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Association of Race and Age on Transplant Waitlisting among Incident ESKD Patients in the United States

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Association of Race and Age on Transplant Waitlisting among Incident ESKD Patients in the United States

By

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B.A., Yale University, 2020

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An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health in Epidemiology
2022

Abstract

Association of Race and Age on Transplant Waitlisting among Incident ESKD Patients in the United States

By Jade Buford

Background: Racial disparities exist in access to kidney transplantation, and older patients have reduced access to the national transplant waiting list. However, it is unknown whether racial disparities in waitlisting differ by age. We examined whether age modifies racial disparities in placement on the national transplant waitlist.

Methods: Non-Hispanic White (NHW) and non-Hispanic Black (NHB) adults that initiated ESKD treatment between 2015 and 2018 and were followed through 2020 were identified from the US Renal Data System. Age was categorized as 18-29, 30-49, 50-64, and 65-80. The incidence of waitlisting overall and by race and age was calculated. Age- and race-stratified waitlisting rates were compared and age was examined as an effect modifier in multivariable-adjusted Cox proportional hazards models accounting for the competing risk of death.

Results: Overall, 19.4% of patients were waitlisted, including 19.1% NHB and 19.5% NHW patients. Waitlisting was higher among younger patients (51% overall; 60% NHW, 40% NHB). For patients 65-80, 9% were waitlisted overall, including 8% NHW and 9% NHB. Overall, in unadjusted analysis, NHB patients had lower waitlisting rates (HR: 0.87, 95% CI, 0.85, 0.88). After stratifying by age and adjusting for demographic and clinical characteristics, NHB patients had significantly lower waitlisting rates than their NHW counterparts between 18-29 years (aHR: 0.74, 95% CI, 0.69, 0.80), 30-49 (aHR: 0.89, 95% CI, 0.86, 0.92), 50-64 (aHR: 0.89, 95% CI, 0.86, 0.91), and 65-80 (aHR: 0.82, 95% CI: 0.79, 0.86); $p < .001$ for interaction terms.

Conclusions: Racial disparities in waitlisting exist between NHB and NHW adult patients with incident ESKD undergoing dialysis treatment. This disparity is more pronounced among the youngest age group and less evident among patients ≥30.

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Acknowledgements

I would like to thank Dr. Rachel Patzer and Samantha Retzloff for their guidance and support throughout this project. I would also like to thank Laura McPherson, Dr. Adam Wilk, Dr. Stephen Pastan, and Dr. Cecile Janssens for their collaboration and feedback.

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Introduction

Racial discrimination and bias have been longstanding within the healthcare system, directly affecting patient access and satisfaction of care, including access to kidney transplantation within the end-stage kidney disease (ESKD) care system.[1] In 2018, the number of individuals with ESKD in the U.S. exceeded 785,000, with the prevalence being 3.4 times greater among Black patients compared to white patients.[2] Kidney transplantation results in significantly better survival, quality-of-life, and economic benefits compared to indefinite dialysis for people with ESKD.[3,4] Yet barriers in the transplant process impede access, making transplantation an under-utilized medical option in the U.S.[2,4] Racial disparities exist at all steps of the kidney transplant process, including referral, completion of evaluation, waitlisting on the national registry, and receiving a kidney transplant. These disparities are evident across geographic regions, socioeconomic status, race/ethnicity, and sex.[5-13] Notably, Black (vs. white) patients with ESKD have lower rates of living donor transplant and preemptive transplantation despite more rapid progression to ESKD.[14-16]

Other population-based studies have identified age as a factor associated with delayed access to kidney transplantation. Older age has been associated with lower likelihood of transplant evaluation, directly influencing the receipt of living donor transplants.[9,10,13,17] However, many of the factors associated with barriers in the transplantation process, such as lower socioeconomic status and insurance coverage, are more common among younger patients.[11] Given that the age of patients beginning ESKD treatment continued to increase annually, with a median age of 65 in 2017 and a higher among patients ≥75 years old in 2019, the results of many studies examining disparities may be influenced by populations with a majority of older patients with few analyses examining subgroups based on age.[18,19] For

example, while Black vs. white patients on dialysis have higher survival, this "survival paradox" only applies to older individuals. Younger Black patients have a higher risk of death compared to their white counterparts.[20-22] Similarly, findings from a study assessing kidney replacement therapies by race/ethnicity and age concluded that racial disparities in transplantation and home dialysis are more prominent among younger adults.[23] It is unknown how race and age interact to influence access to waitlisting among ESKD patients.

Because patients with ESKD experience barriers throughout the transplant process, including placement on the waitlist, gaining a clear understanding of existing disparities in transplant is imperative to inform the development of new policies and interventions. In this study, we used national surveillance data of incident ESKD patients in the U.S. to a) examine whether waitlisting for kidney transplantation differs by Black vs. white race and age; and b) explore whether age modifies observed racial disparities in kidney transplant waitlisting.

Methods

Study population, data sources, and exclusion criteria

The underlying cohort for this study was obtained from the 2020 US Renal Data System (USRDS) Standard Analytic Files that provide patient and facility information about CKD and ESKD in the United States up to December 31, 2018. We identified incident adult ESKD patients (age ≥18) undergoing dialysis between January 1, 2015 and December 31, 2018 (n=517,612). Patients under the age of 18 were excluded because pediatric kidney failure care is administered in an alternative provider system (n=3,827). In addition, patients older than 80 (>80) were also excluded from the cohort (n=54,982) because of limited waitlisting among older patients due to increased comorbidities and likelihood of poor post-transplant outcomes.[24-26]

Pertinent patient information was obtained from the USRDS patient data, Medical Evidence Form (CMS-2728) data, and United Network for Organ Sharing (UNOS) data on waitlisting. Given that some patients had multiple CMS Medical Evidence Forms, the first record providing information on comorbidity status at ESKD onset was used. Patients identified as having a prior transplant (n=2,322), "other" (n=31,882) or unknown (n=593) race, Hispanic ethnicity (n=71,972), and those missing ethnicity information (n=1,110) were excluded. The final analytic sample included 350,924 patients (**Figure 1**).

Data on characteristics of patients' residential neighborhoods, defined by patient 5-digit ZIP code tabulation area was obtained from the 2015-2019 American Community Survey and linked by patient residential ZIP code at the start of dialysis by USRDS. This study was exempt from review from the Emory Institutional Review Board because it uses publicly available and de-identified data from the USRDS.

Study Variables

This study examines one primary outcome of placement on the UNOS waiting list for a deceased donor kidney (time to waitlisting). Study participants were identified at the initiation of dialysis and followed until placement on the transplant waiting list, death, or the end of the study (December 31, 2020). Race and age were the exposures in the analysis. Patient characteristics included demographic and clinical data reported by clinicians on the CMS-2728 Medical Evidence Form at the time of first dialysis treatment. Race was defined as non-Hispanic white versus non-Hispanic Black and defined as a social construct, not a biologic categorization.[27] Age groups were created *a priori* by mirroring the age stratification used in Kucirka et al. (2011) and separating the group of patients aged 50-80 to account for known low waitlisting, lack of access

to other steps in the transplantation process, and low transplantation among patients >65.[20,28] Age was stratified into four categories: 18-29, 30-49, 50-64, and 65-80. Patient-level characteristics included age, sex, race, body-mass index, attributed cause of ESKD, year of ESKD start, and comorbidities at the time of ESKD start. Socioeconomic indicators on the individual level included primary health insurance and pre-ESKD nephrology care. We also examined neighborhood-level (ZIP code) poverty. We defined high neighborhood poverty as ≥20% of households living below the poverty level.

Statistical Analyses

Descriptive statistics were calculated for patient- and neighborhood-level factors for the study population and stratified by race and age. According to the methods of Fine and Gray, competing risk regression models were used to account for death as a competing risk for waitlisting.[29,30] The cumulative incidence estimated probabilities of ESKD patients' placement on waitlist during follow-up by race and age, treating death as a competing risk. The 95% confidence intervals (95% CIs) were calculated with robust variance estimates.

Waitlisting among patients by race and age was compared using multivariable-adjusted Cox proportional hazards models, treating death as a competing risk, and respective 95% CIs.[20] Given our large sample size, the proportional hazards assumption was tested by examining log-log curves, with no evidence of nonproportionality. For this analysis, patients were censored at time of waitlisting or end of study (December 31, 2020). Patients who were preemptively waitlisting (waitlisted prior to dialysis start) were included in the analysis with their time to waitlisting coded as zero. A complete-case analysis, omitting cases with missing data, was used to account for the presence of missing patient data for explanatory variables. Demographic and

clinical characteristics were considered for potential inclusion in the model *a priori* if they had previously been shown to be associated with race and/or age, or a risk factor for waitlisting.[5-13,31,32] These characteristics included: age, race (non-Hispanic Black vs non-Hispanic white), sex, primary health insurance type at ESKD onset, body-mass index, attributed cause of ESKD (diabetes, hypertension, glomerulonephritis, polycystic kidney, urologic, unknown), atherosclerotic heart disease, cardiac failure, peripheral vascular disease, cerebrovascular disease, hypertension, pre-ESKD nephrology care, diabetes, tobacco use, cancer, chronic obstructive pulmonary disease, drug abuse, alcohol abuse, and neighborhood poverty, all assessed at the time of ESKD onset.

Subgroup Analysis

Waitlisting among additional subgroups within the 18-29 age group were explored by sex, insurance type, body-mass index, pre-ESKD nephrology care, primary cause of ESKD, and percentage of neighborhood poverty to determine whether racial disparities remained across all patients or were specific to patients with certain demographic characteristics or comorbidities. To obtain information on the frequency of waitlisting, crude waitlisting within each subgroup was obtained. Multivariable-adjusted Cox proportional hazards models, treating death as a competing risk, were repeated within each subgroup to examine 18–29-year-old patients given that they were identified as having a higher magnitude of disparities in waitlisting between non-Hispanic Black versus white ESKD patients. The results were intended to inform whether racial disparity in waitlisting persisted among specific subgroups of this age group.

SAS 9.4 (SAS Institute Inc., Cary, NC) was used for data management and analyses. Two-sided P-values were calculated, with $P < 0.05$ defined as statistically significant.

Results

Study Population Characteristics

A total of 350,924 ESKD patients were included in our sample. Among these patients, there were approximately twice as many non-Hispanic white patients (67.7%) patients compared to non-Hispanic Black patients (32.3%). Non-Hispanic white patients were more likely to have private insurance (21.3% NHW vs 19.4% NHB), while a higher percentage of non-Hispanic Black patients had Medicaid (20.3% NHW vs 34.3% NHB) or no insurance coverage (3.19% NHW vs 6.3% NHB). Hypertension (39.3%) and diabetes (44.6%) were the attributed causes of ESKD most often for non-Hispanic Black patients. The percentage of patients with ZIP codes containing <20% of residents below the poverty line was higher among non-Hispanic white patients (91.7% NHW vs 69.7% NHB). These racial differences in population characteristics persist across all age groups. The percentage of patients receiving pre-ESKD nephrology care increased with age, with care less common among patients aged 18-29. Other comorbidities were similar between non-Hispanic white and Back ESKD patients (**Table 1**).

Placement on the Deceased Donor Waitlist for Transplant by Race

Overall, crude waitlisting of ESKD patients was 19% over the median 2-year follow-up (IQR: 1-3), with no differences in waitlisting between racial groups (**Table 2**). 35.3% of ESKD patients died before placement on the waitlist, including 28.0% non-Hispanic white and 39.1% non-Hispanic Black patients. Accounting for death as a competing risk, the overall cumulative incidence of waitlisting was 19.4%. The incidence of waitlisting in the study population was

similar between non-Hispanic Black (19.1%) and non-Hispanic white patients (19.5%) during the study period (**Table 3, Figure 2a**); the median time from ESKD start to waitlisting was 2 years (IQR: 1-3) for non-Hispanic Black and white patients. Overall, in unadjusted analysis, treating death as a competing risk, non-Hispanic Black patients had lower rates of waitlisting compared to non-Hispanic white patients (HR: 0.87, 95% CI, 0.87, 0.88; **Table 4**). After adjusting for demographic and clinical characteristics and the competing risk of death, the observed racial disparity in waitlisting remained the same (aHR: 0.87, 95% CI, 0.85, 0.88; **Table 4**).

Age-Stratified Analyses

Crude waitlisting was higher among patients aged 18-29 (49% overall; 58% non-Hispanic white vs. 38.5% non-Hispanic Black). Death prior to waitlisting was higher among patients aged 65-80 (40% overall; 42% non-Hispanic white vs. 32% non-Hispanic Black). Non-Hispanic Black patients aged 18-29 had a higher risk of death compared to their white counterparts. However, the risk of death was greater for white patients aged 30-49, 50-64, and 65-80 (**Table 2**).

Cumulative incidence rates demonstrated that waitlisting was more frequent among younger patients (18-29). Treating death as a competing risk, the cumulative incidence of waitlisting among all patients was 50.9% in the 18-29 subgroup, 36.3% for 30-49, 23.1% for 50-64, and 8.9% for patients ≥65 (**Table 3**). Subgroup estimates of the cumulative incidence rates of waitlisting by age group also indicate that racial disparities in waitlisting between non-Hispanic white and non-Hispanic Black patients differed by age (**Figure 2b**). The cumulative incidence of waitlisting during the study period among incident ESKD patients aged 18-29 was 40.5% for

non-Hispanic Blacks and 59.9% for non-Hispanic whites. The incidence among patients 30-49 was 32.3% for non-Hispanic Black patients compared to 39.9% among non-Hispanic white patients. The incidence of waitlisting among patients aged 50-64 was 20.3% for non-Hispanic Black patients and 24.7% for non-Hispanic white patients, while this incidence among patients aged 65-80 was 7.5% for non-Hispanic Black patients and 9.3% for non-Hispanic white patients (**Table 3**).

In the fully-adjusted model including interaction terms for race and each age category, all interaction terms were statistically significant, providing evidence of age modification on the relationship between race and waitlisting among ESKD patients ($p < 0.001$). In an adjusted multivariable model, treating death as a competing risk and stratifying by age, non-Hispanic Black patients had significantly lower waitlisting rates than their non-Hispanic white counterparts between 18-29 years (aHR: 0.74, 95% CI, 0.69, 0.80). The smallest disparity in waitlisting was among patients aged 30-49 and 50-64. However, we see this disparity marginally increase among patients aged 65-80 (aHR: 0.82, 95% CI, 0.79, 0.86). Despite a decrease in the racial disparities in waitlisting within the age subgroups 30-49 and 50-64, non-Hispanic Black ESKD patients continue to experience lower waitlisting rates (30-49, aHR: 0.89, 95% CI, 0.86, 0.92; 50-64, aHR: 0.89, 95% CI: 0.86, 0.91; **Table 4**).

Subgroup Analyses Among 18–29-Year-Olds

Multivariable-adjusted Cox proportional hazards models were repeated within different subgroups of 18–29-year-old patients based on demographic and clinical characteristics. Among 18–29-year-olds, non-Hispanic white patients were more likely to have private insurance, while a higher percentage of non-Hispanic Black patients had Medicaid (36.9% NHW vs 50.2% NHB), or no insurance coverage (9.5% NHW vs 16.1% NHB). In addition, hypertension was the

attributed cause of ESKD for a higher percentage of non-Hispanic Black patients (16.3% NHW vs 28.8% NHB). The percentage of patients with ZIP codes containing ≥20% of residents below the poverty line was higher among non-Hispanic Black patients (9.4% NHW vs 31.2% NHB). Other comorbidities were similar between non-Hispanic white and non-Hispanic Black ESKD patients (**Table 1**).

Waitlisting rates within the various demographic and clinical groups demonstrate that these observed disparities in waitlisting between non-Hispanic Black and non-Hispanic white patients persist and are not specific to certain characteristics. Non-Hispanic Blacks had lower rates of waitlisting regardless of sex, body-mass index, pre-ESKD care, percentage of neighborhood poverty, and attributed cause of hypertension, glomerulonephritis, and polycystic kidney.

Discussion

Although many studies have observed disparities by race and by age in access to kidney transplantation, little is known about how race and age interact to influence access to waitlisting among ESKD patients. This study, which used national data on adult patients with ESKD, finds evidence of racial disparities exist in waitlisting among non-Hispanic Black and non-Hispanic white patients, despite Black individuals being overrepresented within the ESKD population and experiencing more rapid progression to ESKD. [2,14-16] Although research has identified age as an effect modifier for dialysis survival, treatment modality, and transplantation among patients[20,23], this study reports for the first time that racial disparities in waitlisting also differ by age. We find that age modifies observed racial disparities in waitlisting, with the largest observed disparity among patients aged 18-29.

While the United Network for Organ Sharing instituted a new kidney allocation system (KAS) in 2014 that resulted in a decline from 19% to 12% in racial difference in waitlisting among Black vs. white patients,[33] this racial disparity reduction in waitlisting was in part due to declines among white patients rather than increases among Black patients with ESKD. Our results suggest that interventions to address racial disparities in kidney transplant access should be specifically targeted to young, Black patients with ESKD. Given the undermentioned numerous upstream social determinants of health that have been found to influence racial disparities in kidney transplantation, overall and by age, it is important to focus interventions on these complex and multi-level factors, which serve as the underlying fundamental causes of these inequities.[34] Specifically, health system level interventions may be necessary in order to make a significant impact on observed disparities in access. For example, multi-component interventions to improve education and quality of care within kidney transplant and dialysis centers nationally have the opportunity to improve equity in access.[35] Another potential opportunity for intervention at the system-level is exploring the implementation of data systems that will improve communication and interactions between dialysis facilities and transplant centers to coordinate patient care.[36]

Prior research on disparities in the care of ESKD patients suggested that Black patients receiving dialysis have a survival advantage when compared to white patients receiving the same treatment. The results of our study mirror those found by Kucirka et al., suggesting that the survival advantage of Black patients on dialysis is only among older patients.[20] The decrease in waitlisting disparities among ESKD patients we observed in our results may be explained by this survival advantage, with more white patients dying before waitlisting at older ages than their non-Hispanic Black counterparts. The increased risk of complications following kidney

transplant among older populations and the higher prevalence of comorbidities in both older Black and white patients may also explain the reduced racial disparities among patients ≥30.[12,26,37]

A number of system- and provider-level factors can be considered potential contributors to the observed racial disparity across all age groups in access to transplantation including poverty, insurance status, physician bias, medical mistrust, patient-perceived racism within the healthcare setting, and discrimination.[6,13,31,32] Some dialysis facility providers are unaware of racial disparities in waitlisting, uncertain of which patients are already on the waitlist, have limited information on referral criteria.[38,39] Ayanian et al. (2004) found that provider viewpoints regarding the survival advantage of transplantation by race, reasons for disparities, and patient preferences may influence communication of transplantation as a treatment offer.[40] In addition to barriers created by dialysis facilities and providers that notably disadvantage Black patients. At least one study has reported that Black patients are less likely to be interested in transplantation.[7] However, more recent research indicates that Black patients undergoing hemodialysis are interested in receiving a transplant, but are hindered by lack of communication from providers and limited knowledge of the transplantation process which influence perceptions of lack of interest.[41-44] Cultural and personal beliefs also contribute to patient related barriers to transplantation.[7,31,45,46]

Studies that examined racial disparities in waitlisting and other steps in the transplantation process have found that reasons for racial disparities are due to systematic racism and prejudice. Moreover, medical mistrust and attitudes of fear or suspicion towards medical institutions have been shown to be greater among younger and non-Hispanic Black patients.[1] Physician bias, medical mistrust, and discrimination because of a patient's race/ethnicity have

been proposed as explanations for observed differences in waitlisting and the increased disparities among patients aged 18-29. Previous research has cited that only a small portion of dialysis staff are minorities and many believe that patients are the reason for observed disparities rather than institutionalized or internalized biases. Perceived laziness of Black patients was cited by staff as a reason for disparities, which is likely a perception rooted in racial stereotypes forced upon Black individuals.[47,48]

In addition, insurance type, pre-ESKD nephrology care, and neighborhood poverty are also factors that may explain greater racial disparities among younger patients. A recent review found that disparities at all steps of the transplantation process are influenced by poverty, insurance status, physician bias, medical mistrust, patient-perceived racism within the healthcare setting, and discrimination.[6,13,31,32] In addition, the greater disparities, lack of insurance and poverty status that we observed in our results among younger NHB ESKD patients may also explain differences in pre-ESKD nephrology care and increased prevalence of untreated comorbidities that have the potential to influence placement on the waitlist.[23,49] There are other unmeasured factors that may explain the observed racial disparities in waitlisting, especially among younger patients, including social networks, information about the transplant process, cultural/personal beliefs, and patient preference.

This study has several notable limitations. First, there are potential factors that may be associated with placement on the waitlist, such as educational attainment, patient preferences, cultural/linguistic barriers, employment status, and other patient comorbidities, that were not available to be included in the current analysis.[6,12,13,31,32] It is possible that the magnitude of disparities between non-Hispanic Black and non-Hispanic white patients may be affected when adjusting for these factors; however, it is likely that a disparity would still exist. Other studies

have found that racial disparities in waitlisting and receipt of a transplant persist after accounting for many of these factors.[12,14] Third, this analysis is limited to non-Hispanic Black and non-Hispanic white patients because of the larger population available for the subgroup analyses, and due to the longstanding inequities between Black vs. White patients with ESKD. Future analysis should examine disparities in waitlisting among other subgroups. Fourth, comorbidity data and information on patient race/ethnicity and other patient characteristics were captured in the CMS-2728 Medical Evidence Form but may have been underreported or changed over time. Another notable limitation is that patient race/ethnicity information was documented by clinicians or staff rather than self-reported by patients.

This study is the first to examine age as an effective modifier for waitlisting among non-Hispanic Black and non-Hispanic white patients. This study has several strengths. The data used in this analysis was obtained from USRDS, a universal and population-based surveillance system. For this reason, it is likely that all cases of ESKD and placement on waitlist have been captured, limiting the potential for misclassification bias. Furthermore, a competing risk analysis was conducted to account for death as a competing risk for waitlisting.[29,30]

In summary, this study provides evidence that disparities in waitlisting still exist between non-Hispanic Black and non-Hispanic white patients and that these disparities are modified by patient age. Younger non-Hispanic Black patients experience greater differences in waitlisting compared to their white counterparts. In addition, future studies should explore age as an effect modifier for racial disparities in earlier steps in the transplantation process, such as referral and evaluation. Determining the reason for greater disparities in waitlisting between non-Hispanic Black and non-Hispanic white patients, especially within the younger patients who experienced greater disparities, is critical to improving equity. A deeper understanding of the reason for these

disparities, especially focusing on individuals experiencing the greatest disparities, can help to inform future interventions and policies to improve access to transplantation.

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Tables and Figures

Table 1. Baseline Characteristics of Incident U.S. Adult ESKD Patients within USRDS by Age and Race, 2015-2018[a] (N=350,924)

	Patient Age (Years)							
	18-29		30-49		50-64		65-80	
	Non-Hispanic White (n=4551)	Non-Hispanic Black (n=3911)	Non-Hispanic White (n=29977)	Non-Hispanic Black (n=26291)	Non-Hispanic White (n=78406)	Non-Hispanic Black (n=46560)	Non-Hispanic White (n=118643)	Non-Hispanic Black (n=42585)
Sex								
Men	2552 (56.1)	1890 (48.3)	18324 (61.1)	15484 (58.9)	47710 (60.6)	26262 (56.4)	69702 (58.8)	20921 (49.1)
Women	1999 (43.9)	2021 (51.7)	11653 (38.9)	10807 (41.1)	30696 (39.2)	20298 (43.6)	48941 (41.3)	21664 (50.9)
Insurance type[b]								
Medicaid	1599 (36.8)	1929 (50.2)	10024 (34.8)	10662 (41.4)	20388 (27.1)	17130 (37.8)	12991 (11.5)	9897 (24.3)
Medicare	175 (4.0)	175 (4.6)	3200 (11.1)	2611 (10.1)	17435 (23.2)	9340 (20.6)	83060 (73.3)	24454 (60.1)
Private	1553 (35.8)	779 (20.3)	10188 (35.4)	6877 (26.7)	24347 (32.3)	10843 (23.9)	11058 (9.8)	3899 (9.6)
Other	601 (13.8)	343 (8.9)	2904 (10.1)	2124 (8.2)	9380 (12.5)	4981 (11.0)	5717 (5.1)	2257 (5.5)
No coverage	414 (9.5)	619 (16.1)	2476 (8.6)	3504 (13.6)	3737 (5.0)	3007 (6.6)	436 (0.4)	207 (0.5)
Body-mass index[c]								
<18	313 (7.2)	205 (5.4)	762 (2.7)	524 (2.0)	1764 (2.3)	1307 (2.9)	3091 (2.7)	1608 (3.8)
18-24.9	1877 (43.4)	1285 (33.5)	7003 (24.4)	5236 (20.3)	16074 (21.2)	11019 (24.2)	28957 (25.0)	12046 (28.8)
25-29.9	969 (22.4)	861 (22.5)	7068 (24.6)	6183 (24.0)	19347 (25.5)	11933 (26.2)	33686 (29.0)	12098 (28.9)
≥30	1171 (27.0)	1483 (38.7)	13901 (48.4)	13798 (53.6)	38706 (51.0)	21344 (46.8)	50248 (43.3)	16097 (38.5)

Attributed cause of ESKD[d]								
Diabetes	700 (16.0)	926 (24.0)	12764 (44.0)	10072 (38.8)	39582 (51.8)	21553 (47.0)	55003 (47.2)	19972 (47.5)
Hypertension	712 (16.3)	1110 (28.8)	5570 (19.2)	10551 (40.7)	15866 (20.8)	17574 (38.3)	33618 (28.9)	16996 (40.4)
Glomerulonephritis	1602 (36.7)	1262 (32.7)	4270 (14.7)	2674 (10.3)	5996 (7.9)	2367 (5.16)	6889 (5.9)	1279 (3.0)
Polycystic kidney	429 (9.8)	71 (1.8)	2554 (8.8)	479 (1.9)	3720 (4.9)	634 (1.4)	2153 (1.9)	337 (0.8)
Urologic	227 (5.2)	49 (1.3)	531 (1.8)	100 (0.4)	1433 (1.9)	268 (0.6)	2191 (1.9)	283 (0.7)
Other	607 (13.9)	403 (10.5)	3019 (10.4)	1870 (7.2)	9042 (11.8)	3167 (6.9)	15406 (13.2)	2838 (6.8)
Unknown	92 (2.1)	37 (1.0)	310 (1.1)	209 (0.8)	725 (1.0)	351 (0.8)	1228 (1.1)	349 (0.8)
Comorbidity								
Hypertension	3184 (73.2)	3285 (85.2)	24271 (83.9)	23655 (91.3)	65124 (85.4)	41921 (91.4)	100943 (86.8)	38296 (91.4)
Diabetes	786 (18.1)	1106 (28.7)	14354 (49.6)	12745 (49.2)	47116 (61.8)	28198 (61.5)	70078 (60.2)	26969 (64.2)
Cardiac failure	234 (5.4)	405 (10.5)	4059 (14.0)	5304 (20.47)	19571 (25.7)	13159 (28.7)	40300 (34.6)	13967 (33.3)
Tobacco use	351 (8.1)	273 (7.1)	3453 (11.9)	2323 (9.0)	8052 (10.6)	4481 (9.8)	6359 (5.5)	2327 (5.5)
Drug abuse	197 (4.5)	99 (2.6)	1042 (3.6)	821 (3.2)	1197 (1.6)	1488 (3.3)	259 (0.2)	399 (1.0)
Atherosclerotic heart disease	28 (0.6)	40 (1.0)	1478 (5.1)	1032 (4.0)	9446 (12.4)	3887 (8.5)	22389 (19.25)	5347 (12.7)
Peripheral vascular disease	52 (1.2)	65 (1.7)	1533 (5.3)	1083 (4.2)	8149 (10.7)	3414 (7.5)	14347 (12.33)	3952 (9.4)
Cerebrovascular disease	53 (1.2)	66 (1.7)	1345 (4.7)	1382 (5.3)	6315 (8.3)	4788 (10.4)	11183 (9.6)	5244 (12.5)
Cancer	47 (1.1)	28 (0.7)	730 (2.5)	391 (1.5)	4798 (6.3)	1949 (4.3)	13018 (11.2)	3638 (8.7)
Alcohol abuse	63	26	797	426	1906	1236	1235	561

	(1.5)	(0.7)	(2.8)	(1.6)	(2.5)	(2.7)	(1.1)	(1.3)
Chronic obstructive pulmonary disease	27 (0.6)	25 (0.7)	1078 (3.7)	656 (2.5)	8392 (11.0)	3437 (7.5)	17457 (15.0)	4361 (10.4)
Pre-ESKD nephrology care[e]								
No	1110 (29.0)	1225 (37.3)	6220 (24.4)	7165 (32.8)	14630 (22.0)	10493 (27.5)	18794 (18.6)	7710 (22.4)
Yes	2721 (71.0)	2059 (62.7)	19305 (75.6)	14711 (67.3)	51766 (78.0)	27617 (72.5)	82175 (81.4)	26720 (77.6)
Neighborhood poverty (% of ZIP code residents below poverty)[f]								
0%-19.9% below poverty	4080 (90.6)	2663 (68.8)	26612 (89.8)	18071 (69.6)	70181 (90.6)	31533 (68.8)	109088 (92.9)	29806 (70.9)
≥20% below poverty	422 (9.4)	1208 (31.2)	3021 (10.19)	7910 (30.5)	7264 (9.4)	14329 (31.2)	8319 (7.1)	12237 (29.1)

Abbreviations: CI, confidence interval; ESKD, end-stage kidney disease.

[a] Data shown as No. (%), unless indicated otherwise.

[b] Insurance information missing for 13603 patients (3.88%)

[c] Body-mass index missing for 8959 patients (2.55%)

[d] Patient attributable cause missing for 6904 patients (1.97%)

[e] Nephrology care information missing for 56503 (16.10%)

[f] Information on neighborhood poverty missing for 4180 (1.19%)

Table 2. Crude Incidence of ESKD Patients Placement on the Waitlist and Death by Race and Age, 2015-2018

	Overall			Non-Hispanic Black			Non-Hispanic White		
	Waitlisting N (%)	Death N (%)	Total No.	Waitlisting N (%)	Death N (%)	Total No.	Waitlisting N (%)	Death N (%)	Total No.
Overall	65385 (18.6)	123975 (35.3)	350924	21485 (18.0)	33384 (28.0)	119347	43900 (19.0)	90591 (39.1)	231577
Age									
18-29	4145 (49.0)	966 (11.4)	8462	1506 (38.5)	526 (13.5)	3911	2639 (58.0)	440 (9.7)	4551
30-49	19543 (34.7)	9614 (17.1)	56268	7960 (30.3)	4150 (15.8)	26291	11583 (38.6)	5464 (18.2)	29977
50-64	27711 (22.2)	36748 (29.4)	124966	8926 (19.2)	11876 (25.5)	46560	18785 (24.0)	24872 (31.7)	78406
65-80	13986 (8.7)	76647 (47.5)	161228	3093 (7.3)	16832 (39.5)	42585	10893 (9.2)	59815 (50.4)	118643

Non-Hispanic, White patients are reference group. ESKD, end-stage kidney disease

Table 3. Cumulative Incidence of ESKD Patients Placement on the Waitlist by Race and Age, 2015-2018[a]

		Patient Race		
		Overall	**Non-Hispanic Black**	**Non-Hispanic White**
		CIF (95% CI)	CIF (95% CI)	CIF (95% CI)
Overall		19.4% (19.3, 19.5)	19.1% (18.9, 19.3)	19.5% (19.4, 19.7)
Age				
	18-29	50.9% (49.8, 52.1)	40.5% (38.8, 42.1)	59.9% (58.4, 61.4)
	30-49	36.3% (35.9, 36.8)	32.3% (31.7, 32.9)	39.9% (39.3, 40.5)
	50-64	23.1% (22.9, 23.3)	20.3% (19.9, 20.7)	24.7% (24.4, 25.1)
	65-80	8.9% (7.7, 9.0)	7.5% (7.3, 7.8)	9.3% (9.2, 9.5)

Non-Hispanic, White patients are reference group. CI, confidence interval; ESKD, end-stage kidney disease

[a]Calculated using cumulative incidence function and adjusted for competing risk of death

Table 4. Relative Adjusted Hazard of Waitlisting (non-Hispanic Black vs non-Hispanic White) Among Dialysis Patients, by Age, 2015-2018[a]

	Unadjusted HR (95% CI)	Adjusted HR (95% CI)[a]
Overall	0.87 (0.85, 0.88)	0.87 (0.85, 0.88)
Age		
18-29	0.55 (0.51, 0.58)	0.74 (0.69, 0.80)
30-49	0.70 (0.68, 0.72)	0.89 (0.86, 0.92)
50-64	0.73 (0.72, 0.75)	0.89 (0.86, 0.91)
65-80	0.73 (0.70, 0.76)	0.82 (0.79, 0.86)

Non-Hispanic, White patients are reference group. CI, confidence interval

[a] Cox models were performed to obtain hazard ratios adjusting for age, race (non-Hispanic Black vs non-Hispanic white), sex, insurance type at ESKD onset, body-mass index, attributed cause of ESKD (diabetes, hypertension, glomerulonephritis, polycystic kidney, urologic, unknown), atherosclerotic heart disease, cardiac failure, peripheral vascular disease, cerebrovascular disease, hypertension, pre-ESKD nephrology care, diabetes, tobacco use, cancer, chronic obstructive pulmonary disease, drug abuse, alcohol abuse, and neighborhood poverty.

Table 5. Relative Adjusted Hazard of Waitlisting (non-Hispanic Black vs non-Hispanic White) Among Dialysis Patients 18-29, 2015-2018[a]

	Patient Race		
	Non-Hispanic Black Patients	Non-Hispanic White Patients	
	Waitlisting (%)	Waitlisting (%)	aHR (95% CI)[a]
Sex			
Men	750 (39.68)	1500 (58.75)	0.71 (0.62, 0.78)
Women	756 (37.41)	1139 (56.98)	0.65 (0.58, 0.72)
Insurance type			
Medicaid	638 (33.07)	681 (42.59)	0.80 (0.71, 0.912)
Medicare	57 (32.57)	96 (54.86)	0.51 (0.35, 0.749)
Private	470 (60.33)	1234 (79.46)	0.61 (0.54, 0.683)
Other	159 (46.36)	396 (65.89)	0.62 (0.50, 0.769)
No coverage	168 (27.14)	140 (33.82)	0.68 (0.53, 0.883)
Body-mass index			
<18	82 (40.00)	185 (59.11)	0.64 (0.47, 0.876)
18-24.9	539 (41.95)	1146 (61.05)	0.69 (0.62, 0.776)
25-29.9	345 (40.07)	569 (58.72)	0.67 (0.575, 0.786)
≥30	521 (35.13)	641 (54.74)	0.63 (0.551, 0.718)
Attributed cause of ESKD			
Diabetes	261 (28.19)	233 (33.29)	1.03 (0.835, 1.258)
Hypertension	391 (35.23)	357 (50.14)	0.64 (0.543, 0.754)
Glomerulonephritis	643 (50.95)	1091 (68.10)	0.65 (0.582, 0.725)
Polycystic kidney	43 (60.56)	334 (77.86)	0.62 (0.427, 0.898)
Urologic	29 (59.18)	164 (72.25)	1.00 (0.645, 1.550)
Other	113 (28.04)	329 (54.20)	0.46 (0.360, 595)
Unknown	14 (37.84)	58 (63.04)	0.36 (0.177, 0.742)
Pre-ESKD nephrology care			
No	387 (31.59)	538 (48.47)	0.66 (0.572, 0.757)
Yes	924 (44.88)	1779 (65.38)	0.69 (0.630, 0.749)
Neighborhood poverty (% of ZIP code residents below poverty)[e]			
0%-19.9% below poverty	1116 (41.91)	2435 (59.68)	0.65 (0.602, 0.706)
≥20% below poverty	376 (31.13)	176 (41.71)	0.84 (0.684, 1.032)

Abbreviations: CI, confidence interval; ESKD, end-stage kidney disease; HR, hazard ratio.

[a] Cox models were performed to obtain hazard ratios adjusting for age, race (non-Hispanic Black vs non-Hispanic white), sex, insurance type at ESKD onset, body mass index, attributed cause of ESKD (diabetes, hypertension, glomerulonephritis, polycystic kidney, urologic, unknown), atherosclerotic heart disease, cardiac failure, peripheral vascular disease, cerebrovascular disease, hypertension, pre-ESKD nephrology care, diabetes, tobacco use, cancer, chronic obstructive pulmonary disease, drug abuse, alcohol abuse, and neighborhood poverty.

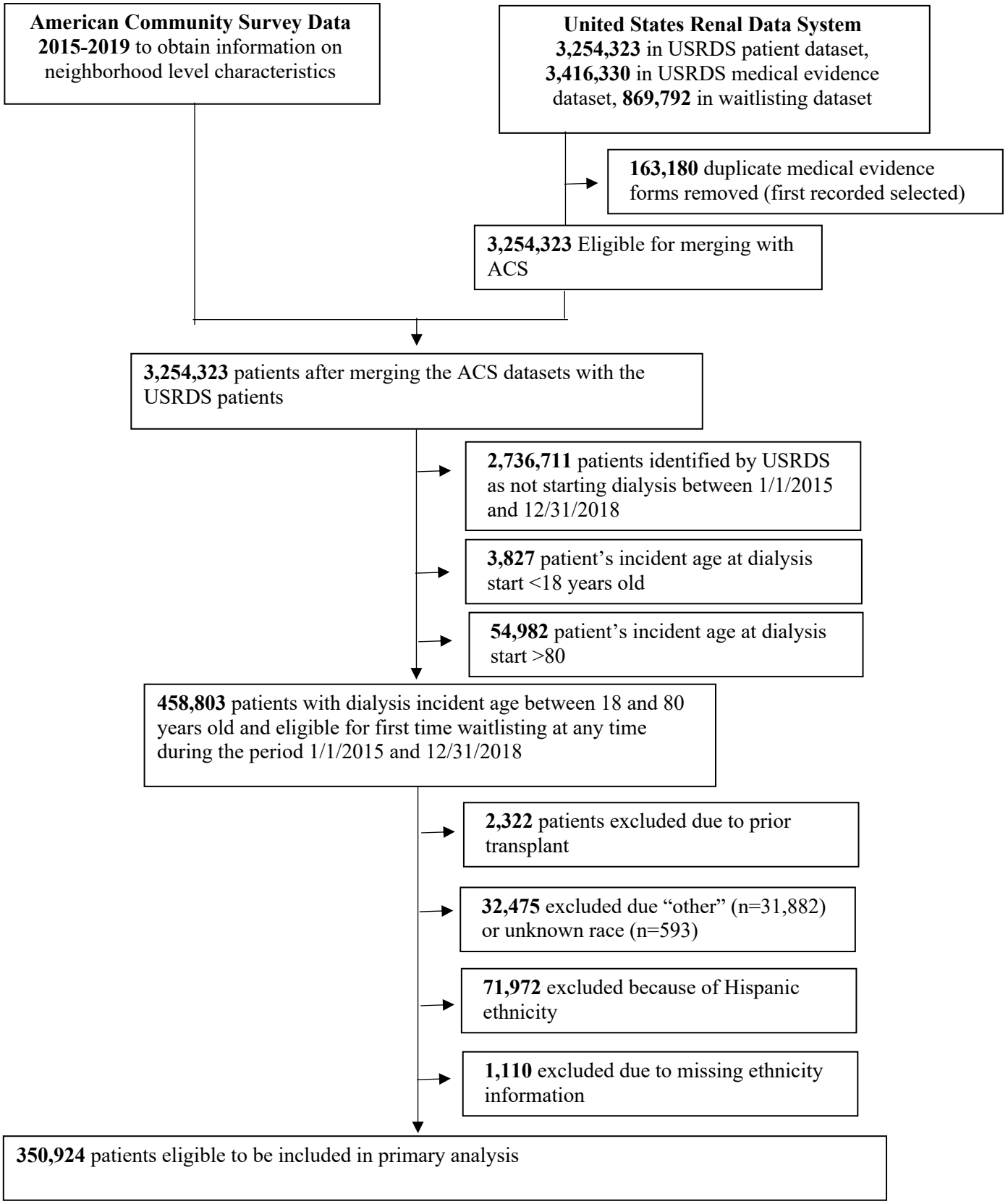

Figure 1. Data merge and cohort selection to examine the relationship between race and age on waitlisting on the national transplant waitlist.

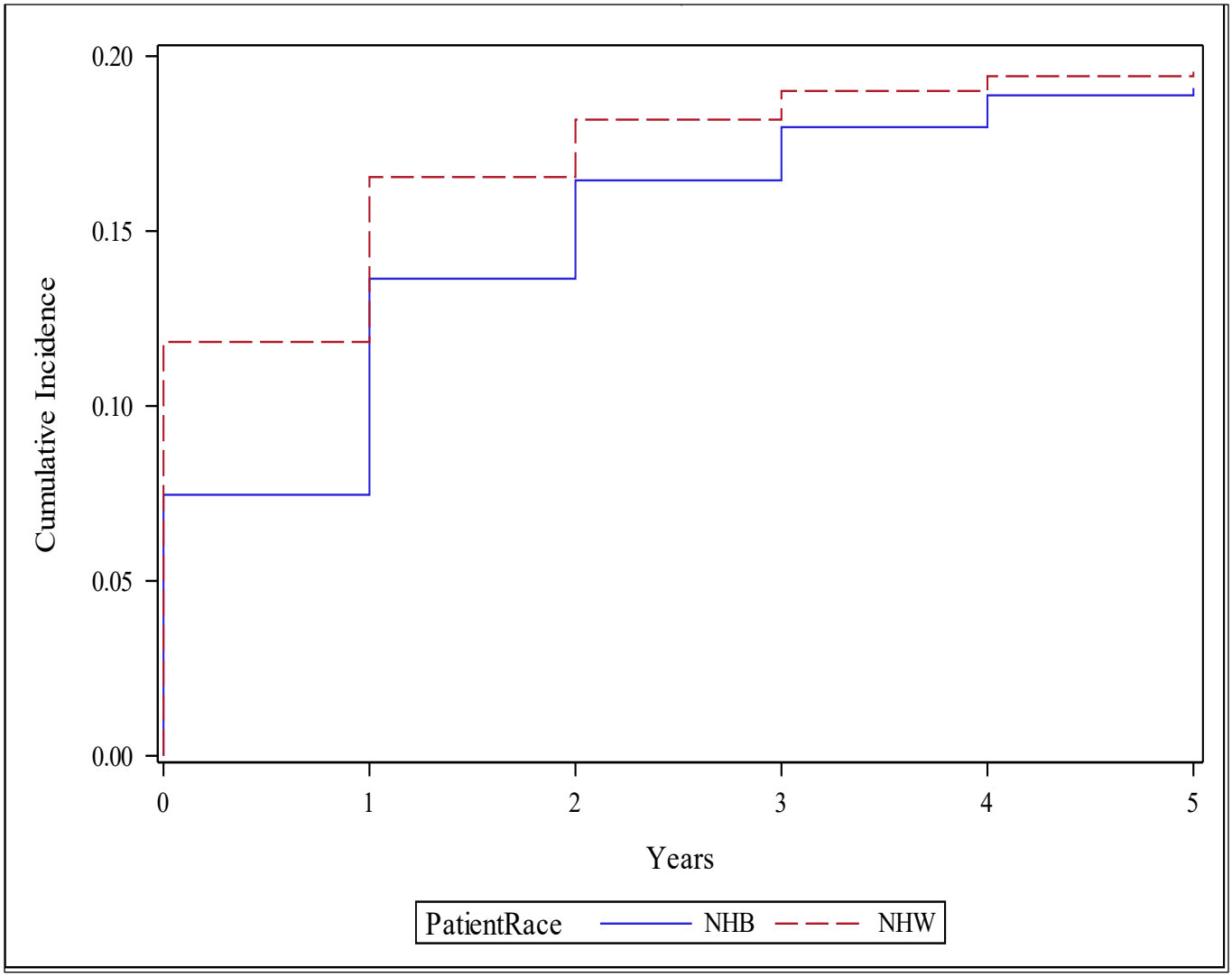

Figure 2a. Cumulative Incidence of Waitlisting During the Study Period Among Incident ESKD Patients by Race, 2015-2018

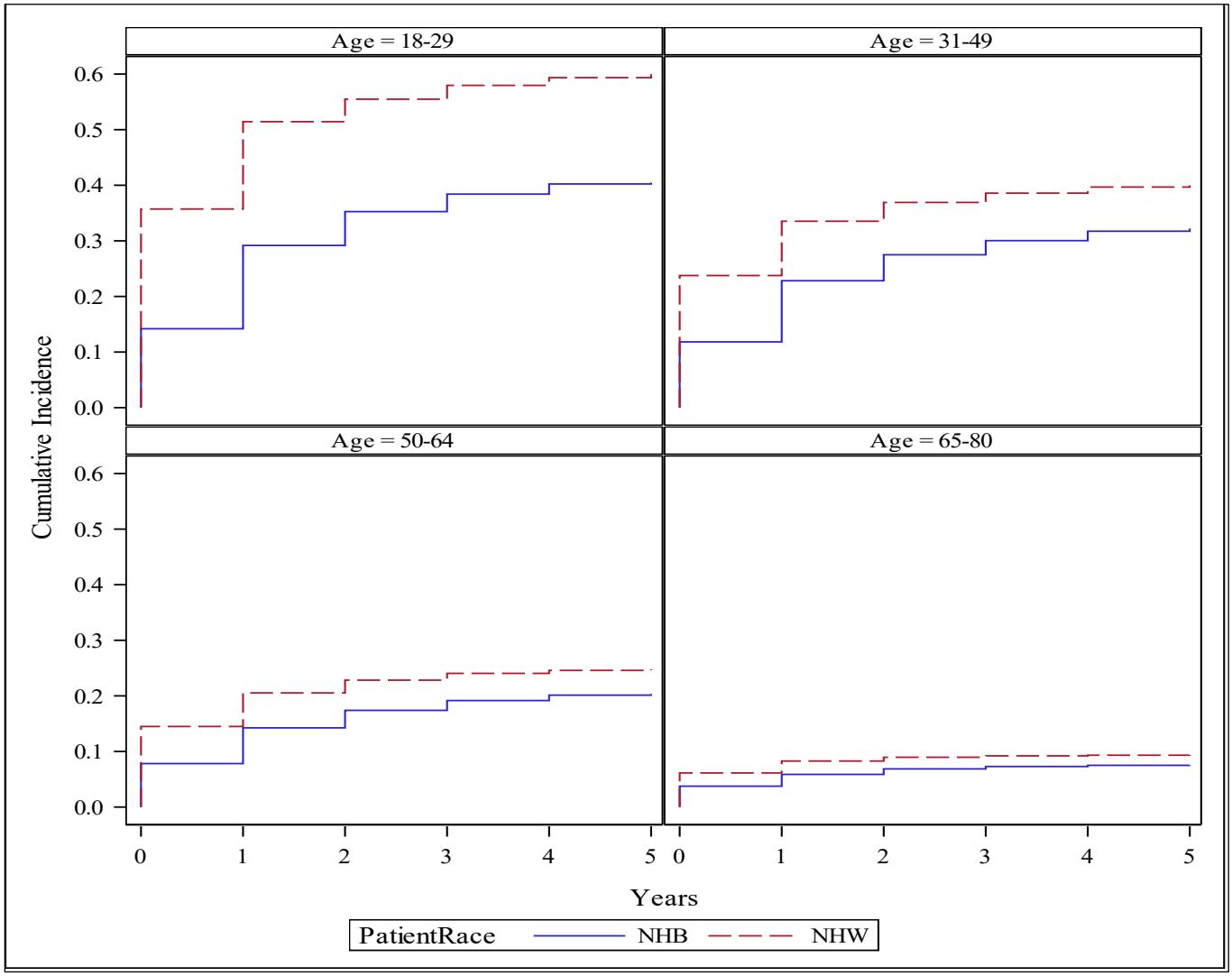

Figure 2b. Cumulative Incidence of Waitlisting During the Study Period Among Incident ESKD Patients by Race and Age**,** 2015-2018