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Original article

Using residential segregation to predict colorectal cancer stage at diagnosis: two different approaches

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ABSTRACT

Purpose: Studies have found a variety of evidence regarding the association between residential segregation measures and health outcomes in the United States. Some have focused on any individuals living in residentially segregated places, whereas others have examined whether persons of specific races or ethnicities living in places with high segregation of their own race or ethnicity have differential outcomes. This article compares and contrasts these two approaches in the study of predictors of late-stage colorectal cancer (CRC) diagnoses in a cross-national study. We argue that it is very important when interpreting results from studies like this to carefully consider the geographic scope of the analysis, which can significantly change the context and meaning of the results.

Methods: We use US Cancer Statistics Registry data from 40 states to identify late-stage diagnoses among over 500,000 CRC cases diagnosed during 2004–2009. We pool data over the states and estimate a multilevel model with person, county, and state levels and a random intercepts specification to ensure robust effect estimates. The isolation index of residential segregation is defined for racial and ethnic groups at the county level using Census 2000 data. The association between isolation indices and late-stage CRC diagnosis was measured by (1) anyone living in minority-segregated areas (place-centered approach) and by (2) individuals living in areas segregated by one's own racial or ethnic peers (person-centered approach).

Results: Findings from the place-centered approach suggest that living in a highly segregated African American community is associated with lower likelihood of late-stage CRC diagnosis, whereas the opposite is true for people living in highly segregated Asian communities, and living in highly segregated Hispanic communities has no significant association. Using the person-centered approach, we find that living in places segregated by one's racial or ethnic peers is associated with lower likelihood of late-stage CRC diagnosis.

Conclusions: In a model that covers a large geographic area across the nation, the place-centered approach is most likely picking up geographic disparities that may be deepened by targeted interventions in minority communities. By contrast, the person-centered approach provides a national average estimate suggesting that residential isolation may confer community cohesion or support that is associated with better CRC prevention.

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Introduction

Cancer is the second most common cause of death in the United States [1,2], and colorectal cancer (CRC) is second behind lung cancer in the number of people who died from it in the United States in 2015 [1]. The incidence rate for CRC is now fourth highest among all cancer types in the United States [1,3]. CRC screening rates are lower than recommended, resulting in higher rates of late-staged cancers and higher morbidity and mortality rates [1,4,5]. Of policy importance, there are disparities across population racial or ethnic subgroups in the likelihood of cancer being diagnosed at late stage [4].

Using data from the United States Cancer Statistics (USCS) database, which is a population-based surveillance system of cancer registries with data representing 96% of the US population [6],

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we examined all newly diagnosed CRC cases during 2004–2009. The overall rates of late-stage diagnoses for CRC vary considerably across the states (Fig. 1), where states with proportions above the national average (54.3%) are shaded as the darkest two colors. The highest proportions are in the West and Pacific Northwest states.

A large literature has examined the role that social forces may play in shaping health outcomes such as these, where in addition to availability of services and financial means, personal information, and motivation are required to enable timely access to preventive cancer screenings. We focus here on the role that residential segregation may play in providing this sort of support for CRC screening using endoscopy (colonoscopy and sigmoidoscopy).

Literature on residential segregation and health

Williams and Collins [7] were some of the first social scientists to argue that residential segregation caused racial or ethnic disparities in health outcomes because it helped determine access to education and employment opportunities that can lead to differences in socioeconomic status, which is a fundamental cause of health disparities. Subsequently, many researchers have studied this phenomenon, using various different measures of residential segregation, citing the seminal work by Massey and Denton [8] who rigorously defined several measures as a multidimensional phenomenon. Dimensions varied along five distinct axes of measurement: evenness, exposure, concentration, centralization, and clustering. Examples of these dimensions are found in measures such as the Diversity Index (evenness), Isolation Index (exposure), Interaction Index (exposure), Index of Spatial Proximity (clustering), and White's Clustering Measure (clustering).

Kramer and Hogue [9] reviewed 39 studies of ecological factors and social outcomes to determine which of Massey and Denton's segregation measures had been used in research, and by whom. They found that isolation, clustering, and dissimilarity indices had been used most often. In this study, we chose to use the isolation index to measure residential segregation. The isolation index used here is a minority-weighted average across census tracts of each county, using the formula defined as follows [8,10]:

$$P_1 = \sum_{i=1}^{N} \frac{x_i}{X} \frac{x_i}{t_i}$$

where x_i is the number of a minority group at tract i; X is the sum of all members of that minority group across all tracts; t_i is the total number of people of all races or ethnicities in tract i; and N is the number of tracts within each county. The county isolation index defined for a particular minority group reflects the extent to which the minority group comes into contact with others of this minority group within the county. The index ranges in value from 0 to 1, and a higher index value reflects the higher probability of contact among members of the minority group.

The isolation index has been interpreted as enhancing social cohesion or support [11–19]. However, some studies argue that residential isolation reflects an adverse environment [7,20–25]. Others argue that segregation might be positively enhanced by a high degree of clustering into enclaves which increase political empowerment [26–28]. This political empowerment interpretation may be valid for the isolation index defined at larger geopolitical units such as metropolitan areas or states (rather than smaller neighborhoods or counties) because a higher valued index at a larger scale indicates a greater degree of spatial clustering [26]. It can be argued that the region may reflect broader factors such as political influence or community solidarity among minorities in the geopolitical units. Contradictory associations found *within the same study* contrasting models using different-sized areal units to define communities demonstrate that findings may be sensitive to the areal unit size over which the isolation index is constructed [14].

We extend this argument here and posit that the geographic scope of the analysis may also impact the interpretation of the segregation effects. A study that is examining residential isolation effects within a metropolitan area or state may reflect something quite different than a cross-national study that pools data across 40 states, which is what we do in this article. To date, there is no

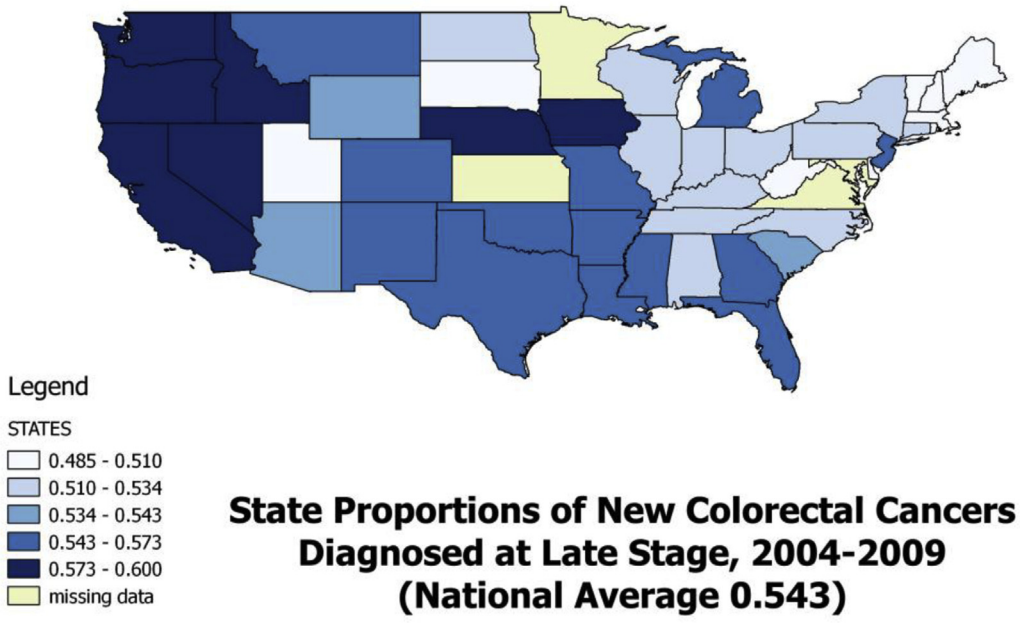

Fig. 1. Proportions of CRC cases diagnosed at late-stage in the United States, 2004–2009.

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