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Influence of Neighborhood-level Factors on Social Support in Early-stage Breast Cancer Patients and Controls

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Abstract

Rationale—Low social support has been linked to negative health outcomes in breast cancer patients.

Objective—We examined associations between perceived social support, neighborhood socioeconomic deprivation, and neighborhood-level social support in early-stage breast cancer patients and controls.

Methods—This two-year longitudinal study in the United States included information collected from telephone interviews and clinical records of 541 early-stage patients and 542 controls recruited from 2003 to 2007. Social support was assessed using the Medical Outcomes Study Social Support Survey (MOS-SS). Residential addresses were geocoded and used to develop measures including neighborhood social support (based on MOS-SS scores from nearby controls) and neighborhood socioeconomic deprivation (a composite index of census tract characteristics). Latent trajectory models were used to determine effects of neighborhood conditions on the stable (intercept) and changing (slope) aspects of social support.

Results—In a model with only neighborhood variables, greater socioeconomic deprivation was associated with patients' lower stable social support (standardized estimate = -0.12 , $p = .027$); neighborhood-level social support was associated with social support change (standardized estimate = 0.17 , $p = .046$). After adding individual-level covariates, there were no direct neighborhood effects on social support. In patients, neighborhood socioeconomic deprivation was associated with support indirectly through marriage, insurance status, negative affect, and general

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health. In controls, neighborhood socioeconomic deprivation was associated with support indirectly through marriage ($p < .05$).

Conclusion—Indirect effects of neighborhood socioeconomic deprivation on social support differed in patients and controls. Psychosocial and neighborhood interventions may help patients with low social support, particularly patients without partnered relationships in deprived areas.

Keywords

Breast cancer; perceived social support; neighborhood socioeconomic deprivation; health disparities; longitudinal cohort study

Introduction

Social support has been recognized as an important determinant of morbidity and mortality in both the general population (Galea, Tracy, Hoggatt, Dimaggio, & Karpati, 2011) and in cancer patients (Pinquart & Duberstein, 2010). Although social support's effects on health have been hypothesized to be mediated by mental health pathways, researchers have found evidence of direct physiological effects of social support through the endocrine, cardiovascular, and immune systems (Uchino, Bowen, Carlisle, & Birmingham, 2012; Umberson & Montez, 2010).

Social support plays a key role in quality of life and other outcomes following breast cancer diagnosis and treatment (Courtens, Stevens, Crebolder, & Philipsen, 1996; Epplen et al., 2011). Low social support at the time of breast cancer diagnosis and initial treatment has been linked to the development of anxiety and depression following diagnosis (Hill et al., 2011; Patten, Williams, Lavorato, & Bulloch, 2010; Schroevers, Ranchor, & Sanderman, 2003). Higher levels of social support have been associated with better subsequent physical health (Ganz et al., 2003), lower levels of distress (Andreu et al., 2011), decreased risk of recurrence (Epplen et al., 2011), and longer survival (Epplen et al., 2011; Kroenke et al., 2013; Pinquart & Duberstein, 2010; Soler-Vila, Kasl, & Jones, 2003). Although social support at the time of diagnosis may be protective, the literature suggests that support tends to decrease over time (Bloom & Kessler, 1994; Courtens et al., 1996; Den Ouden, Van Heck, Van der Steeg, Roukema, & De Vries, 2010) and that women with a greater decrease have worse psychosocial outcomes (Thompson, Rodebaugh, Pérez, Schoutman, & Jeffe, 2013).

Although social support is often measured at the individual level, social support by definition involves interaction between people, often living in close proximity to one another. Healthy People 2020, the blueprint of health goals for the United States, asserts, "Understanding the relationship between how population groups experience 'place' and the impact of 'place' on health is fundamental to the social determinants of health—including both social and physical determinants" (U.S. Department of Health and Human Services, 2014).

Residential neighborhoods have both direct and indirect effects on health (Adler & Rehkopf, 2008; Macintyre & Ellaway, 2003; Robert, 1999b) and may provide both *social support* and

social capital, (Bernard et al., 2007). Social support is a term used to encompass functions provided by others in order to assist someone (e.g. emotional support) (Thoits, 2011), whereas the term social capital refers to social networks and the generalized norms of trust and reciprocity held by the people within such networks (Putnam, 2001). Although social support is conceptually related to social capital, social capital has both individual and collective properties, including the dimension of the collective efficacy of a group (Putnam, 2001). Social capital may affect the social support available to individuals, with places with lower levels of social capital offering fewer opportunities for individuals to develop supportive relationships (Taylor, Repetti, & Seeman, 1997). Informal resources such as social support that need to be accessed frequently may be especially affected by physical proximity, and one of the posited pathways through which a neighborhood's built environment may affect health is through providing places and opportunities for social interaction (Bernard et al., 2007). Neighborhood effects on factors such as social support may vary by population group or health outcomes (Macintyre & Ellaway, 2003). In addition to these social factors, socioeconomic deprivation at the neighborhood level may also affect general health (Malmstrom, Sundquist, & Johansson, 1999; Robert, 1999a). A longitudinal study of initially healthy men and women found that neighborhood socioeconomic deprivation was associated with higher overall mortality and marginally higher cancer-related mortality (Major et al., 2010).

The effects of neighborhood-level characteristics on cancer-related outcomes—including incidence, tumor characteristics, treatment, survivorship, and mortality—also have been assessed (Gomez et al., 2015). Research describing neighborhood-level characteristics has focused largely on racial/ethnic composition and socioeconomic conditions at the neighborhood level (Gomez et al., 2015). In breast cancer patients, low neighborhood socioeconomic status (SES) predicts worse all-cause and non-breast-cancer-specific survival above and beyond the effects of individual SES (Lian et al., 2014); these associations may, however, vary by race/ethnicity (Shariff-Marco et al., 2014). African American women with breast cancer living in metropolitan areas with higher levels of racial segregation are at increased risk of mortality from breast cancer compared to White women living in those same metropolitan areas (Russell et al., 2012). In addition, breast cancer patients living in census tracts with a high risk of home foreclosure reported worse self-rated health than women living in areas with low foreclosure risk; this association was explained by lower income, lower physical activity levels, and worse perceived neighborhood conditions (Schoutman, Deshpande, Pruitt, & Jeffe, 2012). Neighborhood characteristics also may affect health behaviors. Breast cancer survivors living near alcohol outlets (retail and restaurants) were more likely to consume alcohol excessively compared to survivors living farther away (Schoutman et al., 2013).

Little is known, however, about how such neighborhood factors affect trajectories of social support over time in breast cancer patients. Our prior latent trajectory analysis of change in perceived social support in early-stage breast cancer patients and women without breast cancer (age-matched controls) in a Midwestern metropolitan area found that marital status and negative affect (a latent variable derived from anxiety and depression scores) were associated with the stable level of perceived social support over time in both patients and controls. Specifically, we found that married women and women with lower negative affect

consistently reported higher levels of social support at four separate interviews conducted over two years (Thompson et al., 2013). Strikingly, we found in patients that being African American was linked both to higher stable levels of social support *and* a steeper drop in social support (slope) over the two-year study period following a breast cancer diagnosis. Race may, however, be a proxy for other variables linked to health, such as neighborhood of residence (LaVeist, Pollack, Thorpe, Fesahazion, & Gaskin, 2011).

The current study was designed to examine how neighborhood factors affect social support. We build on prior analyses that focused solely on individual characteristics (Thompson et al., 2013) by adding a new dimension: neighborhood context. Using geocoded residential addresses, we developed neighborhood measures of both social support and socioeconomic deprivation that would allow us to examine the effects of the neighborhood context on change in social support. First, we determined whether neighborhood characteristics, including neighborhood-level social support and neighborhood socioeconomic deprivation, would predict the slope and intercept of individual-level perceived social support in breast cancer patients. Second, we examined these same neighborhood variables as predictors of the slope and intercept of individual-level perceived social support in patients after adjusting for individual-level variables. Next, we explored the indirect effects of neighborhood-level variables on individual-level perceived social support through the individual-level variables in patients. Finally, we determined whether the indirect effects for neighborhood variables were the same for patients and controls.

We hypothesized that lower neighborhood-level social support and higher neighborhood socioeconomic deprivation would be associated with a lower intercept and steeper slope of social support in patients, and that these independent effects would hold after adjusting for individual-level variables. We previously found that controls exhibited stable levels of individual-level perceived social support over time (Thompson et al., 2013) and therefore did not believe that neighborhood variables would affect slope in controls. Thus, we also hypothesized that higher levels of neighborhood socioeconomic deprivation would predict lower intercept of individual-level social support in controls.

Methods

Between October 2003 and June 2007, we prospectively identified patients and controls aged 40 and older (i.e., the age then recommended for screening mammography (American Cancer Society, 2014)) from two university hospitals in a Midwestern metropolitan area for a longitudinal quality-of-life study. Patients with newly diagnosed with ductal carcinoma *in situ* (DCIS) or early-stage (I and IIA) invasive breast cancer confirmed by surgical pathology following definitive treatment surgery (lumpectomy or mastectomy) were eligible to participate. We concurrently recruited controls, matched to patients by age group (40-49, 50-69, 70), following a normal/benign screening mammogram from one of the hospital's cancer screening centers. After obtaining informed consent, we conducted computer-assisted telephone interviews with all participants to collect demographic and psychosocial data at 4-6 weeks, 6 months, 12 months, and 24 months after definitive surgery (patients) or normal/benign mammogram (controls). Clinical information was obtained from medical records.

Women were eligible to participate if they spoke English, had no prior history of breast cancer, had not received neoadjuvant chemotherapy, and did not demonstrate cognitive impairment on the Orientation-Memory-Concentration Test, administered to women 65 years of age (Katzman et al., 1983). The study was approved by Institutional Review Boards at Washington University in St. Louis and at Saint Louis University. More details about study design are available elsewhere (Jefte et al., 2012; Pérez et al., 2010).

Individual-level Measures

Dependent variable: Perceived social support—Perceived availability of social support was assessed using the Medical Outcomes Study Social Support Survey (MOS-SS) (Sherbourne & Stewart, 1991). Perceived support was assessed because it has been strongly associated with emotional and physical health outcomes (Uchino, 2009). The MOS-SS includes 19 items using five-point, Likert-scaled response options, the responses to which were transformed into standardized scores from 0-100 (RAND Corporation, 2014); higher scores indicate greater perceived social support. Among patients with chronic conditions, the scale has high discriminant and convergent validity (Sherbourne & Stewart, 1991). Items demonstrated excellent internal consistency ($\alpha = .97$ at every time point).

Clinical and demographic information—Patients' clinical data included cancer stage (based on surgical pathology), type of surgery (lumpectomy versus mastectomy), and receipt of adjuvant radiation therapy and/or chemotherapy. Home address was obtained at baseline for both patients and controls. Demographic information included age, race, marital status, and insurance status, each of which had predicted either intercept or slope of social support in our previous examination of individual-level data.

Negative affect—A latent variable for negative affect was constructed using anxiety and depressive symptoms (as described in Thompson et al., 2013). Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977). Scores on the CES-D range from zero to 60; scores of 16 indicate elevated depressed mood. Participants who met that cutoff at any interview were provided counseling referrals. The CES-D has shown good construct and concurrent validity and has demonstrated reliability in a range of populations (Radloff, 1977; Radloff & Teri, 1986). At baseline, items demonstrated high internal consistency ($\alpha = .91$). Anxiety over the prior seven days was assessed using the 21-item Beck Anxiety Inventory (Beck, Epstein, Brown, & Steer, 1988). The scale has demonstrated good discriminant validity in distinguishing between depression and anxiety (Beck et al., 1988). Cronbach's α at baseline was .86.

General health—General health was assessed using a subscale from the RAND Medical Outcomes Study 36-Item Health Survey (Hays, Sherbourne, & Mazel, 1993; Ware & Sherbourne, 1992). This subscale includes five items that assess both mental and physical health, although it is more strongly related to physical health than mental health (McHorney, Ware, & Raczek, 1993). Higher scores indicate better health perceptions. At baseline, Cronbach's α was .76.

Neighborhood Measures

Participants' residential addresses at study enrollment were geocoded with ArcGIS 9.3 (ESRI, Redlands, CA, USA). This geocoding allowed us to link participants to neighborhood-level data from their census tracts. Neighborhood-level variables were constructed using SAS 9.3 (SAS Institute Inc., Cary, NC, USA).

Neighborhood socioeconomic deprivation index—Using an approach described previously (Lian et al., 2014), we used data from the 2000 U.S. Census to examine the structure of 21 census-tract-level socioeconomic variables using principal-components analysis with varimax rotation for data reduction. We selected nine variables loading on the first common factor to construct a neighborhood socioeconomic deprivation index. These variables included the percentage of: civilian labor force unemployed, households with at least one person per room, female-headed households with dependent children, households with public assistance income, households without a vehicle, the population below the federal poverty line, non-Hispanic African Americans, vacant households, and households without plumbing. This factor accounted for 44.4% of total variance. Cronbach's α was .94 for the variables included in this index.

Neighborhood-level social support—Studies have recently started to incorporate neighborhood-level constructs using survey data. Using the distance area for clinical care method (Fang, Brooks, & Chrischilles, 2010; Fang, Brooks, & Chrischilles, 2012), a measure of neighborhood-level social support for patients was estimated based on social support scores of nearby controls. We averaged individual-level perceived social support scores at the corresponding interview for controls in the most proximal census tracts to the tract occupied by each patient; proximity was based on the population centroid of the patient's census tract. Proximal tracts were included until a five-control threshold was attained. Due to the scarcity of patients and controls at the geographic extremes of the data, we used control data from only the areas of greatest density to reasonably reflect variation at the census tract level. Control data were therefore drawn from all contiguous census tracts that included patients and five controls (at minimum) living within four miles of the census tract population centroid. Multiple imputation was used to estimate data for remaining patients (described below).

Data Analysis

We used latent trajectory models, which allow researchers to differentiate between systematic change in a construct over time (i.e., the slope) and stable tendencies toward a certain level of that construct (i.e., the intercept, here basically equivalent a latent estimate of a participant's starting point) (Curran & Hussong, 2003). Our models were similar to those reported in our previous work (Thompson et al., 2013) in that they included intercept and slope latent factors, as well as predictors of intercept and slope, but they differed because they included neighborhood-level predictors.

Descriptive analyses were conducted using SPSS (IBM SPSS Statistics for Windows, Version 22.0, Armonk, NY: IBM Corp.). Latent trajectory modeling was conducted in Mplus

Version 7.1 (Muthén & Muthén, 1998-2012). Missing data were estimated using multiple imputation in Amelia II (Honaker, King, & Blackwell, 2012).

Variables that did not predict either intercept or slope of social support in our previous examination of only individual-level data, including education, employment status, comorbidity, pain subscale of the RAND 36-Item Health Survey, and breast cancer stage (Thompson et al., 2013), were not included in these models. Relationship status was categorized as married/partnered versus not married/partnered, surgery type was categorized as lumpectomy versus mastectomy, and race was categorized as White or African American. Due to missing data for annual household income (over 7% of participants), we used insurance status (some private insurance versus public/no insurance) as a proxy for individual-level SES (coded as some private insurance versus no private insurance). The Spearman correlation between these variables was moderate (-0.38); in a follow-up test, we found that the indirect effects observed for insurance held for income as well. Due to the concern that income may not be missing at random, we used the insurance variable in the analyses reported here.

Additional missing data affected less than 13% of participants and resulted from participant attrition or lack of response to specific measures, as well as inability to link U.S. Census data to participants lacking a street address for geocoding. We used multiple imputation and, as is typically done, combined results across five multiply imputed datasets for each analysis (Rubin, 1987). However, *two sets* of imputed datasets were constructed. The first group of five imputed datasets included patients only and contained all relevant patient variables; the second group of five imputed datasets included patients and controls but excluded variables used in the models that related specifically to patients (i.e., surgery type and computed neighborhood-level social support scores based on controls living in proximity to patients). That is, the two sets of multiply imputed datasets were used to address the fact that controls lacked some information that should also not be considered missing. Those variables were estimated in the patient-only datasets, but deleted in the datasets including both patients and controls. To aid in imputation, we included all variables that were used in the analyses below in addition to other clinical data (e.g., number of comorbidities) that appeared informative for estimation purposes; a list of these variables is available from the second author. The population density of each census tract was included in the imputation, and for the patient-only data set, the number of controls used to estimate neighborhood-level social support was also included. We examined how well our imputation strategies represented the likely values of the missing data using three diagnostic tests (overimputation and overdispersion with one and two dimensions) (Honaker, King, & Blackwell, 2012). Diagnostics indicated successful imputation of missing values. In addition, tests of direct effects for the neighborhood-level variables were run using the non-imputed data set; these results showed effect sizes equivalent to or larger than those found using imputed data sets.

In Model 1, only the neighborhood-level variables were used to predict slope and intercept, with plans to retain only those predictors that showed at least a tendency to predict perceived social support (at $p < .10$). In Model 2, previously reported significant predictors of either intercept or slope of social support (Thompson et al., 2013) were added to determine if any neighborhood-level variables from Model 1 continued to predict perceived social support

after adjusting for known individual-level predictors. In Model 3, we tested potential indirect effects of neighborhood-level variables through other individual-level predictors. In Model 4, which included both patients and controls, we tested whether effects of the retained neighborhood-level variables (both direct and indirect) differed by group (patients vs. controls).

Models were tested in Mplus 7.1 using the robust χ^2 statistic (i.e., the Satorra-Bentler χ^2 , referred to as the MLM estimator in Mplus). In testing indirect effects we used 5,000 draws to generate bias-corrected bootstrapped confidence intervals. To evaluate global fit, we used the following: (a) Tucker-Lewis incremental fit index (TLI) (Tucker & Lewis, 1973); (b) comparative fit index (CFI) (Bentler, 1990); (c) root mean square error of approximation (RMSEA) (Steiger & Lind, 1980); and (d) standardized root mean square residual (SRMR) (Bentler, 1995; Jöreskog & Sörbom, 1981). For the TLI and CFI, values of .90 and above were considered adequate, whereas values of .95 or above were considered very good; for the RMSEA and SRMR, values of .08 and below were considered adequate and .05 or below very good (Hu & Bentler, 1999).

Results

Baseline Characteristics

A total of 1,096 participants were enrolled in the study, and 1,011 completed all four interviews. To have sufficient power to detect differences between racial groups, we excluded 13 participants (1.2%) who identified their race as other than African American or White. Because only two of the remaining participants—both White—considered themselves Hispanic/Latina, we did not test for the effects of ethnicity in our analyses. Analyses were based on the 541 patients and 542 controls with at least partial data (Table 1).

Using non-imputed data from the 291 patients with at least five controls within a four-mile radius of the census tract centroid, mean neighborhood social support at baseline was 81.6 (standard deviation [*SD*] = 7.3). Figure 1 maps baseline neighborhood social support.

Model 1 was used to test our hypothesis that lower neighborhood-level social support and higher neighborhood socioeconomic deprivation would be associated with a lower latent estimate of initial social support (intercept) and steeper change in social support (slope) in patients. This model, which included only neighborhood-level variables to predict perceived social support intercept and slope in patients, showed good model fit (CFI = .98, TLI = .97, RMSEA = .06, SRMR = .04). Higher neighborhood socioeconomic deprivation predicted lower perceived social support intercept ($p = .032$), but not slope ($p = .206$) (Table 2). In contrast, neighborhood-level social support predicted the slope ($p = .046$), but not intercept ($p = .122$). There was a small negative correlation between neighborhood socioeconomic deprivation and neighborhood-level social support ($r = -.10$, $p < .001$). Patients living in less deprived areas had the highest initial perceived social support, and their social support was more likely to increase over time given higher neighborhood-level social support.

Model 2 was similar to Model 1, but, in order to test whether neighborhood effects would be predictive of change in perceived social support after adjusting for the effects of individual-

level variables, we added known individual-level predictors of change in patients' perceived social support (Thompson et al., 2013). Predictors were allowed to correlate or have predictive relationships among themselves, consistent with indirect tests planned for Model 3 (see below). Model 2 demonstrated very good model fit ($CFI = .98$, $TLI = .97$, $RMSEA = .04$, $SRMR = .02$). When individual-level predictors were added, there were no direct effects of the neighborhood-level variables on intercept or slope for patients; the effect of neighborhood-level social support on patients' perceived social support slope approached significance ($p = .077$) (Table 2). The significant decline in patients' social support over time was associated with being African American (vs. White) and having had a mastectomy (vs. lumpectomy), with an indication that living in neighborhoods in which controls had higher social support might mitigate this decline in support. For the social support intercept in patients, higher support was associated with lower levels of negative affect, higher levels of general health, having private insurance, and being married.

Model 3 was used to test potential indirect effects of neighborhood-level variables through other predictors. Model 3 was similar to Model 2, but we estimated the model for patients using bootstrapping (5000 draws) and assessed the following indirect effects: 1) neighborhood socioeconomic deprivation on the intercept through negative affect, general health, insurance, and marriage, and 2) neighborhood-level social support on the slope through surgery type. These indirect effects were selected because they all: (a) specified a potential statistically significant path (because the mediator predicted the outcome), and (b) included a plausible causal mechanism. Thus, we did not include race as a mediator, because socioeconomic deprivation or neighborhood social support could not "cause" race. Because bootstrapping is incompatible with multiple imputation, we report exact figures from a single dataset, but all of the multiply imputed datasets showed the same pattern unless otherwise noted.

The individual indirect effects of neighborhood socioeconomic deprivation on the intercept for patients were strong for all potential mediators (Figure 2); the 99% confidence interval for each coefficient did not contain zero ($p < .01$). Therefore, although neighborhood socioeconomic deprivation no longer showed a direct effect on intercept in the model, there was evidence that it might act on the intercept by influencing whether patients were married and had private insurance as well as their levels of negative affect and general health. Among breast cancer patients, living in more deprived areas was associated with being unmarried, having public/no insurance, and reporting lower levels of general health and higher negative affect; in this group, neighborhood-level social support showed no indirect effect through surgery type ($p > .10$).

Model 4, which included both patients and controls, was used to test whether the influence of the retained neighborhood-level variables (both direct and indirect) differed for patients and controls. Because this model included controls as a separate group, patient-only variables, such as the neighborhood-level social support variable, were excluded. For Model 4, a version of Model 3 was constructed with neighborhood socioeconomic deprivation as the only neighborhood-level predictor. We evaluated indirect paths to determine whether the effects for controls differed from the effects for patients. Again, the indirect effects had to be tested separately across each of the five multiply imputed datasets. For controls,

neighborhood socioeconomic deprivation acted on the intercept indirectly through marriage ($p < .01$) but not through general health, negative affect, or insurance status ($p > .05$, although in a single dataset, neighborhood socioeconomic deprivation acted on the intercept indirectly through negative affect, $p < .05$). Thus, of the indirect effects observed for patients, only the path through marriage was consistently supported for controls.

Exploratory Test

At the suggestion of an anonymous reviewer, we used a series of multiple-group models to examine whether race might moderate the effects found. The only neighborhood-related effect that showed an indication of being moderated by race was neighborhood-level social support, which showed a trend ($p < .10$) toward predicting social support slope among African American but not White patients (in models both with and without individual-level predictors). The direction of the effect indicated that lower neighborhood support was related to decreasing perceived social support over time. Given that race was already known to affect the slope of perceived social support in this cohort, it therefore appeared plausible that race might directly relate to area of residence, such that the data would display an indirect effect of race acting on the slope through neighborhood social support. Four of the five imputed datasets suggested that this indirect effect was significant ($p < .05$), but one dataset failed to support this conclusion. The indirect effect indicated that African American patients were significantly ($p < .001$) more likely than White patients to live in neighborhoods with lower social support, and residents of these neighborhoods showed a non-significant tendency toward decreasing individual social support over time.

Discussion

We found that neighborhood socioeconomic deprivation and neighborhood-level social support affected individual-level perceived social support indirectly through individual-level predictors in breast cancer patients and, to a lesser extent, controls. Our results provided partial support for our hypotheses. We found that patients' neighborhood socioeconomic deprivation was negatively associated with perceived social support intercept, whereas neighborhood-level social support was positively associated with perceived social support slope. We found no support for our hypothesis that neighborhood-level variables would predict perceived social support after adjusting for individual-level variables. There was, however, a non-significant trend in the ability of neighborhood-level social support to predict perceived social support slope. Results of exploratory tests suggested that race may moderate the direct or indirect effects of neighborhood social support on individual-level perceived social support in African American but not White patients.

We also observed indirect effects of neighborhood socioeconomic deprivation and neighborhood-level social support on individual-level perceived social support in patients through four mediating variables: marriage, insurance status, level of negative affect, and general health. Patients in neighborhoods with higher socioeconomic deprivation reported lower individual-level perceived social support; these patients also were less likely to be married or to have private insurance, and they reported lower general health and higher negative affect. We found that the indirect effects for neighborhood socioeconomic

deprivation differed for controls; the only indirect effect for neighborhood socioeconomic deprivation on perceived social support intercept for controls occurred through marriage.

Little is known about the effects of neighborhood factors on social support in breast cancer patients. Our results suggest that neighborhood-level socioeconomic deprivation operates through a variety of pathways at the individual level. Prior work has shown that neighborhood and individual characteristics may interact in their effects on health (Macintyre & Ellaway, 2003). Our finding that neighborhood socioeconomic deprivation affects social support in different ways for patients compared to controls suggests that neighborhood socioeconomic deprivation may have effects on individuals that depend on situational factors, including disease status. In particular, these findings suggest that the context of socioeconomic deprivation—captured in our index by factors associated with having a higher percentage of neighbors living under impoverished conditions—may have important indirect effects on women with breast cancer. For example, access to health insurance and the ability to pay for care may affect the degree to which people perceive themselves to be supported. In contrast, such factors may not affect people who do not have breast cancer, such as our controls.

The suggestion that race may moderate the effects of neighborhood support on patients' individual-level perceived support should be examined further in future work. Our findings that African Americans were less likely than Whites to live in neighborhoods with higher levels of neighborhood support is consistent with past work that has documented high levels of segregation in this Midwestern metropolitan area and linked such segregation to economic and health disparities (East-West Gateway, 2015). In our data, the link between race and the tendency to live in specific areas was so strong that, despite the fact that there was no significant *direct* effect of neighborhood on social support over time, there was an *indirect* effect of race on social support through neighborhood.

The Institute of Medicine report *From Cancer Patient to Cancer Survivor* advocates the creation of survivorship care plans that consider survivors' psychosocial needs (Institute of Medicine, 2005). Given the relationship between social support and emotional and physical health outcomes (e.g. Hill et al., 2011; Kroenke et al., 2013), our results suggest that clinicians, social workers, and others who develop breast cancer survivorship care plans should consider assessing neighborhood-level factors in patients (Hudson & Gehlert, 2015) and providing psychosocial interventions for patients with low social support, particularly those who are living in impoverished areas or who do not have partnered relationships. The pathway by which neighborhood socioeconomic deprivation affects social support through negative affect (i.e., a combination of anxiety and depressive symptoms) may be especially amenable to intervention, given the existence of empirically supported treatments for depression and anxiety (Cuijpers, van Straten, Andersson, & van Oppen, 2008; Hofmann & Smits, 2008). Public health practitioners should also consider multi-level neighborhood and community interventions for breast cancer patients who reside in impoverished areas (Gehlert, Small, & Bollinger, 2011; Holmes et al., 2008). Resources such as designated "neighborhood support coordinators" may help breast cancer patients receive individualized support and engage with their communities, seek resources, and solve both social and health-related problems (Gehlert et al., 2011). Public health practitioners should also

consider interventions to improve neighborhoods in general, as well as policy interventions to reduce socioeconomic disparities (Hudson & Gehlert, 2015).

Our analyses underline the importance of marriage and other intimate partnerships in providing social support, both in breast cancer patients and women without breast cancer. It is intriguing that neighborhood socioeconomic deprivation may influence social support indirectly through marriage, especially given the well-documented disparities in marriage rates by income, education, and race (Pew Research Center, 2010). In our study, both marriage and neighborhood socioeconomic deprivation were assessed at baseline, so we cannot know for certain the direction of influence. Our assumption that neighborhood socioeconomic context affected marital status is supported, however, by literature examining the effects of economic factors on family structure (Carbone & Cahn, 2014).

Strengths and Limitations

Strengths of this study include the longitudinal design, inclusion of age-matched controls, and use of neighborhood-level variables, constructed specifically for this study using study participants' residential addresses. We had a very high rate of retention and a sample of patients and controls that was representative of the racial distribution in this metropolitan area.

Several limitations must also be noted. Participants were recruited from a National Cancer Institute-designated Comprehensive Cancer Center and another academic medical center, and our findings may not be generalizable to women treated in other settings. Results may differ for women under 40, women with advanced disease, and women of other races. The small number of Hispanic/Latina women did not allow us to test the effects of ethnicity.

Our neighborhood-level variables were created based on information from participants who came primarily from one Midwestern metropolitan area, and findings may not generalize to other areas. Our neighborhood-level social support measure averaged perceived social support scores from nearby controls, but we do not know whether the people whose scores were used to derive these average scores would have been considered neighbors by the breast cancer patients. Our strategy limited the participants for whom we had useable data, which led to reduced power to detect the effects of neighborhood-level social support. Nevertheless, our measure of neighborhood social support showed a trend, albeit non-significant, toward predicting change in individual social support over time. Our analyses included a compositional measure of neighborhood social support (i.e., a composite measure based on individual-level perceived availability of support). Future research should consider additional ways to measure neighborhood social support, including interviews, direct observation, and evaluation of contextual neighborhood features that may influence support (e.g., the built environment) (Raudenbush, 2003). In addition, future research would also benefit from recruiting participants at the neighborhood level to ensure sufficient samples sizes at the neighborhood and individual levels and allow for multilevel modeling (Gomez et al., 2015).

As is common in the literature, we examined neighborhood socioeconomic deprivation at the census tract level. However, census tracts may not align with people's perceptions of the

boundaries of their neighborhoods (Coulton, Korbin, Chan, & Su, 2001; Gomez et al., 2015), and using census tracts as the unit of neighborhood measurement may bias results toward the null (Kawachi & Berkman, 2003). People often are not confined by geographic proximity when accessing resources (Cummins, Curtis, Diez-Roux, & Macintyre, 2007), and they may have different relationships with places depending on characteristics such as age, health, or income (Bernard et al., 2007). In addition, the neighborhood socioeconomic deprivation index did not account for all aspects of a neighborhood that may affect social support, such as crime or residents' perceptions of neighborhoods. We also did not have information about changes in address or neighborhood characteristics after the baseline interview, which could have affected both a participant's perceived social support at follow-up interviews and neighborhood social support. Because our study lasted only two years, it is likely that a large percentage of participants remained at the same address; the mean age in our sample was 58 years, and older people are less likely to move than younger people (Molloy, Smith, & Wozniak, 2011). Again, the fact that we found multiple significant indirect effects on social support despite these limitations indicates that we have successfully identified broad neighborhood factors that could have a strong effect on perceived social support.

Conclusion

Public health professionals have long acknowledged that an individual's health is affected by a variety of factors, including individual characteristics and behaviors, the social environment, the built environment, and the policy context (Bronfenbrenner, 1995; Holmes et al., 2008). Our analyses constitute an important first step in examining the effects of neighborhood-level factors on perceived social support in patients with breast cancer. Our results suggest that women living in more deprived neighborhoods may be more vulnerable to low perceived social support because they are less likely to be married and to have private insurance, and they have lower levels of general health and higher negative affect. Lower levels of social support may, in turn, negatively affect breast cancer patients' health outcomes. Survivorship care plans and neighborhood interventions must take into account both individual characteristics and characteristics of the social context to ensure that vulnerable patients receive appropriate social support after a cancer diagnosis.

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Research Highlights

- In cancer patients, neighborhood deprivation was associated with lower social support
- In cancer patients, neighborhood-level support affected change in social support
- Individual-level variables reduced neighborhood factors' direct effects on support
- Neighborhood deprivation affected support indirectly through several variables
- Indirect effects of neighborhood deprivation differed in patients and controls

Figure 1. Neighborhood social support scores by quintile at baseline, estimated based on controls' scores on the Medical Outcomes Study Social Support Survey. Figure is based on data before multiple imputation.

Figure 2.

Significant indirect effects of neighborhood socioeconomic deprivation on patients (using first multiply imputed dataset, bootstrapped unstandardized estimates). Estimates for indirect paths were $-.78$ for insurance status, $-.78$ for marital status, $-.65$ for negative affect, and $-.38$ for general health (each $p < .05$)

* $p < .01$

Table 1

Descriptive statistics at baseline (N = 1083: 541 patients, 542 controls)

Variable	Total Sample Mean (SD) or N (%)	Patient Mean (SD) or n (%)	Control Mean (SD) or n (%)	P *
Age	57.7 (10.6)	58.3 (10.6)	57.1 (10.5)	.065
MOS-SS score	84.6 (17.9)	86.8 (16.4)	82.4 (18.9)	<.001
CES-D score	7.7 (9.0)	8.3 (9.5)	7.1 (8.5)	.023
Beck Anxiety Inventory	6.1 (6.8)	6.3 (7.1)	5.9 (6.5)	.356
RAND General Health Subscale	70.1 (21.1)	68.7 (21.6)	73.2 (20.3)	.001
Race				
White	837 (77.3)	439 (81.1)	398 (73.4)	.002
African American	246 (22.7)	102 (18.9)	144 (26.6)	
Marital status ^a				
Married/partnered	655 (60.9)	323 (60.4)	332 (61.4)	.227
Not married/partnered	421 (39.1)	212 (39.6)	209 (38.6)	
Insurance				
Private	899 (83.0)	453 (83.8)	446 (82.3)	.114
Public/uninsured/unknown	184 (17.0)	88 (16.2)	96 (17.7)	
Surgery Type				
Lumpectomy	–	351 (64.9)	–	–
Mastectomy	–	190 (35.1)	–	–

^aTotal N = 1076, patient n = 535 and control n = 541 due to missing data.

Note: SD = standard deviation, MOS-SS = Medical Outcomes Study Social Support Survey, CESD = Center for Epidemiologic Studies Depression Scale

* $p < .05$

Table 2

Results for Models 1 and 2 showing direct effects on intercept and slope of perceived social support (Medical Outcomes Social Support Survey score) in breast cancer patients (N = 541)

Intercept	Model 1		Model 2	
	Estimate	Standardized coefficient	Estimate	Standardized coefficient
Neighborhood social support	-4.95	-0.10	-4.26	-0.09
Neighborhood socioeconomic deprivation	-1.68 *	-0.12	0.26	0.02
Negative affect			-0.48 *	-0.32
Age			-0.03	-0.02
General health			0.10 *	0.16
Race			2.64	0.07
Marital status			4.44 *	0.16
Insurance type			-6.73 *	-0.17
Surgery type			0.69	0.03
Slope				
Neighborhood social support	1.62 *	0.17	1.48	0.16
Neighborhood socioeconomic deprivation	-0.33	-0.12	0.02	0.01
Negative affect			0.03	0.11
Age			-0.02	-0.08
General health			0.01	0.09
Race			-1.65 *	-0.24
Marital status			0.04	0.01
Insurance type			0.70	0.09
Surgery type			-1.10 *	-0.24

Note: The partially standardized coefficient is used for categorical variables, and the fully standardized coefficient is used for continuous variables.

* $p < .05$.