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Influence of Race, Insurance, and Rurality on Equity of Breast Cancer Care

Chad Markey, BA,^a Julie E. Weiss, MS,^{b,c} and Andrew P. Loehrer, MD, MPH^{a,d,e,*}^aThe Geisel School of Medicine at Dartmouth, Hanover, New Hampshire^bDepartment of Biomedical Data Science, Geisel School of Medicine at Dartmouth, Lebanon, New Hampshire^cNorris Cotton Cancer Center, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire^dDepartment of Surgery, Dartmouth-Hitchcock Medical Center, Lebanon, New Hampshire^eThe Dartmouth Institute for Health Policy and Clinical Practice, Lebanon, New Hampshire

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ABSTRACT

Background: Considerable gaps in knowledge remain regarding the intersectionality between race, insurance status, rurality, and community-level socioeconomic status that contribute in concert to disparities in breast cancer care delivery.

Methods: Women age 18-64 y old with either private, Medicaid, or no insurance coverage and a diagnosis of breast cancer from the North Carolina Central Cancer Registry (2010-2015) were identified and reviewed. Logistic regression models examined the impact of race, insurance status, rurality, and the Social Deprivation Index (SDI) on advanced stage disease at diagnosis (III, IV) and receipt of cancer directed surgery (CDS). Models tested two-way interactions between race, insurance status, rurality, and SDI.

Results: Of the study population ($n = 23,529$), 14.6% were diagnosed with advanced stage disease (III, IV), and 97.1% of women with non-metastatic breast cancer ($n = 22,438$) received cancer directed surgery (CDS). Twenty percent of women were non-Hispanic Black (NHB), 3.0% Hispanic, 10.9% Medicaid insured, 5.9% uninsured, 20.0% of women resided in rural areas, and 20.0% resided in communities of the highest quartile SDI. NHB race, Medicaid or uninsured status, and residence in rural or socially deprived areas were associated with advanced stage breast cancer at diagnosis. NHB and Medicaid or uninsured women were significantly less likely to receive CDS. There were no statistically significant interactions found influencing stage at diagnosis or receipt of cancer directed surgery.

Conclusions: In a heterogeneous population across the state of North Carolina, non-Hispanic Black race, Medicaid or uninsured status, and residence in rural or high social deprivation communities are independently associated with advanced stage breast cancer at diagnosis,

* Corresponding author. Department of Surgery, Dartmouth-Hitchcock Medical Center, 1 Medical Center Drive, Lebanon, NH 03756. Tel.: 603-650-9479, fax: 603-650-8608.

E-mail address: Andrew.P.Loehrer@hitchcock.org (A.P. Loehrer).

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while non-Hispanic Black race and Medicaid or uninsured status are associated with lower odds to receive cancer directed surgery.

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Introduction

Breast cancer is the most common malignancy among women in the United States, yet disparities in access to and receipt of breast cancer care exist across multiple domains including race, insurance status, geography, and socioeconomic status.¹⁻¹² Racial and ethnic disparities have contributed to inequitable access to screening, stage at diagnosis, receipt of cancer directed surgery, and survival.^{1-3,8,9,13,14} Racial disparities demonstrate that Black Americans, regardless of insurance status, more often present with later-stage disease compared to White patients.¹⁵ Data have also been shown to demonstrate Black patients are much less likely to receive surgery for a variety of resectable, non-metastatic cancers compared to White patients in the United States, with physicians less often recommending surgery.^{8,9,16} Furthermore, socioeconomic status often mirrors insurance status, and uninsured patients are more likely to present with later-stage breast cancer and are less likely to receive cancer directed surgery.^{2,4,10,13,17-19} Uninsured status has continually been associated with reduced healthcare access, decreased quality of care, and ultimately, worse outcomes for nearly all medical conditions, including cancer.^{20,21} Uninsured patients also have lower odds of receiving cancer directed surgery and of receiving care at high-quality hospitals.²² Additionally, geographic factors such as rural place of residence and local spatial factors like community-level socioeconomic resources play an increasingly recognized role in equity of breast cancer care.^{5,10,11,13,17,23-27} Rural non-elderly populations are less likely to have employee-sponsored insurance coverage and are more likely to rely on public insurance or lack insurance coverage altogether, compared to metropolitan residents.²⁸

However, much less is known about how patient race and insurance status interact with these geographic factors, including rural place of residence and community-level measures of socioeconomic resources. Additionally, considerable gaps in geospatial knowledge remain regarding the impact of area-level socioeconomic deprivation on disparities in breast cancer care delivery. Previous work has described racial and insurance-based disparities, however, the current understanding of rural disparities and area-level socioeconomic deprivation has been inadequately evaluated.

The objective of this study is to evaluate the degree to which race, insurance coverage, rural place of residence, and community-level socioeconomic resources influence stage at diagnosis and receipt of breast cancer directed surgery for non-elderly adult women in North Carolina and whether these factors interact with each other to influence disease presentation and care. We hypothesize that patient who are Black, uninsured or receive Medicaid, and reside in rural areas or communities of high social deprivation will have higher odds of presenting with advanced stage breast cancer and have lower odds of receiving cancer directed surgery. Under-

standing the social and geospatial risks associated with breast cancer – a disease that has since made great strides at reducing mortality and morbidity when treated early and effectively – can help clinicians and policy makers close remaining gaps in care inequity for breast cancer and provide guidance for treating these patient populations with an intersectional approach.

Methods

This cohort study used the North Carolina Central Cancer Registry (CCR) to identify all non-elderly adult women without insurance or with Medicaid or private coverage diagnosed with breast cancer between 2010 and 2015. Developed by the North Carolina Department of Health and Human Services and maintained by the North Carolina State Center for Health Statistics, the CCR is a comprehensive database containing clinical, demographic, and geographic information on nearly all cancer diagnoses for North Carolina residents.

Our study population included all non-elderly women (age 18-64) from the CCR diagnosed with breast cancer between the years of 2010 and 2015 and had either private insurance (employee or individually purchased), Medicaid, or were uninsured or had self-pay coverage (Fig. 1). Women, whose insurance was Medicare or whose race was other or unknown were excluded. Breast cancer was defined using International Classification of Disease for Oncology, third edition (ICD-O-3) site codes C50.0-C50.9.^{29,30}

Our primary outcomes were stage at diagnosis and receipt of cancer directed surgery (CDS). For this analysis, stage at diagnosis was dichotomized as advanced (III, IV) versus early (0, I, II) and definition of breast cancer stage was derived from AJCC stage seventh edition stage groups based on stage codes attached to each diagnosis in the CCR (Supplementary Appendix A).³¹ In evaluating receipt of cancer directed surgery, we included only patients who presented without evidence of metastatic disease. Receipt of cancer directed surgery was defined as the presence or absence of the most definitive surgical procedure to the primary site as part of the first course of treatment (Supplementary Appendix B).³² Breast cancer directed surgeries included partial mastectomy, lumpectomy, re-excision of the biopsy site for gross or microscopic residual disease, segmental mastectomy (including wedge resection, quadrantectomy, tylectomy), subcutaneous mastectomy, total (simple) mastectomy, bilateral mastectomy, modified radical mastectomy, and radical mastectomy.

Non-Hispanic Black (NHB), non-Hispanic White (NHW), and Hispanic races were derived from the CCR's race and North American Association of Central Cancer Registries Hispanic Identification Algorithm Derived Hispanic variables. Insurance coverage was determined using the CCR's insurance status for private insurance (including managed care, health maintenance organization, or preferred provider organization

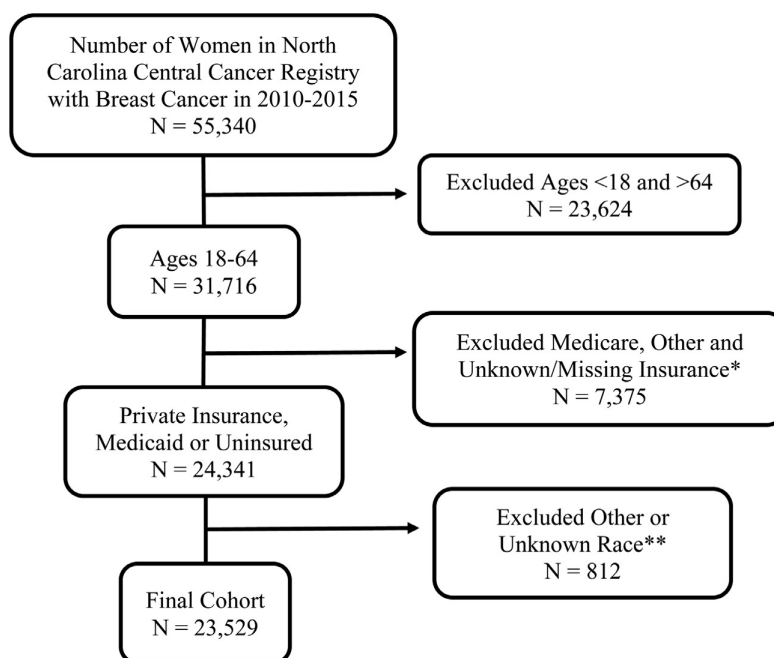


Fig. 1 – Breast cancer cohort derivation. Abbreviation: NOS: Not otherwise specified. Color version of figure is available online.

***Insurance exclusions (N): Medicare (2,749); Other insurance (3,889) includes TRICARE, Military, Veterans Affairs, Indian/Public Health Service, Insurance, not otherwise specified. Insurance status unknown and missing (737).**

****Race exclusions (N): Other Race (784) includes: American Indian, Aleutian, or Eskimo, Chinese, Japanese, Filipino, Hawaiian, Korean, Vietnamese, Laotian, Kampuchean (Cambodian), Thai, Asian Indian or Pakistani, NOS, Asian Indian, Pakistani, Guamanian, NOS, Polynesian, NOS, Samoan, Other Asian, including Asian, NOS and Oriental, NOS, Other Asian, including Asian, NOS and Oriental, NOS, Pacific Islander, NOS, Other. Unknown Race (28).**

and fee for service), Medicaid, or uninsured (including self-pay coverage). Rurality was determined by rural-urban commuting area (RUCA) codes merged with patient ZIP level data.³³ Rurality was dichotomized as ‘rural’ (RUCA secondary codes 4.0, 5.0, 6.0, 7.2, 8.0, 8.2, 9.0, 10.0, 10.2, 10.3) or ‘urban’ (1.0, 1.1, 2.0, 2.1, 3.0, 4.1, 5.1, 7.1, 8.1, 10.1). The first RUCA integer determines the size of the resident’s area based on population density, and the second integer indicates what percentage of that population commutes to another metropolitan area. Community-level socioeconomic deprivation was defined using the Social Deprivation Index (SDI).³⁴ The SDI is an area level composite measure of demographic characteristics determined by census data including housing, income, education, employment, and transportation factors. Higher scores indicate high community social deprivation. CCR ZIP level data was merged with SDI census tract level data and SDI was defined from the data quartiles.

Multivariable logistic regression models examined the impact of race, insurance status, rurality, and SDI on stage at diagnosis and receipt of cancer directed surgery. Models were adjusted for age at diagnosis, year of diagnosis, and comorbidities. Independent variables of interest, control variables, and two-way interaction terms were selected a priori. Comorbidities were computed using the patient’s Elixhauser Comorbidity Index. The CCR’s comorbid/complication diagnosis codes were inputted into the Healthcare Cost and Utilization

Project software for the Elixhauser comorbidity index and values were dichotomized as 0 or 1+.³⁵ Models included two-way interactions among race, insurance, rurality, and SDI. The CDS model was among women with non-metastatic disease and additionally adjusted for stage. *P* for trend was determined by treating the SDI quartiles as a continuous variable.

Analysis was performed using SAS (SAS 9.4 System Options: Reference, 2nd ed.; 2011. SAS Institute Inc., Cary, North Carolina). All *P*-values ≤ 0.05 were deemed significant. This study was deemed exempt from review by the Dartmouth-Hitchcock Institutional Review Board.

Results

We identified a total of 23,529 non-elderly breast cancer patients who were diagnosed and staged from January 1, 2010 through December 31, 2015. Of those women, 22,438 were diagnosed with non-metastatic disease and were included in our CDS model. Of the study population, 14.6% were diagnosed with advanced stage disease (III, IV). Women of younger age, NHB race, Medicaid insured or uninsured status, and those residing in rural or high SDI communities presented more frequently with advanced stage breast cancer. Of the non-metastatic patients, most women (97.1%) received cancer directed surgery ($n = 21,797$). Women who were younger, NHB,

Table 1 – Patient characteristics among women with breast cancer (2010-2015) by stage and cancer directed surgery.¹

Characteristic [†]	Total (N = 23,529) N (%)	Advanced stage at diagnosis (N = 23,529) N (Row %)		Cancer directed surgery* (N = 22,438)	
		0, I, II N = 20,086; 85.4%	III, IV N = 3,443; 14.6%	No N = 641; 2.9%	Yes N = 21,797; 97.1%
Age					
18 - 44	4,433 (18.8)	3,597 (81.1)	836 (18.9)	145 (3.5)	4,042 (96.5)
45 - 54	8,788 (37.3)	7,518 (85.5)	1,270 (14.5)	240 (2.8)	8,184 (97.2)
55 - 64	10,308 (43.8)	8,971 (87.0)	1,337 (13.0)	256 (2.6)	9,571 (97.4)
Race					
Non-Hispanic White	17,407 (74.0)	15,140 (87.0)	2,267 (13.0)	373 (2.2)	16,335 (97.8)
Non-Hispanic Black	5,417 (23.0)	4,364 (80.6)	1,053 (19.4)	236 (4.7)	4,820 (95.3)
Hispanic	705 (3.0)	582 (82.6)	123 (17.4)	32 (4.7)	642 (95.3)
Diagnosis Year					
2010	3,523 (15.0)	3,012 (85.5)	511 (14.5)	80 (2.4)	3,308 (97.6)
2011	3,833 (16.3)	3,254 (84.9)	579 (15.1)	80 (2.2)	3,559 (97.8)
2012	3,732 (15.9)	3,153 (84.5)	579 (15.5)	105 (3.0)	3,442 (97.0)
2013	4,032 (17.1)	3,418 (84.8)	614 (15.2)	121 (3.1)	3,729 (96.9)
2014	4,253 (18.1)	3,680 (86.5)	573 (13.5)	133 (3.3)	3,930 (96.7)
2015	4,156 (17.7)	3,569 (85.9)	587 (14.1)	122 (3.1)	3,829 (96.9)
Stage					
0	4,727 (20.1)	4,727 (100.0)	NA	119 (2.5)	4,608 (97.5)
I	8,482 (36.0)	8,482 (100.0)	NA	89 (1.0)	8,393 (99.0)
II	6,877 (29.2)	6,877 (100.0)	NA	264 (3.8)	6,613 (96.2)
III	2,352 (10.0)	NA	2,352 (100.0)	169 (7.2)	2,183 (92.8)
IV	1,091 (4.6)	NA	1,091 (100.0)	NA	NA
Elixhauser Comorbidity Index					
0	20,292 (86.2)	17,379 (85.6)	2,913 (14.4)	571 (2.9)	18,823 (97.1)
1+	3,237 (13.8)	2,707 (83.6)	530 (16.4)	70 (2.3)	2,974 (97.7)
Insurance					
Private	19,570 (83.2)	17,164 (87.7)	2,406 (12.3)	441 (2.3)	18,441 (97.7)
Medicaid	2,563 (10.9)	1,886 (73.6)	677 (26.4)	111 (4.8)	2,204 (95.2)
Uninsured	1,396 (5.9)	1,036 (74.2)	360 (25.8)	89 (7.2)	1,152 (92.8)
Rurality					
Urban	18,538 (80.0)	15,930 (85.9)	2,608 (14.1)	496 (2.8)	17,210 (97.2)
Rural	4,644 (20.0)	3,866 (83.2)	778 (16.8)	132 (3.0)	4,267 (97.0)
Social Deprivation Index					
Q1 (1 – 25)	5,577 (24.1)	4,952 (88.8)	625 (11.2)	125 (2.3)	5,282 (97.7)
Q2 (26 – 50)	5,852 (25.3)	5,056 (86.4)	796 (13.6)	146 (2.6)	5,478 (97.4)
Q3 (51 – 75)	7,110 (30.7)	6,002 (84.4)	1,108 (15.6)	180 (2.7)	6,577 (97.3)
Q4 (76 – 100)	4,627 (20.0)	3,772 (81.5)	855 (18.5)	176 (4.1)	4,125 (95.9)

* Cancer directed surgery among women with non-metastatic breast cancer.

[†] Missing (N): Rurality (Stage = 347; Cancer Directed Surgery = 333); Social Deprivation Index (Stage = 363; Cancer Directed Surgery = 349)

Medicaid insured or uninsured, or residing in high SDI areas received cancer directed surgery less frequently compared to those who were older, NHW, privately insured, and living in lower SDI communities, respectively (Table 1).

Multivariable models found that non-Hispanic Black women were more likely to present with advanced stage disease than non-Hispanic White women (OR = 1.29, 95% CI 1.18-1.41). Women with Medicaid coverage or who were unin-

Table 2 – Multivariable logistic regression models* for equity of breast cancer presentation and care delivery.

Characteristic	Advanced stage at diagnosis OR (95 % CI)	Cancer directed surgery
Race Ethnicity		
Non-Hispanic White	Reference	Reference
Non-Hispanic Black	1.29 (1.18 - 1.41)	0.59 (0.49 - 0.71)
Hispanic	0.98 (0.80 - 1.21)	0.72 (0.49 - 1.07)
Insurance		
Private	Reference	Reference
Medicaid	2.16 (1.95 - 2.40)	0.62 (0.49 - 0.78)
Uninsured	2.18 (1.91 - 2.50)	0.40 (0.31 - 0.52)
Rurality		
Urban	Reference	Reference
Rural	1.12 (1.02 - 1.23)	1.01 (0.83 - 1.24)
Social Deprivation Index	P for Trend = 0.0003	P for Trend = 0.45
Quartile 1 (1 - 25)	Reference	Reference
Quartile 2 (26 - 50)	1.15 (1.03 - 1.29)	1.00 (0.77 - 1.26)
Quartile 3 (51 - 75)	1.22 (1.10 - 1.37)	1.07 (0.84 - 1.36)
Quartile 4 (76 - 100)	1.24 (1.10 - 1.41)	0.87 (0.67 - 1.14)

Abbreviations: CI = Confidence Interval; OR = Odds Ratio.

* Models adjusted for age at diagnosis, comorbidities, and year of diagnosis. Additionally, the cancer directed surgery model adjusted for stage.

sured compared to those privately insured were more likely to present with advanced disease (OR = 2.16, 95% CI 1.95-2.40, OR = 2.18, 95% CI 1.91-1.50; respectively). Women residing in rural communities versus urban areas or in communities of the highest social deprivation quartile (SDI Q4) were more likely to present with advanced disease than those in the lowest quartile of social deprivation (SDI Q1) (OR = 1.12, 95% CI 1.02-1.23, OR = 1.24, 95% CI 1.10-1.41; respectively)(Table 2). Furthermore, a positive trend (P for trend = 0.0003) and higher SDI quartiles (Q2-Q4) compared to those with the lowest SDI quartile were more likely to present with advanced stage breast cancer (Table 2).

For those presenting with non-metastatic disease, non-Hispanic Black women were less likely to receive cancer directed surgery than non-Hispanic White women (OR = 0.59, 95% CI 0.49-0.71). Additionally, Medicaid and uninsured patients were much less likely to receive surgery than those privately insured (OR = 0.62, 95% CI 0.49-0.77, OR = 0.40 95% CI 0.31-0.52; respectively). The model did not find statistically significant odds of receiving cancer directed surgery for those living in rural areas or communities of higher social deprivation.

No significant two-way interactions were found between race, rurality, insurance, or SDI for stage at diagnosis or receipt of CDS.

Discussion

In this study, non-Hispanic Black race, Medicaid or a lack of insurance, rural residence, and residence in a community with high social deprivation were individually associated with increased odds of advanced stage breast cancer at diagnosis.

Non-Hispanic Black women and those who received Medicaid or were uninsured were found to have lower odds of receiving cancer directed surgery if presenting with non-metastatic disease. There was however, no statistically significant evidence of interaction between these characteristics that influenced stage at diagnosis or receipt of cancer directed surgery. Collectively, these findings show that race, insurance status, rurality, and socioeconomic deprivation all have an independent effect on breast cancer diagnosis and subsequent care. The strongest indicator for both advanced stage at diagnosis and not receiving cancer directed surgery was insurance status. Following that was non-Hispanic Black race.

Previous work has demonstrated that uninsured and Black patients are much more likely to present with more advanced cancers and not receive the healthcare services that they need.^{13,16,36-40} There are likely multiple layers of racism underlying these inequities, including systemic and interpersonal racism. Our study controlled for upstream geographic and community-level socioeconomic factors in addition to insurance status, suggesting that structural and interpersonal factors contribute to persistent inequity. Though the incidence of more aggressive cancer is higher in Black populations when compared to non-Hispanic White patients, in this study we could not control for such biologic features that could also contribute to our gap in stage at presentation.

Type of insurance coverage was the strongest predictor of advanced stage at presentation and failure to receive cancer directed surgery. This is consistent with a wide volume of literature including observations suggesting that a majority of advanced stage breast cancer disparities based on race and ethnicity can be attenuated by obtaining insurance coverage.²¹ Data also suggest expansion of Medicaid through the Affordable Care Act was associated with a marked reduction in in-

cidence of advanced stage breast cancer, with African Americans and patients younger than 50 benefitting the most.²² However, North Carolina did not expand Medicaid eligibility during the timeframe of this study, so the observed lack of care when accounting for those with Medicaid is expected. Those with Medicaid are particularly poor, with additional financial or special needs, and may have been enrolled after diagnosis. Thus, our finding regarding Medicaid coverage being associated with later stage at time of diagnosis is not surprising.

Geographic factors such as rural residence and local spatial factors including community-level social deprivation are also key upstream drivers of inequity. Our findings linking diagnosis of advanced stage disease are consistent with prior studies showing association between where one lives and earlier access to care.^{7,13,15,17,41-44} This could be secondary to decreased or deferred screening, or a lack of access to primary care providers, as past literature suggests that there exists a general lack of primary care access for those residing in census areas of high social deprivation, and that deprived areas carry excess risk of lung, colorectal, prostate, and cervical cancer mortality.^{13,45}

This study further clarifies and consolidates these relationships by demonstrating that, for breast cancer care, there are grave inequities that exist across socio-demographic and geospatial dimensions that physicians, payers, and patients must recognize in order to improve breast cancer related outcomes. This study suggests that a malignancy prominent for potential early detections by screening or symptom assessment is still diagnosed later in its course for the marginalized groups we evaluated here, despite advancements in screening technology and breast cancer awareness.^{46,47}

Our results revealed no statistically significant interactions between race, rurality, insurance status and social deprivation on the odds of presenting with advanced stage disease or receiving cancer directed surgery. However, there is strong evidence suggesting that among hospitalized breast cancer patients, in-hospital mortality is substantially higher among Black and rural patients even when stratified by private insurance and Medicaid or Medicare.⁴⁰ This suggests that more studies need to evaluate the intersection of social determinants of health to better understand and work toward eliminating institutional racism and inequitable care that effects breast cancer detection and disease management. Additional drivers, including institutional and interpersonal racism, could influence equity of care at the level of treating facility or provider, which were not captured in this study.

Our study does have several limitations. First, our findings are specific to North Carolina, and thus may not be generalizable to other states or the nation at large. We chose North Carolina for this study because it is underrepresented in other national datasets and provides demographic diversity in terms of race and ethnicity as well as a large rural population. Second, based on how the North Carolina CCR data set coded demographics including race and ethnicity, we were not able to confidently account for other races and ethnicities in our model including American Indian or Alaska Native, Asian, Native Hawaiian or Other Pacific Islander due to low reported numbers in the registry, lower than would be expected

from state demographics. Thus, while we used non-Hispanic White race as a reference group and demonstrated that non-Hispanic Black patients had lower odds of having access to receipt of care, our model cannot be broadly associated with other races or ethnicities, and disaggregating racial and ethnic data among breast cancer research can provide important associations.⁴⁸ Third, our classifications of both rurality and social deprivation were determined at the level of 5-digit zip codes, which may be too large an area to provide discriminatory power between smaller areas such as census tracts or block groups. While we are reassured since our findings of rural and SDI related disparities are consistent with prior work, further study with more granular measures of geospatial determinants may be warranted in these regards. Fourth, with data points being pulled from area-level census records, our variable for social deprivation did not account for individual level measures. Additionally, our models did not account for payer mix among patients with insurance. Finally, we could not account for where patients were diagnosed, if they were referred to a specialist, or where they ultimately received care.

Our collective findings suggest that Black race, Medicaid or a lack of insurance, rural residence, and high community-level socioeconomic deprivation all independently lead to higher risks of presenting with advanced stage breast cancer, and the Black, Medicaid insured and uninsured Americans that do present are less likely to receive life-saving surgery. Moving forward, research in this area should focus on addressing the unmet needs of the groups evaluated in this study. In addition, it would be important to continue examining cancer care disparities through the lens of geospatial characteristics to further address local area-level drivers of inequity and shape targeted interventions to communities most at risk. This study demonstrates that significant inequities independently exist at multiple levels and that targeted interventions aimed at each of these drivers may be needed to improve the access to and receipt of equitable cancer care.

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Disclosure

None

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at doi:[10.1016/j.jss.2021.09.042](https://doi.org/10.1016/j.jss.2021.09.042).

REFERENCES

- Hines RB, Markossian TW. Differences in late-stage diagnosis, treatment, and colorectal cancer-related death between rural and urban African Americans and whites in Georgia. *J Rural Health*. 2012;28:296–305 Epub 2012/07/05PubMed PMID:22757954 . doi:[10.1111/j.1748-0361.2011.00390.x](https://doi.org/10.1111/j.1748-0361.2011.00390.x).
- Paquette I, Finlayson SR. Rural versus urban colorectal and lung cancer patients: Differences in stage at presentation. *J Am Coll Surg*. 2007;205:636–641 Epub 2007/10/30PubMed PMID:17964438 . doi:[10.1016/j.jamcollsurg.2007.04.043](https://doi.org/10.1016/j.jamcollsurg.2007.04.043).
- Zahnd WE, Fogleman AJ, Jenkins WD. Rural-urban disparities in stage of diagnosis among cancers with preventive opportunities. *Am J Prev Med*. 2018;54:688–698 Epub 2018/03/20PubMed PMID:29550163 . doi:[10.1016/j.amepre.2018.01.021](https://doi.org/10.1016/j.amepre.2018.01.021).
- Johnson AM, Hines RB, Johnson 3rd JA, Bayakly AR. Treatment and survival disparities in lung cancer: The effect of social environment and place of residence. *Lung Cancer*. 2014;83:401–407 Epub 2014/02/05PubMed PMID:24491311 . doi:[10.1016/j.lungcan.2014.01.008](https://doi.org/10.1016/j.lungcan.2014.01.008).
- Nfonsam VN, Vijayasekaran A, Pandit V. Patients diagnosed with colorectal cancer in rural areas in Arizona typically present with higher stage disease. *J Gastrointest Dig Syst*. 2015;5 Epub 2016/08/26PubMed PMID:27559492PMCID: PMC4993096. doi:[10.4172/2161-069x.1000346](https://doi.org/10.4172/2161-069x.1000346).
- Siegel RL, Miller KD, Jemal A. Cancer statistics, 2019. *CA Cancer J Clin*. 2019;69:7–34 Epub 2019/01/09PubMed PMID:30620402 . doi:[10.3322/caac.21551](https://doi.org/10.3322/caac.21551).
- Chow CJ, Al-Refaie WB, Abraham A. Does patient rurality predict quality colon cancer care? A population-based study. *Dis Colon Rectum*. 2015;58:415–422 Epub 2015/03/10PubMed PMID:25751798PMCID: PMC4356018. doi:[10.1097/dcr.000000000000173](https://doi.org/10.1097/dcr.000000000000173).
- Shah A, Chao KS, Ostbye T, et al. Trends in racial disparities in pancreatic cancer surgery. *J Gastrointest Surg*. 2013;17:1897–1906 Epub 2013/09/05PubMed PMID:24002757 . doi:[10.1007/s11605-013-2304-4](https://doi.org/10.1007/s11605-013-2304-4).
- Steele CB, Pisu M, Richardson LC. Urban/rural patterns in receipt of treatment for non-small cell lung cancer among black and white Medicare beneficiaries, 2000–2003. *J Natl Med Assoc*. 2011;103:711–718 Epub 2011/11/04PubMed PMID:22046848 .
- Hines R, Markossian T, Johnson A, Dong F, Bayakly R. Geographic residency status and census tract socioeconomic status as determinants of colorectal cancer outcomes. *Am J Public Health*. 2014;104:e63–e71 May 2020 16Epub 2014/01/18PubMed PMID:24432920PMCID: PMC3953793. doi:[10.2105/ajph.2013.301572](https://doi.org/10.2105/ajph.2013.301572).
- Atkins GT, Kim T, Munson J. Residence in rural areas of the United States and lung cancer mortality. Disease incidence, treatment disparities, and stage-specific survival. *Ann Am Thorac Soc*. 2017;14:403–411 Epub 2017/01/25PubMed PMID:28118039 . doi:[10.1513/AnnalsATS.201606-469OC](https://doi.org/10.1513/AnnalsATS.201606-469OC).
- Suga JM, Nguyen DV, Mohammed SM. Racial disparities on the use of invasive and noninvasive staging in patients with non-small cell lung cancer. *J Thorac Oncol*. 2010;5(11):1772–1778 Epub 2010/10/01PubMed PMID:20881638 . doi:[10.1097/JTO.0b013e3181f69f22](https://doi.org/10.1097/JTO.0b013e3181f69f22).
- Singh GK, Williams SD, Siahpush M, Mulhollen A. Socioeconomic, rural-urban, and racial inequalities in US cancer mortality: Part I—all cancers and lung cancer and part II—colorectal, prostate, breast, and cervical cancers. *J Cancer Epidemiol*. 2011;2011:107497 Epub 2011/01/01PubMed PMID:22496688PMCID: PMC3307012. doi:[10.1155/2011/107497](https://doi.org/10.1155/2011/107497).
- Cronin KA, Lake AJ, Scott S, et al. Annual report to the nation on the status of cancer, part I: National cancer statistics. *Cancer*. 2018;124:2785–2800 Epub 2018/05/23PubMed PMID:29786848PMCID: PMC6033186. doi:[10.1002/ncr.31551](https://doi.org/10.1002/ncr.31551).
- Esnaola NF, Knott K, Finney C, Gebregziabher M, Ford ME. Urban/rural residence moderates effect of race on receipt of surgery in patients with nonmetastatic breast cancer: a report from the South Carolina central cancer registry. *Ann Surg Oncol*. 2008;15:1828–1836.
- Halpern MT, Ward EM, Pavluck AL, Schrag NM, Bian J, Chen AY. Association of insurance status and ethnicity with cancer stage at diagnosis for 12 cancer sites: a retrospective analysis. *Lancet Oncol*. 2008;9:222–231.
- Blake KD, Moss JL, Gaysynsky A, Srinivasan S, Croyle RT. Making the case for investment in rural cancer control: an analysis of rural cancer incidence, mortality, and funding trends. *Cancer Biomarkers Prev*. 2017;26:992–997 Epub 2017/06/11PubMed PMID:28600296PMCID: PMC5500425. doi:[10.1158/1055-9965.Epi-17-0092](https://doi.org/10.1158/1055-9965.Epi-17-0092).
- Kistner B, Zahnd W, Ali A, Mellinger J, Ganai S. Exploration of rural disparities in pancreatic cancer staging and mortality to incidence ratio in Illinois. *J Clin Oncol*. 2015;33(3_suppl):260. doi:[10.1200/jco.2015.33.3_suppl.260](https://doi.org/10.1200/jco.2015.33.3_suppl.260).
- Medbery RL, Gillespie TW, Liu Y, et al. Socioeconomic factors are associated with readmission after lobectomy for early stage lung cancer. *Ann Thorac Surg*. 2016;102:1660–1667 Epub 2016/10/25PubMed PMID:27476821PMCID: PMC5077657. doi:[10.1016/j.athoracsur.2016.05.060](https://doi.org/10.1016/j.athoracsur.2016.05.060).
- Chu QD, Hsieh MC, Chu Y, et al. Do rural patients with operable breast cancer fare worse than urban patients in Louisiana? Results of the Louisiana cancer consortium. *Surgery*. 2020;168:653–661.
- Ko NY, Hong S, Winn RA, Calip GS. Association of Insurance Status and Racial Disparities With the Detection of Early-Stage Breast Cancer. *JAMA Oncol*. 2020;6:385–392.
- Le Blanc JM, Heller DR, Friedrich A, Lannin DR, Park TS. Association of medicaid expansion under the affordable care act with breast cancer stage at diagnosis. *JAMA Surg*. 2020;155:752–758.
- McCullough LE, Flowers CR. Identifying and addressing disparities in survival outcomes for rural patients with cancer. *JAMA Network Open*. 2018;1:e181243 -ePMID:30646109 . doi:[10.1001/jamanetworkopen.2018.1243](https://doi.org/10.1001/jamanetworkopen.2018.1243).
- Henley SJ, Anderson RN, Thomas CC, Massetti GM, Peaker B, Richardson LC. Invasive cancer incidence, 2004–2013, and deaths, 2006–2015, in nonmetropolitan and metropolitan counties - United States. *MMWR Surveill Summ*. 2017;66:1–13 Epub 2017/07/07PubMed PMID:28683054PMCID: PMC5879727. doi:[10.15585/mmwr.ss6614a1](https://doi.org/10.15585/mmwr.ss6614a1).
- Bertens KA, Massman 3rd JD, Helton S, et al. Initiation of adjuvant therapy following surgical resection of pancreatic ductal adenocarcinoma (PDAC): are patients from rural, remote areas disadvantaged? *J Surg Oncol*. 2018;117:1655–1663 Epub 2018/05/16PubMed PMID:29761510 . doi:[10.1002/jso.25060](https://doi.org/10.1002/jso.25060).
- Fairfield KM, Black AW, Lucas FL, et al. Association between rurality and lung cancer treatment characteristics and timeliness. *J Rural Health*. 2019 Epub 2019/02/20PubMed PMID:30779871 . doi:[10.1111/jrh.12355](https://doi.org/10.1111/jrh.12355).
- Pandit V, Khalil M, Joseph B, et al. Disparities in management of patients with benign colorectal disease: impact of urbanization and specialized care. *Am Surg*. 2016;82:1046–1051 Epub 2017/02/17PubMed PMID:28206929 .

28. Cheeseman Day, Jennifer. Health Insurance in Rural America - Rates of Uninsured Fall in Rural Counties, Remain Higher Than Urban Counties. The United States Census Bureau. Available at: <https://www.census.gov/library/stories/2019/04/health-insurance-rural-america.html#:~:text=Residents%20of%20rural%20counties%20still,percent%20for%20mostly%20urban%20counties>. Published September 24, 2019. Accessed January 5, 2021.
29. Fritz A, Percy C, Jack A, Shanmugaratnam K, et al. International Classification of Diseases for Oncology: ICD-O. World Health Organization. Ed 3, 1st Rev. Available at: https://apps.who.int/iris/bitstream/handle/10665/96612/9789241548496_eng.pdf Accessed July 20, 2020.
30. ICD-O-3 SEER. Coding Materials Archive. U.S. Department of Health and Human Services. *Natl Inst Health*. 2001;1: 215-219. Available at: <https://seer.cancer.gov/archive/icd-o-3/>.
31. SEER Research Data Record Description: Cases Diagnosed in 1975-2016. U.S. Department of Health and Human Services. *Natl Inst Health*. 2019. Available at: <https://seer.cancer.gov/datasoftware/documentation/seerstat/nov2018/TextData.FileDescription.pdf>.
32. American College of Surgeons Commission on Cancer. Standards for Oncology Registry Entry 2018. Accessed July 10, 2020, pages 468-470, Appendix B: Site-Specific Surgery Codes, Available at: https://www.facs.org/~media/files/quality%20programs/cancer/ncdb/store_manual_2018.ashx
33. Rural-Urban Commuting Area Codes. Economic Research Service, United States Department of Agriculture. Accessed August 20, 2020. Available at: <https://www.ers.usda.gov/data-products/rural-urbancommuting-area-codes/>.
34. Social Deprivation Index (SDI). Robert Graham Center. Accessed July 10, 2020. Available at: https://www.graham-center.org/rgc/maps-data-tools/sdi/social-deprivationindex.html/ACS2015_CTallvars.xlsx.
35. Elixhauser Comorbidity Software, Version 3.7. Healthcare Cost and Utilization Project. Accessed November 6, 2020. Available at: <https://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp>.
36. Ward E, Halpern M, Schrag N, et al. Association of insurance with cancer care utilization and outcomes. *CA Cancer J Clin*. 2008;58:9-31.
37. DeSantis C, Jemal A, Ward E. Disparities in breast cancer prognostic factors by race, insurance status, and education. *Cancer Causes Control*. 2010;21:1445-1450.
38. Niu X, Roche LM, Pawlish KS, Henry KA. Cancer survival disparities by health insurance status. *Cancer Med*. 2013;2:403-411.
39. Walker GV, Grant SR, Guadagnolo BA, et al. Disparities in stage at diagnosis, treatment, and survival in nonelderly adult patients with cancer according to insurance status. *J Clin Oncol*. 2014;32:3118-3125.
40. Akinyemiju T, Sakhuja S, Vin-Raviv N. Racial and socio-economic disparities in breast cancer hospitalization outcomes by insurance status. *Cancer Epidemiol*. 2016;43:63-69.
41. McLafferty S, Wang F, Luo L, Butler J. Rural - urban inequalities in late-stage breast cancer: spatial and social dimensions of risk and access. *Environ Plann B Plann Des*. 2011;38:726-740.
42. Huo Q, Cai C, Yang Q. Rural-urban disparities contributed to distinct outcomes of early stage breast cancer. *Oncol Res Treat*. 2014;37:596-597.
43. Williams F, Thompson E. Disparity in breast cancer late stage at diagnosis in missouri: does rural versus urban residence matter? *J Racial Ethn Health Disparities*. 2016;3:233-239.
44. Bergin RJ, Emery J, Bollard RC, et al. Rural-Urban Disparities in time to diagnosis and treatment for colorectal and breast cancer. *Cancer Epidemiol Biomarkers Prev*. 2018;27:1036-1046.
45. Butler DC, Petterson S, Phillips RL, Bazemore AW. Measures of social deprivation that predict health care access and need within a rational area of primary care service delivery. *Health Serv Res*. 2013;48(2 Pt 1):539-559.
46. Mann RM, Hooley R, Barr RG, Moy L. Novel approaches to screening for breast cancer. *Radiology*. 2020;297:266-285. doi:10.1148/radiol.20200172.
47. Santiago-Rivas M, Benjamin S, Andrews JZ, Jandorf L. Breast density awareness and knowledge, and intentions for breast cancer screening in a diverse sample of women age eligible for mammography. *J Cancer Educ*. 2019;34:90-97. doi:10.1007/s13187-017-1271-y.
48. Champion CD, Thomas SM, Plichta JK, et al. Disparities at the intersection of race and ethnicity: examining trends and outcomes in hispanic women with breast cancer. *JCO Oncol Pract*. 2020:OP2000381 Epub ahead of print. PMID:33026950 . doi:10.1200/OP.20.00381.