



Published in final edited form as:

Circulation. 2015 January 13; 131(2): 124–127. doi:10.1161/CIRCULATIONAHA.114.013871.

Assessing Neighborhood-Level Effects on Disparities in Cardiovascular Diseases

Adolfo Correa, MD, PhD, Sophia Greer, MPH, and Mario Sims, PhD

the Department of Medicine, University of Mississippi Medical Center, Jackson, MS (A.C., M.S.); and the Division for Cardiovascular Disease and Stroke Prevention, Centers for Disease Control and Prevention, Atlanta, GA (S.G.)

Keywords

Editorials; cardiovascular diseases; disparities; healthcare; epidemiology; inequalities

Race and Ethnic Disparities in Cardiovascular Diseases

Despite declines in mortality from cardiovascular diseases (CVDs) and many CVD risk factors, CVD remains the leading cause of death in the United States, and racial and ethnic disparities persist. In 2010, rates of CVD mortality per 100 000 were: 192.2 for white women; 260.5 for black women; 278.4 for white men; and 369.2 for black men.¹ In 2009 and 2010, metrics of ideal cardiovascular health factors (ie, blood pressure, physical activity, healthy diet, healthy weight, smoking status, and glucose) were noted to be lower for blacks and Mexican Americans than for whites or other racial groups.¹ In 2012, the following age-adjusted prevalence estimates among nonwhite adult populations were noted compared with the white population:² (1) the prevalence of heart disease and coronary heart disease (CHD) was similar in blacks, lower in Hispanics and Asians, and higher in American Indians/Alaska natives, and native Hawaiian or other Pacific Island populations; (2) the prevalence of hypertension was higher in blacks, similar or lower in Hispanics and Asians, and higher in American Indians/Alaska natives, and native Hawaiian or other Pacific island populations; and (3) the prevalence of having had a stroke was higher in blacks, lower in Hispanics, and lower in Asian populations.

The persistence of racial and ethnic disparities in CVD is a major public health problem that calls for more understanding of root causes that may inform evidence-based deliberations and policies. Studies have shown that racial and ethnic disparities in CVD: (1) appear to remain after adjusting for known individual-level risk factors such as blood pressure, smoking, body mass index (BMI), and socioeconomic status (SES);³ and (2) tend to vary with age, time, and geography.^{4,5} These observations suggest that neighborhood-level social

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Correspondence to Adolfo Correa, MD, PhD, Department of Medicine, University of Mississippi Medical Center, 2500 North State St, Jackson, MS 39216, acorrea@umc.edu.

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

Disclosures: The authors have indicated no financial conflicts of interest.

or environmental factors not captured by conventional measures of SES (eg, neighborhood segregation, discrimination, perceptions of neighborhood) need to be considered as potential drivers of such disparities and as priority areas for population-based research.

Within this context, one factor that has received increasing attention in epidemiological research is racial/ethnic residential segregation, defined as “the degree to which two or more racial/ethnic groups live separately from one another.”⁶ The study by Kershaw et al.⁷ in this issue of *Circulation* is important in this regard. Based on data from the Multi-Ethnic Study of Atherosclerosis (MESA), and a novel measure of neighborhood residential segregation, the study shows associations between racial/ethnic residential segregation and an increased CVD risk for blacks, decreased risk for whites, and no effect for Hispanic participants in the study. After accounting for demographics (ie, age, sex, study site, and nativity for Hispanics), neighborhood covariates (ie, neighborhood poverty, neighborhood social environment, and neighborhood physical environment), socioeconomic position (ie, education, income, and health insurance status), and clinical risk factors (ie, systolic blood pressure, total cholesterol, HDL cholesterol, diabetes mellitus, BMI, cigarette smoking, current alcohol use, and physical activity), these associations remained for black but not for white participants. Analyses by subgroup of CVD revealed an association between residential segregation and increased risk for CHD only among black participants. No associations were evident for residential segregation and increased or decreased risk for CHD in other race/ethnicity groups or for incident stroke or stroke death for any of the race/ethnicity groups examined. The differences in the association by race/ethnicity could reflect both the harmful effects of segregation through social and economic isolation and the beneficial effects of segregation through social support. This study highlights 4 important points: (1) knowledge and knowledge gaps related to residential segregation and CVD disparities; (2) value of new developments in measuring neighborhood residential segregation; (3) opportunities for future research in residential segregation and CVD outcomes; and (4) implications for research and policies regarding residential segregation as a contributor to CVD disparities by race/ethnicity.

Knowledge Gaps Related to Racial Residential Segregation and CVD

Historically, residential segregation in the United States resulted from discriminatory housing practices, laws, and economic and educational institutions that limited choices and created neighborhoods that were racially separate. Although the Civil Rights Act of 1968 made housing discrimination illegal, the effects of these practices coupled with institutional discrimination led to the lack of social and economic investment in the predominantly minority neighborhoods, and to persistent lack of access to educational, economic, social, and health opportunities.⁸ Currently, black and Hispanic populations are more likely to live in neighborhoods that are poor and lack social and economic opportunities compared with their white counterparts.^{9,10} These neighborhoods are characterized by a high prevalence of poverty, lack of access to physical activity resources and healthy foods, unsafe conditions, and fewer educational resources.^{8,11} These are contributing factors to CVD disparities.

Several knowledge gaps are identified by Kershaw et al with regard to the role of racial/ethnic segregation in CVD risk. First, segregation is often examined in relation to mortality

but has not been examined in relation to incident CVD. Second, the pathways by which segregation operates to increase risk of CVD have not been identified. Third, segregation has not often been modeled as a time-varying predictor to account for differential exposure across the life course. Fourth, the occurrence of segregation may be a result of individual and family choices (eg, being close to a group with similar culture, religious practices, language, physical activity, diet, and social cohesion), which could have a beneficial effect on health, but these beneficial effects of segregation have not been fully explored.

Evaluating the impact of residential segregation on CVD risk requires conceptual models that trace the pathways from residential segregation to CVD risk. Kershaw et al modeled residential segregation as a main predictor of CVD incidence and biological, behavioral, and select neighborhood characteristics as potential confounders, mediators, or pathways. Although these additional covariates/characteristics modeled in the Kershaw et al paper were found to confound or mediate the association of segregation and CVD risk for white participants but not for black participants, several additional neighborhood characteristics that could impact CVD risk, such as access to health care and quality of health care,¹² were not included and should be explored in future studies.

Value of New Developments in Measures of Residential Segregation

In their assessment of residential segregation and CVD risk, Kershaw et al used the Getis-Ord G_i^* statistic, which measures the extent to which the number or proportion of the racial/ethnic population that resides in the census tract (as well as neighboring census tracts) varies from the mean racial/ethnic composition of the larger areal unit (in this case, a set of counties) represented in each metropolitan area site in the MESA cohort. Higher positive G_i^* scores indicate higher segregation (or clusters of relatively high proportions of a racial/ethnic group), whereas lower scores near 0 represent lower segregation (or neighborhoods with relatively similar concentrations of a racial/ethnic group compared with larger geographic area). Lower negative scores indicate underrepresentation (or clusters of relatively lower concentrations of the racial/ethnic group compared with the larger geographic area). The authors highlighted that this measure is an improvement on the census tract-level racial composition measure, which has served as a proxy for residential segregation in much of the previous neighborhood segregation literature. Using a similar technique, the Figure shows a national view of the census-tract level Getis G_i^* segregation measure for blacks, whites, and Hispanics for the contiguous United States. These data are from the 2000 US Census. As shown in the Figure, there is significant geographic variation of highly segregated neighborhoods among whites, blacks, and Hispanics.

Use of the G_i^* statistic is also important in that it adds an additional neighborhood-level approach to the residential segregation literature, which has been most commonly conceptualized and examined at the metropolitan level.¹³ This is an important distinguishing feature of the work by Kershaw et al. The process of segregation can operate at many geographic levels. Use of metropolitan-level measures of segregation may help to identify macrolevel interventions that may be considered for mitigating the effects of structural inequality on CVD phenotypes. On the other hand, neighborhood-level segregation measures describe more proximal processes that affect how social and economic resources

are distributed within neighborhoods and may help to identify potential interventions at the microlevel.

Although spatial measures of segregation improve the measurement of segregation on the neighborhood scale, challenges still remain. There is no standard measure of neighborhood segregation that limits the ability to compare one study with another. Also, the spatial scale at which segregation is measured influences the value of the segregation metric as well as the interpretability. Reliance on census tracts and other administrative boundaries may not reflect the level at which segregation is operating. Consequently, it has been suggested that the interpretation of segregation may vary by the measure used and the geographic scale.¹⁴

Opportunities for Future Research

Future work examining the relationship between racial residential segregation in different populations and CVD should examine multiple dimensions of segregation with CVD risk in order to delineate the extent to which segregation operates at the neighborhood scale, metropolitan scale, or other geographic scale. Such analyses will help public health practitioners and policymakers determine at what geographic scale programs aimed at ameliorating the effects of segregation will be most effective. Using different measures of segregation (eg, clustering and dissimilarity index) by race/ethnicity and SES could help define the processes by which segregation may operate. Given that segregation operates through a variety of different pathways outside of limiting education and economic opportunities, future work should expand to examine how factors such as housing, transportation, and labor markets help explain the association between segregation and cardiovascular health.

To gain further insight into the findings by Kershaw et al, additional analyses could be conducted to identify pathways by which segregation influences cardiovascular health. For instance, Jargowsky used the neighborhood typology proposed in his seminal work¹⁵ and found that the distribution of neighborhoods by poverty status (high, low, and none) was directly associated with less favorable social and economic life chances (ie, education, job, family formation, etc.) in US metropolitan areas. Using such an approach or other similar methodologies in racial residential segregation research could possibly show how segregation differentially exposes different population groups to conditions that predispose them to CVD or to other chronic disorders.

Future work should utilize Geographic Information Systems (GIS) tools such as mapping and spatial statistics, including the segregation measure used in the Kershaw et al paper, to examine spatial relationships between segregation and CVD risk. The presentation of GIS tools, such as maps, could provide a clear visualization and better appreciation of the findings from the statistical models of segregation and CVD. Another possibility for future research is the use of path analysis methods that may enable separation of the direct, indirect, and mediating effects between racial residential segregation and CVD risk. This method can estimate the potential for bidirectionality in the association between racial residential segregation and CVD risk through nonrecursive modeling. Because individual-level and neighborhood-level factors do not occur in isolation, the simultaneity of estimation

used in path analysis¹⁶ may enable the researcher to portray a more realistic effect of segregation on CVD.

The work by Kershaw et al suggests a number of additional research questions for consideration for future research. Examples of such questions include: the extent to which CVD risk from residential segregation might vary with degree, duration, and age of exposure to residential segregation; the extent to which CVD risk from residential segregation might be amenable to amelioration by implementation of focused interventions; the relative impacts of independent and joint effects of SES and racial/ethnic segregation on CVD risk and how these might vary by race/ethnicity group; and possible factors that could account for the beneficial health effects resulting from neighborhood segregation of majority racial/ethnic groups. Such evaluations may suggest beneficial factors (eg, availability of healthier diet choices, access to health services, safe environment, and greater opportunities for physical activity) that could become part of pilot or prototype interventions for possible replication and evaluation in neighborhoods characterized by poorer health outcomes.

Implications for Intervention Deliberations

The work by Kershaw et al has implications for deliberations on addressing racial/ethnic inequities in CVD. Public health interventions designed to reduce disparities in CVD should consider the barriers and consequences that result from residing in racially segregated neighborhoods. Some of the broader social factors that could be associated with residential segregation and should be considered are concentrated poverty, lack of access to quality health care, lack of access to healthy foods, and lack of physical activity resources.^{8,11,17} These contextual factors are likely to be barriers to medication adherence, adoption of healthy dietary practices, and efforts to increase physical activity levels and will need to be taken into account in the development of intervention efforts targeted to the needs of different groups in a given community, particularly the most vulnerable groups. At the neighborhood level, formulation of interventions will need to consider efforts on various fronts, ranging from improving social and economic conditions to more structural changes such as improving access to healthy foods and physical activity resources. These tasks are daunting, with no simple or readily available solutions, but such tasks need to be given appropriate attention and priority to ensure that future interventions have a strong likelihood of success in reducing racial/ethnic disparities in CVD in a substantive manner. From a public health policy perspective, it will be important to identify neighborhood-level interventions that address these underlying social and economic conditions and are effective in reducing CVD disparities resulting from racial residential segregation. Securing and sustaining interventions aimed at modifying social and economic conditions will be a critical challenge and an opportunity for policymakers. Such changes will be necessary to ensure that the concentration of segregated and under-resourced neighborhoods and related adverse health effects in the residents of such neighborhoods will be minimized and, eventually, eliminated.

Acknowledgments

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. Drs Correa and Sims were supported by contracts

HHSN268201300046C, HHSN268201300047C, and HHSN268201300049C from the National Heart, Lung, and Blood Institute and the National Institute on Minority Health and Health Disparities, and by a subaward from P60MD002249-01 (Diez-Roux) from the National Institute on Minority Health and Health Disparities.

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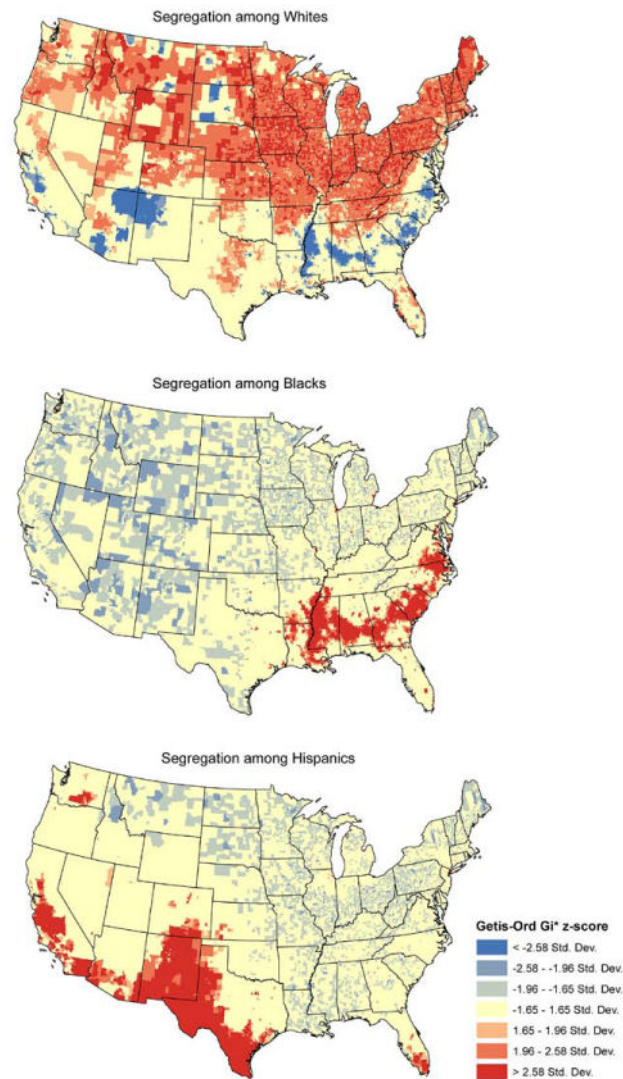


Figure.

Maps show clusters of high and low concentrations of whites, blacks, and Hispanics in US census tracts. Dark red areas represent hot spots or highly segregated areas in which the racial/ethnic group is clustered. Dark blue spots represent cold spots or areas in which the particular race group is underrepresented. The areas in between represent areas where the proportion of the race/ethnic group does not differ significantly than expected. Data Source: US Census, 2000; Analysis performed in ArcMap10.1 (ESRI, Redlands, CA). Std. Dev. indicates standard deviation.