Racial and ethnic disparities in kidney transplantation for end-stage renal disease: An analysis of the national inpatient sample (NIS) database

Analysis for RCOP NIS Med2

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## Preamble:

* **Reference Papers:**
  + [Ismail et al. 2024](https://linkinghub.elsevier.com/retrieve/pii/S0146280624000380)
* **Study Objective**: Investigate racial and ethnic disparities in the proportion of kidney transplantation recipients among end-stage renal disease (ESRD) patients and evaluate in-hospital outcomes among these recipients.
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions for patients aged 18 and older with a diagnosis of ESRD.
* **Race Categories**:
  + White
  + Asian or Pacific Islander
  + Black
  + Hispanic
  + Other
* **Primary Outcomes**:
  + Proportion of kidney transplantation recipients among ESRD patients
  + In-hospital all-cause mortality
* **Secondary Outcomes**:
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($)
* **Statistical Analysis**: Multiple logistic and linear regression models were used to evaluate independent associations of race and ethnicity with kidney transplantation rates and in-hospital outcomes in ESRD patients, adjusting for, adjusted for:
  + Demographics: Age, sex, residential income, insurance type, hospital region, hospital bedsize, hospital location, and teaching status.
  + Medical History: Coronary artery disease, previous heart failure, obesity, peripheral vascular disease, chronic pulmonary disease, liver disease, and previous stroke or TIA.
  + Comorbidities: Charlson comorbidity index.
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Table:

| **Characteristic** | **White** N = 1,267,560*1* | **Asian or Pacific Islander** N = 128,830*1* | **Black** N = 1,041,245*1* | **Hispanic** N = 527,665*1* | **Other** N = 132,010*1* | **p-value***2* | **Overall** N = 3,097,310*1* |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Age, y | 65 (14) | 66 (15) | 59 (15) | 59 (15) | 61 (15) | <0.001 | 62 (15) |
| Sex |  |  |  |  |  | <0.001 |  |
| Female | 539,440 (43) | 57,810 (45) | 509,600 (49) | 232,110 (44) | 59,995 (45) |  | 1,398,955 (45) |
| Male | 728,095 (57) | 71,020 (55) | 531,605 (51) | 295,545 (56) | 72,005 (55) |  | 1,698,270 (55) |
| Residential income |  |  |  |  |  | <0.001 |  |
| $1 - $51,999 | 352,660 (28) | 18,885 (15) | 548,405 (53) | 219,395 (42) | 51,420 (41) |  | 1,190,765 (39) |
| $52,000 - $65,999 | 362,685 (29) | 26,615 (21) | 228,040 (22) | 137,665 (27) | 29,465 (23) |  | 784,470 (26) |
| $66,000 - $87,999 | 305,695 (24) | 36,835 (29) | 158,170 (15) | 108,430 (21) | 25,080 (20) |  | 634,210 (21) |
| $88,000 or more | 228,130 (18) | 45,335 (36) | 90,550 (8.8) | 53,140 (10) | 20,020 (16) |  | 437,175 (14) |
| Expected primary payer |  |  |  |  |  | <0.001 |  |
| Private | 156,400 (12) | 18,760 (15) | 107,955 (10) | 74,640 (14) | 17,000 (13) |  | 374,755 (12) |
| Medicaid | 85,135 (6.7) | 17,905 (14) | 147,605 (14) | 118,135 (22) | 23,615 (18) |  | 392,395 (13) |
| Medicare | 1,001,210 (79) | 90,840 (71) | 769,735 (74) | 327,685 (62) | 88,745 (67) |  | 2,278,215 (74) |
| Other | 23,720 (1.9) | 1,245 (1.0) | 14,950 (1.4) | 6,620 (1.3) | 2,465 (1.9) |  | 49,000 (1.6) |
| Hospital region |  |  |  |  |  | <0.001 |  |
| Midwest | 320,940 (25) | 12,055 (9.4) | 212,525 (20) | 39,645 (7.5) | 18,515 (14) |  | 603,680 (19) |
| Northeast | 233,715 (18) | 19,100 (15) | 158,885 (15) | 66,720 (13) | 25,805 (20) |  | 504,225 (16) |
| South | 505,405 (40) | 19,170 (15) | 582,485 (56) | 205,095 (39) | 46,365 (35) |  | 1,358,520 (44) |
| West | 207,500 (16) | 78,505 (61) | 87,350 (8.4) | 216,205 (41) | 41,325 (31) |  | 630,885 (20) |
| Hospital bedsize |  |  |  |  |  | 0.017 |  |
| Large | 665,330 (52) | 72,730 (56) | 557,015 (53) | 269,080 (51) | 69,005 (52) |  | 1,633,160 (53) |
| Medium | 367,030 (29) | 33,920 (26) | 296,735 (28) | 166,470 (32) | 39,030 (30) |  | 903,185 (29) |
| Small | 235,200 (19) | 22,180 (17) | 187,495 (18) | 92,115 (17) | 23,975 (18) |  | 560,965 (18) |
| Hospital location and teaching status |  |  |  |  |  | <0.001 |  |
| Rural | 89,345 (7.0) | 1,595 (1.2) | 47,555 (4.6) | 6,220 (1.2) | 6,825 (5.2) |  | 151,540 (4.9) |
| Urban, non-teaching | 244,835 (19) | 26,355 (20) | 146,800 (14) | 111,240 (21) | 22,450 (17) |  | 551,680 (18) |
| Urban, teaching | 933,380 (74) | 100,880 (78) | 846,890 (81) | 410,205 (78) | 102,735 (78) |  | 2,394,090 (77) |
| Charlson comorbidity index | 4.96 (1.77) | 4.98 (1.78) | 4.90 (1.88) | 4.86 (1.71) | 4.86 (1.70) | <0.001 | 4.92 (1.80) |
| Coronary artery disease | 537,565 (42) | 52,135 (40) | 317,990 (31) | 174,930 (33) | 46,510 (35) | <0.001 | 1,129,130 (36) |
| Previous congestive heart failure | 326,575 (26) | 29,985 (23) | 282,495 (27) | 107,805 (20) | 28,225 (21) | <0.001 | 775,085 (25) |
| Obesity | 253,700 (20) | 12,985 (10) | 188,465 (18) | 86,745 (16) | 19,610 (15) | <0.001 | 561,505 (18) |
| Peripheral vascular disease | 173,980 (14) | 17,220 (13) | 127,875 (12) | 54,090 (10) | 12,990 (9.8) | <0.001 | 386,155 (12) |
| Chronic pulmonary disease | 372,995 (29) | 22,240 (17) | 252,010 (24) | 80,650 (15) | 25,945 (20) | <0.001 | 753,840 (24) |
| Liver disease | 123,735 (9.8) | 11,915 (9.2) | 86,905 (8.3) | 57,805 (11) | 14,150 (11) | <0.001 | 294,510 (9.5) |
| Previous stroke/TIA | 170,775 (13) | 19,000 (15) | 180,145 (17) | 67,710 (13) | 15,905 (12) | <0.001 | 453,535 (15) |
| *1*Mean (SD); n (%) | | | | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | | | | |

## Outcomes Tables:

### Outcomes of ESRD patients:

| **Characteristic** | **White** N = 1,267,560*1* | **Asian or Pacific Islander** N = 128,830*1* | **Black** N = 1,041,245*1* | **Hispanic** N = 527,665*1* | **Other** N = 132,010*1* | **p-value***2* | **Overall** N = 3,097,310*1* |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Proportion of kidney transplant recipient | 27,370 (2.2) | 4,030 (3.1) | 16,755 (1.6) | 10,830 (2.1) | 2,495 (1.9) | <0.001 | 61,480 (2.0) |
| *1*n (%) | | | | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment | | | | | | | |

### Outcomes of ESRD patients undergoing kidney transplant:

| **Characteristic** | **White** N = 27,370*1* | **Asian or Pacific Islander** N = 4,030*1* | **Black** N = 16,755*1* | **Hispanic** N = 10,830*1* | **Other** N = 2,495*1* | **p-value***2* | **Overall** N = 61,480*1* |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Died during hospitalization | 150 (0.5) | 15 (0.4) | 95 (0.6) | 55 (0.5) | 25 (1.0) | 0.71 | 340 (0.6) |
| Length of stay (days) | 5.0 (3.0 – 7.0) | 5.0 (4.0 – 7.0) | 5.0 (4.0 – 7.0) | 5.0 (4.0 – 7.0) | 5.0 (4.0 – 7.0) | <0.001 | 5.0 (4.0 – 7.0) |
| Inflation-adjusted total charge ($) | 232,693 (179,743 – 312,012) | 265,887 (199,431 – 396,772) | 249,269 (190,646 – 332,673) | 275,519 (205,481 – 379,200) | 270,972 (207,241 – 378,876) | <0.001 | 246,963 (188,356 – 337,335) |
| *1*n (%); Median (Q1 – Q3) | | | | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | | | | |

## Multivariable Logistic Regression:

### Odds of Receiving Kidney Transplantation

| **Characteristic** | **OR** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 1.32 (1.16 to 1.51) | <0.001 |
| Black | 0.70 (0.64 to 0.76) | <0.001 |
| Hispanic | 0.95 (0.83 to 1.08) | 0.43 |
| Other | 0.87 (0.73 to 1.04) | 0.12 |
| Age, y | 0.97 (0.97 to 0.98) | <0.001 |
| Sex |  |  |
| Female | — |  |
| Male | 1.20 (1.15 to 1.25) | <0.001 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 1.29 (1.21 to 1.38) | <0.001 |
| $66,000 - $87,999 | 1.56 (1.44 to 1.70) | <0.001 |
| $88,000 or more | 2.13 (1.89 to 2.40) | <0.001 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 0.15 (0.13 to 0.18) | <0.001 |
| Medicare | 0.63 (0.59 to 0.66) | <0.001 |
| Other | 0.44 (0.33 to 0.60) | <0.001 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 0.96 (0.76 to 1.23) | 0.76 |
| South | 0.96 (0.76 to 1.21) | 0.72 |
| West | 0.87 (0.65 to 1.15) | 0.31 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | 0.24 (0.18 to 0.33) | <0.001 |
| Small | 0.12 (0.08 to 0.20) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 4.54 (1.08 to 19.1) | 0.039 |
| Urban, teaching | 98.6 (26.4 to 369) | <0.001 |
| Charlson comorbidity index | 0.62 (0.61 to 0.63) | <0.001 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | 0.94 (0.88 to 1.00) | 0.036 |
| Previous heart failure |  |  |
| No | — |  |
| Yes | 0.40 (0.37 to 0.43) | <0.001 |
| Obesity |  |  |
| No | — |  |
| Yes | 1.41 (1.31 to 1.52) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.94 (0.85 to 1.03) | 0.16 |
| Chronic pulmonary disease |  |  |
| No | — |  |
| Yes | 0.65 (0.60 to 0.70) | <0.001 |
| Liver disease |  |  |
| No | — |  |
| Yes | 1.28 (1.17 to 1.39) | <0.001 |
| Previous stroke/TIA |  |  |
| No | — |  |
| Yes | 0.66 (0.61 to 0.71) | <0.001 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | |

### All-Cause Mortality:

| **Characteristic** | **OR** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 0.96 (0.28 to 3.26) | 0.95 |
| Black | 1.04 (0.54 to 1.99) | 0.91 |
| Hispanic | 1.23 (0.50 to 3.00) | 0.65 |
| Other | 2.24 (0.81 to 6.19) | 0.12 |
| Age, y | 1.02 (1.00 to 1.05) | 0.057 |
| Sex |  |  |
| Female | — |  |
| Male | 1.08 (0.65 to 1.78) | 0.76 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.59 (0.28 to 1.22) | 0.15 |
| $66,000 - $87,999 | 0.65 (0.31 to 1.34) | 0.24 |
| $88,000 or more | 0.66 (0.31 to 1.42) | 0.29 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 0.44 (0.10 to 1.88) | 0.27 |
| Medicare | 0.83 (0.49 to 1.41) | 0.49 |
| Other | 1.34 (0.16 to 11.1) | 0.78 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 0.95 (0.44 to 2.05) | 0.89 |
| South | 1.07 (0.55 to 2.06) | 0.85 |
| West | 0.55 (0.24 to 1.28) | 0.17 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | 1.80 (0.97 to 3.33) | 0.062 |
| Small | 0.70 (0.21 to 2.26) | 0.55 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 15,590 (1,781 to 136,481) | <0.001 |
| Urban, teaching | 12,184 (2,650 to 56,011) | <0.001 |
| Charlson comorbidity index | 1.08 (0.93 to 1.24) | 0.32 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | 0.87 (0.45 to 1.66) | 0.67 |
| Previous heart failure |  |  |
| No | — |  |
| Yes | 2.09 (0.96 to 4.52) | 0.062 |
| Obesity |  |  |
| No | — |  |
| Yes | 0.63 (0.32 to 1.26) | 0.19 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 1.77 (0.71 to 4.44) | 0.22 |
| Chronic pulmonary disease |  |  |
| No | — |  |
| Yes | 0.56 (0.20 to 1.57) | 0.27 |
| Liver disease |  |  |
| No | — |  |
| Yes | 13.0 (6.99 to 24.1) | <0.001 |
| Previous stroke/TIA |  |  |
| No | — |  |
| Yes | 0.47 (0.11 to 2.00) | 0.31 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | -0.40 (-1.0 to 0.24) | 0.22 |
| Black | 0.48 (-0.09 to 1.1) | 0.10 |
| Hispanic | -0.07 (-0.64 to 0.49) | 0.80 |
| Other | 1.0 (-0.53 to 2.6) | 0.20 |
| Age, y | 0.01 (-0.01 to 0.02) | 0.43 |
| Sex |  |  |
| Female | — |  |
| Male | 0.08 (-0.28 to 0.45) | 0.65 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 0.05 (-0.48 to 0.57) | 0.85 |
| $66,000 - $87,999 | 0.60 (-0.03 to 1.2) | 0.063 |
| $88,000 or more | -0.34 (-0.88 to 0.20) | 0.22 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 1.4 (0.31 to 2.5) | 0.012 |
| Medicare | 0.12 (-0.33 to 0.57) | 0.59 |
| Other | 1.0 (-0.64 to 2.6) | 0.23 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 0.64 (-0.19 to 1.5) | 0.13 |
| South | -0.11 (-0.85 to 0.64) | 0.78 |
| West | -0.42 (-1.4 to 0.53) | 0.38 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | -0.21 (-1.2 to 0.80) | 0.68 |
| Small | -1.2 (-1.9 to -0.51) | <0.001 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 3.9 (1.3 to 6.6) | 0.004 |
| Urban, teaching | 1.7 (1.0 to 2.4) | <0.001 |
| Charlson comorbidity index | 1.0 (0.79 to 1.3) | <0.001 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | -0.92 (-1.5 to -0.39) | <0.001 |
| Previous heart failure |  |  |
| No | — |  |
| Yes | 1.1 (0.01 to 2.2) | 0.048 |
| Obesity |  |  |
| No | — |  |
| Yes | -1.1 (-1.4 to -0.70) | <0.001 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 0.98 (-0.57 to 2.5) | 0.21 |
| Chronic pulmonary disease |  |  |
| No | — |  |
| Yes | -1.8 (-2.4 to -1.3) | <0.001 |
| Liver disease |  |  |
| No | — |  |
| Yes | 9.1 (7.0 to 11) | <0.001 |
| Previous stroke/TIA |  |  |
| No | — |  |
| Yes | -1.1 (-1.7 to -0.52) | <0.001 |
| *1*CI = Confidence Interval | | |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** **(95% CI)***1* | **p-value** |
| --- | --- | --- |
| Race |  |  |
| White | — |  |
| Asian or Pacific Islander | 11,507 (-20,249 to 43,264) | 0.48 |
| Black | 19,074 (3,836 to 34,313) | 0.014 |
| Hispanic | 23,533 (4,415 to 42,652) | 0.016 |
| Other | 58,770 (8,642 to 108,898) | 0.022 |
| Age, y | -239 (-726 to 249) | 0.34 |
| Sex |  |  |
| Female | — |  |
| Male | -243 (-11,915 to 11,429) | 0.97 |
| Residential income |  |  |
| $1 - $51,999 | — |  |
| $52,000 - $65,999 | 3,452 (-11,577 to 18,481) | 0.65 |
| $66,000 - $87,999 | 20,766 (-2,917 to 44,449) | 0.086 |
| $88,000 or more | 11,033 (-9,360 to 31,426) | 0.29 |
| Expected primary payer |  |  |
| Private | — |  |
| Medicaid | 23,654 (-15,660 to 62,969) | 0.24 |
| Medicare | -6,185 (-22,172 to 9,803) | 0.45 |
| Other | 39,514 (-91,359 to 170,388) | 0.55 |
| Hospital region |  |  |
| Midwest | — |  |
| Northeast | 29,259 (-13,520 to 72,038) | 0.18 |
| South | -11,813 (-39,060 to 15,435) | 0.39 |
| West | 107,956 (34,832 to 181,080) | 0.004 |
| Hospital bedsize |  |  |
| Large | — |  |
| Medium | -28,849 (-83,327 to 25,628) | 0.30 |
| Small | 11,390 (-35,667 to 58,447) | 0.63 |
| Hospital location and teaching status |  |  |
| Rural | — |  |
| Urban, non-teaching | 190,757 (66,099 to 315,415) | 0.003 |
| Urban, teaching | 103,351 (63,825 to 142,878) | <0.001 |
| Charlson comorbidity index | 34,457 (24,559 to 44,355) | <0.001 |
| Coronary artery disease |  |  |
| No | — |  |
| Yes | -23,532 (-38,909 to -8,155) | 0.003 |
| Previous heart failure |  |  |
| No | — |  |
| Yes | 40,681 (3,239 to 78,123) | 0.033 |
| Obesity |  |  |
| No | — |  |
| Yes | -17,857 (-32,623 to -3,092) | 0.018 |
| Peripheral vascular disease |  |  |
| No | — |  |
| Yes | 22,620 (-16,973 to 62,212) | 0.26 |
| Chronic pulmonary disease |  |  |
| No | — |  |
| Yes | -56,345 (-75,312 to -37,378) | <0.001 |
| Liver disease |  |  |
| No | — |  |
| Yes | 261,235 (199,459 to 323,011) | <0.001 |
| Previous stroke/TIA |  |  |
| No | — |  |
| Yes | -45,441 (-67,943 to -22,938) | <0.001 |
| *1*CI = Confidence Interval | | |