs white):	
Black	0.77 (0.71–0.84)
Hispanic	0.75 (0.67–0.82)
Other	0.82 (0.71–0.94)
Education level (vs college):	
Less than high school	0.66 (0.54–0.77)
High school	0.78 (0.73–0.82)
Some college	0.88 (0.83–0.93)
Primary payer (vs Medicare):	
Private	0.95 (0.89–1.01)
Medicaid	0.80 (0.67–0.94)
Other	1.14 (0.97–1.31)
Previous transplantation	1.13 (1.04–1.23)
Dialysis type (vs hemodialysis):	
None or preemptive	1.03 (0.97–1.08)
Peritoneal dialysis	1.09 (1.01–1.18)
Comorbid disease:	
Coronary artery	0.92 (0.84–0.99)
Peripheral vascular	0.85 (0.73–0.96)
SESI	1.01 (1.00–1.02)
<i>Transplant center</i>	
High laparoscopy vol	1.26 (1.18–1.34)
Annual kidney transplant vol (vs 100 or greater)	
Less than 50	0.89 (0.82–0.95)
50–99	1.04 (0.99–1.10)

**Table 2.** Recipient and donor education level by donor-recipient relationship

	No. Recipient Education (%)			
	Less Than High School	High School	Some College	College Degree
<i>Related donor-recipient pairs</i>				
Overall	243 (2)	5,356 (36)	4,014 (27)	5,147 (35)
Donor education:				
Less than high school	64 (13)	119 (2)	36 (1)	24 (1)
High school	251 (52)	3,157 (50)	1,202 (31)	746 (18)
Some college	100 (21)	1,638 (26)	1,284 (34)	992 (24)
College degree	67 (14)	1,403 (22)	1,290 (34)	2,387 (57)
<i>Unrelated donor-recipient pairs</i>				
Overall	40 (1)	1,309 (31)	1,208 (29)	1,613 (39)
Donor education:				
Less than high school	8 (9)	15 (1)	8 (1)	9 (1)
High school	49 (54)	644 (43)	319 (30)	297 (19)
Some college	17 (19)	435 (29)	351 (33)	405 (27)
College degree	16 (18)	421 (28)	380 (36)	796 (53)

higher SES neighborhoods and had a higher mean neighborhood SESI than related donors.

Neighborhood SESI differences varied by the magnitude of the intimacy of the recipient-donor relationship. Recipients had a higher neighborhood SESI than donors in 52% of related recipient-donor pairs and in 53% of unrelated recipient-donor pairs ( $p = 0.03$ ). Between recipients and donors the SESI difference was greatest among the least intimately connected recipient-donor pair, that is unrelated donors of other/unknown relation (mean  $\pm$  SD  $0.27 \pm 3.35$  vs spousal pairs  $-0.01 \pm 1.48$ , vs other unrelated pairs  $-0.08 \pm 3.73$ , vs unrelated extended family  $0.06 \pm 3.61$  and vs unrelated colleague/friend donors  $0.23 \pm 3.74$ ). However, the mean neighborhood SESI for that group was higher than the national median for donors and recipients ( $0.37 \pm 3.51$  and  $0.64 \pm 3.67$ , respectively). Unrelated donors had a higher neighborhood SESI than nonspousal related donors ( $p < 0.001$ ).

## DISCUSSION

We identified several important factors that influence unrelated living donation. In 20% of the almost

40,000 living donor-recipient pairs that we studied the donor was unrelated to the recipient by first-degree biological relationship or marriage. LURT recipients were older and were more likely to be white and better educated, and to have availed themselves of private insurance than LRRT recipients. Our previous studies showed that transplant candidates with these characteristics are more likely to receive living rather than deceased donor transplants, possibly since these characteristics serve as proxies for access to care.<sup>10</sup> They may also serve as proxies for access to donors with similar educational and demographic characteristics. Indeed, unrelated living donors in this study were also older and more likely to be white and better educated than related donors. Formal education level may correlate with awareness of the benefits of living donation, which can affect the willingness to donate and receive a kidney.<sup>12</sup>

There are wide geographic and programmatic variations in related and unrelated living kidney donation in the United States and much of this variation is unexplained.<sup>5,13</sup> We noted that the recipients of unrelated pairs more commonly received a transplant at high volume centers where laparoscopic donor nephrectomy services are prioritized. We believe that several explanations underlie this observation. 1) All forms of living kidney donation are more likely to be done at centers that have invested in the professional and administrative infrastructure required to support live donor programs. This includes experience with minimally invasive surgery for the donor operation. 2) Individuals with higher educational background more likely have at their disposal information and financial means that provide access to high volume programs that prioritize laparoscopic donor nephrectomy. That more unrelated recipients underwent surgery at these centers likely reflects their higher SES and education. 3) High volume centers and centers with robust infrastructure to support live donor programs may aggressively pursue live donor options for recipient candidates beyond the immediate family.

**Table 3.** SES of residential neighborhood of living related and unrelated donors and recipients

Neighborhood	Mean $\pm$ SD Recipient*		Mean $\pm$ SD Donor		p Value
	Related	Unrelated	Related	Unrelated	
Median income (\$)	46,469 $\pm$ 17,679	48,321 $\pm$ 17,861	46,723 $\pm$ 17,531	47,397 $\pm$ 16,575	0.002
Median housing value (\$)	143,437 $\pm$ 105,071	150,976 $\pm$ 110,960	144,048 $\pm$ 104,714	146,340 $\pm$ 105,897	0.09
% Investment income	36.6 $\pm$ 13.5	38.7 $\pm$ 13.1	36.6 $\pm$ 13.4	38.1 $\pm$ 12.6	<0.001
% High school degree	29.0 $\pm$ 9.2	28.4 $\pm$ 9.5	28.7 $\pm$ 9.2	28.8 $\pm$ 9.3	0.22
% Completed college	15.7 $\pm$ 8.7	16.9 $\pm$ 9.0	16.0 $\pm$ 8.7	16.5 $\pm$ 8.6	<0.001
% Professional occupation	33.2 $\pm$ 11.8	34.8 $\pm$ 12.0	33.5 $\pm$ 11.8	34.1 $\pm$ 11.6	<0.001
SESI	0.03 $\pm$ 3.85	0.62 $\pm$ 3.74	0.10 $\pm$ 3.87	0.44 $\pm$ 3.63	<0.001

\*  $p < 0.001$ .

Medical factors also determine the likelihood of unrelated living donation. The disproportionate number of unrelated recipients with polycystic kidney disease reflects the autosomal dominant inheritance of this condition and the relative unavailability of biologically related donors. Recipients with polycystic kidney disease may have higher innate knowledge of live donor transplantation, given the familial nature of the disease, than recipients with acquired conditions such as diabetes mellitus. Preemptive transplantation (transplantation before the commencement of chronic dialysis), which is associated with improved patient and graft survival,<sup>14</sup> is less common among racial minorities, those with less education and those who must rely on Medicare for primary payment.<sup>10</sup> Thus, it is not surprising that we found a greater likelihood of LURT among preemptive transplant recipients. The increased incidence of LURT in patients who were previously transplanted may represent exhaustion of donor options in the immediate family. Those previously transplanted may be more cognizant of the option of unrelated transplantation.

The socioeconomic characteristics of our sample suggest that unrelated donors and recipients have an average higher SES than related donors and recipients. Education levels were higher among unrelated than related pairs. Although the neighborhood SESI difference between recipients and donors was greatest among the least intimately connected donor-recipient pairs, absolute recipient and donor SESIs were higher for unrelated recipients and donors than for related pairs. The SESI difference may initially raise concern regarding the potential for financial or other coercion among unrelated pairs but this margin likely reflects the greater geographic proximity of the neighborhoods of related pairs. LURT recipients and donors tended to live in neighborhood SESIs that were greater than the median in the United States.

Our study was limited by the comprehensiveness of our data source. Although we evaluated individual donor and recipient education levels, we could not assess individual recipient income. We attempted to evaluate SES beyond individual education level using an index of the SES characteristics

of donor and recipient ZIP Codes, which were valid in other data sets when individual SES indicators were unavailable.<sup>9,15</sup>

Also, our large sample size may have rendered statistically significant differences that may not be clinically meaningful. Although this may have confounded comparisons of individual SESI components, the magnitude of the difference between the SESI of LURT donors and recipients was substantial enough that we believe that our finding has clinical import. Furthermore, we cannot account for the myriad reasons that prospective recipients pursue living donor renal transplantation through related or unrelated donors, nor can we account for donor availability for prospective recipients.

Despite these limitations the steady increase in the number and proportion of live donor renal transplants in which the donor is unrelated to the recipient represents a largely unheralded success for American kidney transplant programs. In contrast to the socioeconomic features of unrelated donors in the developing world, unrelated donors in the United States have individual and neighborhood SES characteristics that are higher than their related counterparts. The safety of related and unrelated donors remains a paramount concern that has been largely but not totally assuaged by long-term followup data.<sup>6</sup>

## CONCLUSIONS

Our observations highlight potential opportunities to increase the number of living donor renal transplants. Measures to improve patient education about organ donation may help increase living donor renal transplantation. Our study shows that unrelated donors are more commonly used by patients with characteristics that are more common among recipients of living vs deceased donors and of those transplanted preemptively. Expanding unrelated donation to groups with a lower rate of live donor transplantation could help address disparities in the use of live donor allografts. The greater use of unrelated donation at larger centers underscores the need to better understand the resources required to promote the diverse forms of living donation.

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