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Rural – urban inequalities in late-stage breast cancer: spatial and social dimensions of risk and access

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Abstract

Rural – urban inequalities in health and access to health care have long been of concern in health-policy formulation. Understanding these inequalities is critically important in efforts to plan a more effective geographical distribution of public health resources and programs. Socially and ethnically diverse populations are likely to exhibit different rural – urban gradients in health and well-being because of their varying experiences of place environments, yet little is known about the interplay between social and spatial inequalities. Using data from the Illinois State Cancer Registry, we investigate rural – urban inequalities in late-stage breast cancer diagnosis both for the overall population and for African-Americans, and the impacts of socioeconomic deprivation and spatial access to health care. Changes over time are analyzed from 1988 – 92 to 1998 – 2002, periods of heightened breast cancer awareness and increased access to screening. In both time periods, the risk of late-stage diagnosis is highest among patients living in the most urbanized areas, an indication of *urban* disadvantage. Multilevel modeling results indicate that rural – urban inequalities in risk are associated with differences in the demographic characteristics of area populations and differences in the social and spatial characteristics of the places in which they live. For African-American breast cancer patients, the rural – urban gradient is reversed, with higher risks among patients living outside the city of Chicago, suggesting a distinct set of health-related risks and place experiences that inhibit early breast cancer detection. Findings emphasize the need for combining spatial and social targeting in locating cancer prevention and treatment programs.

Introduction

Rural – urban inequalities in health and access to health care have long been of concern in health-policy debates. Conventional wisdom suggests that, due to poor spatial accessibility

to health-care services, rural residents are less likely than their urban counterparts to receive early and appropriate diagnoses and effective treatments for diseases such as cancer (Eberhardt and Pamuk, 2004; Pampalon et al, 2008; Pearce et al, 2007). However, recent research raises questions about this hypothesized pattern of rural disadvantage. For some types of health outcomes, studies have found that the risk of poor health is higher in urban than in rural areas (O'Reilly et al, 2007; Pearce and Boyle, 2005). Other research has uncovered considerable socioeconomic and geographic variation in health outcomes within urban and rural settings (Haynes and Gale, 2000; Riva et al, 2009). Socially and ethnically distinct populations, because of their varying experiences of place environments, are likely to exhibit different rural – urban gradients in health and well-being, yet little is known about the interplay between social and spatial inequalities. Moreover, geographic inequalities in health are also historically specific, changing over time in response to demographic and socioeconomic transformations, changes in service provision and transportation, and perhaps more importantly, changes in public health awareness and availability of medical technologies.

Understanding how cancer risks vary both socially and spatially is critically important in efforts to plan and improve the locations of cancer screening and prevention programs. In the US such programs have become much more widespread in the past several decades, yet significant gaps remain in serving socially diverse populations who live in different rural – urban settings. We investigate how rural – urban inequalities in late-stage breast cancer in Illinois changed from 1990 to 2000, both for the overall population and for African-Americans, and the impacts of socioeconomic deprivation and spatial access to health care. Late-stage breast cancer (also called advanced-stage) is cancer that has spread to distant tissues or organs before it is first diagnosed. Cancer stage is a key predictor of medical prognosis: patients whose cancer is diagnosed late have a higher risk of morbidity and mortality and are more likely to experience complications both from the disease itself and from medical treatments (National Cancer Institute, 2010). The 1990s is an important decade for investigation because it was a period of rapid change in early breast cancer detection in the US. The fraction of breast cancer cases detected early increased significantly during the decade as mammography screening became more widespread (Anderson et al, 2006). Federal guidelines for mammography screening (eg Mammography Quality Standards Act or Public Law 102–539) were issued in the early 1990s: federal funding of breast cancer research expanded; mammography screening became more widely available; and mammography utilization increased dramatically. Using data from the Illinois State Cancer Registry (ISCR) (<http://www.idph.state.il.us/cancer/statistics.htm>), we analyze rural – urban disparities in late-stage risk in this period of rapid change. The roles of spatial access to care, socioeconomic disadvantage, and compositional differences in area populations in accounting for rural – urban variations are examined. The changing rural – urban gradient for the black population is also assessed.

Risks, health inequalities, and geographical access to care

Breast cancer stage at diagnosis is the outcome of social, biological, and spatial factors that affect the likelihood that the disease will be detected and diagnosed for a given person in a particular context. Access to health care is critically important because most cancers are

ultimately diagnosed by medical professionals in formal medical care settings. Regular mammography screening is strongly associated with early detection. In the US people who lack health insurance are much more likely than others to be diagnosed with late-stage breast cancer (Kuzmiak et al, 2008). Patients who have no primary care physician are much less likely to receive regular and age-appropriate mammograms (Schueler et al, 2008). Lack of transportation, long distances and travel times, and other spatial barriers reduce opportunities for early breast cancer detection (Wang et al, 2008). Risk is also higher in vulnerable populations—low income, racial and ethnic minorities, and those with low levels of education (Martin and Newman, 2007). In the US African-American breast cancer patients are almost 50% more likely than comparable whites to be diagnosed with late-stage disease (Virnig et al, 2009). Living in high poverty and otherwise disadvantaged communities has also been tied to late-stage breast cancer risk (MacKinnon et al, 2007; Schootman et al, 2003). These social and geographical processes give rise to varying degrees of advanced-stage breast cancer risk in urban and rural settings.

Research on rural – urban inequalities in late-stage breast cancer risk includes mixed and contradictory evidence of geographic variation. Much of the research literature has focused on the hypothesis of rural disadvantage—the expectation that the risk of late diagnosis will be higher for rural residents because they face geographical barriers in accessing cancer screening and treatment services, including long travel times and lack of providers. Some breast cancer research finds evidence of rural disadvantage, with higher rates of late-stage diagnosis among rural residents (Elliott et al, 2004). While focusing on cancer survival rather than stage, Haynes et al (2008) uncover a higher risk of death among breast cancer patients who live in remote areas distant from cancer treatment facilities than among those living in more urban places. The hypothesis of rural disadvantage also stems from rural – urban disparities in access to mammography. In the US rural residents are less likely than their urban counterparts to receive regular and age-appropriate mammography screening (Coughlin et al, 2002; Doescher and Jackson, 2009). Long travel times and distances pose significant barriers to mammography utilization and early detection for people living in areas distant from urban centers (Lannin et al, 1998). Residents of remote and impoverished rural communities are especially vulnerable, as are African-Americans living in rural settings (Amey et al, 1997).

Despite the emphasis in the research literature on rural disadvantage, a growing body of evidence suggests that in the US breast cancer outcomes for rural residents are on a par with or even superior to those for people residing in more urban locations. A California study found no statistically significant differences in cancer stage at diagnosis between urban and rural breast cancer patients (Blair et al, 2006). Similar findings are reported in breast cancer research in New Zealand and Australia (Bennett et al, 2007; Wilkinson and Cameron, 2004). Moreover, unusually high rates of advanced-stage breast cancer diagnosis have been identified in large cities in the US, especially among low-income, less-educated residents (Bradley et al, 2002; MacKinnon et al, 2007; McLafferty and Wang, 2009). A study conducted in Massachusetts observed a 12% higher risk of late-stage diagnosis in urban than in rural areas (Sheehan and DeChello, 2005). Although some of the observed urban disadvantage stems from the concentration of high-risk populations in large cities,

neighborhood characteristics such as socioeconomic deprivation, economic dislocations, and crime rates also play an important role (Barrett et al, 2008; Tarlov et al, 2009).

These mixed and contradictory findings emphasize the importance of research that is grounded in more complex understandings of rural and urban place environments and that adopts a more nuanced and dynamic view of geographic disparities. Several points warrant attention. First is the need to move beyond a simple binary categorization of rural or urban. Contemporary geographic research investigates health inequalities along a gradient of geographic settings from highly urban, central city locations to the most remote, isolated rural regions (Pampalon et al, 2008; Riva et al, 2009). Second is the need for a more dynamic perspective that sees rural – urban disparities as evolving and changing over time. Changes in population and environmental and transportation characteristics of rural and urban places intersect with changes in medical practices, policies, and awareness resulting in new social and spatial landscapes of care. A breast cancer study in a county in Wisconsin suggested that the rural – urban disparity in late-stage diagnosis decreased over time (McElroy et al, 2006); however this finding has not been evaluated in larger and more geographically diverse study regions. Finally, the intersections between social and spatial health inequalities deserve more attention in rural – urban research. Health geographers have highlighted the need for relational perspectives that examine the mutual interactions between people and places which affect health and well-being (Cummins et al, 2007). Such a perspective is highly relevant for research on rural – urban disparities. It focuses attention on people's differing experiences of rural and urban places environments, which in turn may result in different rural – urban health gradients among population groups. For breast cancer, one can hypothesize that the rural – urban gradient for socially or economically disadvantaged populations will be distinct from that for more advantaged populations.

Our research explores these issues with reference to geographic inequalities in late-stage breast cancer in Illinois. To assess geographic disparities we employ a five-tier classification that differentiates among rural and urban place contexts. Multilevel modeling is used to examine the impacts of compositional differences in breast cancer patient populations and contextual factors such as socioeconomic disadvantage and spatial access to primary care on rural – urban disparities in late-stage cancer risk. As noted earlier, changes over time are assessed to determine if rural – urban disparities diminish during a period of heightened breast cancer awareness and increased access to mammography screening. We investigate trends for the African – American breast cancer-patient population to explore sociospatial inequalities for a high-risk group.

Data and methods

The study area, Illinois, provides an interesting context for examining rural – urban disparities for two reasons. The state encompasses a diversity of geographic settings, from the densely populated city of Chicago to smaller metropolitan areas to remote rural communities in the southern and western parts of the state. Illinois' population is racially and ethnically diverse. In 2000, 15% of the 12.5 million state residents identified their race as black or African-American. Moreover, although the black population is clustered in Chicago and its suburbs, there are sizeable concentrations in other metropolitan areas and

small cities and even in some rural districts. This geographical dispersion provides an opportunity to examine rural – urban disparities among black breast cancer patients only. The breast cancer data come from the ISCR and were approved for release by the Illinois State Department of Public Health (<http://www.idph.state.il.us/>). The data describe all reported breast cancer cases among Illinois residents in two time periods, 1988 – 92 and 1998 – 2002. Cases among Illinois residents that were diagnosed in neighboring states such as Missouri and Wisconsin are included, and the completeness of case ascertainment is estimated to be 98% (Lehnerr and Havener, 2002). Each record in the dataset represents an individual breast cancer case. For each cancer case, we know the zip code of residence, stage of disease at diagnosis, age category, gender, and self-reported race. The limited number and diversity of individual-level variables is due to privacy and confidentiality restrictions. In addition, variable classifications are problematic: in particular, ‘race’ is only classified as ‘white’, ‘black’, and ‘other’. We acknowledge that the ‘race’ information may be inaccurate due to errors in coding and the generally problematic nature of racial classifications. Breast cancer stage is defined according to tumor size and the presence of invasion to lymph nodes and distant sites. Following previous research, we designated late-stage as cancers whose stage was classified as regional or distant (stages 2 – 7) at the time of diagnosis. Cases with missing stage information (unstaged) were excluded from analysis (table 1).

Because of privacy and confidentiality concerns, the data were only released to us with zip codes as geographical identifiers. Zip codes are areas created to facilitate mail delivery. They have an average population size of 30 000, although zip-code populations vary substantially. The areas have several important limitations such as the fact that zip-code boundaries are imprecise and can change over time, and the fact that zip codes may not represent socially meaningful geographic areas. Despite these limitations, for a state-level analysis in the US, zip codes provide much more geographic detail than the more widely used county areas. For the 1988 – 92 data, there are 1260 zip codes, with an average of 28 breast cancer cases per zip code. The 1998 – 2002 data comprise a similar number of zip codes, although the average number of cases per zip code is slightly higher at 33.

Variable definitions

We used multilevel modeling to analyze the rural – urban gradient in late-stage cancer risk and to evaluate the role of population composition and zip code-level contextual factors in accounting for rural – urban variation. Multilevel modeling is an appropriate method for investigating contextual effects—the effects of the local environment or neighborhood on health outcomes (Duncan et al, 1996). For this study, data are available at two levels—individual and zip code. The *dependent variable* in the multilevel models is a binary variable representing *late-stage diagnosis* (1 = late; 0 = nonlate), so a logistic model formulation is used. Individual-level variables are limited to *age category* and *race*, the only individual sociodemographic variables in the dataset. We created dummy variables identifying two key age groups, <50 years and >70 years, that have been shown in previous studies to be linked to late breast cancer detection (Joslyn et al, 2005). Race was designated by a dummy variable identifying ‘black’ race versus all other racial groups. The ‘black’ group primarily comprises African-Americans, although immigrants and others who self-identify as members of this racial group are also included.

To investigate geographic variation in late-stage cancer risk and differentiate various types of urban and rural locations, we subdivided the state into five categories (or zones) (McLafferty and Wang, 2009). Urban regions of the state were classified into three groups: (1) Chicago city, representing the largest, densest population concentration in the state; (2) Chicago suburbs, the urbanized areas surrounding and linked to Chicago; and (3) other metropolitan areas, large cities and their suburbs located outside the Chicago region. Rural areas were classified into two categories: (4) large towns, towns with population sizes from 10 000 – 50 000 and surrounding rural areas with high commuting into the town, and (5) rural areas, comprising small towns (population <10 000) and isolated rural places. These latter two categories were based on the rural – urban commuting areas classification scheme (RUCA) developed by the Office of Rural Health Policy (Hart et al, 2005). The RUCA scheme classifies areas on the basis of urbanized population and commuting flow. Categories 4 and 5 differentiate towns of moderate size (10 000 – 50 000 population) dispersed throughout the rural areas of Illinois (category 4) from more isolated small communities and dispersed rural areas (category 5). The RUCA scheme has been widely used in examining rural health concerns in the US, and it captures some of the localized variation in geographic contexts within rural areas. Although simplified, the five-tier classification scheme reflects two key dimensions of rural – urban differentiation: a settlement's population size and its geographical relationship to 'the urban' (Woods, 2009).

Separate rural – urban classifications were developed for each of the two time periods on the basis of RUCA codes and census data for the years 1990 and 2000. There was strong agreement between the classifications for the two years. Only 107 zip codes out of 1595 (6.7%) changed categories. Most of the changes occurred on the fringe of the Chicago metropolitan region where urban sprawl resulted in shifts from categories 4 or 5 (large town, rural) to category 2 (Chicago suburbs). Similar changes also took place around other metropolitan areas across the state.

A set of *contextual variables at the zip-code level* was constructed to represent spatial accessibility to primary health care physicians and socioeconomic characteristics of zip-code populations. The latter variables were summarized via factor analysis. As the first point of contact with the health care system, primary care physicians are critically important for early breast cancer detection. They not only detect and diagnose cancers, but also educate patients and refer them for screening and treatment services. In defining primary care physicians, we included family physicians, general practitioners, general internists, and obstetrician-gynecologists. The primary care physician data for Illinois in 1990 and 2000 were obtained from the Physician Master File of the American Medical Association (<http://www.ama-assn.org/ama/pub/about-ama/physician-data-resources/physician-masterfile.shtml>). Because of inaccuracies and omissions in the physician address information, we represented each physician's location by the zip code of his or her office. Therefore, we have the number of primary care physicians, measured in terms of full-time equivalent physicians, in each zip-code area.

Measures of *spatial access to primary care physicians* need to account for the match between supply and demand within a region and the complex interaction between them. A previous study (Luo and Wang, 2003) compared different methods for measuring spatial accessibility

and recommended the two-step floating catchment area (2SFCA) method because of its intuitive interpretation and convenience of implementation in a GIS environment while addressing major fallacies of other methods. Since its inception, the 2SFCA method has been used in a number of health studies (eg Albert and Butar, 2005; Cervigni et al, 2008; Langford and Higgs, 2006; Langford et al, 2008; Scott et al, 2006; Wang, 2007). In essence, the 2SFCA method measures spatial accessibility as a ratio of primary-care physicians to population. It first assesses ‘physician availability’ at each physician (supply) location as the ratio of physicians to their surrounding population (ie within a threshold travel time from the physicians). It then sums the ratios (ie physician availability scores) around (ie within the same threshold travel time from) each residential (demand) location.

Many *socioeconomic characteristics* at the neighborhood level are related to breast cancer diagnosis stage (Barry and Breen, 2005; Merkin et al, 2002). On the basis of the literature, we identified 11 variables: demographic (ie population with high healthcare needs including seniors aged over 65 years, children aged 0 – 4 years, and women of child-bearing age 15 – 44 years), socioeconomic status (eg population in poverty, female-headed households, home ownership, and median income), environment (eg households with an average of more than one person per room and housing units that lack basic amenities), linguistic barriers and education (eg nonwhite population, population without a high-school diploma, and households linguistically isolated), and transportation mobility (eg households without vehicles). Many of these variables are correlated and thus contain duplicate information.

We used factor analysis to consolidate these variables into three independent factors (Wang and Luo, 2005). Factor 1 captured variables that are all related to socioeconomic well-being, and thus is labeled *socioeconomic disadvantage*. Factor 2, labeled *sociocultural barriers*, includes variables such as linguistic isolation and low education attainment, which tend to be associated with lower service awareness and thus create an important barrier to healthcare access. Factor 3 is labeled *high healthcare needs* since it mainly captures the concentrations of populations such as the elderly and disabled who exhibit high need for health-care services. On the basis of the research literature, a higher value of factor 1 or factor 2 should be associated with a higher risk of advanced-stage breast cancer due to social, economic, and cultural barriers to cancer screening.

All contextual variables (spatial access to primary physicians, three factor scores) were initially calibrated at the census-tract level. Then spatial interpolation methods were used to estimate the values for zip-code areas. In our case, we employed the simple areal weighting interpolator (Goodchild and Lam, 1980).

Multilevel logistic models

The specific multilevel-model formulation used in this research is a two-level, logistic, random intercepts model with covariates. We assume that the effects of individual-level variables are fixed across zip codes and that zip-code intercepts vary as a function of zip-code socioeconomic and spatial variables as well as an error component. For each time period, we estimated three multilevel models in sequence. Model 1 included four dummy variables, each representing one of the rural – urban zones. Category 1 (Chicago) was the omitted group, so all model coefficients indicate the difference in late-stage breast cancer

risk between patients living in a particular rural – urban zone compared with those living in Chicago. In model 2, the age and race individual variables were added in to assess their associations with late-stage risk. The third model incorporates the zip-code-level factor score variables and spatial access to primary care. Differences between models 1 and 2 in the coefficients for the rural – urban variables reveal the impacts of age and racial differences in zonal patient populations on rural – urban disparities. Model 3 shows the added impacts of spatial access to primary care and socioeconomic or cultural attributes of zip-code populations. All models were run in the statistical software package, STATA (<http://www.stata.com>) using the xtmelogit command for performing mixed-effects logistic regression.

Results

From 1990 to 2000, the percentage of breast cancer patients with late-stage diagnosis fell from 38.5% to 36.9%. This is consistent with trends in other areas of the US, and it reflects heightened patient awareness and education, as well as more intensive breast cancer screening and outreach efforts (Anderson et al, 2006). However, the decline in late-stage diagnosis was uneven across the rural – urban gradient (figure 1). Late detection fell most sharply in large towns where it dropped from 40% to 33.9%. Decreases of 4 – 5 percentage points also occurred in Chicago, other metropolitan areas, and rural areas. The Chicago suburbs registered the smallest decline, two percentage points.

There are strong similarities in the rural – urban gradients for both time periods. Breast cancer patients living in Chicago consistently have the highest risk of late diagnosis: the percentage of late-stage diagnosis exceeds that in the other regions by at least 5 percentage points (figure 1). For 1988 – 92, the percentage of patients diagnosed with advanced-stage disease drops sharply as we shift from Chicago to the Chicago suburbs. It remains low in other metropolitan areas, then increases slightly in the large town and rural areas. The main disparity is between Chicago and the rest of the state, an indication of urban disadvantage. By 1998 – 2002, a more nuanced gradient emerges, following the J-shaped association noted in previous research (McLafferty and Wang, 2009). Late-stage diagnosis decreases with increasing rurality, with a slight upturn in the most rural settings. Underlying these trends are the contrasting rates of improvement in early breast cancer detection among rural – urban settings, particularly the modest decline in the Chicago suburbs compared with the sharp decline in the large-town context.

Multilevel models estimated for each time period reveal the extent to which these rural – urban disparities are due to demographic differences in patient populations in each zone and to differences in spatial access to primary care and zip-code-level socioeconomic indicators (table 2). Model 1, which includes only rural – urban dummy variables, shows the differences noted above. In both time periods, late-stage risk is significantly less for patients residing in the four zones outside Chicago than for those living in the city. Taking into account the age and racial characteristics of patients (model 2) diminishes rural – urban disparities. Both age and race strongly influence late-stage risk. Black breast cancer patients are significantly more likely to be diagnosed with late-stage disease than are other patients. In 1988 – 92 they were 60% more likely to be diagnosed late, while in 1998 – 2002 the

racial disparity was 45%. These wide racial inequalities reflect the close ties between health vulnerability and race in the US. Age is also associated with late diagnosis. The risk of late-stage breast cancer diagnosis is less among older patients (≥ 70 years) and higher among younger patients (age <50 years), confirming disparities noted in the literature. The relative advantage for older patients and disadvantage for younger patients both increased over time resulting in a wider age gap in late-stage disease at the end of the decade. These diverging trends may reflect heightened publicity in the 1990s about the importance of annual mammograms for women over 50 years of age. Additionally, after 1990 elderly women's financial access to mammograms increased when Medicare, which provides health insurance coverage for elderly Americans, began reimbursing patients for mammography screening (Romans, 1993).

Adjusting for these individual characteristics reduces some of the inequality in risk along the rural – urban gradient but significant differences remain. In 1988 – 92, patients living in the Chicago suburbs and other metropolitan areas have a lower adjusted late-stage risk compared with their counterparts in the other regions (table 2); however, differences in risk between Chicago and the rural and large-town zones are due to compositional differences in age and race among the zonal populations. Findings are similar for 1998 – 2002 except that late-stage risk among patients in the large-town zone remains significantly below that in Chicago and rural areas.

The third of the multilevel models (model 3) adds zip-code-level socioeconomic indicators and the measure of spatial access to primary care. In each time period, the factors representing socioeconomic disadvantage and sociocultural barriers are significantly and positively associated with late-stage risk. These results support the large body of research which indicates that people living in places with high levels of social and economic deprivation are more likely than others to be diagnosed with advanced-stage breast cancer (Barrett et al, 2008; Tarlov et al, 2009). It is notable that the coefficient for socioeconomic deprivation diminishes over time suggesting that the area-level socioeconomic gradient has declined. Spatial access to primary care is statistically significant only in the more recent time period (1998 – 2002) when it is inversely related to late diagnosis. As expected, people living in areas where primary care physicians are more geographically accessible are less likely to be diagnosed with late-stage disease. The lack of significance in 1988 – 92 suggests that other nonspatial barriers such as socioeconomic deprivation were more important in that time period.

Adding these contextual variables completely eliminates the rural – urban gradient in risk in both time periods. This means that the observed geographic inequalities in risk are largely due to differences in the age and racial composition of patients in each zone, local differences in socioeconomic and cultural characteristics, and spatial access to primary care. The higher likelihood of late diagnosis in Chicago stems from its concentration of high-risk patients (young, black) and of socioeconomically and culturally disadvantaged communities. Similarly, lower average levels of risk in other types of rural – urban settings are due to differences in population composition and contextual factors that reflect spatial and nonspatial barriers to access.

In both time periods, black breast cancer patients have a significantly higher risk of late diagnosis and the disparity remains when other variables are controlled. Among the black patient population, the percentage of breast cancers diagnosed at an advanced stage was 53.1% in 1988 – 92 and 46.6% in 1998 – 2002. Both values far exceed those for the population as a whole. To explore whether this highly vulnerable population has a distinct rural – urban gradient in risk, we estimated a similar set of multilevel models for the black population only (table 3) and graphed the late-stage percentage by rural – urban zone (figure 2). Due to the small sample sizes in the large town and rural categories, these two categories were pooled to form a single ‘rural’ zone for analysis. Figure 2 and table 3 reveal a very different rural – urban gradient for the black population than for the population as a whole in 1988 – 92. For black breast cancer patients, the odds of late-stage diagnosis are lower among those living in Chicago and its suburbs than for those residing in more rural parts of the state. Patients who live in a rural (and large-town) context are 50% more likely to be diagnosed with late-stage cancer than their counterparts in Chicago. These rural – urban disparities not only persist but become stronger after we adjust for age and zip code characteristics. After adjustment, the risk for black patients living in rural settings is almost double that for similar women living in similar areas in Chicago (table 3).

By 1998 – 2002, the rural – urban gradient for black patients changes dramatically (figure 2). There are no significant rural – urban disparities in risk in the unadjusted model (model 1) and in the model which adjusts for age (model 2) (table 3). However, when zip-code socioeconomic indicators and spatial access to primary care are included (model 3), some hints of rural – urban disparity emerge. The odds of a late-stage diagnosis are roughly 20% higher for black breast cancer patients living in suburban and other metropolitan areas compared with women of similar age who live in socioeconomically similar communities in Chicago. This suggests that all else being equal, black patients who live outside Chicago, in suburban and other metropolitan areas, face unique barriers to breast cancer screening that translate into higher late-stage risk. These barriers do not appear to involve spatial barriers to primary care, at least to the extent that we have captured such barriers with our spatial access measure. Instead, they may involve social or cultural barriers in these geographic settings that reduce opportunities for early diagnosis.

Conclusions

For the overall population we find no evidence of rural disadvantage in either time period. In fact the percentage of breast cancer cases diagnosed late is higher in the highly urbanized city of Chicago than it is in other regions of the state—an indication of *urban* disadvantage. This finding is consistent with previous studies in Illinois and certain other areas of the US (McLafferty and Wang, 2009; Paquette and Finlayson, 2007), and it has important policy implications. More intensive outreach, education, and breast cancer screening initiatives are needed in Chicago, particularly programs emphasizing socially and economically vulnerable populations.

As in much of the US, the percentage of breast cancer cases diagnosed at a late stage fell in Illinois during the 1990s, which is a reflection of higher rates of mammography screening and the rise in early detection. Chicago’s percentage decreased significantly, but still

remained higher than in the rest of the state. Outside Chicago, the percentage changed unevenly along the rural – urban continuum. Most notable was the relatively small decline in the Chicago suburbs. This likely reflects social and economic transformations in the suburbs in the 1990s as suburban populations became more socioeconomically, ethnically, and racially diverse, and as poverty and deprivation have increased in some suburban communities (Madden, 2003).

Rural – urban inequalities in late-stage breast cancer risk stem primarily from differences in the demographic characteristics of area populations and differences in the social and spatial characteristics of the places in which they live. Race and age were significant predictors in both time periods. Associations between zip-code-level variables and late-stage risk were also generally consistent over time. The most important difference between the two time periods was that spatial access to primary care became a statistically significant predictor of late-stage risk at the end of the 1990s. We can only speculate about why this occurred. There is some evidence in the decreasing coefficient value for socioeconomic disadvantage that the links between deprivation and late-stage breast cancer detection weakened during the 1990s, perhaps as a result of increased awareness, cancer screening initiatives, and expanded insurance coverage for mammography. As socioeconomic barriers declined in importance, the significance of spatial barriers to health care may have increased.

For the black population, rural – urban disparities were markedly different: there is clear evidence of rural disadvantage as opposed to the urban disadvantage observed for the population as a whole. Moreover, the higher risk of late-stage diagnosis among black breast cancer patients residing outside Chicago was not simply a result of differences in patient age, spatial access to health care, or area-based socioeconomic characteristics. The causes of these distinctive patterns of rural – urban inequality are unclear. Black women who live outside Chicago may face unique kinds of social, cultural, or provider-related barriers to accessing breast cancer screening services and primary health care. Ethnographic research reveals that suburban service providers sometimes do not cater to the needs of impoverished or ethnically diverse residents (Murphy, 2007). Slow and inconvenient public transportation options outside Chicago may also play a role. Research indicates that African-Americans have longer travel times to health care than do whites despite the fact that average distances are similar suggesting greater reliance on public transportation (Probst et al, 2007). Finally social and cultural barriers including racial discrimination vary among urban, suburban, and rural settings. A recent study highlights the importance of differing cultural practices and beliefs about breast cancer screening between rural and urban African-American women (Husaini et al, 2005).

The finding of rural and suburban disadvantage for black breast cancer patients is important in several respects. It highlights the need to disaggregate analysis of rural – urban health disparities to focus on the distinctive experiences of vulnerable, high-risk populations. For these populations, the availability of resources and information in particular settings and the kinds of barriers encountered are likely to be quite different from those for the general population. Although limited by its reliance on quantitative data and a restricted set of variables, our research also emphasizes the value of a relational perspective (Cummins et al, 2007) that addresses the diversity of population health needs in diverse places. Our results

also might indicate the need for breast cancer outreach and education programs targeted specifically at African-Americans in suburban and rural settings. Their needs may be hidden from view by the large and important health concerns in Chicago, and they may require unique and innovative kinds of public health interventions.

This research also has implications for health-care planning. Policies to reduce late-stage breast cancer risk increasingly rely on spatial targeting—selectively focusing services and public health campaigns in the places where they are most needed. This spatial targeting is widely viewed as key to generating long-term improvements in cancer morbidity and mortality (Short et al, 2002). The results presented here demonstrate the importance of integrating spatial *and* social targeting in efforts to plan health-policy interventions. Different population groups have different types of place-based vulnerabilities that in turn influence the effectiveness of spatially targeted policies and programs.

Our findings may be limited due to the coarse geographic scale of analysis which can mask differences within geographic zones and obscure more subtle urban – rural gradients (Haynes and Gale, 2000; Senior et al, 2000). Another important shortcoming is the very limited set of individual-level variables considered, particularly the lack of individual-level education and income measures. These factors are strongly associated with late-stage cancer risk, and their omission, due to data limitations, may adversely affect estimation of area-level socioeconomic effects. The racial classification variable is also problematic, relying on a simple binary classification that fails to capture people's diverse racialized experiences. This research is also constrained by the lack of data on cancer screening and health-care utilization. More direct efforts to understand how people's experiences of contrasting place environments affect their access to health care and the corresponding impacts on health outcomes are sorely needed.

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Figure 1.
Percentage of late-stage breast cancer cases by rural – urban location, 1988 – 92 and 1998 – 2002.

Figure 2.
Percentage of late-stage breast cancer cases, black patients only, by time period and rural – urban location, 1988 – 92 and 1998 – 2002.

Table 1

Characteristics of breast cancer cases, Illinois, 1988 – 92 and 1998 – 2002. Percentage totals are shown in parentheses.

	1988 – 92		1998 – 2002	
<i>Cases</i>				
Total	37 392		44 070	
Late-stage	14 409	(38.5)	15 454	(36.9)
Unstaged	1 714	(4.6)	2 226	(5.1)
<i>Location</i>				
Chicago	8 156	(21.8)	8 235	(18.7)
Chicago suburbs	15 276	(40.9)	19 850	(45.0)
Other metropolitan areas	7 366	(19.7)	8 961	(20.3)
Large town	2 815	(7.5)	3 136	(7.1)
Rural	3 776	(10.1)	3 888	(8.8)
<i>Demographic characteristics</i>				
Black	3 824	(10.2)	5 386	(12.2)
Age <50 years	8 172	(21.9)	9 487	(21.5)
Age >70 years	13 654	(36.5)	15 644	(35.5)

Table 2

Multilevel model coefficients, 1988 – 92 and 1998 – 2002. Standard errors in parentheses. See text for definitions of models.

	1988 – 92			1998 – 2002		
	model 1	model 2	model 3	model 1	model 2	model 3
Chicago suburbs	-0.281* (0.044)	-0.159* (0.041)	0.018 (0.054)	-0.182* (0.037)	-0.068* (0.036)	0.006 (0.043)
Other metropolitan areas	-0.274* (0.049)	-0.145* (0.046)	0.007 (0.060)	-0.279* (0.041)	-0.147* (0.040)	-0.058 (0.048)
Large town	-0.209* (0.061)	-0.048 (0.058)	0.088 (0.072)	-0.311* (0.054)	-0.141* (0.053)	-0.096 (0.062)
Rural	-0.227* (0.053)	-0.048 (0.051)	0.102 (0.070)	-0.206* (0.048)	-0.026 (0.048)	0.023 (0.064)
Black		0.475* (0.044)	0.374* (0.053)		0.371* (0.037)	0.360* (0.044)
Age <50 years		0.230* (0.028)	0.224* (0.029)		0.346* (0.026)	0.345* (0.026)
Age 70 years		-0.114* (0.025)	-0.112* (0.026)		-0.209* (0.024)	-0.210* (0.024)
Socioeconomic disadvantage			0.142* (0.030)			0.050* (0.025)
Sociocultural barriers			0.084* (0.027)			0.121* (0.018)
High health care need			-0.045 (0.027)			0.001 (0.018)
Spatial access			-8.082 (46.204)			-37.092* (13.14)
Random effect: intercept	0.040* (0.007)	0.024* (0.006)	0.019* (0.006)	0.021* (0.005)	0.013* (0.004)	0.004 (0.003)
Deviance	47 945.1	46 501.3	46 201.0	54 988.6	53 951.1	535 40.6

* Statistically significant, $p < 0.05$.

Table 3

Multilevel model coefficients for late-stage breast cancer risk, black patients only, 1988 – 92 and 1998 – 2002. Standard errors in parentheses. See text for definitions of models.

	1988 – 92			1998 – 2002		
	model 1	model 2	model 3	model 1	model 2	model 3
Chicago suburbs	-0.041 (0.042)	-0.076 (0.097)	0.100 (0.115)	0.024 (0.084)	-0.016 (0.082)	0.235* (0.093)
Other metropolitan areas	0.210* (0.116)	0.205* (0.116)	0.295* (0.142)	-0.020 (0.105)	-0.047 (0.104)	0.202* (0.111)
Rural	0.402* (0.260)	0.428* (0.264)	0.692* (0.292)	0.008 (0.229)	-0.017 (0.228)	0.328 (0.242)
Age <50 years		0.049 (0.077)	0.052 (0.078)		0.272* (0.068)	0.279* (0.067)
Age 70 years		-0.240* (0.085)	-0.249* (0.086)		-0.129* (0.073)	-0.142* (0.073)
Socioeconomic disadvantage			0.159* (0.053)			0.146* (0.043)
Sociocultural barriers			0.052 (0.048)			0.204* (0.040)
High health care need			-0.098* (0.059)			-0.009 (0.056)
Spatial access			-100.39 (151.2)			29.010 (41.087)
Random effects: intercept	0.011 (0.013)	0.009 (0.013)	0.000 (0.000)	0.038* (0.019)	0.032* (0.018)	0.000 (0.001)
Deviance	5067.2	5056.2	4968.0	6976.6	6848.3	6805.4

* Statistically significant, $p < 0.05$.