
Residential Segregation and Access to Surgical Care by Minority Populations in US Counties

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- BACKGROUND:** Minority groups in the US have comparatively poorer access to a range of health care services. Access can be considered a function of opportunity and use and can vary with the level of segregation within a county. We hypothesized that with varying levels of segregation, increasing the proportion of the minority population within a county was accompanied by decreasing levels of access to surgical care.
- STUDY DESIGN:** A cross-sectional analysis was performed on data from the 2004 Area Resource File. Each county in the US was categorized into one of three levels: most, moderately, or least segregated, using the Isolation Index. Multivariable linear regression analysis was performed to examine the association between access to surgical services and proportion of minority population with varying levels of segregation adjusting for socioeconomic and health characteristics.
- RESULTS:** In the most segregated counties, each percentage point increase in Hispanic or African-American population was associated with a statistically significant decrease in outpatient surgery volume ($p < 0.0001$), ambulatory surgical facilities ($p < 0.0001$), and number of general surgeons ($p < 0.0001$). In the least segregated counties, these associations showed no statistical significance. A significant increase ($p < 0.0001$) in the volume of emergency medical visits was associated with increasing proportions of African-American and Hispanic populations within the most segregated counties.
- CONCLUSIONS:** In the most segregated counties, an increase in the African-American or Hispanic population was associated with a decrease in the availability and use of surgical services and an increase in emergency visits after adjustment for socioeconomic and health characteristics. (J Am Coll Surg 2009;208:1017–1022. © 2009 by the American College of Surgeons)
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Healthy People 2010 set a timeline to eliminate health disparities in the US.¹ Attainment of this goal appears somewhat uncertain as the deadline quickly approaches. Several studies continue to report that African-American and Hispanic patients have comparatively poorer access to health care services.^{2,3} This differential in access has been demonstrated across an array of clinical arenas, including primary care, antenatal care, breast cancer care, chronic renal failure, and rectal cancer care.^{2,4-7} In this report, we broadly consider access as a function of opportunity and use of health care resources.

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Improving access, as defined by increasing both opportunity and use across racial lines, continues to pose a considerable challenge to health policy makers in their attempts to establish equity in the provision of care. These efforts are compounded by the fact that the reasons fueling racial differences in medical treatment have been relatively inconclusive, leading to a number of both clinical and non-clinical hypotheses attempting to explain the disparities. These have included, among others, patient preference, expectations, provider bias, mistrust of the health care system, referral patterns, access to care, and insurance status.^{5,8-10} A growing number of studies have found evidence for geographic and area effects on health care access.^{11,12} There is increasing interest as a result, in the effect of residential location on geographic availability of health care resources. To our knowledge, this is the first report to examine the relationship between residential segregation and access to surgical health care resources.

We sought to examine the effects of segregation on disparities in access to outpatient surgical care and use of emergency services among minorities at the county level.

We hypothesized that with varying levels of segregation, increasing the proportion of the African-American and Hispanic population within a county influenced access to surgical care. We examined access as a function of both opportunity and geographic availability of surgical services as determined by the number of surgeons and ambulatory surgical centers in a county and a function of use as measured by the overall outpatient surgical procedure volume.

METHODS

A cross-sectional analysis was performed on data from the 2004 version of the Area Resource File (US Department of Health and Human Services, Health Resources and Services Administration, Bureau of Health Professions). This is a nationwide database of health care, economic, and demographic sources with data from the American Medical Association, American Hospital Association, US Census Bureau, Centers for Medicare and Medicaid Services, Bureau of Labor Statistics, Veterans' Administration, and the National Center for Health Statistics. The Area Resource File comprises aggregate data collected from all 3,219 counties in the US.¹³ It is the largest such composite health care data set bearing >6,000 variables of socioeconomic, health, and demographic details, including those from the last US census conducted in April 2000. Different geographic codes are included in the data set, including Federal Processing Information Standard state code, metropolitan-micropolitan statistical area codes, urban/rural continuum code, typology codes, economic area codes, and region codes, so that the data can be easily aggregated to higher geographic levels. Sampling error was minimized as the data from all the counties in the US were used.

The Isolation Index was used because it is a well-established proxy for segregation.¹⁴ The Isolation Index is a measure of the probability that a member of one minority group will come into contact with members of the same racial group, as opposed to coming into contact with Caucasians. This is then compared with residential neighbors in the same county. It serves as a correlate of the Index of Dissimilarity, which is the percentage of African Americans, for example, who would have to move to achieve a uniform racial distribution across a metropolitan area.¹⁴ The Isolation Index was calculated (as described previously¹⁵) for the African-American population as shown in the equation:

$$\text{Isolation Index for African Americans} = \sum (B_i/B_{\text{total}}) \times (B_i/T_i)$$

Where $i = 1$ of N number of census tracts in the county;
 B_i = number of African Americans in the census tract i ;
 B_{total} = total number of African Americans in the county;
 and T_i = total population of the census tract.

The Isolation Index ranges from 0 to 1.0. The higher the Isolation Index, the more segregated the county. We assigned each county to a segregation tertile depending on its Isolation Index: least segregated (0 to 0.15), moderately segregated (0.16 to 0.30), or most segregated (>0.31) in increasing extent of segregation. For each of the tertiles of segregation, crude and adjusted analyses were performed to examine the relationship between racial ethnicity and access measured by both opportunity and use of surgical health care resources with varying levels of segregation.

Opportunity

The dependent variables in the first analysis were considered a surrogate for opportunity and geographic availability to receive surgical health care. These variables included the number of general surgeons and the number of ambulatory surgical centers per 100,000 population. We also examined the number of primary care physicians per 100,000 population within the county on subset analysis as a surrogate for the existence of a referral base. The independent variables were the prevalence of the African-American, Hispanic, and Asian populations in a county. The models were each adjusted using county-level independent variables for demographic characteristics (ie, median age, number of people older than age 65 years per 100,000 [Medicare enrollees], gender [proportion of men and women], and population per square mile), and socioeconomic characteristics (ie, number of white-collar workers, number of privately insured, and number of people living below the federal poverty level [\$15,670, \$18,850, and \$22,030 for families of three, four, and five, respectively] per 100,000, and education [defined as number of people with a high school diploma per 100,000], unemployment rate, median household income and managed care market penetration). The extent of urbanization was estimated using the rural-urban continuum code.

Use

For each of the tertiles of segregation, the dependent variable used as a proxy for use was outpatient surgery volume selected to represent surgical health care resource use within the county. Within the subset analysis, we also examined the volume of emergency room visits as measured by the number of emergency room visits per county. This served as a proxy for use of emergency care facilities. The independent variables were the number of African Americans, Hispanics, and Asians per 100,000 population in a county and the models were each adjusted for demographic and socioeconomic characteristics in manner similar to those examining opportunity.

Unadjusted linear regression analyses were first performed to examine the relationship between each of the

Table 1. Geographic, Demographic, Socioeconomic, and Health Care Characteristics of the Counties

Variable	Mean	SD	95% CI
Population density	2,683	16,675.61	-30,668.22 to 36,043.22
Housing unit density	1,117.5	7,679.264	-14,241.04 to 16,476.04
Rural persons per 100,000 population	58,710	31,620	57,622-59,808
Urban persons per 100,000 population	41,280	31,620	40,191-42,377
Hispanic population (%)	6.42	18.56	6.78-9.06
Caucasian population (%)	84.32	16.50	83.75-84.89
African-American population (%)	8.44	1.42	8.40-8.49
Asian population (%)	0.83	2.11	0.75-0.90
Primary care physicians per 100,000	6	1.2	5.6-6
Ambulatory surgery centers per 1,000 population	0.005	0.017	0.0049-0.0061
Outpatient surgery procedures per 1,000 population	45.3	60.6	43.27-47.47
General surgeons per 100,000 population	6.8	8.9	6.5-7.1
No. of Medicare enrollees per 1,000 population	16,900	5,160	16,781-17,139
Inpatient surgical procedures per 1,000 population	21.6	40.3	20.25-23.03
Emergency room visits per 1,000 population	32,723.7	96,829.6	29,380.6-36,066.88
Median household income (\$)	35,403.56	10,643	35,036.1-35,771.02
White collar employees per 1,000 population	228.04	58.73	226.04-230.10
No. of persons living below federal poverty level per 100,000 population*	1,250	560	1,238-1,276

*Federal poverty level of \$15,670, \$18,850, and \$22,030 for families of three, four, and five, respectively.

measures of surgical care access and racial composition within each tertile of segregation. A multivariable analysis was then conducted to predict the effect of mean differences in the proportion of ethnic minorities (ie, number of African Americans, Hispanics, and Asians per 100,000 population) on the availability and use of surgical health care resources in a county. We used commercially available software (Stata Intercooled version 10; StataCorp). Similar to research conducted by Xirasagar and colleagues,¹⁶ linear regression analysis using ordinary least squares was used rather than logistic regression to emulate past analyses of personal-level data from national surveys. We sought to assess the net effect of the prevalence of ethnic minorities on the opportunity to access and use surgical health care resources in a county. The Department of Health and Human Services uses weighted sequential hot-deck imputation for missing values in the dataset.¹⁷

RESULTS

There were 3,219 counties. These counties had an average of 60 primary care physicians per 100,000 population, 6.8 general surgeons per 100,000 population, and 90 nurses per 100,000 population. Median household income per county was US\$35,403 and 1,250 persons per 100,000 persons in the county lived below the federal poverty level (\$15,670, \$18,850, and \$22,030 for families of three, four, and five, respectively). There were 16,900 Medicare beneficiaries and 10,600 persons with private insurance per 100,000 people per county. Seven thousand per 100,000

had at least a high school education (see Table 1). Minority racial isolation was highest in the South and in urban areas and 581 counties had mean isolation indices >0.31 (eg, Bullock, Alabama [Isolation Index 0.73] and Cook County, Illinois [Isolation index 0.77]). The majority of counties in the US, a total of 2,273, had indices <0.11 (see Table 2). This was most common in the West (eg, Napa, California [Isolation Index of 0.08]) and is consistent with previous reports.⁵ The areas of greatest segregation also included metropolitan areas, such as Chicago and New York, featuring inner-city ethnic enclaves with low median incomes and high costs of living, each of which had segregation indices in excess of 0.50.

Opportunity

In the most segregated counties, a mean increase of 1% in either the percentage of African-American or Hispanic population was associated with a corresponding statistically significant decrease in the number of general surgeons ($p < 0.0001$) and of ambulatory surgical centers ($p < 0.0001$). There was a decrease in the mean number of primary care physicians that was not statistically significant ($p = 0.63$). The decrease in mean number of general sur-

Table 2. Number of Counties by Level of Segregation

Mean Isolation Index for African Americans	No. of counties
0-0.15 (least segregated)	2,273
>0.16 to ≤0.30 (moderately segregated)	365
>0.30 (most segregated)	581

geons and surgical centers persisted on multivariable analysis after adjusting for the demographic, health, and socioeconomic characteristics within the county ($p = 0.87$; $R^2 = 0.32$, Adjusted $R^2 = 0.323$). In the least segregated counties, these all lost statistical significance ($p = 0.83$, $p = 0.43$).

Use

In the most segregated counties, a mean increase of 1% in either the African-American or Hispanic population was associated with a statistically significant decrease in number of outpatient surgical procedures per 100,000 population ($p < 0.0001$) on both unadjusted and adjusted analyses. This lost statistical significance in counties with the least segregation. The statistically significant increase in the number of emergency visits per county by the Hispanic population persisted across the three tertiles of segregation ($p < 0.0001$) (see Table 3).

DISCUSSION

Residential segregation is the physical separation of racial groups from others and has been shown to adversely affect access to high-quality health care.⁵ Independently, it can result in a decline in the adequacy of care and serve to limit access to specialized board-certified providers and tertiary care facilities.^{18,19} Minorities are postulated to underuse health care resources as a direct result of this decreased access, often resulting in late presentations of illness and delayed treatment.^{18,20} African Americans are the most segregated racial group in the US and within segregated African-American communities infant mortality rates are higher, access to dialysis is decreased, outcomes from transplantation are worse, and availability of appropriate cancer care is lowest compared with all other racial groups.^{2,4-7} In addition, areas of segregation are disproportionately characterized by unemployment, social isolation, and poverty. Both African Americans and Hispanics living in counties with a higher proportion of African-American population report that they experience difficulty obtaining health care as compared with African Americans living in counties with a smaller African-American population.¹⁴ For a multitude of reasons, segregation has been identified as a substantial predictor of mortality.^{3,12}

Health care disparities, as a whole, have featured prominently in clinical outcomes discussions during the past decade. The federal government, through the National Institutes of Health and *Healthy People 2010*, has set forth goals to explore, account for, and minimize these disparities.¹ The discussion within the literature has, until now, focused on use of health care resources rather than geographic availability and seldom covered access to general

Table 3. Linear Regression β Coefficients Representing Mean Differences in Health Care Indices within US Counties by Racial Composition in the Most Segregated Counties

β coefficient for:	African American	Hispanic	95% CI	Hispanic	95% CI	Asian	95% CI
No. of doctors per 1,000 population	-0.098	-0.008	-0.13 to -0.066 ($p < 0.0001$)	-0.008	-0.01 to -0.006 ($p < 0.0001$)	0.11	0.095 to 0.138 ($p < 0.0001$)
No. of emergency visits per 1,000 population	-7.661.16	543.97	-10,138.17 to -5,184.16 ($p < 0.0001$)	543.97	716.53 to 371.41 ($p < 0.0001$)	5,985.66	4,291.91 to 7,679.40 ($p < 0.0001$)
No. of general surgeons per 1,000 population	-0.005	-0.0005	-0.008 to -0.003 ($p < 0.0001$)	-0.0005	-0.0007 to -0.0004 ($p < 0.0001$)	0.004	0.002 to 0.005 ($p < 0.0001$)
Ambulatory surgical centers per 1,000 population	-0.0007	-0.00004	-0.001 to -0.0002 ($p = 0.004$)	-0.00004	-0.00008 to -0.00001 ($p = 0.011$)	0.0001	-0.0001 to 0.005 ($p = 0.299$)
No. of outpatient surgical procedures per 1,000 population	-4.21	-0.41	-5.98 to -2.44 ($p < 0.0001$)	-0.41	-0.54 to -0.29 ($p < 0.0001$)	1.77	0.56 to 2.98 ($p = 0.004$)
No. of inpatient surgical procedures per 1,000 population	-2.64	-0.17	-3.82 to -1.47 ($p < 0.0001$)	-0.17	-0.26 to -0.09 ($p < 0.0001$)	1.34	0.54 to 2.14 ($p = 0.001$)
Medicare enrollees per 1,000 population	4.97	-0.19	3.54 to 6.39 ($p < 0.0001$)	-0.19	-0.29 to -0.095 ($p < 0.0001$)	-2.1	-3.8 to -1.1

surgical health care resources. This is the first report of the effect of segregation on access to surgical health care as defined by both geographic availability and use at the county level. The increased use of emergency services by Hispanic and African-American patients has, as described here, been reported in earlier accounts and might reflect the interplay between insurance status, socioeconomic hardship, lack of access to primary health care, and geographic absence of resources within the counties in which they live.^{21,22}

Residential segregation is a longstanding characteristic of the American social environment. It peaked after World War II, but has since reduced somewhat with modifications in housing laws and a comparatively improved economic outlook for African Americans in particular. Segregation still remains high and there still persists the concentration of people of color in certain neighborhoods. It is well-accepted that segregation affects income, wealth accumulation, and educational opportunities.¹⁴ Segregated neighborhoods are often neglected by the larger society and often have higher levels of poverty and little or no political power.²³ Because African Americans experience the highest level of residential segregation of any other racial group in the US, this can contribute considerably to their higher mortality rates.^{11,24} The majority of African-American and Hispanic populations in the US live in major metropolitan areas, often within racially specific inner-city ethnic enclaves that are highly segregated.²³ This residential segregation might be a fundamental contributor to racial disparities in health in the US.³

We examined outpatient surgical volume as a proxy for use of surgical resources as a whole. This is supported by the fact that the greater number of surgical procedures in the US are performed in an ambulatory setting.^{25,26} Using outpatient surgical volume also allowed inclusion of procedures performed at both hospitals and ambulatory surgical centers. In counties with the most segregation, an increase by 1% in the resident African-American or Hispanic population resulted in a statistically significant ($p < 0.05$) decrease in availability and use of surgical services that was not present in counties with the least segregation. The decrease in access to surgical health care was accompanied by an increase in the use of emergency visits in counties with the greatest segregation on subset analysis. This was not the case in counties with the least segregation, except for those counties with a large Hispanic population. Segregation has been linked with an increased risk of death from preventable causes, all-cause mortality, and infant mortality.¹⁴ It might, in this manner, exert considerable influence on disparities in health care by decreasing geographic proximity to surgeons, limiting access to providers for referrals, and decreasing proximity to surgical facilities. In addition, seg-

regation can create a disinclination to seek care far away from one's own county and where facilities were not present, result in sharply defined differential in access. Conversely, we found that with decreasing levels of segregation, the negative association with availability of surgical care lost significance. These findings correspond with other published reports that have demonstrated better access to care and lower mortality rates in areas of less segregation.

The application of this article lies in its ability to guide policy makers and urban planners with mandates for affected jurisdictions to make pointed decisions about where to support the opening of ambulatory surgical facilities within counties based on racial composition and geographic location and, in this manner, address potential areas of need and improve opportunity and use. This allows a proactive rather than retrospective approach in identifying those counties suffering from disparities in access, perhaps even before the deleterious effects had taken root and prevent the compounding of surgical resource maldistribution. We promote greater scrutiny of residential segregation as a possible barrier to care and a contributor toward health care disparities.¹⁸ We also advocate the consideration of access as a function of both opportunity and use and not one with the exclusion of the other on the premise that without the opportunity there can be no use.

This work has a number of limitations. First, because it represents a cross-sectional analysis, we are unable to make any causal inferences about access to outpatient surgical care or use of emergency services at the individual level. Second, as this is an analysis at the county level, it would be an ecologic fallacy to attribute the characteristics of the county to the individual. Similar analysis of counties has been used and reported in earlier accounts in the literature.¹¹ From a policy perspective, analysis at the county level makes for a compelling argument for legislators with municipal and county jurisdiction. These data allow for a sharper focus on neighborhood racial composition, allowing health policy and municipal planning to better address geographic availability of health care resources, particularly in inner-city ethnic enclaves within large metropolitan cities that have witnessed "white flight" into the suburbs, leaving behind high levels of poverty, lower levels of educational achievement, and high costs of living.^{14,18} We were also unable to determine the effects of the affluence of neighboring counties from the variables within the database. Despite the limitations, the study strengths lie in the use of a large, nationally representative data set with detailed information on demographic and socioeconomic detail at the county level.

We concluded that counties with the greatest extent of segregation have decreasing access to outpatient surgical

services as determined by both opportunity (availability) and use together with an increased use of emergency services. This report should guide budgetary decisions and incentives by health policy makers in their bid to close the racial health disparity gap and to strive to increase access to surgical health care across racial lines, particularly in areas identifiable for being the most segregated. We do not ascribe any of the attributes discussed here to the individual, but instead proffer a plausible direction in which to turn the policy lens and better focus on a subject matter that will likely fuel the next wave of health disparity research as outcomes from surgical outpatient volume as a whole take center stage.

Author Contributions

Study conception and design: Hayanga, Chang

Acquisition of data: Hayanga, Kaiser

Analysis and interpretation of data: Hayanga, Kaiser, Chang

Drafting of manuscript: Hayanga, Kaiser, Sinha

Critical revision: Hayanga, Kaiser, Makary

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