Disparities in kidney transplantation across the United States: Does residential segregation play a role?

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ABSTRACT

Background: Although residential segregation has been implicated in various negative health outcomes, its association with kidney transplantation has not been examined.

Methods: Age- and sex-standardized kidney transplantation rates were calculated from the Scientific Registry of Transplant Recipients, 2000–2013. Population characteristics including segregation indices were derived from the 2010 U.S. Census data and the U.S. Renal Data System. Separate multivariable Poisson regression models were constructed to identify factors independently associated with kidney transplantation among Blacks and Whites.

Results: Median age- and sex-standardized kidney transplantation rates were 114 per 100,000 for Blacks and 38 per 100,000 for Whites. 16.1% of the U.S. population lived in counties with high segregation. There was no difference in the kidney transplantation rates across the levels of segregation among Blacks and Whites.

Conclusion: Factors other than residential segregation may play roles in kidney transplantation disparities. Continued efforts to identify these factors may be beneficial in reducing transplantation disparities across the U.S.

Summary: Using the Scientific Registry of Transplant Recipients and U.S. census data, we aimed to determine whether residential segregation was associated with kidney transplantation rates. We found that there was no association between residential segregation and kidney transplantation rates.

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1. Introduction

Although disparities in kidney transplantation rates in the United States are well documented, the factors that drive these disparities are yet to be fully understood.[1–4] Among the 85,991 adult candidates on the kidney transplant waiting list in 2010, 59% were from minority racial groups.[5] However, less than half of the 17,727 kidney transplants performed that year were on minority patients. Lower socioeconomic status, less participation in organ donation and biological differences are factors that have been implicated in the reduced transplantation rates among minority populations.[2] Most of these factors are based on individual-level factors and efforts to modify these characteristics have only been marginally successful. Since the environment individuals reside in could influence their health outcomes, identifying and modifying population-level factors associated with disparities could potentially affect a larger group of individuals and lead to significant reductions in the disparities associated with kidney transplantation.

There have been several reports that have linked disparate health outcomes to residential segregation.[6–8] Residential segregation refers to the geospatial distribution of individuals into

different spaces within defined geographical locations based on characteristics such as race.[9] Areas with high residential segregation, where Whites and Black residents live in separate neighborhoods, have been shown to have higher rates of lung cancer mortality, increased incidence of cardiovascular disease, and lower access to surgical care.[7,10,11] Specifically, many of the studies have shown that the disadvantage associated with highly segregated areas is more pronounced among Black residents than White residents.[9,10,12,13] Although the causal link between residential segregation and these outcomes are still being explored, some suggest that the heightened emotional tension in those areas, the higher levels of crime, and the lower investment of resources seen in highly segregated areas might contribute to the observed associations.[9,14] Whether residential segregation could explain some of the disparities in kidney transplantation across the United States has not been investigated.

Therefore, to examine this relationship, we made a national assessment of kidney transplantation, residential segregation, and characteristics of individuals living within defined locations. The objective of our study was to examine U.S. Black, non-Hispanic and White, non-Hispanic residents and identify population-level factors associated with kidney transplantation rates. Our hypothesis was that areas with higher levels of residential segregation will have lower kidney transplantation rates and that this association will be most pronounced among Black residents.

2. Methods

2.1. Data sources

This study used data from the Scientific Registry of Transplant Recipients (SRTR) 2000–2013. The SRTR data system includes data on all donors, waitlisted candidates, and transplant recipients in the U.S., submitted by the members of the Organ Procurement and Transplantation Network (OPTN). The Health Resources and Services Administration (HRSA), U.S. Department of Health and Human Services, provides oversight to the activities of the OPTN and SRTR contractors.[15] Population characteristics such as size, urbanicity and income were derived from the 2013 Area Health Resource Files (AHRF). The AHRF, which is administered by HRSA, contains information regarding health resources, socioeconomic and environmental characteristics of all counties in the United States.[16]

The distribution of Black, non-Hispanic and White, non-Hispanic individuals across the United States was examined using the U.S. Census Bureau, 2010 Census.[17] Information regarding patients with end-stage renal disease by race and number of dialysis centers in each county were extracted from the 2010 United States Renal Data System (USRDS). The USRDS is the largest and most comprehensive national surveillance system for chronic kidney disease.[18,19]

2.2. Determination of county-level characteristics

Using data from the SRTR and AHRF, we calculated the rate of kidney transplants among Blacks and Whites in each county. We expressed this as the number of individuals who had transplants per 100,000 of the population for each racial group. In order to account for the variation in the age and sex composition across the country, we used direct standardization methods to determine age- and sex-standardized transplant rates by county and by race.

We categorized the population size and level of urbanicity for each county using the Rural-Urban Continuum Codes into three categories: non-metro areas with population of <20,000; non-metro and metro areas with population of 20,000–249,000; and metro areas with population of ≥250,000.[20] The median household income was categorized as < \$40,000, \$40,000 − \$54,999, and ≥ \$55,000. The regions were North-East, South, West and Mid-West. The number of dialysis centers in each county was classified as <10 and ≥10. The prevalence of end-stage renal disease in each county was assessed separately for each race and modeled as a continuous variable in the analyses.

2.3. Assessment of segregation

The index of dissimilarity was used to measure the degree of segregation for each county. The index of dissimilarity measures the evenness of the distribution of majority and minority groups across a geographical area.[21,22] This index could range from 0 indicating complete integration to 100 indicating complete segregation. In other words, a county with Black and White individuals living in completely separate neighborhoods will have an index of dissimilarity close to 100, while a county with similar proportions of Black and White individuals in all neighborhoods will have an index of dissimilarity close to 0. The value of the index indicates the percentage of one racial group that will be required to relocate neighborhoods in order for the distribution of the group in each neighborhood to be the same as the distribution of the group across the county.

The index of dissimilarity was calculated with the following formula:

$$D = \frac{1}{2} \sum_{i=1}^{n} \left| \frac{b_i}{B} - \frac{w_i}{W} \right|$$

where

b_i = Black population in the ith census tract
B = Black population in the county
w_i = White population in the ith census tract
W = White population in the county
n = number of census tracts in the county

We categorized the index of dissimilarity as < 40 (low segregation), 40−59 (moderate segregation) and ≥60 (high segregation).[10,21]

2.4. Statistical analysis

We included counties in the 50 U.S. states and the District of Columbia in our analyses. A map of the United States was constructed to indicate the index of dissimilarity for each county across the country. Proportions of the population living in counties with moderate to high levels of segregation were calculated by state.

Kidney transplant rates were compared across strata of county-level variables using Wilcoxon rank sum and Kruskal Wallis one way analysis of variance tests. Poisson multivariable regression analyses were used to identify independent factors associated with kidney transplant rates. Only counties with Black or White transplant kidney recipients were included in the analyses. Models were constructed separately for Black and White populations. Weights based on the total population of each county were used in each of the models to account for differences in county population size. Variables included in the models were the index of dissimilarity, population size, prevalence of end-stage renal disease for each race, median household income and U.S. region. Additional models were constructed where counties were stratified by the number of dialysis centers they had. The estimates of the models were expressed as incidence rate ratios and statistical significance was set at $P < 0.05$. All analyses were done using Stata Statistical