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Ethnic Density and Cancer: A Review of the Evidence

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Abstract

Accumulating data suggest that factors in the social environment may be associated with cancer-related outcomes. Ethnic density, defined as the proportion of racial/ethnic minority individuals who reside in a given geographic area, is one of the most frequently studied social environment factors, but studies on ethnic density and cancer have yielded inconsistent findings. Thus, the objective of this review was to summarize the extant data on ethnic density and cancer-related outcomes (cancer risk, stage at diagnosis, and mortality) with a view to identifying pathways by which ethnic density may contribute to outcomes across populations. In general, the findings indicated that ethnic density was associated with increased risk for cancers of an infectious origin (e.g., liver, cervical), but lower risk for breast and colorectal cancers, particularly among Hispanic and Asian Americans. Hispanic ethnic density was associated with greater odds of late-stage cancer diagnosis, whereas Black ethnic density was associated with greater mortality. In addition, this review highlights several methodological and conceptual issues surrounding the measurement of ethnic neighborhoods and their available resources. Clarifying the role of neighborhood ethnic density is critical to developing a greater understanding of the health risks and benefits accompanying these environments, and how they may affect racial and ethnic disparities in cancer-related outcomes.

Keywords

Cancer risk; Stage at diagnosis; Mortality; Neighborhood; Environment; Residential segregation; Isolation

INTRODUCTION

National data demonstrate that the United States population is growing more racially and ethnically diverse, but at the same time, we are also becoming more residentially segregated, particularly in certain communities.[1] How this social landscape relates to health is of considerable interest. Accumulating data suggest that neighborhood factors, such as ethnic density and residential segregation, may be associated with a variety of cancer-related

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outcomes.[2,3] Ethnic density, defined as the proportion of racial/ethnic minority individuals who reside in a given geographic area, has been reported to have both detrimental and protective effects.[4] On the one hand, areas of high ethnic density are highly segregated and often characterized by socioeconomic (SES) disadvantage and deprivation -- conditions commonly associated with poor health outcomes and greater disparities.[3] On the other hand, established ethnic neighborhoods or "ethnic enclaves" may offer a variety of social benefits, including greater availability of social support and community resources, that can be beneficial to health.[4]

Prior cancer-specific review papers addressed social and built environment characteristics more broadly,[2] or residential segregation with a focus on Black-White cancer outcomes only.[3] Thus, the objective of this review was to provide a focused examination of ethnic density and its various measures in relation to cancer outcomes across different populations. Inconsistent findings across studies of ethnic density and health may be due, in part, to the multiple methods used to assess ethnic density, and to differences in the racial/ethnic groups studied. Indeed, while areas characterized by "high ethnic density" may share some similarities, it is acknowledged that these neighborhoods can also be quite distinct. For example, some ethnic neighborhoods are comprised predominantly of individuals who share a common country of origin (e.g., Chinatown), whereas other communities (e.g., East Harlem) encompass co-ethnic residents who hail from multiple regions (Puerto Rico, Dominican Republic, Mexico, Cuba, etc.). For ease of exposition in the current paper, aggregate groupings (e.g., Black, Hispanic, Asian) will be used to designate the heterogeneous collection of populations that construct "ethnic density". Below, we first summarize the current approaches used to measure ethnic density, and then review the empirical studies of ethnic density and cancer with attention to the racial/ethnic populations included in each study.

METHODS

Literature Search

A literature search was conducted using the National Library of Medicine's PubMed search engine. The search included articles published through June 2017. We used the Boolean operator "AND" to identify combinations of search terms including: ethnic enclave, ethnic density, residential segregation, racial segregation, neighborhood environment, and immigrant (first terms) with cancer, cancer incidence, cancer mortality, cancer stage, cancer survival, and cancer risk (second terms). We followed PRISMA guidelines for reporting the studies that were identifed and included in this review.[5] Articles were excluded if they were review papers or theoretical in nature, did not include an outcome of cancer incidence or risk, cancer stage at diagnosis, or cancer mortality, or if they focused solely on access to care or utilization of cancer screening, treatment, or supportive care. Also excluded were papers that considered only neighborhood SES, or those that examined racial/ethnic differences in a cancer outcome without consideration of neighborhood ethnic composition. The electronic search was supplemented with a manual search of reference lists from reviews and related papers. We identified 1,415 articles through the database search and an additional 13 from reference lists. We assessed 127 full-text articles for eligibility and excluded 76 that did not

meet inclusion criteria, resulting in 51 empirical studies included in this review (see Supplemental Materials).

All studies were based on participants' neighborhood of residence, with no exploration of their 'activity space,'[6] or other geographic locations where they spent time during the day. Studies used different methods to operationalize residence in a neighborhood with a high ethnic concentration. Further, we acknowledge the significant heterogeneity that exists within ethnic and racial groups. Asian Americans can include individuals from East Asia, Southeast Asia, and South Asia. Similarly, Hispanic ethnicity broadly represents individuals with diverse ancestry from Spain or Latin America; and Black or African American designation can include individuals of African descent as well as immigrants from Caribbean nations. For the purpose of this paper, designations of racial and ethnic minority populations are based according to the US Census Bureau definitions of race and ethnicity. We use the phrase 'ethnic density' to capture all these methods and use more specific terms to refer to individual studies as appropriate.

RESULTS

Measures of Ethnic Density

Measures of ethnic density fell into two general categories: measures based on the ethnic composition of the neighborhood, and measures of residential segregation (see Table 1). Most studies defined 'neighborhood' as a Census tract, taking advantage of data available at that level of analysis, although areas varied from Census block-groups to counties.

Studies of Blacks included both types of measures. Studies of Hispanics mostly used measures of ethnic composition, although several also used segregation measures. Almost all studies of Asian Americans used measures of ethnic composition.

The most commonly used measure of ethnic composition was percent of the population of a specified race/ethnic group. Other common measures of ethnic composition were based on percent of the population that was foreign-born or recent immigrant (<5 years), language use (e.g., percent with limited English proficiency), or a combination of these. Several studies of Hispanic or Asian/Pacific Islander (API) populations used an enclave index that was derived from principal components analysis on block-group-level variables, which were then averaged across Census tracts (see Table 1 for details).

In comparison, fewer studies used measures of residential segregation, and most of these focused on Black-White segregation. In their seminal paper, Massey and Denton defined residential segregation generally as 'the degree to which two or more groups live separately from one another, in different parts of the urban environment,' and they identified five dimensions of residential segregation[7]: (1) evenness; (2) exposure; (3) concentration; (4) centralization; and (5) clustering. With the exception of studies by Warner and Gomez,[8] who explored all five dimensions of residential Black-White segregation, and Rice and colleagues[9] who examined four dimensions, most other studies utilized a single dimension of residential segregation. The most commonly used indicator was the Isolation Index, a measure of exposure to or degree of contact with majority group members. Evenness was the

second most commonly examined dimension and was measured primarily using the Dissimilarity Index, which represents the proportion of minority group members that would have to move to achieve the racial-ethnic distribution of the metropolitan area. Three studies used the Location Quotient as a local index of segregation.[10–12]

Below, the empirical studies included in this review are grouped according to whether they addressed cancer incidence (Table 2), stage at diagnosis (Table 3), or cancer-specific mortality (Table 4). Summary information for each of the studies is provided in the tables; because four of the 51 studies examined multiple outcomes, such as cancer incidence and mortality[13] or cancer stage at diagnosis and mortality,[8,14,15] they are included in more than one table.

Cancer Incidence/Risk

To facilitate interpretation, studies were first grouped according to neighborhood race or ethnicity, and then subsequently organized by the measure used to characterize ethnic density.

For Black ethnic density and cancer incidence, we identified three studies, which measured ethnic density in different ways and examined different outcomes. Findings were mixed. In a study by Cooper and colleagues, increasing percent of Blacks was associated with lower colorectal cancer incidence among Medicare beneficiaries.[13] In contrast, a positive association was reported between a Black-White segregation and crime index and higher risk of self-reported cancer,[16] and no association was observed between Black population density and prostate cancer incidence in Connecticut and Massachusetts.[17]

The majority of studies on cancer incidence examined Hispanic or Asian American ethnic density, and all of these used measures of ethnic composition rather than residential segregation except one.[16] In general, the studies noted a positive association between ethnic density and risk for cancers of infectious origin.[18–20] For example, liver cancer incidence was higher in high-enclave/low-SES tracts, particularly among Hispanic women and Asian men.[18] Cervical cancer incidence was also higher in high-enclave/low-SES tracts for both Hispanic and Asian women.[20] Among Hispanics, non-cardia gastric cancer incidence was higher in high-enclave/low-SES tracts, while gastric cardia tumors (which are less influenced by *H. pylori* infection) were more common in low-enclave/high-SES tracts.[21]

On the other hand, Hispanic or Asian ethnic density was associated with lower risk for colorectal and breast cancers,[19,22,23] Hodgkin's lymphoma,[24] lymphoid malignancies (among women only),[25] and self-reported cancer.[16,26] Two studies found that incidence of thyroid cancer was higher in high-enclave Hispanic/Asian neighborhoods[27] and in Census tracts with a higher percentage of observant Jewish population.[28]

Five studies examined estimated cancer risk rather than cancer incidence.[9,29–32] All studies reported at least one measure of ethnic density to be associated with higher estimated cancer risk.

In summary, ethnic density is generally associated with increased estimated lifetime risk and greater incidence of cancers of an infectious origin such as liver and cervical cancers, but

lower incidence of breast and colorectal cancers in Hispanic and Asian neighborhoods. At present, studies on Black ethnic density are too few to draw conclusions.

Cancer Stage at Diagnosis

All six studies of Black ethnic density utilized measures of residential segregation, but findings were mixed. Greater Black-White segregation was not associated with breast cancer stage in one study,[8] associated with later stage at diagnosis in two studies,[33,34] and inversely associated with breast[35] and colorectal (CRC)[36] cancer stage in two studies. Two studies reported Black-White disparities in stage at diagnosis were reduced in highly segregated areas.[35,37] Specifically, in low-segregated areas, Blacks had a greater probability of late-stage diagnosis compared to Whites; but this disparity was eliminated in highly segregated areas.[35]

Studies on Hispanic ethnic density, which made up the majority of studies on cancer stage, were somewhat more consistent. All studies that quantified Hispanic ethnic density using % Hispanic, % recent immigrant, or an immigrant concentration index found a positive association between greater ethnic density and later stage at diagnosis for breast, colorectal, and cervical cancers[38–41] and melanoma.[42] Notably, in two of the studies, the association was observed even though the study participants were not necessarily Hispanic.[38,39] For example, among women in Florida, Black and White women residing in areas with a higher proportion of Hispanics had greater odds of late-stage disease.[38]

Two studies utilized an enclave index, one of which also reported a positive association with late-stage diagnosis of breast cancer.[15] The other study, which was focused on cervical cancer stage at diagnosis, found a weak negative association of Hispanic enclave in low-SES neighborhoods.[14] Of the remaining four studies, all used the isolation index to assess residential segregation. One of the four studies reported a positive association between living in segregated Hispanic communities and late-stage diagnosis of breast cancer[34]; the other three studies found that greater segregation was associated with reduced Hispanic-White disparities,[37] or lower probability of late-stage breast[35] and colorectal cancers.[36]

There were only three studies on Asian ethnic density, and these reported mixed findings. Two studies were conducted by Mobley and colleagues using the isolation index.[34,36] For breast cancer, living in a highly segregated Asian neighborhood was associated with lower odds of late-stage breast cancer diagnosis, regardless of individual ethnicity or race; but living in a neighborhood with others of the same race/ethnicity was associated with greater odds of late-stage diagnosis.[34] This association appeared to be primarily driven by findings for the White population, however.[34] The opposite pattern was observed for CRC. Specifically, living in a highly segregated Asian neighborhood was associated with higher odds of CRC diagnosis regardless of individual ethnicity or race, but living in a community of one’s own ethnicity or race was associated with lower odds of late-stage diagnosis.[36] The third study showed no association between ethnic composition and CRC stage for Asians.[41]

Two studies examined associations among individuals of French ancestry.[43,44] In one study, living in areas with a higher proportion of individuals of French ancestry was associated with greater odds of late-stage prostate cancer, but was protective for men with French

surnames.[44] The same team found no association for CRC stage.[43] Two studies were identified in which the ethnicity of the community was not specified. One study reported that women living in areas with a higher percent of recent immigrants were more likely to be diagnosed with late-stage breast cancer.[45] The second study found that living in a more segregated community was associated with lower odds of late-stage breast cancer diagnosis, but only in states that mandated insurance coverage for inpatient stays after mastectomy.[46]

Overall, these studies show Hispanic ethnic density to be more consistently associated with later stage at diagnosis. Findings for Black ethnic density are mixed, and few studies have been conducted in other populations.

Survival or Mortality

Of eleven studies that examined Black ethnic density, five used measures of ethnic composition (primarily percent Black residents). All of these studies reported a positive association between ethnic density and higher mortality from CRC,[13] breast,[8,47,48] and cervical cancers[49] for all patients or for Whites residing in Black neighborhoods.[8] The remaining studies, which utilized varied measures of residential segregation, produced more mixed findings. Pruitt and colleagues found that higher Black segregation was associated with greater all-cause mortality among all women,[10] but other studies noted an inverse association among Black women.[8,11] Two studies reported no association with mortality.[12,50] Finally, in two lung cancer studies, higher segregation was associated with greater mortality among Blacks, but not Whites.[51,52]

Findings are less consistent across the eleven studies that examined Hispanic ethnic density. Three studies included measures of residential segregation; of these, two utilized the location quotient and found a positive association between Hispanic segregation and greater breast cancer-specific or overall mortality.[10,11] The third study used the isolation index and reported no association with breast cancer mortality.[50] The remaining studies all utilized measures of ethnic composition, but no clear pattern of findings emerged. One study reported a positive association,[53] but two reported no association with breast cancer mortality.[15,54] A study of women with cervical cancer reported no association of Hispanic ethnic density with mortality.[49] Three studies of Hispanics in California found that enclave residence moderated the association of nativity with survival among lung,[55] prostate,[56] and cervical[14] cancer cases.

Two studies examined Asian ethnic density, and both reported no association with either breast[57] or cervical[49] cancer mortality. In one study that did not specify ethnicity, residing in neighborhoods with more foreign-born residents was associated with lower breast cancer-specific mortality.[58]

Taken together, these studies show relatively consistent findings of ethnic density and higher mortality for Black communities. Findings are less consistent for Hispanic ethnic density, and few studies have examined Asian ethnic density in relation to cancer mortality.

DISCUSSION

Despite variability in the methods used to assess ethnic density, this review noted several consistent patterns of findings. First, ethnic density was generally associated with increased risk for cancers of an infectious origin (e.g., liver, cervical), but lower risk for breast and colorectal cancers, particularly among Hispanic and Asian Americans. In addition, regardless of the measure used, ethnic density was associated with increased cancer risk estimated based on air toxics. Second, with respect to stage at diagnosis, Hispanic ethnic density was associated with later stage at diagnosis, and this pattern was predominantly observed in studies that utilized measures of ethnic composition. Third, Black ethnic density was generally associated with greater mortality, but findings were mixed for Hispanic ethnic density. Overall, there have been too few studies of Asian ethnic density to draw any meaningful conclusions with respect to cancer stage or mortality.

Theoretical work on the concept of ethnic density,[59,60] in conjunction with the cultural and historical context in which neighborhoods are formed, suggest several possible pathways by which ethnic density might influence cancer outcomes in racial/ethnic minority populations. Many of these pathways have been previously discussed and explored in detail[4,59]; thus, for the purpose of this review, we focus on three domains that may vary in distinct ways across ethnic neighborhoods - cultural norms, healthcare resources, and social factors - and how they may impact cancer-related outcomes.

Cultural norms and beliefs

It is well-established that diet and other health behaviors vary across ethnic and racial groups.[61,62] Therefore, residence in an ethnic enclave (with its associated cultural norms) may help preserve various health behaviors (e.g., diet) among immigrants and US-born co-ethnic residents. Indeed, studies have shown that living in a tract with a higher proportion of immigrants was associated with lower consumption of high-fat foods among Hispanics and Chinese and better healthy food availability in those neighborhoods.[63] In ethnic enclave settings, length of US residence was only minimally associated with adoption of American culture, particularly among those individuals who immigrated as adults.[64] Thus, for cancers associated with lifestyle factors, such as breast and colon cancers,[65] ethnic enclaves may confer a protective effect through social and cultural norms that support the maintenance of traditional behaviors or via decreased dietary and reproductive acculturation.

On the other hand, cultural beliefs surrounding cancer screening and/or the value of secondary prevention may adversely impact healthcare-seeking behaviors, which could have implications for cancer stage at diagnosis and/or survival.[66,67] A lack of preventive health orientation has been consistently associated with low screening rates in some minority populations.[66,68] Similarly, traditional beliefs about fatalism commonly endorsed in many racial/ethnic minority communities have also been associated with lower adherence to screening guidelines,[69,70] which could contribute to the association noted between Hispanic ethnic density and later stage at diagnosis. Beliefs or misperceptions about “Western” medicine or conventional medical procedures may lead to delays in treatment initiation, differential choice of treatments, or poor adherence to treatment guidelines, which have been reported among racial/ethnic minorities.[71,72]

Healthcare resources

Factors limiting access to health care likely contribute to associations of ethnic density with cancer outcomes. Minorities and immigrants are more likely to be uninsured or underinsured,[73,74] and residents in communities of high ethnic density may have less access to healthcare or receive poorer quality of care.[60,75] And immigrants may face additional hurdles as limited English proficiency has been found to be negatively associated with receipt of cancer screening.[76] These factors might explain the relatively consistent findings of Hispanic ethnic density with later stage at diagnosis.

Studies have also reported neighborhood factors to be associated with lower odds of receiving standard of care.[77–79] In an analysis of Medicare data, Blacks were more likely than Whites to receive surgery at low-quality hospitals, and this disparity was greatest among Blacks residing in the most segregated areas.[80] Blacks and Hispanics were also more likely than non-Hispanic Whites to undergo lung resection in low-volume hospitals.[81] Because low hospital volume of lung resection procedures is associated with higher mortality, this could partially explain the higher mortality observed among Black lung cancer patients. Residents in census tracts with a high percentage of minorities were also less likely to receive hospice care,[82] which could have implications for cancer survival.[83] These reported disparities in care are consistent with our finding that Black ethnic density is associated with greater mortality.

Social factors

Ethnic density is commonly hypothesized to have a beneficial effect on health through psychosocial mechanisms, including greater social support and interpersonal connections and lower exposure to discrimination.[4,84] Low social support and high social isolation has been associated with cancer progression[85] and increased risk of cancer mortality, independent of neighborhood poverty.[86] However, in most of the studies reviewed here, ethnic density did not appear to have a clear beneficial effect, but instead was positively associated with mortality across the majority of studies of Black ethnic density. This finding likely reflects not only the adverse impact of various factors attendant with greater ethnic density (e.g., low SES, limited or inadequate healthcare resources), but also the unique aspects of Black segregation that may differ from Hispanic or Asian segregation. Neighborhoods with high Black ethnic density are more likely to be characterized by "hypersegregation" (i.e. high levels of segregation across multiple domains of segregation)[7] and may experience higher rates of crime, compared to segregated Hispanic neighborhoods.[87]

Other social factors, such as the stigmatising effects of minority status, could also outweigh any perceived benefits of ethnic neighborhoods. Differences in the socio-historical circumstances that led to the emergence of ethnic neighborhoods, as well as the persistence of segregation and residents' perceived mobility, are key factors that diverge across racial and ethnic groups. For example, data reveal that indices of segregation are higher among Black neighborhoods compared to Hispanic and Asian neighborhoods, and that this hypersegregation is not voluntary.[88] Although Blacks report preferences for residing in areas that are racially integrated, they experience greater resistance to integration from other

groups and face the most severe housing discrimination,[89] which presents obstacles to assimilation. Neighborhood inequality is less pronounced among other minority groups,[90,91] which may enable “segmented assimilation” (economic and educational attainment along with preservation of ethnic values) to occur.[92] Thus, the deleterious effects of social stress (e.g., racism, stigma, crime), combined with the disadvantages conferred by low SES and poor healthcare access, may explain the association between ethnic density and greater mortality that was observed primarily in studies of Black neighborhoods.

Whether and how these factors contribute to mortality outcomes in other ethnic neighborhoods is less clear. Direct associations between Hispanic ethnic density and mortality were inconsistently observed and trended toward a positive association. However, it is of interest to note that among foreign-born Hispanics, ethnic enclaves were protective and associated with a survival advantage. In light of the potential health benefit, more studies are needed to explore the extent to which ethnic enclaves (and their attendant social networks) are able to positively impact health and to identify the subgroups that may benefit most.

Methodological Considerations and Opportunities for Future Research

Population diversity—Broad conclusions about whether ethnic density is beneficial (or harmful) for health are difficult to draw because findings are not consistent across populations. Some of the disparate findings may be attributed to cultural differences in the prevalence of various lifestyle factors or cancer risk behaviors, such as smoking, which can lead to differential outcomes. For example, national data indicate that smoking rates are significantly higher among White and Black adults compared with Hispanics.[93] Racial and ethnic differences have also been observed in smoking duration and the percentage of smokers who quit. In both cases, Blacks had the lowest quit ratio[94] and a longer duration of smoking compared to Whites, whereas Hispanic smokers had a shorter duration of smoking compared to Whites.[95] Further complicating matters is the wide within-group variation noted across specific subgroups. For example, although smoking prevalence appears relatively low among Asian Americans overall compared with Whites, smoking prevalence ranges from 7.6% in Chinese Americans to 20.0% among Korean Americans.[96] Similarly, smoking prevalence varies widely across Hispanic subgroups, with the lowest prevalence among Central/South Americans (15.6%) and the highest prevalence among Puerto Ricans (28.5%).[96]

Health behaviors, such as diet and cancer screening, also differ across groups, and these factors can have direct implications for cancer risk and outcomes. Large-scale studies suggest that Asian Americans have higher fruit and vegetable consumption and lower soda consumption than non-Hispanic whites,[97,98] whereas Black respondents reported eating fruits and vegetables fewer times per day, and fast-food more times per week, compared with non-Hispanic Whites.[99] Further, Hispanics and Blacks were more likely to be overweight or obese, whereas Asian Americans were less likely to be overweight/obese, compared to non-Hispanic Whites.[99] With respect to cancer screening, national data indicate that Black and Hispanic populations are less likely to undergo mammography screening compared with Whites.[100,101] Findings are somewhat less clear for Asian Americans as some studies report

no difference in mammography utilization between Asian Americans and Whites,[100,102] and others indicate lower cancer screening rates among Asian Americans compared with Whites.[103]

The significant heterogeneity observed within ethnic/racial groups was also not consistently accounted for in the studies reviewed. Although many studies of Hispanic and Asian populations assess nativity (US-born vs. foreign-born), none of the studies of US Blacks that were included in this review did so, even though data suggest that nativity is likely associated with cancer risk factors and outcomes in this population as well.[104–106] Similarly, it is well-documented that US Hispanics and Asians represent multiple diverse ethnic groups, with variations in cancer risk[107] and screening behaviors.[103] For example, Pap test receipt varies significantly across Hispanic subgroups, with the lowest rates of cervical cancer screening in Mexican and Cuban American women.[101] Likewise, Chinese and Korean American women consistently have among the lowest screening rates compared to other Asian subgroups.[102,103,108] Yet, few studies have differentiated among subgroups within each broad racial/ethnic grouping. As we move forward in this field, future studies may need to consider characterizing groups by nativity and country of origin to enable a more fine-grained analysis of specific and unique subgroups.

Variability in resources associated with ethnic density—Neighborhoods may vary in the levels and types of resources that are available to residents, as a result of historical circumstances that led to the emergence of those neighborhoods. Considering neighborhood SES in combination with ethnic density has been one strategy to distinguish socioeconomic from ethnic density-related resources. In various studies, for example, incidence of colorectal cancer in Asians,[23] breast cancer in Hispanics,[22] and classical Hodgkin's lymphoma in both Asians and Hispanics[24] was lower in high-enclave neighborhoods, suggesting that ethnic neighborhoods might confer some protection despite fewer socioeconomic resources. Taking this one step further, researchers have suggested a typology for Asian American ethnic neighborhoods that incorporates neighborhood SES (e.g., communities of constraint; resurgent communities).[109,110] These distinctions may be helpful for characterizing whether residents chose to live in a neighborhood (suggesting a potential benefit to be gained from the resources available), or whether they had no choice (suggesting possible detriment due to being isolated from wider resources). In future studies, the application of such a typology may help explain the varied associations often observed within one population.

In summary, operationalizing ethnic neighborhoods in terms of ethnic composition or residential segregation is useful for studying ethnic density as a global concept, and to compare findings across study populations and contexts. But it may not accurately reflect enclave residence with its presumed resources and institutions, such as churches, food markets, health care providers, and social service agencies, nor does it distinguish among types of enclaves, although indirect evidence suggests that differences do exist in the resources that various neighborhoods offer. Moreover, given that ethnic neighborhoods are somewhat fluid and not static over time, the ability to accurately capture neighborhood changes (as populations move in and out of various areas) and gains or losses in terms of community resources, will be important considerations in the development of future

measures. Differences in what we mean by ‘ethnic density,’ how we measure it, and what resources are actually being captured (or not) could explain why findings for an ‘ethnic density effect’ have been inconsistent, even among similar populations. Thus, future research in this field may benefit from the use of detailed typologies or other comparable measure of ethnic density that can distinguish among varying levels and types of available resources.

Spatial polygamy and heterolocalism—Previous studies may also over- or understate the effects of ethnic density because people are not limited to the resources in their neighborhood of residence. People often traverse multiple neighborhoods beyond their own residence to use non-local resources.[111] Recent studies also confirm a pattern of heterolocalism, in which individuals maintain cultural ties and access to ethnic institutions despite residence in non-enclave neighborhoods.[112–114] As a result, enclaves might provide benefits that extend beyond its residents to the larger, non-resident community. Likewise, residents of segregated neighborhoods might take advantage of resources outside of their communities. Thus, in addition to a theoretically-based operationalization of ethnic density, assessments may also need to include measures of exposure that can better identify the use of specific resources within that neighborhood, such as social networks, health care, and food shopping, rather than just considering residential exposure.

Contextual vs. compositional effects—Besides the challenge of measuring ethnic density, or exposure to it, is the challenge of distinguishing contextual from compositional effects. To illustrate, it is often difficult to ascertain whether the lower incidence of colorectal cancer observed in ethnic enclaves is due to cultural norms guiding individual lifestyle behaviors (a contextual effect), or because those who are drawn to live in enclaves simply have healthier lifestyles (a compositional effect). In this sense, ethnic density is a purely collective construct, based on the aggregation of individuals. A strategy to address this has been to estimate the neighborhood effect, and then control for characteristics of individuals.[115,116] However, due to financial and geographic constraints, a primary barrier to identifying the relative importance of contextual versus compositional effects has been due to the limited existence of individual-level data collected across different ethnic neighborhood types, and from a sufficient number of individuals within each neighborhood type.

The utilization of existing, large-scale databases such as state cancer registries, the SEER registry, and Census information has been informative for illuminating issues related to ethnic density and cancer-related outcomes. But a critical next step will be to expand the collection of data elements to the local and individual level, including relevant biologic markers of cancer risk or outcomes. These data are necessary to evaluate the validity of the assumptions made across different settings using higher-level data and to more fully understand the distinct contextual and compositional effects associated with different neighborhood types. Emerging initiatives, such as the NIH Precision Medicine Initiative Cohort,[117] may offer unique opportunities to obtain the necessary micro- and macro-level data to address such questions.

Conclusions—There is substantial interest in identifying the positive -and detrimental—attributes of ethnic density. Despite the diversity of measures used to assess ethnic density, the studies reviewed suggest that Hispanic and Asian ethnic density are associated with lower risk for breast and colorectal cancers, but increased risk for cancers of an infectious origin. Hispanic ethnic density was generally associated with later stage at diagnosis, whereas Black ethnic density was associated with greater mortality. At present, there are too few studies of Asian ethnic density and cancer stage or mortality to draw any meaningful conclusions. Nonetheless, these findings help highlight a number of methodological and conceptual challenges that remain to be addressed, including issues surrounding the measurement of ethnic neighborhoods and their specific resources and benefits, the interpretation of differential effects across populations, and the need to augment existing assessments. Ultimately, this research will have significant impact for identifying not only the most vulnerable neighborhoods and groups to target for outreach, but also key neighborhood-level resources that are most promising for producing positive health outcomes. Clarifying the role of ethnic density will help promote a greater understanding of what ethnic neighborhoods may offer in terms of health risks vs. health resources, how they affect racial/ethnic disparities in cancer, and the pathways by which they exert their influence.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Indices of Ethnic Density and Segregation

Ethnic density measure	Common areas of measurement	Description	Studies
MEASURES OF ETHNIC COMPOSITION			
% Black or Hispanic/Latino or Mexican American; % Franco ancestry	Census block group, tract County	Often divided into quartiles or other categories	8, 9, 13, 19, 26, 29, 30, 32, 38, 40, 42–44, 47–49, 53
% recent immigrants or % foreign-born	Census block-group, tract	'Recency' not always defined, but sometimes defined as within last 5 years	41, 42, 45, 58
Language	Census tract	Often conceptualized using any or a combination of the following items: - % speaking Spanish/Asian language - % linguistically isolated (% households lacking at least one member who speaks English 'well' or 'very well' - % limited English proficiency (Definitions varied: Generally included individuals who reported speaking English 'Not at all' or 'Not well' but could also include individuals who reported speaking English 'well,' excluding only those speaking English 'very well') - % children speaking Yiddish at home (<5%, 5–20%, >20%)	28,41, 42
Immigrant concentration	Census tract	Often conceptualized using a combination of the following items: - % Hispanic - % foreign-born - % limited English proficiency - % linguistically isolated - Isolation Index (see measures of residential segregation below)	16, 39
Enclave index	Census tract	Neighborhood Hispanic or Asian enclave index based on: - % linguistically isolated - % linguistically isolated who speak Spanish/Asian language - % speaking limited English - % speaking limited English who spoke Spanish/Asian language - % of recent immigrants - % Hispanic/Asian - % foreign-born Derived using principal components analysis across block groups, with block group values averaged across census tracts. In some studies, quintiles dichotomized to	14, 15, 18, 20–25, 27, 54–57

Ethnic density measure	Common areas of measurement	Description	Studies
		lower (quintiles 1–3) or higher (quintiles 4 and 5) enclave status	
MEASURES OF RESIDENTIAL SEGREGATION			
EVENNESS: Spatial distribution of the subject population			
Dissimilarity Index	Census tract	The degree to which each neighborhood has the same distribution of the subject population compared to the majority population as the larger region (e.g., metropolitan area or county) overall; the proportion of persons of the subject population in a neighborhood that would have to move for the neighborhood to have the same racial distribution as the surrounding, larger region.	8, 9, 16, 42, 51
Multigroup Dissimilarity Index	Census tract	A version of the dissimilarity index generalized to capture concurrent segregation between multiple racial/ethnic groups.	31
Theil index	Metropolitan area	Represents proportion of subject population that would need to move to a different neighborhood to achieve an even distribution within the region.	48
EXPOSURE: Degree of potential contact, or possibility of interaction, between minority and majority group members			
Isolation Index	Census tract Other area (county, state)	The extent to which members of the subject population are exposed to other members of their own group (as opposed to members of the majority population) in their neighborhood. May be calculated using either a place-centered or person-centered approach.	8, 9, 16, 33–37, 46, 50, 52
CONCENTRATION: Relative amount of physical space occupied by a minority group in the region			
Delta	Census tract	The relative (to population size) amount of physical space occupied by the subject population in a given neighborhood; situations in which the subject population is of the same relative size as the majority population but occupies less space would indicate greater concentration (and hence greater residential segregation)	8, 9
CENTRALIZATION: Degree to which a group is spatially located near the center of an urban area			
Relative centralization		The extent (relative to the majority population) to which members of the subject population are located near the center of the metropolitan area; a dimension of residential segregation in the US because of historical circumstances that ‘confine[d] minorities to declining central city areas’	8, 9
CLUSTERING: Extent to which areal units inhabited by minority members adjoin one another, or cluster, in space			
Spatial Proximity	Census tract	The extent to which neighborhoods of the subject population are adjacent to each other in physical space, relative to the majority population; a high degree of clustering is generally interpreted as representing a ghetto or ethnic enclave.	8, 9
LOCAL SEGREGATION INDICES			
Location quotient (LQ)	Census tract	The ratio of the proportion of the subject population in the neighborhood divided by the proportion of the subject population group in the larger surrounding region; represents the concentration or density of a population group in an area relative to the larger region	10–12
Local Exposure/Isolation (Lex/Is)	ZIP Code Tabulation Areas (ZCTAs)	The probability that two individuals (of either the same or different race/ethnicity) living within a specific areal subunit will interact. A zero value indicates that the estimated probability of interaction in the subunit is equivalent to the	11

Ethnic density measure	Common areas of measurement	Description	Studies
		probability in the larger metropolitan statistical area (MSA). Values > 0 indicate that interaction is more likely to occur in the subunit than in the MSA, whereas values < 0 indicate that interaction is less likely.	
Index of concentration at extremes (ICE)	ZIP Code Tabulation Areas (ZCTAs) County	This index characterizes the extent to which an area's population is concentrated in extreme deprivation or extreme privilege. The index ranges from −1 to 1. A value of −1 indicates that 100% of the population is concentrated in the most deprived group, whereas a value of 1 indicates that 100% of the population is concentrated in the most privileged group.	11

Table 2

Studies of Ethnic Density/Segregation and Cancer Incidence or Estimated Risk

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
Black Neighborhood						
Cooper (1997)[13]	% Black	329 US counties (1989–1991)	148,947 Medicare beneficiaries ages 65+ years	Colorectal cancer incidence	—	As % Blacks in the county increased, incidence rates for both white and black patients decreased
Freedman (2011)[16]	Crime-segregation scale (based on crime, Black Isolation index, and Black-White Dissimilarity Index)	2002 Health and Retirement Study	6580 men and 8794 women aged 55+ years	Self-reported cancer (unspecified)	+	Living in highly segregated, higher-crime areas was associated with greater odds of developing cancer
DeChello (2006)[17]	Race-specific population density	CT Tumor and MA Cancer Registries (1994, 1998)	29,040 Whites and 1,647 Blacks	Prostate cancer incidence	No association	Patterns of prostate cancer incidence differed across Blacks and Whites, and argue against shared environmental exposures
Hispanic Neighborhood						
Chang (2010)[18]	Enclave index	CA Cancer Registry (1988–2004)	5,400 Hispanics and 5,809 Asians	Liver cancer incidence	+	In both populations, incidence rates were higher in high enclave/low-SES neighborhoods.
Chang (2012)[21]	Enclave index	CA Cancer Registry (1988–2004)	9,001 Hispanics	Gastric cancer incidence	+	Incidence rates were higher in high enclave/low-SES neighborhoods, except for gastric cardia tumors
Froment (2014)[20]	Enclave index	CA Cancer Registry (1990–2004)	11,125 NHW, 8,670 Hispanic, and 2,394 Asian women	Cervical cancer incidence	+	For Hispanic and Asian women, living in high enclave/low-SES neighborhoods

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
						was associated with higher incidence
Horn-Ross (2014)[27]	Enclave index	CA Cancer Registry (1988–2009)	10,940 men and 35,147 women	Thyroid cancer incidence	+	Incidence rates increased over time in all groups. Among Hispanic and Asians, incidence rates were generally higher in more dense enclaves.
Glaser (2015)[24]	Enclave index	CA Cancer Registry (1988–1992, 1998–2002)	1,463 Hispanics and 348 APIs	Hodgkin lymphoma incidence	—	In both populations, incidence rates were higher in less ethnic compared to more ethnic enclaves. Enclave effect was more pronounced among APIs than Hispanics.
Keegan (2010)[22]	Enclave index	CA Cancer Registry (1988–2004)	35,134 Hispanic women	Breast cancer incidence	—	Higher Hispanic enclave quintile was associated with lower incidence rates
Eschbach (2005)[19]	% Hispanic	SEER Registry from 9 areas (CT, IO, NM, UT, HI, Detroit, Atlanta, SFO, Seattle-Puget Sound) (1988–1992)	8970 Hispanics	Breast, colorectal, lung, prostate, or cervical cancer incidence	—	Living in areas with higher % Hispanic was associated with lower incidence of male and female lung, female breast, and male colorectal cancers
Eschbach (2004)[26]	% Mexican American	Hispanic Established Population for the Epidemiological Study of the Elderly (H-EPESE)	3050 Mexican Americans aged 65+ years	Self-reported cancer (unspecified)	—	Living in areas with higher % Mexican Americans was associated with lower odds of having cancer
Freedman (2011)[16]	Hispanic immigrant concentration scale	2002 Health and Retirement Study	6580 men and 8794 women aged 55+ years	Self-reported cancer (unspecified)	No association	
Asian Neighborhood						

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
Chang (2010)[18]	Enclave index	CA Cancer Registry (1988–2004)	5,400 Hispanics and 5,809 Asians	Liver cancer incidence	+	In both populations, incidence rates were higher in high enclave/low-SES neighborhoods.
Froment (2014)[20]	Enclave index	CA Cancer Registry (1990–2004)	11,125 NHW, 8,670 Hispanic, and 2,394 Asian women	Cervical cancer incidence	+	For Hispanic and Asian women, living in high enclave/low-SES neighborhoods was associated with higher incidence
Horn-Ross (2014)[27]	Enclave index	CA Cancer Registry (1988–2009)	10,940 men and 35,147 women	Thyroid cancer incidence	+	Incidence rates increased over time in all groups. Among Hispanic and Asians, incidence rates were generally higher in more dense enclaves.
Ladabaum (2014)[23]	Enclave index	CA Cancer Registry (1990–2004)	16,159 APIs and 153,804 NHWs	Colorectal cancer incidence	—	Among APIs, higher ethnic enclave was associated with lower incidence rates
Glaser (2015)[24]	Enclave index	CA Cancer Registry (1988–1992, 1998–2002)	1,463 Hispanics and 348 APIs	Hodgkin lymphoma incidence	—	In both populations, incidence rates were higher in less ethnic compared to more ethnic enclaves. Enclave effect was more pronounced among APIs than Hispanics.
Clarke (2011)[25]	Enclave index	CA Cancer Registry (1988–2004)	8,638 Asians and 110,789 NHWs	Lymphoid malignancies incidence	— (women)	Among APIs, no association between ethnic enclave status and incidence rates in men; but among women, higher enclave status was associated with lower incidence
Other Neighborhood						

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
Soloway (2011)[28]	% of children speaking Yiddish and presence of synagogue	NY Cancer Registry (1998–2007)	15,367 NHWs	Thyroid cancer incidence	+	Living in high Yiddish-speaking areas was associated with increased risk. Living in census tracts with synagogues, but without a high proportion of Yiddish-speaking children, was also associated with increased risk.
Estimated Risk						
Morello-Frosch (2006)[31]	Multi-group dissimilarity index	1996 NATA linked with Census data for 309 US metropolitan areas		Cancer risk estimated based on air toxics	+	Increasing segregation was associated with increased estimated cancer risk associated with ambient air toxics for all groups, but strongest for Hispanics
Rice (2014)[9]	Isolation index Dissimilarity index Relative cluster Delta % Black	2005 NATA for Charleston, SC		Cancer risk estimated based on air toxics	+ (isolation index)	Isolation index was associated with greater lifetime cancer risk.
Apelberg (2005)[29]	% Black % Hispanic % White	1996 NATA linked with Census data for MD		Cancer risk estimated based on air toxics	+ (Black) — (Hispanic)	Risk of being a high cancer risk tract increased as % Black increased; Risk of being a high cancer risk tract increased as % Hispanic decreased
Linder (2008)[30]	% Black % Hispanic	1999 NATA linked with Census data for Houston, TX		Cancer risk estimated based on air toxics	No association (Black) + (Hispanic)	No clear association observed for % Black; Risk of being a high-risk tract increased as % Hispanic increased

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
Wilson (2015)[32]	% Hispanic % Non-White	2005 NATA linked with Census data for SC		Cancer risk estimated based on air toxics	+	Risk of being a high-risk tract increased as % Hispanic and % non-white increased

Note:

[a]In this column, we use "+" to indicate findings in which greater ethnic density was associated with higher cancer incidence, whereas "—" is used to denote findings in which greater ethnic density was associated with lower incidence.

Table 3

Articles on Ethnic Density/Segregation and Stage at Diagnosis

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
Black neighborhood						
Warner (2010)[8]	Dissimilarity; Delta; Isolation; Relative centralization; Spatial proximity; % Black	CA Cancer Registry (1996–2004)	8,482 Black and 95,672 White women with breast cancer	Breast stage	No or weak association	Overall, no association between segregation and odds of late-stage diagnosis, but selected comparisons showed a positive association
Dai (2010)[33]	Isolation index	MI Cancer Surveillance Program (1998- 2002)	12,413 women	Breast stage	+	Residing in areas with higher Black segregation was associated with greater likelihood of late-stage breast cancer
Mobley (2017)[34]	Isolation index	2004–2009 US Cancer Statistics database (40 states)	973,143 women with breast cancer	Breast stage	+	Living in segregated communities of one's own race/ ethnicity was associated with greater odds of late-stage diagnosis.
Kuo (2011)[35]	Isolation index	CA SEER Registry (2000–2005)	33,838 women with breast cancer aged 67+ years	Breast stage	—	Among Black and Hispanic women, high isolation was associated with lower probability of late-stage diagnosis. High isolation also reduced disparities in probability of late-stage diagnosis (relative to White women).

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
Haas (2008)[37]	Isolation index	SEER Medicare (1992–2002)	410,870 cases aged 65+ years	Breast, colorectal, lung, or prostate stage	Reduced Black-White disparities	Black/white disparity in early-stage CRC diagnosis was largest in low-SES/low-segregated areas and smallest in high segregation areas.
Mobley (2017)[36]	Isolation index	US Cancer Statistics Registry database (40 states) (2004–2009)	553,629 cases	Colorectal stage	—	Regardless of own race, living in a highly segregated Black community was associated with lower odds of late-stage CRC diagnosis
Hispanic Neighborhood						
Reyes-Ortiz (2008)[40]	% Hispanic	SEER registry from 13 areas (CT, IA, NM, UT, HI, AK, Detroit, Atlanta, San Francisco-Oakland, Seattle-Puget Sound, San Jose-Monterey, Los Angeles, and rural GA) (1988 to 2002)	20,818 Hispanic cases	Breast, colorectal, or cervical stage	+	Hispanics living in neighborhoods with higher density of Hispanic populations were more likely to be diagnosed with late-stage breast, cervical, or colorectal cancer.
Amey (1997)[38]	% Hispanic	FL Cancer Data System (FCDS) (1981–1989)	79,946 Black and White women with breast cancer	Breast stage	+	% Hispanic was associated with later stage at diagnosis; in analyses stratified by race, the association was significant only for white women
Mojica (2015)[41]	% Recent immigrants	CA Cancer Registry (2005–2007)	36,030 cases	Colorectal stage	+ (% recent immigrant)	Across all groups, but most notably among Hispanics, living in neighborhoods with a greater percentage of

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
						recent immigrants was associated with greater odds of late-stage CRC diagnosis.
	% Limited English proficiency				- (% limited English, among Hispanics only)	Among Hispanics only, living in neighborhoods with the highest % of residents with limited English proficiency was associated with lower odds of late-stage CRC diagnosis.
Harvey (2017)[42]	% Hispanic % immigrant % limited English Dissimilarity index	CA, TX, and FL cancer registries (1996–2012)	12,493 Hispanic men	Melanoma stage	+ (% Hispanic in CA, FL) + (% immigrant in CA, TX) No association (dissimilarity index)	Living in areas with a higher % Hispanic residents was associated with greater odds of late-stage diagnosis in CA and FL. Living in areas with a higher % immigrants was associated with greater odds of late-stage diagnosis in CA and TX. Across all states, segregation (dissimilarity index) was not associated with odds of late-stage diagnosis.
Cho (2011)[39]	Concentrated immigration index	IL Cancer Registry (1994–2003)	42,714 women with breast cancer in Cook County, IL	Breast stage	+	Greater immigrant concentration was associated with greater odds of late stage diagnosis
Keegan (2010)[15]	Enclave index	CA Cancer Registry (1988 – 2005)	37,695 Hispanic women with breast cancer	Breast stage	+	Residing in low-SES/high-enclave neighborhoods was associated with greater odds of late-stage

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
						diagnosis (compared with high-SES/low-enclave neighborhoods)
Gomez (2015)[14]	Enclave index	CA Cancer Registry (1994–2009)	7958 Hispanic women with cervical cancer	Cervical stage	Weak negative association in low-SES neighborhoods	Women in low-SES neighborhoods had increased odds of late-stage diagnosis, but adverse effects of low SES were attenuated in high-enclave settings
Mobley (2017)[34]	Isolation index	2004–2009 US Cancer Statistics database (40 states)	973,143 women with breast cancer	Breast stage	+	Living in segregated communities of one's own race/ethnicity was associated with greater odds of late-stage diagnosis.
Haas (2008)[37]	Isolation index	SEER Medicare (1992–2002)	410,870 cases aged 65+ years	Breast, colorectal, lung, or prostate stage	Reduced Hispanic-White disparities	Hispanic-white disparity in early-stage breast cancer largest in low-SES/low-segregated areas and smallest in low-SES/high-segregated areas.
Kuo (2011)[35]	Isolation index	CA SEER Registry (2000–2005)	33,838 women with breast cancer aged 67+ years	Breast stage	—	Among Black and Hispanic women, high isolation was associated with lower probability of late-stage diagnosis. High isolation also reduced disparities in probability of late-stage diagnosis (relative to White women).

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
Mobley (2017)[36]	Isolation index	US Cancer Statistics Registry database (40 states) (2004–2009)	553,629 cases	Colorectal stage	—	Living in segregated communities of one's own race/ethnicity was associated with lower odds of late-stage CRC diagnosis
Asian neighborhood						
Mobley (2017)[34]	Isolation index	2004–2009 US Cancer Statistics database (40 states)	973,143 women with breast cancer	Breast stage	— (Asian segreg.) + (Own race)	Regardless of own race, living in a highly segregated Asian community was associated with lower odds of late-stage diagnosis. However, living in segregated communities of one's own race/ethnicity was associated with greater odds of late-stage diagnosis.
Mobley (2017)[36]	Isolation index	US Cancer Statistics Registry database (40 states) (2004–2009)	553,629 cases	Colorectal stage	+ (Asian segreg.)— (Own race)	Regardless of own race, whereas living in a highly segregated Asian community was associated with greater odds of late-stage diagnosis. However, living in segregated communities of one's own race/ethnicity was associated with lower odds of late-stage CRC diagnosis

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association[a]	Main Findings
Mojica (2015)[41]	% Recent immigrants % Limited English proficiency	CA Cancer Registry (2005–2007)	36,030 cases	Colorectal stage	No association	
Other Neighborhood						
Parsons (2007)[44]	% Franco ancestry	ME Cancer Registry (1995–1998)	3,287 cases	Prostate stage	+ — (for men with French surname)	Living in towns with higher % Franco ancestry was associated with greater odds of late-stage diagnosis, but protective for French-surnamed men.
Parsons (2007)[43]	% Franco ancestry	ME Cancer Registry (1995–1998)	3,286 cases	Colorectal stage	No association	
Unspecified neighborhood						
Davidson (2005)[45]	% Recent immigrant (≤5 yrs)	CA Cancer Registry (1994–1999)	112,471 women with breast cancer	Breast stage	+	Women residing in areas with higher % recent immigrants were more likely to receive a late-stage diagnosis
Mobley (2012)[46]	Isolation index	SEER Registry in 11 states (CA, CT, IA, KY, LA, NJ, NM, UT, GA, MI, WA) (2000-2005)	116,121 women with breast cancer	Breast stage	— (only in states with inpatient stay laws)	Living in a more segregated community was associated with lower odds of late-stage breast cancer diagnosis, but only in states with mandated inpatient hospitalization after mastectomy

Note:

[a] In this column, we use "+" to indicate findings in which greater ethnic density was associated with greater odds of receiving a late-stage cancer diagnosis, whereas "—" is used to denote findings in which greater ethnic density was associated with lower odds of receiving a late-stage diagnosis.

Table 4

Articles on Ethnic Density/Segregation and Cancer Mortality

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association	Main Findings
Black neighborhood						
Cooper (1997)[13]	% Black	329 US counties (1989–1991)	148,947 Medicare beneficiaries with colorectal cancer aged 65+ years	2-year mortality among CRC cases	+	As % Blacks in the county increased, 2-year mortality rates for both White and Black patients increased
Russell (2011)[47]	% Black	GA Cancer Registry (1999–2003)	15,256 Black and White women with breast cancer	Breast cancer- specific mortality	+	Increasing % Black residents was associated with higher breast cancer-specific mortality for all women
Russell (2012)[48]	% Black; Theil Index	GA Cancer Registry (1999–2003)	20,088 Black and White women with breast cancer	Breast cancer- specific and all-cause mortality	+	Increasing % Black residents was associated with higher all-cause mortality for White (but not Black) women. Increasing segregation was associated with higher breast cancer-specific mortality for Black (but not White) women.
Warner (2010)[8]	% Black; Dissimilarity; Delta; Isolation; Relative centralization; Spatial proximity	CA Cancer Registry (1996–2004)	8,482 non-Hispanic Black and 95,672 NHW women with breast cancer	Breast cancer- specific and all-cause mortality	+ (Whites) — (Blacks)	Among Whites, living in neighborhoods with greater % Blacks was associated with higher all-cause mortality. Among Blacks, living in neighborhoods with ≥20% Blacks was associated with lower breast cancer-specific and all-cause mortality. Protective effect was observed across most segregation measures.
Lim (2011)[49]	% Black % Hispanic % Asian	Los Angeles County Cancer Registry (1997- 2003)	1811 women with cervical cancer	Cervical cancer-specific mortality	+	Living in neighborhoods with a high proportion of Black households was associated with increased risk of death

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association	Main Findings
Pruitt (2015)[10]	Location quotient	TX Cancer Registry (1995–2009)	109,749 Black, Hispanic, and White women with breast cancer aged 50+ yrs	Breast cancer-specific and all-cause mortality	+	Among all women, higher Black segregation was associated with greater all-cause mortality. In analyses stratified by patient race/ethnicity, greater segregation was not associated with greater mortality among Blacks.
Bemanian (2017)[11]	Location quotient Local exposure & isolation (Lex/Is) Index of concentration at extremes (ICE)	WI Cancer Reporting System (2002–2011)	7,164 White, 940 Black, and 252 Hispanic women with breast cancer	Breast cancer-specific and all-cause mortality	—	In race-stratified analyses, Black patients residing in areas of high Black isolation had lower breast cancer-specific and all-cause mortality.
Zhou (2017)[12]	Location quotient	WI Cancer Reporting System (2002–2011)	4,699 Whites and 682 Blacks with colorectal cancer	Colorectal cancer-specific and all-cause survival	No association	
Haas (2008)[50]	Isolation index	SEER-Medicare (1992–2002)	47,866 White, Black, and Hispanic women with breast cancer aged 66–85 yrs	Breast cancer-specific and all-cause mortality	No association	
Johnson (2016)[52]	Isolation index	GA Comprehensive Cancer Registry (2000–2009)	8,322 White and Black early-stage non-small cell lung cancer cases	Lung cancer mortality	+ (Blacks) NA (Whites)	High segregation and high economic deprivation were associated with greater mortality among Blacks, but not among Whites
Hayanga (2013)[51]	Dissimilarity index	SEER registry (2003–2007)	Black and White populations per US county	Race-specific lung cancer mortality rates by county	+ (Blacks) — (Whites)	Dissimilarity index was associated with greater lung cancer mortality for Blacks, but lower mortality for Whites
Hispanic neighborhood						
Pruitt (2015)[10]	Location quotient	TX Cancer Registry (1995–2009)	109,749 Black, Hispanic, and White women with breast cancer aged 50+ yrs	Breast cancer-specific and all-cause mortality	+	Among all women, higher Hispanic segregation was associated with greater breast cancer-specific and greater all-cause mortality.

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association	Main Findings
						In analyses stratified by patient race/ethnicity, greater segregation was not associated with greater mortality among Hispanics.
Bemanian (2017)[11]	Location quotient Local exposure & isolation (Lex/Is) Index of concentration at extremes (ICE)	WI Cancer Reporting System (2002–2011)	7,164 White, 940 Black, and 252 Hispanic women with breast cancer	Breast cancer-specific and all-cause mortality	+	Local Hispanic isolation was associated with greater overall mortality for all women.
Haas (2008)[50]	Isolation index	SEER-Medicare (1992–2002)	47,866 White, Black, and Hispanic women with breast cancer aged 66–85 yrs	Breast cancer-specific and all-cause mortality	No association	
Pruitt (2016)[53]	% Hispanic	TX Cancer Registry (1995–2009)	166,254 NHW and Hispanic women with breast cancer	Breast cancer- specific and all-cause mortality	+	Residing in higher Hispanic density neighborhoods was generally associated with higher all-cause and breast cancer-specific mortality, although associations differed slightly by ethnicity and birthplace.
Lim (2011)[49]	% Black % Hispanic % Asian	Los Angeles County Cancer Registry (1997- 2003)	1811 women with cervical cancer	Cervical cancer-specific mortality	No association	
Keegan (2010)[15]	Enclave index	CA Cancer Registry (1988 – 2005)	37,695 Hispanic women with breast cancer	Breast cancer-specific and all-cause mortality	No association	
Banegas (2014)[54]	Enclave index	CA Cancer Registry (2005–2010)	16,380 Hispanic women with breast cancer	Breast cancer-specific and all-cause mortality	No association	
Patel (2013)[55]	Enclave index	CA Cancer Registry (1998–2007)	14,280 NHWs and Hispanics with lung cancer	Lung cancer-specific and all-cause mortality	Birthplace × enclave interaction	The association between birthplace and survival differed by enclave residence, with a protective effect of foreign-birth observed only among cases

Reference	Ethnic Density Measure(s)	Dataset	Sample	Outcome(s)	Association	Main Findings
						living in high enclave/low SES neighborhoods
Schupp (2014)[56]	Enclave index	CA Cancer Registry (1996–2004)	35,427 Hispanic men with prostate cancer	Prostate cancer-specific survival	Birthplace × enclave interaction	Foreign-born Hispanics had significantly better survival, but ethnic enclave modified this effect, with the survival advantage being more pronounced in the high enclave compared with low enclave neighborhoods.
Gomez (2015)[14]	Enclave index	CA Cancer Registry (1994–2009)	7958 Hispanic women with cervical cancer	Cervical cancer-specific mortality	Birthplace × enclave interaction	The association between birthplace and survival differed by enclave residence, with a protective effect of foreign-birth observed only among cases living in high enclave settings.
Asian neighborhood						
Gomez (2010)[57]	Enclave index	CA Cancer Registry (1988 – 2005)	20,747 Asian women with breast cancer	Breast cancer-specific and all-cause mortality	No association	
Lim (2011)[49]	% Black % Hispanic % Asian	Los Angeles County Cancer Registry (1997- 2003)	1811 women with cervical cancer	Cervical cancer-specific mortality	No association	
Unspecified neighborhood						
Keegan (2014)[58]	% Immigrant	Neighborhoods and Breast Cancer Study (NABC), northern CA	4,345 women with breast cancer	Breast cancer- specific and all-cause mortality	—	Residing in neighborhoods with more foreign-born residents was associated with lower breast cancer-specific mortality.

Note:

[a] In this column, we use "+" to indicate findings in which greater ethnic density was associated with higher mortality, whereas "—" is used to denote findings in which greater ethnic density was associated with lower mortality.