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Isolation and survival: The impact of local and MSA isolation on survival among non-Hispanic Black women diagnosed with breast cancer in the United States using a SEER-Medicare cohort

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Abstract

Background: Residential segregation is an important factor that negatively impacts cancer disparities, yet studies yield mixed results and complicate clear recommendations for policy change and public health intervention. In this study, we examined the relationship between local and Metropolitan Statistical Area (MSA) measures of Black isolation (segregation) and survival among older non-Hispanic (NH) Black women with breast cancer (BC) in the United States. We hypothesized that the influence of local isolation on mortality varies based on MSA isolation—specifically, that high local isolation may be protective in the context of highly segregated MSAs, as ethnic density may offer opportunities for social support and buffer racialized groups from the harmful influences of racism.

Methods: Local and MSA measures of isolation were linked by Census Tract (CT) with a SEER-Medicare cohort of 5,231 NH Black women aged 66–90 years with an initial diagnosis of stage I-IV BC in 2007–2013 with follow-up through 2018. Proportional and cause-specific hazards models and estimated marginal means were used to examine the relationship between local and MSA isolation and all-cause and BC-specific mortality, accounting for covariates (age, comorbidities, tumor stage, and hormone receptor status).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.healthplace.2023.103090.

Findings: Of 2,599 NH Black women who died, 40.0% died from BC. Women experienced increased risk for all-cause mortality when living in either high local (HR = 1.20; CI = 1.08–1.33; $p < 0.001$) or high MSA isolation (HR = 1.40; CI = 1.17–1.67; $p < 0.001$). A similar trend existed for BC-specific mortality. Pairwise comparisons for all-cause mortality models showed that high local isolation was hazardous in less isolated MSAs but was not significant in more isolated MSAs.

Interpretation: Both local and MSA isolation are independently associated with poorer overall and BC-specific survival for older NH Black women. However, the impact of local isolation on survival appears to depend on the metropolitan area's level of segregation. Specifically, in highly segregated MSAs, living in an area with high local isolation is not significantly associated with poorer survival. While the reasons for this are not ascertained in this study, it is possible that the protective qualities of ethnic density (e.g., social support and buffering from experiences of racism) may have a greater role in more segregated MSAs, serving as a counterpart to the hazardous qualities of local isolation. More research is needed to fully understand these complex relationships.

Keywords

Segregation; Survival; Breast cancer disparities; Neighborhood effects; Ethnic enclaves

1. Introduction

1.1. Background

Breast cancer (BC) is the most diagnosed cancer and the second leading cause of cancer-related mortality among women in the United States (Giaquinto et al., 2022; Siegel et al., 2023). In 2023, an estimated 297,790 women are expected to be diagnosed with BC (31% of new cancer diagnoses) and approximately 43,170 women are expected to die from BC (15% of cancer-related deaths) (Siegel et al., 2023). Since 2000, BC incidence and mortality rates have declined, however significant racial disparities (primarily impacting Black women) remain (Giaquinto et al., 2022). Although the rate of BC incidence among non-Hispanic (NH) Black women is slightly lower compared to NH White women (128.4 compared to 135.2 per 100,000 women in 2019), mortality rates among NH Black women are significantly higher (27.8 compared to 19.3 deaths per 100,000 women) (U.S. Cancer Statistics Working Group). Socioeconomic and environmental factors associated with mortality are well-documented, but research also suggests that racial residential segregation is an important upstream factor (Williams and Collins, 2001; Kramer and Hogue, 2009; Landrine et al., 2017; Logan and Parman, 2018; Yang et al., 2020; Poulson et al., 2021; Goel et al., 2022; Lee et al., 2022; Swope et al., 2022).

Residential segregation—the sorting of different groups by characteristics such as race, ethnicity, or income into different geographic units of unequal status—is increasingly identified as a cause of poor health outcomes and mortality in communities of color (Massey and Denton, 1988; Williams et al., 2019; Yang et al., 2020). Neighborhoods built on practices of forced residential segregation (produced by historical and contemporary institutional racism) are often characterized by disadvantage and deprivation, including

economic disadvantage, crime, and poor neighborhood quality and disinvestment (Massey and Denton, 1994). The socioeconomic consequences are vast and residents in these neighborhoods often lack or have inadequate access to basic needs such as quality education, employment opportunities, language services, reliable transportation, healthy food, and affordable health insurance (Williams et al., 2019; Steil and Arcaya, 2023). These factors, in addition to others, are commonly associated with poor health outcomes (Williams and Collins, 2001; Kramer and Hogue, 2009; Landrine and Corral, 2009; Bailey et al., 2017; Riley, 2018; Williams et al., 2019). Not surprisingly, epidemiological research suggests that these factors contribute to BC disparities, including early detection/screening, treatment, quality of life, and, ultimately, survival (Landrine et al., 2017; Smith and Madak-Erdogan, 2018; Coughlin, 2019; Yedjou et al., 2019; Poulson et al., 2021; Shariff-Marco et al., 2021; Goel et al., 2022).

Lack of or inadequate access to resources, driven by socioeconomic status (SES), is a primary source of racial cancer disparities and continues to burden segregated communities (Yedjou et al., 2019). Residents of segregated neighborhoods often lack access to resources such as education, employment opportunities, childcare, transportation, and health insurance (Williams et al., 2019; Yedjou et al., 2019). These shortfalls and other conditions of segregation not only create health inequities (such as disparities in cancer incidence) but sustain them (Lim et al., 2017; Williams et al., 2019; Bevel et al., 2023). A lack of educational resources can limit health literacy and the ability to make informed decisions regarding general health screening, routine health management, and treatment uptake and compliance/adherence (Kobayashi and Ishizaki, 2020). A lack of childcare and transportation services can make it more difficult to access healthcare facilities (Nock et al., 2023). A lack of healthcare insurance can restrict access to screening and treatment options (Yedjou et al., 2019; Jatoi et al., 2022). In fact, researchers argue that differences in coverage of mammography screening and adjuvant endocrine therapy (medical interventions instrumental in the early detection and treatment of BC, respectively) stemming from the 1980s are a main source of racial BC disparities (Yedjou et al., 2019; Jatoi et al., 2022). Although screening rates and treatment utilization among Black women have improved since the 1980s, Black women continue to shoulder the burden of aggressive BC subtypes (hormone receptor [HR]-negative and triple-negative) and gain less benefit from these medical interventions (Jatoi et al., 2022). All these adverse outcomes are examples of the myriad ways residential segregation and the resulting limitations in access to salutogenic resources can impact time to treatment, adherence to treatment, response to treatment, and survival after a BC diagnosis (Yedjou et al., 2019; Sadigh et al., 2022).

However, careful examination reveals that the impacts of residential segregation vary by race, with Black women experiencing both harmful and protective effects (Warner and Gomez, 2010; Bemanian and Beyer, 2017; Landrine et al., 2017; Logan and Parman, 2018; Coughlin, 2019; Linnenbringer et al., 2020; Poulson et al., 2021; Shariff-Marco et al., 2021). While residential segregation undoubtedly burdens communities, racial clustering resulting from racialized groups voluntarily congregating in ethnic enclaves can provide protection. Ethnic enclaves are geographic areas that experience a high volume of spatial clustering of a particular racial and/or ethnic group (Lim et al., 2017). These established neighborhoods are socially and economically distinct and can offer many protections,

including connections to cultural and religious institutions, social support and cohesion, protection against discrimination, increased opportunities for employment, and political empowerment (Vinikoor et al., 2008; Kramer and Hogue, 2009; Williams et al., 2016; Lim et al., 2017; Espinoza-Kulick et al., 2021). This, in turn, may provide protective health benefits, with social support and stress reduction having the most positive influence on cancer outcomes (Kroenke et al., 2006; Williams et al., 2016; Coughlin, 2019). Although more research is needed to identify the specific mechanisms, it has been hypothesized that racial and ethnic density (due to social policies and/or preferences) improves social connectedness and sociocultural resilience and eliminates some of the harm caused by loneliness and perceived discrimination, thus reducing the risk for adverse health outcomes and improving survival (Saini et al., 2019). In the context of cancer outcomes, recent research on stage at diagnosis (Gomes et al., 2023) and survival (Price et al., 2021) suggests residence in an ethnic enclave provides specific protective pathways such as the impact of social integration and cultural influence on health behaviors. Integrating residence in an ethnic enclave into research on mortality disparities experienced by Black women with BC may elucidate additional potentially protective qualities.

Additional research on these complex relationships is warranted in order to inform effective policy change, and careful consideration of measurement is needed. In 1988, Massey and Denton conceptualized five distinct axes of residential segregation which included evenness, exposure, concentration, centralization, and clustering (Massey and Denton, 1988). Within each axis, various metrics exist to measure residential segregation on different geographical scales. Measures of evenness and exposure remain popular measures of residential segregation and tend to emphasize larger spatial units (e.g., Metropolitan Statistical Areas [MSAs]). Examples of these measures include the dissimilarity index, the Gini coefficient, and the interaction/isolation indices. A systematic review of the literature published in 2020 found that the majority of research studies operationalize measures of segregation at the county or MSA level using the evenness or exposure dimensions (Yang et al., 2020). These measures illustrate segregation on a larger scale, but lack the detail of local or neighborhood exposure, closer to individuals' lived experience. Therefore, various researchers have advocated for the use of local measures of segregation that may provide stronger associations and have larger implications for public health policy (Warner and Gomez, 2010; Oka and Wong, 2015; Bemanian and Beyer, 2017; Krieger et al., 2017; Fang and Tseng, 2018; Bemanian et al., 2021). However, as Oka and Wong (2015) argue, the need for segregation measures to be as fluid as segregation itself is necessary to understand the social environment in which people live and experience health (Oka and Wong, 2015).

A few examples of commonly used local measures include the location quotient (LQ) and the Index of Concentration at the Extremes (ICE) (Pruitt et al., 2015; Krieger et al., 2016; Krieger et al., 2017). The LQ measures relative percent composition and is interested in how a racial/ethnic group is represented in a local geography (e.g., Census Tract [CT]) relative to a larger geography (e.g., MSA) (Pruitt et al., 2015; Bemanian and Beyer, 2017). The ICE, another relative measure, is the absolute rate difference between "privileged" and "disadvantaged" groups (Krieger et al., 2016; Krieger et al., 2017; Bemanian and Beyer, 2017). While both measures help describe local experiences of segregation, neither provides a clear way to examine interactions between racial/ethnic groups (Oka and Wong, 2015). In

2017, Bemanian and Beyer introduced local exposure and isolation (LEx/Is), which adapt the exposure and isolation indices into local measures (Bemanian and Beyer, 2017). LEx/Is measure the relative likelihood of different racial/ethnic groups interacting in the same space and brings attention to co-residence. Bemanian and Beyer compared their metric to LQ and ICE and argue their measure may be more suitable to apply to survival modeling and other regression analyses, because it has superior normality, is not finitely bound by range of proportions, and suffers from less multicollinearity (Bemanian and Beyer, 2017). Furthermore, the local exposure metric has a more direct interpretation for interactions between racial/ethnic groups, and does not require an *a prior* prescription of advantaged versus disadvantaged groups (Bemanian and Beyer, 2017). This is an important distinction when measuring segregation at the local level. While each of these measures has been described as a measure of segregation, each is also based on the measurement of racial and ethnic density, which, as described above, may have both positive and negative health impacts.

Although it is useful to examine how local and non-local measures influence health outcomes independently, there is also value in exploring how different measures interact. An analysis by Bemanian et al. in 2021 investigated how the relationship between local isolation and liver cancer mortality in the five largest Wisconsin MSAs varied by the MSA (Bemanian et al., 2021). When combining the analysis across all MSAs, there was evidence of higher mortality in ZCTAs with higher Black and Hispanic local isolation. However, when the analysis was stratified by MSA it became clear these effects were concentrated in only two of the five MSAs. This example highlights why local and metropolitan measures of segregation need to be considered together and why it is important to either stratify the analysis or look for interaction effects. LEx/Is intrinsically normalizes against the background of the MSA population distribution, so it is helpful to add a measure of MSA segregation to an analysis comparing multiple MSAs to account for segregation at the MSA level (Bemanian and Beyer, 2017; Bemanian et al., 2021).

1.2. Objective

The objective of this study is to examine how local and metropolitan area measures of NH Black isolation interact and relate to survival among older NH Black women with BC in the United States. We hypothesize that the influence of local isolation—exposure to members of the same racial/ethnic group—on mortality will vary based on an MSA's level of isolation. Specifically, we hypothesize that high local isolation will be hazardous in MSAs with lower overall isolation of Black populations, due to more stressors and fewer resources in these local areas. However, we hypothesize that high local isolation may be protective in the context of MSAs where Black residents are highly isolated at the MSA level, as the local exposure to ethnic density may buffer them from discrimination and offer social support in the context of metropolitan area wide racial tension and inequity.

2. Methods

2.1. Study cohort

This cohort study was approved by the Medical College of Wisconsin Institutional Review Board. The study area consists of all MSAs and 2010 U.S. Census Tracts (CTs) in Surveillance, Epidemiology, and End Results (SEER). Data on 171,696 women with a first incident BC diagnosis between 2007 and 2013 were identified from the SEER-Medicare database linking the National Cancer Institute's SEER program data with Medicare claims. For inclusion, women had to be 66–90 years old, diagnosed with stage I-IV BC (6th edition of the American Joint Committee on Cancer [AJCC]), be alive for the first month after BC diagnosis, and be enrolled in Medicare Parts A and B 12-months prior to BC diagnosis. Additionally, women had to reside in a 2010 CT within a 2013 MSA and identify as NH Black/African American. After applying the eligibility criteria, the final sample size for all-cause mortality included 5,231 women. Lastly, women had to have a known cause of death for the BC-specific analysis which included a final sample size of 5,207 women (Fig. 1).

2.2. Outcome measures

The main outcome was survival time after BC diagnosis. Survival time was calculated using vital status information available through December 31, 2018, from the Medicare enrollment file. All-cause and BC-specific mortality were assessed. BC-specific mortality was determined using cause of death information from SEER. Patients were excluded from the BC-specific analyses if cause of death was unknown (n = 24).

2.3. Local isolation

The primary independent variable, local isolation, measures the probability of exposure of a person of a particular racial identity to others in the same group in a specific geographic unit (or isolation with members from the same group) (Bemanian and Beyer, 2017). This study specifically evaluates NH Black local isolation, constructed based on the LEx/Is measures developed by Bemanian and Beyer (2017) and addresses shortcomings in the literature on the use of isolation as a measure of segregation (Oka and Wong, 2015). A zero value for a specific CT indicates that the estimated probability of the interaction between two people identifying as NH Black within a CT is equal to the expected probability if the MSA were perfectly mixed. In other words, a zero value indicates the local composition of a group equals the region's composition (perfectly mixed) and creates a situation where there is no measurable segregation. Values greater than zero indicate that the interaction is more likely to occur within the CT than in the MSA, or more isolation of the group with its own members. Values less than zero indicate that the interaction is less likely to occur, or less isolation of the group. For analyses, local isolation was dichotomized as "Low Local Isolation (LLI)" for values equal to or less than zero and "High Local Isolation (HLI)" for values greater than zero. Our decision to dichotomize local isolation using this threshold was informed by the interpretation of zero. While theoretically possible, there are no zeros in the dataset.

2.4. Metropolitan Statistical Area isolation

The secondary independent variable, MSA isolation, is based on the isolation index (conceptualized as the standard measure of evenness by Massey and Denton [1988]) and measures the extent to which minority members are exposed only to other minority members, rather than to majority members. For this study, the isolation index was measured as the probability that individuals identifying as NH Black will be exposed to only each other in an MSA. This measure ranges on a scale between 0 and 1, with values closer to 1 representing greater isolation of the group with its own members. For analyses, MSA isolation was dichotomized as "Low MSA Isolation (LMI)" for values less than 0.6 and "High MSA Isolation (HMI)" for values equal to or greater than 0.6. Preliminary analyses examining the association between local isolation and survival at different cut-points of MSA isolation suggest 0.6 as a meaningful cut-point and represent those women living in the most isolated MSAs. The smallest p-value for cut-points 0.1 to 0.6 guided the decision for the final binary classification.

Both measures were calculated using 2010 U.S. Census population and 2013 MSA boundary data and illustrated in Figs. S1 and S2. Isolation measures were then linked to the study cohort based on CT of residence at the time of diagnosis.

2.5. Covariates

Covariates were selected based on prior research indicating their association with patient survival. Patient age at diagnosis was obtained from the Medicare enrollment file. The Klabunde algorithm was used to calculate comorbidities from inpatient, outpatient, and carrier Medicare data 12 months prior to first incident BC diagnosis (Klabunde et al., 2007). Data on tumor stage (I-IV) and hormone receptor status (HR-positive if estrogen and/or progesterone receptor is positive) were extracted from SEER. HER2/neu receptor status was not available for the full study cohort and was not included. Race and ethnicity variables from SEER were combined to categorize patient race/ethnicity. The Medicare race variable was used to impute race for patients with unknown SEER race. For this analysis, we elected to only include patients who identified as NH and Black in order to focus on associations among this population. Other sociodemographic, clinical, and cancer characteristics conceptualized as mediators in the association between isolation and survival (e.g., treatment disparities) are not included in this analysis.

3. Analysis

We used descriptive analyses to summarize the characteristics of the cohort. Unadjusted Kaplan Meier (all-cause mortality) and Aalen-Johansen (BC-specific mortality) estimators were used to estimate the relationship between levels of isolation and mortality. Cox proportional and cause-specific hazards regression models with robust sandwich estimators of standard errors estimated the hazard of mortality with local isolation as the main independent variable. Dates of death, obtained from the Medicare enrollment file, were available for women who died before the censoring date of December 31, 2018. For all-cause mortality, women were censored at the end of the study; for BC-specific mortality, women were censored at death from other causes and at the end of the study. We tested

the proportional hazards assumption of the Cox model and stratified variables that violated this assumption. Final models were adjusted for comorbidities and stratified by age, tumor stage, and HR status. Additionally, an interaction term for local isolation and MSA isolation was included. Finally, a cluster term was added to account for potential spatial dependency of local isolation within MSAs after sensitivity analyses measuring MSA as a random effect in generalized linear mixed effects models showed no reliable random effects. To examine the interaction between local and MSA isolation, post-hoc methods to estimate the marginal means of pairwise comparisons in the interaction were included. All analyses were performed using R.

4. Results

4.1. Descriptive analysis

Table 1 summarizes the characteristics of the cohort. The mean age of the cohort was 74.7 (6.3) years. Almost two-thirds of the cohort had at least 1 comorbidity. Most women were diagnosed with Stage I or II BC (78%) and had a HR-positive cancer (73%). The mean value for local isolation was 0.85 (1.12); most women lived in high local isolation (77%). The mean value for MSA isolation was 0.48 (0.19); most women lived in low MSA isolation (71%). A greater proportion of women living in high local isolation CTs experienced all-cause (51%) and BC-specific (21%) mortality compared to women living in low local isolation CTs (45% and 18% respectively). Similarly, a greater proportion of women living in high MSA isolation died from all-causes (54%) and BC (24%) compared to women living in low MSA isolation (48% and 18% respectively). This pattern persists when examining the interaction between local and MSA isolation, with the greater proportion of women who died living in both high local and high MSA isolation (55% from all-causes and 24% from BC). At a median follow-up of 73 months, 2,599 (49.7%) women had died, of whom 1,039 (40%) died of BC.

Figs. 2 and 3 show an unadjusted Kaplan Meier survival curve (all-cause mortality) and an unadjusted Aalen-Johansen curve for competing events (BC-specific mortality) for the interaction between local and MSA isolation. A gradient effect was observed, with women living in both high local and high MSA isolation experiencing poorer survival outcomes. These relationships persist for both all-cause and BC-specific mortality.

4.2. Model results

Cox proportional and cause-specific hazards regression model results are presented in Table 2. Women living in high local isolation had a significantly greater risk of death from all-causes (HR = 1.20; CI = 1.08–1.33; $p < 0.001$) after adjusting for comorbidity and stratifying by age, stage, and HR status. High MSA isolation was significantly associated with all-cause mortality (HR = 1.40; CI = 1.17–1.67; $p < 0.001$). Women living in high local isolation had an 18% elevated risk of mortality from BC (HR = 1.18; CI = 0.99–1.41; $p = 0.058$) and women living in high MSA isolation had a 36% elevated risk (HR = 1.36; CI = 1.06–1.76; $p = 0.016$). The largest effects were found for women with two or more comorbidities for both all-cause (HR = 2.23; CI = 1.97–2.53; $p < 0.001$) and BC-specific (HR = 1.43; CI = 1.21–1.70; $p < 0.001$) mortality. Additionally, a significant interaction

effect between local and MSA isolation was observed for all-cause mortality (HR =0.78; CI = 0.67–0.91; p = 0.002). All other tested interactions were not significant.

To explore the interaction effect for all-cause mortality presented in Table 2, estimated marginal means were obtained using post hoc methods. Table 3 summarizes pairwise comparisons when MSA isolation is held constant. Among women living in less isolated MSAs, those women who live in highly isolated CTs (high local isolation) experience a greater risk of all-cause mortality compared to women living in less isolated CTs (HR = 1.20; CI = 1.08–1.33; p < 0.001). However, the hazardous effect of local isolation is not replicated in more isolated MSAs. In more isolated MSAs, local isolation is neither protective nor hazardous (HR = 0.94; CI = 0.84–1.05; p = 0.3). This suggests that local isolation impacts survival outcomes differently based on the overall MSA level of segregation. Although the interaction term was not significant for BC-specific mortality, we found comparable results. Table S1 summarizes pairwise comparisons when local isolation is held constant.

5. Discussion

The purpose of this study was to evaluate the association between local isolation and survival among older NH Black women with BC, and how it varies by MSA isolation. This was accomplished by examining the impact of NH Black local and MSA isolation on all-cause and BC-specific survival using data from SEER-Medicare and the 2010 U.S. Census. When considered independently, both local and MSA isolation are associated with poorer all-cause and BC-specific survival. A larger proportion of women living in high local and high MSA isolation died from all-causes and BC compared to women living in low local and low MSA isolation. Additionally, models revealed a greater hazard ratio for both all-cause and BC-specific mortality for women living in high local and high MSA isolation compared to women living in low local and low MSA isolation, even after adjusting for comorbidities and stratifying by age, tumor stage, and HR status. These results suggest that living in more isolated neighborhoods and MSAs is hazardous and results in an increased risk of mortality.

After demonstrating the independent effect of local and MSA isolation on survival, we then sought to evaluate the interaction between local and MSA isolation given evidence in the literature that local segregation measures could encompass potential protective qualities of high racial and ethnic density, such as social support or protection from interpersonal discrimination (Logan and Parman, 2018; Warner and Gomez, 2010; Linnenbringer et al., 2020; Bemanian and Beyer, 2017; Williams et al., 2016). We found that among women living in less segregated (low isolation) MSAs, those who lived in high local isolation experienced a 20% higher hazard of all-cause mortality and an 18% higher hazard of BC-specific mortality compared to women living in low local isolation. However, this finding was not replicated for women in more segregated (highly isolated) MSAs where the comparison of low local to high local isolation, when holding high MSA isolation constant, was not significant. Our results suggest that in highly segregated MSAs, the tension between harmful and protective qualities of highly isolated neighborhoods is different, with the benefits of ethnic density having a stronger influence than in less segregated MSAs. In

this example, the benefits of living in a place with high local and high MSA isolation emerge as an attenuated risk of mortality after BC diagnosis. Plausible explanations include greater social connections and support, protection against discrimination, and increased socioeconomic opportunities which provide a buffer against institutionalized racism and have a positive effect on health (Kroenke et al., 2006; Vinikoor et al., 2008; Kramer and Hogue, 2009; Williams et al., 2016; Lim et al., 2017; Coughlin, 2019; Saini et al., 2019; Espinoza-Kulick et al., 2021; Price et al., 2021; Gomes et al., 2023).

5.1. Strengths

This study contributes to an understanding of the complex relationship between isolation and health by examining both independent effects and the interaction between local and metropolitan measures in relation to the outcome of survival among older NH Black women with BC. Our findings add to an existing literature that has found mixed results in studying these relationships. Many studies use measures that focus on “composition” or “proportions” to measure racial and ethnic density and segregation. These measures have been criticized for different reasons including failing to appropriately consider the spatial patterning of population distributions and interracial interactions and limiting the understanding of pathways by which racial and ethnic density may shape health outcomes (Wong, 1998; Reardon and O’Sullivan, 2004; Oka and Wong, 2015; Bemanian and Beyer, 2017; Bemanian et al., 2021). LEx/Is (local isolation) measures the probability that two people (either from the same or different racialized groups) living in a specific geographic unit will interact and provides an intuitive way to examine co-residence of people from the same, or different, racial and ethnic groups.

Study findings align with previous research on both the hazardous and protective effects of racial and ethnic density, referred to as “segregation” and/or “enclaves.” Studies evaluating measures similar to NH Black isolation have found associations with optimal outcomes due to health-promoting characteristics such as social support, less exposure to psychosocial stress and discrimination, better access to culturally relevant resources, etc. (Warner and Gomez, 2010; Williams et al., 2016; Bemanian and Beyer, 2017; Logan and Parman, 2018; Linnenbringer et al., 2020; Espinoza-Kulick et al., 2021). While these studies suggest a modest reduced risk of mortality among women living in segregated areas, it is important to note that the stressors, resource scarcity, and environmental conditions associated with segregation continue to negatively influence health outcomes for racialized groups. Future studies should explore potential mediating factors that may explain complex beneficial and harmful influences on health outcomes.

The mixed results found in our study highlight the complex relationships, and related measurement challenges, facing studies of residential segregation, racial and ethnic density, enclaves, and health. Although inconclusive, our findings suggest that there is value in reexamining how segregation, racial and ethnic density, and enclaves are measured, and the degree to which these measures, when associated with health outcomes, may find negative or positive effects. Our findings also suggest that the risk/benefit ratio of high racial and ethnic density neighborhoods may depend on the nature of the MSAs within which they are nested. This creates an opportunity to focus on alternative approaches to measurement, not

derived from population distribution information, such as more direct measures of access to housing (e.g., redlining or homeownership), measures related to social processes (e.g., social networks, social support, discrimination), or measures that can be targeted for change (e.g., housing policies). Nevertheless, more work is needed to understand this in greater depth.

Research often focuses solely on the negative aspects of segregation without acknowledging potential benefits of racial and ethnic density. This perspective may perpetuate the stigmatization of neighborhoods inhabited by racialized groups and could lead to policies that contribute to the decline of these neighborhoods, the disruption of social structures, or the displacement of residents. Myriad studies have revealed the negative effects of gentrification and displacement on the physical and mental wellbeing of residents. Displaced residents are more likely to live in overcrowded housing or experience homelessness (Fynn Bruey, 2019), which can lead to safety concerns including exposure to unsanitary conditions and disease (Deola and Patel, 2014). Displacement can impact food security and physical activity, which can create or exacerbate chronic health conditions, and affect mental health, creating immediate and lifelong burdens (Sanders et al., 2004; Deola and Patel, 2014). Finally, uprooted residents may lose access to primary care as they are forced to find alternative healthcare solutions (Lim et al., 2017). Policies promoting displacement effectively dismantle livelihoods and existing social structures in favor of neighborhood renewal and property value increases instead of creating opportunities that promote greater access to quality and affordable housing, housing choice, home ownership, and home equity for racialized groups. Therefore, it is important to evaluate protective effects of ethnic enclaves using carefully considered measurements to thwart additional socioeconomic and health inequities.

This study reveals the need for a greater understanding of the complex interactions between hazardous effects of segregation and protective effects of ethnic density. This is a critical issue to address given implications for policy. If ethnic density offers significant health benefits in the context of highly segregated metropolitan areas, policy solutions should attempt to preserve these benefits while dismantling segregation. Policies that advocate for inclusive development and neighborhood stabilization, production, and preservation can be supported (Dorazio, 2022). Examples of such policies can include the development of high-quality training programs to further career advancement (Dorazio, 2022), rent control and affordable housing (Durning, 2020; Dorazio, 2022), community land trusts (Durning, 2020; Dorazio, 2022), and preservation of the built environment in racially and ethnically dense communities (Dorazio, 2022). Research that directly examines the benefits of racially and ethnically dense neighborhoods, along with the negative impacts of segregation, can help to build the necessary evidence base for effective and long-lasting solutions.

5.2. Limitations

This study has several limitations. First, the cohort was limited to women ages 66 and older who identified as NH Black. Although other studies suggest a protective effect of ethnic density on Hispanic and Latino communities, known as the Hispanic paradox, we excluded Hispanic/Latina women from this study to focus on NH Black women given their unique histories and experiences (Ruiz et al., 2016; Price et al., 2021). Future studies

could focus on women of other and mixed identities. Second, our cohort was limited to women living in an MSA in the SEER registries. This limits our findings to urban and suburban women and excludes highly isolated MSAs that do not participate in the SEER program (e.g., Milwaukee, Wisconsin, Chicago, Illinois, and St. Louis, Missouri). Future research should consider how these questions apply in rural contexts and outside of SEER MSAs in the United States. Third, important tumor characteristics related to BC-specific mortality (e.g., HER2/neu status) were either not available or not available for the full cohort in our data set. Fourth, our analysis does not include important information on BC treatment characteristics. Although treatment plays a significant role in BC survival, the literature focuses on treatment differences as an important racial disparity (Yedjou et al., 2019; Jatoi et al., 2022; Stabellini et al., 2023). Since our cohort was limited to NH Black women, we decided to remove treatment from our already complex models. Despite these limitations, our cohort includes women from neighborhoods and MSAs with varied levels of isolation and our findings illustrate how isolation can influence health and survival outcomes differently at various levels of geography. These initial findings will guide our next steps. Future research should consider the factors that mediate the relationship between segregation and mortality and continue to explore how racial and ethnic density impacts mortality outcomes.

6. Conclusion

In conclusion, relationships among segregation, racial and ethnic density, enclaves, and health outcomes are complex. In this study, we found that older NH Black women with BC living in either high local or MSA isolation experienced poorer survival. This suggests that racial residential segregation is harmful and provides an opportunity for policy and interventions to mitigate negative impacts on health and mortality outcomes. However, we also tested the hypothesis that living in a combination of high local and high MSA isolation may be protective because these women may benefit from the protective aspects of ethnic enclaves (e.g., social support, cultural supports, protection from interpersonal racism) that become more important as the racial and ethnic density in an MSA increases. We found that the interaction between local and MSA level isolation metrics suggests that a protective effect, or buffer, may exist.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data sharing

The data underlying this article were provided by SEER-Medicare with permission under a Data Use Agreement. Per the DUA, data will not be shared. SEER-Medicare data may be requested from SEER-Medicare (https://healthcaredelivery.cancer.gov/seermedicare/obtain/). Data used to calculate local and MSA isolation are based on 2010 U.S. Census population, 2010 U.S. Census Tract boundaries, and 2013 U. S. Metropolitan Statistical Area boundaries are publicly available (https://data.census.gov/).

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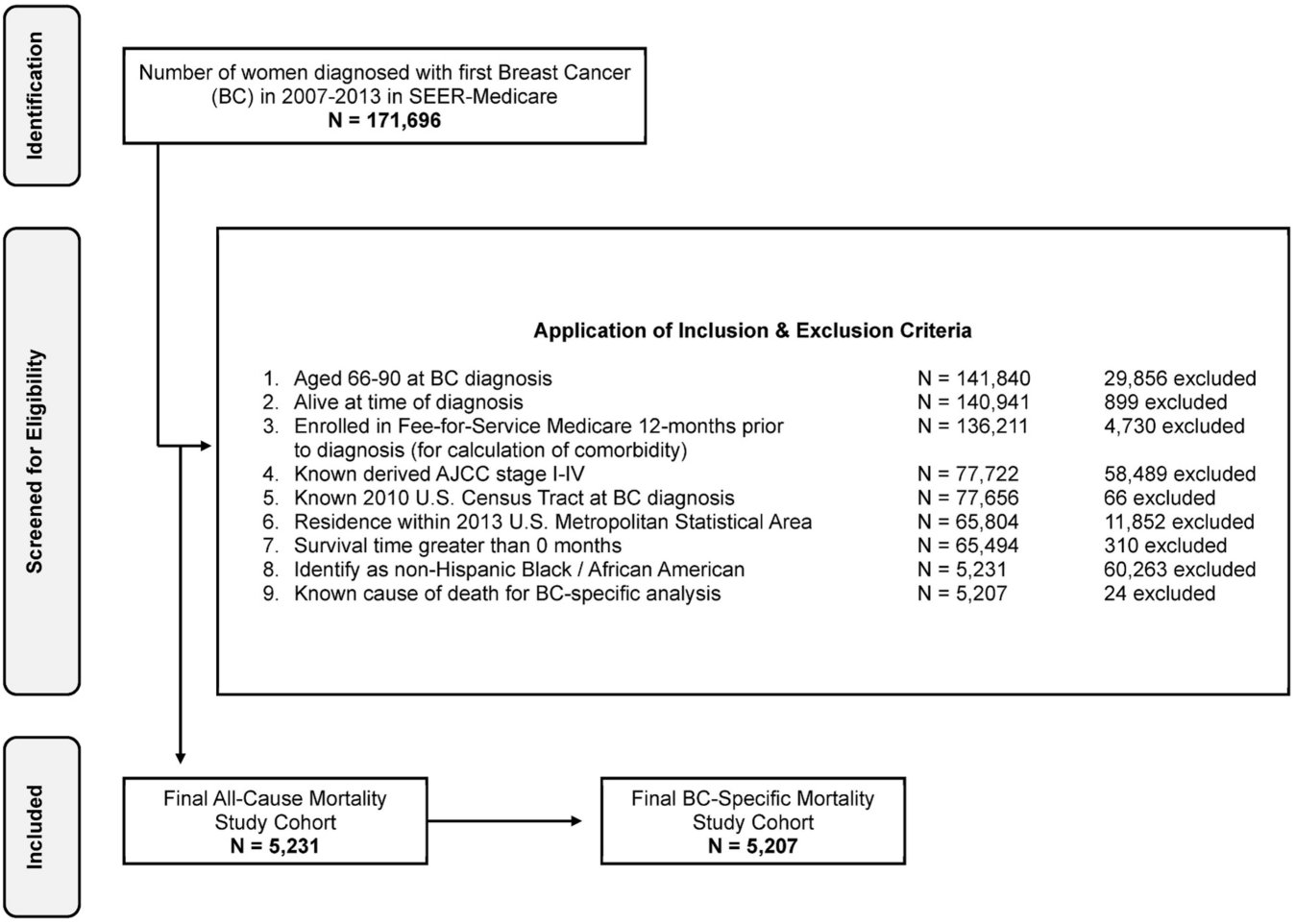

Fig. 1.

Flow diagram of 2007–2013 SEER-Medicare BC cohort eligibility criteria.

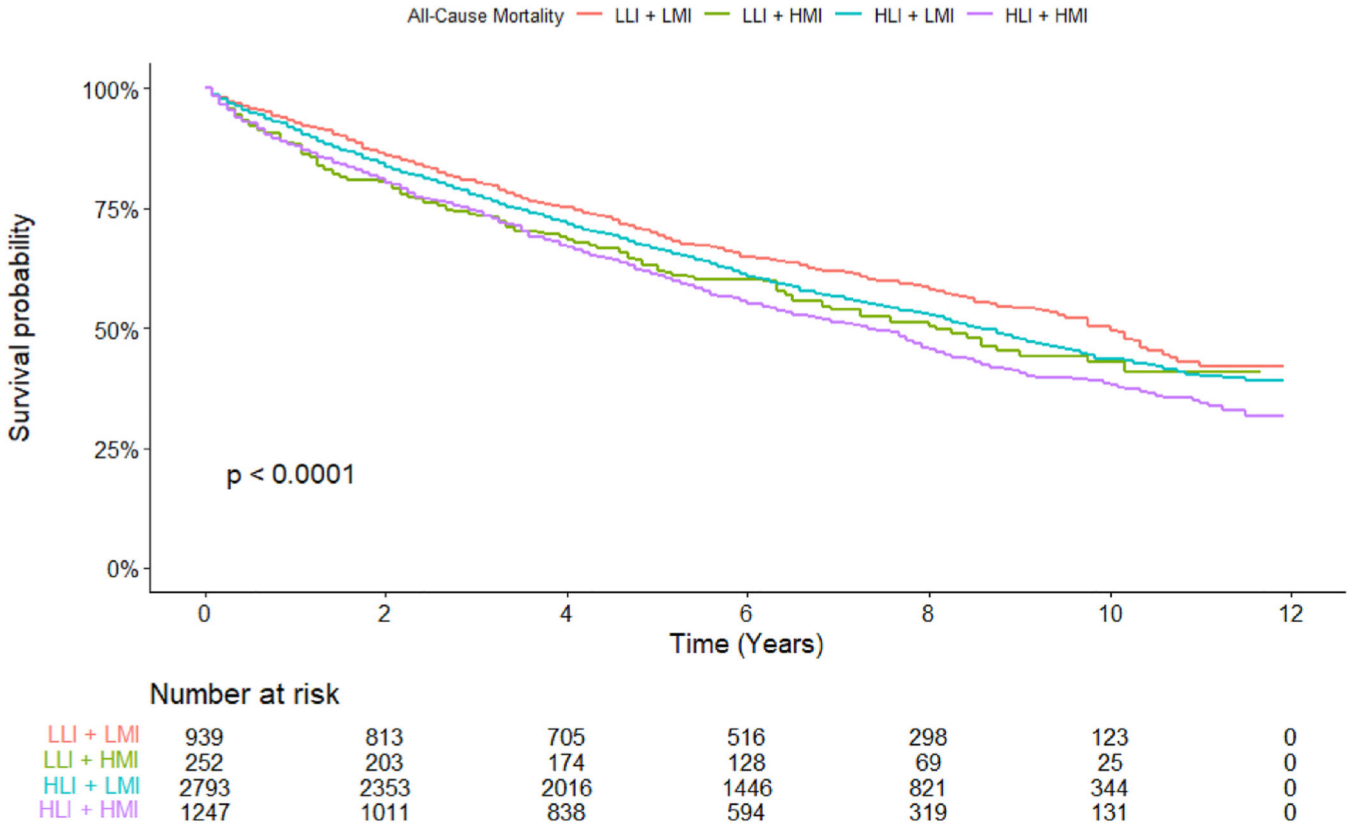

Fig. 2.
All-cause mortality unadjusted kaplan-meier curve.

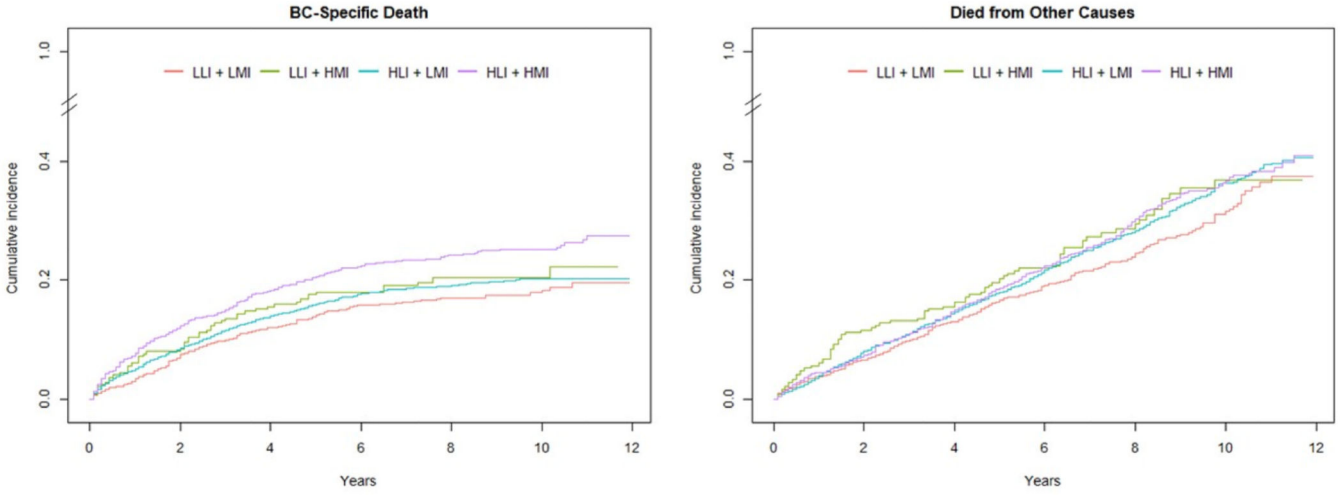

Fig. 3.

Breast cancer-specific mortality unadjusted aalen-johansen estimate of cumulative incidence Curve *LLI = Low Local Isolation, LMI = Low MSA Isolation, HLI = High Local Isolation, HMI = High MSA Isolation*.

Table 1

Characteristics of the 2007–2013 SEER-Medicare BC cohort by survival status.

	All-Cause Mortality				Breast Cancer Mortality				
	Total N = 5,231[a]	**Alive, N = 2,632[a]**	**Died, N = 2,599[a]**	**P-value[b]**	**Total N = 5,207[a]**	**Alive, N = 2,632[a]**	**Died from Other Causes, N = 1,536[a]**	**Died from BC, N = 1,039[a]**	**P-value[c]**
Demographic & Clinical Characteristics									
Age				**<0.001**					**<0.001**
66–70 years	1,676 (32%)	1,039 (62%)	637 (38%)		1,668 (32%)	1,039 (62%)	326 (20%)	303 (18%)	
71–75 years	1,413 (27%)	804 (57%)	609 (43%)		1,410 (27%)	804 (57%)	346 (25%)	260 (18%)	
76–80 years	1,053 (20%)	481 (46%)	572 (54%)		1,048 (20%)	481 (46%)	357 (34%)	210 (20%)	
81–85 years	728 (14%)	251 (34%)	477 (66%)		723 (14%)	251 (35%)	302 (42%)	170 (24%)	
86–90 years	361 (6.9%)	57 (16%)	304 (84%)		358 (6.9%)	57 (16%)	205 (57%)	96 (27%)	
Comorbidities				**<0.001**					**<0.001**
None	1,865 (36%)	1,142 (61%)	723 (39%)		1,857 (36%)	1,142 (61%)	354 (19%)	361 (19%)	
1 comorbidity	1,461 (28%)	802 (55%)	659 (45%)		1,457 (28%)	802 (55%)	374 (26%)	281 (19%)	
2+ comorbidities	1,905 (36%)	688 (36%)	1,217 (64%)		1,893 (36%)	688 (36%)	808 (43%)	397 (21%)	
Stage				**<0.001**					**<0.001**
Stage I	2,258 (43%)	1,466 (65%)	792 (35%)		2,255 (43%)	1,466 (65%)	652 (29%)	137 (6.1%)	
Stage II	1,846 (35%)	941 (51%)	905 (49%)		1,835 (35%)	941 (51%)	578 (31%)	316 (17%)	
Stage III	649 (12%)	197 (30%)	452 (70%)		642 (12%)	197 (31%)	196 (31%)	249 (39%)	
Stage IV	478 (9.1%)	28 (5.9%)	450 (94%)		475 (9.1%)	28 (5.9%)	110 (23%)	337 (71%)	
Hormone Receptor Status				**<0.001**					**<0.001**
ER and/or PR Positive	3,841 (73%)	2,074 (54%)	1,767 (46%)		3,824 (73%)	2,074 (54%)	1,133 (30%)	617 (16%)	
ER and/or PR Negative	1,133 (22%)	482 (43%)	651 (57%)		1,126 (22%)	482 (43%)	303 (27%)	341 (30%)	
Unknown	257 (4.9%)	76 (30%)	181 (70%)		257 (4.9%)	76 (30%)	100 (39%)	81 (32%)	
Months from time of diagnosis to death or end of follow-up	71 (38) [1, 143]	96 (24) [60, 143]	45 (33) [1, 138]	**<0.001**	71 (39) [1, 143]	96 (24) [60, 143]	52 (34) [1, 138]	33 (27) [1, 132]	**<0.001**
Isolation Measures									

	All-Cause Mortality				Breast Cancer Mortality				
	Total N = 5,231[a]	**Alive, N = 2,632[a]**	**Died, N = 2,599[a]**	**P-value[b]**	**Total N = 5,207[a]**	**Alive, N = 2,632[a]**	**Died from Other Causes, N = 1,536[a]**	**Died from BC, N = 1,039[a]**	**P-value[c]**
NH Black Local Isolation (Continuous)	0.85 (1.12) [−5.04, 3.02]	0.80 (1.15) [−3.58, 3.02]	0.91 (1.09) [−5.04, 3.02]	**0.003**	0.86 (1.12) [−5.04, 3.02]	0.80 (1.15) [−3.58, 3.02]	0.91 (1.08) [−2.79, 2.96]	0.93 (1.09) [−5.04, 3.02]	**0.005**
NH Black Local Isolation				**<0.001**					**0.001**
LLI	1,191 (23%)	651 (55%)	540 (45%)		1,178 (23%)	651 (55%)	319 (27%)	208 (18%)	
HLI	4,040 (77%)	1,981 (49%)	2,059 (51%)		4,029 (77%)	1,981 (49%)	1,217 (30%)	831 (21%)	
NH Black MSA Isolation (Continuous)	0.48 (0.19) [0.01, 0.70]	0.47 (0.19) [0.01, 0.70]	0.48 (0.19) [0.01, 0.70]	**<0.001**	0.48 (0.19) [0.01, 0.70]	0.47 (0.19) [0.01, 0.70]	0.48 (0.19) [0.01, 0.70]	0.49 (0.18) [0.02, 0.70]	**<0.001**
NH Black MSA Isolation				**<0.001**					**<0.001**
LMI	3,732 (71%)	1,948 (52%)	1,784 (48%)		3,711 (71%)	1,948 (52%)	1,077 (29%)	686 (18%)	
HMI	1,499 (29%)	684 (46%)	815 (54%)		1,496 (29%)	684 (46%)	459 (31%)	353 (24%)	
Local & MSA Isolation				**<0.001**					**<0.001**
LLI & LMI	939 (18%)	525 (56%)	414 (44%)		926 (18%)	525 (57%)	243 (26%)	158 (17%)	
LLI & HMI	252 (4.8%)	126 (50%)	126 (50%)		252 (4.8%)	126 (50%)	76 (30%)	50 (20%)	
HLI & LMI	2,793 (53%)	1,423 (51%)	1,370 (49%)		2,785 (53%)	1,423 (51%)	834 (30%)	528 (19%)	
HLI & HMI	1,247 (24%)	558 (45%)	689 (55%)		1,244 (24%)	558 (45%)	383 (31%)	303 (24%)	

LLI = Low Local Isolation, LMI = Low MSA Isolation, HLI = High Local Isolation, HMI = High MSA Isolation.

[a] n (%); Mean (SD) [Range].

[b] Pearson's Chi-squared test; Wilcoxon rank sum test.

[c] Pearson's Chi-squared test; Kruskal-Wallis rank sum test.

Table 2

Adjusted Cox-proportional hazards models for the effects of isolation on survival.

Characteristic	All-Cause Mortality[b]			Breast Cancer Mortality[b]		
	HR[a]	95% CI[a]	p-value	HR[a]	95% CI[a]	p-value
NH Black Local Isolation						
Low Local Isolation	-	-		-	-	
High Local Isolation	1.20	1.08, 1.33	**<0.001**	1.18	0.99, 1.41	0.058
NH Black MSA Isolation						
Low MSA Isolation	-	-		-	-	
High MSA Isolation	1.40	1.17, 1.67	**<0.001**	1.36	1.06, 1.76	**0.016**
Comorbidities						
None	-	-		-	-	
1 comorbidity	1.25	1.12, 1.39	**<0.001**	1.08	0.94, 1.25	0.3
2+ comorbidities	2.23	1.97, 2.53	**<0.001**	1.43	1.21, 1.70	**<0.001**
Local & MSA Isolation Interaction						
High Local Isolation * High MSA Isolation	0.78	0.67, 0.91	**0.002**	0.86	0.69, 1.08	0.2

[a] HR = Hazard Ratio, CI = Confidence Interval.

[b] Adjusted for comorbidity and stratified by age, tumor stage, and hormone receptor status.

Table 3

Estimated hazard ratios at different levels of local isolation.

Reference	Comparison	HR	95% CI	*p*	Interpretation
All-Cause Mortality					
Low Local Isolation + *Low MSA Isolation*	High Local Isolation + *Low MSA Isolation*	1.20	1.08–1.33	**<0.001**	High Local Isolation in less segregated MSAs is significantly associated with worse survival for Black women with breast cancer.
Low Local Isolation + *High MSA Isolation*	High Local Isolation + *High MSA Isolation*	0.94	0.84–1.05	0.3	High Local Isolation in more segregated MSAs is not significantly associated with worse survival for Black women with breast cancer.
BC-Specific Mortality					
Low Local Isolation + *Low MSA Isolation*	High Local Isolation + *Low MSA Isolation*	1.18	0.99–1.41	0.058	High Local Isolation in less segregated MSAs may be associated with worse breast cancer survival for Black women with breast cancer (not significant at alpha-level 0.05).
Low Local Isolation + *High MSA Isolation*	High Local Isolation + *High MSA Isolation*	1.02	0.88–1.19	0.8	High Local Isolation in more segregated MSAs is not significantly associated with worse breast cancer survival for Black women with breast cancer.