Do Socially Deprived Urban Areas Have Lesser Supplies of Cancer Care Services?

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ABSTRACT

Purpose

Area social deprivation is associated with unfavorable health outcomes of residents across the full clinical course of cancer from the stage at diagnosis through survival. We sought to determine whether area social factors are associated with the area health care supply.

Patients and Methods

We studied the area supply of health services required for the provision of guideline-recommended care for patients with breast cancer and colorectal cancer (CRC) in each of the following three distinct clinical domains: screening, treatment, and post-treatment surveillance. We characterized area social factors in 3,096 urban zip code tabulation areas by using Census Bureau data and the health care supply in the corresponding 465 hospital service areas by using American Hospital Association, American Medical Association, and US Food and Drug Administration data. In two-level hierarchical models, we assessed associations between social factors and the supply of health services across areas.

Results

We found no clear associations between area social factors and the supply of health services essential to the provision of guideline recommended breast cancer and CRC care in urban areas. The measures of health service included the supply of physicians who facilitate screening, treatment, and post-treatment care and the supply of facilities required for the same services.

Conclusion

Because we found that the supply of types of health care required for the provision of guideline-recommended cancer care for patients with breast cancer and CRC did not vary with markers of area socioeconomic disadvantage, it is possible that previously reported unfavorable breast cancer and CRC outcomes among individuals living in impoverished areas may have occurred despite an apparent adequate area health care supply.

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INTRODUCTION

Multiple lines of research have shown that geography is associated with the health care people use and health outcomes they experience.^{1,2} Neighborhoods and health research has shown that area social factors measured at a variety of spatial units are associated with the health outcomes patients with cancer experience across the clinical cancer continuum. For example, it is well documented that area social features, particularly area measures of socioeconomic deprivation, are associated with the clinical course of breast cancer and colorectal cancer (CRC) from screening^{3,4} to the stage of cancer at diagnosis,⁵⁻¹⁵ treatment,^{6,16-29} post-treatment surveillance,^{30,31} and, ultimately, survival.^{6,8,16,19,33-42} However, it is unclear what pathways mediate these associations.

One possibility is that more economically deprived areas may have limited the supply of the requisite cancer-related health care required for the provision of guideline-recommended cancer care. If this was the case, then such unobserved insufficiencies in the area health care supply could in part have mediated the previously reported associations between area socioeconomic factors and health outcomes of individual patients with cancer (Fig 1).

In this study, we sought to determine whether area social factors are associated with the area supply of cancer care that is highly relevant to the clinical courses of breast cancer and CRC. This study was ecologic and assessed attributes of geographic regions rather than characteristics or outcomes of individual patients. We chose to focus on the types of health care required for the

Fig 1. Is area social deprivation associated with insufficiencies in the supply of area cancer care? Illustration of the study hypothesis that area social deprivation is associated with area insufficiencies in the supply of cancer care. Our analyses tested the pathway indicated by the question mark. If the hypothesis is true, it may be that insufficiencies in the supply of cancer care may, at least in part, mediate the previously documented poor cancer outcomes of individuals living in socially deprived areas.

provision of breast cancer and CRC care because screening detects these cancers at earlier and, thus, more-curable stages,⁴³⁻⁴⁷ treatment can cure patients,⁴⁸⁻⁵¹ and post-treatment surveillance extends life.^{52,53} Hence, there are clear screening, treatment, and post-treatment cancer surveillance guidelines for each of these cancer types.⁵⁴⁻⁵⁸ We hypothesized that the supply of cancer-specific services essential to the provision of guideline-recommended care for breast cancer and CRC would be inversely associated with measures of area social deprivation.

PATIENTS AND METHODS

Area Definitions

We used the following two conceptually distinct types of geographic units for this study: social areas and health care–supply areas.

We used zip code tabulation areas (ZCTAs) as the spatial unit of analysis for social characteristics (ie, social context).⁵⁹ ZCTAs are geographical approximations to US Postal Service zip code service areas formed by aggregating all census blocks in which the plurality of addresses have a given zip code. The

Census Bureau notes that “in most instances the ZCTA code is the same as the zip code for an area.”⁶⁰ ZCTAs are convenient for our analysis because hospital service areas (HSAs) are also defined as aggregates of contiguous zip codes.

Previous studies of ecologic associations between area social disadvantage and population health that utilized administrative data have found that the choice of geospatial unit for analysis could be of significant importance. For example, Krieger et al⁶¹ have shown that associations between social factors and cancer incidence varied depending on the spatial unit studied (ie, census block group [CBG], census tract [CT], or zip code). Krieger et al⁶¹ also showed that associations between area poverty and mortality from cancer were similar across all three spatial units (ie, CBG, CT, and zip code). Because our research was focused on the use of mortality-modifying health care and not cancer incidence, we believe that the work of Krieger et al⁶¹ supports the appropriateness of our decision to study social areas at the ZCTA spatial unit.

In addition, we restricted our study to urban social areas for two reasons. First, previous work suggested that area “social disadvantage” in rural settings may manifest differently than in urban settings; second, it is well established that rural areas of the United States have fewer health services per capita including those health services related to cancer.⁶²⁻⁷⁰ Consequently, conflating urban and rural areas might yield results that are not generalizable to either setting.

We used hospital service areas (HSAs) previously defined by investigators at Dartmouth Medical School as the spatial unit of analysis for health care supply (ie, health care context).⁷¹ HSAs are groups of contiguous zip codes defined such that most residents of the area received their hospital care within the area.⁷² There are 3,436 HSAs in the United States, and most HSAs contain one to two hospitals and 10 zip codes. Our assumption in choosing this unit was that patients will travel distances for cancer services that are similar to those they travel for other hospital services.

Data Sources

We used variables listed in Table 1 from the US Census 2000 Summary File 3 to characterize social attributes of ZCTAs.

To characterize the health care supply at the HSA level, we obtained data on hospitals including hospital accreditation status, hospital type, capacity, and other aspects of services provided by hospitals in 2000 through the American Hospital Association (AHA) survey.⁷³ We obtained physician-specialty work-force counts in 2000 from American Medical Association (AMA) data. Finally, we obtained counts of US Food and Drug Administration (FDA)–approved mammogram facilities in 2000 from the FDA. All of these data sources are indexed at the zip code level and were aggregated up to the HSA level by using a zip code–to-HSA crosswalk file provided by the Dartmouth group.⁷⁴ We transformed the health care supply variables into counts per

Table 1. Social Attributes of US Urban Zip Code Tabulation Areas in 2000 (N = 3096)

Area Social Attributes (%)	Median	Interquartile Range	Factor Loadings*	
			Socioeconomic Disadvantage	Ethnic Isolation
Individuals below poverty line	6.8	3.9-13.3	0.79	
Black individuals	3.8	1.2-13.5	†	†
Disabled, civilian non-institutionalized individuals	17.6	13.6-22.1	0.66	
Female-headed households	7.5	4.9-12.1	0.91	
Foreign-born individuals	5.6	2.4-12.6		0.97
Households with responsibility for grandchildren < 18 years old	0.9	0.4-1.7	0.79	
Linguistically isolated	2.9	1.3-6.9		0.95
Living alone, household with one occupant	24.6	18.8-30.9		
Households with no telephone	0.7	0.3-1.8	0.78	
Households with no vehicle	6.9	3.8-13.5		
Individuals receiving social security income/public assistance	4.5	2.8-8.5	0.90	
Unemployed individuals	4.3	3.1-6.9	0.68	

NOTE. US Census 2000 Summary File 3 variables reported at the zip code tabulation area level for all the urban zip code tabulation areas in the United States that were studied.

*The two composite variables were created with oblique rotated factor patterns (loadings > 0.60) in 3,096 US urban zip code tabulation areas, and both of their eigenvalues were > 1.

†The variable percentage black was purposely excluded from the factor analyses.

Table 2. Candidate Area Health Care Variables in 2000 by Cancer Care Domain

Health Service by Domain	Counts per 100,000 HSA Residents		No. of HSAs
	Mean	95% CI	
Breast cancer and CRC screening			
Gastroenterology MDs	4.3	3.9 to 4.7	465
Mammogram facilities/women age ≥ 40 years	16.2	15.3 to 17.1	465
Cancer-screening MDs	68.6	64.5 to 72.7	465
Breast cancer and CRC treatment			
General medical/surgical hospitals	3.8	3.4 to 4.2	372
Hospital beds	852.6	751.8 to 953.4	457
Medical oncology MDs	2.5	2.1 to 2.8	465
Oncology hospitals	3.2	2.8 to 3.6	372
Operating rooms	39.5	32.8 to 46.2	347
Radiation oncology MDs	1.3	1.1 to 1.5	465
Surgeons	10.2	9.9 to 10.5	465
Breast cancer and CRC post-treatment surveillance*			
Gastroenterology MDs	4.3	3.9 to 4.7	465
Mammogram facilities/women age ≥ 40 years	16.2	15.3 to 17.1	465
Cancer-screening MDs	68.6	64.4 to 72.7	465
Medical oncology MDs	2.5	2.1 to 2.8	465
Radiation oncology MDs	1.3	1.1 to 1.5	465
Surgeons	10.2	9.9 to 10.5	465

NOTE. Each area health care variable represents the key x variable of interest in each of four distinct hierarchical regression equations that also include the census region as a covariate.

Abbreviations: CRC, colorectal cancer; HSA, hospital service area; MD, physician; ZCTA, zip code tabulation area.

*Because gastroenterologists, mammography facilities, and cancer-screening MDs are crucial to both cancer screening and post-treatment care, these variables were listed under both screening and post-treatment domains. Similarly, because medical oncology MDs, radiation oncology MDs, and surgeons all treat patients with breast cancer and CRC and provide follow-up care, these variables are listed under both treatment and post-treatment domains.

100,000 residents in the HSA by using zip code population estimates. For counts of FDA-approved mammogram facilities, we restricted the population denominator to women ≥ age 40 years in the HSA. The 10 health care variables we selected measured the availability of services required for the provision of guideline-recommended care relevant to breast cancer and CRC across the clinical cancer continuum. For screening, we identified the number per capita of AMA cancer-screening physicians and gastroenterologists and FDA-approved mammography facilities; for treatment, we identified the number per capita of AMA medical oncologists, radiation oncologists, and surgeons, AHA general medical/surgical hospitals, hospital beds, operating rooms, and hospitals with oncology services; and for post-treatment surveillance, we identified screening variables and number per capita of medical oncologists and radiation oncologists. The AMA collects and updates information regarding US physicians, including physician specialties. The variable cancer-screening physicians was the sum of counts for the following physician specialties documented in AMA data transformed to a per capita rate: adolescent medicine—pediatrics, family practice, family practice/geriatric medicine, internal medicine—family practice, internal medicine, internal medicine—geriatrics, internal medicine—preventive medicine, public health/general preventive medicine, gynecology, and obstetrics and gynecology, because any physicians of these specialties could perform cancer screening (including breast and/or CRC screening) and could assist specialty physicians in post-treatment follow-up. The surgeon variable was the sum of counts for the following physician specialties documented in AMA data that was then transformed to a per capita rate: abdominal surgery, surgical oncology, general surgery, colon and rectal surgery, and proctology. The AHA defines hospitals with an oncology service as those that provide “an organized program for the treatment of cancer by the use of drugs or chemicals.” These variables are listed in Table 2. An illustration of how social areas cluster within larger health care areas is shown in Figure 2.

Analytic Sample

There were 30,145 distinct zip codes in 2000 and 3,436 HSAs. We were able to assign 29,799 zip codes (99%) to 3,429 unique HSAs. We had 2000 AMA data for 98% of HSAs (3,382 of 3,436), 2000 AHA data for 97% of HSAs (3,323 of 3,436), and 2000 US Food and Drug Administration mammography

data for 88% of HSAs (3,037 of 3,436). We used the Department of Agriculture Rural Urban Commuting Areas algorithm⁷⁵⁻⁷⁷ (N = 9,528). We selected the subset of zip codes that formed fully urban HSAs (3,200 of 9,528). The excluded areas represented zip codes and corresponding HSAs on the margin of urban areas. Such HSAs represented an indeterminate combination of urban, suburban, and sometimes rural areas. Finally, we used a crosswalk file developed by Dartmouth investigators to assign each unique zip code (n = 3,200) to its corresponding ZCTA (n = 3,096).⁷⁸ Our data structure ultimately consisted of 3,096 ZCTAs nested into 465 HSAs.

Statistical Analyses

We evaluated potential associations between the area health care supply and four area social factors, specifically the percentage of individuals in poverty, the percentage of black individuals, and indices that summarized other measures of social deprivation derived by factor analysis on candidate census variables.⁷⁹

Consistent with the nested structure of our data, health care–supply variables (measured at the level of the HSA) were predictors in the model and social variables (measured at the level of the ZCTA) were modeled as outcomes. We interpreted these models as descriptive of associations but not causal. Our two-level random-effects model was specified by the equation

$$y_{ij} = \beta_0 + \beta_1 x_j + \beta_{2r(j)} + u_j + e_{ij} \quad (1)$$

Fig 2. Illustration of the nested structure of the two-level analytic data set in which the zip code tabulation area (ZCTA)–level social areas (depicted as groups of four houses) are nested within geographically larger hospital service area (HSA)–level health care supply areas (depicted as boxed crosses).

with ZCTA at level 1 nested within HSAs at level 2, in which y_{ij} is a social characteristic (eg, percentage black) of ZCTA i in HSA j , $\beta_{2r(j)}$ is the effect for the census region $r(j)$ (one of four) in which the HSA is located, and x_j is a HSA-level characteristic (eg, counts of gastroenterologists). The fixed parameter β_1 represents the association between the ZCTA-level social attribute and the HSA-level health care–supply variable. The random intercept parameter u_j captures the between-HSA variation on the social characteristic, which is assumed to have a normal distribution, and e_{ij} captures the within-HSA variation unexplained by the predictor.

Sensitivity Analyses

Because our main analyses focused on fully urban HSAs, the many urban ZCTAs ($n = 12,373$) that are located at the margin of urban and nonurban areas were not studied. To evaluate whether partially but not fully urban HSAs (ie, the 694 HSAs that contained at least one urban ZCTA but were not composed entirely of urban ZCTAs) differed from fully urban HSAs with respect to associations between social attributes and the health care supply, we re-estimated our models in partially urban HSAs.

The research was approved by the Harvard Medical School Committee on Human Subjects. All analyses were performed by using SAS version 9.2 statistical software (SAS Institute, Cary, NC).

RESULTS

Data Reduction and Variable Selection

The area social variables that we identified as possibly associated with the availability of cancer care services are listed in Table 1. Two composite variables, which we labeled “socioeconomic disadvantage”

and “ethnic isolation,” emerged from the factor analysis of census variables (with corresponding eigenvalues exceeding one) and are also listed in Table 1.

Area measures of cancer-relevant health services grouped according to clinical domains (ie, screening, treatment, and surveillance) are listed in Table 2. We modeled health care variables separately rather than creating composites to provide policy-relevant evidence on which specific health services might be have been under-supplied in underserved areas.

Tests of Association

Regression models that tested associations between each area social factor and each area health care factor (Table 3) revealed only three statistically significant associations of 40 associations tested. Area socioeconomic deprivation was negatively associated with the per capita availability of cancer-screening physicians ($\beta_1 = -0.002$; 95% CI, -0.004 to -0.001) and gastroenterologists ($\beta_1 = -0.017$; 95% CI, -0.031 to -0.004), two types of physicians who facilitate breast cancer and CRC screening and post-treatment surveillance. Area poverty was negatively associated with the per capita availability of cancer screening physicians ($\beta_1 = -0.014$; 95% CI, -0.027 to -0.001). To better understand these associations, we examined mean values of the health service variables by quartiles of social variables (Appendix Tables A1 and A2, online only). There was not a consistent trend evident for any of the three associations. Instead, the data exhibited a U-shaped relationship. The apparent significance of the associations

Table 3. Results of Two-Level Models of Associations Between Area Social Factors and Area Health Care Supply in Fully Urban HSAs

Health Service by Domain	% Poverty		% Black		Deprivation*		Ethnic Isolation*	
	β_1	95% CI	β_1	95% CI	β_1	95% CI	β_1	95% CI
Breast cancer and CRC screening								
Gastroenterologists	-0.102	-0.233 to 0.029	-0.063	-0.364 to 0.238	-0.017†	-0.031 to -0.004	+0.009	-0.005 to 0.023
Mammography facilities	-0.019	-0.082 to 0.045	-0.086	-0.231 to 0.060	-0.004	-0.011 to 0.002	-0.003	-0.010 to 0.004
Cancer-screening MDs	-0.014†	-0.027 to -0.001	-0.002	-0.033 to 0.030	-0.002†	-0.004 to -0.001	+0.001	-0.001 to 0.002
Breast cancer and CRC treatment								
General medical/surgical hospitals	-0.009	-0.162 to 0.143	-0.035	-0.387 to 0.318	-0.004	-0.019 to 0.012	-0.013	-0.030 to 0.004
Hospital beds	-0.001	-0.001 to 0.001	+0.001	-0.001 to 0.002	-0.001	-0.001 to 0.001	-0.001	-0.001 to 0.001
Medical oncology MDs	-0.017	-0.166 to 0.132	+0.037	-0.305 to 0.380	-0.008	-0.024 to 0.007	+0.010	-0.006 to 0.026
Oncology hospitals	+0.015	-0.140 to 0.170	+0.104	-0.253 to 0.461	-0.001	-0.016 to 0.016	-0.013	-0.030 to 0.004
Operating rooms	+0.007	-0.004 to 0.017	+0.012	-0.012 to 0.037	+0.001	-0.001 to 0.002	-0.001	-0.001 to 0.001
Radiation oncology MDs	-0.026	-0.308 to 0.257	+0.364	-0.284 to 1.00	-0.013	-0.042 to 0.017	+0.012	-0.019 to 0.043
Surgeons	+0.016	-0.050 to 0.081	+0.128	-0.023 to 0.278	-0.001	-0.008 to 0.006	+0.003	-0.004 to 0.010
Breast cancer and CRC post-treatment surveillance								
Gastroenterologists	-0.102	-0.233 to 0.029	-0.063	-0.364 to 0.238	-0.017†	-0.031 to -0.004	+0.009	-0.005 to 0.023
Mammography facilities	-0.019	-0.082 to 0.045	-0.086	-0.231 to 0.060	-0.004	-0.011 to 0.002	-0.003	-0.010 to 0.004
Cancer-screening MDs	-0.014†	-0.027 to -0.001	-0.002	-0.033 to 0.030	-0.002†	-0.004 to -0.001	+0.001	-0.001 to 0.002
Medical oncology MDs	-0.017	-0.166 to 0.132	+0.037	-0.305 to 0.380	-0.008	-0.024 to 0.007	+0.010	-0.006 to 0.026
Radiation oncology MDs	-0.026	-0.308 to 0.257	+0.364	-0.284 to 1.01	-0.013	-0.042 to 0.017	+0.012	-0.019 to 0.043
Surgeons	+0.016	-0.050 to 0.081	+0.128	-0.023 to 0.278	-0.001	-0.008 to 0.006	+0.003	-0.004 to 0.010

NOTE. Each cell in Table 3 represents results of a single two-level model of association between area social factors and area health care supply. Health care supply is expressed as counts per 100,000 residents in an HSA and is the right-hand side variable in the previously specified equations. Social factors are expressed as the percentage of ZCTA residents with the attribute or as a composite score variable that incorporated multiple social factors to construct latent variables corresponding to socioeconomic deprivation and ethnic isolation as the left-hand side variable. All models were adjusted for census regions (ie, Northeast, South, Midwest, and West) described at the HSA level.

Abbreviations: CRC, colorectal cancer; HSA, hospital service area; MD, physician; ZCTA, zip code tabulation area.

*Composite score variable.

†Associations were significantly different from 0 at a level of $\leq 5\%$.

Table 4. Results of Two-Level Models of Associations Between Area Social Factors and Area Health Care Supply in Partially Urban HSAs (N = 694)

Health Service by Domain	% Poverty		% Black		Deprivation*		Ethnic Isolation*	
	β_1	95% CI	β_1	95% CI	β_1	95% CI	β_1	95% CI
Breast cancer and CRC screening								
Gastroenterologists	-0.046	-0.193 to 0.101	+0.299†	0.028 to 0.569	-0.015†	-0.030 to 0.001	+0.003	-0.016 to 0.022
Mammography facilities	+0.082†	0.028 to 0.136	+0.095	-0.005 to 0.194	+0.011†	0.006 to 0.017	-0.001	-0.007 to 0.006
Cancer-screening MDs	-0.006	-0.025 to 0.012	+0.053†	0.019 to 0.086	-0.002†	-0.004 to -0.001	-0.002†	-0.005 to -0.001
Breast cancer and CRC treatment								
General medical/surgical hospitals	+0.045†	0.005 to 0.085	+0.018	-0.057 to 0.093	+0.004	-0.001 to 0.008	-0.005†	-0.010 to -0.001
Hospital beds	+0.001†	0.001 to 0.001	+0.001	-0.001 to 0.001	+0.001	-0.001 to 0.001	-0.001	-0.001 to 0.001
Medical oncology MDs	+0.005	-0.205 to 0.215	+0.327	-0.062 to 0.717	-0.014	-0.035 to 0.008	+0.001	-0.026 to 0.028
Oncology hospitals	+0.031	-0.025 to 0.088	+0.015	-0.091 to 0.121	+0.002	-0.004 to 0.007	-0.006	-0.014 to 0.001
Operating rooms	+0.001	-0.001 to 0.001	+0.001	-0.002 to 0.003	+0.000	-0.001 to 0.001	-0.001	-0.001 to 0.001
Radiation oncology MDs	+0.447†	0.097 to 0.797	+0.654†	0.009 to 1.30	+0.021	-0.016 to 0.057	-0.034	-0.079 to 0.010
Surgeons	+0.153†	0.060 to 0.246	+0.366†	0.196 to 0.536	+0.008	-0.002 to 0.017	-0.015†	-0.027 to -0.003
Breast cancer and CRC post-treatment surveillance								
Gastroenterologists	-0.046	-0.193 to 0.101	+0.299†	0.028 to 0.569	-0.015†	-0.030 to 0.001	+0.003	-0.016 to 0.022
Mammography facilities	+0.082†	0.028 to 0.136	+0.095	-0.005 to 0.194	+0.011†	0.006 to 0.017	-0.001	-0.007 to 0.006
Cancer-screening MDs	-0.006	-0.025 to 0.012	+0.053†	0.019 to 0.086	-0.002†	-0.004 to -0.001	-0.002†	-0.005 to -0.001
Medical oncology MDs	+0.005	-0.205 to 0.215	+0.327	-0.062 to 0.717	-0.014	-0.035 to 0.008	+0.001	-0.026 to 0.028
Radiation oncology MDs	+0.447†	0.097 to 0.797	+0.654†	0.009 to 1.30	+0.021	-0.016 to 0.057	-0.034	-0.079 to 0.010
Surgeons	+0.153†	0.060 to 0.246	+0.366†	0.196 to 0.536	+0.008	-0.002 to 0.017	-0.015†	-0.027 to -0.003

NOTE. Each of cells in the above table represents results of a single two-level model of association between area social factors and area health care supply. Health care supply is expressed as counts/100,000 residents in HSA and is the right-hand side variable in the previously specified equations. Social factors are expressed as % of ZCTA residents with the attribute or as a composite score variable (denoted by the symbol α) which incorporate multiple social factors to construct latent variables corresponding to socioeconomic deprivation and ethnic isolation as the left-hand side variable. All models adjusted for Census regions (ie, Northeast, South, Midwest, and West) described at the HSA level.

Abbreviations: CRC, colorectal cancer; HSA, hospital service area; MD, physician; ZCTA, zip code tabulation area.

*Composite score variable.

†Associations were significantly different from 0 at a level $\leq 5\%$.

would have diminished if we adjusted for the multiplicity of analyses we performed. On the other hand, even values at the extremes of the 95% CIs for regression coefficients were small in most of the analyses (ie, between -0.3 and 0.3), which suggested, at most, a low to moderate correlation. Thus, the results offered little evidence for associations between neighborhood characteristics and the supply of health care.

Sensitivity Analyses

ZCTAs in the 694 partially urban HSAs were 48% urban, 39% suburban, and 13% rural ZCTAs. Unlike fully urban HSAs, an analysis of partially urban HSAs revealed many associations between markers of social disadvantage and the health care supply (Table 4). Of the 40 unique associations tested, 37% of the associations (15 of 40) were statistically significant, and the majority, 67% (10 of 15), were positive. For example, as shown in Table 4, the supply of radiation oncologists per capita was higher in areas with high poverty ($\beta_1 = +0.447$; 95% CI, 0.097 to 0.797) and a high black racial composition ($\beta_1 = +0.654$; 95% CI, 0.009 to 1.300). The remaining 33% of associations (five of 15) were negative but of a comparatively small magnitude. For example, high area deprivation was significantly but weakly associated with a lower per capita density of gastroenterologists ($\beta_1 = -0.015$; 95% CI, -0.030 to -0.001), and high ethnic isolation was significantly but weakly associated with a lower per capita density of surgeons ($\beta_1 = -0.015$; 95% CI, -0.027 to -0.003).

DISCUSSION

Our analyses of cross-sectional data from 2000 suggest that socially and economically disadvantaged areas in the urban United States were not systematically deficient in the health care required to provide national guideline-recommended care for patients with breast cancer and CRC across the cancer continuum. Area concentrations of residents who were black or impoverished and indices of area socioeconomic deprivation or linguistic isolation were not associated with the supply of any of the types of health care we studied. The three apparently significant associations noted in regression analyses did not reflect consistent trends on closer study.

These results suggest that previously reported associations between characteristics of social areas and clinical outcomes of individual resident with breast cancer and/or CRC may not have been mediated by deficiencies in the supply of appropriate cancer care. Instead, individuals who live in impoverished urban areas may experience unfavorable cancer outcomes even when requisite cancer care is apparently present in the geographic region.^{80,81}

Our sensitivity analyses of partially urban HSAs confirmed that areas with high levels of deprivation and ethnic isolation did not appear to have lesser supplies of cancer care. In contrast, we were surprised by large and significant positive associations of poverty and the proportion black individuals with the supply of cancer services. In these more heterogeneous HSAs, we conjectured

that the poor/black concentration might be a proxy for nearness to the center of the city in which both poor people and hospitals are located, whereas the whiter/richer fringe areas are more suburbanized. An additional analysis in which fraction of urban zips in these partially urban HSAs was controlled for did not change the results significantly (data not shown).

This study had several limitations. The relationships we estimated were aggregated nationally and may not reveal local variations that could have affected the availability of services to some disadvantaged areas or unequal distribution of providers within HSAs. We also did not assess factors that affected the accessibility of these services to disadvantaged populations and the quality of the care they received. Potential barriers to the use of local health care by individuals could have included a myriad of factors such as inadequate health insurance, cultural barriers, language barriers, neighborhood crime, and inadequacy of transportation and childcare.⁸²⁻⁹¹ Similar factors might also have affected the quality of care provided.⁹²⁻⁹⁵ Finally, our results only showed a lack of association between area social deprivation and the health care supply. Additional research by studying patient-level outcomes is required to assess the roles of the health care supply as a mediator of sociodemographic variations in patient outcomes.

In this study of the urban United States, we found that the types and amount of health care required for the provision of

guideline-recommended cancer care across the clinical course of breast cancer and CRC did not vary systematically according to the area social factors we studied, including poverty, socioeconomic disadvantage, and ethnic isolation. This finding raises the possibility that previously reported unfavorable breast cancer and CRC outcomes among individuals who lived in impoverished areas may have occurred despite an apparent adequate area health care supply.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

The author(s) indicated no potential conflicts of interest.

AUTHOR CONTRIBUTIONS

Conception and design: Elizabeth B. Lamont, S.V. Subramanian, Alan M. Zaslavsky

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Administrative support: Elizabeth B. Lamont

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