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Racial and Ethnic Disparities in Kidney Transplant Access within a Theoretical Context of Medical Eligibility

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Abstract

Background: Non-Hispanic black (NHB) and Hispanic patients have lower access to kidney transplantation compared to non-Hispanic whites (NHWs). We examined whether differences in the prevalence of co-morbidities that affect eligibility for transplant contribute to disparities in receipt of transplantation.

Methods: We performed a retrospective study of 986,019 adults who started dialysis between 2005-2014 according to the US Renal Data System. We compared prevalence of co-morbidities that could influence transplant eligibility by race/ethnicity. We examined time to first transplant by race/ethnicity in this overall cohort and in a “very healthy” sub-cohort without conditions that could be contraindications to transplantation.

Results: During 2.3 years of mean follow-up, 64,892 transplants occurred. NHBs and Hispanics had a lower prevalence of medical barriers to transplantation at the time of dialysis initiation than NHWs, including age >70 years (26% in NHB vs. 47% in NHW) and malignancy (4% in Hispanics vs. 10% in NHWs). Access to transplant was 65% lower (95% CI 0.33-0.37) in NHBs and 43% lower (95% CI 0.54-0.62) in Hispanics (versus NHWs) in the first year after ESRD, but by Year 4, access to transplantation was not statistically significantly different between Hispanics

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Authorship

EK participated in research design, drafted first draft of the paper, oversaw data analysis and performance of the study.
BKL participated in research design and writing of the paper
CEM participated in research design, supervised data analysis and revised all drafts of the paper
GRR participated in research design and writing of the paper
BG participated in data analysis, participated in research design
DA participated in research design, revised all drafts of the paper, and oversaw performance of the study.
KLJ participated in research design, revised all drafts of the paper, and oversaw performance of the study.

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or NHBs (versus NHWs). In our very healthy cohort, racial and ethnic disparities in access to transplantation persisted up to Year 5 in NHBs and Year 4 in Hispanics after ESRD onset.

Conclusions: Differences in medical eligibility do not appear to explain racial/ethnic disparities in receipt of kidney transplantation and may mask the actual magnitude of the inequities that are present.

Introduction

Black and Hispanic children and adults are less likely to receive deceased donor kidney transplantation, preemptive transplantation, and living donor kidney transplantation than their white counterparts.[1-4] Although lack of access to medical care, lack of recognition of chronic kidney disease (CKD), and socioeconomic considerations may contribute to the racial and ethnic disparities in transplant access,[5-11] these are likely not the only explanatory factors because black and Hispanic individuals are less likely to receive transplants even when their disease is recognized and treated after dialysis initiation[12,13] Some of the inequities in access to kidney transplantation may be related to differences in demographic characteristics (such as older age at the time of ESRD onset) or other medical factors that affect eligibility for kidney transplantation (such as morbid obesity or history of or presence of malignancy) in the potential recipient. On the other hand, it is also possible that differential assessments of medical eligibility for kidney transplantation by race or ethnicity could contribute to disparities in access to kidney transplantation.

Our main objective was to examine disparities in the receipt of kidney transplantation (deceased or living donor transplantation) among non-Hispanic black (NHB) and Hispanic individuals starting dialysis (compared with their non-Hispanic white [NHW] counterparts) within the context of their potential medical eligibility for transplantation. We determined differences in the prevalence of medical factors that may potentially affect eligibility for kidney transplantation by race/ethnicity at the start of dialysis.

We then examined how these medical factors may be associated with racial and ethnic disparities in the receipt of kidney transplantation using two theoretical approaches: first, we compared receipt of transplant in unadjusted versus adjusted models that accounted for factors that may affect eligibility for kidney transplantation to determine the potential contribution of these factors to the known disparities in transplant access. In a second approach, we created a “very healthy” cohort of dialysis patients by excluding individuals with any characteristics or co-morbid conditions that could preclude eligibility for kidney transplant and re-examined receipt of kidney transplantation by race/ethnicity. We hypothesized that the racial and ethnic disparities in receipt of kidney transplantation would be attenuated in our adjusted models and in our “very healthy” cohort due to the greater prevalence of potential medical barriers to kidney transplantation in NHBs and Hispanics (compared with NHWs).

Material and Methods:

Study Population and Data Source

We performed a retrospective cohort study of adults over the age of 18 who developed ESRD treated initially with dialysis between January 1, 2005 and December 31, 2014 using data from the United States Renal Data System (USRDS), the national ESRD registry. Patient demographic characteristics (age at incident ESRD, sex, race, ethnicity), cause of ESRD, insurance type at ESRD onset (none, Medicare, Medicaid, private/other, or Veterans Health Administration), zip code, date of ESRD onset, height, and weight at incident ESRD were abstracted from the USRDS Centers for Medicare and Medicaid Services 2728 (CMS-2728) Medical Evidence (MEDEVID) Form and USRDS Patients file. Zip code was used to determine median household income of patients' neighborhood using data from the American Community Survey between 2006–2010.[14] Initial ESRD treatment modality (transplant versus dialysis) was determined at the first ESRD service date as listed in the USRDS MEDEVID file. We excluded patients who received a preemptive transplant during the study period, as the vast majority of these patients were missing co-morbidity data on their CMS-2728 forms. This study was deemed not human subjects research by the Institutional Review Board at University of California San Francisco (17–23042).

Predictor and Outcome

Race and ethnicity were defined according to the USRDS Patients file. Our primary predictor (henceforth referred to as race/ethnicity) was a variable that accounted for both race and ethnicity: individuals were categorized as NHW, NHB, or Hispanic, and NHWs served as the reference group. We excluded patients of other races.

We determined transplant dates and donor source (living versus deceased) for the first transplant using USRDS Patient and Transplant files, which contain data reported by transplant centers to the United Network for Organ Sharing. We included both living and deceased donor transplantation as a composite outcome of interest, but also in secondary analyses examined these outcomes separately.

We abstracted first waitlist date and death dates (to account for death as a competing risk to transplant) from the USRDS Patients file.

Covariates

We ascertained the presence of co-morbid conditions and the ESRD network at the time of dialysis initiation based on data collected on the CMS-2728 form, including history of past or current congestive heart failure (CHF), ischemic heart disease or coronary artery disease (CAD), cerebrovascular disease, malignancy, diabetes, hypertension, and tobacco, drug, and alcohol dependence.

Based on patients' zip codes, we also determined the census tract location (West, Northeast, South, or Midwest) of individuals starting dialysis to additionally account for geographic variations in the average wait time for deceased donor kidney transplantation (beyond those captured by ESRD network).

Statistical analyses

Characteristics of patients at dialysis initiation that may influence medical eligibility for transplantation

We first compared patient characteristics at the time of dialysis initiation that could potentially affect eligibility for kidney transplantation based on prior studies addressing this issue[15,16] and characteristics that were available on the CMS-2728 form. Thus, we examined the prevalence of older age (>70 years), history of past or current malignancy, coronary artery disease (CAD), heart failure (HF), cerebrovascular disease, and body mass index (BMI) over 35 kg/m^2 at dialysis initiation and considered these factors to be potential contraindications to kidney transplantation.[15,16]

Provider-indicated assessment of medical eligibility for kidney transplantation

We used data from the CMS-2728 form about whether patients had been informed of the option of transplantation to evaluate the face validity of our approach to determining medical eligibility for transplantation by race/ethnicity. Specifically, the CMS form asks providers to indicate whether patients were informed of the option of transplantation and if not, to list the reasons for not doing so. Reasons a patient could not be informed of the option for transplantation included “medically unfit,” “psychologically unfit,” “too old,” “patient declined,” “patient refused,” “patient not yet assessed,” or “other.” These data have been used to examine the provision of transplant education in prior studies.[17,18]

Overall access to kidney transplantation by race and ethnicity

We examined the association between race/ethnicity and access to a living or deceased donor transplant (as a composite outcome) using unadjusted Fine-Gray models (accounting for the competing risk of death) to determine the extent to which race/ethnicity itself was associated with differential access to transplant. Time to transplant was determined starting from the date of dialysis initiation until the occurrence of the first transplant (deceased or living donor). Because the risk of transplant was nonproportional over the long-term, we examined the risk of transplant using Fine-Gray models (accounting for the competing risk of death) starting from the time of dialysis initiation until five years after ESRD onset (a time period we deemed reasonable for most individuals to receive transplantation) and determined the sub-hazard ratio for transplantation by one-year intervals. We then repeated our unadjusted and adjusted analyses using Fine-Gray models for the outcome of living donor transplantation separately from deceased donor transplantation. For 95% confidence intervals, we used a Bonferroni correction to derive a joint confidence interval that accounted for the confidence intervals of both race and our time-varying covariate terms.

Next, we determined the extent to which demographic characteristics and co-morbid conditions contributed to the racial/ethnic disparities in access to kidney transplantation in two approaches. First, we adjusted for age at dialysis initiation, sex, insurance type, median income by neighborhood zip code, tobacco use, drug dependence, alcohol dependence, body mass index, co-morbidities (CHF, CAD, cerebrovascular disease, diabetes, hypertension), ESRD network, calendar year of dialysis onset (to account for temporal trends in practice), and region of the US using Fine-Gray models.

Secondly, we took an alternative approach to determining whether disparities in access to transplant were related to medical eligibility at the time of dialysis initiation. In this approach, we used a *best case* theoretical scenario where those with any demographic characteristics (older age) or co-morbidities that could *potentially* impact access to transplantation (specifically age >70 years, tobacco use, alcohol use, drug use, non ambulatory status at dialysis initiation, CAD, stroke, CHF, BMI > 35 kg/m^2, malignancy as reported at dialysis initiation) were excluded from our analysis (see Figure S1). We took a very conservative approach and assumed that the presence of *any* such co-morbidities could potentially be a medical barrier to transplantation in order to arrive at a remaining cohort henceforth referred to as our "very healthy" sub-cohort. We repeated our unadjusted and adjusted Fine-Gray models (accounting for the competing risk of death) to determine the extent to which racial and ethnic disparities in access to transplant persisted in our "very healthy" sub-cohort by one-year intervals up to Year 5 after dialysis initiation. We also repeated these analyses separately for living donor transplantation and deceased donor transplantation.

To confirm whether our "very healthy" sub-cohort did represent a population that was likely to be medically eligible for kidney transplantation (as we intended), we re-examined the proportion of this sub-cohort who ultimately received kidney transplantation by race/ethnicity.In addition, we also re-examined the prevalence of patients deemed "medically unfit" or "too old" for transplantation on the CMS-2728 form within this "very healthy" sub-cohort.

Finally, in sensitivity analyses, we examined the outcome of time to waitlist registration (or transplantation if patients were not waitlisted prior to transplantation) as a separate outcome, treating death as a competing risk using unadjusted and adjusted Fine-Gray models. We repeated these analyses both in our overall cohort and "very healthy" sub-cohort.

For select nonprimary analyses, we split our cohort into 10 random datasets and used meta-analysis approaches to derive a final effect size due to infeasible compute times.

Results:

Study Cohort

We identified 986,019 NHW, NHB, or Hispanic adults who initiated dialysis as their first mode of renal replacement therapy between 2005–2014 in the US. Mean age was 63 years (SD 15), 57% were male, 56% NHW, 29% NHB, and 15% Hispanic. NHB and Hispanic individuals were more likely to have no insurance and lower neighborhood median income than NHWs at the time of dialysis onset. The prevalence of diabetes was highest among Hispanic patients, whereas the prevalence of CAD and CHF was highest among NHW patients (Table 1).

Differences in the prevalence of medical factors potentially affecting eligibility for kidney transplantation at dialysis initiation by race/ethnicity

At the time of dialysis initiation, NHWs were older than NHB and Hispanic individuals (Table 1). The proportion of patients who were older than 70 years of age was highest

among NHW patients (47%) and was lowest among NHB and Hispanic individuals ($p<0.001$ for the difference, Table 1). Malignancy was more common among NHWs compared to NHBs or Hispanic individuals (Table 1).

The prevalence of BMI over 35 kg/m^2 at the time of dialysis initiation was highest among NHBs (Table 1). Drug dependence was slightly more prevalent among NHB patients compared to persons of other racial and ethnic groups (Table 1).

Provider assessment of medical eligibility for kidney transplantation

Provider-indicated transplant eligibility differed by race. Specifically, the number of patients who were thought to be “unsuitable due to age” by their nephrologist was lower among NHBs (4%) and Hispanics (4%) compared to NHWs (7%, Table 2). NHBs and Hispanics were only slightly less likely to be deemed “medically unfit” by their nephrologist compared to NHWs (Table 2).

Access to transplant by race/ethnicity

A total of 64,892 individuals received a kidney transplant (approximately 7% of the total population) during a mean follow-up of 2.3 years, of which 40,340 were deceased donor transplants. When we examined the time to first kidney transplant by race/ethnicity in the overall cohort in unadjusted analysis accounting for the competing risk of death, we found that the disparity in access to kidney transplant was more profound in the early years following dialysis initiation in both unadjusted and adjusted analysis for all groups (Table 3A). In adjusted analysis, the disparities in access to kidney transplant among NHB and Hispanic individuals widened compared to point estimates noted in unadjusted analysis (Table 3A). Over time, racial/ethnic disparities in access to transplant among NHBs and Hispanics (versus NHWs) improved with each one-year interval following dialysis initiation. By Year 5, access to transplant was estimated to be better for Hispanics and NHBs compared to NHWs (Table 3A).

When we examined the risk of deceased donor and living donor transplantation as separate outcomes of interest, we found that the trends in receipt of living and deceased donor transplantation differed over time by race/ethnicity. For NHBs, occurrence of living donor transplantation was substantially less likely compared to NHWs until Year 5 in adjusted models (Table 3A). In contrast, by Year 3, Hispanics did not statistically significantly differ from NHWs in receipt of living donor transplantation in adjusted models and had better access than NHWs to living donor transplantation thereafter.

NHBs and Hispanics had similar lower risk (compared to NHWs) of receipt of deceased donor transplantation, but rates of deceased donor transplantation improved and became similar if not better for both groups compared to NHWs by Year 4 in adjusted models. By Years 4 and 5, deceased donor transplantation was statistically significantly more likely for NHBs and Hispanics compared to NHWs, respectively.

Disparities in access to transplant among a "very healthy" sub-cohort and characteristics of this sub-cohort

Of the entire study population, we excluded 746,771 who had at least one characteristic that could affect transplant eligibility (Figure S1). Of the remaining 239,248 individuals (24% of the total population) in our "very healthy" sub-cohort, 43% were NHW, 35% NHB, and 22% Hispanic. In this "very healthy" sub-cohort, 17% (N=39,992) ultimately received a kidney transplant (living or deceased donor).

Of the individuals we deemed likely ineligible for kidney transplantation at the time of dialysis initiation and whom we excluded from our "very healthy" sub-cohort, 3% received a kidney transplant and 54% died without receiving a transplanted kidney. To further confirm that our "very healthy" sub-cohort had face validity, we re-evaluated whether patients in this "very healthy" sub-cohort were deemed "unsuitable due to age" or "medically unfit." We found the number of patients who were thought to be ineligible for kidney transplant by their nephrologist to be substantially lower (1–2%) in this "very healthy" sub-cohort compared to the full cohort, and that >85% were informed of the option of kidney transplantation (Table 2).

When we repeated our Fine-Gray models in our "very healthy" cohort, the disparities in receipt of kidney transplantation by race/ethnicity were similar in their overall trends compared to analysis of the full cohort (Table 3B). For deceased donor transplantation, NHBs and Hispanics had similar likelihood of receiving deceased donor transplantation by Year 4 compared to NHWs. For living donor transplantation, rates of transplantation remained lower in NHBs compared to NHWs until Year 5 in our "very healthy" cohort but was similar in NHWs and Hispanics by Year 3.

Access to waitlist registration

When we performed sensitivity analysis examining access of dialysis patients to waitlist registration or transplantation as a composite outcome, we found that overall access to this composite outcome was lower for both NHBs and Hispanics initially at time of dialysis initiation (Table S1). However, in the overall cohort, by Year 2, access to waitlist registration was better for NHBs and Hispanics (compared to NHWs) in adjusted analyses, even after accounting for death as a competing risk (Table S1).

In our "very healthy" sub-cohort, access to the waitlist was also lower initially for NHBs and Hispanics, but by Year 2, access to waitlist registration was also better for NHBs and Hispanics compared with NHWs in both unadjusted and adjusted analyses (Table S1).

Discussion

In this study, we examined differences in the prevalence of factors that may affect transplant eligibility at the time of dialysis initiation by race/ethnicity, differences in receipt of kidney transplant or access to waitlist registration by race/ethnicity, and the extent to which medical eligibility may drive the disparities in access to transplantation within a theoretical framework. Overall, we found that NHBs and Hispanics were less likely to have absolute or relative contraindications to kidney transplantation than NHWs, including older age and

malignancy at the time of dialysis initiation. Yet, despite the worse health status of NHWs, they were only deemed “unfit” for transplantation at slightly higher rates than NHBs and Hispanics, suggesting that there may be differential determination of medical eligibility by race/ethnicity. We found that the disparities in receipt of kidney transplantation were most profound among NHBs, followed by Hispanic individuals, compared to NHWs for the first four years after dialysis initiation, but that access to kidney transplant was actually better thereafter compared to NHWs. These disparities were especially pronounced for NHBs (vs. other race/ethnicities) in terms of receipt of living donor transplantation. Adjustment for clinical factors in the entire cohort and restriction to a subset of “very healthy” patients who should be medically eligible for kidney transplant resulted in *amplification* rather than attenuation of the racial and ethnic disparities in access to transplant.

We believe the finding that NHB and Hispanic patients had a lower prevalence of potential medical barriers to transplantation is an important observation. NHBs and Hispanics tended to be younger at the time of dialysis initiation and appeared to have a lower prevalence of co-morbidities, including heart failure and coronary artery disease, compared to NHW patients. Thus, in general, it does not appear that higher rates of medical barriers among NHBs accounted for the racial and ethnic disparities in access to kidney transplantation.[15] Instead, our observations are contrary to our hypotheses: NHB and Hispanic individuals appeared to be healthier than NHWs at the time of dialysis initiation. This is also supported by the continued improvement in transplant access over time in NHBs and Hispanic patients relative to NHWs (Table 3), suggesting that despite the comorbid conditions that may develop during treatment with dialysis, NHB and Hispanic dialysis patients were healthy enough to remain eligible for kidney transplantation over time and eventually have better access to kidney transplant than their NHW counterparts. Although we do not know whether differences in the severity of co-morbidities were present, the better survival of NHBs and Hispanics over the long-term would not be compatible with the theory that the severity of co-morbidities may have been worse in NHBs and Hispanics compared to NHWs.

Our data also suggest that differential assessment of medical eligibility for kidney transplantation could be occurring. Despite the fact that NHWs had more comorbidities, they were more likely to receive kidney transplant than any other racial or ethnic group. The percentage of NHWs deemed “medically unfit” for transplant on the CMS-2728 form was not much higher than that of NHBs or Hispanics, which could reflect differences in the standards by which “fitness” for transplant is judged among different racial and ethnic groups. This is confirmed by prior studies of this issue, which have shown that failure to inform patients of the option of transplantation (and failure of patients to acknowledge receipt of this information) may contribute to disparities in access to transplantation.[17,18] We also note that although many studies have cited differences in attitudes towards kidney transplantation as a barrier,[19-21] based on data from the CMS-2728 form, the proportion of patients who declined kidney transplantation was very low and did not differ substantially across races and ethnicities. Although some studies have shown discrepancies between prior nephrology care and actual claims data among Medicare patients,[22] the co-morbid data reported in the USRDS and data surrounding provider provision of transplant education have been used as the basis for numerous prior studies and have been shown to be specific (albeit less sensitive).[23] It is disappointing that despite the absence of many medical conditions that

could have affected transplant eligibility in our “very healthy cohort,” the disparities in receipt of kidney transplant not only failed to improve, but widened. This observation suggests that differences in health status by race may be masking even larger disparities in transplantation.

We did find that obesity may be an important barrier to kidney transplantation among NHB patients, as it was much more prevalent among NHBs at the time of dialysis initiation. Many transplant centers have adopted policies that restrict kidney transplantation among recipients with BMI above varying thresholds.[24-26] Using a conservative threshold of 35 kg/m^2 as the cutoff for potential transplant eligibility, more NHB patients would not have qualified for kidney transplantation at the time of dialysis initiation than NHW or Hispanic individuals based on body size. Although there are concerns surrounding the higher rates of surgical complications in the setting of morbid obesity for kidney transplant candidates that are beyond the scope of this study,[25,27] our data suggest that BMI thresholds for transplant eligibility may contribute to disparities in kidney transplant, although we acknowledge that BMI is modifiable and that we may be overestimating the contribution of BMI to these disparities.

Of note, when we examined receipt of living versus deceased donor transplantation separately, we found that the disparities in receipt of living donor transplantation were more pronounced than those seen in deceased donor transplantation for NHBs, especially in the early years after dialysis initiation. In contrast, we did not find that access to waitlist registration was lower among NHB or Hispanic patients (compared to NHWs) within one to two years of dialysis initiation. The observed early disparities in access to waitlist registration could be due in part to lack of early referral to transplant centers prior to dialysis initiation among NHBs and Hispanics, and the occurrence of “catch-up” in waitlist registration thereafter.[8] However, our findings also suggest that the conversion from waitlist registration to actual receipt of transplantation may be a greater barrier to receipt of kidney transplantation in NHBs and Hispanics (versus NHWs).

The strengths of our study include the large size of the national cohort in which there were a large number of transplant events and the contemporary nature of the data. Limitations include the observational nature of the data, potential for missing data from Kidney Transplant Registration or CMS-2728 forms, and lack of more granular data surrounding patient and provider attitudes towards kidney transplantation as well as severity of co-morbidities. We cannot rule out the presence of potential residual confounding, and we recognize that different transplant centers may use different criteria for determining eligibility. We did not have blood type on all patients, and given known differences in the prevalence of various blood type by race, residual confounding may be present. Although our study is focused on medical barriers to transplantation, we acknowledge that we have limited data surrounding access of patients to transportation, patient knowledge about transplantation, patients’ ability to meet co-pay requirements for medications, and changes in insurance status over time which are other considerations that may be contributing to the disparities in access to transplantation by race/ethnicity. It is also possible for some co-morbid conditions to be misclassified, and we recognize that some co-morbidities that were used to determine in-eligibility for kidney transplantation could be modified over time (such

as obesity, smoking or alcohol use). However, we emphasize that our study was designed to provide a hypothetical scenario in which we evaluated whether racial disparities in access to transplant would be attenuated if we eliminated potential differences in medical eligibility (i.e. in our “very healthy” sub-cohort).

In conclusion, less than one-third of the patients who started dialysis between 1995–2014 appeared to be without any apparent medical contraindications to kidney transplantation. Racial and ethnic disparities in access to kidney transplantation persist and could be of greater magnitude than previously reported when accounting for the health of dialysis patients who are potential transplant candidates. Differences in the perception or assessment of eligibility by race or ethnicity may be important. Our findings deserve confirmation given recent changes to the kidney allocation system, and further studies are needed to develop interventions to improve parity in transplantation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

BMI	body mass index
CAD	coronary artery disease
CHF	congestive heart failure
CMS	Centers for Medicare and Medicaid
ESRD	end-stage renal disease
KAS	Kidney Allocation System
MEDEVID	Medical Evidence Form
PVD	peripheral vascular disease
NHB	Non-Hispanic black
NHW	Non-Hispanic white
USRDS	United States Renal Data System
CKD	chronic kidney disease

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Table 1.

Characteristics of patients at first ESRD onset (dialysis only), including characteristics that affect transplant eligibility. *

Mean ± SD or %	Overall N=986,019	Non-Hispanic White N=555,819	Non-Hispanic Black N=283,164	Hispanic N=147,036
Factors affecting transplant eligibility				
Age at dialysis initiation (yrs)	63 ± 15	67 ± 14	59 ± 15	59 ± 15
Age over 70 at dialysis initiation	38	47	26	27
Insurance *				
None	7	4	11	12
Medicare	59	67	50	46
Medicaid	12	7	17	20
Other/private	21	20	21	21
Veterans Affairs	1	1	1	1
Tobacco use	6	7	7	3
Alcohol use	2	2	2	1.4
Drug use	1	0.8	3	1
BMI over 35 kg/m^2	20	20	23	16
Malignancy	8	10	6	4
Additional factors affecting transplant eligibility				
Median income ($) by zip code [IQR]	46438 [36969, 59713]	46869 [40733, 64628]	39886 [31576, 51840]	44342 [35117, 56272]
Region				
West	18	17	8	43
Midwest	22	27	18	7
South	43	36	58	38
Northeast	18	20	15	12
Coronary artery disease	20	25	13	17
Heart failure	32	35	30	27
Stroke	9	10	10	7
Diabetes	59	56	59	72
Blood type **				
O	49	45	50	59

Mean ± SD or %	Overall N=986,019	Non-Hispanic White N=555,819	Non-Hispanic Black N=283,164	Hispanic N=147,036
A	33	40	25	29
B	14	11	20	10
AB	4	4	4	2

* p<0.05 for differences across all race and ethnic groups.

** Available only in N=167,459 of those included for analysis.

Table 2.

Nephrology care and nephrologist assessment of transplant eligibility since 2005.

Percent (%)	**Non-Hispanic White**	**Non-Hispanic Black**	**Hispanic**
Total population* (%) of total population by race	N=555,819 (56%)	N=283,164 (29%)	N=147,036 (15%)
Reason patient not yet informed of transplant as treatment option			
Patient informed/medically fit	75	80	80
Medically unfit	7	4	3
Psychologically unfit	0.4	0.7	0.4
Unsuitable due to age	7	4	4
Patient declined	0.4	0.2	0.3
Patient not yet assessed	11	11	12
“Very healthy” sub-cohort N (%) of sub-cohort by race	N=102,938 (43%)	N=82,899 (35%)	N=53,411 (22%)
Reason patient not yet informed of transplant as treatment option			
Patient informed/medically fit	87	87	86
Medically unfit	2	1	1
Psychologically unfit	0.4	0.4	0.2
Unsuitable due to age	0.2	0.2	0.2
Patient declined	0.2	0.1	0.1
Patient not yet assessed	10	11	12

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Table 3A.

Fine-Gray models for the outcome of transplantation starting from the time of ESRD onset in the overall by race/ethnicity.

Overall (N=986,019) Living or deceased donor transplantation	**Number of years after dialysis initiation**					
Unadjusted	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.34 (0.33-0.36)	0.50 (0.47-0.53)	0.72 (0.67-0.78)	1.05 (0.96-1.15)	1.52 (1.37-1.69)	2.20 (1.95-2.49)
Hispanic	0.58 (0.55-0.61)	0.73 (0.68-0.78)	0.92 (0.85-1.01)	1.16 (1.05-1.29)	1.47 (1.30-1.66)	1.86 (1.61-2.14)
Adjusted[a]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.25 (0.24-0.26)	0.35 (0.33-0.37)	0.50 (0.46-0.53)	0.70 (0.63-0.76)	0.98 (0.88-1.09)	1.37 (1.21-1.55)
Hispanic	0.47 (0.45-0.49)	0.57 (0.54-0.62)	0.70 (0.64-0.77)	0.86 (0.77-0.96)	1.05 (0.92-1.20)	1.29 (1.11-1.50)
Deceased donor transplantation						
Unadjusted	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.44 (0.41-0.46)	0.61 (0.56-0.66)	0.85 (0.77-0.93)	1.18 (1.05-1.32)	1.64 (1.43-1.88)	2.28 (1.95-2.66)
Hispanic	0.49 (0.46-0.53)	0.65 (0.59-0.71)	0.85 (0.75-0.96)	1.11 (0.95-1.29)	1.45 (1.22-1.73)	1.90 (1.55-2.32)
Adjusted[a]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.34 (0.32-0.36)	0.44 (0.42-0.50)	0.59 (0.57-0.69)	0.80 (0.75-0.96)	1.09 (1.01-1.34)	1.49 (1.35-1.86)
Hispanic	0.42 (0.39-0.45)	0.53 (0.48-0.59)	0.68 (0.60-0.78)	0.87 (0.75-1.03)	1.12 (0.93-1.35)	1.43 (1.16-1.77)
Living donor transplantation						
Unadjusted	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.29 (0.27-0.31)	0.40 (0.36-0.44)	0.56 (0.49-0.64)	0.77 (0.65-0.92)	1.07 (0.87-1.32)	1.48 (1.16-1.89)
Hispanic	0.62 (0.58-0.66)	0.83 (0.75-0.91)	1.11 (0.97-1.27)	1.48 (1.25-1.76)	1.98 (1.62-2.43)	2.65 (2.09-3.37)
Adjusted[a]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Hispanic White	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.21 (0.20-0.21)	0.29 (0.26-0.32)	0.38 (0.33-0.44)	0.51 (0.43-0.61)	0.69 (0.56-0.85)	0.92 (0.72-1.17)
Hispanic	0.47 (0.43-0.50)	0.62 (0.55-0.68)	0.81 (0.70-0.93)	1.06 (0.88-1.26)	1.38 (1.12-1.71)	1.81 (1.41-2.32)

[a] Adjusted for age at ESRD onset (whichever is first), sex, median income by neighborhood zip code, insurance status, region of the US, BMI, CAD, cerebrovascular disease, heart failure, diabetes, hypertension, tobacco, alcohol, and drug dependence, ESRD network, and calendar year of initiation.

Table 3B.

Fine-Gray models for the outcome of transplantation from the time of ESRD onset in the “very healthy” sub-cohort by race/ethnicity.

HEALTHY COHORT						
Overall (living or deceased) (N=239,248)	**Number of years after dialysis initiation**					
Unadjusted	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Hispanic White (Ref)	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.22 (0.21-0.23)	0.31 (0.30-0.33)	0.45 (0.41-0.48)	0.64 (0.57-0.70)	0.90 (0.80-1.02)	1.28 (1.12-1.47)
Hispanic	0.33 (0.31-0.34)	0.41 (0.39-0.44)	0.52 (0.48-0.57)	0.66 (0.59-0.74)	0.84 (0.74-0.96)	1.07 (0.92-1.24)
Adjusted[a]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Non-Hispanic White (Ref)	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.23 (0.22-0.24)	0.32 (0.29-0.34)	0.44 (0.40-0.49)	0.62 (0.55-0.69)	0.86 (0.75-0.98)	1.20 (1.02-1.40)
Hispanic	0.39 (0.37-0.41)	0.48 (0.44-0.53)	0.60 (0.54-0.67)	0.75 (0.66-0.85)	0.93 (0.80-1.09)	1.16 (0.97-1.39)
Deceased donor transplantation						
Unadjusted	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Overall						
Non-Hispanic White (Ref)	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.29 (0.28-0.32)	0.39 (0.36-0.43)	0.52 (0.46-0.59)	0.69 (0.60-0.80)	0.92 (0.78-1.10)	1.22 (1.00-1.49)
Hispanic	0.29 (0.26-0.31)	0.37 (0.33-0.41)	0.47 (0.41-0.55)	0.61 (0.51-0.73)	0.78 (0.63-0.97)	1.00 (0.78-1.28)
Adjusted[a]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Overall						
Non-Hispanic White (Ref)	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.32 (0.30-0.34)	0.43 (0.39-0.47)	0.57 (0.51-0.65)	0.77 (0.66-0.89)	1.03 (0.89-1.22)	1.37 (1.12-1.68)
Hispanic	0.38 (0.34-0.42)	0.49 (0.43-0.55)	0.63 (0.53-0.74)	0.81 (0.67-0.98)	1.04 (0.83-1.30)	1.34 (1.03-1.74)
Living donor transplantation						
Unadjusted	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Overall						
Non-Hispanic White (Ref)	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.18 (0.17-0.20)	0.25 (0.22-0.28)	0.34 (0.29-0.40)	0.46 (0.37-0.58)	0.63 (0.49-0.82)	0.87 (0.64-1.18)
Hispanic	0.33 (0.31-0.36)	0.45 (0.40-0.51)	0.62 (0.53-0.73)	0.85 (0.69-1.04)	1.16 (0.90-1.48)	1.58 (1.18-2.11)
Adjusted[a]	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5

HEALTHY COHORT						
Overall (living or deceased) (N=239,248)	**Number of years after dialysis initiation**					
Non-Hispanic White (Ref)	Ref	Ref	Ref	Ref	Ref	Ref
Non-Hispanic Black	0.19 (0.18-0.21)	0.26 (0.23-0.30)	0.36 (0.30-0.42)	0.48 (0.39-0.60)	0.66 (0.51-0.86)	0.90 (0.66-1.23)
Hispanic	0.40 (0.37-0.44)	0.55 (0.49-0.63)	0.76 (0.65-0.90)	1.05 (0.85-1.30)	1.45 (1.12-1.87)	2.00 (1.48-2.70)

[a]Adjusted for age at ESRD onset (whichever is first), sex, median income by neighborhood zip code, insurance status, and region of the US, BMI, CAD, cerebrovascular disease, heart failure, diabetes, hypertension, tobacco, alcohol, and drug dependence, ESRD network, and calendar year of initiation.