Race and Mortality in Hemodialysis Patients in Brazil

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Rationale & Objective: Studies in the United States and United Kingdom generally report better survival for Black than White patients undergoing maintenance hemodialysis, a finding not explained by differences in sociodemographics or comorbid conditions. It is not clear if such findings can be generalized to other countries. We investigated the association between race and mortality among a Black, White, and Mixed-Race sample of maintenance hemodialysis patients in Salvador, Brazil.

Study Design: Prospective cohort study. Baseline data collection from July 1, 2005 through December 31, 2010. The follow-up period ended on December 31, 2017.

Setting & Participants: The Prospective Study of the Prognosis of Chronic Hemodialysis Patients (PROHEMO) is a cohort of 1,501 patients from 4 dialysis units in Salvador, Brazil.

Predictor: Race categorized as White (12.9%), Mixed-Race (62.4%), and Black (24.8%), using White as the reference category.

Outcome: Survival.

A higher mortality in White patients with chronic kidney disease on maintenance hemodialysis, when compared to Black and other races, has been reported in studies from the United States and United Kingdom. A US study of 1,282,201 incident dialysis patients showed a 70% higher mortality for White compared to Black and Hispanic patients, even after adjusting for effects of individual risk factors of death, such as smoking and major comorbid conditions. In addition, there are some indications that age may be an effect modifier of associations between race and mortality in patients undergoing maintenance dialysis in the United States in that a higher mortality was observed for Black than White patients only among those younger than 50 years. A higher death rate for infection was also observed in US Black patients on hemodialysis for ages 18-30 years.

It is unclear if the above US and UK racial differences in mortality among patients on hemodialysis can be generalized to other countries. Although race is often self-reported in these studies, in others, notably those from Latin American countries, racial classification is often based on skin color and facial features. Regardless of the classification scheme, however, “race” is increasingly appropriately recognized as a sociopolitical construct with profound implications for how population-level health inequities are socially patterned within countries.

Analytical Approach: Using Cox regression models, we tested the association between race and mortality, with adjustments for age, sex, social factors, laboratory results, and comorbid conditions.

Results: The mean age was 49 years for Black and Mixed-Race patients and 55 years for White patients. In a Cox model adjusted for age, mortality did not differ between Black and White patients (HR, 1.00; 95% CI, 0.66-1.83) or between Mixed-Race and White patients (HR, 1.00; 95% CI, 0.65-1.54). Adjustment for sociodemographics and comorbid conditions had minimal impact on these results.

Limitations: Potential residual confounding and lack of adjustment for time-varying variables.

Conclusions: Contrary to studies in the United States and United Kingdom, we did not find racial difference in mortality among patients in our Brazilian setting who were being treated by maintenance hemodialysis. These results underscore the importance of investigating racial differences in mortality among patients undergoing maintenance hemodialysis in different populations and countries.

Using data from a multiracial Brazilian maintenance hemodialysis population, the present study investigates associations between race and mortality and the role of sociodemographic factors and comorbid conditions in any observed association.

METHODS

Data Source

The data are from the Prospective Study of the Prognosis of Chronic Hemodialysis Patients (PROHEMO), an open prospective cohort study that began in 2005 in 4 satellite dialysis centers in the city of Salvador, Bahia, Brazil. Salvador is the capital of Brazil’s northeastern state of Bahia and home of the largest African descendant population outside of Africa. As in all regions of Brazil, the cost of hemodialysis treatment for most patients in PROHEMO was covered by the Brazilian Public Health Care System. A minority of patients used their supplemental private health insurance options. The Brazilian Public Health Care System also financed diagnostic evaluations and surgery for the creation of arteriovenous fistula and provided free access to medications.

The Institutional Review Board of the University Hospital of the Medical School of the Federal University of Bahia, in Salvador, Brazil, approved the study protocol.
PLAIN-LANGUAGE SUMMARY

A higher mortality in White than non-White patients has been reported in hemodialysis patients with chronic kidney disease in the United States and United Kingdom. These are intriguing findings given the poorer health outcomes for non-White than White individuals in general populations. It is unclear if the US and UK results can be generalized to other countries. Contrary to the US and UK results, we did not find differences in mortality between White and non-White enrollees in our Brazilian cohort of 1,501 hemodialysis patients. These results underscore the importance of investigating racial differences in mortality among hemodialysis patients in a variety of settings and cultures before concluding that results from the United States and United Kingdom also apply elsewhere.

Lopes et al17 and now used by many Brazilian investigators.9,18 These criteria, which focus on skin color, hair texture, and shape of the nose, were further aided during training by the use of photos of well-known Brazilian artists and athletes as examples of persons who, in the local context, would be considered “Black,” “White,” or “Mixed-Race.”

The Brazilian Institute of Market Research classification system, which focuses on the presence or absence of household consumer goods, was used to determine economic class: A, B, C, D, or E,19 whereby patients in classes D and E were categorized as poor and very poor, respectively.

Follow-up and Outcome Ascertainment

Follow-up mortality data were obtained from cohort entry date through December 31, 2017, with censoring because of withdrawal from hemodialysis, transplantation, switch to peritoneal dialysis, or end of study follow-up.

As shown in Fig 1, of 1,601 eligible patients (aged greater than or equal to 18 years), 75 (4.7%) did not agree to participate. Of the 1,526 who agreed, 7 had missing data for race and 18 had missing mortality outcome data. A total of 1,501 patients without missing data for race and mortality constituted the analysis sample.

Analytical Approach

When study variables were quantitative, group differences were compared using the t test or Mann-Whitney test. When study variables were categorical, the χ² test or the Fisher exact test were used to compare group differences. Poisson regression with robust estimate of confidence intervals (CIs) was used to assess variation in the rate ratio (RR) involving associations between race and mortality across age categories, or after adjusting rate ratios for age.

Poisson regression was also used to assess the influence of potential confounders on comparisons of race with the prevalence of diabetes and hemodialysis by catheter.

With White patients as the reference category, Cox models were used to estimate the hazard ratio (HR) and 95% CI for associations between race and death from all-causes. In Model 1, the HR was adjusted only for age. Model 2 adjusted the HR for months on dialysis, age, sex, education, economic class, living with family, and health insurance. Model 3 adjusted the HR for all variables shown in Table 1. A separate Cox regression model examined the association between race and all-cause mortality after excluding patients who died in the first 90 days of follow-up. We calculated time at risk as the time interval from study entry until the earliest event, whether death, end of follow-up, or censoring events (ie, kidney transplantation, switch to peritoneal dialysis, withdrawal from dialysis). Missingness occurred in less than 3.5%, except for body mass index (20.5%) and Kt/V (6.7%). Missing data for covariates were imputed using sequential regression multiple imputation to generate a total of 20 samples. Estimates of association for each sample were generated and pooled to obtain the final estimate. Analyses were
performed using the SPSS version 28 and the following packages of the R Project for Statistical Computing version 4.1.1: epiR, Hmisc, stats, and the sandwich.

**RESULTS**

As shown in Table 1, the 1,501 patients in the analysis sample consisted of 372 (12.9%) White, 936 (62.4%) Mixed-Race, and 372 (24.8%) Black patients. The mean age of the sample was 49.6 years overall, with 55.3 years for White, 48.7 years for Mixed-Race, and 48.8 years for Black patients. Among the 18 patients not included in the analysis sample, the distribution by race was 2 (11.1%) White, 9 (50.0%) Mixed-Race, and 7 (38.9%) Black. Of the 18 missing patients, the mean age (not shown in Table 1) was 48.0 years overall, with 56.9 years for White, 45.0 years for Mixed-Race, and 49.3 years for Black patients.

The proportion of patients classified as either poor/very poor, lacking health insurance, or less than high school education was higher for Black and Mixed-Race than for White patients. The prevalence of hypertensive nephropathy was higher in Black (43%) and Mixed-Race (30%) than in White patients (25%). Similarly, a higher prevalence of glomerulonephritis was observed in Black (21%) and Mixed-Race (24%) than in White patients (15%). By contrast, a higher prevalence of diabetic nephropathy was observed in White (33%) than in Mixed-Race (24%) and Black patients (18%). Also, the diagnosis of diabetes was higher for White (43%) than for Mixed-Race (26%) and Black (24%) patients. The prevalence of hemodialysis through catheter was lower among Black (30%) and Mixed-Race (39%) than among White patients (51%). Lower concentrations of serum creatinine and parathyroid hormone (both median and mean log) were also observed for White than for Mixed-Race and Black patients.

Using the data in Table 1, point estimates of prevalence ratios (PRs) of dialysis by catheter were 0.76 (39%/51%) comparing Mixed-Race and White patients and 0.59 (30%/51%) comparing Black and White patients. Using Poisson regression with adjustments for age, diabetes, kidney disease, and months on hemodialysis, the point estimate of the PR of dialysis by catheter was 0.90 comparing Mixed-Race to White (the reference category) and 0.83 comparing Black to White patients (the reference category). When comparing prevalence of diabetes by race for the comparison between Mixed-Race and White patients, the unadjusted PR was 0.60 (26%/43%) and the PR adjusted for age was 0.73. A similar picture emerged comparing prevalence of diabetes between Black and White patients, where the unadjusted PR was 0.56 (24%/43%) and the PR adjusted for age was 0.70.

The median (interquartile range) of follow-up was 41 (16-86) months. For White, Mixed-Race, and Black patients, kidney transplant occurred in 4.7%, 6.5%, and 4.8% of patients, respectively; dialysis withdrawal occurred in 1.0%, 0.7%, and 0.8%, respectively; and switches to peritoneal dialysis occurred in 6.7%, 4.1%, and 5.4%, respectively. Table 2 summarizes death rates per 100 person-years (pys) by race, overall, and stratified by age categories. A total of 710 deaths occurred in 6,562.5 pys of follow-up, and an overall death rate of 10.8 cases per 100 pys. Compared to the White death rate (12.4/10^5 pys), the death rate was slightly lower for Mixed-Race (10.4/10^2 prys), yielding a crude RR of 0.84 (95% CI, 0.66-1.06). Black patients also had a slightly lower death rate (11.3/10^3 pyps) than their White peers, yielding a crude RR of 0.91 (95% CI, 0.7-1.18). For each comparison, the 95% CI included the null value. When age was adjusted in the Poisson regression analysis, the RR for Mixed-Race versus White patients (the reference category) changed (RR, 1.05; 95% CI, 0.83-1.31), but still included the null value. Age adjustment also changed the RR for the comparison between Black and White patients (RR, 1.26; 95% CI, 0.99-1.61), but included the null value. Similar results were observed after excluding mortality in the first 90 days.

Figure 2 compares mortality by race in the unadjusted and covariate-adjusted Cox models; White patients are again the reference category. In the unadjusted model, the HR was 0.84 (95% CI, 0.67-1.05) for Mixed-Race and 0.91 (95% CI, 0.71-1.17) for Black patients. Adjusting for age (Model 1), the HR was 1.00 (95% CI, 0.65-1.54) for Mixed-Race and 1.10 (95% CI, 0.66-1.83) for Black patients. In the Cox model with extensive adjustments for all variables in Table 1 (Model 3), the HRs were 1.10 (95% CI, 0.69-1.74) for Mixed-Race compared to White, and 1.25 (95% CI, 0.72-2.17) for Black compared to White patients.

In a Cox model including only diabetes as a covariate, the HR was 0.95 (95% CI, 0.75-1.20) for Mixed-Race and White (the reference category), and 1.10 (95% CI, 0.85-1.42) for Black and White patients. After excluding patients who died in the first 90 days of follow-up, a sensitivity analysis using fully adjusted Cox models investigating associations among the longer surviving 1,416 patients produced a HR of 1.19 (95% CI,
In contrast to studies in the United States and United Kingdom, we found no meaningful differences in mortality between White, Mixed-Race, and Black maintenance hemodialysis patients being treated in nephrology clinics in Salvador, Bahia, Brazil, a large metropolitan city located in the Northeast region of the country. Mixed-Race and Black patients in our study were younger than White patients, a fact that might have explained their slightly lower survival in the crude analyses. Indeed, after adjusting for racial group differences in age, the initial, slight survival advantage for Black and Mixed-Race patients was no longer observed. These null findings persisted after additional, extensive, statistical adjustments for sociodemographic variables, laboratory test results, type of vascular access, and comprehensive, statistical adjustments for socioeconomic factors.

DISCUSSION

In contrast to studies in the United States and United Kingdom, we found no meaningful differences in mortality between White, Mixed-Race, and Black maintenance hemodialysis patients being treated in nephrology clinics in Salvador, Bahia, Brazil, a large metropolitan city located in the Northeast region of the country. Mixed-Race and Black patients in our study were younger than White patients, a fact that might have explained their slightly lower survival in the crude analyses. Indeed, after adjusting for racial group differences in age, the initial, slight survival advantage for Black and Mixed-Race patients was no longer observed. These null findings persisted after additional, extensive, statistical adjustments for sociodemographic variables, laboratory test results, type of vascular access, and comprehensive, statistical adjustments for socioeconomic factors.

Table 1. Characteristics of the Study Sample by Racial Groups

| Characteristics | Racial Groups | White (13%) | Mixed-Race (62%) | Black (25%) | Total (1,501) |
|----------------|--------------|-------------|-----------------|-------------|---------------|
| Patients, n (row %) |              | 193         | 936             | 372         | 1,501         |
| Demographics |              |             |                 |             |               |
| Age in years, mean (SD) |              | 55.3 (13.7) | **48.7** (14.9) | **48.8** (14.2) | **49.6** (14.8) |
| Age ≥60 y |              | 79/193 (41%) | 230/936 (25%) | 82/372 (22%) | 391/1,501 (26%) |
| Male |              | 126/193 (65%) | **544/936** (58%) | 229/372 (62%) | 899/1,501 (60%) |
| Body mass index, mean (SD) |              | 24.1 (4.7) | **22.8** (4.2) | 22.4 (3.6) | 22.8 (4.2) |
| Socioeconomic factors |              |             |                 |             |               |
| Less than high school education |              | 80/193 (42%) | **557/936** (60%) | 266/372 (72%) | 903/1,500 (60%) |
| Poor or very poor |              | 35/187 (19%) | **335/928** (36%) | 184/367 (60%) | 554/1,482 (37%) |
| Living with family |              | 173/193 (90%) | 844/936 (90%) | 332/371 (90%) | 1,349/1,500 (90%) |
| Without private health insurance |              | 85/191 (45%) | **636/922** (69%) | 282/361 (78%) | 1,003/1,474 (68%) |
| Kidney disease |              |             |                 |             |               |
| Hypertensive nephropathy |              | 48/192 (25%) | 285/927 (31%) | 159/369 (43%) | 492/1,488 (33%) |
| Diabetic nephropathy |              | 64/192 (33%) | **224/927** (24%) | 68/369 (18%) | 356/1,488 (24%) |
| Glomerulonephritis |              | 28/192 (15%) | **221/927** (24%) | 79/369 (21%) | 328/1,488 (22%) |
| Polycystic kidney disease |              | 23/192 (12%) | **49/927** (5%) | 8/369 (2%) | 80/1,488 (5%) |
| Other or undetermined |              | 29/192 (15%) | 148/927 (16%) | 55/369 (16%) | 232/1,488 (16%) |
| Treatment variables |              |             |                 |             |               |
| Catheter as vascular access |              | 98/192 (51%) | **367/936** (39%) | 111/372 (30%) | 576/1,500 (38%) |
| <6 mo on dialysis |              | 114/191 (60%) | **430/928** (46%) | 130/368 (35%) | 674/1,487 (45%) |
| Kt/V, mean (SD) |              | 1.44 (0.44) | 1.50 (0.47) | 1.50 (0.43) | 1.49 (0.45) |
| Laboratory |              |             |                 |             |               |
| Albumin, g/dL, mean (SD) |              | 3.8 (0.7) | 3.9 (0.6) | 3.9 (0.5) | 3.9 (0.6) |
| Creatinine, mg/dL, mean (SD) |              | 8.8 (3.5) | **9.7** (3.7) | **10.2** (3.6) | 9.7 (3.7) |
| Hemoglobin, g/dL, mean (SD) |              | 9.5 (1.8) | 9.6 (1.9) | 9.5 (2.0) | 9.6 (1.9) |
| Calcium, mg/dL, mean (SD) |              | 9.2 (1.1) | 9.1 (0.9) | 9.2 (0.8) | 9.1 (0.9) |
| Phosphorus, mg/dL, mean (SD) |              | 5.0 (1.4) | 5.1 (1.7) | 5.0 (1.6) | 5.0 (1.6) |
| PTH, pg/mL, median [IQR] |              | 160 [77, 307] | **204 [95, 434]** | 234 [118, 519] | 214 [96, 425] |
| log(PTH), pg/mL, mean (SD) |              | 5.02 (1.23) | **5.27** (1.17) | **5.43** (1.20) | 5.28 (1.19) |
| Comorbid conditions |              |             |                 |             |               |
| Cerebrovascular disease |              | 9/187 (5%) | 47/913 (5%) | 25/364 (7%) | 81/1,464 (6%) |
| Heart failure |              | 21/186 (11%) | 104/905 (12%) | 51/360 (14%) | 176/1,451 (12%) |
| Ischemic heart disease |              | 18/188 (10%) | 80/912 (9%) | 37/362 (10%) | 135/1,462 (9%) |
| Peripheral vascular disease |              | 15/187 (8%) | **34/907** (4%) | **12/362** (3%) | 61/1,456 (4%) |
| Nonskin cancer |              | 8/187 (4%) | 22/907 (2%) | 12/358 (3%) | 42/1,452 (3%) |
| Hypertension |              | 155/188 (82%) | 782/917 (85%) | 305/365 (84%) | 1242/1,470 (85%) |
| Diabetes |              | 82/192 (43%) | **242/935** (26%) | **91/372** (24%) | **415/1,499** (28%) |

Notes: Results are expressed by percentage, mean (standard deviation) or median [interquartile range]. Bold numbers identify P values < 0.05 for the comparisons with White race. Percent of missing values were: 20.5% for body mass index, 6.7% for Kt/V, 3.3% for heart failure and nonskin cancer, 3.3% for peripheral vascular disease, 2.6% for cerebrovascular disease, 2.5% for hypertension, 1.3% for economic class (poor or very poor), 0.9% for diabetes, 2.6 for ischemic heart disease, 0.9% for months on dialysis, 0.1% for vascular access, 0.9% for kidney disease, 1.8% for health insurance, 0.1% for living with family.

Abbreviations: IQR, interquartile range; PTH, parathyroid hormone; SD, standard deviation.

1 in Table 1, please use parenthesis around the % in (79/369) 21% an add close parenthesis in 1349/1500 (90%)

2 In Table 1, please use parenthesis around the % in (79/369) 21%

3 In Table 1, the percent should be 15 in 55/369 (16%)
cause of kidney failure and comorbid conditions, and taking into account transplantation, dialysis withdrawal, and switch from hemodialysis to peritoneal dialysis. Similar null findings were observed after excluding persons who died within the first 90 days of follow-up, which rules out differential early mortality by race as a likely explanation for the null findings. In a Cox model including only diabetes as a covariate, the associations between race and mortality were similar to those in the model that included only age, suggesting that the null findings for race and mortality are partially explained by underlying racial differences in age and the prevalence of diabetes.

The DOPPS studied a representative sample of maintenance hemodialysis patients treated in the United States, randomly selected from 142 dialysis facilities.20 Similar to the present study, Black patients were much younger than White patients in the DOPPS. However, different from the present study, a lower mortality was observed for Black than for White patients in the analysis adjusted for age. An approximately 21% lower mortality was observed for Black as compared with White patients after adjusting for age, sex, underlying kidney disease, social characteristics, and comorbid conditions. The race difference was attenuated in the DOPPS only after including nutritional indicators, medical events (hospitalization days, outpatient procedures, and vascular access procedures), laboratory measures, and hemodialysis measures (hemodialysis treatment time, systolic blood pressure, and ultrafiltration) in the Cox regression model.

Compared to White, Black and Mixed-Race patients enrolled in the present study had higher proportions lacking private health insurance, educational level less than high school, and economic class classified as poor or very

| Table 2. Crude Death Rates by Race and Age and Rate Ratios of Death |
|-----------------------------------------------|
| **Race** | **Total** | **Deaths** | **Person-years** | **Rate per 100 Person-years** | **Rate Ratio (95% CI)** |
|-----------------------------------------------|
| **Age 18-44 y**                              |
| **White** | 36        | 6         | 203.6           | 2.9                          | Ref=1                     |
| **Mixed-Race** | 386 | 106       | 1,975.9         | 5.4                          | 1.82 (0.81-4.08)           |
| **Black** | 150       | 63        | 949.2           | 6.6                          | 2.25 (0.99-5.12)           |
| **45-59 y**                                  |
| **White** | 78        | 32        | 299.7           | 10.7                         | Ref=1                     |
| **Mixed-Race** | 320 | 158       | 1,384.2         | 11.4                         | 1.07 (0.75-1.53)           |
| **Black** | 140       | 75        | 581.4           | 12.9                         | 1.21 (0.82-1.78)           |
| **≥60 y**                                    |
| **White** | 79        | 51        | 217.1           | 23.5                         | Ref=1                     |
| **Mixed-Race** | 230 | 161       | 740.3           | 21.7                         | 0.93 (0.67-1.28)           |
| **Black** | 82        | 58        | 211.2           | 27.5                         | 1.17 (0.81-1.68)           |
| **All patients**                             |
| **White** | 193       | 89        | 720.3           | 12.4                         | Ref=1                     |
| **Mixed-Race** | 936 | 425       | 4,100.4         | 10.4                         | 0.84 (0.66-1.06)           |
| **Black** | 372       | 196       | 1,741.8         | 11.3                         | 0.91 (0.70-1.18)           |
| **Total** | 1,501     | 710       | 6,562.5         | 10.8                         |                          |

**Excluding Mortality in the First 90 Days**

| **Race** | **Total** | **Deaths** | **Person-years** | **Rate per 100 Person-years** | **Rate Ratio (95% CI)** |
|-----------------------------------------------|
| **White** | 175       | 83        | 717.8           | 11.6                         | Ref=1                     |
| **Mixed-Race** | 886 | 406       | 4,094.6         | 9.9                          | 0.86 (0.68-1.09)           |
| **Black** | 355       | 187       | 1,739.5         | 10.8                         | 0.93 (0.72-1.21)           |
| **Total** | 1,416     | 676       | 6,551.9         | 10.3                         |                          |

Abbreviations: CI, confidence interval; Ref, reference.
*Adjusted using Poisson regression

Figure 2. Risk of death by level of adjustment, using hazard ratios (95% CI) of the associations between race and mortality. Model 1: Included age. Model 2: Included months on dialysis, age, sex, education, economic class, living with family, health insurance and diagnosis of kidney disease. Model 3: included catheter for vascular access, Kt/V, albumin, creatinine, hemoglobin, calcium, phosphorus, parathyroid hormone, body mass index, cerebrovascular disease, heart failure, ischemic heart disease, peripheral vascular disease, nonskin cancer, hypertension, diabetes, plus covariates in adjusted Model 2. Abbreviations: CI, confidence interval; HR, hazard ratio.
poor, findings consistent with observations for the Brazilian population as a whole.\textsuperscript{14} The higher prevalence of hypertensive nephropathy and glomerulonephritis as a cause of kidney failure in Black relative to White patients is similar to reports from the kidney failure population in the United States.\textsuperscript{21,22} It is well established that Black patients develop both hypertension (including more severe forms) and glomerulonephritis (particularly focal segmental glomerulosclerosis) at an earlier age than their White peers.\textsuperscript{23,24} The higher prevalence of diabetes and diabetic nephropathy observed in White patients in our study is consistent with their older average age.

Interestingly, hemodialysis via catheter was more prevalent among White than Mixed-Race and Black patients in the present study, despite their having had a higher percentage of private health insurance. This finding disagrees with the high prevalence of hemodialysis by catheter in Black than in White hemodialysis patients in the United States. In a study of over 650,000 patients initiating hemodialysis, US Black patients were less likely to have an arteriovenous fistula even after adjusting for clinical and socioeconomic factors including insurance status and poverty.\textsuperscript{25} The fact that the Brazilian Public Health Care System finances surgery for the creation of arteriovenous fistula for all hemodialysis patients could perhaps explain difference in race comparison in vascular access between the present study and the US study. The results suggest that race difference in hemodialysis via catheter in PROHEMO is partly explained by the confounding effect of age, diabetes, kidney disease, and months on hemodialysis.

Studies in the United States indicate that the higher mortality in White than Black patients treated by maintenance hemodialysis is largely explained by the higher mortality among older White relative to older Black patients and that a higher mortality occurs among younger Black than younger White patients.\textsuperscript{6,7} Hence, age modifies the association between race and mortality in US hemodialysis patients. In contrast to US studies, however, age did not modify the association between race and mortality in the current study. In our study, no differences in death rates between White, Mixed-Race, and Black patients were observed for persons aged 18–44 years, 45–59 years, or greater than or equal to 60 years of age.

The lower mortality in Black than White patients treated by hemodialysis in the United States and United Kingdom are intriguing findings, especially given the well-known poorer health outcomes for Black people in the general populations of these 2 countries.\textsuperscript{5,26–29} The data from the Ministry of Health of Brazil showed a lower life expectancy in Black than White Brazilians for both males and females.\textsuperscript{30} Despite wide socioeconomic differences between White and Mixed-Race individuals, however, standard life table methods show that Mixed-Race women had higher life expectancy than White women, whereas life expectancy was similar between Mixed-Race men and White men.

Several methodological limitations of our study must be acknowledged. Because covariates used for statistical adjustment were measured only at baseline, it was not possible to assess the importance of changes over time in comorbid conditions, health behaviors, living conditions, etc. We investigated all-cause mortality as an outcome, and not a specific cause of death, such as cardiovascular disease, which could be highly relevant in understanding racial inequities in outcomes among hemodialysis patients. Although a US study of incident hemodialysis patients showed a higher prevalence of coronary heart disease and heart failure in White compared to Black patients,\textsuperscript{31} in the current study, we observed a similar prevalence of cardiovascular comorbid conditions by race.

These results are not necessarily generalizable to other regions of Brazil or Latin America. Race composition is diverse in different countries and areas globally, and it is likely that determinants of race and the distribution of society resources and opportunities by racial group and/or other identities are influenced by local histories. Moreover, we defined race according to physical traits of the individual, which may not perfectly overlap with self-reported race but in fact align with race being a socially assigned construct, associated socioeconomic inequalities based on social assignment (not self-assignment), and in the United States, social assignment by others being a stronger determinant of health than self-assignment.\textsuperscript{8}

Our results underscore the importance of investigating racial differences in maintenance hemodialysis outcomes in a variety of cultures and populations to better understand under what circumstances racial differences in survival appear and how they might be eliminated when they do appear. The sociodemographic background of the population of Salvador, Bahia, Brazil is somewhat unique, even compared to other regions and cities in Brazil. With a population of nearly 3 million inhabitants, this research setting has the largest population of African descent outside of Africa.\textsuperscript{32} Because of the high proportion of African descendants in Salvador, Black and Mixed-Race persons are not, collectively, a numerical racial minority group in this city, which may provide greater group-level social support and sense of self-identity, thereby attenuating internalized racism. The distribution of socioeconomic indicators by racial groups, however, are precisely what one would expect given the historical roots of the persistent white skin color/political/economic hierarchy and associated advantages in the larger Brazilian society. Despite these larger societal-level factors, however, we found similar rates of mortality by race in the maintenance hemodialysis population of Salvador, Bahia, Brazil. Given that Brazil is the largest country in South America and has a racially and culturally diverse population, it provides an especially interesting setting to investigate racial health disparities, including health disparities such as kidney failure, which disproportionately affect African descended populations throughout the Western Hemisphere.
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REFERENCES

1. Price DA, Owen WF Jr. African-Americans on maintenance dialysis: a review of racial differences in incidence, treatment, and survival. Adv Ren Replace Ther. 1997;4(1):3-12. doi:10.1016/s1073-4449(97)70011-6

2. Agodoa L, Eggers P. Racial and ethnic disparities in end-stage kidney failure-survival paradoxes in African-Americans. Semin Dial. 2007;20(6):577-585. doi:10.1111/j.1525-139X.2007.00350.x

3. Kalantar-Zadeh K, Kovesdy CP, Norris KC. Racial survival paradox of dialysis patients: robust and resilient. Am J Kidney Dis. 2012;60(2):182-185. doi:10.1053/j.ajkd.2012.02.321

4. Yen G, Norris KC, Yu AJ, et al. The relationship of age, race, and ethnicity with survival in dialysis patients. Clin J Am Soc Nephrol. 2013;8(6):953-961. doi:10.2215/cjn.01900912

5. Cole N, Bedford M, Cai A, Jones C, Cairms H, Jayawardene S. Black ethnicity predicts better survival on dialysis despite greater deprivation and co-morbidity: a UK study. Clin Nephrol. 2014;82(2):77-82. doi:10.5414/cn108247

6. Kucirka LM, Grams ME, Lessler J, et al. Association of race and age with survival among patients undergoing dialysis. JAMA. 2011;306(6):620-626. doi:10.1001/jama.2011.1127

7. Yu AJ, Norris KC, Cheung AK, Yen G. Younger black patients have a higher risk of infection mortality that is mostly non-dialysis related: a national study of cause-specific mortality among U.S. maintenance dialysis patients. Hemodial Int. 2017;21(2):232-242. doi:10.1111.hdi.12469

8. Telles E, Flores RD, Urrea-Giraldo F. Pigmentocracies: educational inequality, skin color and census ethnoracial identification in eight Latin American countries. Res Soc Stratif Mobil. 2015;40(1):39-58. doi:10.1016/j.resss.2015.02.002

9. Parra FC, Amado RC, Lamberti JR, Rocha J, Antunes CM, Pena SD. Color and genomic ancestry in Brazilians. Proc Natl Acad Sci U S A. 2003;100(1):177-182. doi:10.1073/pnas.0126614100

10. Eneanya ND, Boulware LE, Tsai J, et al. Health inequities and the inappropriate use of race in nephrology. Nat Rev Nephrol. 2022;18(2):84-94. doi:10.1038/s41581-021-00501-8

11. Martins MTS, Matos CM, Lopes MB, et al. Vascular calcification by conventional x-ray and mortality in a cohort of predominantly African descent hemodialysis patients. Int J Artif Organs. 2021;44(5):318-324. doi:10.1177/0391398820962805

12. Lopes MB, Silva LF, Dantas MA, Matos CM, Lopes GB, Lopes AA. Sex-age-specific handgrip strength and mortality in an incident hemodialysis cohort: the risk explained by nutrition and comorbidities. Int J Artif Organs. 2018;41(12):825-832. doi:10.1177/0391398818793088

13. Lopes MB, Silva LF, Lopes GB, et al. Additional contribution of the malnutrition-inflammation score to predict mortality and patient-reported outcomes as compared with its components in a cohort of African descent hemodialysis patients. J Ren Nutr. 2017;27(1):45-52. doi:10.1016/j.jrn.2016.08.006

14. Instituto Brasileiro de Geografia e Estatística - IBGE. Síntese de Indicadores Sociais. Uma Análise das Condições de Vida da População Brasileira, 2009. Capítulo Cor ou Raça, p. 184-199. Accessed June 2022. https://biblioteca.ibge.gov.br/visualizacao/livros/liv42820.pdf

15. Sesso RC, Lopes AA, Thomé FS, Lugon JR, Martins CT. Brazilian chronic dialysis survey 2016. J Bras Nefrol. 2017;39(3):261-266. doi:10.5935/0101-2800.20170049

16. Pisoni RL, Gillespie BW, Dickinson DM, Chen K, Kutner MH, Wolfe RA. The Dialysis Outcomes and Practice Patterns Study (DOPPS): design, data elements, and methodology. Am J Kidney Dis. 2004;44(5)(suppl 2):7-15. doi:10.1053/j.ajkd.2004.08.005

17. Krieger H, Morton NE, Mi MP, Azevêdo E, Freire-Maia A, Yasuda N. Racial admixture in north-eastern Brazil. Ann Hum Genet. 1965;29(2):113-125.

18. Azevêdo ES. Subgroup studies of black admixture within a mixed population of Bahia, Brazil. Ann Hum Genet. 1980;44(1):55-60.

19. Associação Brasileira de Empresas de Pesquisa (ABEP). Critério Padrão de Classificação Econômica Brasil/2008.
20. Robinson BM, Joffe MM, Pisoni RL, Port FK, Feldman HI. Revisiting survival differences by race and ethnicity among hemodialysis patients: the Dialysis Outcomes and Practice Patterns Study. *J Am Soc Nephrol*. 2006;17(10):2910-2918. doi:10.1681/asn.2005101078

21. Lopes AAS, Hornbuckle K, James SA, Port FK. The joint effects of race and age on the risk of end-stage renal disease attributed to hypertension. *Am J Kidney Dis*. 1994;24(4):554-560.

22. Lopes AA. Relationships of race and ethnicity to progression of kidney dysfunction and clinical outcomes in patients with chronic kidney failure. *Adv Ren Replace Ther*. 2004;11(1):14-23. doi:10.1053/j.arrt.2003.10.006

23. Patel R, Ansari A, Grim CE, Hidaka M. Prognosis and predisposing factors for essential malignant hypertension in predominantly black patients. *Am J Cardiol*. 1990;66(10):868-869. doi:10.1016/0002-9149(90)90370-g

24. Reidy KJ, Hjorten R, Parekh RS. Genetic risk of APOL1 and kidney disease in children and young adults of African ancestry. *Curr Opin Pediatr*. 2018;30(2):252-259. doi:10.1097/mop.0000000000000603

25. Nee R, Moon DS, Jindal RM, et al. Impact of poverty and health care insurance on arteriovenous fistula use among incident hemodialysis patients. *Am J Nephrol*. 2015;42(4):328-336. doi:10.1159/000441804

26. Sorlie P, Rogot E, Anderson R, Johnson NJ, Backlund E. Black-white mortality differences by family income. *Lancet*. 1992;340(8815):346-350. doi:10.1016/0140-6736(92)91413-3

27. Mays VM, Cochran SD, Barnes NW. Race, race-based discrimination, and health outcomes among African Americans. *Annu Rev Psychol*. 2007;58:201-225. doi:10.1146/annurev.psych.57.102904.190212

28. Evandrou M, Falkingham J, Feng Z, Vlachantoni A. Ethnic inequalities in limiting health and self-reported health in later life revisited. *J Epidemiol Community Health*. 2016;70(7):653-662. doi:10.1136/jech-2015-206074

29. Sloan FA, Ayyagari P, Salm M, Grossman D. The longevity gap between Black and White men in the United States at the beginning and end of the 20th century. *Am J Public Health*. 2010;100(2):357-363. doi:10.2105/ajph.2008.158188

30. Chiavegatto Filho AD, Beltrán-Sánchez H, Kawachi I. Racial disparities in life expectancy in Brazil: challenges from a multi-racial society. *Am J Public Health*. 2014;104(11):2156-2162. doi:10.2105/ajph.2013.301565

31. Volkova N, McClellan W, Soucie JM, Schoolwerth A. Racial disparities in the prevalence of cardiovascular disease among incident end-stage renal disease patients. *Nephrol Dial Transplant*. 2006;21(8):2202-2209. doi:10.1093/ndt/gfl078

32. Magalhães da Silva T, Sandhya Rani MR, de Oliveira Costa GN, et al. The correlation between ancestry and color in two cities of Northeast Brazil with contrasting ethnic compositions. *Eur J Hum Genet*. 2015;23(7):984-989. doi:10.1038/ejhg.2014.215