**Inequity in Access to Transplantation in the United Kingdom**

**Running Title:** Inequity in Access to Transplantation

Rishi Pruthi PhD1,2, Matthew L Robb PhD3, Gabriel C. Oniscu MD4, Charles Tomson DM5, Andrew Bradley PhD6, John L. Forsythe MD4, Wendy Metcalfe MD4, Clare Bradley PhD7, Christopher Dudley MD8, Rachel J Johnson MSc3, Christopher Watson MD6, Heather Draper PhD9, Damian Fogarty MD10, \*Rommel Ravanan MD8, \*Paul J. Roderick MD2. On Behalf of the ATTOM Investigators

1. Guy's and St Thomas’ NHS Foundation Trust, London, SE1 9RT, UK
2. Primary Care and Population Sciences, Faculty of Medicine, University of Southampton, SO17 1BJ, UK
3. NHS Blood and Transplant, Bristol, BS34 7QH, UK
4. Edinburgh Transplant Centre, Royal Infirmary of Edinburgh, Edinburgh, EH16 4SA, UK
5. Renal Unit, Freeman Hospital, Newcastle, NE7 7DN, UK
6. Department of Surgery, University of Cambridge and the NIHR Cambridge Biomedical Research Centre, Cambridge, CB2 0QQ, UK
7. Health Psychology Research Unit, Royal Holloway, University of London, Egham, TW20 0EX, UK
8. Richard Bright Renal Unit, Southmead Hospital, Bristol, BS10 5NB, UK
9. Department of Social Science and Systems in Health, University of Warwick, Coventry, United Kingdom
10. Belfast Health and Social Care Trust, Belfast, Northern Ireland, BT9 7ABUK

\*denotes joint final author

**Corresponding author:**

Rishi Pruthi,

Consultant Nephrologist,

Guy’s Hospital, London SE1 9RT

Tel: 020 7188 7188

Email: [rishi.pruthi@nhs.net](mailto:rishi.pruthi@nhs.net)

Word Count: 3454

**Abstract**

**Background and objectives:** Despite the presence of a universal healthcare system it is unclear if there is inter-centre variation in access to kidney transplantation in the UK. This study aims to assess whether equity exists in access to kidney transplantation in the UK after adjustment for patient specific factors and centre practice patterns.

**Design, setting, participants, and measurements:** Prospective observational cohort study including all 71 UK kidney centres. Incident kidney replacement therapy (KRT) patients recruited between November 2011-March 2013 as part of the Access to Transplantation and Transplant Outcome Measures study (ATTOM) were analysed to assess pre-emptive listing (n=2676) and listing within 2 years of starting dialysis (n=1970) by centre.

**Results:** Seven hundred and six participants (26%) were listed preemptively, whereas 585 (30%) were listed within 2 years of commencing dialysis. The interquartile range across centers was 6%–33% for preemptive listing and 25%–40% for listing after starting dialysis. Patient factors, including increasing age, most comorbidities, body mass index >35 kg/m2, and lower socioeconomic status, were associated with a lower likelihood of being listed and accounted for 89% and 97% of measured intercenter variation for preemptive listing and listing within 2 years of starting dialysis, respectively. Asian (odds ratio, 0.49; 95% confidence interval, 0.33 to 0.72) and Black (odds ratio, 0.43; 95% confidence interval, 0.26 to 0.71) participants were both associated with reduced access to preemptive listing; however Asian participants were associated with a higher likelihood of being listed after starting dialysis (odds ratio, 1.42; 95% confidence interval, 1.12 to 1.79). As for center factors, being registered at a transplanting center (odds ratio, 3.1; 95% confidence interval, 2.36 to 4.07) and a universal approach to discussing transplantation (odds ratio, 1.4; 95% confidence interval, 1.08 to 1.78) were associated with higher preemptive listing, whereas using a written protocol was associated negatively with listing within 2 years of starting dialysis (odds ratio, 0.7; 95% confidence interval, 0.58 to 0.9).

**Conclusions:** Patient case-mix accounts for most of the inter-centre variation seen in access to transplantation in the UK with practice patterns also contributing some variation. Socioeconomic inequity exists despite having a universal healthcare system.

**Introduction**

In the UK, it is expected that 2.6 million adults are living with CKD stage 3-51, with over sixty-three thousand patients receiving renal replacement therapy (RRT) for end-stage kidney disease (ESKD)2. Rates of RRT have risen in most high income countries in the last few decades (including the UK)3,4 and are greater in lower socioeconomic groups5,6 and in ethnic minorities5,7. Though many undergo dialysis, it is recognized that for ‘suitable patients’ with ESKD, kidney transplantation confers both better clinical outcomes compared to dialysis8,9, and leads to improvements in self-reported health10, and is therefore the preferred RRT modality.

The UK National Health Service was founded on the principle of delivering equitable healthcare based on need and not the ability to pay and was ranked first on equity in a recent international healthcare comparison11. Equity is a key consideration for assessing the pathway to kidney transplantation for patients with ESKD. Achieving prompt assessment and timely activation on the transplant waiting list is crucial to accessing transplantation. Increasing length of time on dialysis adversely affects graft and patient survival12, and deceased donor organ allocation algorithms in many countries (including the UK) give priority to those who have spent greater time on the waiting list.

Despite national clinical practice guidelines for transplant assessment, retrospective analyses of UK Renal and Transplant Registries data suggest there is variation in access to listing for transplantation between kidney centres13-15; and that although ethnic minorities and individuals from lower socioeconomic groups have a higher incidence of ESKD5-7, they have reduced access to transplantation14-17. It is not known whether this difference is due to a higher burden of co-morbidity associated with ethnic minority status or lower socioeconomic status, or due to differences in centre practices that might disadvantage these groups14. Studies to date have been limited in their ability to examine these factors due to their retrospective design and use of routine and limited registry data.

This study uses a prospective cohort of patients starting RRT recruited to the Access to Transplantation and Transplant Outcome Measures (ATTOM) study18 to determine (i) if access to pre-emptive listing (being listed before starting dialysis) and to listing within 2 years of starting dialysis, is equitable for socially deprived and ethnic minority populations in the UK after morbidity adjustment; and ii) whether centre-specific factors are associated with access to transplant listing.

**Methods**

Study Population

In the UK there are 71 kidney centres (23 transplanting and 48 non-transplanting centres) which collectively provide RRT for all patients in the UK as well as managing all patients approaching ESKD. In each centre, over a 12-month period, between 1 November 2011 and 31 March 2013 all incident dialysis patients and incident kidney transplant recipients aged 18-75 years of age were recruited at the time of starting dialysis or transplantation as part of the ATTOM Study. ATTOM is a national prospective cohort study investigating the factors that influence access, clinical and patient-reported outcomes and cost-effectiveness of kidney transplantation in the UK. Dedicated research nurses collected clinical and demographic information from the case notes and local electronic databases, and collected health status and well-being data from participants. The data were uploaded onto a secure website designed, developed and maintained by the UK Renal Registry (UKRR). A full description of the ATTOM study methods and protocol has been reported previously18.

For the analysis of access to pre-emptive listing all incident dialysis participants (n=2623) and all incident transplant participants with a pre-emptive transplant (n=431) recruited to ATTOM were considered for inclusion (Figure 1). Participants excluded were those with a previous transplant (n=251), those listed for multi-organ transplantation (n=4), those who recovered kidney function (n=25) and those that could not be linked to the UKRR/NHS Blood and Transplant (NHSBT) database (n=6). Lastly, participants who were suspended from the waiting list for > 30 days within 90 days of first activation (n=92) were also excluded to avoid any potential bias from centres that may activate patients on the transplant list and then immediately suspend them before more permanent activation at a later date after more formal medical assessment of the patient’s suitability.

For analysis of access to the transplant waiting list within 2 years of starting dialysis, all incident dialysis participants that were not pre-emptively listed i.e. who were not listed before starting dialysis were considered (n=2348) using the same exclusion criteria (Figure 1).

Data collection

Patient variables

Demographic, socioeconomic, clinical and comorbidity data were collected for each patient at the time of recruitment. Trained research nurses collected uniformly defined data items from patient interviews, case notes and local electronic patient information systems across the UK. Patient variables collected and analysed included, age, gender, ethnicity, BMI, co-morbidities and primary renal diagnosis. Several measures of socioeconomic status were also explored including: education status, employment status, accommodation and car ownership. Civil status, number of children in household, number of adults in household and total numbers in household were other measures. Other demographic data collected and explored included place of birth, whether English was their first language, whether any assistance was needed with reading, the length of time a patient was known to kidney services pre RRT and in the case of listing after starting dialysis, their dialysis modality. Full details of how these variables were categorized can be found in Appendix S1.

Centre Variables

Thematic analysis of 45 semi-structured qualitative interviews with key stakeholders and 53 patients conducted across 9 kidney centres in the UK informed the development of an online survey, which was distributed to the Clinical Directors of all 71 UK kidney centres19. This survey achieved a 100% response rate and was utilized to derive and quantify centre variables for analysis in this study. Centre variables examined were chosen by study investigators who examined the level of variance across centre responses for each potential variable and took into account the ability to readily categorize them. A full list of centre variables chosen for analysis can be found in Appendix S1.

Outcomes

Date of activation on the waiting list and, where applicable, the date of transplantation, were extracted from the UK Transplant Registry held by the Organ Donation and Transplantation Directorate of NHS Blood and Transplant. Date of death was retrieved from the UKRR database and the Scottish Renal Registry (SRR).

Statistical methods

For access to pre-emptive listing a multi-level logistic regression model was constructed to analyse the association of patient variables (level 1) and centre factors (level 2). Individual participants (Level 1) were nested within kidney centres (Level 2) to allow for clustering of participants within centres. Analysis of each patient-level factor was adjusted for all other patient-level factors and analysis of each centre factor was adjusted for those patient-level factors found to be associated with pre-emptive listing. The difference in -2\*log-likelihood was used to compare model fit between nested models. The overall effect of centre in the analysis was considered by including kidney centre as a random effect. A significance level of <0.05 was taken as evidence of a significant association.

For access to the transplant waiting list within 2 years of starting dialysis, time to listing was analysed using a multi-level Cox proportional hazards regression model. The time to listing was taken to be the time from start of dialysis to activation on the kidney transplant list. Participants were censored at 2 years or at patient death. Statistical significance was defined a priori as p<0.05. Proportional hazards assumptions were tested using Schoenfeld residuals. The presence of an overall kidney centre effect was considered using a frailty term whilst death was also considered as a competing risk using a Fine and Gray model in a separate competing risk analysis.

Multiple imputation was used to account for missing data in each analysis. For access to preemptive listing, data were missing for BMI (n=243), comorbidity (n= 30), time since first seen by a nephrologist (n=24) and socioeconomic variables (n=146). For access to listing after starting dialysis, data were missing for BMI (n=220), comorbidity (n=22) and socioeconomic variables (n=104). No participants were lost to follow up. Sensitivity analysis using complete case analysis did not change conclusions.

All data were analysed using SAS 9.4 (SAS Institute, Cary, NC, USA).

**Results**

The baseline characteristics of participants analysed for pre-emptive listing and listing within 2 years of starting dialysis are shown in Table 1. For pre-emptive listing,

2676 participants were analysed following exclusion of 378 participants (12%), see methods. This study cohort had a median age of 57 years (interquartile range 45-66), of which 64% were male, 81% reported their ethnicity as White and diabetes was the most prevalent comorbidity (39%). Amongst socio-demographic factors, 54% of participants reported owning their own home with 69% owning their own car.

As for listing within 2 years of starting dialysis, of 2348 eligible participants, 1970 participants were analysed following exclusion of 378 patients (16%), see methods. The median age of this cohort was 58 years (interquartile range 47-67 years), of which 65% were male, 80% reported their ethnicity as White and 45% had diabetes listed as a co-morbidity. Amongst socio-demographic factors, 49% of participants reported owning their own home whilst 16% of participants reported being in employment. Full details of these baseline characteristics are shown in Table 1.

Access to Pre-emptive Listing

Of 2676 participants, 706 participants (26%) were pre-emptively listed with a mean age of 49 years. The IQR across centres was 6%-33%. An unadjusted funnel plot showing centre variation in the percentage of participants pre-emptively listed is shown in Figure 2a. Associations between patient and centre variables and the likelihood of being pre-emptively listed were characterized using univariable (Appendix S2 & S3) and multivariable (Appendix S4) logistic regression; before proceeding to analyse them in a final multivariable logistic regression including imputed missing data (table 2).

Several patient factors were independently associated with reduced access to pre-emptive listing. These included: increasing age, ethnicity (both Asian and Black participants), most co-morbidities, having a BMI of >35, and not being seen by a nephrologist for at least 12 months before starting RRT. Lower socioeconomic status as indicated by housing tenure and car ownership status was also associated with reduced access.

Three centre level factors were negatively associated with pre-emptive listing: being cared for primarily in a non-transplanting centre, having <6 Whole Time Equivalent (WTE) consultant nephrologists in the centre, and not adopting an approach where transplantation is discussed with all patients. The impact on centre variation of adjusting for these centre factors, along with patient factors, is shown in figure 2(b). Whilst inter-centre variation in pre-emptive listing significantly reduced following the addition of centre as a random effect to the model there was still evidence of variation/unaccounted confounding (p=0.0007 1 df). Of the 1020.9 (2679.2-1658.3) difference in -2logL between the null model and model with patient and centre variables, 89% (907) of the difference was observed when including the patient factors only (Appendix S5).

Access to the Transplant Waiting List After Starting Dialysis

Of 1970 participants included in this analysis, 585 (30%) were listed within 2 years of starting dialysis with a mean age of 49 years. The IQR across centres was 25%-40%. Associations between patient and centre variables and the likelihood of being listed after starting dialysis were characterized using univariable (Appendix S6 & S7) and multivariable (Appendix S8) Cox regression; before proceeding to analyse them in a final multivariable Cox proportional hazards regression model including imputed missing data (table 3).

Several patient factors were independently associated with reduced access to listing after starting dialysis. These included: increasing age, female gender, having vascular disease, heart failure, type II diabetes, the presence of blood borne viruses, a previous history of malignancy, being a current smoker, and having a BMI >35.

As with pre-emptive listing, lower socioeconomic status was associated with reduced access to listing after starting dialysis. Living in rented/housing association accommodation, lack of car ownership, and being long term sick/disabled or being retired from paid work, as compared to being in full time/part time employment, were all negatively associated with being listed within 2 years of starting dialysis. In contrast, having a university degree, being on Peritoneal Dialysis as opposed to Haemodialysis, and Asian ethnicity were all associated with an higher likelihood of being listed.

Amongst centre practice patterns, having >6 consultant nephrologists in the centre (OR 1.3 CI: 1.00-1.59) was associated positively with being listed within 2 years of starting dialysis as was having a multidisciplinary team (MDT) approach to listing all patients for transplantation (OR 1.2 CI: 0.99-1.52). An MDT approach was defined as having a multi-disciplinary team of physicians, surgeons and other allied health care professionals who regularly convened to discuss patients under consideration for transplant listing before activation.

Utilisation of a written protocol for listing patients for transplantation (OR 0.7 CI: 0.58-0.90) was negatively associated with being listed within 2 years of starting dialysis. Of the (7166.2-6566.8) 599.4 difference in -2logL between the null model and model with patient and centre variables, 97% (583.8) of the difference was observed when including the patient factors only (Appendix S9). After adjusting centre factors along with patient factors though much of the observed inter-centre variation from unadjusted analyses was again reduced there was still evidence of a difference between the centres (p=0.041, 1df).

Interactions and Competing Risk Analysis

When considering age as a linear factor, an interaction with type 2 diabetes was found to be important in the model (p=0.002, 1df). The association between increasing age and time to listing was stronger in participants with type 2 diabetes (data not shown). As for the competing risk analysis, sub-hazard ratios derived did not highlight any significant differences.

**Discussion**

This national prospective cohort study of patients aged <75 years starting RRT in the UK found significant variation between kidney centres in access to pre-emptive listing for kidney transplantation and listing after starting dialysis. This was largely explained by patient case-mix factors though some centre level effects were also found to be important. There was evidence of socioeconomic inequity in both measures of listing, despite extensive comorbidity adjustment; ethnic minority associations were inconsistent and inequity was only seen for pre-emptive listing.

Strengths and Limitations

The main strengths of this study are its prospective cohort design, national representativeness and high levels of data completeness (especially for socioeconomic status and co-morbidity) which meant that it was not subject to the inherent weaknesses of retrospective studies that have affected studies exploring access to transplantation to date. As for limitations, this study was observational so causal relationships cannot be determined. There was also no adjustment for comorbidity severity, or for pre transplant work-up. In the case of access to pre-emptive listing, analyses could not take into account all those patients who had CKD 5 or who were approaching the need for dialysis and were being worked up for listing, as these patients were not recruited as part of ATTOM. There may also be residual confounding factors not accounted for, as suggested by the persistence of a centre effect in the final models.

Comparison with Other Studies and Implications on Health Policy

Lower socioeconomic status was independently associated with both lower pre-emptive transplant listing and a lower likelihood of being listed after starting dialysis, even after extensive adjustment for demographic factors and comorbidity. Though this observation could arise in part from residual confounding by comorbidity due to lack of data on disease severity, this inequity is consistent with multiple studies in the US and the UK which have highlighted reduced access to the transplant waiting list in socially deprived patients14,20. Similarly, several studies around the world have also shown that socioeconomically deprived individuals are less likely to undergo pre-emptive transplantation21,22, though this has never been reported in the UK to date. As for potential explanations, studies, primarily in the US, have suggested that socially deprived patients may not appreciate the advantages of kidney transplantation and may be less likely to complete the pre-transplant work up20. Additionally, clinicians may consciously or subconsciously manage patients in ways that make it less likely for socially deprived patients to be listed for transplantation23. Another possible reason may be lower levels of health literacy amongst patients of lower socioeconomic status. This hypothesis is supported by studies from the US and UK24,25 and may represent an area for targeted interventions to reduce inequity caused by social deprivation.

As for the association of ethnicity and the transplant pathway, this was seen to vary by measure; both Asian and Black participants being less likely to be pre-emptively listed as compared to white participants; but Asian ethnicity was associated with an higher likelihood of being listed after starting dialysis. Other studies have also found conflicting associations in terms of ethnicity. Many studies in the US16,17,20,23 and UK14,15 have reported that ethnic minorities have decreased access to the transplant waiting list, whilst other studies have reported equal access26. One explanation for differing historical outcomes may be that previous studies reporting that ethnic minorities having reduced access to listing may have been confounded, by combining and analysing pre-emptive listing and listing after starting dialysis together; whilst in the present study they were treated independently. It is also possible that the lower likelihood of pre-emptive listing in ethnic minorities is partly a reflection of their lower rates of live donor transplantation, found in both the US and in the UK27. Institutional prejudice, distrust and reluctance to engage with the medical system, cultural and religious beliefs, and lack of suitable donors or concern over a higher risk for living donors from minority ethnic backgrounds have all been cited as possible reasons for these disparities28-31. Further research is clearly needed to understand potential reasons.

In contrast the reasons for the observation that Asian participants had an higher likelihood of being listed once starting dialysis are unclear. Likewise, the reasons for the observation that female gender was negatively associated with listing after starting dialysis but not pre-emptive listing is uncertain; it is revealed by analyzing these cohorts separately rather than combining them as in studies to date, and may be due to chance.

Whilst patient case-mix was seen to account for the majority of inter-centre variation, some centre practice patterns were also seen to be associated with being listed. Being registered at a transplanting centre was associated with an increase in pre-emptive listing but not post-dialysis listing. This has been described in previous retrospective studies24-25, and may reflect more efficient listing processes in transplanting centres as a consequence of having access to on-site specialist clinicians to assist in assessing suitability; and to on-site live donor co-ordinators to aid earlier identification of potential living donors.

The observation that a critical mass of consultant nephrologist availability (> 6 consultant nephrologists) was independently associated with a higher likelihood of listing also suggests a direct link between improved quality of patient care (i.e. early wait-listing) and senior workforce capacity. Whilst we are not able to clarify why this may be the case, a possible explanation is the ability to embed sub-specialist interest in transplantation and/or CKD pathway progress which may be more likely in larger units.

The finding that discussing transplantation with all patients and not utilising a written protocol both improve listing is intriguing and has not been reported before. An inclusive approach to discussion about transplantation is likely to help eliminate personal bias and assist in a more patient-centred approach that may result in more open conversation, as well as aid in the early identification of potential live donors. Likewise, clinicians at centres not using a written protocol (i.e. centres which do not list patients using defined criteria as part of a in house centre protocol), might benefit from listing more patients due to the ability to exercise more flexibility and their own personal clinical judgment which would otherwise be hampered by restrictions imposed by local guidelines.

Conclusions

This study has shown that patient case-mix and, to a lesser extent, centre practice patterns account for the majority of observed inter-centre variation in access to pre-emptive listing and listing after starting dialysis in the UK. However, socioeconomic inequity exists in access to kidney transplantation in the UK despite the existence of a universal healthcare system. Further research is needed to understand the causal pathways between socioeconomic status and listing for transplantation including the role of health literacy in influencing access to transplantation to reduce inequity.

**Disclosures**

None

**Acknowledgments**

This article presents independent research funded by the National Institute for Health Research (NIHR) under the Programme Grants for Applied Research scheme (RP-PG-0109-10116). The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health. Ethical approval for this study was obtained from the NHS/HSC Research Ethics Committee via Cambridgeshire Central REC (Ref:11/EE/0120), and all data were collected and stored in keeping with the requirements of the UK Data Protection Act 1998.

**Supplementary Material Table of Contents**

1. Categorization of patient and centre variables in analyses for pre-emptive listing and listing after starting dialysis
2. Univariate logistic regression for patient level effects on pre-emptive listing
3. Univariate logistic regression for centre level effects on pre-emptive listing/transplantation, adjusting for patient level factors
4. Multivariable logistic regression model for the probability of being pre-emptively listed adjusting for both patient and centre factors
5. Univariate Cox proportional hazard model for patient level effects on time to listing within 2 years of starting dialysis
6. Univariate Cox proportional hazard models for centre level effects on listing within 2 years of starting dialysis, adjusting for patient level factors
7. Multivariable Cox proportional hazards model for the probability of being listed within 2 years of starting dialysis adjusting for both patient and centre factors

**References**

1. <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/612303/ChronickidneydiseaseCKDprevalencemodelbriefing.pdf>
2. MacNeill SJ, Ford D, Evans K, Medcalf JF. Chapter 2 UK Renal Replacement Therapy Adult Prevalence in 2016: National and Centre-specific Analyses. Nephron. 2018;139 Suppl 1:47-74. doi: 10.1159/000490960
3. Gilg J, Methven S, Casula A, Castledine C. UK Renal Registry 19th Annual Report: Chapter 1 UK RRT Adult Incidence in 2015: National and Centre-specific Analyses. Nephron. 2017;137 Suppl 1:11-44. doi: 10.1159/000481363.
4. United States Renal Data System. 2017 USRDS annual data report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2017.
5. Volkova N, McClellan W, Klein M, et al. Neighbourhood poverty and racial differences in ESRD incidence. J Am Soc Nephol 2008;19(2):356-64
6. Ward MM. Socioeconmic status and the incidence of ESRD. Am J Kidney Dis 2008;51(4):563-72.
7. Roderick PJ, Raleigh VS, Hallam L, Mallick NP. The need and demand for renal replacement therapy in ethnic minorities in England. Journal of Epidemiology and Community Health. 1996;50(3):334-339.
8. Wolfe RA, Ashby VB, Milford EL*, et al.* Comparison of mortality in all patients on dialysis, patients on dialysis awaiting transplantation, and recipients of a first cadaveric transplant. *N Engl J Med* 1999; 341: 1725-1730.
9. Oniscu GC, Brown H, Forsythe JL. Impact of cadaveric renal transplantation on survival in patients listed for transplantation. *J Am Soc Nephrol* 2005; 16: 1859-1865.
10. Neipp M, Karavul B, Jackobs S*, et al.* Quality of life in adult transplant recipients more than 15 years after kidney transplantation. *Transplantation* 2006; 81: 1640-1644.
11. <https://www.commonwealthfund.org/publications/fund-reports/2017/jul/mirror-mirror-2017-international-comparison-reflects-flaws-and>
12. Meier-Kriesche HU, Kaplan B. Waiting time on dialysis as the strongest modifiable risk factor for renal transplant outcomes: a paired donor kidney analysis. Transplantation.2002;74:1377-1381.
13. Taylor D, Robb M, Casula A, Caskey F. UK Renal Registry 19th Annual Report: Chapter 11 Centre Variation in Access to Kidney Transplantation (2010-2015). Nephron 2017;137(suppl 1):259-268. doi: 10.1159/000481373
14. Oniscu GC, Schalkwijk AA, Johnson RJ, Brown H, Forsythe JL. Equity of access to renal transplant waiting list and renal transplantation in Scotland: cohort study. BMJ2003;327:1261.
15. Ravanan R, Udayaraj U, Ansell D, et al. Variation between centres in access to renal transplantation in UK: longitudinal cohort study. BMJ. 2010 Jul 20;341:c3451. doi: 10.1136/bmj.c3451.
16. Kasiske BL, London W, Ellison MD. Race and socioeconomic factors influencing early placement on the kidney transplant waiting list. J Am soc Nephrol 1998;9(11):2142-7.
17. Yeates KE, Schaubel DE, Cass A, Sequist TD, Ayanian JZ. Access to renal transplantation for minority patients with ESRD in Canada. Am J Kidney Dis 2004;44(6):1083-9.
18. Oniscu GC, Ravanan R, Wu D, et al. Access to Transplantation and Transplant Outcome Measures (ATTOM): study protocol of a UK wide, in-depth, prospective cohort analysis. BMJ Open. 2016;6(2):e010377. doi:10.1136/bmjopen-2015-010377.
19. Pruthi R, Tonkin-Crine S, Calestani M, et al. Variation in Practice Patterns for Listing Patients for Renal Transplantation in the United Kingdom: A National Survey. Transplantation. 2018 Jun;102(6):961-968. doi: 10.1097/TP.0000000000002046.
20. Alexander GC, Sehgal AR. Barriers to cadaveric transplantation among blacks, women and the poor. JAMA 1998;280(13):1148-52.
21. Grams ME, Chen BP, Coresh J, Segev DL. Preemptive deceased donor kidney transplantation: considerations of equity and utility. Clin J Am Soc Nephrol. 2013 Apr;8(4):575-82.
22. Riffaut N, Lobbedez T, Hazzan M, et al. Access to preemptive registration on the waiting list for renal transplantation: a hierarchical modeling approach. Transpl Int. 2015 Sep;28(9):1066-73.
23. Navaneethan SD, Singh S. A systematic review of barriers in access to renal transplantation among African Americans in the United States. Clin Transplant 2006;20(6):769-75.
24. Taylor DM, Bradley JA, Bradley C, et al. Limited health literacy in advanced kidney disease. Kidney Int. 2016 Sep;90(3):685-95. doi: 10.1016/j.kint.2016.05.033.
25. V. Grubbs, S.E. Gregorich, E.J. Perez-Stable, C.Y. Hsu. Health literacy and access to kidney transplantation. Clin J Am Soc Nephrol, 4 (2009), pp. 195-200.
26. Jeffrey RF, Woodrow G, Mahler J, Johnson R, Newstead CG. Indo-asian experience of renal transplantation in Yorkshire: results of a 10 year survey. Transplantation 2002;73(10):1652-7.
27. Udayaraj U, Ben-Shlomo Y, Roderick P, et al. Social deprivation, ethnicity, and uptake of living kidney donor transplantation in the United Kingdom. Transplantation. 2012 Mar 27;93(6):610-6.
28. Norris KC, Agodoa LY. Unraveling the racial disparities associated with kidney disease. Kidney Int. 2005 Sep;68(3):914-24.
29. Boulware LE, Cooper LA, Ratner LE, LaVeist TA, Powe NR. Race and trust in the health care system. Public Health Rep 2003;118(4):358-65.
30. Bratton C, Chavin K, Baliga P. Racial disparities in organ donation and why. Current opinion in organ transplantation 2011;16(2):243-9.
31. Doshi M, Garg AX, Gibney E, Parikh C. Race and renal function early after live kidney donation: an analysis of the United States Organ Procurement and Transplantation Network Database. Clin Transplant 2010;24(5):E153-7.

**Table 1:** Baseline characteristics of participants in the Access to Transplantation and Transplant Outcome Measures study, United Kingdom, analysed for access to pre-emptive kidney transplant listing and kidney transplant listing within two years of starting dialysis

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variable** | **Access to Pre-emptive Listing** | |  | **Access to Listing within 2 years of Starting Dialysis** | |
| **Total N (%)** | **Number Pre-emptively listed N (%)** |  | **Total N (%)** | **Number Listed within 2 years of starting Dialysis N, (%)** |
| **Age (Mean, (SD))** | 55 (13.6) | 49 (12.9) |  | 57 (13) | 49 (14) |
| **Gender** |  |  |  |  |  |
| Male | 1706 (64) | 421 (60) |  | 1285 (65) | 406 (69) |
| Female | 970 (36) | 285 (40) |  | 685 (35) | 179 (31) |
| **Ethnic Group** |  |  |  |  |  |
| White | 2177 (81) | 611 (87) |  | 1566 (80) | 416 (71) |
| Asian | 293 (11) | 60 (8) |  | 233 (12) | 103 (18) |
| Black | 177 (7) | 31 (4) |  | 146 (7) | 54 (9) |
| Other | 29 (1) | 4 (1) |  | 25 (1) | 12 (2) |
| **Primary Renal Disease** |  |  |  |  |  |
| Diabetes | 711 (28) | 112 (16) |  | 599 (30) | 119 (20) |
| Glomerulonephritis | 428 (16) | 148 (21) |  | 280 (14) | 142 (24) |
| Hypertension | 171 (6) | 40 (6) |  | 131 (7) | 50 (9) |
| Missing | 30 (1) | 10 (1) |  | 20 (1) | 14 (2) |
| Other | 388 (15) | 88 (13) |  | 300 (15) | 75 (13) |
| Polycystic | 249 (9) | 135 (19) |  | 114 (6) | 56 (10) |
| Pyelonephritis | 221 (8) | 91 (13) |  | 130 (7) | 31 (5) |
| Renal vascular disease | 95 (4) | 12 (2) |  | 83 (4) | 9 (2) |
| Uncertain | 383 (14) | 70 (10) |  | 313 (16) | 89 (15) |
| **BMI** |  |  |  |  |  |
| Less than 20 | 165 (6) | 40 (6) |  | 125 (6) | 41 (7) |
| 20 - <25 | 729 (27) | 232 (33) |  | 497 (25) | 195 (33) |
| 25 - <30 | 771 (29) | 274 (39) |  | 497 (25) | 186 (32) |
| 30 - <35 | 435 (16) | 107 (15) |  | 328 (17) | 91 (16) |
| 35 - <40 | 202 (8) | 24 (3) |  | 178 (9) | 34 (6) |
| ≥ 40 | 131 (5) | 6 (1) |  | 125 (6) | 8 (1) |
| Missing | 243 (9) | 23 (3) |  | 220 (11) | 30 (5) |
| **Diabetes** |  |  |  |  |  |
| No | 1614 (60) | 552 (78) |  | 1065 (54) | 398 (68) |
| Type 1 | 256 (10) | 80 (11) |  | 176 (9) | 60 (10) |
| Type 2 | 776 (29) | 67 (10) |  | 709 (36) | 115 (20) |
| Missing | 27 (1.0) | 7 (1) |  | 20 (1) | 12 (2) |
| **Heart Disease** |  |  |  |  |  |
| No | 2159 (81) | 650 (92) |  | 1509 (77) | 508 (87) |
| Yes | 488 (18) | 48 (7) |  | 440 (22) | 63 (11) |
| Missing | 29 (1) | 8 (1) |  | 21 (1) | 14 (2) |
| **Heart Failure** |  |  |  |  |  |
| No | 2467 (92) | 691 (98) |  | 1776 (90) | 551 (94) |
| Yes | 178 (7) | 7 (1) |  | 171 (9) | 18 (3) |
| Missing | 31 (1) | 8 (1) |  | 23 (1) | 16 (3) |
| **Atrial Fibrillation** |  |  |  |  |  |
| No | 2547 (95) | 687 (97) |  | 1860 (94) | 559 (96) |
| Yes | 97 (4) | 11 (2) |  | 86 (4) | 10 (2) |
| Missing | 32 (1) | 8 (1) |  | 24 (1) | 16 (3) |
| **Cardiac Valve Replacement** |  |  |  |  |  |
| No | 2612 (98) | 689 (98) |  | 1923 (98) | 568 (97) |
| Yes | 31 (1) | 7 (1) |  | 24 (1) | 1 (0.2) |
| Missing | 33 (1) | 10 (1) |  | 23 (1) | 17 (3) |
| **Pacemaker** |  |  |  |  |  |
| No | 2604 (97) | 694 (98) |  | 1910 (97) | 567 (97) |
| Yes | 41 (2) | 4 (0.6) |  | 37 (2) | 2 (0.3) |
| Missing | 31 (1) | 8 (1) |  | 23 (1) | 16 (3) |
| **Cerebrovascular Disease** |  |  |  |  |  |
| No | 2422 (91) | 674 (96) |  | 1748 (89) | 541 (93) |
| Yes | 222 (8) | 23 (3) |  | 199 (10) | 28 (5) |
| Missing | 32 (1) | 9 (1) |  | 23 (1) | 16 (3) |
| **Vascular Disease** |  |  |  |  |  |
| No | 2432 (91) | 686 (97) |  | 1746 (89) | 545 (93) |
| Yes | 212 (8) | 12 (2) |  | 200 (10) | 24 (4) |
| Missing | 32 (1) | 8 (1) |  | 24 (1) | 16 (4) |
| **Abdominal Aortic Aneurysm** |  |  |  |  |  |
| No | 2597 (97) | 693 (98) |  | 1904 (97) | 569 (97) |
| Yes | 46 (2) | 4 (0.6) |  | 42 (2) | 1 (0.2) |
| Missing | 33 (1) | 9 (1) |  | 24 (1) | 15 (3) |
| **Respiratory Disease** |  |  |  |  |  |
| No | 2335 (87) | 643 (91) |  | 1692 (86) | 523 (89) |
| Yes | 310 (12) | 55 (8) |  | 255 (13) | 47 (8) |
| Missing | 31 (1) | 8 (1) |  | 23 (1) | 15 (3) |
| **Liver Disease** |  |  |  |  |  |
| No | 2582 (97) | 691 (98) |  | 1891 (96) | 563 (96) |
| Yes | 64 (2) | 7 (1) |  | 57 (3) | 7 (1) |
| Missing | 30 (1) | 8 (1) |  | 22 (1) | 15 (3) |
| **Blood Borne Viruses** |  |  |  |  |  |
| No | 2576 (96) | 688 (98) |  | 1888 (96) | 562 (96) |
| Yes | 70 (3) | 10 (1) |  | 60 (3) | 9 (2) |
| Missing | 30 (1) | 8 (1) |  | 22 (1) | 14 (2) |
| **Malignancy** |  |  |  |  |  |
| No | 2328 (87) | 659 93) |  | 1669 (85) | 545 (93) |
| Yes | 321 (12) | 39 (6) |  | 282 (14) | 25 (4) |
| Missing | 27 (1) | 8 (1) |  | 19 (1) | 14 (2) |
| **Mental Illness** |  |  |  |  |  |
| No | 2422 (91) | 657 (93) |  | 1765 (90) | 532 (91) |
| Yes | 225 (8) | 41 (6) |  | 184 (9) | 39 (7) |
| Missing | 29 (1) | 8 (1) |  | 21 (1) | 14 (2) |
| **Dementia** |  |  |  |  |  |
| No | 2637 (99) | 697 (99) |  | 1940 (99) | 568 (97) |
| Yes | 8 (0.3) | 1 (0.1) |  | 7 (0.4) | 1 (0.2) |
| Missing | 31 (1) | 8 (1) |  | 23 (1) | 16 (3) |
| **Smoking** |  |  |  |  |  |
| No | 1145 (43) | 364 (52) |  | 781 (40) | 253 (43) |
| Current | 381 (14) | 66 (9) |  | 315 (16) | 73 (13) |
| Ex-smoker | 763 (29) | 185 (26) |  | 578 (29) | 158 (27) |
| Don’t Know | 370 (14) | 85 (12) |  | 285 (15) | 93 (16) |
| Missing | 17 (0.6) | 6 (1) |  | 11 (0.6) | 8 (1) |
| **Born in UK** |  |  |  |  |  |
| No | 485 (18) | 86 (12) |  | 399 (20) | 149 (26) |
| Yes | 2032 (76) | 578 (82) |  | 1454 (74) | 404 (69) |
| Missing | 159 (6) | 42 (6) |  | 117 (6) | 32 (6) |
| **English First Language** |  |  |  |  |  |
| No | 325 (12) | 58 (8) |  | 267 (14) | 110 (19) |
| Yes | 2192 (82) | 606 (86) |  | 1586 (81) | 443 (76) |
| Missing | 159 (6) | 42 (6) |  | 117 (6) | 32 (6) |
| **Read Help** |  |  |  |  |  |
| No | 2058 (77) | 597 (85) |  | 1461 (74) | 459 (78) |
| Yes | 457 (17) | 66 (9) |  | 391 (20) | 94 (16) |
| Missing | 161 (6) | 43 (6) |  | 118 (6) | 32 (6) |
| **Accommodation** |  |  |  |  |  |
| Owned by you (outright or with a mortgage) | 1436 (54) | 468 (66) |  | 968 (49) | 281 (48) |
| Part rent, part owned (shared ownership) | 55 (2) | 11 (2) |  | 44 (2) | 17 (3) |
| Rented privately from Council/ Housing Association | 861 (32) | 145 (21) |  | 716 (36) | 203 (35) |
| Other | 154 (6) | 37 (5) |  | 117 (6) | 49 (8) |
| Missing | 170 (6) | 45 (6) |  | 125 (6) | 35 (6) |
| **Employment** |  |  |  |  |  |
| Working PT/FT | 627 (23) | 316 (45) |  | 311 (16) | 185 (32) |
| Long term sick/disabled | 700 (26) | 132 (19) |  | 568 (29) | 156 (27) |
| Retired from paid work | 889 (33) | 124 (18) |  | 765 (39) | 114 (20) |
| Unemployed | 173 (7) | 37 (5) |  | 136 (7) | 65 (11) |
| Other | 122 (5) | 52 (7) |  | 70 (4) | 33 (6) |
| Missing | 165 (6) | 45 (6) |  | 120 (6) | 32 (6) |
| **Education** |  |  |  |  |  |
| Degree, Higher or NVQ 4-5 | 446 (17) | 160 (23) |  | 286 (15) | 137 (23) |
| GCSE, A-level or NVQ 1-3 | 1051 (39) | 346 (49) |  | 705 (36) | 241 (41) |
| No Qualifications | 1023 (38) | 160 (23) |  | 863 (44) | 175 (30) |
| Missing | 156 (6) | 40 (6) |  | 116 (6) | 32 (6) |
| **Car Ownership** |  |  |  |  |  |
| No | 658 (25) | 76 (11) |  | 582 (30) | 153 (26) |
| Yes | 1852 (69) | 586 (83) |  | 1266 (64) | 399 (68) |
| Missing | 166 (6) | 44 (6) |  | 122 (6) | 33 (6) |
| **Civil Status** |  |  |  |  |  |
| Single (never married) | 480 (18) | 136 (19) |  | 344 (17) | 136 (23) |
| Married | 1386 (52) | 388 (55) |  | 998 (50) | 286 (49) |
| Living with partner | 173 (7) | 64 (9) |  | 109 (6) | 43 (8) |
| Divorced | 238 (9) | 49 (7) |  | 189 (10) | 49 (8) |
| Separated (but still legally married) | 81 (3) | 12 (2) |  | 69 (4) | 19 (3) |
| Widowed | 148 (6) | 14 (2) |  | 134 (7) | 17 (3) |
| Missing | 170 (6) | 43 (6) |  | 127 (6) | 35 (6) |
| **Children in Household** |  |  |  |  |  |
| None | 1978 (74) | 472 (67) |  | 1506 (76) | 387 (66) |
| 1 | 264 (10) | 97 (14) |  | 167 (9) | 76 (13) |
| 2 or more | 265 (10) | 92 (13) |  | 173 (9) | 88 (15) |
| Missing | 169 (6) | 45 (6) |  | 124 (6) | 34 (6) |
| **Adults in Household** |  |  |  |  |  |
| 0-1 | 699 (26) | 127 (18) |  | 572 (29) | 154 (26) |
| 2 | 1261 (47) | 378 (54) |  | 883 (45) | 263 (45) |
| 3 or more | 545 (20) | 156 (22) |  | 389 (20) | 134 (23) |
| Missing | 171 (6) | 45 (6) |  | 126 (6) | 34 (6) |

**Table 2** – Associations of patient-level and centre-level characteristics with listing for pre-emptive kidney transplantation\*.

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **N** | **Adjusted Odds Ratio (95% Confidence Interval)** | **p-value** |
|
| **Patient Variables**± |  |  |  |
| **Age** |  |  | <0.0001 |
| 18-29 | 149 | 1 |  |
| 30-39 | 235 | 0.9 (0.51-1.57) |  |
| 40-49 | 455 | 0.79 (0.47-1.32) |  |
| 50-59 | 657 | 0.57 (0.34-0.97) |  |
| 60-64 | 372 | 0.47 (0.26-0.87) |  |
| 65-75 | 808 | 0.19 (0.1-0.37) |  |
| **Ethnic Group** |  |  | <0.0001 |
| White | 2177 | 1 |  |
| Asian | 293 | 0.49 (0.33-0.72) |  |
| Black | 177 | 0.43 (0.26-0.71) |  |
| Other | 29 | 0.23 (0.07-0.8) |  |
| **BMI** |  |  | <0.0001 |
| Less than 20 | 184 | 0.66 (0.4-1.09) |  |
| 20 - <25 | 798 | 1 |  |
| 25 - <30 | 845 | 1.31 (0.99-1.73) |  |
| 30 - <35 | 482 | 0.97 (0.69-1.38) |  |
| 35 - <40 | 223 | 0.31 (0.18-0.54) |  |
| ≥ 40 | 144 | 0.12 (0.05-0.28) |  |
| **Time Since First Seen by Nephrologist** |  |  | <0.0001 |
| <1 Year | 701 | 1 |  |
| 1-3 Years | 619 | 8.12 (5.44-12.1) |  |
| >3 Years | 1355 | 11.55 (8.05-16.55) |  |
| **Diabetes** |  |  | <0.0001 |
| No | 1626 | 1 |  |
| Type 1 | 266 | 1.12 (0.76-1.64) |  |
| Type 2 | 784 | 0.37 (0.26-0.52) |  |
| **Peripheral Vascular Disease** |  |  |  |
| No | 2456 | 1 |  |
| Yes | 220 | 0.29 (0.13-0.61) | 0.0013 |
| **Heart Disease** |  |  |  |
| No | 2170 | 1 |  |
| Yes | 506 | 0.55 (0.36-0.82) | 0.004 |
| **Heart Failure** |  |  |  |
| No | 2490 | 1 |  |
| Yes | 186 | 0.25 (0.08-0.77) | 0.016 |
| **Cerebrovascular Disease** |  |  |  |
| No | 2448 | 1 |  |
| Yes | 228 | 0.53 (0.3-0.92) | 0.025 |
| **Malignancy** |  |  |  |
| No | 2340 | 1 |  |
| Yes | 336 | 0.33 (0.2-0.53) | <0.0001 |
| **Smoking** |  |  | 0.0005 |
| No | 1148 | 1 |  |
| Current | 383 | 0.53 (0.36-0.78) |  |
| Ex-smoker | 769 | 0.95 (0.72-1.25) |  |
| Don’t know | 377 | 0.75 (0.52-1.07) |  |
| **Socioeconomic Variables** |  |  |  |
| **Employment** |  |  | <0.0001 |
| Working full time/ part time | 667 | 1 |  |
| Long term sick/disabled | 746 | 0.42 (0.3-0.58) |  |
| Retired from paid work | 948 | 0.55 (0.37-0.82) |  |
| Unemployed | 185 | 0.51 (0.31-0.85) |  |
| Other | 130 | 0.93 (0.54-1.6) |  |
| **Accommodation** |  |  | <0.0001 |
| Owned by you (Outright or with a Mortgage) | 1533 | 1 |  |
| Other | 166 | 0.58 (0.34-1.0) |  |
| Part rent, Part owned (shared ownership) | 59 | 0.32 (0.13-0.74) |  |
| Rented Privately from Council / Housing Association | 918 | 0.55 (0.41-0.75) |  |
| **Car ownership** |  |  |  |
| No | 701 | 1 |  |
| Yes | 1975 | 1.98 (1.41-2.76) | <0.0001 |
| **Education** |  |  | 0.08 |
| GCSE, A-level or NVQ 1-3 | 1115 | 1.26 (0.96-1.67) |  |
| Degree, Higher or NVQ 4-5 | 477 | 1.06 (0.74-1.51) |  |
| No Qualifications | 1084 | 1 |  |
| **Centre Level Variables** |  |  |  |
| **Transplanting Centre** |  |  |  |
| No | 48 | 1 |  |
| Yes | 23 | 3.1 (2.36-4.07) | <0.0001 |
| **No. of Consultant Nephrologists** |  |  |  |
| ≤6 | 30 | 1 |  |
| >6 | 41 | 2.16 (1.5-3.1) | <0.0001 |
| **Transplantation Discussed with All Patients** |  |  |  |
|  |  |  |  |
| No | 20 | 1 |  |
| Yes | 51 | 1.39 (1.08-1.78) | 0.0094 |

**\*** Derived using multivariable logistic regression and multiple imputation. 20 imputed data sets were modelled separately then combined to produce final parameter estimates.

± Missing data was imputed for BMI (n=243), comorbidity (n= 30), time since first seen by a nephrologist (n=24) and socioeconomic variables (n=146).

**Table 3** – Associations of patient-level and centre-level characteristics with listing for kidney transplantation within 2 years of starting dialysis\*

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **N** | **Adjusted Hazard Ratio (95% Confidence Interval)** | **p-value** |
|
| **Patient Variables** |  |  |  |
| **Age** |  |  | <0.0001 |
| 18-29 | 86 | 1 |  |
| 30-39 | 137 | 0.8 (0.56-1.12) |  |
| 40-49 | 280 | 0.64 (0.46-0.89) |  |
| 50-59 | 462 | 0.35 (0.25-0.49) |  |
| 60-64 | 290 | 0.27 (0.18-0.41) |  |
| 65-75 | 715 | 0.15 (0.1-0.23) |  |
| **Gender** |  |  |  |
| Male | 1285 | 1 |  |
| Female | 685 | 0.82 (0.68-0.99) | 0.035 |
| **Ethnic Group** |  |  | 0.002 |
| White | 1566 | 1 |  |
| Asian | 233 | 1.42 (1.12-1.79) |  |
| Black | 146 | 1.04 (0.76-1.43) |  |
| Other | 25 | 1.56 (0.85-2.87) |  |
| **BMI** |  |  | <0.0001 |
| Less than 20 | 143 | 0.85 (0.6-1.21) |  |
| 20 - <25 | 561 | 1 |  |
| 25 - <30 | 558 | 1.15 (0.93-1.42) |  |
| 30 - <35 | 369 | 0.88 (0.67-1.14) |  |
| 35 - <40 | 200 | 0.48 (0.33-0.7) |  |
| ≥ 40 | 141 | 0.15 (0.08-0.3) |  |
| **Dialysis Modality** |  |  |  |
| Haemodialysis | 1603 | 1 |  |
| Peritoneal dialysis | 367 | 1.34 (1.1-1.64) | 0.004 |
| **Diabetes** |  |  | <0.0001 |
| No | 1085 | 1 |  |
| Type 1 | 176 | 0.76 (0.57-1.02) |  |
| Type 2 | 709 | 0.62 (0.49-0.79) |  |
| **Peripheral Vascular Disease** |  |  |  |
| No | 1764 | 1 |  |
| Yes | 206 | 0.6 (0.37-0.96) | 0.035 |
| **Heart Disease** |  |  |  |
| No | 1520 | 1 |  |
| Yes | 451 | 0.8 (0.59-1.09) | 0.16 |
| **Heart Failure** |  |  |  |
| No | 1797 | 1 |  |
| Yes | 173 | 0.58 (0.36-0.93) | 0.025 |
| **Blood Borne Viruses** |  |  |  |
| No | 1906 | 1 |  |
| Yes | 64 | 0.36 (0.18-0.71) | 0.0035 |
| **Malignancy** |  |  |  |
| No | 1677 | 1 |  |
| Yes | 293 | 0.33 (0.2-0.53) | <0.0001 |
| **Smoking** |  |  | 0.05 |
| No | 784 | 1 |  |
| Current | 316 | 0.76 (0.58-1.0) |  |
| Ex-smoker | 582 | 1.17 (0.95-1.45) |  |
| Don’t know | 289 | 1.06 (0.82-1.36) |  |
| **Socioeconomic Variables** |  |  |  |
| **Employment** |  |  | <0.0001 |
| Working full time/ part time | 331 | 1 |  |
| Long term sick/disabled | 606 | 0.54 (0.43-0.68) |  |
| Retired from paid work | 814 | 0.58 (0.42-0.8) |  |
| Unemployed | 144 | 0.77 (0.56-1.06) |  |
| Other | 75 | 0.74 (0.5-1.1) |  |
| **Accommodation** |  |  | 0.009 |
| Owned by you (Outright or with a Mortgage) | 1035 | 1 |  |
| Other | 126 | 0.81 (0.58-1.13) |  |
| Part rent, Part owned (shared ownership) | 47 | 1.07 (0.64-1.8) |  |
| Rented Privately from Council / Housing Association | 762 | 0.76 (0.61-0.94) |  |
| **Car ownership** |  |  |  |
| No | 619 | 0.73 (0.6-0.9) | 0.0026 |
| Yes | 1351 | 1 |  |
| **Education** |  |  | 0.01 |
| GCSE, A-level or NVQ 1-3 | 749 | 1.05 (0.85-1.3) |  |
| Degree, Higher or NVQ 4-5 | 305 | 1.38 (1.07-1.79) |  |
| No Qualifications | 916 | 1 |  |
| **Centre Level Variables** |  |  |  |
| **Consultant Nephrologists** |  |  |  |
| ≤6 | 30 | 1 |  |
| >6 | 41 | 1.26 (1.0-1.59) | 0.054 |
| **MDT** |  |  |  |
| No | 17 | 1 |  |
| Yes | 54 | 1.23 (0.99-1.52) | 0.057 |
| **Written Protocol for listing** |  |  |  |
| No | 21 | 1 |  |
| Yes | 50 | 0.72 (0.58-0.9) | 0.0033 |

**\*** Derived using multivariable Cox regression and multiple imputation. 20 imputed data sets were modelled separately then combined to produce final parameter estimates.

± Missing data was imputed for BMI (n=220), comorbidity (n=22) and socioeconomic variables (n=104).

**Figure 1:** Flow diagram showing the study recruitment of participants (with inclusion and exclusion criteria) for (1) access to pre-emptive listing and (2) listing after starting dialysis

![A close up of a logo

Description automatically generated]()

A close up of a map

Description automatically generated

**Figure 2 (a)\*** – Unadjusted funnel plot showing variation in proportion listed for pre-emptive kidney transplant by centre according to number of participants evaluated.

\*Centres with less than 10 observations are not shown

\*\* Number of Patients, denotes the number of participants from a given centre that were analysed (from cohort of patients recruited at each centre for the ATTOM study)

A close up of a map

Description automatically generated

**Figure 2(b)\*** – Risk adjusted funnel plot showing variation in proportion listed for pre-emptive kidney transplant by centre according to number of participants evaluated

\*Risk adjusted for all patient and centre factors associated with pre-emptive listing as highlighted in table 2. Centres with less than 10 observations are not shown.

\*\* Number of Patients, denotes the number of participants from a given centre that were analysed (from cohort of patients recruited at each centre for the ATTOM study)