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The Measurement of Neighborhood Socioeconomic Characteristics and Black and White Residential Segregation in Metropolitan Detroit: Implications for the Study of Social Disparities in Health

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Research has suggested that the pattern of residence (integration or segregation) alone is insufficient to explain health disparities by race. Socioeconomic characteristics of neighborhoods where blacks and whites reside must also be considered to explain health disparities. This article has three aims: (1) to describe the component socioeconomic characteristics of census tracts (neighborhoods) of residence in metropolitan Detroit in 2000 for three indexes of socioeconomic position (SEP); (2) to assess the concordance of the three indexes of SEP of census tracts (neighborhoods) categorized into quintiles based on metropolitan Detroit census data in 2000; and (3) to compare the extent to which black-white residential segregation is revealed by SEP of neighborhoods in metropolitan Detroit. Census data from the U.S. Bureau of the Census (SF3) were used to define three indexes of SEP of neighborhoods, the modified Darden/Kamel Composite Socioeconomic Index, the modified Krieger Composite Deprivation Index, and an index of percentage poverty. Residential segregation was measured using the index of dissimilarity. The three indexes similarly captured variability in neighborhood socioeconomic characteristics. Further, sharp geographic inequality was revealed by race and socioeconomic status in the Detroit metropolitan area. The social and spatial structure created by the indexes will help researchers and policymakers better understand the effects of racial and socioeconomic characteristics as well as racial residential segregation on the complex factors related to social disparities in health by race. *Key Words:* blacks, health disparities, metropolitan Detroit, neighborhood socioeconomic inequality, race, residential segregation, social class.

有研究表明, 居住模式(聚居或隔离)本身并不足以解释种族上的健康差距。黑人和白人居住社区的社会经济特征也必需加以考虑来解释健康差距。本文有三个目标,(1)基于2000年人口普查的地区数据(社区级别),对底特律大都市区居民的社会经济特征进行分析,研究社会经济地位(SEP)的三个指数;(2)基于底特律大都市区2000年人口普查数据,将人口普查的地区数据(社区级别)进行五分之一分类,评估SEP三个指数的一致性;(3)比较底特律大都市区那些黑白隔离居住的社区在何种程度上可以从SEP指数上得到揭示。人口普查的数据来自美国人口普查局(SF3),被用于定义社区SEP的三个指数,既修正的达登/卡迈社会经济综合指数,修正的克里格社会剥夺综合指数,以及贫穷比例指数。居住的隔离情况是通过差异指数来测定的。上述三个指数都可以类似地用于捕捉社区社会经济特征的变化。此外,底特律大都市区种族和社会经济地位揭示出该地区严重的地域不平等性。上述指数所创建的社会和空间结构,将有助于研究人员和决策者更好地了解种族和社会经济特征的影响,以及居住隔离等复杂的社会因素,和它们与种族上的健康差异的相关性。关键词:黑人,健康状况差异,底特律大都会区,社区的社会经济不平等,种族,住宅区的隔离,社会阶层。

La investigación indica que por sí solo el patrón de residencia (integración o segregación) es insuficiente para explicar las disparidades en salud por raza. Las características socioeconómicas de los vecindarios donde residen negros y blancos también deben considerarse para explicar las disparidades en salud. Este artículo tiene tres fines: (1) describir el componente de características socioeconómicas de los tractos censales (vecindarios) de residencia en el Detroit metropolitano del 2000, para tres índices de posición socioeconómica (SEP); (2) evaluar la

concordancia de los tres índices de la SEP de los trectos censales (vecindarios) categorizados en quintiles, con base en datos censales de la Detroit metropolitana del 2000; y (3) comparar la amplitud con la que se revela la segregación residencial de negros y blancos por la SEP de vecindarios en la Detroit metropolitana. Se utilizaron datos censales del Bureau de los Censos de EE.UU. (SF3) para definir tres índices de SEP de los vecindarios, el Índice Socioeconómico Compuesto de Darden/Kamel modificado, el Índice de Privación Compuesta de Krieger modificado, y un índice del porcentaje de pobreza. La segregación residencial fue medida por medio de un índice de disimilitud. Similarmente, los tres índices captaron la variabilidad de las características socioeconómicas de los vecindarios. Más aun, una aguda desigualdad geográfica se reveló por raza y estatus socioeconómico en el área metropolitana de Detroit. La estructura social y espacial creada por los índices ayudará a investigadores y formuladores de políticas a entender mejor los efectos de características raciales y socioeconómicas, lo mismo que la segregación residencial por raza, sobre los complejos factores relacionados con las disparidades de salud por raza. *Palabras clave:* negros, disparidades de la salud, Detroit metropolitana, desigualdad socioeconómica del vecindario, raza, segregación residencial, clase social.

Social scientists and health researchers have developed an increasing interest in understanding social disparities in health by race, socioeconomic status, and neighborhood characteristics (Guest, Almgren, and Hussey 1998). Research suggests that black and white population groups living in the same neighborhood (integration) tend to have more similar health outcomes than groups living in different neighborhoods (segregation). Research has also suggested that the pattern of residence (integration or segregation) alone is insufficient to explain health disparities by race. Socioeconomic characteristics of neighborhoods where blacks and whites reside must also be considered to explain health disparities (Polednak 1993; Bayer and McMillan 2005).

In metropolitan areas throughout the United States, blacks tend to live in significantly poorer and lower quality neighborhoods than whites (Darden and Kamel 2000b; Bayer and McMillan 2005). The situation is magnified by the fact that as Bayer and McMillan (2005) have demonstrated, there are few high-socioeconomic-status (SES) black neighborhoods in most metropolitan areas. The limited number of high-SES black neighborhoods does not allow a direct comparison of high-SES black neighborhoods with high-SES white neighborhoods. Sampson and Wilson (1995) showed that black families with median incomes and educational and occupational attainment levels equal to that of white families often do not live in neighborhoods that are equal in quality and characteristics to white neighborhoods. Massey, Condran, and Denton (1987) found similar results for Philadelphia when they compared black and white families by residential characteristics of neighborhoods. The authors found that high-status blacks were living in neighborhoods with fewer resources and amenities than whites of similar socioeconomic backgrounds. Specifically, blacks lived in poorer, more dilapidated

areas characterized by high rates of poverty, crime, and mortality (Jargowsky 1997). Thus, higher incomes do not ensure that blacks will live in neighborhoods with the same quality of housing, schools, recreation, shopping, and health care facilities as whites with comparable incomes (Massey and Denton 1993; Darden and Kamel 2000a). Regardless of the income of the individual black household, the quality of housing, schools, recreation, shopping, and health care facilities where the individual white household of comparable income resides will usually be better (Massey and Denton 1993). Thus, most blacks, regardless of individual socioeconomic status, are impacted greatly by neighborhood effects that are often distinctly different from the neighborhood effects impacting whites. Research has suggested that such differential neighborhood effects contribute to health disparities by race (Diez Roux et al. 2001).

Metropolitan Detroit as a Study Area

Metropolitan Detroit is an ideal area to demonstrate the extent of socioeconomic and racial disparity, the potential for health disparity outcomes, and implications for public policy. In 2000, metropolitan Detroit was the most racially segregated large metropolitan area in the United States (Darden, Stokes, and Thomas 2007). Accompanying such extreme racial residential segregation is extreme class segregation. The city of Detroit had the highest poverty rate (33.8 percent) among large cities (250,000 or more) in 2007 (U.S. Bureau of the Census 2008). Nationally, the poverty rate was 9.8 percent. The stark inequality between poor blacks in the central city and the more affluent whites in the suburbs makes metropolitan Detroit unusual (Farley, Danzinger, and Holzer 2000). All of the eleven concentrated affluent neighborhoods

(defined as census tracts where more than 50 percent of the residents had median family income above 150 percent of the median family income for the Detroit metropolitan area as a whole) were located in suburban Oakland County.

In 2000, the Detroit metropolitan area (Wayne, Oakland, and Macomb counties) consisted of 4,043,467 people, of whom 2,720,689, or 67.2 percent, were white, and 1,000,853, or 25 percent, were black. Of whites, 96 percent lived in the suburbs and only 4.3 percent resided in the city. By 2000, the city of Detroit had declined in population from 1 million people in 1990 to a total of 951,270, and the population was estimated to have dropped to 808,327 by 2007 (U.S. Bureau of the Census 2008). The percentage of black population had increased from 75 percent in 1990 to 81.3 percent in 2000 and 83.0 percent in 2007 (U.S. Bureau of the Census 2008). Indeed, over the decade from 1990 to 2000, Detroit lost 44.5 percent of its white population, as most whites moved to the suburbs. On the other hand, the decline of the black population was less than 1 percent, as most blacks remained in the city of Detroit. (For a discussion of how the patterns of race and class residential segregation were created and maintained in metropolitan Detroit, see Darden et al. 1987; Farley, Danzinger, and Holzer 2000; Darden 2007a, 2007b). With the demographic and geographic structure of the Detroit metropolitan area fixed primarily by years of racial discrimination in housing, from 1950 to 1980, at least fifty incorporated places were added to Detroit's metropolitan area. The population of those suburban places consisted of 737,007 whites and only 4,852 blacks.

Movement of whites to the suburbs increased the race and class divide. Suburban Oakland County has a higher proportion than other counties of automotive executives, professionals, and other managerial and high-level administrative workers, who chose to settle in high-income communities such as Bloomfield Hills, Birmingham, and Huntington Woods. Detroit, on the other hand, has a higher proportion of the poor. Detroit was one of ten cities with a population over 250,000 with a median household income below \$30,000 (\$28,097) in 2007. The city of Detroit has been experiencing an economic decline related to globalization, auto industry disinvestment, and economic restructuring, whereas the suburbs located in Oakland County remain comparatively prosperous. Indeed, Oakland County is one of the wealthiest counties in the United States. Thus, population growth, social and spatial mobility, and economic development in

metropolitan Detroit have been uneven, and this unevenness is most visible by class, race, place, and quality of life.

Conceptual and Theoretical Framework Linking Neighborhood Characteristics to Health Disparities

Conceptually and theoretically, the quality of life of residents varies by the characteristics of neighborhoods where they reside. Whereas some neighborhoods have characteristics that enhance the residents' quality of life, others have characteristics that have been shown to be harmful (Logan 2002; Darden 2007a, 2007b; Stoll 2007). Geographers and other social scientists have been studying the effects of neighborhood characteristics and racial inequality on homeownership, employment, and education for some time (Mills 1972; Darden et al. 1987; Charles 2001; Darden 2003). Health researchers have more recently examined the specific effects of characteristics of neighborhoods on health disparities (O'Campo et al. 1997; Diez Roux et al. 2001; N. Krieger et al. 2003). Emerging from this body of literature is a concept of a *neighborhood effect*, which is an independent effect of a neighborhood combined with its composite characteristics on any number of outcomes (Oakes 2004).

There are a variety of approaches to studying the potential effects of neighborhoods on the well-being of individuals across neighborhoods (Wilson 1987, 1996; Jencks and Mayer 1990; Ellen and Turner 1997). Most studies begin by presenting data that show that poor neighborhoods have a limited availability of jobs, quality housing, grocery stores, and other shopping facilities, putting them at a disadvantage compared to more affluent neighborhoods (Stoll 2007). Predominantly non-white neighborhoods usually have poorer quality and quantity of resources (Bayer and McMillan 2005). Thus, neighborhood effects studies are often conceptualized within the context of race and concentrated poverty or socioeconomic characteristics of places (Ellen 2000; Katz, Kling, and Liebman 2001; Kling et al. 2004). We describe four approaches that have been taken to examine neighborhood effects.

The first approach is in the tradition of Wilson (1987) and Massey and Denton (1993). In the book *The Truly Disadvantaged*, Wilson (1987) emphasized the importance of concentrated poverty (i.e., neighborhoods where 40 percent or more of the residents

are poor) on the creation and perpetuation of an underclass isolated from the economic opportunities for upward mobility. Such structural characteristics of the neighborhood influenced the level of unemployment and teen pregnancy rates. Endorsing Wilson's underclass views, Massey and Denton (1993) argued in *American Apartheid* that racial residential segregation contributes to concentrated poverty by limiting upward mobility and access to economic opportunities. This led other researchers, such as C. E. Ross and Mirowsky (2008), to argue that low income and economic hardship erode health, increasing the risk of impairment.

Our perspective, which evolved from earlier studies of concentrated poverty and concentrated race in assessing neighborhood effects on health, has been reinforced by the U.S. Department of Housing and Urban Development's Moving to Opportunity (MTO) program, which based its policy research on the idea that tenants living in neighborhoods of concentrated poverty and concentrated race have poor health outcomes (Acevedo-Garcia et al. 2004). The MTO research project, the first multisite experimental study of neighborhood effects, was designed to answer questions about what happens to poor families when they are given the opportunity to move out of distressed public housing in the poorest neighborhoods of five very large metropolitan areas (Baltimore, Boston, Chicago, Los Angeles, and New York City). Using a randomized experimental design, the MTO study of neighborhood effects remains unique, enabling researchers and policy analysts to address the long-term effects of living in poor neighborhoods, and to measure whether and how families who moved improved their lives in such areas as employment, earnings, educational attainment, and health compared to those left in their poverty-stricken neighborhoods. The results to date remain mixed regarding neighborhood effects on employment, earnings, and educational attainment; however, researchers have found large and statistically significant positive effects on the mental health of adults and girls who changed neighborhoods.

A second approach on the potential effects of neighborhoods on populations focuses on *social processes*, or mechanisms that result in outcomes. Rather than rely on census demographic and socioeconomic data only, the approach also examines the social and institutional processes related to problem behavior that might cause an outcome, such as the range of adolescent behaviors from teenage pregnancy to dropping out

of school. Lanctot and Smith (2001) examined young African American girls in Rochester, New York. They focused on the processes of neighborhood disorganization, deviant influences, and risky time with friends and gang members. The outcome was early sexual activity and teen pregnancy. Studies of social processes have focused most often on mental rather than physical health.

The social processes approach provides accounts of how neighborhoods bring about a change in a given condition (Sampson, Morenoff, and Gannon-Rowley 2002), but it has many similarities with the concentrated poverty and race approach. Both use census tracts or similar spatial units for analysis and both approaches can trace their roots back to the Chicago School of urban analysis (Sampson, Morenoff, and Gannon-Rowley 2002).

A third approach to examining neighborhood effects is the systematic social observation approach, which has been used extensively by Sampson and Raudenbush (1999) based on data collected by researchers themselves on the physical and social features of neighborhoods that cannot be obtained using surveys or public access census data. This approach involves driving slowly down every street within a sample of neighborhoods to capture and videotape social activities and physical features, such as graffiti or abandoned cars to create an index of physical disorder or the presence of adults drinking alcohol in public as an index of social disorder. A major limitation of this approach is the cost involved in collecting a sufficient database for analysis. There might also be a risk that the researchers might apply their own concept of disorder based on normative ideas of what a neighborhood should be, especially if the researchers are white and residents are black.

A fourth approach in the study of neighborhood effects involves space-time analyses, which incorporate not only where a population resides but also the location of daily activities such as traveling to work or to shop. This approach has its roots in Hägerstrand's (1970) space-time analyses and has been used extensively by Kwan (1998, 1999) to show significantly lower access to urban opportunities for women than for men.

This approach also has its limitations. Although there is potential for this approach to contribute more to our understanding of neighborhood effects on health, few of these studies have focused on the poor and black populations and health disparities. Indeed, Kwan's

(1999) important study showing gender differences focused on affluent suburban whites with automobiles; a forthcoming work with health potential might provide more understanding about drug use, abuse, and addiction within a socio-geographic context (Kwan et al. 2008).

In sum, although different approaches have been used to study neighborhood effects, our approach, which captures race and the socioeconomic characteristics of neighborhoods, remains an important component related to many outcomes, including health. It also has the greatest potential for linking housing policy and health policy to understand and address health disparities in metropolitan areas where residential segregation by race and class is the prevailing spatial pattern.

Past Research on Segregation and Health Outside the United States

Although the majority of studies of neighborhood effects focus on large metropolitan areas in the United States, other researchers outside of the United States have also found that socioeconomically segregated disadvantaged neighborhoods influence health outcomes negatively. That was the conclusion of Bartley and Plewis (1997), who examined health and socioeconomic differences in England and Wales. Doornbos and Kromhout (1990) linked educational attainment to mortality in The Netherlands, and Knesebeck, Verde, and Dragano (2006) found a similar link between education and health status in more than twenty European countries.

Instead of census tracts as surrogates for neighborhoods, several British studies have used wards (which are larger than tracts) to measure economic deprivation's influence on health outcomes. For example, Jones and Duncan (1995) linked economic deprivation and poor self-reported health, especially in the areas of heart illnesses; however, the relationship between economic deprivation and all-cause mortality was weak (see Sloggett and Joshi 1994).

The importance of neighborhood economic deprivation on health outcomes varies from country to country. According to Stafford et al. (2004), socioeconomic segregation by neighborhood might be greater in some countries than in others, so one would expect a stronger impact on health outcomes in different countries. For example, unlike the United States, many industrialized countries have universal access to high-quality health

care facilities and services and this fact might somewhat diminish the effect of neighborhood deprivation on health. N. Ross et al. (2000) examined segregation by income and its relationship to mortality in metropolitan areas in the United States and Canada and found a strong relationship between income inequality and mortality in the United States but not in Canada. They concluded that their findings could be because in the United States health care provision is not universal, and Canada has a universal health care system.

Even in two countries with universal health care, however, if socioeconomic segregation and deprivation are greater in one country than another, health outcomes can differ. That is what Stafford et al. (2004) found when they compared the effects of area deprivation on self-rated health among public employees in London and Helsinki. They found that socioeconomic segregation was higher in London than in Helsinki and sex- and age-adjusted differences in self-rated health between neighborhoods were also greater in London. Their overall conclusion was that neighborhood socioeconomic context is associated with health in both countries with some evidence of greater neighborhood effects in London. They attributed the differences to both greater socioeconomic segregation and differences in public policies impacting both health and housing (see also Tuohy 1999).

Measuring Health Disparities: The Rationale for Developing Area-Based Indexes of Socioeconomic Characteristics

Health researchers have examined the influence of geography on health since Hippocrates' *Airs, Waters, and Places* in 400 BCE. They have examined the relationship between health and geography in both England and the United States (see Snow 1855; Goldberger, Wheeler, and Sydenstricker 1920; Paneth et al. 1994). Only recently, however, have health researchers begun to look in depth at the effects of specific neighborhood characteristics on health disparities (Diez Roux et al. 2001; Williams and Collins 2001; N. Krieger et al. 2003). In efforts to better understand social disparities in health, geographers, other social scientists, and epidemiologists have been collaborating recently with a focus on developing quantitative methods to measure neighborhood effects on health by merging health data with census tract data.

Using Census Tracts as Surrogates for Neighborhoods

The use of census tracts as surrogates for neighborhoods has a long history and was associated with the Chicago School of sociology (Park 1916; Suttles 1972). A neighborhood, according to the view of Park (1916), is a subsection of a larger community, including people and institutions, occupying a spatially defined area influenced by ecological culture and political forces. Most researchers who study neighborhoods have relied on geographically defined subunits that provide geographic boundaries as well as statistical data on the populations residing within them. Such information has usually been provided by governmental agencies such as the U.S. Bureau of the Census.

Census tracts have been defined as small, relatively permanent geographic entities within counties (or the statistical equivalents of counties) delineated by a committee of local data users. Generally, census tracts have between 2,500 and 8,000 residents and boundaries that follow visible features. When first established, census tracts were to be as homogeneous as possible with respect to population characteristics, economic status, and living conditions (U.S. Bureau of the Census 2000). Although census tracts are not perfect, they allow for the most comprehensive investigations of the demographic and socioeconomic characteristics of residents at a small scale and of any disparities between them.

Because there are constraints on individual-level health data, including data for metropolitan areas such as Detroit, there has been a need to combine different data sets (N. Krieger and Ebel 1997). For example, unlike cancer registries in some European countries, U.S. medical records lack socioeconomic data (N. Krieger, Williams, and Moss 1997). Cancer registries are unable to determine the extent to which socioeconomic conditions contribute to the marked racial and ethnic disparities in metropolitan areas (N. Krieger 2001). Thus, cancer registry data, which do contain addresses, are coded with census tracts.

Gathering census tract or other area-based census data on racial and socioeconomic characteristics of residence linked to health data has the advantage of making quantitative research on racial and ethnic disparities in health possible (N. Krieger 1992). U.S. public health surveillance systems and hospital data systems have accomplished this goal by geo-coding each health record by residential address, obtained from health databases, and linking the health records to a corresponding census tract whose population in terms of racial and socioeco-

nomics characteristics is obtained from census tract data (N. Krieger 2006). As a result, cancer incidence rates for poor and affluent census tracts can be calculated; however, a possible disadvantage of using area-level measures as a proxy for an individual indicator could be the ecological fallacy; that is, making the inference that individuals in the tract reflect the group in terms of characteristics (Elreedy et al. 1999). According to N. Krieger (2006), however, geo-coding methods related to census tracts and addresses have made it possible to provide estimates of socioeconomic gradients on par with those obtained with individual-level socioeconomic measures, thus indicating that ecological fallacy is not a major concern.

Collaboration between geographers and epidemiologists has facilitated the use of area-based socioeconomic data and measures to understand and monitor health disparities. Researchers from both fields have increasingly recognized the merit of using area-based census data on racial and socioeconomic characteristics of residence linked to health data to estimate contextual effects on health (see N. Krieger and Ebel 1997; Diez Roux et al. 2001; N. Krieger et al. 2005; Diez Roux 2007).

Studies have established the link between residential neighborhoods and all-cause mortality (Fang et al. 1998), as well as heart disease (Diez Roux et al. 2001), cancer (Harper et al. 2008), and birth outcomes (Chen et al. 2006; Grady 2006). For example, Grady (2006) investigated the effect of racial residential segregation on the risk of low birth weight among African American infants and mothers, employing a cross-sectional multilevel analysis using birth records at the individual level and racial isolation indexes at the census tract (neighborhood) level to measure the independent and cross-level effects of low birth weight, to find that racial residential segregation and neighborhood poverty operate at different geographic scales to increase the risk of low birth weight. At the neighborhood scale, residential segregation was found to be positively and significantly associated with low birth weight after controlling for individual-level risk factors and neighborhood poverty. At the individual scale, increasing levels of residential segregation did not significantly reduce individual-level risk factors for low birth weight. Grady concluded that residential segregation and neighborhood poverty are important determinants of racial disparity in low birth weight in New York City.

Although Grady's (2006) study was limited to a single city, a similar pattern has been found for many metropolitan areas. Bell et al. (2006) examined the

relationship between residential segregation and birth outcomes in a sample of 434,000 births to African American women living in 225 metropolitan areas. The authors linked the data from the National Center for Health Statistics 2002 birth files to 2000 U.S. Census data. Employing multilevel regression models, controlling for individual- and metropolitan-level SES, the researchers found that high levels of black isolation (a form of segregation) were associated with birth outcomes among African American women. Subramanian et al. (2005) used low birth weight data from Massachusetts to compare estimates of health disparities detected with census tract and block group level area-based socioeconomic measures and related the disparities to poverty and education. Multilevel linear regression techniques were used to model the variation in birth weight. They concluded that census tract area-based socioeconomic measures detected socioeconomic gradients in birth weight among births to mothers younger than twenty-five years old.

According to these authors, area-based inequality assessments are likely to generate effect estimates analogous to those yielded by individual-level measures (Subramanian, Acevedo-Garcia, and Osypuk 2005). The results strengthened their belief that appropriately chosen area-based socioeconomic measures can be used to monitor socioeconomic inequalities in health; however, caution is advised in interpreting the results. Other researchers agree that area-based measures are effective at predicting health disparities as long as the results are interpreted as collective or contextual dimensions (Geronimus 2006).

In sum, using area-based measures, social scientists and health researchers have been increasingly documenting that neighborhoods influence health outcomes (Macintyre, Maciver, and Soomans 1993; Diez Roux et al. 2001; Pickett and Pearl 2001). Such research has been facilitated by advances in social epidemiology, multilevel theories, and sophisticated statistical models (Fang et al. 1998; Diez Roux et al. 2001; Pickett and Pearl 2001; Oakes 2004; Subramanian et al. 2005).

Lack of Research on the Combined Effects of Neighborhood Socioeconomic Characteristics and Racial Residential Segregation

Although area-based measures are increasingly used by researchers to assess socioeconomic effects of neighborhoods on health, research combining the effects

of both socioeconomic characteristics of neighborhoods and racial residential segregation has been limited (Acevedo-Garcia and Lochner 2003; N. Krieger et al. 2005; Grady 2006). Past research seems to suggest that the negative effects of racial residential segregation on health are related to the differential characteristics of the neighborhoods where racial groups reside (Subramanian, Acevedo-Garcia, and Osypuk 2005; Acevedo-Garcia and Osypuk 2008). Racial minorities (blacks and Latinos) compared to whites are usually the most effected (Darden et al. 1987; Laveist 1993; Schill and Wachter 1995; Acevedo-Garcia and Lochner 2003).

Extensive research has shown that the quality of neighborhoods (i.e., their internal and external built environments) matters to health. For example, Galeas et al. (2005) found that living in neighborhoods characterized by a poor quality built environment is associated with a greater likelihood of depression among residents of New York City. Houston et al. (2004) examined minority neighborhoods, concentrated poverty, and the magnitude of traffic in Southern California and found that minority neighborhoods in concentrated poverty areas had over twice the level of traffic density, thus disproportionately exposing the population to vehicle-related pollutants with serious health consequences. The authors also concluded that, unlike the declining trends (1990–2000) in racial residential segregation (Glaeser 2001) and concentrated poverty (Jargowsky 2003) in the nation as a whole, concentrated poverty neighborhoods in Southern California have almost twice the traffic density of the least poor neighborhoods, and minority neighborhoods (most of them poor) have almost 2.5 times the traffic density of nonminority neighborhoods. Thus, given the magnitude of the disparities in the distribution of traffic within the concentrated poverty neighborhoods, the authors argued that there is reason to suspect that residents of minority and concentrated poverty neighborhoods are at a higher risk of health effects associated with vehicle-related pollutants, such as respiratory illnesses, adverse birth outcomes, cancer, and mortality (Savitz and Feingold 1989; Oosterlee et al. 1996; Van Vliet et al. 1997; Wilhelm and Ritz 2003).

We suggest that collaborative research among geographers, other social scientists, and epidemiologists is the most effective way to examine the combined effects of socioeconomic characteristics of neighborhoods and racial residential segregation on health disparities. We also believe that assessment of neighborhood effects

using census tract socioeconomic and demographic data as surrogates for neighborhood characteristics is an effective method to capture the racial, socioeconomic, and spatial structure of a metropolitan area and should be done to lay the foundation for the study of health disparities.

Objectives

The objectives of this article are threefold: (1) to describe the component socioeconomic characteristics of census tracts (neighborhoods) of residence in metropolitan Detroit in 2000 for three indexes of socioeconomic position (SEP); (2) to assess the concordance of the three indexes of SEP of census tracts (neighborhoods) categorized into quintiles based on metropolitan Detroit census data in 2000; and (3) to compare the extent to which black–white residential segregation is captured by the three indexes of SEP in metropolitan Detroit.

Our purpose was not to create new indexes of SEP but rather to compare and contrast three previously constructed indexes to determine how well they reveal the extent of disparity and diversity over neighborhoods by socioeconomic characteristics and racial composition (e.g., residential segregation). Our ultimate objective was to demonstrate how the indexes could be used by other health researchers, such as epidemiologists, to better understand the effects that living in different neighborhoods might have on health outcomes, which can in turn inform health policymakers and health care providers. Health policymakers already know that health disparities exist between high-income white populations and low-income black populations at various geographic scales, such as counties (see Commonwealth Fund Commission 2008). As for health outcomes, individuals with low levels of education continue to be at significantly greater risk of death from chronic diseases, including heart disease, diabetes, and cancer (Commonwealth Fund Commission 2008, 37); however, what is not well known is how much health disparity might vary depending on the characteristics of the neighborhoods where the populations reside. As to why we reduced the three indexes of SEP into quintiles, it is well known that the most useful statistics for health policymakers are rates of disease reported in different populations to identify populations at highest risk to target appropriate interventions (e.g., infant mortality rates in black and white women, age-adjusted cancer rates in poor vs. wealthy men, etc.). To

generate a rate for relatively rare diseases, it is necessary for health researchers to pool data across population subgroups and group populations at risk into categories (e.g., quintiles). We are aware that quintiles of categorization are not optimal given potential heterogeneity in risk within categories. Nonetheless, some arbitrary cut points must be imposed to be able to generate stable and meaningful rates in defined population subgroups. As a result, we assumed and research has shown (Acevedo-Garcia and Lochner 2003) that risk for most diseases will increase or decrease in a relatively linear fashion across the distribution of SEP, and given that categorizing exposures of interest in calculating rates of disease into quantiles is common practice (N. Krieger et al. 2003), in comparing the indexes of SEP for use by health researchers, we similarly examined quantile categories in our analyses before deciding on quintiles.

The index of dissimilarity (also a previously constructed index) was used to enable health policymakers and researchers to see to what extent “place of residence” of the black and white populations differs not only in terms of location but also in terms of the characteristics of neighborhoods. Such characteristics (some disadvantageous and others advantageous) impact health outcomes that have implications for both health and housing policy (U.S. Department of Housing and Urban Development 2002).

Data and Methodology

Data for this study were obtained from the U.S. Bureau of the Census Census of Population and Housing (SF3) for metropolitan Detroit for 2000 (see U.S. Bureau of the Census 2002). Metropolitan Detroit is defined as Wayne, Oakland, and Macomb counties. Our unit of analysis was the census tract. We use census tract-level data rather than block group or ZIP code-level data based on findings from N. Krieger et al. (2003) that census tracts more consistently detected socioeconomic gradients in health (N. Krieger et al. 2003; N. Krieger et al. 2005). For the purpose of this study, only those who identified themselves as belonging to a single racial group (white, non-Hispanic, or black) in the 2000 Census are included. According to the U.S. Bureau of the Census (2001), 97.6 percent of the population reported a single race compared to 2.4 percent of persons in the 2000 Census who reported more than one race.

The analytic sample for these analyses is based on census data for the three-county (Wayne, Oakland,

and Macomb) Detroit metropolitan area and consists of 1,165 total census tracts. Census tracts were excluded from the current analyses if they had fewer than 100 people ($n = 10$ census tracts), had only juvenile institutions ($n = 3$ census tracts), and if they had Arab or Hispanic populations that made up more than 10 percent of the census tract ($n = 61$ census tracts). Census tracts with more than 10 percent of the population reporting Arab or Hispanic race or ethnicity were excluded from analyses because we are comparing only black and non-Hispanic white populations in these analyses given that there were too few members of other groups available for analyses. A total of 1,091 census tracts were eligible for analyses.

We considered two composite indexes of SEP of census tracts and one single-variable index along with its associated neighborhood characteristics. The two composite indexes were based on two approaches. First, we used the modified Darden–Kamel Composite Socioeconomic Index (Darden and Kamel 2000b). Second, we used a modified version of the Composite Socioeconomic Index created by N. Krieger et al. (2002). Finally, we used a single variable to represent a poverty index.

The Modified Darden–Kamel Composite Index

The modified Darden–Kamel Composite Index measures SES and assigns a higher score to tracts with high SEP. A high score reflects better socioeconomic quality of neighborhood characteristics and a low score reflects poor quality neighborhood characteristics. The modified Darden–Kamel Index incorporates nine variables to calculate a Composite Socioeconomic Index (CSI) defined as follows:

1. *Percentage of residents with university degrees.* This is the percentage of the population with at least a bachelor's degree (i.e., four or more years of schooling beyond high school) as a percentage of the total population twenty-five years or older.
2. *Median household income.* This is the median household income of the total number of family members fifteen years and older, including those with no income in 1999.
3. *Percentage of managerial and professional positions.* This is the percentage of workers sixteen years and older at the top of the occupational hierarchy based on the occupational classification system used by the U.S. Bureau of the Census during 2000. It is based on twenty-three major occupational groups stratified.

4. *Median value of dwelling.* This is the median value of specified owner-occupied housing units. The value is the respondent's estimate of how much the property would sell for if it were for sale. It includes only one-family houses on less than ten acres without a business or medical office on the property.
5. *Median gross rent of dwelling.* Median rent is the contract rent plus the estimated average monthly cost of utilities.
6. *Percentage of homeownership.* This is the percentage of all housing units that are owner occupied if the owner lives in the unit, even if it is mortgaged or not fully paid for.
7. *Percentage below poverty.* This is the percentage of families that are below the U.S. poverty threshold for families of a particular size and income in 1999. We used the family size of four, which is the standard size used by the Bureau of the Census to assess the SES of families.
8. *Unemployment rate.* This is the percentage of all civilians sixteen years and older who were neither at work nor with a job but who were not at work during the reference week or who were looking for work during the last four weeks and were available to start a job.
9. *Percentage of households with vehicle.* This is the percentage of households with a vehicle available.

The Modified Krieger Composite Index

The N. Krieger et al. (2003) Composite Index measures SEP and assigns a higher score to tracts with low SEP. A high score indicates high deprivation of a neighborhood of residence and a low score indicates low deprivation. It includes six variables based on the 1990 Census definitions of characteristics used by N. Krieger et al. (2003). We modified the index to apply it to the definitions of the 2000 Census characteristics and the composite variables are defined as follows:

1. *Percentage working class.* The variable of working class was defined by N. Krieger et al. (2003, 1664) as “percentage of persons employed in predominantly working-class occupations, which includes eight occupational categories: administrative support; sales; private household service; other service (except protective); precision production, craft, and repair; machine operators, assemblers, and inspectors; transportation and material moving; handlers, equipment cleaners, and laborers.” We used the definitions of these categories as defined by the 2000 Census.

- Working class was redefined to include four of the six categories, namely, sales and office occupations; service occupations; construction, extraction, and maintenance occupations; and production, transportation, and material occupations.
2. *Unemployment*. This has the same definition as for the modified Darden–Kamel Composite Index.
 3. *Percentage below the poverty line*. This has the same definition as for the modified Darden–Kamel Composite Index.
 4. *Low education (less than high school)*. This is the percentage of persons with less than a twelfth-grade education among adults aged twenty-five years or older.
 5. *Expensive homes*. This is the percentage of owner-occupied homes in the tract worth 400 percent or more of the median value of owned homes among the total tracts in the Detroit metropolitan area (Wayne, Oakland, and Macomb counties).
 6. *Median household income*. This has the same definition as for the modified Darden–Kamel Composite Index.

The Poverty Index

1. *Percentage below poverty*. This has the same definition as for the modified Darden–Kamel Composite Index.

Calculating and Standardizing Composite Socioeconomic Variables

The modified Darden–Kamel Composite Index, the modified Krieger Composite Index, and the percent poverty index were used to sort and rank the Detroit metropolitan area census tracts of residence according to their overall status. The Composite Socioeconomic Z Score Index was calculated by using the formula:

$$CSI_i = \sum_{j=1}^k \frac{V_{ij} - V_{jDMA}}{S(V_{jDMA})}$$

where CSI_i = the composite socioeconomic Z-score index for census tract i , the sum of Z scores for the SES variables j , relative to the Detroit metropolitan area's SES; DMA = the three-county Detroit metropolitan area; k = the number of variables in the index; V_{ij} = the j th SEP variable for a given census tract i ; V_{jDMA} = mean of the j th variable in the three-county Detroit metropolitan area; and $S(V_{jDMA})$ = standard deviation

of the j th variable in the three-county Detroit metropolitan area.

We calculated Z scores for the original variables characterizing census tracts to standardize the contribution of each census variable included in the modified Darden–Kamel Composite Index and the modified Krieger Composite Index. These were calculated by subtracting the mean value of that variable for a census tract from the grand mean for the Detroit metropolitan area and then dividing by the standard deviation of the respective variables for the Detroit metropolitan area. We then ensured that all variables with negative contributions to the indexes (e.g., the percentage below the poverty level and the percentage of all civilians aged sixteen years and older in the labor force who were unemployed) captured the depreciating effect of these variables on area-based socioeconomic characteristics. To ensure that each variable contributed appropriately when calculating the indexes, for the modified Darden–Kamel Index, we multiplied the Z scores of percentage poverty and percentage unemployment by -1 . For the modified Krieger Composite Index, we multiplied the Z scores of percentage of households owning expensive homes and percentage of households having access to vehicles by -1 .

For each index, the Detroit metropolitan area was divided into five levels (i.e., ranges of SEP) with boundaries at the 20th, 40th, 60th, and 80th percentiles (quintiles) of the CSI frequency distribution. This categorization allowed the division of census tracts of residence into five socioeconomic groups with approximately equal proportions of the population in each group: very high socioeconomic position (VHSEP), high socioeconomic position (HSEP), middle socioeconomic position (MSEP), low socioeconomic position (LSEP), and very low socioeconomic position (VLSEP).

In addition to the variables selected for the composite socioeconomic indexes, neighborhoods (census tracts) were also examined by a poverty index. The spatial pattern of poverty was examined across neighborhoods with five increasing levels of poverty ranging from less than or equal to 2.7 to 61.2 percent. Although it is only a single variable, N. Krieger et al. (2002) stressed its usefulness because of its simplicity in calculation and interpretation. Also, extreme concentrated poverty (i.e., levels at 40 percent or more) is the basis for policy research related to the Department of Housing and Urban Development's (2002) residential mobility programs. Therefore, we have included it in our study here for comparative purposes.

The Kappa Measure

The second objective was to assess the concordance of the three indexes of SEP of census tracts (neighborhoods) categorized into quintiles based on metropolitan Detroit Census data in 2000. We employed the Kappa measure, which is a useful statistical method to assess agreement among categorical variables. One of the most important features of the Kappa statistic is that it is a measure of agreement that naturally controls for chance (Green 1997). According to Fleiss (1981), there is a natural means of correcting for chance using indexes of agreement. Kappa is based on these indexes. If there is complete agreement, $Kappa = 1$. The general consensus is that Kappa values greater than 0.75 are considered to have a high degree of agreement beyond chance. Values below 0.40 have a low degree of agreement and values between 0.40 and 0.75 represent a fair to good level of agreement beyond chance alone (Green 1997). Kappa, which was created by Cohen (1968), is a popular measure of association in the medical literature. Kappa is similar to the phi coefficient (Norman and Streiner 2000). Either method could be used; however, we chose the more popular Kappa measure. Unlike phi, Kappa can be generalized to more complex situations such as multiple levels and dimensions (Norman and Streiner 2000). SAS statistical software was used to conduct all statistical analyses (SAS Institute 2004).

The Index of Dissimilarity

The third objective of this article was to compare the extent to which black–white residential segregation is captured by the three indexes of SEP. Residential segregation is defined here as the overall unevenness in the spatial distribution of blacks and whites. We employed the index of dissimilarity D to measure the extent of residential segregation by census tracts grouped into quintiles based on socioeconomic characteristics. Mathematically, the index of dissimilarity is defined as:

$$D = 100(1/2) \left(\sum_{i=1}^k |x_i - y_i| \right)$$

where x_i = the proportion of the Detroit metropolitan area's black population residing in a given quintile (grouped census tracts) and y_i = the proportion of the Detroit metropolitan area's white (non-Hispanic) population residing in the same quintile (grouped census tracts); k = the total number of grouped tracts in the metropolitan area (e.g., $k = 5$ when we use quintiles);

and D = the index of dissimilarity, which is equal to one half the sum of the absolute differences (positive and negative) between the proportion distributions of the black and white population in metropolitan Detroit (Duncan and Duncan 1955; Darden and Tabachneck 1980). The value of the index can be directly interpreted as the minimum proportion of one group (blacks) that would have to shift its area of residence to achieve an identical spatial distribution with whites (Darden and Tabachneck 1980; Peach 1996). We recognize that the index of dissimilarity is limited to measuring only one dimension of residential segregation, "unevenness" (Darden and Tabachneck 1980; Massey and Denton 1988). We also recognize that it is limited to revealing only the average situation about segregation; however, we are not using the index for intercity comparisons as employed by Johnston, Paulsen, and Forrest (2007). Furthermore, alternative indexes of residential segregation have similar limitations (see, e.g., Dawkins 2004; Reardon and O'Sullivan 2004; Wong 2005; Johnston, Paulsen, and Forrest 2007). Because our major focus is neighborhood socioeconomic inequality within a single metropolitan area, the index of dissimilarity is suitable for our purpose. It is simple to compute and easy to understand by both researchers and policymakers and remains the most widely used measure of residential segregation (Logan 2002; Darden 2003).

Results

The results of our analyses are presented in three phases. In the first phase we describe the component socioeconomic characteristics of census tracts (neighborhoods of residence) captured by three indexes of socioeconomic characteristics. In the second phase we examine the concordance of three calculated socioeconomic indexes, which reveal a good to high level of concordance. In the third phase we examine the spatial distribution of blacks and whites by the three neighborhood socioeconomic indexes. The indexes reveal high levels of both black–white racial residential segregation and black–white neighborhood socioeconomic inequality.

Characteristics of Neighborhoods Based on the Modified Darden–Kamel Index

The modified Darden–Kamel Index assigns a higher score to tracts with HSEP. The mean characteristics within quintiles of the modified Darden–Kamel Composite Index of SEP are presented in Table 1. The

Table 1. The spatial and social structure of metropolitan Detroit in 2000 based on the modified Darden–Kamel Composite Socioeconomic Index

Neighborhood index of SEP (quintiles)	Mean characteristics of census tracts								
	% poverty	Unemployment (%)	Median income (\$)	Vehicle ownership (%)	Professional and managerial workers (%)	Bachelor's degree or higher education (%)	Median house value (\$)	Median monthly rent (\$)	Home ownership (%)
Very high SEP	2.3	1.7	88,407	98.0	35.3	54.8	258,507	993	91.3
High SEP	4.0	2.2	60,572	95.6	25.8	35.9	166,602	707	81.0
Middle SEP	5.8	3.0	49,247	93.5	18.9	26.0	129,590	639	76.0
Low SEP	12.0	4.7	38,752	88.7	13.4	18.9	94,126	553	65.0
Very low SEP	32.5	17.9	23,757	70.7	7.6	11.6	46,850	450	44.1
All tracts ^a	11.3	7.2	52,223	89.5	20.2	29.4	139,415	671	71.7

Notes: SEP = socioeconomic position. Source: Calculated by the authors from data in the U.S. Bureau of the Census (2000) Population and Housing Summary File 3 (SF3).

^aThe census data for the three-county (Wayne, Oakland, and Macomb) Detroit metropolitan area for this study are based on a total of 1,091 census tracts.

mean percentage of the population living below the poverty line in the VHSEP neighborhoods was only 2.3 percent, which is one fifth of the mean percentage of the population below poverty for the metropolitan area as a whole. In the VLSEP neighborhoods, however, the mean percentage of persons below the poverty line was 32 percent. The VHSEP neighborhoods had a mean unemployment rate of only 1.69 percent, far below the mean for the metropolitan area as a whole (7.2 percent), and less than one fifth the mean rate in the VLSEP neighborhoods (17.9 percent). The modified Darden–Kamel Composite Index also shows that the median income in VHSEP neighborhoods was \$88,407, which was 1.69 times higher than the metro area as a whole (\$52,223) and 3.7 times higher than the \$23,757 median income in the VLSEP neighborhoods (Table 1).

In accordance with the modified Darden–Kamel Index of SEP, residents of the VHSEP neighborhoods are more likely to come in contact with professional workers because 35 percent of the population held this type of occupation. This is 1.75 times higher than the level for the metropolitan area as a whole and 4.8 times higher than the level for the VLSEP neighborhoods. Whereas the majority of residents in the VHSEP neighborhoods (54.8 percent) have college degrees, only 11 percent of the residents in households in the VLSEP neighborhoods have reached this level of education. The median housing value in the VHSEP neighborhoods was \$258,507, which is 1.85 times that of the metropolitan area as a whole (\$139,415) and 5.5 times the median housing value (\$46,850) in the VLSEP neighborhoods. Although the mean percentage of home ownership in the metropolitan area as a whole

was high (71.7 percent), the mean percentage of the households in the VHSEP neighborhoods that owned their homes was 91.3 percent.

Characteristics of Neighborhoods Based on the Modified Krieger Composite Index

Unlike the modified Darden–Kamel Index, which assigns a higher score to tracts with HSEP, the modified Krieger Socioeconomic Composite Index assigns a higher score to tracts with LSEP. The characteristics of neighborhoods based on the modified Krieger Composite Index are presented in Table 2. Thirty percent of the population in the VLSEP neighborhoods lived below the poverty line. This rate was 2.6 times the rate for the metropolitan area as a whole and thirteen times the percentage of poverty for those living in the VHSEP neighborhoods. The unemployment rate in the VLSEP neighborhoods was 9 percent, twice the rate for the metropolitan area as a whole and five times the rate for the VHSEP neighborhoods. The median household income for the VLSEP neighborhoods was \$26,382, almost half the median income for the metropolitan area as a whole and less than one third the median income for VHSEP neighborhoods (Table 2). Interestingly, the percentage of workers considered working class and living in the VLSEP neighborhoods (38 percent) was lower than those considered middle SEP (42.1 percent) and low SEP (47.8 percent) and not significantly different from the percentage (38 percent) for the metropolitan area as a whole. This might be due to a percentage of VLSEP residents who are outside the labor force and therefore not considered to be

Table 2. The spatial and social structure of metropolitan Detroit in 2000 based on the Krieger Deprivation Index

Neighborhood index of SEP (quintiles)	Mean characteristics of census tracts					
	% poverty	Unemployment (%)	Median income (\$)	Working class (%)	Less than twelfth-grade education (%)	Expensive homes 400% above median for all homes (%)
Very high SEP	2.3	1.7	87,044	29.3	6.2	15.1
High SEP	4.0	2.2	59,959	38.6	11.9	1.9
Middle SEP	6.0	3.0	49,615	42.1	16.4	0.8
Low SEP	14.3	4.9	37,682	47.8	34.0	0.6
Very low SEP	29.7	9.0	26,382	38.0	34.0	0.0
All tracts ^a	11.3	7.2	52,223	38.0	18.4	3.7

Notes: SEP = socioeconomic position. Source: Calculated by the authors from data in the U.S. Bureau of the Census (2000) Population and Housing Summary File 3 (SF3).

^aThe census data for the three-county (Wayne, Oakland, and Macomb) Detroit metropolitan area for this study are based on a total of 1,091 census tracts.

working class. Thirty-four percent of the population living in VLSEP neighborhoods had not finished high school. This was almost twice the percentage for the metropolitan area as a whole (18.4 percent) and five times the percentage for the VHSEP neighborhoods (6.2 percent). Finally, none of the VLSEP neighborhoods had owner-occupied housing valued at 400 percent of the median value for the metropolitan area as a whole. Such homes were concentrated in the VHSEP neighborhoods, which had 15 percent.

The Characteristics of Neighborhoods Based on the Percent Poverty Index

The poverty index demonstrates the spatial variation in percentage of poverty in metropolitan Detroit. Those residents residing in neighborhoods with VLSEP

(19.9–61.2 percent poverty) experienced an unemployment rate of 17.9 percent (Table 3). This rate was more than twice the rate for the metropolitan area as a whole (7.2 percent) and six times the rate for the VHSEP neighborhoods. More than one third (34.5 percent) of the residents in the VLSEP neighborhoods had less than a twelfth-grade education. This far exceeded the mean percentage for residents in the VHSEP neighborhoods (8.3 percent). Less than 1 percent of residents resided in expensive homes, compared to 10.6 percent for the VHSEP neighborhoods. Whereas 32 percent of the professional and managerial workers lived in the VHSEP neighborhoods, only 8 percent of the professional and managerial workers lived in the VLSEP neighborhoods. Moreover, the difference in the percentage of residents with a bachelor's degree or higher residing in the VLSEP neighborhoods and the VHSEP neighborhoods

Table 3. The spatial and social structure of metropolitan Detroit in 2000 based on the percentage of poverty

Neighborhood index of SEP (quintiles)	Mean characteristics of census tracts							
	Unemployment (%)	Less than twelfth-grade education (%)	Median income (\$)	Expensive homes 400% above median for all homes (%)	Professional and managerial workers (%)	Bachelor's degree or higher education (%)	Vehicle ownership (%)	Home ownership (%)
Very high SEP	2.8	8.3	79,887	10.6	31.9	48.4	97.2	88.6
High SEP	3.5	12.3	63,973	4.9	24.8	35.9	95.7	83.7
Middle SEP	4.2	15.4	52,347	1.8	21.1	29.4	93.9	73.2
Low SEP	7.4	21.4	41,477	0.8	15.3	21.5	89.5	66.2
Very low SEP	17.9	34.5	23,898	0.5	8.0	12.2	71.1	44.9
All tracts ^a	7.2	18.4	52,223	3.7	20.2	29.4	89.5	71.7

Notes: SEP = socioeconomic position. Source: Calculated by the authors from data in the U.S. Bureau of the Census (2000) Population and Housing Summary File 3 (SF3).

^aThe census data for the three-county (Wayne, Oakland, and Macomb) Detroit metropolitan area for this study are based on a total of 1,091 census tracts.

was extremely high. The VLSEP neighborhoods had only 12.2 percent with this level of education compared to 48.4 percent in the VHSEP neighborhoods. The rate of vehicle ownership was 97.2 percent in the VHSEP neighborhoods compared to only 71.1 percent in the VLSEP neighborhoods. Vehicle ownership is probably more important in metropolitan Detroit compared to other large metropolitan areas because metropolitan Detroit is more automobile dependent as it does not have a reliable rapid transit system. Finally, the VLSEP neighborhoods are the only ones where less than half of the residents do not own their homes. Their 44.9 percent homeownership rate compares to 88.6 percent in the VHSEP neighborhoods. Finally, the VLSEP neighborhoods were the only group of neighborhoods where the mean homeownership rate was less than 50 percent. Similar to the two composite indexes, the poverty index also provides variation in characteristics of neighborhoods. The extent of agreement among the indexes is revealed in the next section.

The Concordance Among the Three Indexes of Socioeconomic Position

In the previous section, we presented the socioeconomic characteristics of census tracts (grouped into quintiles). Each quintile reflected different characteristics and these characteristics were presented in the form of three indexes. In Table 4 we report the concordance of these three indexes of SEP measured by the Kappa statistic. We observed the highest degree of concordance (77 percent) between the modified Darden–Kamel Composite SEP Index and the modified Krieger Composite SEP Index. The Kappa, as a measure of agreement between these two indexes, was 0.72, which was found to be statistically significant at the 0.001 level. Both the modified Darden–

Kamel and the modified Krieger Index were similarly at a lower level of agreement or concordance with the index of percentage poverty (63 and 61 percent, respectively) and had similar Kappa scores (0.53 and 0.51, respectively). These findings suggest that the modified Darden–Kamel and modified Krieger indexes, which are most highly concordant but less concordant with percentage poverty, might be capturing similar composite neighborhood socioeconomic characteristic variability, despite their different emphasis in capturing the high versus low end of SEP. Given that the modified Darden–Kamel and modified Krieger indexes incorporate multiple components of SEP and are less concordant with the percentage poverty index (0.53–0.51 Kappa), they might be better than the percentage poverty index at capturing the complexity in the variability in neighborhood SEP in metropolitan Detroit. The more simplistic measure of neighborhood SEP, the percentage poverty index, might be less useful at capturing the complexity of the neighborhood characteristics (Table 4).

Discussion

Comparing Racial Residential Segregation and Neighborhood Socioeconomic Inequality Based on Three Socioeconomic Indexes

Racial residential segregation is revealed by the extent to which the share of the total black population and the share of the total white population are unevenly distributed over grouped census tracts with different socioeconomic characteristics in metropolitan Detroit. The results reported in Table 5 demonstrate the sharp racial socioeconomic inequality in metropolitan Detroit. In a situation where race was not a factor, one would expect an equal proportion of blacks and whites

Table 4. Level of concordance between indexes of socioeconomic position in metropolitan Detroit, 2000

Indexes	Concordance of indexes of socioeconomic position			
	Concordance (%)	Kappa and 95% confidence interval (CI)		p value
Darden vs. Krieger Index	77	0.72	0.68–0.75	<0.0001
Darden vs. Poverty Index	63	0.53	0.50–0.57	<0.0001
Krieger vs. Poverty Index	61	0.51	0.47–0.55	<0.0001

Notes: The census data for the three-county (Wayne, Oakland, and Macomb) Detroit metropolitan area for this study are based on a total of 1,091 census tracts. Concordance was determined using the Kappa measure, which is similar to the phi coefficient. Both measure the strength of association between two categorical variables (see Norman and Streiner 2000, 219).

Source: Calculated by the authors from data in the U.S. Bureau of the Census (2000) Population and Housing Summary File 3 (SF3).

to reside in each of the SEP quintiles. Instead, race is obviously a factor and it is evident by the racial composition of neighborhoods defined by SEP because they differ by the total population living in neighborhoods by SEP characteristics based on the three socioeconomic indexes. As revealed by the modified Darden–Kamel Composite Index, more than a quarter (26.6 percent) of all whites in the Detroit metropolitan area reside in neighborhoods that have a VHSEP. On the other hand, only 4 percent of all blacks in metropolitan Detroit reside in such neighborhoods. Instead, most blacks (55 percent) live in neighborhoods with VLSEP. As the modified Krieger Composite Index reveals, 53 percent of all blacks in the Detroit metropolitan area live in neighborhoods where deprivation is very high, whereas only 3.6 percent of all whites live in such deprived neighborhoods (Table 5). Finally, whereas the majority of all blacks (56 percent) in metropolitan Detroit lived in neighborhoods with a poverty rate ranging from 19.9 to 61.2 percent, only 2.5 percent of all whites resided in such poverty-stricken neighborhoods. The majority of whites (54.9 percent) resided in neighborhoods with poverty rates of less than 5 percent (Table 5). Thus, regardless of the socioeconomic index employed, results

Table 5. The share of each racial group’s population living in neighborhoods based on three indexes of socioeconomic characteristics in metropolitan Detroit in 2000

Index of SEP Quintiles	% of total population	
	Whites	Blacks
Darden–Kamel Socioeconomic Index		
Very high SEP	26.6	4.4
High SEP	27.9	3.8
Middle SEP	26.0	7.8
Low SEP	16.8	28.8
Very low SEP	2.6	55.1
Krieger Deprivation Index		
Very high SEP	26.5	3.9
High SEP	26.6	5.6
Middle SEP	25.7	9.8
Low SEP	17.6	27.4
Very low SEP	3.6	53.4
Percentage poverty index		
≤2.7 Very high SEP	27.6	2.0
2.8–4.6 High SEP	27.3	3.3
4.7–7.6 Middle SEP	26.1	6.5
7.7–19.8 Low SEP	16.5	31.9
19.9–61.2 Very low SEP	2.5	56.3

Notes: SEP = socioeconomic position. Source: Calculated by the authors from data in the U.S. Bureau of the Census (2000) Population and Housing Summary File 3 (SF3).

Table 6. Variation in black versus white residential segregation in metropolitan Detroit in 2000 based on characteristics of neighborhoods defined by indexes

Socioeconomic index	Indexes of dissimilarity
Modified Darden–Kamel Index	64.5
Krieger Deprivation Index	59.5
Percentage poverty index	69.7

Source: Calculated by the authors from data in Table 5.

reveal that black and white populations were extremely unevenly distributed by neighborhood socioeconomic characteristics in metropolitan Detroit in 2000.

Our final objective was to examine variations in the degree of racial residential segregation over neighborhoods with different socioeconomic characteristics. This was done by computing an index of dissimilarity for each socioeconomic index. Results are revealed in Table 6, which shows that the degree of black–white residential segregation ranges from a high of 69.7 based on the poverty index to a low of 59.5 based on the modified Krieger Composite Index. It is important to note that all of the socioeconomic indexes show a level of residential segregation above 50 percent. This reflects a high level of racial residential segregation by neighborhood socioeconomic characteristics. Thus, a high level of black–white residential segregation is captured by all three indexes of SEP. Therefore, rather than map the location of the various neighborhoods of metropolitan Detroit using all three indexes, we have mapped the five types of neighborhoods based on the modified Darden–Kamel Composite Socioeconomic Index.

Mapping the Neighborhoods of Metropolitan Detroit Based on the Modified Darden–Kamel Composite Socioeconomic Index

Figure 1 shows the location of neighborhoods in metropolitan Detroit that have very high (VHSEP) SES characteristics. An overwhelming majority of those neighborhoods are located in Oakland County. This suburban county is where wealth is concentrated in the Detroit metropolitan area. Those VHSEP neighborhoods are where 26.6 percent of all whites in the Detroit metropolitan area reside. On the other hand, only 4 percent of all blacks in the three-county Detroit metropolitan area reside in those VHSEP status neighborhoods in Oakland County.

Figure 2 indicates where neighborhoods of high SES (HSEP) are located. Such neighborhoods are more evenly distributed across the three-county metropolitan

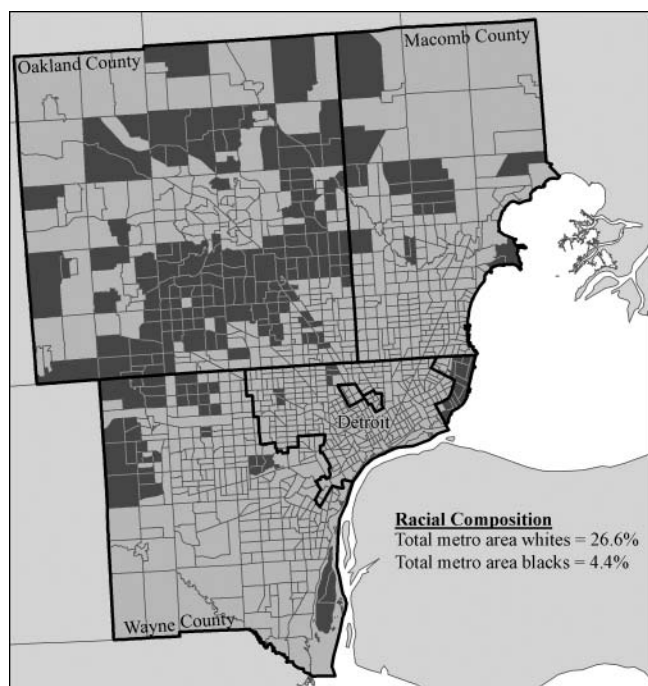


Figure 1. Very high socioeconomic position (VHSEP) neighborhoods.

area, but they are distinctly absent from the city of Detroit. Of the total number of whites in the Detroit metropolitan area, 28 percent reside in these HSEP SES neighborhoods; however, less than 4 percent of all blacks in the Detroit metropolitan area also live in

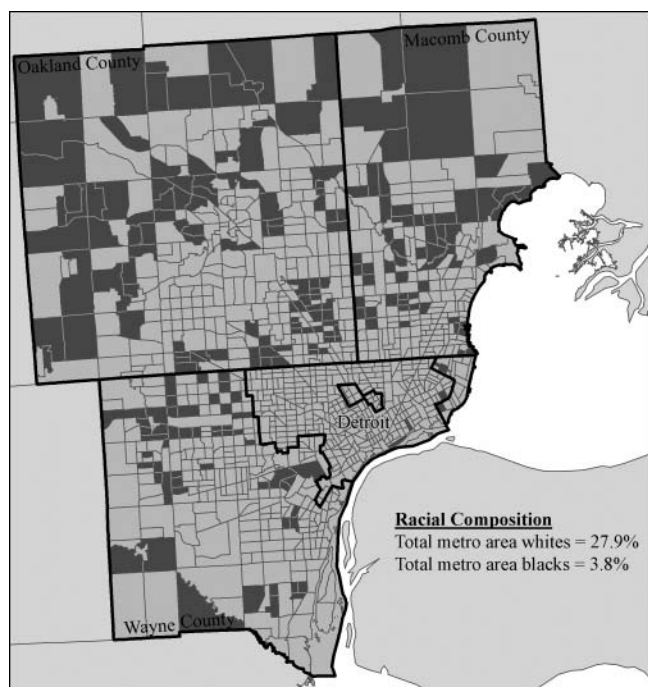


Figure 2. High socioeconomic position (HSEP) neighborhoods.

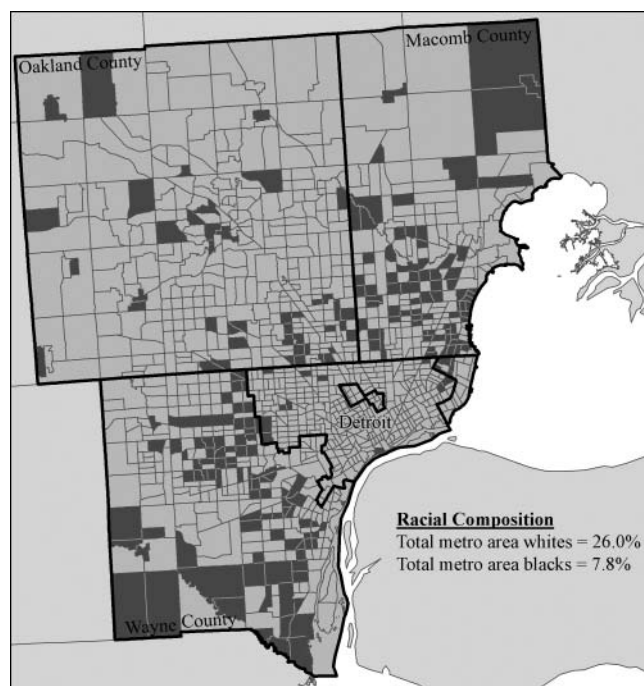


Figure 3. Middle socioeconomic position (MSEP) neighborhoods.

such HSEP neighborhoods. If one combines the VHSEP neighborhoods and HSEP neighborhoods, one is able to identify the locations and to describe the living conditions of 54.5 percent of all whites in the Detroit metropolitan area.

Figure 3 presents the distribution of neighborhoods with socioeconomic characteristics that fall in the middle of the socioeconomic spectrum (MSEP). Such neighborhoods are more represented in Wayne and Macomb counties. Few are found in Oakland County and the city of Detroit. These neighborhoods are where 26 percent of all whites in the Detroit metropolitan area reside. On the other hand, less than 8 percent of all blacks live in such neighborhoods.

Figure 4 indicates where neighborhoods with LSEP characteristics are located. These neighborhoods are more represented in Wayne and Macomb counties (older inner suburbs) and in the northern region (near the city limits) of the city of Detroit. Of all blacks in the Detroit metropolitan area, 29 percent reside in these types of neighborhoods. On the other hand, only 17 percent of all whites also live there.

Figure 5 shows that the city of Detroit is where the neighborhoods with VLSEP socioeconomic characteristics are concentrated. Such neighborhoods are virtually nonexistent in the suburbs. The only exceptions are the older historically industrial suburbs such as Pontiac in Oakland County and Ecorse,

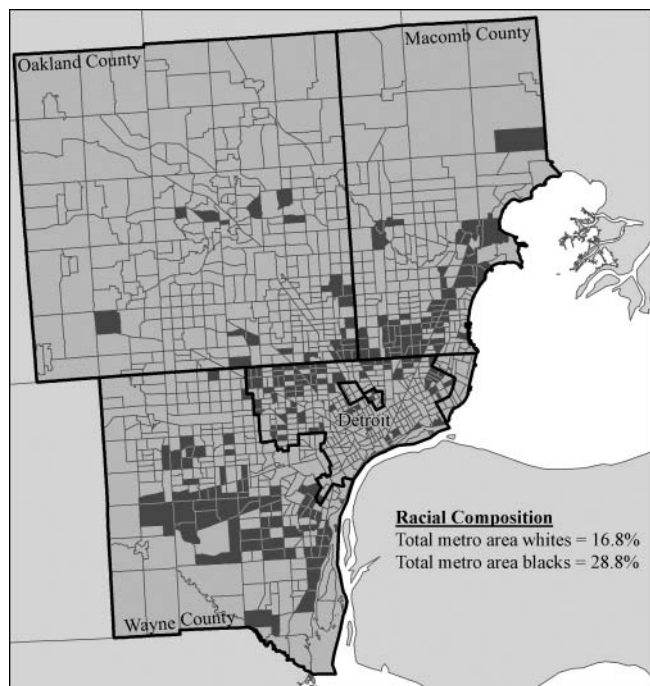


Figure 4. Low socioeconomic position (LSEP) neighborhoods.

Inkster, and River Rouge in Wayne County. These VLSEP SES neighborhoods are where 55 percent of all blacks in the Detroit metropolitan area reside. On the other hand, less than 3 percent of all whites in the Detroit metropolitan area also reside there.

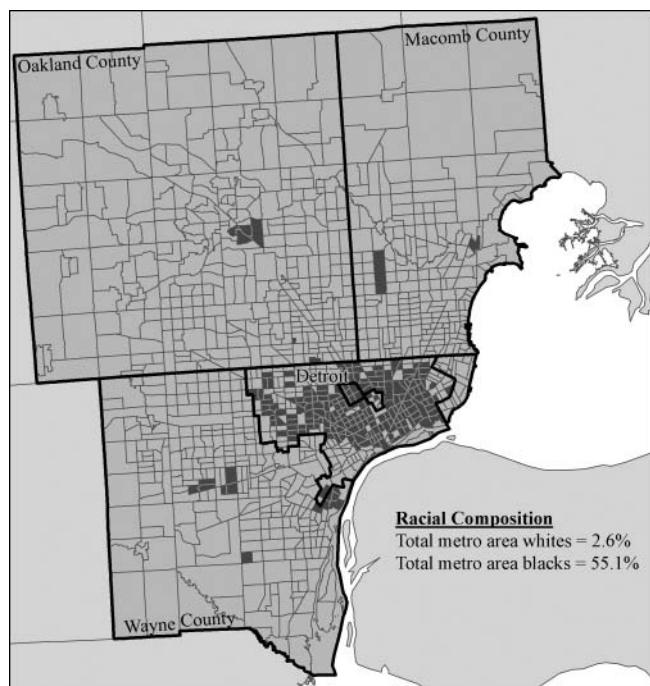


Figure 5. Very low socioeconomic position (VLSEP) neighborhoods.

Thus, if one combines the VLSEP neighborhoods and the LSEP SES neighborhoods of metropolitan Detroit, one is able to locate and describe the living conditions of 84 percent of all blacks in the Detroit metropolitan area. These figures suggest that the overwhelming reality of metropolitan Detroit is that it is sharply divided by racial composition, place of residence, and unequal socioeconomic neighborhood characteristics.

Not only is there widespread socioeconomic inequality, but there is also extreme spatial separation between blacks and whites. The populations living in the VHSEP neighborhoods with few exceptions are white and very affluent and live in the suburbs of Oakland County. Comprised of sixty-two cities, villages, and townships, Oakland County has an abundance of professional and managerial workers, especially in the suburbs of Birmingham, Bloomfield Hills, Troy, Farmington Hills, and Auburn Hills. These are the places where a host of Fortune 500 companies are also located; however, Oakland County also has the blue-collar, inner-ring suburb of Ferndale, which borders the city of Detroit.

The other cluster of VHSEP neighborhoods is located in the Wayne County suburbs adjacent to the city of Detroit. They are Grosse Pointe Woods, Grosse Pointe Shores, Grosse Pointe Farms, Grosse Pointe, and Grosse Pointe Park. These places are close in geographic distance but far apart socioeconomically and racially. A second cluster of VHSEP neighborhoods is located in northeast Wayne County, in Van Buren, Canton, Plymouth, and Northville Townships. The third cluster is in blue-collar Macomb County in the central and northwest sections. Finally, there are two small clusters of VHSEP neighborhoods in Detroit. One is along Grand River Avenue and Southfield Road near the Schoolcraft and Cooley subcommunities. The other is near the city's eight-mile road boundary separating the city from the suburbs. This is the Palmer Park subcommunity, which has a high percentage of professors, doctors, and lawyers. Although predominantly black, it is a pocket of affluence in a city that is overwhelmingly poor in neighborhood characteristics. Thus, disparities are revealed more effectively at the neighborhood scale.

Although Oakland County is wealthy in general, it also has pockets of VLSEP neighborhoods. One cluster is found in the city of Pontiac. This is an industrial suburb located twenty-five miles northwest of the city of Detroit. Pontiac evolved as the birthplace of the General Motors truck and motor division. It is a blue-collar

industrial suburb surrounded by white-collar professional neighborhoods. There are also two VLSEP clusters of neighborhoods located in the Macomb County suburbs of Sterling Heights and Mt. Clemens. Macomb is a blue-collar suburban county.

A third cluster of VLSEP neighborhoods can be found in suburban Wayne County, including the declining industrial suburbs of Inkster, River Rouge, and Ecorse. These suburbs do not fit the pattern of growth of most suburbs. Their populations evolved as manufacturing workers came to work in the auto plants before the 1950s. Each of these industrial suburbs has historically had a sizable black population who came to work in the auto plants before the traditional pattern of suburbanization in the 1950s.

Thus, the pattern of distribution of the VLSEP neighborhoods in metropolitan Detroit can be described as follows. The dominant nucleus is in the city of Detroit. There are also industrial smaller suburban nuclei, namely, Pontiac in Oakland County and Sterling Heights and Mt. Clemens in blue-collar Macomb County. These are followed by the smaller, older declining industrial suburbs of Inkster, Ecorse, and River Rouge.

Conclusions

The major arguments of this article were that (1) racial residential segregation alone is insufficient to explain health disparities, (b) socioeconomic characteristics of neighborhoods (census tracts) must be analyzed, and (c) useful area-based methods can be applied to achieve the link between health disparities and racial residential segregation and socioeconomic characteristics of neighborhoods.

We also argue that an understanding of racial and socioeconomic disparities in health is enhanced by collaboration among geographers, epidemiologists, and other social scientists. Because there are limitations on individual-level health data for metropolitan Detroit and other metropolitan areas in the United States, as medical records do not contain socioeconomic data, we discuss alternative methods to assess health disparities by using census tracts as surrogates for neighborhoods. When census tract data on racial and socioeconomic characteristics of neighborhoods are linked to health data, the connection makes research on racial and social disparities in health possible. For example, geo-coded health data by address and census tract can provide the link between cancer incidence rates in poor and afflu-

ent neighborhoods (N. Krieger 2006). Researchers can also examine other incidence rates by place, race, and class.

Although this analysis focused on metropolitan Detroit, the three area-based methods are applicable to any metropolitan area with census tracts as subunits. In examining health disparities by race and socioeconomic characteristics, the first step is to construct the social and spatial structure of the metropolitan area and the second step is to map it before proceeding to calculate rates of cancer or other diseases. These methods will enable the researcher to better understand health disparities by interpreting the rates within a social and spatial context.

The area-based methods involved analyzing the socioeconomic characteristics of census tracts (neighborhoods) of residence based on three indexes of SEP. We also assessed the concordance of the three indexes of SEP of census tracts (neighborhoods) in metropolitan Detroit in 2000 categorized into quintiles. Finally, we compared the extent of black-white residential segregation over the five quintiles based on the three socioeconomic indexes.

Both the modified Darden-Kamel Composite Index and the modified Krieger Composite Index appear to have discriminative capability to detect greater inequality in socioeconomic characteristics among the five types of neighborhoods (census tracts) in metropolitan Detroit than does the percentage poverty index (Tables 1–4). By incorporating multiple components, they capture the complexity of variability in neighborhood SEP.

The simpler poverty index, however, captures more racial residential segregation by socioeconomic characteristics of neighborhoods. For example, the index of dissimilarity between blacks and whites based on the poverty index was 69.7 compared to 64.5 for the modified Darden-Kamel Index and 59.5 based on the Krieger Deprivation Index (Table 6). These results were derived by computing the index of dissimilarity from the data presented in Table 5. The index of dissimilarity is one half the absolute difference in the spatial distribution of blacks and whites over the five types of neighborhoods with different socioeconomic characteristics. If blacks and whites had the same share of their racial group in each type of neighborhood, the index of dissimilarity would be zero, reflecting no racial residential segregation by socioeconomic characteristics of neighborhoods. If blacks and whites did not share any of the same types of neighborhoods, the index would be 100, reflecting complete residential

segregation. The greater the difference in the neighborhoods that the two groups occupy, the higher the index of dissimilarity will be. Each index demonstrates the extreme spatial variation in the socioeconomic characteristics of neighborhoods where widespread inequality of neighborhoods by socioeconomic characteristics was evident based on each index. Furthermore, two of the indexes had a good level of agreement beyond chance (Green 1997). Such agreement was achieved between the modified Darden–Kamel Composite Index and the modified Krieger Composite Index.

Given the extreme inequality of neighborhoods by SEP revealed by the indexes, we employed the index of dissimilarity to see how much black–white residential segregation was captured by the indexes. Results for metropolitan Detroit showed that the majority of blacks were segregated in neighborhoods with VLSEP characteristics and the majority of whites were segregated in neighborhoods with VHSEP and HSEP characteristics. The index of dissimilarity was above 50 percent for all of the indexes, reflecting a high level of racial residential segregation by neighborhood socioeconomic characteristics. The analysis clearly showed two populations (blacks and whites) living in neighborhoods in metropolitan Detroit that are separate and unequal by SES and characteristics. Such separate and unequal neighborhoods should be reflected in the extent of health disparities in the metropolitan area.

Implications for Public Policy

We have argued that not only are health disparities related to the SES and race of population groups but that such disparities are also place based; that is, they are related to where such population groups reside. Therefore, health policies to address disparity will be more effective if they are linked to other policies that are designed to address racial residential segregation and socioeconomic inequality in the neighborhood characteristics. According to Grigsby (2007), the notion of place must be fundamental in the formulation of health policies for the purpose of reducing disparities because that is where the constellation of forces influencing health comes together to create the conditions in which people are, or are not healthy, and where disparities in health are most dramatically revealed. Our study of metropolitan Detroit has reinforced that conclusion.

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