

Multilevel Examination of Health Disparity: The Role of Policy Implementation in Neighborhood Context, in Patient Resources, and in Healthcare Facilities on Later Stage of Breast Cancer Diagnosis



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Abstract

Background: There is a substantial racial/ethnic disparity in female breast cancer mortality in Chicago between non-Hispanic black (NHblack) and Hispanic patients compared with their non-Hispanic white (NHwhite) counterparts. This observation prompted a multilevel examination of factors that might account for the disparity, with the goal of identifying potential policy interventions that might meaningfully address it.

Methods: In the Breast Cancer Care in Chicago study, 411 NHblack, 397 NHwhite, and 181 Hispanic patients diagnosed between the ages of 30 and 79 were interviewed, and medical records were abstracted for information on screening and diagnostic follow-up. We conducted a multilevel analysis to assess the role of neighborhood context, patient resources, facility characteristics, and mode of detection in determining the disparity in later stage at diagnosis.

Results: After adjustment for neighborhood context, mode of detection, and facility accreditation/resources, there was no

significant disparity in later stage breast cancer diagnosis between NHblack or Hispanic patients compared with NHwhite patients.

Conclusions: The results suggest that racial/ethnic differences in mode of detection and facility accreditation/resources account for most of the disparity in stage at diagnosis. Understanding the causes of differential screen detection and access to highly accredited facilities could inform interventions to meaningfully address this disparity.

Impact: Multilevel approaches to studying health disparities are becoming the research standard for understanding and addressing health disparities. Optimal design of multilevel interventions addressing disparities in later stage diagnosis would benefit from enhanced understanding of pathways to detection and diagnosis available to patients in medically underserved communities.

Introduction

Despite improvements in overall survival from breast cancer, racial and ethnic disparities in survival in the United States remain (1–3). Access to mammography and diagnostic follow-up of abnormal screens, which permit identification of breast cancer at early stages when prognosis is most favorable, play an important role in these disparities. In particular, minority and socioeconomically disadvantaged women are more likely to be screened at lower resourced and nonaccredited facilities (4, 5), experience delays in care (6), and are less likely to be referred to compre-

hensive care centers for follow-up (4, 5). For disadvantaged women, the processes of referral for screening, getting screened, and receiving high quality follow-up care in a timely manner is complex. The process is affected at multiple levels, ranging from national level policies, to neighborhood context to patient and facility characteristics.

Using data from a study conducted in Chicago, we conducted an analysis in a multilevel framework to further understand how disparities in later stage at diagnosis among Hispanic and non-Hispanic black patients (NHblack) compared with non-Hispanic white patients (NHwhite) come about and might be reduced. (7–9) Our ultimate goal was to identify potential policy interventions that might meaningfully address the problem.

At the time of data collection for this study (2005–2008), Chicago was one of the most racially and ethnically segregated cities in the United States. (10–12) Low income and racial and ethnic minority patients, largely residing in medically underserved communities on the south and west sides of the city, often received their care in under resourced safety net hospitals and public health clinics (4, 5, 13). Residents of the more racially, ethnically, and socioeconomically diverse north and east sides were more likely to receive their care at academic and high volume health centers primarily located there (4, 5). Breast screening and

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diagnosis at safety net hospitals was often fragmented. Referral for guideline-concordant specialty care to accredited facilities usually required travel outside the patient's area of residence. Choice was further constrained by whether the patient's provider network, established by third-party payers, included accredited facilities (4, 5, 14) Reimbursement policy, distance, and the primary care provider's (PCP) preferences often resulted in patient referral for diagnostic follow-up of an abnormal mammogram to a local safety net hospital. These hospitals in turn, often lack the full range of diagnostic and treatment options requiring that patients be referred elsewhere for diagnostic resolution of an abnormal mammogram (4, 5, 15).

Conceptual model

Models by Taplin, Zapka, and Warnecke (7, 16, 17) inform our multilevel logic model focused on the influence of policy implementation on patient outcomes during mammography screening and follow-up. Details of the model are shown in Figure 1.

Level 1, Policy Creation and Implementation, refers to agencies, institutions, and professional associations which create policy. The American College of Radiology (ACR) defines current standards for radiologic screening and follow-up and accredits high-performing facilities as Breast Imaging Centers of Excellence (BICOE; refs. 18, 19). Federal and state agencies including Medicare and Medicaid (CMS) determine criteria for designation of

disproportionate share (DSH) hospitals. The Centers for Disease Control and Prevention (CDCP), the Illinois Breast and Cervical Cancer Program (IBCCP), create and define reimbursement criteria and eligibility for free services. The Health Resources and Service Administration's Bureau of Primary Care designates communities as medically underserved areas or populations (MUA/MUP). The U.S. Preventive Services Task Force (USPSTF) defines the evidence base for reimbursement and provides a rationale for reimbursement policies.

Level 2, Neighborhood Context, focuses primarily on neighborhood designation as MUA/MUP, which carries with it capital support for implementing federally qualified health centers (FQHC), prospective payment for patient care, discounted drug pricing, free vaccines, and assistance in recruiting and retaining PCPs. It is necessary to apply for such a designation and proposals from a particular area must demonstrate significant community participation. Failure to receive designation limits the development of community health centers and requires patient travel for health care services at accredited facilities outside their neighborhood (6, 13, 14). Furthermore, details on designation criteria are discussed below.

Level 3, Patient Resources and Reimbursement Criteria, refers to patient resources and policies that affect patient control and access to resources and service reimbursement for mammography and follow-up care. Sociodemographic factors, including age, race/ethnicity, education, household income and insurance

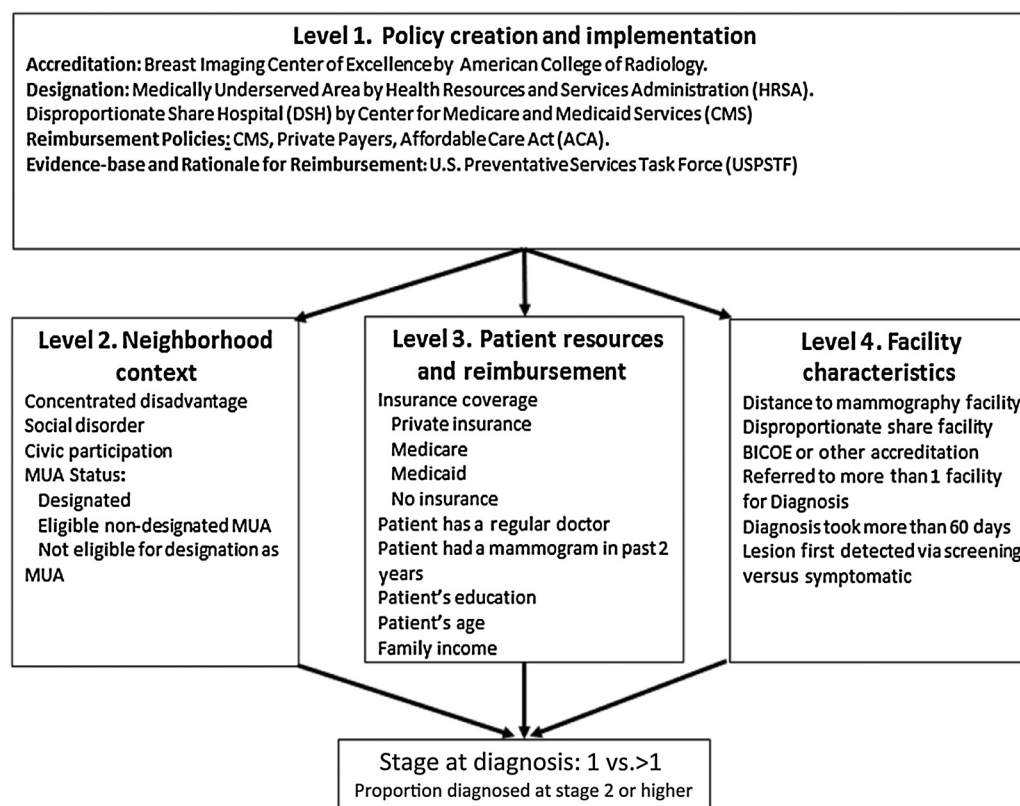


Figure 1.

Multilevel model of hypothesized pathways of influence on disparity in stage of breast cancer diagnosis. Figure 1 represents a multilevel model for the analysis of the influence of policy on stage at diagnosis. Level 1 includes policies that could influence the outcome stage at diagnosis. Levels 2, 3, and 4 represent the locations of potential policy influence.

status, affect the level of control the patient has over access to mammography and necessary diagnostic work-up following an abnormal mammogram. Insurance is a primary determinant of access to guideline concordant care (4, 5, 14). Reimbursement policies differ across Medicare, Medicaid, and private insurance. Moreover, if the patient's insurance provider network does not include a highly accredited provider (e.g., BICOE-accredited facility) in the patient's network, the PCP may not know of or consider such referrals. Other relevant resources include having a regular source of primary care, a history of regular screening mammography, and knowledge and eligibility for programs IBCCP or charities.

Level 4, Facility Characteristics, considers the influence of policies governing proximal factors influencing how the tumor is first detected: these include level of facility accreditation, and DSH designation of facilities, a marker for low resources (5). Accreditation as a BICOE by the ACR indicates the screening program exceeds the national standard for mammography screening and follow-up for diagnosis (5). In Chicago, at the time of this research, 11 full service or academic facilities had BICOE designation. During this period, many patients received mammograms and diagnostic follow-up at unaccredited facilities (4, 5).

We hypothesized that access to accredited sources of screening and follow-up was an important deterrent of later stage breast cancer diagnosis but that such access depended on local practice regarding referral. For example, if a PCP made a referral for mammography or follow-up diagnosis to a facility that was able to provide follow-up diagnostic imaging then the referral will be more likely to lead to timely diagnosis (6, 20, 21). However, if the PCP referral was to a local DSH hospital that was unable to provide the recommended diagnostic follow-up, diagnostic resolution might require one or more additional referrals resulting in additional delays (4–6).

Materials and Methods

Sample

Between 2005 and 2008, with the assistance of the Illinois State Cancer Registry, the Breast Cancer Care in Chicago study (BCCC) identified 1,754 patients with newly diagnosed breast cancer, using rapid case ascertainment from 54 hospitals located in and adjacent to Chicago. These patients were invited to participate in a survey designed to track their experience from initial discovery of a lesion through diagnosis. Eligible patients were female, diagnosed between ages 30 and 79, and Chicago residents when diagnosed. A total of 989 patients, including 411 (42%) NHblack patients, 397 (40%) NHwhite patients, and 181 (18%) Hispanic patients, completed a 90-minute computer-assisted personal interview representing a 56.4% response rate. A set of post stratification weights brought the sample back to approximately the distribution of the initial population of 1,754 patients. From medical record data on 857 consenting patients, we obtained information on pathologic stage at diagnosis, tumor characteristics, and information on date of diagnosis (22). We obtained verbal consent at the time the patient was recruited and written consent at the time of the face to face interview. The Institutional Review Boards of the University of Illinois at Chicago (UIC) and the State of Illinois Department of Public Health approved the BCCC study.

Measures

Stage at diagnosis was determined from the surgical pathology report abstracted from the patient's medical record and assigned

using the American Joint Commission on Cancer staging system (22). Stage was dichotomized at the point where patients with breast cancer are most likely to have the best outcome from early detection and guideline concordant diagnostic follow-up. Stage 0 is *in situ* or cancer cells that have not invaded into breast tissue; stage 1 consists of smaller tumors that are confined to the breast. Stages 2 to 4 define larger tumors and those with regional or distant spread to lymph nodes and adjacent or distant organs. Stages 0 and 1 were coded as early stage and 2, 3, and 4 are coded as later stage in this analysis (23).

Neighborhood context

Index of concentrated disadvantage. Index of concentrated disadvantage, based on data from the 2010 census, is a census tract-level measure based on the sum of the proportion of residents in each census tract below the poverty line, unemployed, female heads of households, under age 18 years (24–26).

MUA designation. All census tracts in Chicago are clustered into 77 community areas. For each area eligibility for designation as MUA/MUP depends on a score between 0 and 62.5 on the Index of Medical Underservice (IMU), composed of four elements: ratio of PCPs per 1,000 population, the infant mortality rate, percent of population with incomes below the poverty rate, and percent over age 65. In Chicago between June 4, 1984 and August 28, 2008, 39 had IMU scores from 36.7 to 61.8 and were designated MUA/MUPs. Seven other eligible communities, which scored from 48.6 to 61.7, were never designated (27). At the time of this study, the rate of poverty in eligible but never designated areas was 26% compared with 23% and 13% in designated and not eligible areas, respectively. There were 195 safety net clinics in the designated areas compared with 15 in the eligible but never designated areas (27).

At their initial contact with the project, patients provided their home address from which we assigned patient's residence in areas that were either designated, eligible but never designated, or not eligible for MUA/MUP designation. The patient's address also was used to calculate driving time as the measure of distance to the facility.

Patient resources and health care access

The BCCC assessed past cancer screening behavior by whether the patient received a mammogram within 2 years. Whether the patient self-reported that she had a regular doctor was also obtained in the interview. Insurance was included as a component of patient resources and coded as private (no Medicaid or Medicare), Medicare (solely or with a private supplement), Medicaid (regardless of other insurance), or no insurance. This classification is mutually exclusive and exhaustive. A count of comorbidities ranging from zero to six was also obtained during the BCCC interview as were race, ethnicity, patients' date of birth, years of schooling, and family income. Age and education were measured in years; family income was measured categorically and recoded to midpoints in thousands of dollars.

Policy and facility characteristics

Accreditation of the facility of medical presentation is defined as accredited by the American College of Radiology as a BICOE (18). In Chicago, 11 mammography facilities were designated as BICOE. Twenty-three percent ($N = 26$) of the facilities including nonhospital sites and public health facilities included in this analysis were designated as disproportionate share facilities

(DSH) by the state of Illinois. The BCCC ascertained the number of referrals involved in the diagnosis and dichotomized it as one or more than one facility visited. Diagnostic delay was defined as more than 60 days between self-reported date of first medical presentation and the date of a definitive diagnosis/biopsy. Mode of detection was based on the patients' responses to a series of questions at interview and defined as symptomatic (lump, pain, clinical breast exam, etc.) versus screen detection (asymptomatic, routine radiologic screening).

Descriptive statistics

Table 1 shows raw sample sizes, unweighted means or percentages, and SDs for all variables by race/ethnicity prior to missing data imputation. Results for dichotomous variables are reported as percentages. As noted previously, 18% of the respondents were of Hispanic origin. The remainder were split about equally between NHwhite and NHblack, about 40% each. Thirty-five percent of NHwhite patients had later stage breast cancer (stage 2–4 vs. 0, 1) compared with 47% of NHblack and 53% of Hispanic patients.

About half of the patients lived in areas not eligible for designation as MUA/MUP. NHwhite patients were considerably less likely than NHblack and Hispanic patients to live in designated MUAs/MUPs (29% vs. 46% and 53%, respectively) or to live in eligible but undesignated areas (0.5% vs. 24% and 2%, respectively).

Nearly all patients (86%) reported having a regular doctor. About 40% had either Medicare or Medicaid, 70% reported private insurance, and 12% were uninsured. NHwhite patients

were more likely than NHblack and Hispanic patients to be covered by private insurance (54% and 41%, respectively); Hispanic patients were most likely to be uninsured.

Compared with NHwhite patients (11%), NHblack and Hispanic patients were more likely to be diagnosed at a DSH facility (37% and 47% vs. 11%, respectively), to be referred to more than one facility, (36% and 47% vs. 26%) to experience a diagnostic delay in excess of 60 days (27% and 32% vs. 12%) and less likely to be diagnosed at a BICOE facility (46% and 49% vs. 81%). Finally, NHwhite patients were more likely than NHblack or Hispanic patients to have their breast cancer initially detected through screening (59% vs. 47% and 42%, respectively).

Missing data imputation

As shown in Table 1, there was a considerable amount of missing data on stage at diagnosis (13%), drive-time to mammography facilities (10%), diagnostic delay (8%), and household income (4%), resulting in 713 of 989 patients with complete data on all variables. To account for missing data, we used multiple imputation methods as implemented in Stata version 14 (28, 29). We used a "fully conditional" approach to impute 50 datasets (28), using a separate statistical model appropriate for each variable with missing data. The dichotomous variables, later stage and diagnostic delay, were modeled using logistic regression. Income and drive time to mammography, continuous variables having skewed distributions, were modeled using predictive mean matching. The predictor variables in the imputation models

Table 1. Descriptive statistics by race/ethnicity

Variable	Total N 989	White 397	Black 411	Hispanic 181	P ^a
Stage at diagnosis (N = 857) ^{b,c}					0.003
0	200 (23%)	93 (27%)	81 (23%)	26 (16%)	
1	289 (34%)	131 (38%)	109 (31%)	49 (30%)	
2	255 (30%)	89 (26%)	108 (31%)	58 (36%)	
3	97 (11%)	28 (8%)	46 (13%)	23 (14%)	
4	16 (2%)	2 (1%)	9 (3%)	5 (3%)	
Concentrated disadvantage ^d	-0.00 (3.02)	-2.13 (1.34)	2.18 (3.05)	-0.28 (1.99)	<0.001
MUA status ^c					<0.001
Noneligible	487 (49%)	281 (71%)	125 (30%)	81 (45%)	
Designated MUA	399 (40%)	114 (29%)	189 (46%)	96 (53%)	
Eligible, nondesignated	103 (10%)	2 (1%)	97 (24%)	4 (2%)	
Drive time to mammography (minutes; N = 887) ^{b,d}	17.6 (12.7)	17.2 (13.8)	18.34(12.1)	16.6 (11.0)	0.253
Age (years) ^d	56.0 (11.3)	55.9 (11.2)	56.9 (11.2)	54.3 (11.6)	0.043
Education (years) ^d	13.1 (3.1)	14.6 (2.4)	12.9 (2.2)	10.4 (4.0)	<0.001
Family income (000's; N = 952) ^{b,d}	60.6 (58.0)	93.0 (66.3)	39.5 (39.5)	38.9 (39.2)	<0.001
Regular doctor ^e	854 (86%)	354 (89%)	355 (86%)	145 (80%)	0.013
Comorbidities (count) ^d	0.71 (1.03)	0.52 (0.89)	0.90 (1.09)	0.69 (1.09)	<0.001
Insurance coverage ^c					<0.001
Private	524 (53%)	282 (71%)	166 (40%)	76 (42%)	
Medicare	205 (21%)	83 (21%)	94 (23%)	28 (15%)	
Medicaid	140 (14%)	13 (3%)	94 (23%)	33 (18%)	
None	120 (12%)	19 (5%)	57 (14%)	44 (24%)	
Mammogram within past 2 years ^e	630 (64%)	259 (65%)	261 (64%)	110 (61%)	0.585
Disproportionate share facility ^e	279 (28%)	42 (11%)	152 (37%)	85 (47%)	<0.001
BICOE-accredited facility ^e	600 (61%)	321 (81%)	190 (46%)	89 (49%)	<0.001
Visited more than one facility for dx ^e	335 (34%)	103 (26%)	147 (36%)	85 (47%)	<0.001
Dx delayed more than 60 days (N = 856) ^{b,e}	199 (22%)	45 (12%)	100 (27%)	54 (32%)	<0.001
Radiologic dx ^e	507 (51%)	236 (59%)	195 (47%)	76 (42%)	<0.001

Abbreviations: dx, diagnosis.

^a χ^2 tests on categorical variables, ANOVA on continuous.

^bReduced N due to missing data.

^cCategorical variable (N, %).

^dContinuous variable (mean, SD).

^eDichotomous variable (N, %).

Table 2. Imputation results

Variable	Observations			Total
	Complete	Incomplete	Imputed	
Later stage diagnosis	852	125	120	977
Diagnosis took >60 days	902	75	71	977
Drive time to mammography	883	94	91	977
Family income	849	28	27	977

consisted of all analysis variables with complete data and two "auxiliary variables," whether the respondent survived for 5 years following diagnosis and an initial estimate of stage at diagnosis, obtained during initial case finding prior to definitive surgery. Table 2 summarizes the imputation process. After imputation and after eliminating a few cases with scattered missing data, our final analytic weighted sample contained 977 cases.

Results

Bivariate associations

Table 3 shows bivariate associations between each of the independent variables and later stage diagnosis, again prior to missing data imputation. Although the strength of association varies as measured by the OR from logistic regression, almost all variables are statistically significant. The exceptions are drive time to mammography, family income, comorbidity count, and diagnostic delay. However, all neighborhood context and institutional variables were significantly associated with later stage. Given the complex pattern of associations among these variables we retained all of them in the multivariate models reported below. We then estimated a sequence of multivariate logistic regression models for later stage, with variables entered into the model in the order corresponding to the multilevel theoretical approach described earlier and in Fig. 1.

Table 3. Bivariate associations with late-stage diagnosis

Variable	OR	P	LCI	UCI
Race/Ethnicity				
NHblack	1.560	0.004	1.151	2.122
Hispanic	1.941	0.001	1.313	2.871
NHwhite (ref)	1.000			
Concentrated disadvantage	1.072	0.004	1.022	1.124
MUA status				
Designated MUA	1.368	0.036	1.021	1.833
Eligible, nondesignated	1.914	0.008	1.181	3.101
Noneligible (ref)	1			
Drive time to mammography (minutes)	0.996	0.499	0.985	1.007
Age	0.972	0.000	0.960	0.985
Education (years)	0.955	0.051	0.913	1.000
Family income (000's)	0.999	0.662	0.997	1.002
Regular doctor	0.540	0.003	0.361	0.808
Comorbidities (count)	0.881	0.154	0.780	1.040
Insurance coverage				
Medicare	0.673	0.031	0.470	0.965
Medicaid	1.404	0.101	0.936	2.106
No insurance	1.377	0.139	0.901	2.104
Private (ref)	1.000	0.029	0.527	0.996
Mammogram within 2 years	0.484	0.000	0.363	0.645
Disproportionate share facility	1.403	0.030	1.033	1.907
BICCOE-accredited facility	0.564	0.000	0.425	0.749
Visited more than one facility for dx	2.661	0.000	1.978	3.579
Diagnosis delayed more than 60 days	0.948	0.767	0.665	1.352
Radiologic dx	0.128	0.000	0.092	0.176

Abbreviations: dx, diagnosis; LCI, lower confidence interval; ref, referent; UCI, upper confidence interval.

To deal with the collinear relationship between race/ethnicity and MUA/MUP status, we created indicator variables corresponding to the cells of the cross classification of MUA/MUP status and race/ethnicity. Two strata corresponding to NHwhites and Hispanics residing in MUA/MUP eligible but not designated areas had very small sample sizes (2 and 4, respectively). These 6 cases were dropped from further analysis.

Results are shown in Table 4. Model 1 shows unadjusted ORs for later stage diagnosis among the groups jointly defined by MUA/MUP status and race/ethnicity, compared with NHwhites in noneligible areas (referent). For example, the ORs of a later stage diagnosis for NHblacks living in eligible not designated areas are 2.31 times as high as the reference group. For NHblacks living in MUA/MIUP-designated areas the ORs is 1.65. Hispanic odds are 2.24 for residents in not-eligible areas and 2.94 for those in designated areas relative to the reference group.

After adjustment for concentrated disadvantage and drive time to mammography, (model 2) all of the ORs for the race/ethnicity-MUA disparity in later stage were modestly attenuated but most remained significantly elevated compared with the referent (NHwhite patients residing in ineligible areas). The exceptions were comparison of NHblacks residing eligible but not designated area and all Hispanics regardless of residence.

After controlling for patient resources in model 3, none of the race/ethnicity-MUA disparity ORs for later stage were materially changed and all remained significant or marginally so. In particular, the disparity ORs for NHblacks living in eligible not designated areas remained substantially elevated (OR = 2.53). The disparity ORs for Hispanics, regardless of residence area also remained substantially elevated. Patients who received a mammogram in the previous 2 years had a one-third lower OR of a late-stage diagnosis (OR = 0.645).

Finally, after controlling additionally for facility variables (including accreditation, DSH designation, diagnostic delay, whether more than one facility was visited in the diagnostic process) and mode of detection in model 4, the disparity ORs for all race/ethnicity-MUA groups compared with the referent were substantially diminished and only the OR for NHblacks living in eligible but not designated areas remained marginally elevated. Detection through screening was strongly inversely associated with later stage diagnosis (OR 0.13). In addition, diagnosis at a BICOE-accredited facility was marginally and inversely associated with later stage diagnosis (OR 0.693).

Discussion

The focus of this study is the effect of various levels of policy on disparity between NHwhite female patients with breast cancer and NHblack and Hispanic patient with breast cancer on later stage of diagnosis of breast cancer. After adjustment for policies affecting neighborhood context, mode of detection, and facility accreditation/resources, there was no significant disparity in later stage breast cancer diagnosis between NHblack or Hispanic patients compared with NHwhite patients. The results suggest that racial/ethnic differences in mode of detection and facility accreditation/resources account for most of the disparity in stage at diagnosis.

Comparison of patients in MUA/MUP-designated areas with areas eligible but never designated provides another dimension to existing literature on how community organization may affect service delivery and potentially health outcomes like later stage at

Table 4. Multivariate logistic regression models^a

Variable	Model 1: Race/ethnicity				Model 2: Neighborhood			
	OR	P	LCI	UCI	OR	P	LCI	UCI
Race/ethnicity/MUA								
NHwhite-designated MUA	1.609	0.055	0.990	2.615	1.551	0.076	0.955	2.519
NHblack noneligible	1.609	0.046	1.008	2.570	1.357	0.258	0.799	2.302
NHblack-designated MUA	1.650	0.016	1.096	2.485	1.410	0.177	0.856	2.321
NHblack eligible, nondesignated	2.431	0.001	1.450	4.077	2.004	0.025	1.090	3.684
Hispanic noneligible	2.238	0.005	1.280	3.913	2.109	0.010	1.199	3.710
Hispanic-designated MUA	2.294	0.001	1.390	3.787	2.049	0.008	1.211	3.468
NHwhite noneligible (ref)	1.000				1.000			
Concentrated disadvantage					1.043	0.186	0.980	1.111
Drive time to mammography					0.994	0.378	0.982	1.007
Model 3: Patient								
Variable	OR	P	LCI	UCI	Model 4: Organizational			
OR	P	LCI	UCI	OR	P	LCI	UCI	
Race/ethnicity/MUA								
NHwhite-designated MUA	1.571	0.080	0.947	2.604	1.326	0.327	0.754	2.330
NHblack noneligible	1.622	0.090	0.928	2.836	1.273	0.470	0.661	2.454
NHblack-designated MUA	1.462	0.157	0.864	2.472	1.081	0.803	0.587	1.991
NHblack eligible, nondesignated	2.528	0.005	1.324	4.829	1.865	0.092	0.904	3.848
Hispanic noneligible	2.082	0.019	1.126	3.850	1.520	0.243	0.752	3.071
Hispanic-designated MUA	1.847	0.052	0.994	3.432	1.321	0.448	0.643	2.711
NHwhite noneligible (ref)	1.000				1.000			
Concentrated disadvantage	1.037	0.292	0.969	1.110	1.036	0.384	0.957	1.121
Drive time to mammography	0.991	0.180	0.979	1.004	0.988	0.100	0.973	1.002
Age	0.978	0.016	0.961	0.996	0.996	0.704	0.976	1.017
Education	0.971	0.359	0.912	1.034	0.968	0.375	0.901	1.040
Family income	1.002	0.143	0.999	1.006	1.004	0.037	1.000	1.007
Regular doctor	0.754	0.225	0.478	1.190	0.954	0.852	0.578	1.573
Comorbidities	0.940	0.453	0.799	1.105	0.987	0.893	0.814	1.196
Insurance coverage								
Medicare	1.023	0.925	0.639	1.638	1.019	0.946	0.594	1.747
Medicaid	1.249	0.380	0.760	2.052	1.224	0.478	0.700	2.141
No insurance	0.933	0.793	0.558	1.561	0.903	0.729	0.506	1.611
Private (ref)	1.000				1.000			
Mammogram within 2 years	0.645	0.010	0.462	0.901	0.885	0.509	0.616	1.272
Disproportionate share facility					1.018	0.933	0.677	1.531
BICOE-accredited facility					0.693	0.051	0.480	1.001
Visited more than one facility for dx				0.939	0.760	0.628	1.404	
Dx delayed >60 days					0.784	0.290	0.500	1.230
Radiologic dx					0.132	0.000	0.089	0.196

Abbreviations: dx, diagnosis; LCI, lower confidence interval; ref; referent; UCI, upper confidence interval.

^aResults are based on multiple imputation of weighted data.

diagnosis (20, 26, 27, 30–33). But designation is primarily related to NHblack and NHwhite disparity and in the end, the primary issues related to disparity in later stage at diagnosis appear to be access to mammography and follow-up at accredited facilities.

Although the relationship between race/ethnicity and MUA/MUP status is complex, by creating a set of indicator variables to represent the joint relationship we were able to determine that after controlling on neighborhood characteristics in model 2, first, regardless of where they live, Hispanics suffered a disparity relative to NHwhites who live in ineligible areas and second, NHblacks living in eligible but undesignated areas also were at a disadvantage compared with the reference group. This pattern persisted in model 3. However, the disparities were eliminated after controlling on level four variables (organizational characteristics) in model 4.

Limitations

There are aspects of this study that limit its generalizability. First, the data were cross-sectional and the experiences were self-reported. Although medical record data confirmed some dates such as when screening and diagnostic follow-up took place, we

had no information on the systemic aspects of the process, particularly the patterns of interaction between patients, primary care providers, and specialists.

Second, patients were interviewed between 2005 and 2008, prior to the introduction of the Affordable Care Act (ACA). At that time, the disparity in breast cancer mortality between NHblack and NHwhite patients in Chicago was 68% higher than the national disparity (11). Recent data indicate that the Chicago mortality disparity is equal to national disparity level 48% (11, 12, 15). This significant change probably reflects increased insurance coverage due to the ACA and local efforts in patient navigation to improve screening and follow-up at DSH hospitals and the implementation of state-wide quality assurance program supported with state funding (34).

Third, access to primary care in the eligible, but never designated areas, was more limited than in the designated areas and the literature contains several studies documenting the lack of integration of the primary care practices with specialty care providers, more generally (21, 22, 35, 36).

Finally, although modest, the study response rate of 54% is in line with response rates found in current surveys. Registrars who

collected data for the Illinois State Cancer Registry identified eligible patients and provided information on diagnosing facility and patient age and race ethnicity for those whom they could not contact, enabling us to create post stratification weights that brought the distribution of our analysis sample closer to the total population of eligible patients with breast cancer during the study period.

However, our findings are consistent with findings from other research about the experience of disadvantaged women in obtaining a mammogram and where necessary follow-up diagnosis of an abnormality conducted during our study period. Those results showed that women were more likely to be screened at lower resourced and nonaccredited facilities (4, 5) to experience delays in care (6) and less likely to be referred to comprehensive care centers for follow-up (4, 5).

Recommendations for further research

Optimal design of multilevel interventions addressing disparities in later stage breast cancer diagnosis should focus on the health care system and would benefit from enhanced understanding of pathways to detection and diagnosis available to patients in medically underserved communities and potential incentives for improvements that enhance the process. Future studies should track patients through the process from initial receipt of an abnormal screening mammogram result through diagnostic resolution and collect detailed data on patient and provider interaction and the resulting barriers related to travel burden, insurance networks of care, copays and deductibles, inability to obtain timely appointments, missed appointments by the patient; primary care requirements for return visits for new orders rather than providing a global order for follow-up, unnecessary repetition of diagnostic procedures, and other factors.

Multilevel approaches to studying health disparities are becoming the research standard for understanding and addressing health disparities (7–9) It is worth noting that multilevel approaches to policy are already an important tool in public health, as demonstrated by the successful policy outcomes in tobacco use and other areas such as energy balance behavior and HPV vaccination. This and other studies (4, 11, 13, 22, 26, 31, 32) conducted in Chicago strongly support a policy focus including exploration of policies and incentives to increase referrals to BICOE facilities and to support facilities in obtaining BICOE designation. Navigation research studies could be developed to study how to best increase referrals to BICOE facilities and overcome systematic barriers to accessing them (8, 34) New research should also address insur-

ance and the role of primary care including mergers of PCP clinic systems with specialty care providers and other attempts to integrate primary care in safety net clinics into specialty care practice. Our study did not allow actual assessment of the primary care role in the process in Chicago.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

Conception and design: R.B. Warnecke, R.T. Campbell, G. Vijayasiri, R.E. Barrett, G.H. Rauscher

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Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): R.B. Warnecke, G. Vijayasiri, R.E. Barrett

Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): R.B. Warnecke, R.T. Campbell, G. Vijayasiri, R.E. Barrett, G.H. Rauscher

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Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): R.B. Warnecke, R.T. Campbell, G. Vijayasiri, R.E. Barrett

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References

- Jemal A, Ward EM, Johnson CJ, Cronin KA, Ma J, Ryerson B, et al. Annual Report to the Nation on the Status of Cancer, 1975–2014, featuring survival. *J Natl Cancer Inst* 2017;109:1–22.
- Maskarinec G, Sen C, Koga K, Conroy SM. Ethnic differences in breast cancer survival: status and determinants. *Womens Health* 2011;7:677–87.
- O'Keefe EB, Meltzer JP, Bethea TN. Health disparities and cancer: racial disparities in cancer mortality in the United States, 2000–2010. *Front Public Health* 2015;3:51.
- Rauscher GH, Allgood KL, Whitman S, Conant E. Disparities in screening mammography services by race/ethnicity and health insurance. *J Womens Health* 2012;21:154–60.
- Rauscher GH, Murphy AM, Orsi JM, Dupuy DM, Grabler PM, Weldon CB. Beyond the mammography quality standards act: measuring the quality of breast cancer screening programs. *AJR Am J Roentgenol* 2014;202:145–51.
- Molina Y, Silva A, Rauscher GH. Racial/ethnic disparities in time to a breast cancer diagnosis: the mediating effects of health care facility factors. *Med Care* 2015;53:872–8.
- Warnecke RB, Oh A, Breen N, Paskett E, Tucker KL, Nicole Lurie N, et al. Approaching health disparities from a population perspective: the National Institutes of Health centers for population health and health disparities. *Am J Public Health* 2008;98:1608–15.
- Paskett E, Thompson B, Ammerman AS, Ortega AN, Marsteller J, Richardson D. Multilevel interventions to address health disparities show promise in improving population health. *Health Aff* 2016;35:1429–34.
- Croyle RT, Srinivasan S. Informing future population health interventions. *Cancer Epidemiol Biomarkers Prev* 2016;25:583.
- Iceland JD, Weinberg H, Steinmetz E. Racial and ethnic segregation in the United States: 1980–2000. Washington (DC): U.S. Census Bureau; 2002.

11. Hunt BR, Whitman S, Hurlbert MS. Increasing black:white disparities in breast cancer mortality in the 50 largest cities in the United States. *Cancer Epidemiol* 2014;38:118–23.
12. Sighoko D, Murphy AM, Irizarry B, Rauscher G, Ferrans C, Ansell D. Changes in the racial disparity in breast cancer mortality in the ten US cities with the largest African American populations from 1999 to 2013: the reduction in breast cancer mortality disparity in Chicago. *Cancer Causes Control* 2017;28:563–8.
13. Patrick G, Bisgaier J, Hasham I, Navarra T, Hickner J. Specialty care referral patterns for the underserved: a study of community health centers on the south side of Chicago. *J Health Care Poor Underserved* 2011;22:1302–14.
14. Rauscher GH, Conant EF, Kahn JA, Berbaum ML. Mammogram image quality as a potential contributor to disparities in breast cancer stage at diagnosis: an observational study. *BMC Cancer* 2012;13:208–15.
15. Hirschman J, Whitman S, Ansell D. The black:white disparity in breast cancer mortality: the example of Chicago. *Cancer Causes Control* 2007;18:323–33.
16. Zapka J, Taplin SH, Ganz P, Grunfeld E, Sterba K. Multilevel factors affecting quality: examples from the cancer care continuum. *J Natl Cancer Inst Monogr* 2012;2012:11–9.
17. Taplin SH, Anhang Price R, Edwards HM, Foster MK, Breslau ES, Chollette V, et al. Introduction: understanding and influencing multilevel factors across the cancer care continuum. *J Natl Cancer Inst Monogr* 2012;2012:2–10.
18. American College of Radiology. Breast imaging center of excellence (BICOE). Available from: <https://www.acr.org/quality-safety/accreditation/bicoe>.
19. Central Management Services. Disproportionate Share Hospital (DSH). Available from: <https://www.cms.gov/medicare/medicare-fee-for-service-payment/acuteinpatientpps/dsh.html>.
20. Chen AH, Rittenhouse D. The un-managed system of Medicare referrals. *J Gen Intern Med* 2012;27:487–9.
21. Brazda A, Estroff J, Euhus D, Leitch AM, Huth J, Andrews V, et al. Delays in time to treatment and survival impact in breast cancer. *Ann Surg Oncol* 2010;17:291–6.
22. Mortel M, Rauscher GH, Murphy AM, Hoskins K, Warnecke RB. Racial and ethnic disparity in symptomatic breast cancer awareness despite a recent screen: the role of tumor biology and mammography facility characteristics. *Cancer Epidemiol Biomarkers Prev* 2015;24:1599–606.
23. American Joint Committee on Cancer. Cancer staging references. Available from: <https://cancerstaging.org/references-tools/Pages/What-is-Cancer-Staging.aspx>.
24. Browning CR, Cagney KA. Neighborhood structural disadvantage, collective efficacy, and self-rated physical health in an urban setting. *J Health Soc Behav* 2002;43:383–99.
25. Tarlov E, Zenk SN, Campbell RT, Warnecke RB, Block R. Characteristics of mammography facility locations and stage of breast cancer at diagnosis in Chicago. *J Urban Health* 2009;86:196–213.
26. Barrett RE, Cho YI, Weaver KE, Ryu K, Campbell RT, Dolecek TA, et al. Neighborhood change and distant metastasis at diagnosis of breast cancer. *Ann Epidemiol* 2008;18:43–7.
27. Lopes PM. Rational service areas, Washington. In: State-wide rational service areas for primary care services: lessons from six states. Bethesda (MD): Health Resources and Services Administration; 2000.
28. White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. *Stat Med* 2011;30:377–99.
29. Enders CK. Applied missing data analysis. New York: Guilford Press; 2010.
30. Fowler BA. Neighborhood-level influences on delays in diagnostic follow-up from mammography screening in African-American women: a systematic review. *J Womens Health* 2014;3:151–9.
31. Paskett ED, Dudley D, Young GS, Bernardo BM, Wells KJ, Calhoun EA, et al. Impact of patient navigation interventions on timely diagnostic follow up for abnormal cervical screening. *J Womens Health* 2016;25:15–21.
32. Plascak JJ, Llanos AA, Pennell ML, Weier RC, Paskett ED. Neighborhood factors associated with time to resolution following an abnormal breast or cervical cancer screening test. *Cancer Epidemiol Biomarkers Prev* 2014;23:2819–28.
33. Campbell RT, Li X, Dolecek TA, Barrett RE, Weaver KE, Warnecke RB. Economic, racial and ethnic disparities in breast cancer in the US: towards a more comprehensive model. *Health Place* 2009;15:855–64.
34. Battaglia TA, Bak SM, Heeren T, Chen CA, Kalish R, Tringale S, et al. Boston patient navigation research program: the impact of navigation on time to diagnostic resolution after abnormal cancer screening. *Cancer Epidemiol Biomarkers Prev* 2012;21:1645–54.
35. Reschovsky JD, O'Malley AS. Do primary care physicians treating minority patients report problems delivering high-quality care? *Health Aff* 2008;27:222–31.
36. Hurley RE, Pham HH, Claxton G. A widening rift in access and quality: growing evidence of economic disparities. *Health Aff* 2005;Suppl Web Exclusives:W5-566–76.

BLOOD CANCER DISCOVERY

Multilevel Examination of Health Disparity: The Role of Policy Implementation in Neighborhood Context, in Patient Resources, and in Healthcare Facilities on Later Stage of Breast Cancer Diagnosis

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