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New spatially continuous indices of redlining and racial bias in mortgage lending: links to survival after breast cancer diagnosis and implications for health disparities research

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ABSTRACT

Racial health disparities continue to be a serious problem in the United States and have been linked to contextual factors, including racial segregation. In some cases, including breast cancer survival, racial disparities appear to be worsening. Using the Home Mortgage Disclosure Act (HMDA) database, we extend current spatial analysis methodology to derive new, spatially continuous indices of (1) racial bias in mortgage lending and (2) redlining. We then examine spatial patterns of these indices and the association between these new measures and breast cancer survival among Black/African American women in the Milwaukee, Wisconsin metropolitan area. These new measures can be used to examine relationships between mortgage discrimination and patterns of disease throughout the United States.

1. Introduction

Racial health disparities continue to be a serious problem in the United States, despite many years of research and intervention targeted to closing the gaps. In some cases, racial disparities appear to be worsening (Orsi et al., 2010). A prime example of this is the widening gap in breast cancer survival disparities between Black and White women (Orsi et al., 2010; Hunt et al., 2014). In the case of breast cancer survival, as with other disease and injury types, individual characteristics have been shown to be insufficient in explaining observed disparities (Newman et al., 2002; Wallace et al., 2011; Menashe et al., 2009; DeSantis et al., 2013), leading many researchers to turn to an emphasis on more holistic approaches that consider important elements of the environments, systems, and contexts within which health problems arise. A key element of these investigations that requires more attention is the influence of multiple sectors of society, such as housing, education, and labor (Harrison and Dean, 2011). Further, databases that arise from multiple sectors can contribute to a more complete picture of the complex human-environment interactions that take place to ultimately produce health outcomes.

Previous literature has shown clear links between patterns of segregation and health outcomes (Bellatorre et al., 2011; Acevedo-Garcia et al., 2003; Warner and Gomez, 2010; Pruitt et al., 2015b). In order to better understand these effects, there are many articles focused on quantifying patterns of segregation, with early works primarily using the idea of evenness to create the dissimilarity index (Jakubs, 1977; Massey and Denton, 1988; Morrill, 1991). Unfortunately these approaches have two major limitations. Firstly, they were limited because they do not take any of the spatial information of the region they are measuring, such as the shape of the subunits (e. g. census tracts and ZCTAs) and adjacency (i.e. if two subunits are neighboring). Secondly, these are summary measures of a region and do not provide any insight on how segregation manifests at the local (subunit) level. In order to

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combat the former problem, adjustments for centroid location and compactness, the ratio of perimeter to area, were proposed as early spatial metrics (Wong, 1993). Later, these ideas were expanded with more sophisticated techniques such as clustering similar subunits via standard deviational ellipses and looking at the lacunarity or texture of the region (Wong, 2003; Wu and Sui, 2001), but these approaches do not address the issue of disaggregating segregation measures to emphasize local experiences. Recent papers have proposed using the location quotient as a metric for neighborhood segregation (Sudano et al., 2013; Pruitt et al., 2015b), but while this is a local metric that compares the local experience to the larger metropolitan area, it is aspatial. There is at least one example of a local spatial metric based on the principle of standard deviational ellipses and kernel densities (O'Sullivan and Wong, 2007).

While quantification of the spatial distribution of individuals of different racial and ethnic groups throughout a region is the primary concern of segregation metrics, these population distributions manifest as the result of a number of discriminatory and socioeconomic processes, and these processes – which are ultimately the targets for policy changes to reduce residential racial segregation – have received less attention. It is important then to isolate and measure active forms of explicit discrimination in addition to considering the greater issue of racial segregation. Active forms of racial discrimination and racism have been described and conceptualized by a number of scholars. Jones (2000) describes three levels of racism as *institutional* (differential access to the goods, services and opportunities of society), *personally mediated* (prejudice and discrimination), and *internalized* (acceptance by members of stigmatized races of negative messages about their abilities and intrinsic worth) (Jones, 2000). These forms of racism and discrimination are known to affect numerous systems in the United States, including housing, education, employment and the judicial system (Shavers and Shavers, 2006). Experiences of racism via these systems can contribute to health disparities through numerous pathways, including higher exposure to environmental pollution, lack of access to health care, targeted marketing of harmful products (e. g. tobacco), social stigma, and biological changes resulting from prolonged exposure to chronic stress, including inflammation and hastened cellular aging (i. e. telomere shortening) (Mendez et al., 2011; Shavers and Shavers, 2006; Chae et al., 2015; Black et al., 2015; Nelson, 2002).

Housing is a sector that has received increasing attention, not only because of the importance of the quality and stability of housing for human health (Grieb et al., 2013; Marmot et al., 2008), but also because of a clear history in the United States of institutionalized racism manifest as housing discrimination, ultimately producing clear and persistent patterns of residential racial segregation (Seitles, 1998). Because of discriminatory housing practices, and in an attempt to address issues of poverty, The Home Mortgage Disclosure Act (HMDA) was passed in 1975 (Guy et al., 1982; Canner et al., 1991; McCoy, 2007), shortly after the Civil Rights Act in 1968, which prohibited discrimination in housing finance (McCoy, 2007). The intent of the HMDA was to respond to a pattern of mortgage discrimination and resultant decline in housing quality in urban centers. The hope was that knowledge of geographic patterns of mortgage lending could help lending institutions to target spending in areas in need of investment (McCoy, 2007). A key element of the HMDA was the creation of a large, national database representing a collection of mandatorily reported data on mortgage lending practices. While a number of studies have investigated, and found, links between patterns of segregation and health outcomes (Bellatorre et al., 2011; Acevedo-Garcia et al., 2003; Warner and Gomez, 2010; Pruitt et al., 2015b), surprisingly few public health studies have made use of the HMDA database to examine spatial patterns of mortgage discrimination and the influence that this discrimination may have on health outcomes. This is important particularly because housing discrimination is known to be one of the key driving forces that produces patterns of residential racial segregation (Seitles, 1998), and is thus a potential target for intervention to reduce segregation and its public health impacts. Recently, several studies have used the HMDA data to derive indexes of "redlining" and relate these to health outcomes, including pregnancy health and more general measures of health status (Mendez et al., 2011, 2014, 2013; Gee, 2002). These studies are subject to two major limitations, which we address in this work.

First, these studies have relied on administrative units (census tracts) as units of analysis to characterize mortgage discrimination, given the provision of HMDA data at this level. This presents a limitation for several reasons. First, health information is not always available with a census tract geocode; a more frequently available geocode is the ZIP code. ZIP codes and Census tracts do not nest geographically and represent distinctly different types of geocodes (Krieger et al., 2003; Grubesic and Matisziw, 2006; Beyer et al., 2008; Krieger et al., 2002; Grubesic 2008; US Census Bureau, 2011). Further, reliance on boundaries introduces a number of significant limitations, including the *small numbers problem*, whereby rates calculated based on small numbers are less reliable than rates based on large numbers, and the *modifiable areal unit problem*, whereby the choice of boundary can change the observed spatial pattern (Flowerdew et al., 2008; Waller and Gotway, 2004; Gelman and Price, 1999; Lawson, 2013). Disease mapping methods have been developed to mitigate these problems. One method, adaptive spatial filtering (ASF) (Beyer et al., 2012; Beyer and Rushton, 2009; Rushton et al., 2004; Rushton and Lolonis, 1996; Tiwari and Rushton, 2005; Cai et al., 2012), focuses on achieving several key properties in maps of disease: (1) controlling the population basis of support used to calculate a rate, (2) displaying rates continuously over space, and (3) providing maximum geographic detail across the map (Beyer et al., 2012). In ASF, a grid is placed over the study area, and for each grid point, a rate is calculated by using a circular filter that expands, based on a threshold specified by the user, to obtain data from multiple locations until it obtains enough observations to make a stable calculation. The result is a map that displays a disease rate as a continuous surface. Until recently, the ASF method had only been used to calculate incidence and mortality rates using age standardization procedures. The work described here extends this methodological approach by using a (logistic regression) model-based approach for the calculation of two new indices.

Second, previous work has conceptualized the odds of denial of mortgage applications for Black applicants, as compared to White applicants, as "redlining" (Mendez et al., 2011), when this may not in fact be what is represented by such a measure. Redlining is the process of systematically denying mortgages based on location, where these locations are often defined by a predominant race or socioeconomic group. Redlining is more specifically about the neighborhood (albeit neighborhoods characterized by particular groups of residents, often defined by race, ethnicity or SES) than it is about the applicant's race. It is entirely possible, for example, that areas where populations of Blacks are low will have stronger patterns of racial bias in mortgage lending. In this work, we separate the concepts of redlining and racial bias in mortgage lending and examine the ways in which the HMDA database can be used to measure each construct. We conceive of redlining as the denial of mortgages to particular neighborhoods, while racial bias in mortgage lending is conceived as the denial of mortgages to Black applicants, regardless of the neighborhood in which they intend, through a mortgage application, to reside.

In this paper, we make several specific contributions to the literature in this area. We extend filtering methodology to derive