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ORIGINAL ARTICLE – THORACIC ONCOLOGY

Influence of Race, Insurance, Rurality, and Socioeconomic Status on Equity of Lung and Colorectal Cancer Care

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ABSTRACT

Background. This study evaluated the influence that social determinants of health had on stage at diagnosis and receipt of cancer-directed surgery for patients with lung and colorectal cancer in the North Carolina Central Cancer Registry (2010–2015).

Methods. This study examined non-Hispanic uninsured or privately-insured patients 18 to 64 years of age. Multivariable logistic regression models, including two-way interaction terms, assessed the influence of race, insurance status, rurality, and Social Deprivation Index on stage at diagnosis and receipt of surgery.

Results. 6574 lung cancer patients and 5355 colorectal cancer patients were included. Among the lung cancer patients, the uninsured patients had higher odds of having stage IV disease (odds ratio [OR] = 1.46; 95 % confidence interval [CI] = 1.22–1.76) and lower odds of receiving surgery (OR = 0.48; 95 % CI = 0.34–0.69) than the privately-insured patients. Among the colorectal cancer patients, uninsured status was associated with higher odds of stage IV disease (OR = 1.53; 95 % CI = 1.17–2.00) than privately-insured status. A significant insurance status and rurality interaction (p = 0.03) was found in the colorectal model for receipt of surgery. In the privately-insured group, non-Hispanic Black and rural patients had lower odds of receiving colorectal surgery (OR = 0.69; 95 % CI = 0.50–0.94 and OR = 0.68; 95 % CI = 0.52–0.89; respectively) than their non-Hispanic White and urban counterparts.

Conclusions. After controlling for confounding and evaluation of interactions between patient-, community-, and geographic-level factors, uninsured status remained the strongest driver of patients' presentation with late-stage lung and colorectal cancer. As policy and care delivery transformation targets uninsured and vulnerable populations, explicit recognition, and measurement of intersectionality should be considered.

Lung and colorectal cancer are the two most common causes of cancer-related death in the United States, yet particular populations consistently suffer from inequitable access to and receipt of indicated cancer care. Community-level structural factors including race, insurance status, rurality, and socioeconomic status (SES) are well-known barriers to receipt of accessible health care, including quality cancer care.[1–4] For lung and colorectal cancer patients, this leads to delayed presentation and suboptimal treatment, with consequent implications for patient morbidity and mortality.[5,6]

The inequities in cancer care across multiple domains including race, insurance status, geography, and SES have been well-described.[7–10] Non-White cancer patients are less likely to receive cancer-directed surgery than White patients.[7–9,11,12] Additionally, insurance status is associated with screening availability, time of disease presentation, and odds of treatment delays.[10,13–15] Uninsured patients consequently are more likely to present with high tumor burden and late-stage or node-positive disease.[5,16] Rural patients have fewer screening and treatment facilities available, resulting in later stage of disease at diagnosis, poorer surgical care, lower odds of receiving

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chemoradiation, and higher mortality than their urban counterparts.[17–21] Socioeconomic status is a final factor with demonstrated clinical consequences for cancer patients, who often require years of costly multidisciplinary treatment and follow-up care.[9,12,22–24]

This study examined how lack of insurance particularly affected populations by evaluating the interaction between insurance status and social determinants of race, rurality, and Social Deprivation Index (SDI, used as a measure for SES). We hypothesized that non-Hispanic Black (vs non-Hispanic White), uninsured (vs privately-insured), rural (vs urban), and high SDI (vs low SDI) statuses were independently associated with higher odds of advanced disease at diagnosis and lower odds of receiving cancer-directed surgery for lung and colorectal cancer. Furthermore, we hypothesized that insurance coverage would have a differential impact on care delivery for non-White, rural, and high-SDI communities.

METHODS

Data from the North Carolina Central Cancer Registry (NCCCR) identified patients 18 to 64 years of age diagnosed with lung or colorectal cancer from 2010 to 2015. This dataset was used because of North Carolina's generalizability to the U.S. population more broadly. The demographic breakdown of both, based on race, ethnicity, income, education level, and economy, are quite similar.[25,26] For further characterization of the population, excellent state data also were collected and converted into "hot spot" maps describing various social determinants of health by region.[27] The patients included in the study had either private insurance (employer or individually purchased) or no insurance (uninsured status or self-pay coverage).

Lung cancer was defined using International Classification of Diseases for Oncology, third edition (ICD-O-3)[28,29] site codes C34.0 to C34.3, C34.8, and C34.9, and colorectal cancer was identified using the ICD-O-3 site codes C18.0, C18.1, C18.3 to C18.9, C19.9, and C20.9. The study excluded patients younger than 18 years or older than 65 years, and those with either Medicare or Medicaid coverage.

The NCCCR used standardized codes and definitions from the North American Association of Central Cancer Registries (NAACCR)[30] for stage at diagnosis, receipt of cancer-directed surgery, and other demographics including age at diagnosis, sex, race, insurance status, diagnosis year, ZIP code, census tract, and comorbidities.

The primary outcomes of the study were stage at diagnosis (Appendix 1), derived from the American Joint Committee on Cancer's seventh edition staging manual[31] and receipt of cancer-directed surgery[32] (Appendix 2). Stage was dichotomized as advanced for lung cancer at stage IV versus stages I to III and as advanced for colorectal cancer at stage IV versus stages 0 to III.

Among the non-metastatic patients, cancer-directed surgery was defined as the presence or absence of the most definitive surgical procedure or procedures to the primary site as part of the first course of treatment, not exclusively for palliative or diagnostic purposes, determined using CPT codes captured in the North Carolina Cancer Registry. Thoracic surgical procedures included lobectomy or bilobectomy, pneumonectomy, and resection of the lung. Colorectal surgical procedures included colectomy, total and partial plus resection, wedge or segmental resection, and proctocolectomy.

Distributions of patient demographics (*n* [%]) were reported for stage at diagnosis and receipt of cancer-directed surgery by cancer type. The SDI, a measure that compiled seven variables from the United States Census Bureau American Community Survey including income, employment, housing, education, and transportation was used to estimate community-level SES. The SDI was determined at the geographic level of the census tract,[33] with higher scores indicating higher degrees of community-level socioeconomic deprivation. A dichotomous SDI was defined from the data quartiles as high (Q4:76–100) versus low (Q1–Q3:1–75). Rural-urban commuting area (RUCA)[34] ZIP level data secondary codes were used for rural (4.0, 5.0, 6.0, 7.0, 7.2, 8.0, 8.2, 9.0, 10.0, 10.2, 10.3) and urban (1.0, 1.1, 2.0, 2.1, 3.0, 4.1, 5.1, 7.1, 8.1, 10.1) location. Merged with the NCCCR data, the RUCA codes and SDI defined patient geographic location (rural vs urban) and community-level socioeconomic deprivation.

All models were adjusted for age at time of diagnosis, sex, year of diagnosis, and comorbidities. The patient Elixhauser Comorbidity Index (ECI) was calculated using NCCCR's comorbid/complication diagnosis codes and the Healthcare Cost and Utilization Project software, then dichotomized as 0 or 1+.[35] Additional variables in the NCCCR included insurance coverage at the time of diagnosis, race, and ethnicity.

Separate lung and colorectal cancer multivariable logistic regression models assessed the influence of race, insurance, rurality, and SDI on stage at diagnosis and cancer-directed surgery. Models were adjusted for age at diagnosis, sex, diagnosis year, and comorbidities and included two-way interactions among race, insurance, rurality, and SDI. The cancer-directed surgery models included patients with non-metastatic lung or colorectal cancer and were adjusted for stage.

Stratified analyses were conducted for significant interactions. Results are presented as odds ratios (OR) with 95 % confidence intervals (CI), and analyses were performed

in SAS.[36] Given the public availability and de-identified nature of the data in the NCCCR dataset, the study was exempt from institutional review board review.

RESULTS

Our final analytic cohort comprised 11,929 patients, including 6574 patients with lung cancer and 5355 patients with colorectal cancer (Fig. 1). The lung cancer patients were older (68.6 % were 55 to 64 years old), and 33 % reported comorbidities (Table 1). In this group, 51.9 % were male, 17.9 % were non-Hispanic Black, 18.7 % were uninsured, 25.2 % resided in rural areas, and 22.4 % resided in communities of the highest SDI quartile.

The colorectal cancer patients were younger (52.2 % were <55 years old), and 22.6 % reported comorbidities (Table 1). In this group, 53.9 % were male, 22.0 % were non-Hispanic Black, 12.8 % were uninsured, 24.4 % resided in rural areas, and 22.3 % resided in communities of highest SDI quartile.

Of the 6574 lung cancer patients, 52 % (n = 3416) had a diagnosis of stage IV disease. Cancer-directed surgery was performed for 50.8 % (n = 1603) of the patients with non-metastatic lung cancer. The uninsured patients were more likely to have a stage IV disease diagnosis than those with private insurance (OR = 1.46; 95 % CI = 1.22–1.76; Table 2). The uninsured patients with non-metastatic lung cancer were less likely to receive surgery than the privately-insured patients (OR = 0.48; 95 % CI = 0.34–0.69; Table 2). No significant two-way interactions were found for lung cancer stage or receipt of surgery.

Among the 5355 patients with colorectal cancer, 23.7 % (n = 1269) had a diagnosis of with stage IV disease (Table 1). Uninsured patients were more likely to be diagnosed with stage IV disease than privately-insured patients (OR = 1.53; 95 % CI = 1.17–2.00; Table 3). No significant two-way interactions were found for colorectal cancer stage.

Of those diagnosed with non-metastatic colorectal cancer (n = 4086), 84.5 % received cancer-directed surgery (Table 1). A significant interaction was found in the non-metastatic colorectal cancer-directed surgery model

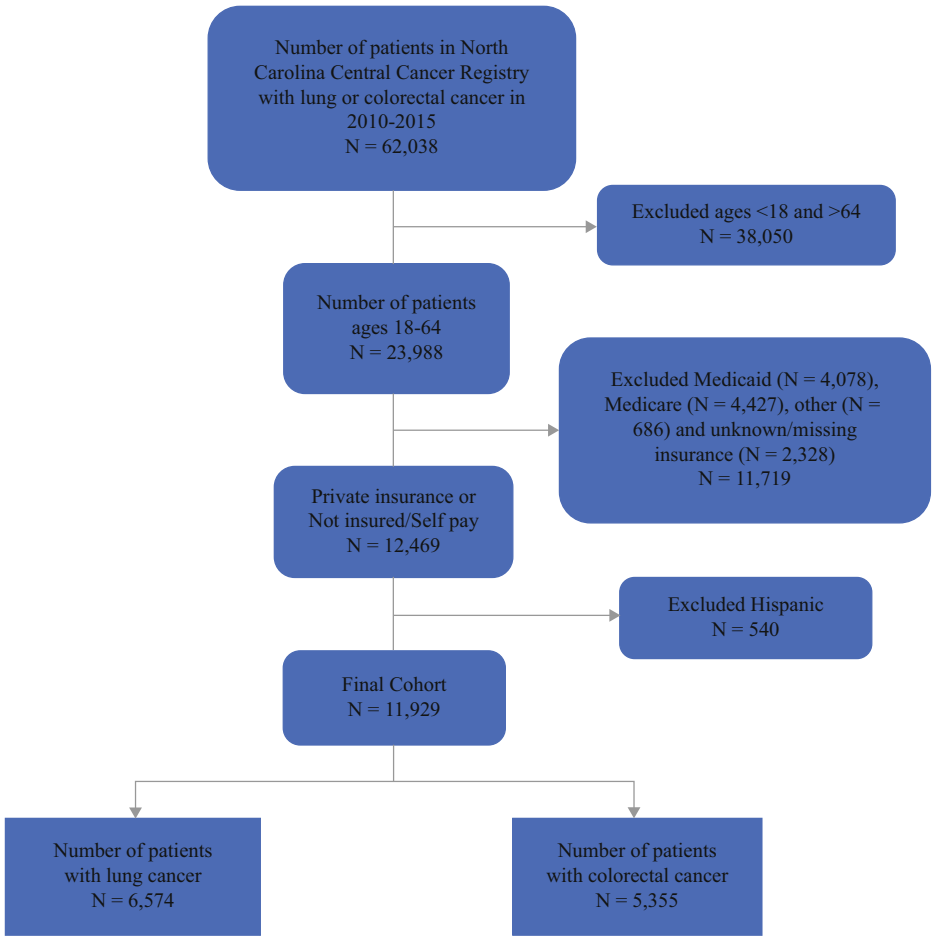

FIG. 1 North Carolina Central Cancer Registry (2010–2015) Lung and Colorectal Cancer Cohort Derivation

TABLE 1 Patient characteristics among 11,929 patients with lung or colorectal cancer (2010–2015) by stage and cancer-directed surgery

	Lung					Colorectal				
		Stage (n = 6574)		Cancer-directed surgery[1] (n = 3158)			Stage (n = 5355)		Cancer-directed surgery[a] (n = 4086)	
Characteristic[b]	Total (n = 6574) n (%)	1–3(n = 3158, 48 %) n (row %)	4 (n = 3416, 52.0 %)	No (n = 1555, 49.2 %)	Yes (n = 1603, 50.8 %)	Total (n = 5355) n (%)	0–3 (n = 4086, 76.3 %) n (row %)	4 (n = 1269, 23.7 %)	No (n = 634, 15.5 %)	Yes (n = 3452, 84.5 %)
Age (years)										
18–44	287 (4.4)	134 (46.7)	153 (53.3)	43 (32.1)	91 (67.9)	830 (15.5)	619 (74.6)	211 (25.4)	88 (14.2)	531 (85.8)
45–54	1778 (27.0)	828 (46.6)	950 (53.4)	395 (47.7)	433 (52.3)	1966 (36.7)	1512 (76.9)	454 (23.1)	241 (15.9)	1271 (84.1)
55–64	4509 (68.6)	2196 (48.7)	2313 (51.3)	1117 (50.9)	1,079 (49.1)	2559 (47.8)	1955 (76.4)	604 (23.6)	305 (15.6)	1650 (84.4)
Sex										
Male	3414 (51.9)	1550 (45.4)	1864 (54.6)	846 (54.6)	704 (45.4)	2886 (53.9)	2201 (76.3)	685 (23.7)	340 (15.4)	1861 (84.6)
Female	3160 (48.1)	1608 (0.9)	1552 (49.1)	709 (44.1)	899 (55.9)	2469 (46.1)	1885 (76.3)	584 (23.7)	294 (15.6)	1591 (84.4)
Race/ethnicity										
NH White	5348 (82.1)	2586 (48.4)	2762 (51.6)	1254 (48.5)	1332 (51.5)	4138 (78.0)	3167 (76.5)	971 (23.5)	450 (14.2)	2717 (85.8)
NH Black	1169 (17.9)	545 (46.6)	624 (53.4)	287 (52.7)	258 (47.3)	1168 (22.0)	876 (75.0)	292 (25.0)	174 (19.9)	702 (80.1)
Diagnosis year										
2010	1046 (15.9)	496 (47.4)	550 (52.6)	233 (46.0)	263 (53.0)	753 (14.1)	578 (76.8)	175 (23.2)	87 (15.1)	491 (84.9)
2011	1094 (16.6)	551 (50.4)	543 (49.6)	268 (48.6)	283 (51.4)	825 (15.4)	638 (77.3)	187 (22.7)	79 (12.4)	559 (87.6)
2012	1045 (15.9)	497 (47.6)	548 (52.4)	226 (45.5)	271 (54.5)	855 (16.0)	646 (75.6)	209 (24.4)	95 (14.7)	551 (85.3)
2013	1136 (17.3)	546 (48.1)	590 (51.9)	296 (54.2)	250 (45.8)	920 (17.2)	700 (76.1)	220 (23.9)	103 (14.7)	597 (85.3)
2014	1089 (16.6)	517 (47.5)	572 (52.5)	256 (49.5)	261 (50.5)	956 (17.8)	733 (76.7)	223 (23.3)	138 (18.8)	595 (81.2)
2015	1164 (17.7)	551 (47.3)	613 (52.7)	276 (50.1)	275 (49.9)	1046 (19.5)	791 (75.6)	255 (24.4)	132 (16.7)	659 (85.3)
Stage										
0	NA	NA	NA	NA	NA	77 (1.4)	77 (100.0)	0 (0.0)	50 (64.9)	27 (35.1)
1	1149 (17.5)	1149 (100.0)	0 (0.0)	238 (20.7)	911 (79.3)	1285 (24.0)	1285 (100.0)	0 (0.0)	421 (32.8)	864 (67.2)
2	547 (8.3)	547 (100.0)	0 (0.0)	132 (24.1)	415 (75.9)	1131 (21.1)	1131 (100.0)	0 (0.0)	70 (6.2)	1061 (93.8)
3	1462 (22.2)	1462 (100.0)	0 (0.0)	1185 (81.0)	277 (19.0)	1593 (29.8)	1593 (100.0)	0 (0.0)	93 (5.8)	1500 (94.2)
4	3416 (52.0)	0 (0.0)	3416 (100.0)	NA	NA	1269 (23.7)	0 (0.0)	1,269 (100.0)	NA	NA
ECI										
0	4408 (67.0)	2106 (47.8)	2302 (52.2)	1025 (49.0)	1075 (51.0)	4145 (77.4)	3199 (77.2)	946 (22.8)	525 (16.4)	2674 (83.6)
1+	2166 (33.0)	1052 (48.6)	1114 (51.4)	524 (49.8)	528 (50.2)	1210 (22.6)	887 (73.3)	323 (26.7)	109 (12.3)	778 (87.7)
Race/ethnicity										
NH White	5348 (82.1)	2586 (48.4)	2762 (51.6)	1254 (48.5)	1332 (51.5)	4138 (78.0)	3167 (76.5)	971 (23.5)	450 (14.2)	2717 (85.8)
NH Black	1169 (17.9)	545 (46.6)	624 (53.4)	287 (52.7)	258 (47.3)	1168 (22.0)	876 (75.0)	292 (25.0)	174 (19.9)	702 (80.1)

Table 1 (continued)

Characteristic[b]	Lung					Colorectal				
		Stage (n = 6574)		Cancer-directed surgery[1] (n = 3158)			Stage (n = 5355)		Cancer-directed surgery[a] (n = 4086)	
	Total (n = 6574) n (%)	1–3(n = 3158, 48 %) n (row %)	4 (n = 3416, 52.0 %)	No (n = 1555, 49.2 %)	Yes (n = 1603, 50.8 %)	Total (n = 5355) n (%)	0–3 (n = 4086, 76.3 %) n (row %)	4 (n = 1269, 23.7 %)	No (n = 634, 15.5 %)	Yes (n = 3452, 84.5 %)
Insurance										
Private	5348 (81.4)	2678 (50.1)	2670 (49.9)	1242 (46.4)	1436 (53.6)	4669 (87.2)	3598 (77.1)	1071 (22.9)	554 (15.4)	3044 (84.6)
Uninsured/self-pay	1226 (18.6)	480 (39.2)	746 (60.8)	313 (65.2)	167 (34.8)	686 (12.8)	488 (71.1)	198 (28.9)	80 (16.4)	408 (83.1)
Geography										
Urban	4848 (74.8)	2366 (48.8)	2482 (51.2)	1134 (47.9)	1232 (52.1)	3978 (75.6)	3036 (76.3)	942 (23.7)	461 (15.2)	2575 (84.8)
Rural	1632 (25.2)	747 (45.8)	885 (54.2)	398 (53.3)	349 (46.7)	1282 (24.4)	972 (75.8)	310 (24.2)	162 (16.7)	810 (83.3)
SDI										
Q1–3 (1–75)	5024 (77.6)	2431 (48.4)	2593 (51.6)	1168 (48.1)	1263 (51.9)	4084 (77.7)	3089 (75.6)	995 (24.4)	105 (13.6)	668 (86.4)
Q4 (76–100)	1451 (22.4)	679 (48.0)	772 (53.2)	362 (53.3)	317 (46.7)	1173 (22.3)	917 (78.2)	256 (21.8)	156 (17.0)	761 (83.0)

NH, non-Hispanic; NA, Not Applicable; ECI, Elixhauser Comorbidity Index; SDI, Social Deprivation Index; Q, quartile

[a]Cancer-directed surgery among patients with non-metastatic cancer

[b]Missing: race (lung = 57; colorectal = 49); rurality (lung = 94; colorectal = 95); Social Deprivation Index (lung = 99; colorectal = 98)

TABLE 2 Multivariable logistic regression models[a] for lung cancer by stage and receipt of cancer-directed surgery

Characteristic	Advanced stage at diagnosis OR (95 % CI)	Receipt of cancer-directed surgery
Non-Hispanic Black[b]	1.17 (0.96–1.42)	0.87 (0.61–1.24)
Uninsured[c]	1.46 (1.22–1.76)	0.48 (0.34–0.69)
Rural[d]	1.16 (0.99–1.34)	0.78 (0.59–1.01)
High SDI[e]	1.11 (0.92–1.33)	0.75 (0.54–1.04)

NOS, Not Otherwise Specified; OR, odds ratio; CI, confidence interval; SDI, Social Deprivation Index; Q1–3, quartiles 1–3

[a]Models adjusted for age at diagnosis, sex, comorbidities, and year of diagnosis.

Additionally, the cancer-directed surgery model adjusted for stage.

[b–e]Reference groups: non-Hispanic White, privately-insured, urban, and SDI Q1–3 (1–75), respectively.

TABLE 3 Multivariable logistic regression models[a] for colorectal cancer by stage, and among those with private insurance, receipt of cancer-directed surgery

Characteristic	Advanced stage at diagnosis OR (95 % CI)	Receipt of cancer-directed surgery	
		Uninsured	Privately-Insured
Non-Hispanic Black[b]	1.16 (0.93–1.44)	0.67 (0.29–1.51)	0.69 (0.50–0.94)
Uninsured[c]	1.53 (1.17–2.00)	—	—
Rural[d]	0.98 (0.81–1.19)	1.60 (0.64–4.01)	0.68 (0.52–0.89)
High SDI[e]	0.93 (0.73–1.19)	1.09 (0.43–2.76)	0.91 (0.64–1.29)

OR, odds ratio; CI, confidence interval; SDI, Social Deprivation Index; Q1–3, quartiles 1–3

[a]Models adjusted for age at diagnosis, sex, comorbidities, and year of diagnosis; additionally, the cancer-directed surgery model adjusted for stage

[b–e]Reference groups: non-Hispanic White, privately-insured, urban, and SDI Q1–3 (1–75), respectively.

between insurance and rurality (p = 0.03). Among privately-insured patients, those in rural areas were less likely to receive surgery than their urban counterparts (OR, 0.68; 95 % CI, 0.52–0.89; Table 3), and the non-Hispanic Black patients were less likely to receive surgery for colorectal cancer than the non-Hispanic White patients (OR, 0.69; 95 % CI, 0.50–0.94; Table 3).

DISCUSSION

Lung and colorectal cancer are the leading causes of cancer-related death in the United States, yet this burden is not experienced equally across society. This study found that insurance status had the largest effect on differences in stage at diagnosis and receipt of surgery. Among the lung cancer patients, uninsured patients were less likely to receive cancer-directed surgery than those with private insurance. Among the colorectal cancer patients and within the privately-insured group, there were persistent disparities by race and rurality.

These findings demonstrate the consequences of singular and combined community-level demographics. They emphasize the critical importance of insurance status to cancer diagnosis and management, and they foreshadow the potential clinical impact of policies that target uninsured patients. If lacking insurance augments existing disparities, then improving insurance access and affordability has the potential to combat them. Prior work has shown that increased access to care through expanded insurance coverage is associated with earlier presentation and improved surgical management for a variety of cancers.[37–40] However, further studies are needed to determine whether these data are generalizable across the country and between communities of differing geographic or socioeconomic characteristics.

Importantly, a nuanced interpretation of these data shows that insurance expansion is not a panacea for variable access to healthcare and that disparities persist even within the privately-insured population. This suggests that beyond insurance status, race and rurality pose additional barriers to receipt of optimal cancer care delivery. These findings may highlight the reach of structural racism and the need for critical evaluations of heterogeneous social determinants among differing populations and communities.

These findings align with existing literature describing independent drivers of cancer care inequities. Prior work has shown that uninsured patients seeking medical

treatment are charged more for care[23] and tend to have diagnoses of more advanced disease.[5,16] Socioeconomic status generally parallels insurance status, with more than 80 % of uninsured patients having a household income below 400 % of the federal poverty line.[23] Additionally, trends in SES mirror trends in poor diet, smoking, reduced physical activity, decreased rates of cancer screening, and higher cancer-related mortality.[24,41] Moreover, Black patients are less likely to receive cancer-directed surgery,[7,8] and when they do, Black patients experience increased mortality, even after adjusting for patient-level differences.[9] The clinical consequences of structural, interpersonal, and intrapersonal racism that contribute to differences in surgical care are dire for non-White patients, with reduced 5-year survival compared with White Americans.[8,12,42] Finally, previous study has described the impact of geography on surgical oncology, with a tendency of high-volume centers with lower procedural mortality rates to be located in urban areas.[43,44]

The limitations of this study included but were not limited to the exclusion of ethnicity. The Hispanic population was likely underestimated in the study cohort (4.3 %, Fig. 1) and therefore would not reflect the underlying Hispanic population in North Carolina (9.8 %).[45] By comparison, the study populations of non-Hispanic White and Black patients more closely correlated with both state and national demographics, so we elected to limit our analysis to those two groups. Our analysis excluded individuals with Medicaid coverage. North Carolina did not elect to expand Medicaid eligibility in conjunction with the Affordable Care Act. Therefore, individuals with Medicaid coverage in North Carolina represent especially poor parents of children (<41 % of the federal poverty limit for a family of three), with childless or single adults notably ineligible for Medicaid regardless of their income.[46] Finally, our study excluded individuals older than 65 years and patients younger than 65 years with Medicare due to the unique structure of the Medicare insurance program. Although cancer is more common in the aging population, we felt that the low barriers to entry, significantly reduced copays, and other aspects of Medicare make the program—its beneficiaries—different enough from other insurance programs and patients that these groups could not be considered together. Furthermore, younger patients with Medicare represent a unique group with either end-stage renal disease or significant disability, limiting comparisons with other cancer patients who had no Medicare coverage.

This study demonstrated the multiple—and at times, intersecting—factors, specifically the impact of insurance status associated with stage at the time of diagnosis and care for lung and colorectal cancer patients. Understanding how social determinants including race, insurance status, SES, and rurality influence cancer diagnosis and subsequent surgical treatment will be critical in urging leaders to reform health policy and delivery to incorporate broad population-level factors. Given the common, costly, and morbid nature of cancer, consideration of racial parity, increased health insurance coverage, geographic access to care, and poverty reduction likely will play an important role in improving equity of cancer care in the United States.

APPENDIX 1

Definition for cancer stage[a]
Derived AJCC-7 stage GRP
NAACCR item no. 3430

Code	Description	Stage
000	Stage 0	0
010	Stage 0a	0
020	Stage 0is	0
100	Stage 1	1
110	Stage 1NOS	1
120	Stage 1A	1
130	Stage 1A1	1
140	Stage 1A2	1
121	Stage 1A NOS	1
150	Stage 1B	1
160	Stage 1B1	1
170	Stage 1B2	1
151	Stage 1B NOS	1
180	Stage 1C	1
190	Stage 1S	1
300	Stage 2	2
310	Stage 2 NOS	2
320	Stage 2A	2
321	Stage 2A NOS	2
322	Stage 2A1	2
323	Stage 2A NOS	2
330	Stage 2B	2
340	Stage 2C	2
500	Stage 3	3
510	Stage 3 NOS	3
520	Stage 3A	3
530	Stage 3B	3
540	Stage 3C	3
541	Stage 3C1	3
542	Stage 3C2	3
700	Stage 4	4
710	Stage 4 NOS	4
720	Stage 4A	4
730	Stage 4B	4
740	Stage 4C	4

Code	Description	Stage
888	Not applicable	9
900	Stage occult	9
999	Stage Unknown	9

[a]Derived from the American Joint Committee on Cancer (AJCC)-7 Stage Group Crosswalk (https://seer.cancer.gov/data-software/documentation/seerstat/nov2018/TextData.FileDescription.pdf, accessed 7/15/2020)

APPENDIX 2

Definition for cancer-directed surgery

Code	Surgical procedure of primary site (NAACCR #1290)[a]	Cancer-directed surgery
00	None; no surgery of primary site; autopsy ONLY	No
10–19	Local tumor destruction, NOS	No
20–80	Site-specific codes[b]	Yes
90	Surgery, NOS	No
99	Unknown whether surgery was performed; death certificate ONLY	No

[a]Retrieved 10 July 2020 at https://www.facs.org/~/media/files/quality%20programs/cancer/ncdb/store_manual_2018.ashx, pages 468–470, Appendix B: site-specific surgery codes

[b]Additional site-specific codes for lung and colorectal cancer coded as "No" for cancer-directed surgery:

Lung
22 Segmental resection, including lingulectomy
23 Excision, NOS
24 Laser excision
Colorectal
20 Local tumor excision, NOS
27 Excisional biopsy
26 Polypectomy, NOS
28 Polypectomy-endoscopic
29 Polypectomy-surgical excision
Any combination of 20 or 26–29 WITH
21 Photodynamic therapy (PDT)
22 Electrocautery
23 Cryosurgery
24 Laser ablation
25 Laser excision

DISCLOSURE There are no conflicts of interests.

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