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# Transplantation rates for living- but not deceased-donor kidneys vary with socioeconomic status in Australia

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**Socioeconomic disadvantage has been linked to reduced access to kidney transplantation. To understand and address potential barriers to transplantation, we used the Australia and New Zealand Dialysis and Transplant Registry and examined primary kidney-only transplantation among adult non-Indigenous patients who commenced chronic renal replacement therapy in Australia during 2000–2010. Socioeconomic status was derived from residential postcodes using standard indices. Among the 21,190 patients who commenced renal replacement therapy, 4105 received a kidney transplant (2058 from living donors (660 preemptive) or 2047 from deceased donors) by the end of 2010. Compared with the most socioeconomic disadvantaged quartile, patients from the most advantaged quartile were more likely to receive a preemptive transplant (relative rate 1.93), and more likely to receive a living-donor kidney (adjusted subhazard ratio 1.34) after commencing dialysis. Socioeconomic status was not associated with deceased-donor transplantation. Thus, the association between socioeconomic status and living- but not deceased-donor transplantation suggests that potential donors (rather than recipients) from disadvantaged areas may face barriers to donation. Although the deceased-donor organ allocation process appears essentially equitable, it differs between Australian states.**

*Kidney International* (2012) **83,** 138–145; doi:10.1038/ki.2012.304; published online 15 August 2012

KEYWORDS: competing risks; disadvantage; kidney transplantation; organ donation

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**Received 25 March 2012; revised 2 July 2012; accepted 6 July 2012; published online 15 August 2012**

Kidney transplantation provides the optimal survival[1,2] and quality of life[3] for patients with end-stage kidney disease. Socioeconomically disadvantaged patients have previously been found to be less likely to receive kidneys from both living[4–6] and deceased[7,8] donors in both the United States and the United Kingdom. Socioeconomic disparities in access to kidney transplantation have been found in high-income countries with universal health care,[9] including Italy[10] and the United Kingdom,[5] and in countries without universal health care, such as the United States.[4] However, this has not been investigated previously in Australia, a country with universal access to health care and a mix of public and private health-care providers. Separate investigations into preemptive, living-donor, and deceased-donor transplantation can highlight what disparities and barriers exist. Furthermore, most studies into socioeconomic status (SES) and access to transplantation have used standard proportional hazard models, with no allowance for competing risks such as death.

We investigated associations between SES and access to transplantation in Australia, with preemptive transplants, and live- and deceased-donor transplants considered separately, as well as potential confounders and covariates, using competing risk regression.

## RESULTS

In total, 21,190 patients were included in this study, of whom 4105 had received a kidney transplant in Australia by 31 December 2010. Among primary transplants, 2058 were from living donors and 2047 from deceased donors. The median age at commencement of renal replacement therapy (RRT) was 64 years, and 64% of patients had one or more comorbidities. Patients from disadvantaged areas were slightly younger, but had overall greater comorbidity at commencement of RRT compared with patients from advantaged areas (Table 1). Living-donor kidneys came from parents (25%), spouses (27%), other relatives (32%), and unrelated donors (16%), and these proportions did not change with SES ($\chi^2_9 = 8$, d.f. $= 9$, $P = 0.5$). Overall, 660 (3.2%) of incident patients received a preemptive transplant

**Table 1 | Patients who commenced RRT in Australia from 2000 to 2010**

| Factor | Quartile 1 (disadvantaged) | Quartile 2 | Quartile 3 | Quartile 4 (advantaged) | *P*-value |
|---|---|---|---|---|---|
| *N* | 3351 | 4213 | 6723 | 6568 | |
| Preemptive | 2.0% | 2.6% | 3.4% | 3.9% | <0.001 |
| Male | 62% | 61% | 62% | 63% | 0.5 |
| Caucasian | 86% | 90% | 88% | 86% | <0.001 |
| Major city | 50% | 50% | 74% | 95% | <0.001 |
| Age, median (IQR) | 64 (52–72) | 64 (52–73) | 64 (51–74) | 65 (52–75) | <0.001 |
| Cancer | 11% | 13% | 12% | 13% | <0.001 |
| Smoker | 56% | 55% | 52% | 48% | <0.001 |
| Chronic lung disease | 18% | 18% | 16% | 14% | <0.001 |
| Peripheral vascular disease | 30% | 26% | 27% | 22% | <0.001 |
| Cerebrovascular disease | 16% | 16% | 16% | 14% | 0.008 |
| Diabetes | 43% | 38% | 38% | 33% | <0.001 |
| Kidney disease: Glomerulonephritis | 21% | 20% | 20% | 22% | <0.001 |
| *Diabetic nephritis + hypertension* | 45% | 42% | 43% | 40% | |
| Polycystic | 6% | 8% | 7% | 8% | |
| Other | 28% | 30% | 30% | 30% | |
| eGFR, median (IQR) | 7.1 (5.5–9.7) | 7.3 (5.5–9.8) | 7.5 (5.5–10.0) | 7.5 (5.6–10.0) | <0.001 |
| Late referral | 24% | 24% | 24% | 22% | 0.02 |
| *BMI* | | | | | |
| Underweight | 2.4% | 3.6% | 3.4% | 4.3% | <0.001 |
| Normal weight | 33.4% | 34.1% | 36.3% | 40.5% | |
| Overweight | 34.5% | 32.2% | 33.4% | 32.7% | |
| Obese+ | 29.7% | 30.1% | 26.8% | 22.5% | |

Abbreviations: BMI, body mass index; eGFR, estimated glomerular filtration rate; IQR, interquartile range; RRT, renal replacement therapy.
Indigenous patients, those <18 years, and recipients of multiple organs were excluded. Postcodes were divided into quartiles using socioeconomic status (SES) scores. Comorbidities were known or suspected: chronic lung, coronary artery, diabetes, and peripheral and cerebrovascular diseases, and eGFR was calculated using the four-variable Modification of Diet in Renal Disease (MDRD) formula.[45] Smoking status (former or current) was at commencement of RRT, and late referral was defined as being referred to a nephrologist <3 months before commencing RRT.

(that is, before any dialysis), and this was more common among patients from advantaged areas. The relative rate (RR) for the most advantaged versus most disadvantaged quartile was 1.93 (95% confidence interval (CI) 1.39–2.68; $P<0.001$; Figure 1). All preemptively transplanted kidneys were from living donors. Waiting time for primary living-donor grafts was much less than for deceased-donor grafts (Figure 2). Patients from the most advantaged quartile were less likely to be referred late to nephrological care (Table 1). The measure of SES used reflects a range of factors including income, education, employment type, and access to information (Figure 3).

Patients from advantaged postcodes were more likely to receive a non-preemptive transplant from a living donor. The competing risk subhazard ratio (SHR) for the most advantaged when compared with the most disadvantaged quartile of postcodes was 1.34 (95% CI 1.11–1.62, $P=0.002$; Figure 2). Conversely, SES was not associated with the likelihood of receiving a deceased-donor kidney (SHR = 0.99; 95% CI 0.86–1.14; $P=0.4$; Figure 2). Adjusting for patient age, demographics, various indicators of health, and late referral made little difference to the effects of SES within competing risk models. Cox models suggested larger associations between SES and deceased-donor transplantation than competing risk models, although both models led to similar conclusions (Table 2). There was some association between race and SES among non-Indigenous RRT patients—the proportion of Caucasian patients was highest in the second and third quartiles, but there was no overall trend when analyzed with SES quartiles as a continuous variable ($\chi^2_3=0.5$, $P=0.5$).

For completeness, we repeated all analyses with Indigenous Australians included, and found that this made very little difference to associations between SES and transplantation. Similarly, including each comorbidity as a separate covariate made no discernible difference to the results.

**Patient demographics, health, and gender**

Advanced age, presence of comorbidities, type of primary kidney disease, and smoking status were all associated with decreased likelihood of receiving any type of kidney graft ($P<0.002$, Figure 4). SES had a marginally larger effect on patients aged 18–39 years at commencement of RRT rather than older patients, who were unlikely to receive a preemptive transplant regardless of SES ($\chi^2_2=5$, $P=0.08$ for the age category: SES interaction; Figure 1).

Patients with comorbidities were considerably less likely to receive any type of transplant (Figure 4). There were no significant interactions between SES and comorbidity burden, race, remoteness, state, previously diagnosed cancer, or body mass index category on the likelihood of receiving a preemptive transplant ($P>0.2$).

There was no gender disparity in access to preemptive transplants ($P=0.9$, Figure 4). Males were more likely to receive a non-preemptive transplant with a living-donor kidney (RR = 1.22, 95% CI 1.09–1.37; $P<0.0007$) or a