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Effects of neighborhood disadvantage on cortisol and interviewer-rated anxiety symptoms in breast cancer patients initiating treatment

Neha Goel[1,2,3], **Alexandra E Hernandez**[1,2], **Molly Ream**[4], **Estefany Saez Clarke**[4], **Bonnie B. Blomberg**[2,5], **Steve Cole**[6], **Michael H. Antoni**[2,4]

[1]Division of Surgical Oncology, Department of Surgery, Sylvester Comprehensive Cancer Center, University of Miami Miller School of Medicine, 1120 NW 14Th Street, Suite 410, Miami, FL 33136, USA

[2]Sylvester Comprehensive Cancer Center, University of Miami Miller School of Medicine, Miami, FL, USA

[3]Harvard T.H. Chan School of Public Health, Harvard University, Boston, MA, USA

[4]Department of Psychology, University of Miami Miller School of Medicine, Miami, FL, USA

[5]Department of Microbiology, University of Miami Miller School of Medicine, Miami, FL, USA

[6]Department of Psychiatry/Biobehavioral Sciences and Medicine, David Geffen School of Medicine, University of California Los Angeles, Los Angeles, CA, USA

Abstract

Purpose—Shorter breast cancer (BC) survival outcomes persist by neighborhood disadvantage independent of patient, tumor, and treatment characteristics. This suggests unaccounted mechanisms by which neighborhood disadvantage "gets under the skin" to impact BC survival outcomes. Here, we evaluate the relationship between neighborhood disadvantage and clinical and neuroendocrine markers of stress in BC patients.

Methods—Women with stage 0–III BC were enrolled 2–10 weeks post-surgery and before initiating adjuvant treatment in a study examining stress and stress management processes. Women provided an afternoon-evening (PM) serum cortisol sample and were administered the Hamilton Anxiety Rating Scale (HAM-A). Home addresses were used to determine the Area Deprivation Index (ADI), a validated measure of neighborhood disadvantage. Multiple regression assessed the relationship between ADI and PM serum cortisol and the presence of elevated HAM-A symptoms.

Results—Our sample (n = 225) was predominately middle-aged (M = 50.4 years; range 23–70 years), non-Hispanic White (64.3%), with stage I (38.1%), or II (38.6%) disease. The majority (n

✉ Neha Goel neha.goel@med.miami.edu.

Author contributions All authors contributed to the study conception and design. MR and ES-C: Material preparation, data collection, and analysis were performed. AH: The first draft of the manuscript was written and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflict of interest Dr. Antoni is a paid consultant for Blue Note Therapeutics and Atlantis Healthcare. He is also the inventor of Cognitive Behavioral Stress Management, filed with the University of Miami as UMIP-483, which is licensed to Blue Note Therapeutics. The other authors declare no disclosures or potential conflicts of interest.

= 175) lived in advantaged neighborhoods (ADI 1–3). After controlling for age, stage, and surgery type, women from high ADI (4–10) (vs low ADI) neighborhoods had higher PM cortisol levels (β = 0.19, 95% CI [0.24, 5.00], p = 0.031) and were nearly two times as likely to report the presence of elevated anxiety symptoms (OR = 1.96, 95% CI [1.00, 3.86], p = 0.050).

Conclusion—Neighborhood disadvantage is significantly associated with higher levels of PM cortisol and elevated anxiety symptoms suggesting stress pathways could potentially contribute to relationships between neighborhood disadvantage and BC survival.

Keywords

Breast cancer; Social adversity; Neighborhood disadvantage; Health disparities; Cortisol; Stress

Introduction

Neighborhoods represent complex environments with unique cultural, physical, and economic attributes that impact health and disease. Living in a disadvantaged neighborhood has been previously linked to an increased risk of breast cancer mortality, even after accounting for individual-level socioeconomic status (SES) [1–3]. Neighborhood disadvantage has been linked to increased risk of aggressive breast cancer subtypes and mortality, but how this occurs is not fully understood [1, 4–10]. Much of the literature attributes these associations to disparities in access to care or treatment incompletion [9, 11–13]. However, a study by Goel et al. revealed that neighborhood disadvantage was associated with lower breast cancer survival above and beyond individual-level factors and access to care barriers such as stage at presentation and NCCN-guideline treatment [14]. This suggests that there may be unaccounted biologic mechanisms by which neighborhood disadvantage "gets under the skin" to impact breast cancer survival outcomes.

Disadvantaged neighborhoods are a byproduct of economic and racial residential segregation and often have higher rates of crime and violence, less access to green spaces and sidewalks, and more noise and chemical pollution which have known effects on overall health, cancer rates, and survival [15, 16]. Chronic stress is thought to contribute to pathways causing or exacerbating chronic diseases, cancer, and increased mortality [5–8]. This adverse environment leads to chronic stress and negative health behaviors, with a recent study in breast cancer patients showing that neighborhood deprivation was associated with lower psychological well-being and quality of life [17]. Additionally chronic stress actually activates harmful biological mechanisms involving interactions between distress responses (e.g., anxiety) and the nervous system, leading to changes in neuroendocrine signaling processes which can affect the immune system and tumor microenvironment [18–22]. Whether chronic stress associated with neighborhood disadvantage relates to distress and neuroendocrine indicators in the context of breast cancer have yet to be explored.

To address this gap, we sought to evaluate the relationship between neighborhood disadvantage and clinician-rated and neuroendocrine markers of distress in breast cancer patients. By integrating neighborhood disadvantage, clinician-rated anxiety symptoms, and serum cortisol, we can further delineate the relationship between neighborhood disadvantage and stress, and potentially identify pathways that could potentially contribute

to neighborhood disparities in breast cancer outcomes. We hypothesized that women with higher levels of neighborhood disadvantage would have higher levels of anxiety symptoms and cortisol.

Methods

Population and data

In this prospective cohort study, women with stage 0–III breast cancer between 1998 and 2005 were enrolled in a clinical trial for stress management 2–10 weeks post-surgery and before initiating adjuvant treatment. IRB approval was obtained at our institution, and patients gave informed consent. Exclusion criteria included a previous diagnosis of cancer (except minor skin cancer), age > 70 years, metastatic disease, prior hospitalization or diagnosis for psychosis, major depressive episode, panic disorder, suicidality, or substance dependency, and non-fluent in English. Participants were also excluded if they had a comorbid major medical condition, were taking medications with known effects on endocrine functioning, or if they began adjuvant chemotherapy or radiation treatment. Patient addresses were used to determine the Area Deprivation Index (ADI), a validated measure of neighborhood disadvantage. At baseline, women provided a late afternoon to evening-time serum cortisol sample (between 4 pm and 6:30 pm) (PM cortisol) and were administered a structured clinical interview of anxiety symptoms (Hamilton Anxiety Rating Scale; HAM-A) [22]. Our primary exposure was ADI, and our primary outcomes were PM cortisol and the presence of elevated HAM-A anxiety symptoms.

Measures

The ADI is a validated composite measure of multilevel measures of socioeconomic disadvantage used by the Centers for Medicare & Medicaid Services and is calculated for each patient using census block group data. The ADI also uses the American Community Survey (ACS) 5-year Estimates. We used the 2015 ADI, which is a 5-year average of ACS data from the years 2011–2015. The ADI was determined using cohort addresses in our database and calculated using the following ADI mapping atlas: https://www.neighborhoodatlas.medicine.wisc.edu/mapping. The ADI score (1–10) includes factors from the domains of income/employment (median family income in US dollars, income disparity, % families below federal poverty level, % population below 150% of federal poverty level, % civilian labor force population aged 16 years and older who are unemployed), education (% population aged 25 years or older with less than 9 years of education, % population aged 25 years or older with at least a high school diploma, % employed population aged 16 years or older in white-collar occupations), housing (median home value in US dollars, median gross rent in US dollars, median monthly mortgage in US dollars, % owner-occupied housing units, % occupied housing units without complete plumbing), and household characteristics (% Single-parent households with children younger than 18). State deciles are typically categorized into tertiles where tertile 1 is the lowest ADI (most advantaged) and tertile 3 is the highest ADI (most disadvantaged) [23]. For study analyses, we grouped women into those falling into the lowest tertile (ADI = 1–3) vs those in the top two tertiles (ADI = 4–10) in order to obtain reasonably sized groups for comparisons. The lowest tertile was defined as living

in an “advantaged neighborhood” and the top two tertiles as living in a “disadvantaged neighborhood.”

Serum cortisol was used as a measure of physiological stress. Blood samples for serum assays were collected between 4 PM and 6:30 PM, as this was the time used in our prior work to control for circadian fluctuations, and was a time that participants were able to come in for assessments [24]. Because cortisol levels can be affected by multiple lifestyle factors we instructed participants to refrain from alcohol use, recreational drug use and caffeinated beverages on the day of the blood draw. Prior reports of this sample indicated that among women providing blood samples for cortisol, 93% were nonsmokers, and they consumed an average of two to three alcoholic beverages per week with half reporting no alcohol use, and average weekly caffeinated coffee consumption of less than one cup per day [24]. During assessments, a phlebotomist collected peripheral venous blood via venipuncture in red-topped vacutainer tubes, which contain no anticoagulants and allow for the serum to be separated from cells when centrifuged. Cortisol levels in serum were measured by competitive enzyme-linked immunosorbent assay (ELISA) with kits from Diagnostic Systems Laboratories (Webster, Texas).

The HAM-A is a clinician-administered interview that assesses 14 symptom-defined elements, and taps both psychological and somatic symptoms, comprising anxious mood; tension (including startle response, fatigability, restlessness); fears (including of the dark/strangers/crowds); insomnia; ‘intellectual’ (poor memory/difficulty concentrating); depressed mood (including anhedonia); somatic symptoms (including aches and pains, stiffness, bruxism); sensory (including tinnitus, blurred vision); cardiovascular (including tachycardia and palpitations); respiratory (chest tightness, choking); gastrointestinal (including irritable bowel syndrome-type symptoms); genitourinary (including urinary frequency, loss of libido); autonomic (including dry mouth, tension headache) and observed behavior at interview (restless, fidgety, etc.) [25]. Each item is scored on a basic numeric scoring of 0 (not present) to 4 (severe). Due to a clerical error, the genitourinary system cluster was not administered to any patient within this study. As this missingness was systematic across all participants, it is considered missing at random. Thus, the mean of the 13 present items was added to the total scores of the HAM-A such that levels were comparable to the 14-item scale. For the purpose of this study, we focused on the presence of anxiety symptoms as opposed to a clinical diagnosis of anxiety, therefore the HAM-A was dichotomized to represent the presence of mild anxiety symptoms using accepted cut-offs (scores > 7) [26].

Covariates

Covariates for each model included stage (0–III), age, and type of surgery (lumpectomy vs. mastectomy). These covariates were chosen based on known confounders and subject matter knowledge. Age was included as cortisol levels are known to vary by age group [27–29]. Race was not included as a covariate in our analysis due to the small number of Black patients living in ADI group 1–3 (n = 3, 1.7%).

Statistical analysis

Data were analyzed using SPSS statistics version 28. Data were first screened for outliers and assumptions of normality. Linear regression analysis was used to assess the relationship between ADI and serum cortisol and binary logistic regression to assess whether ADI group was associated with the presence of elevated anxiety symptoms per the HAM-A. Statistical significance was based on a two-sided alpha of 0.05.

Results

Of the 240 women in the parent trial, ADI was collected on 225 (93.8%). Missing ADI data was due to women who did not provide valid home addresses during the baseline assessment (e.g., provided a P.O. Box). Our sample (n = 225) was predominately middle-aged (mean 50.4 years; range 23–70 years), non-Hispanic White (64.3%), with stage I (38.1%) or II (38.6%) disease. The majority lived in advantaged neighborhoods. On the HAM-A, 47.2% of women reported the presence of elevated anxiety symptoms. The average HAM-A score was 8.29 (SD = 6.05) and the mean cortisol level was 8.68 μg/dL (SD = 5.93).

There were no significant differences by ADI category on age at diagnosis, stage at diagnosis, household income, or type of surgery received. However, there was a significant difference by neighborhood deprivation category on ethnic/racial identity ($\chi 2(3) = 15.73$, $p = 0.001$). Specifically, women in disadvantaged neighborhoods had a higher proportion of Black and Hispanic patients compared to women in advantaged neighborhoods. In addition, women in disadvantaged neighborhoods reported fewer years of education ($t(223) = 1.96$, $p = 0.025$). See Table 1 for baseline medical and demographic variables presented by ADI. HAM-A mean scores were 7.99 (5.98) for women in advantaged neighborhoods, and 9.41 (6.24) for those in disadvantaged neighborhoods ($t(213) = -142$, $p = 0.079$). Statistically significant differences were seen in mean cortisol between ADI categories ($t(120) = -2.35$, $p = 0.020$) are shown in Fig. 1.

In a multivariable linear regression controlling for age, stage, and surgery type, women in disadvantaged neighborhoods had higher cortisol levels than women in advantaged neighborhoods ($\beta = 0.19$, 95% CI [0.24, 5.00], $p = 0.031$). Moreover, in a binary logistic regression accounting for age, stage, and type of surgery, women in disadvantaged neighborhoods were nearly two times as likely to report the presence of elevated anxiety symptoms on the HAM-A (OR = 1.96, 95% CI [1.00, 3.86], $p = 0.050$). See Table 2 and Table 3 for full results of the multivariable linear and logistic regressions. On additional analyses, controlling for age, stage, surgery type, as well as menopausal status and receptor status, women in disadvantaged neighborhoods continued to have higher cortisol levels than women in advantaged neighborhoods (β(SE) = 2.68(1.20), $p = 0.028$).

Conclusion

Our study found that breast cancer patients in disadvantaged neighborhoods had greater evening cortisol levels and were nearly twice as likely to have elevated anxiety symptoms than those in advantaged neighborhoods. These findings remained after controlling for age, stage, and surgery type. Given previous research linking elevated cortisol levels to increased

breast cancer aggressiveness [30–32], these associations may help explain why women with breast cancer living in marginalized neighborhoods have disparate outcomes.

An adverse environment, such as a disadvantaged neighborhood, may lead to chronic stress and negative health behaviors, which are possible pathways to causing or exacerbating chronic diseases, cancer, and increased mortality [5–8]. Psychological stress can evoke physiological stress responses via the hypothalamic–pituitary–adrenal (HPA) axis and sympathetic nervous system (SNS) (Fig. 2) [33]. Activation of these systems leads to the release of cortisol, epinephrine, and norepinephrine, which have downstream effects that can promote tumor biology and suppress antitumor immune responses through catecholamine and glucocorticoid hormone-mediated mechanisms [21]. Stress can also up-regulate inflammatory signaling and lead to psychological and physical “weathering” [20, 31, 34]. While neuroendocrine activation of a stress response can affect the tumor through peripheral circulation, studies in animal models have also shown that tumors can be directly activated by nerves within tumors which has been linked to worse breast cancer outcomes [35, 36]. Glucocorticoids specifically can act directly on cancer cells and the tumor microenvironment to activate cancer cell growth, inhibit apoptosis, and provide an advantageous environment for tumor progression [30, 37–39].

Through activation of the HPA axis, cortisol plays an important role in stress response and signaling in women with breast cancer. Cortisol has a diurnal rhythm, with higher levels in the morning that decrease throughout the day. However, that rhythm can become dysregulated after exposure to chronic stress, inflammation, or disease [33, 40, 41]. Dysregulation leads to flattening of the cortisol slope and elevations of afternoon-evening cortisol, the latter of which was seen in our study in women living in more disadvantaged neighborhoods [40, 41]. In studies on cancer patients, dysregulation of cortisol has been shown to inhibit protective immune responses, promote inflammation, and may facilitate resistance of tumor cells to cytotoxic chemotherapy [33, 42]. Studies in patients with metastatic breast cancer whose night-time cortisol levels were higher had more depressive symptoms and suppressed cell-mediated immunity, and those with flattened or abnormal diurnal cortisol rhythms had earlier mortality [40]. Emerging work in a separate cohort of breast cancer patients from those studied here indicates that greater afternoon–evening cortisol levels in the weeks after surgery are associated with both elevated cancer-specific distress and s100A8/A9 levels, an important breast cancer prognostic marker [43]. Given the current literature, our finding that higher neighborhood deprivation predicts higher levels of cortisol is not surprising but is still a novel association and brings to light a biobehavioral pathway that could explain the effects of neighborhood disadvantage on breast cancer biology and outcomes. These findings add strength to our theoretical model (Fig. 2) that ADI as a stressor may cause a psychological and biological response, respectively.

Anxiety is a stress-related state that exacerbates one’s response to stressful stimuli [44, 45]. Consistent with our findings, one previous study has shown that neighborhood disadvantage (measured by ADI) is associated with elevated anxiety symptoms in cancer patients [46]. Studies have also found that neighborhood disadvantage is associated with markers of biological aging such as DNA methylation patterns and allostatic load in breast cancer survivors [5, 46]. Anxiety in cancer patients has been linked to decreased physiological

function, treatment compliance, psychological function, and quality of life, and may even be an important factor affecting the mortality of breast cancer patients, although studies have not shown consistent findings [44, 45, 47, 48]. A meta-analysis showed that anxiety in cancer patients was associated with increased odds of recurrence and all-cause mortality but not breast cancer-specific survival [44]. One study by Blomberg et al. found that greater anxiety in breast cancer patients was associated with reduced interleukin-2 production, which stimulates activation of natural killer cells and is a growth factor for T cells, both of which contribute to protective immune-cell response to cancer cells [49]. Our finding that women living in disadvantaged neighborhoods were almost twice as likely to have elevated anxiety symptoms at an early point in their treatment is consistent with current literature and supports our theoretical model (Fig. 2). It is important to note, while the clinical cutoff ranges for generalized anxiety disorders for HAM-A are higher than seen in our population, our goal was to use the HAM-A score to quantify the presence of anxiety symptoms, rather than a clinical diagnosis of an anxiety disorder, as a measure of psychologic stress. Additionally, because the HAM-A measures somatic and psychological symptoms, it may also reflect underlying SNS activation associated with anxiety that is not fully measured by cortisol.

The importance of our findings lies in the promise they have to guide future interventions. One approach is through stress reduction interventions for women with breast cancer living in at-risk neighborhoods (high disadvantage). We have already developed a stress reduction intervention shown to decrease evening cortisol [24] and leukocyte pro-inflammatory and pro-metastatic gene expression markers linked with stress, threat, adversity and anxiety [47]. Breast cancer survivors assigned to this intervention have also shown improved breast cancer disease-free survival in a randomized clinical trial [50]. In the context of that study, greater reductions in a leukocyte threat-related gene expression pattern known as the conserved transcriptional response to adversity (CTRA) [51] showed longer DFS over the subsequent 11 years [34, 51, 52]. This intervention—cognitive behavioral stress management (CBSM)—teaches relaxation and cognitive behavioral therapy (CBT) techniques [53], which may provide tools for dealing with both uncontrollable and controllable elements of neighborhood stress. Specifically, CBSM techniques such as relaxation/mindfulness meditation are designed to provide emotion-focused strategies to deal with uncontrollable stressors including neighborhood-level stimuli (poor esthetic quality), while cognitive restructuring and interpersonal skills training (assertiveness and anger management) are designed to provide problem-focused strategies to deal with controllable elements such as anxiety-generating thoughts and social isolation/disruption, respectively, which are also aspects of perceived neighborhood stress. CBSM has already been shown to be feasible, acceptable, and efficacious in improving perceived stress, cancer-specific anxious thoughts, depressive symptoms, and quality of life in lower-income Black breast cancer patients [54] though these studies have not been extended to test for effects on neuroendocrine, immune, tumor biology, and clinical outcomes [22]. The present study provides key information on the stress experienced by breast cancer patients in disadvantaged neighborhoods, justifying efforts to tailor a stress management intervention for this population.

One strength of our study is the recruitment of women in the 2–10 week post-surgical period, a time when they had not yet begun their adjuvant therapy regimens, thus, giving us measures of their stress state free of the confounding effects of chemotherapy and radiation. Another strength is the use of ADI (as opposed to other measures of neighborhood socioeconomic status such as the Yost Index). The ADI provides more flexibly in grouping (as opposed to pre-divided quintiles of the Yost Index); more detailed information integrated in the housing domains; and a smaller geographic measure in the census block group versus the broader census tract [55, 56]. The study was limited by the cross-sectional design, by the generally low-risk nature of the study population as subjects mostly had stage I and II breast cancer, and by the fact that the majority of patients were non-Hispanic White and lived in advantaged neighborhoods (low ADI). Because women in our sample were mostly living in advantaged neighborhoods, this limits generalizability, as this is not the overall distribution in our catchment area [57]. We attempted to mitigate the effects of this on the power of our analyses through our use of ADI grouping. In previous studies, we have used ADI tertiles, in this study we grouped tertile 2 and 3 together (ADI 4–10 group) against tertile 1 to create more equitably sized groups for comparison [57]. The relative proportion of advantaged women in our study may be due to self-selection bias of the participants, where more advantaged patients may be more willing to be involved in research that involves psychologic interventions, have more time and resources to participate, or have generally more trust or comfort with being involved in medical research [58, 59]. The results reported here warrant further investigation in a larger and more diverse cohort. The time period of our cohort limits HER2 receptor status availability as this marker was not in widespread use during the accrual period. We lack access to BMI data, as patients were primarily recruited at community clinics with some incomplete patient information. Another potential limitation would be the use of cortisol alone as a stress biomarker, rather than a more comprehensive array of stress and social adversity markers that include measures of autonomic sympathetic nervous system activity (e.g., norepinephrine levels) or genomic patterns.

To our knowledge, this is the first study to quantify the relationship between breast cancer patient ADI and biological and clinical interview indicators of stress using cortisol and anxiety scores, respectively. This study is consistent with the hypothesis that social adversity-associated stress from a disadvantaged neighborhood leads to biological and psychological changes that may in turn contribute to increased breast cancer progression and poorer clinical outcomes. As clinicians, we have a responsibility to our patients to take their built environment into account when treating them, furthering the goals of precision oncology. Solutions to a stressful built environment should be considered a fundamental part of breast cancer care, such as stress management interventions to reduce anxiety and cortisol levels [47]. Furthermore, our findings can contribute to guiding future therapies, interventions, and health policies focused on mitigating the deleterious effects that a built environment can have on the lives and outcomes of our patients.

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Data availability

The datasets generated and analyzed during the current study are not publicly available and were derived at the University of Miami, but are available from the corresponding author on reasonable request.

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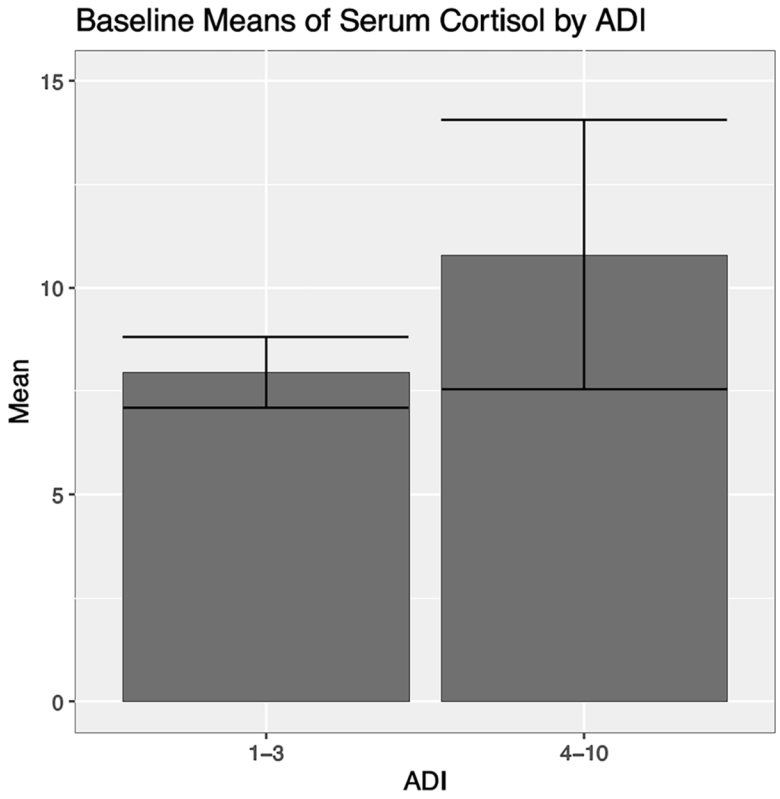

Fig. 1.
Baseline means of serum cortisol by area deprivation index (ADI) groups

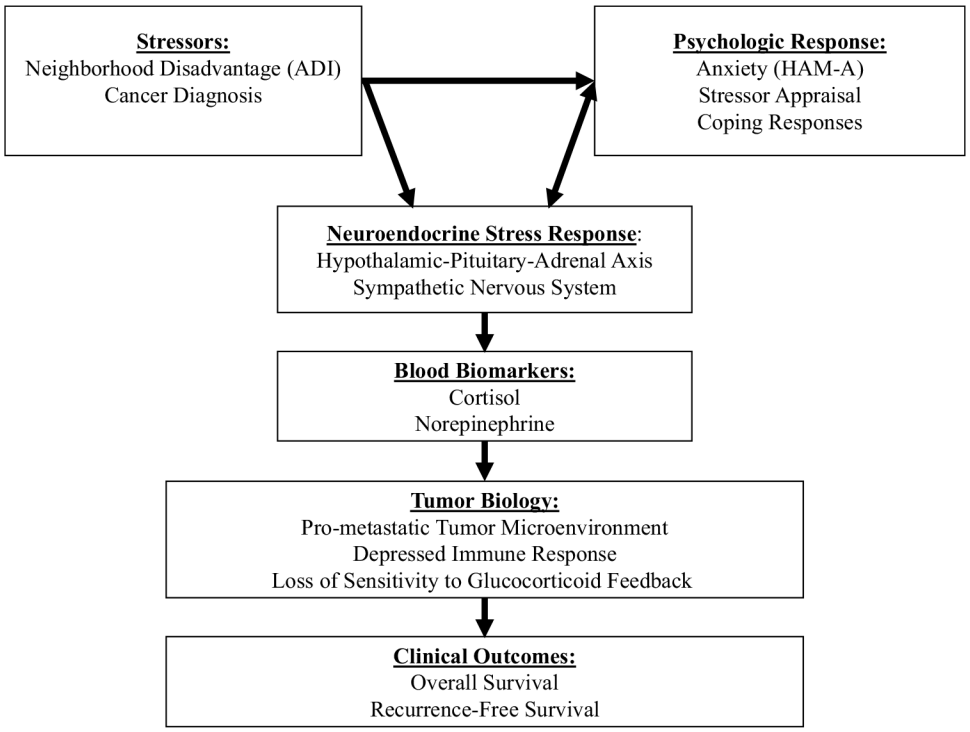

Fig. 2.

Theoretical model of how neighborhood disadvantage-associated stressors activate neuroendocrine stress signaling pathways to affect tumor biology

Table 1

Baseline medical and demographic variables by ADI

Variable	ADI 1–3 (n = 175)	ADI 4–10 (n = 50)	Test statistic	*p*
Age at diagnosis (years)	50.76 (8.88)	49.28 (9.65)	$t(223) = 1.02$	0.309
Race/ethnicity				
Non-hispanic white	119 (68.0%)	25 (50.0%)	$\chi^2(3) = 15.73$	0.001 *
Hispanic	43 (24.6%)	13 (26.0%)		
Black	9 (5.1%)	11 (22.0%)		
Asian	4 (2.3%)	0 (0.0%)		
Stage at diagnosis				
0	24 (13.7%)	10 (20.0%)	$\chi^2(3) = 5.27$	0.153
I	72 (41.1%)	13 (26.0%)		
II	62 (35.4%)	24 (48.0%)		
III	15 (8.6%)	3 (6.0%)		
Household income (thousands)	83.32 (73.85)	68.83 (44.60)	$t(223) = 1.26$	0.104
Years of education	15.74 (2.46)	15.00 (1.98)	$t(223) = 1.96$	0.025 *
Menopausal status				
Pre-menopausal	73 (41.7%)	27 (54.0%)	$\chi^2(2) = 2.55$	0.279
Peri-menopausal	22 (12.6%)	4 (8.0%)		
Post-menopausal	80 (45.7%)	19 (38.0%)		
Hormone receptor status				
ER positive	138 (79.3%)	32 (64.0%)	$\chi^2(2) = 4.98$	0.026 *
ER negative	36 (20.7%)	18 (36.0%)		
Surgery type				
Lumpectomy	90 (51.4%)	27 (54.0%)	$\chi^2(1) = 0.08$	0.776
Mastectomy	84 (48.0%)	23 (46.0%)		
Cortisol (μg/dL)	7.95 (4.13)	10.80 (9.17)	$t(120) = -2.35$	0.020 *
HAM-A scores	7.99 (5.98)	9.41 (6.24)	$t(213) = -1.42$	0.079

SE standard error; *CI* confidence interval; *ADI* area deprivation index

* $p < .05$

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Table 2

Multiple regression illustrating relationship between ADI and serum cortisol

Variable	Evening-time serum cortisol				
	Unstandardized			Standardized	
	B	SE	B [95% CI]	*β*	*p*
ADI (REF = low ADI 1–3 (v. high ADI 4–10)	2.62	1.20	[0.24, 5.00]	0.19	0.031*
Age	− 0.14	0.06	[− 0.26, − 0.02]	− 0.21	0.022*
Surgery type (REF = lumpectomy (v. mastectomy))	0.54	1.12	[− 1.67, 2.74]	0.05	0.632
Stage (0-III)	0.07	0.69	[− 1.29, 1.44]	0.01	0.916
Total model *adjusted* R^2 = .07, F [4,117] = 3.13, p = .017					

SE standard error; *CI* confidence interval; *ADI* area deprivation index

* $p < .05$

Table 3

Logistic regression illustrating relationship between ADI and elevated anxiety on HAM-A clinical interview

Variable	HAM-A presence of anxiety symptoms (score > 7)				
	Unstandardized		Standardized		*pss*
	B	SE	OR	OR [95% CI]	
ADI (REF = Low ADI 1–3 (v. high ADI 4–10)	0.68	0.35	1.96	[1.00, 3.86]	0.050 *
Age	− 0.03	0.02	0.97	[0.94, 1.01]	0.061
Surgery type (REF = lumpectomy (v. mastectomy))	− 0.05	0.30	0.95	[0.53, 1.71]	0.873
Stage (0-III)	0.12	0.17	1.13	[0.80, 1.59]	0.482
Total model *Cox and snell* R^2 = .04, $\chi^2(4) = 9.34$, $p = .053$,					

HAM-A hamilton anxiety rating scale; *SE* standard error; *CI* confidence interval; *OR* odd's ratio; *ADI* area deprivation index

* $p < .05$