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Race, ethnicity, and socioeconomic factors in cholangiocarcinoma: What is driving disparities in receipt of treatment?

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Abstract

Background and Objectives: Race/ethnicity and socioeconomic factors are associated with worse cancer outcomes. Our aim was to determine the association of these factors with receipt of surgery and multimodality therapy for cholangiocarcinoma.

Methods: Patients with cholangiocarcincoma in the National Cancer Database were identified. Racial/ethnic groups were defined as non-Hispanic White, non-Hispanic Black, Asian, and Hispanic. Socioeconomic factors were insurance status, income, and education.

Results: Of 12 095 patients with non-metastatic cholangiocarcinoma, 42% received surgery. Black race was associated with decreased odds of receiving surgery (odds ratio [OR]: 0.66l; $P < .001$) compared to White patients. Socioeconomic factors accounted for 21% of this disparity. Accounting for socioeconomic and clinicopathologic variables, Black race (OR: 0.73; $P < .001$), uninsured status (OR: 0.43; $P < .001$), and Medicaid insurance (OR: 0.63; $P < .001$) were all associated with decreased receipt of surgery. Of 4808 patients who received surgery, 47% received multimodality therapy. There were no racial/ethnic or socioeconomic differences in receipt of multimodality therapy once patients accessed surgical care. Similar results were seen in patients with advanced disease who received chemotherapy as primary treatment.

Conclusion: Racial/ethnic and socioeconomic disparities exist in treatment for cholangiocarcinoma, however only for primary treatment. In patients who received surgery or

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from The American College of Surgeons National Cancer Database. Restrictions apply to the availability of these data, which were used under license for this study. Data are available at https://www.facs.org/quality-programs/cancer/ncdb with the permission of the American College of Surgeons.

chemotherapy, there were no disparities in receipt of multimodality therapy. This emphasizes the need to improve initial access to health care for minority and socioeconomical disadvantaged patients.

Keywords

cholangiocarcinoma; disparities; multimodality; race/ethnicity; socioeconomic factors; treatment

1 | INTRODUCTION

Given the extremely poor prognosis associated with cholangiocarcinoma, access to and timely receipt of appropriate, multimodality treatment is critical. Treatment for metastatic disease centers around systemic chemotherapy, a combination of chemotherapy and radiation is used for locally advanced, unresectable disease, and a combination of surgical resection with systemic chemotherapy and/or targeted radiation depending on primary tumor site is appropriate for resectable disease.[1,2]

Racial and ethnic disparities in receipt of treatment have been documented in other hepatobiliary cancers. Jaruvongvanich et al[3] found that Black patients with gallbladder cancer were less likely to undergo curative resection compared to White patients, despite presenting with similar stage disease, and, in patients undergoing curative resection, Hispanic patients were less likely to have optimal lymph node clearance. When stratifying by time period, these disparities appeared to become more pronounced over time. Similarly, black patients with pancreatic adenocarcinoma have been shown to be less likely to receive surgery, adjuvant chemotherapy, and chemotherapy compared to White patients, despite presenting with the resectable disease at similar rates.[4] Insurance status also affects receipt of treatment: patients with pancreatic adenocarcinoma with Medicaid insurance are less likely to receive surgery, while uninsured patients were less likely to receive adjuvant therapy compared to privately insured patients.[4]

Limited disparities research has been conducted in cholangiocarcinoma. Black, Hispanic, and American Indian/Alaskan Native patients were found to have decreased disease-specific survival compared to White or non-Hispanic patients in an analysis of the service, epidemiology, and end results database when accounting for age, sex, and stage of presentation.[5] We performed a similar analysis using the National Cancer Database (NCDB), but also included socioeconomic factors of insurance status, income, and education. We found that adverse socioeconomic factors, including Medicaid insurance, uninsured status and having a lower income, were associated with decreased overall survival, while non-White race/ethnicity was not.[6]

Whether disparities exist in receipt of treatment for cholangiocarcinoma is unknown. Kneuertz et al[7] investigated time to treatment in patients with intrahepatic cholangiocarcinoma in the Texas Cancer Registry and found that Hispanic patients and patients without insurance had longer times to treatment from diagnosis compared to White patients and patients with Medicare/Medicaid insurance. However, all patients were receiving treatment at low rates; only approximately one-third of patients in the registry with a documented diagnosis received any treatment.[7]

Given these low treatment rates, documented disparities in receipt of treatment for other hepatobiliary cancers, and the potential for receipt of treatment to affect outcomes, our aim was to determine the impact of race/ethnicity and socioeconomic factors on receipt of treatment for cholangiocarcinoma using a large national database.

2 | METHODS

2.1 | National Cancer Database

The NCDB is a joint program of the American College of Surgeons Committee on Cancer and the American Cancer Society.[8] Over 1500 accredited hospitals provide data to the NCDB registry. The database was queried for adult patients with cholangiocarcinoma of all sites and stages from 2004 to 2013. Histology codes representing cholangiocarcinoma and Klatskin tumors were selected using the International Classification of Diseases third revision. Patients with unknown race/ethnicity, insurance status, income, education, and missing treatment information (a receipt of chemotherapy, surgery, or radiation) were excluded, as were patients with 30-day mortality after surgical resection. Racial and ethnic groups were defined as non-Hispanic White, non-Hispanic Black, Hispanic, and Asian. Hispanic ethnicity included patients coded as “Mexican/Chicano”, “Puerto Rican”, “Cuban”, “South or Central American”, “other specified Spanish/Hispanic origin”, “Spanish, NOS Hispanic, NOS Latino, NOS”, or “Dominican Republic”. Asian race included patients coded as “Chinese”, “Japanese”, “Filipino”, “Korean”, “Vietnamese”, “Laotian”, “Hmong”, “Kampuchean”, “Thai”, “Asian Indian or Pakistani”, “Asian Indian”, “Pakistani”, or “other Asian, including “Asian, NOS, and Oriental NOS”. Socioeconomic variables used for analysis included insurance status (private, Medicare, Medicaid and other government-provided insurance, and uninsured), median income, and education quartiles. Income and education quartiles were standard NCDB variables determined by 2008 to 2012 American Community Survey data based on patient zip code. Income quartiles were combined to create two categories, high income (≥ $63 000) and low income (< $63 000). Educational attainment was estimated by the percentage of adults in the patient’s reported zip code that did not obtain a high school diploma (<7%, 7%–20%, and ≥21%).

2.2 | Statistical analysis

Statistical analysis was conducted using SAS version 9.4 and SAS macros or software developed at the Biostatistics and Bioinformatics Department at Winship Cancer Institute.[9] Statistical significance was predefined as two-tailed $P < .05$. Descriptive statistics for each variable were reported. Primary outcomes were (a) receipt of primary therapy, defined as chemotherapy in the entire cohort, including patients with metastatic disease, and surgery in patients with non-metastatic, and thus potentially resectable, disease, and (b) receipt of multimodality therapy, defined as radiation in patients who received chemotherapy, and as either chemotherapy or radiation, or both, in patients who underwent surgical resection. The univariate association between each covariate and study cohorts (racial/ethnic groups and socioeconomic factors) were assessed using the Chi-square test for categorical covariates and analysis of variance for continuous covariates. The univariate and multivariable association between each covariate including study cohorts and study outcomes (a receipt of

primary/initial and multimodality therapy) was assessed using logistic regression models and reported as odds ratios (OR) with corresponding 95% confidence intervals (95% CI).

The contributions of socioeconomic factors to racial disparities in receiving treatment were calculated from OR for receiving treatment for each racial/ethnic group in a multivariable analysis containing race/ethnicity and clinicopathologic variables and a multivariable analysis containing race/ethnicity, clinicopathologic variables, and socioeconomic factors. The formula $(OR_{\text{without SEF}} - OR_{\text{with SEF}})/(OR_{\text{without SEF}}-1) \times 100\%$ was used to determine the percentage of excess risk of not receiving treatment for each racial/ethnic group that was attributable to socioeconomic factors.[10]

3 | RESULTS

3.1 | Patient characteristics

A total of 30 444 patients were included. Mean age was 68 years, and 51% were male (Table 1). Seventy-eight percent were White (n = 23 835), 8% Black (n = 2549), 8% Hispanic (n = 2362), and 6% Asian (n = 1698). Fifty-six percent had Medicare insurance (n = 17 148), 33% private (n = 10 042), 7% Medicaid or other government-provide insurance (n = 2209), and 4% were uninsured (n = 1045). Sixty-six percent had low income (n = 8000) and 18% lived in an area in which more than 20% of adults did not receive a high school degree (n = 2115). Thirty-four percent of patients had stage IV disease (n = 10 264).

Black and Hispanic patients were younger (White: 68.7 ± 11.9 years; Black: 65.1 ± 12 years; Hispanic: 65.8 ± 12.4 years; Asian: 67.0 ± 12.3 years; $P < .001$) and more likely to be female (White: 48%; Black: 54%; Hispanic: 52%; Asian: 47%; $P < .001$). Black and Hispanic patients were also less likely to be privately insured (White: 34%; Black: 31%; Hispanic: 29%; Asian: 34%; $P < .001$) and more likely to be uninsured (White: 2%; Black: 6%; Hispanic: 11%; Asian: 5%; $P < .001$) than White and Asian patients. Black and Hispanic patients were more likely to have low income (White: 65%; Black: 84%; Hispanic: 79%; Asian: 53%; $P < .001$) and all non-White patients were more likely to live in a zip code with low educational attainment (White: 13%; Black: 35%; Hispanic: 52%; Asian: 25%; $P < .001$; Table 2).

3.2 | Receipt of chemotherapy

Overall, 46% of patients received chemotherapy (n = 14 093). On univariate analysis, non-White race (Black: OR, 0.84; 95% CI, 0.77–0.91; Hispanic: OR, 0.84; 95% CI, 0.77–0.92; Asian: OR, 0.80; 95% CI, 0.73–0.89, all $P < .001$) non-private insurance (Medicare: OR, 0.41; 95% CI, 0.38–0.43; Medicaid: OR, 0.58; 95% CI, 0.53–0.64; Uninsured: OR, 0.44; 95% CI, 0.39–0.50, all $P < .001$) low income (< $63,000: OR, 0.74; 95% CI, 0.71–0.78, $P < .001$), and lower educational attainment (7%–20%: OR, 0.84; 95% CI, 0.80–0.89; ≥21%: OR, 0.65; 95% CI, 0.60–0.69, all $P < .001$) were associated with decreased odds of receiving chemotherapy (Table 3).

Four individual multivariable analyses including either race/ethnicity, insurance status, income, or educational attainment along with demographic variables including age, sex, and, Charlson-Deyo Score, facility type and location, clinicopathologic variables including

American Joint Committee on Cancer (AJCC) analytic stage, tumor size, tumor grade, and treatment data including resection status and receipt of radiation therapy were performed. When accounting for these clinicopathologic variables, non-White race (Black:OR, 0.74; 95% CI, 0.67–0.82; Hispanic: OR, 0.75; 95% CI, 0.67–0.83; Asian: OR, 0.72; 95% CI, 0.64–0.82; all $P < .001$), Medicaid and uninsured status (Medicare: OR, 0.99; 95% CI, 0.92–1.07; $P = .886$; Medicaid: OR, 0.59; 95% CI, 0.52–0.66; $P < .001$; Uninsured: OR, 0.48; 95% CI, 0.41–0.56; $P < .001$), low income (< $63,000: OR, 0.74; 95% CI, 0.70–0.78; $P < .001$), and lower educational attainment (7%–20%: OR, 0.84; 95% CI, 0.79–0.90; ≥21%: OR, 0.63; 95% CI, 0.58–0.69; all $P < .001$) were associated with decreased odds of receiving chemotherapy (Table 3).

On final multivariable analysis including race/ethnicity and all socioeconomic factors, demographic variables, facility type and location, clinicopathologic variables, and additional treatment data, Asian and Black race (Black: OR 0.83; 95%CI, 0.75–0.92; $P < .001$; Hispanic: OR, 0.90; 95%CI, 0.81–1.01; $P = .069$; Asian: OR, 0.76; 95% CI, 0.67–0.87; $P < 0.001$), Medicaid and uninsured status (Medicare: OR, 1.02; 95%CI, 0.95–1.10; $P = .597$; Medicaid: OR, 0.65; 95%CI, 0.58–0.73; $P < .001$; Uninsured: OR, 0.52; 95%CI, 0.44–0.61; $P < .001$), low income (< $63,000: OR, 0.81; 95%CI, 0.75–0.87; $P < .001$), and less educational attainment (7%–20%: OR, 0.96, 95%CI, 0.89–1.04, $P = .363$; ≥21%:OR, 0.81, 95%CI, 0.73–0.90, $P < .001$) were associated with decreased odds of receiving chemotherapy (Table 3). When comparing the odds ratios from the first individual multivariable analyses to the final model, socioeconomic factors accounted for 35% of the racial disparity in odds of receiving chemotherapy for Black patients, 14% for Asian patients, and the entire disparity for Hispanic patients. When accounting for socioeconomic factors in the final multivariable model, Hispanic patients did not have significantly different odds of receiving chemotherapy compared to non-Hispanic White patients.

3.3 | Receipt of chemotherapy and radiation for unresectable disease

To investigate whether these racial and socioeconomic disparities persisted in receipt of additional therapy, we focused on patients who received chemotherapy, with the primary outcome of receipt of radiation therapy. Patients who underwent surgical resection and with metastatic disease were excluded to target patients with locally advanced, unresectable disease who would be candidates for the combination of chemotherapy and radiation for local control.

A total of 3163 patients were included in this cohort. Eighty-one percent were White (n = 2573), 8% Black (n = 245), 6% Hispanic (n = 195), and 5% Asian (n = 150). Fifty-three percent had Medicare (n = 1673), 37% private insurance (n = 1171), 7% Medicaid or other government-provided insurance (n = 229), and 3% were uninsured (n = 90). Sixty-five percent had low income (n = 2045), and 15% lived in an area in which more than 20% of adults did not receive a high school degree (n = 486).

Of this cohort, 34% of patients received radiation (n = 1079). There were no racial/ethnic or socioeconomic disparities for receiving radiation in patients who also received chemotherapy on univariate, individual multivariable, or final multivariable analyses (Table 3).

3.4 | Receipt of surgery

To investigate disparities in receiving surgery, 12,095 patients with non-metastatic cholangiocarcinoma were included in the surgery cohort. Eighty percent were White (n = 9673), 8% Black (906), 7% Hispanic (n = 845), and 5% Asian (n = 671). Fifty-six percent had Medicare (n = 6821), 34% private insurance (n = 4114), 7% Medicaid or other government-provided insurance (n = 802), and 3% were uninsured (n = 358). Sixty-six percent had low income (n = 8000) and 18% lived in an area in which more than 20% of adults did not receive a high school degree (n = 2115; Table 4).

Of this cohort, 42% underwent surgical resection (n = 5062). On univariate analysis, Black race (Black: OR, 0.81; 95% CI, 0.70–0.93; $P = .003$; Hispanic: OR, 0.94; 95% CI, 0.81–1.08; $P = .394$; Asian: OR, 0.91; 95% CI, 0.78–1.07; $P = .260$), non-private insurance (Medicare: OR, 0.53; 95% CI, 0.49–0.57; Medicaid: OR, 0.61; 95% CI, 0.52–0.71; Uninsured: OR, 0.49; 95% CI; 0.39–0.61; all $P < .001$), low income (< $63,000: OR, 0.82; 95% CI, 0.76–0.88; $P < .001$), and lower educational attainment (7%–20%: OR, 0.85; 95%CI, 0.78–0.93; ≥21%: OR, 0.71; 95% CI, 0.63–0.79; all $P < .001$) were associated with decreased odds of undergoing surgical resection (Table 5).

Four individual multivariable analyses including either race/ethnicity, insurance status, income, or educational attainment along with demographic variables including age, sex, and, Charlson-Deyo Score, facility type and location, clinicopathologic variables including AJCC analytic stage, tumor size, tumor grade, and additional treatment data were again performed. When accounting for these clinicopathologic variables, Black race (OR, 0.66; 95% CI, 0.5–0.80; $P < .001$), Medicaid and uninsured status (Medicare: OR, 0.97; 95% CI, 0.86–1.10; $P = .665$; Medicaid: OR, 0.59; 95% CI, 0.49–0.72; $P < .001$; Uninsured: OR, 0.42; 95% CI, 0.31–0.56; $P < .001$), low income (< $63,000: OR, 0.81; 95% CI, 0.73–0.89), and lower educational attainment (7–20%: OR, 0.86; 95% CI, 0.77–0.96; $P = .007$; ≥21%: OR, 0.71; 95% CI, 0.61–0.82; $P < .001$) were associated with decreased odds of undergoing surgical resection (Table 5).

On final multivariable analysis including race/ethnicity and all socioeconomic factors, demographic variables, facility type and location, clinicopathologic variables, and additional treatment data, Black race (OR, 0.73; 95%CI, 0.61–0.88; $P < .001$), Medicaid and uninsured status (Medicaid: OR, 0.63; 95% CI, 0.52–0.77; Uninsured: OR, 0.43; 95% CI, 0.33–0.58; all $P < .001$), and low income (OR, 0.88; 95%CI, 0.78–1.00) were associated with decreased odds of undergoing surgical resection. Socioeconomic factors accounted for 21% of the disparity in undergoing surgical resection for Black patients compared to White patients.

3.5 | Receipt of multimodality therapy: surgery and chemotherapy and/or radiation

To investigate disparities in receiving chemotherapy and/or radiation in addition to surgical resection, 4808 patients who received surgery were included in the multimodality cohort. Patients who did not have known chemotherapy or radiation information were excluded from this analysis. Eighty-one percent of patients were White (n = 3912), 7% Black (n = 316), 7% Hispanic (n = 327), and 5% Asian (n = 253). Forty-nine percent had Medicare (n = 2341), 43% private insurance (n = 2046), 6% Medicaid or other government-provided

insurance (n = 304), and 2% were uninsured (n = 117). Sixty-three percent had low income (n = 3046) and 16% lived in an area in which more than 20% of adults did not receive a high school degree (n = 746).

Of this cohort, 22% received chemotherapy alone (n = 1039), 2% radiation therapy alone (n = 106), and 23% receiving both chemotherapy and radiation in addition to surgical resection (n = 1093). Overall, 47% received some combination of multimodality therapy (n = 2238). On univariate analysis, non-private insurance (Medicare: OR, 0.53; 95%CI, 0.47–0.59; $P < .001$; Medicaid: OR, 0.63; 95% CI, 0.49–0.89; $P < .001$; Uninsured: OR, 0.63; 95% CI, 0.43–0.91; $P = .014$), low income (OR, 0.79; 95% CI, 0.71–0.89; $P < .001$), and living in an area in which more than 20% of adults did not receive a high school degree (OR, 0.76; 95% CI, 0.64–0.91; $P = .003$) were associated with decreased odds of receiving multimodality therapy.

These disparities disappeared on individual and final multivariable analyses accounting for demographic variables, facility type and location, and clinicopathologic variables. There were no racial/ethnic disparities in receiving multimodality therapy in univariate, individual multivariable, or final multivariable analyses (Table 5).

4 | DISCUSSION

Both racial/ethnic and socioeconomic disparities exist in the receipt of treatment for cholangiocarcinoma, but only for receipt of initial therapy. Black and Asian patients and patients with Medicaid insurance, no insurance, low income, or lower educational attainment had decreased odds of receiving chemotherapy. Similarly, in patients with non-metastatic disease, Black patients, patients with Medicaid insurance, no insurance, or low income had decreased odds of receiving surgery compared to White, privately insured, and high-income patients.

When looking at receipt of multimodality therapy (radiation in patients who received chemotherapy and chemotherapy and/or radiation in patients who received surgery), there were no racial/ethnic or socioeconomic disparities. This indicates a potential barrier in the initial access to receive care or navigation of the health care system for these patients, rather than a failure to deliver appropriate care to minority race/ethnicity or socioeconomically-disadvantaged patients. Once patients accessed the health care system, evidenced by receipt of chemotherapy or surgery, all patients appeared to receive treatment at the same rates going forward.

What contributes to this disparate access to the health care system is difficult to discern and measure. The Three Delays Model is a useful framework in evaluating disparities in treatment and survival. Originally developed to assess contributing factors to maternal mortality in developing countries, it describes three delays in receiving prompt and adequate treatment: (a) delay in seeking care; (b) delay in reaching care; and (c) delay in receiving care.[11] Though created to assess conditions in the developing world, this model remains remarkably accurate in assessing treatment disparities in the United States. Examples of delays in seeking care include lack of understanding of condition or symptoms, and

socioeconomic or cultural barriers to seeking care, including distrust of the medical system. Delays in reaching care may include the distance of the facility and accessibility and affordability of reliable transportation. Delays in receiving care may include long appointment wait times, insurance coverage, and resources of the facility.[11]

Studies using the Three Delays Model have found delays in reaching and receiving care to be most common, and that appears to be true in our population as well.[12,13] Patients with Medicaid insurance or who were uninsured or low income were less likely to receive chemotherapy and surgery, and this is illustrative of this point. It is possible that financial concerns affected the care that patients were willing to accept, and access to and availability of transportation could have affected the ability of patients to receive multiple treatments–for example multiple chemotherapy infusions. Ability to navigate the healthcare system may also cause delays in receiving treatment and might contribute to these disparities. However, in patients who successfully navigated the healthcare system and received care, it appears that all other potential delays were mitigated as no racial/ethnic or socioeconomic disparities were found in receipt of multimodality treatment, emphasizing the need to improve initial access to care for cholangiocarcinoma.

This study has several limitations. We used a retrospective database, which naturally invites selection bias, however, the NCDB contains a large volume of data allowing for the power needed to perform this analysis on a rare malignancy. We were also forced to make several assumptions in grouping patients for analysis; for example, whether patients are surgical candidates is not captured in the database, thus we used non metastatic disease as a surrogate. We attempted to account for this in our multivariable models by including the clinicopathologic variables available including tumor size, stage, and differentiation to minimize the effects of these assumptions. Additionally, socioeconomic factors were estimated using zip code level, rather than individual-level data, a limitation of the database and retrospective study design, though we recognize that large variation in socioeconomic status within individual zip codes can and does occur. Finally, it is important to acknowledge that there are many factors that contribute to disparities that were not able to be captured in this study. As patients were entered into the NCDB, they had already sought care, reached a facility, and received a diagnosis, and thus already overcame many potential barriers and factors that can contribute to disparities in access to care. However, these other factors are impossible to study in a retrospective manner and even difficult to study prospectively. Ultimately, however, understanding and mitigating these factors is paramount to eliminate disparities.

5 | CONCLUSION

Remaining racial disparities in the receipt of chemotherapy and surgery after accounting for socioeconomic factors mandate further attention. Socioeconomic factors accounted for at most 35% of racial disparity in receiving treatment in our analysis. In other words, it appears that the vast majority of racial/ethnic disparities in receiving primary treatment for cholangiocarcinoma are not due to collinearity with socioeconomic status, but solely due to race. Thus, it appears that race/ethnicity is an important factor driving access to care. It is encouraging that once patients successfully enter the healthcare system there are no

disparities in receipt of treatment for cholangiocarcinoma. However, it is important to identify and address remaining barriers for non-White and socioeconomically disadvantaged patients moving forward.

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Abbreviations:

95% CI	95% confidence interval
AJCC	American Joint Committee on Cancer
Black	non-Hispanic Black
NCDB	National Cancer Database
OR	odds ratio
White	non-Hispanic White

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TABLE 1

Baseline demographic, race/ethnicity, socioeconomic, and clinicopathologic data

Demographics	
Sex	
Male	15 565 (51.1%)
Female	14 879 (48.9%)
Age (mean±SD)	68.0 ± 12.0
Charlson-Deyo score	
0	20 667 (67.9%)
1	6604 (21.7%)
2	3173 (10.4%
Race/ethnicity	
Non-Hispanic White	23 835 (78.3%)
Non-Hispanic Black	2549 (8.4%)
Hispanic	2362 (7.8%)
Asian	1698 (5.6%)
Socioeconomic factors	
Insurance status	
Private	10 042 (33.0%)
Medicare	17 148 (56.3%)
Medicaid	2209 (7.3%)
Uninsured	1045 (3.4%)
Income	
≥ $63 000	10 027 (32.9%)
< $63 000	20 417 (67.1%)
Educational attainment *	
<7%	7386 (24.3%)
7%-20%	17 482 (57.4%)
≥21%	5576 (18.3%)
Clinicopathologic factors	
AJCC analytic stage	
1	4373 (14.4%)
2	4296 (14.1%)
3	3477 (11.4%)
4	10 264 (33.7%)
Unknown	14 120 (46.4%)
Tumor size (mean±SD)	6.0 ± 6.8
Tumor grade	
Well-differentiated	1335 (4.4%)
Moderately differentiated	5382 (17.7%)
Poorly differentiated/undifferentiated	4927 (16.2%)
Not determined	18 800 (61.8%)

Abbreviation: AJCC, American Joint Committee on Cancer.

* % in zip code without high-school diploma.

TABLE 2

Demographic, socioeconomic, and clinicopathologic differences by race/ethnicity

	Non-Hispanic White	Non-Hispanic Black	Hispanic	Asian	
	N = 23 835	**N = 2549**	**N = 2362**	**N = 1698**	***P* value**
Demographics					
Sex					**<.001**
Male	12 348 (51.8%)	1178 (46.2%)	1136 (48.1%)	903 (53.2%)	
Female	11 487 (48.2%)	1371 (53.8%)	1226 (51.9%)	795 (46.8%)	
Age (mean ± SD)	68.7 ± 11.9	65.1 ± 12.0	65.8 ± 12.4	67.0 ± 12.3	**<.001**
Charlson-Deyo					**<.001**
0	16 292 (68.4%)	1560 (61.2%)	1563 (66.2%)	1252 (73.7%)	
1	5075 (21.3%)	669 (26.3%)	538 (22.8%)	322 (19.0%)	
2	2468 (10.3%)	320 (12.5%)	261 (11.0%)	124 (7.3%)	
Socioeconomic factors					
Insurance status					**<.001**
Private	7988 (33.5%)	791 (31.0%)	685 (29.0%)	578 (34.0%)	
Medicare	14 096 (59.1%)	1236 (48.5%)	1042 (44.1%)	774 (45.6%)	
Medicaid	1181 (5.0%)	375 (14.7%)	387 (16.4%)	266 (115.7%)	
Uninsured	570 (2.4%)	147 (5.8%)	248 (10.5%)	80 (4.7%)	
Income					**<.001**
≥ $63 000	8312 (34.9%)	410 (16.1%)	499 (21.1%)	806 (47.5%)	
< $63 000	15 523 (65.1%)	2139 (83.9%)	1863 (78.9%)	892 (52.5%)	
Educational attainment[a]					**<.001**
<7%	6527 (27.4%)	231 (9.1%)	223 (9.4%)	405 (23.9%)	
7%-20%	14 278 (59.9%)	1426 (55.9%)	911 (38.6%)	867 (51.0%)	
≥21%	3030 (12.7%)	892 (35.0%)	1228 (52.0%)	426 (25.1%)	
Clinicopathologic factors					
AJCC analytic stage					**<.001**
1	3481 (14.6%)	337 (13.2%)	309 (13.1%)	246 (14.5%)	
2	3415 (14.3%)	348 (13.7%)	291 (12.3%)	242 (14.2%)	
3	2845 (11.9%)	220 (8.6%)	227 (9.6%)	185 (10.9%)	

	Non-Hispanic White	**Non-Hispanic Black**	**Hispanic**	**Asian**	
	N = 23 835	**N = 2549**	**N = 2362**	**N = 1698**	***P* value**
4	7877 (33.1%)	936 (36.7%)	867 (36.7%)	584 (34.4%)	
Unknown	6217 (26.1%)	708 (27.8%)	668 (28.3%)	441 (26.0%)	
Tumor size (mean ± SD)	6.0 ± 6.8	6.25 ± 7.8	6.4 ± 7.0	5.8 ± 3.9	**<.001**
Tumor grade					**<.001**
Well differentiated	1040 (4.4%)	118 (4.6%)	111 (4.7%)	66 (3.9%)	
Moderately differentiated	4298 (18.0%)	399 (15.7%)	387 (16.4%)	298 (17.6%)	
Poorly differentiated/undifferentiated	3903 (16.4%)	377 (14.8%)	346 (14.7%)	301 (17.7%)	
Not determined	14 594 (61.2%)	1655 (64.9%)	1518 (64.3%)	1033 (60.8%)	

Abbreviation: AJCC, American Joint Committee on Cancer.

Bolded values represent statistically significant $P < .05$.

[a] % in zip code without high school diploma.

TABLE 3

Univariate and multivariable models for receipt of chemotherapy and multimodality therapy with chemotherapy and radiation

	Univariate analysis		Individual multivariable analyses		Final multivariable analysis	
Variable	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
Odds of receiving chemotherapy (entire cohort)						
Race/ethnicity						
Non-Hispanic White	Reference	…	Reference	…	Reference	…
Non-Hispanic Black	0.84 (0.77–0.91)	**<.001**	0.74 (0.67–0.82)	**<.001**	0.83 (0.75–0.92)	**<.001**
Hispanic	0.84 (0.77–0.92)	**<.001**	0.75 (0.67–0.83)	**<.001**	0.90 (0.81–1.01)	.069
Asian	0.80 (0.73–0.89)	**<.001**	0.72 (0.64–0.82)	**<.001**	0.76 (0.67–0.87)	**<.001**
Socioeconomic factors						
Insurance						
Private	Reference	…	Reference	…	Reference	…
Medicare	0.41 (0.39–0.43)	**<.001**	0.99 (0.92–1.07)	.886	1.02 (0.95–1.10)	.597
Medicaid	0.58 (0.53–0.64)	**<.001**	0.59 (0.52–0.66)	**<.001**	0.65 (0.58–0.73)	**<.001**
Uninsured	0.44 (0.39–0.50)	**<.001**	0.48 (0.41–0.56)	**<.001**	0.52 (0.44–0.61)	**<.001**
Income						
≥ $63 000	Reference	…	Reference	…	Reference	…
< $63 000	0.74 (0.71–0.78)	**<.001**	0.74 (0.70–0.78)	**<.001**	0.81 (0.75–0.87)	**<.001**
Educational attainment*						
<7%	Reference	…	Reference	…	Reference	…
7%-20%	0.84 (0.80–0.89)	**<.001**	0.84 (0.79–0.90)	**<.001**	0.96 (0.89–1.04)	.363
≥21%	0.65 (0.60–0.69)	**<.001**	0.63 (0.58–0.69)	**<.001**	0.81 (0.73–0.90)	**<.001**
Demographics						
Sex						
Female	Reference	…	…	…	Reference	…
Male	1.04 (1.00–1.09)	.078			0.95 (0.90–1.00)	.051
Age	0.95 (0.95–0.95)	**<.001**	…	…	0.96 (0.96–0.96)	**<.001**
Charlson-Deyo score						
0	Reference	…			Reference	…
1	0.80 (0.76–0.85)	**<.001**	…	…	0.94 (0.88–1.01)	.098

	Univariate analysis		Individual multivariable analyses		Final multivariable analysis	
Variable	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
2	0.50 (0.46–0.54)	**<.001**			0.56 (0.51–0.62)	**<.001**
Clinicopathologic factors						
AJCC analytic stage						
1	Reference	…			Reference	…
2	2.32 (2.12–2.53)	**<.001**	…	…	2.14 (1.93–2.37)	**<.001**
3	2.59 (2.36–2.84)	**<.001**			2.34 (2.10–2.62)	**<.001**
4	3.00 (2.78–3.23)	**<.001**			3.11 (2.83–3.41)	**<.001**
Tumor size (cm)						
0–3	Reference	…			Reference	…
>3–5	1.00 (0.92–1.09)	.969	…	…	0.98 (0.88–1.09)	.726
>5–8	1.29 (1.18–1.40)	**<.001**			1.24 (1.12–1.38)	**<.001**
>8	1.80 (1.65–1.97)	**<.001**			1.61 (1.44–1.80)	**<.001**
Tumor grade						
Well differentiated	Reference	…			Reference	…
Moderately differentiated	1.27 (1.13–1.43)	**<.001**	…	…	1.20 (1.03–1.39)	**.014**
Poorly/undifferentiated	1.40 (1.24–1.58)	**<.001**			1.22 (1.05–1.41)	**.009**
Not determined	0.97 (0.87–1.09)	.645			0.98 (0.85–1.13)	.764
Treatment						
Resection status						
R0	Reference	…	…	…	Reference	…
R1/R2	2.28 (2.04–2.56)	**<.001**			1.87 (1.63–2.15)	**<.001**
No surgery	1.23 (1.15–1.31)	**<.001**			2.31 (2.10–2.54)	**<.001**
Radiation			…	…		
Yes	Reference	…			Reference	…
No	0.19 (0.18–0.21)	**<.001**			0.18 (0.16–0.19)	**<.001**
Facility type						
Academic/research program	Reference	…			Reference	…
Nonacademic/research program	0.84 (0.80–0.88)	**<.001**	…	…	1.10 (1.04–1.17)	**<.001**
Facility location						
Northeast	Reference	-			Reference	…

	Univariate analysis		Individual multivariable analyses		Final multivariable analysis	
Variable	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
South	0.81 (0.76–0.86)	**<.001**		…	0.73 (0.67–0.78)	**<.001**
Midwest	0.90 (0.84–0.96)	**.002**			0.80 (0.73–0.87)	**<.001**
West	0.75 (0.70–0.81)	**<.001**			0.63 (0.58–0.69)	**<.001**
Odds of receiving radiation (chemotherapy and radiation cohort)						
Race/ethnicity						
Non-Hispanic White	Reference	…	Reference	…	Reference	…
Non-Hispanic Black	0.91 (0.69–1.21)	.513	0.92 (0.68–1.24)	.574	0.92 (0.68–1.24)	.572
Hispanic	0.81 (0.59–1.11)	.194	0.83 (0.59–1.16)	.273	0.85 (0.60–1.20)	.354
Asian	1.24 (0.89–1.74)	.210	1.08 (0.75–1.57)	.668	1.10 (0.76–1.59)	.624
Socioeconomic factors						
Insurance						
Private	Reference	…	Reference	…	Reference	…
Medicare	1.05 (0.90–1.23)	.560	0.97 (0.78–1.21)	.776	0.97 (0.78–1.21)	.816
Medicaid	0.98 (0.72–1.32)	.873	0.98 (0.71–1.35)	.918	1.00 (0.73–1.39)	.976
Uninsured	0.80 (0.50–1.28)	.349	0.74 (0.45–1.22)	.242	0.76 (0.46–1.25)	.273
Income						
≥ $63 000	Reference	…	Reference	…	Reference	…
< $63 000	1.01 (0.86–1.18)	.913	1.01 (0.85–1.19)	.911	1.04 (0.85–1.27)	.728
Educational attainment*						
<7%	Reference	…	Reference	…	Reference	…
7%-20%	0.98 (0.83–1.17)	.854	1.02 (0.85–1.23)	.806	1.02 (0.82–1.26)	.872
≥21%	0.92 (0.72–1.17)	.483	0.95 (0.73–1.23)	.688	0.96 (0.71–1.30)	.799
Demographics						
Sex						
Female	Reference	…	…	…	Reference	…
Male	1.32 (1.14–1.53)	**<.001**			1.25 (1.07–1.46)	**.006**
Age	1.01 (1.00–1.01)	.092	…	…	1.00 (0.99–1.01)	.418
Charlson-Deyo score						
0	Reference	…	…	…	Reference	…
1	0.83 (0.69–1.00)	.052			0.85 (0.70–1.04)	.107

	Univariate analysis		Individual multivariable analyses		Final multivariable analysis	
Variable	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
2	0.83 (0.63–1.09)	.182			0.81 (0.60–1.08)	.151
Clinicopathologic factors						
AJCC analytic stage						
1	Reference	…			Reference	…
2	0.75 (0.62–0.91)	**<.001**	…	…	0.74 (0.61–0.92)	**.006**
3	0.68 (0.56–0.82)	.004			0.72 (0.58–0.88)	**.002**
Tumor size (cm)						
0–3	Reference	…			Reference	…
>3–5	0.45 (0.35–0.58)	**<.001**	…	…	0.48 (0.37–0.62)	**<.001**
>5–8	0.28 (0.22–0.37)	**<.001**			0.31 (0.24–0.41)	**<.001**
>8	0.16 (0.12–0.21)	**<.001**			0.17 (0.12–0.23)	**<.001**
Tumor grade						
Well-differentiated	Reference	…	…	…	Reference	…
Moderately differentiated	0.68 (0.43–1.06)	.090			0.74 (0.46–1.20)	.223
Poorly/undifferentiated	0.51 (0.32–0.80)	**.003**			0.53 (0.33–0.85)	.008
Not determined	1.16 (0.78–1.74)	.465			1.03 (0.67–1.57)	.898
Treatment						
Facility type						
Academic/research program	Reference	…	…	…	Reference	…
Nonacademic/research program	0.93 (0.80–1.07)	.312			0.85 (0.72–1.00)	.044
Facility location						
Northeast	Reference	…			Reference	…
South	1.39 (1.13–1.72)	.002	…	…	1.46 (1.16–1.84)	**.001**
Midwest	1.45 (1.16–1.81)	**<.001**			1.46 (1.15–1.85)	**.002**
West	1.58 (1.25–2.00)	**<.001**			1.64 (1.27–2.12)	**<.001**

Abbreviation: AJCC, American Joint Committee on Cancer; CI, confidence interval; OR, odds ratio.

Bolded values represent statistically significant $P < .05$.

*% in zip code without high-school diploma.

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TABLE 4

Demographic, race/ethnicity, socioeconomic, and clinicopathologic data for the surgery cohort

Demographics	
Sex	
Male	6300 (52.1%)
Female	5795 (47.9%)
Age (mean±SD)	67.8 ±11.7
Charlson-Deyo score	
0	8213 (67.9%)
1	2672 (22.1%)
2	1210 (10.0%)
Race/ethnicity	
Non-Hispanic White	9673 (80.0%)
Non-Hispanic Black	906 (7.5%)
Hispanic	845 (7.0%)
Asian	671 (5.5%)
Socioeconomic factors	
Insurance status	
Private	4114 (34.0%)
Medicare	6821 (56.4%)
Medicaid	802 (6.6%)
Uninsured	358 (3.0%)
Income	
≥ $63 000	4095 (33.9%)
< $63 000	8000 (66.1%)
Educational attainment *	
<7%	3067 (25.4%)
7%-20%	6913 (57.2%)
≥21%	2115 (17.5%)
Clinicopathologic factors	
AJCC analytic stage	
1	4318 (35.7%)
2	4318 (15.7%)
3	3459 (28.6%)
Tumor size (mean±SD)	5.3 ± 5.7
Tumor grade	
Well-differentiated	810 (6.7%)
Moderately differentiated	3062 (25.3%)
Poorly differentiated/undifferentiated	2251 (18.6%)
Not determined	5972 (49.4%)

* % in zip code without high-school diploma.

TABLE 5

Univariate and multivariable models for undergoing surgical resection and multimodality therapy with surgery, chemotherapy, and/or radiation

	Univariate analysis		Individual multivariable analyses		Final multivariable analysis	
Variable	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
Odds of receiving surgery						
Race/Ethnicity						
Non-Hispanic White	Reference	…	Reference	…	Reference	…
Non-Hispanic Black	0.81 (0.70–0.93)	**.003**	0.87 (0.72–1.05)	**<.001**	0.73 (0.61–0.88)	**<.001**
Hispanic	0.94 (0.81–1.08)	.260	0.84 (0.68–1.04)	.144	1.03 (0.85–1.26)	.759
Asian	0.91 (0.78–1.07)	.394	0.66 (0.55–0.80)	.109	0.89 (0.72–1.10)	.269
Socioeconomic factors						
Insurance						
Private	Reference	…	Reference	…	Reference	…
Medicare	0.53 (0.49–0.57)	**<.001**	0.97 (0.86–1.10)	.665	0.99 (0.88–1.13)	.922
Medicaid	0.61 (0.52–0.71)	**<.001**	0.59 (0.49–0.72)	**<.001**	0.63 (0.52–0.77)	**<.001**
Uninsured	0.49 (0.39–0.61)	**<.001**	0.42 (0.31–0.56)	**<.001**	0.43 (0.33–0.58)	**<.001**
Income						
≥ $63 000	Reference	…	Reference	…	Reference	…
< $63 000	0.82 (0.76–0.88)	**<.001**	0.81 (0.73–0.89)	**<.001**	0.88 (0.78–1.00)	**.050**
Educational attainment*						
<7%	Reference	…	Reference	…	Reference	…
7%-20%	0.85 (0.78–0.93)	**<.001**	0.86 (0.77–0.96)	**.007**	0.94 (0.83–1.07)	.369
≥21%	0.71 (0.63–0.79)	**<.001**	0.71 (0.61–0.82)	**<.001**	0.84 (0.70–1.01)	.059
Demographics						
Sex						
Female	Reference	…	…	…	Reference	…
Male	1.13 (1.05–1.21)	**.001**			1.06 (0.97–1.17)	.210
Age	0.96 (0.96–0.97)	**<.001**	…	…	0.96 (0.95–0.97)	**<.001**
Charlson-Deyo score						
0	Reference	-			Reference	…
1	0.90 (0.83–0.99)	**<.001**	…	…	0.92 (0.82–1.03)	.137

	Univariate analysis		Individual multivariable analyses		Final multivariable analysis	
Variable	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
2	0.75 (0.66–0.85)	**.024**			0.72 (0.61–0.84)	**<.001**
Clinicopathologic factors						
AJCC analytic stage						
1	Reference	-			Reference	…
2	1.06 (0.98–1.16)	.167	…	…	0.90 (0.80–1.00)	.057
3	0.61 (0.56–0.67)	**<.001**			0.54 (0.47–0.61)	**<.001**
Tumor size (cm)						
0–3	Reference	…			Reference	…
>3–5	0.77 (0.69–0.88)	**<.001**	…	…	0.77 (0.66–0.89)	**<.001**
>5–8	0.61 (0.55–0.69)	**<.001**			0.54 (0.46–0.62)	**<.001**
>8	0.42 (0.37–0.47)	**<.001**			0.34 (0.29–0.39)	**<.001**
Tumor grade						
Well-differentiated	Reference	…	…	…	Reference	…
Moderately differentiated	1.18 (1.00–1.40)	.056			1.25 (1.03–1.50)	**.022**
Poorly/undifferentiated	0.62 (0.52–0.74)	**<.001**			0.71 (0.58–0.85)	**<.001**
Not determined	0.07 (0.06–0.09)	**<.001**			0.09 (0.08–0.11)	**<.001**
Treatment						
Radiation			…	…		
Yes	Reference	…			Reference	…
No	0.89 (0.81–0.97)	**.007**			0.80 (0.71–0.90)	**<.001**
Chemotherapy						
Yes	Reference	…			Reference	…
No	1.09 (1.02–1.18)	**.017**			1.57 (1.41–1.75)	**<.001**
Facility type						
Academic/research program	Reference	…	…	…	Reference	…
Nonacademic/research program	0.53 (0.49–0.57)	**<.001**			0.65 (0.59–0.72)	**<.001**
Facility location						
Northeast	Reference	…	…	…	Reference	…
South	0.88 (0.80–0.98)	**.014**			0.97 (0.85–1.11)	.691
Midwest	0.90 (0.81–1.00)	.057			0.86 (0.75–0.99)	**.035**

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	Univariate analysis		Individual multivariable analyses		Final multivariable analysis	
Variable	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
West	0.72 (0.64–0.81)	**<.001**			0.76 (0.65–0.89)	**<.001**
Odds of receiving chemotherapy and/or radiation (multimodality cohort)						
Race/Ethnicity						
Non-Hispanic White	Reference	…	Reference	…	Reference	…
Non-Hispanic Black	0.90 (0.72–1.14)	.383	1.25 (0.58–2.73)	.567	1.17 (0.53–2.59)	.697
Hispanic	0.89 (0.71–1.12)	.764	1.29 (0.62–2.73)	.496	1.19 (0.55–2.59)	.662
Asian	1.04 (0.81–1.34)	.328	0.62 (0.21–1.78)	.373	0.60 (0.20–1.76)	.349
Socioeconomic factors						
Insurance						
Private	Reference	…	Reference	…	Reference	…
Medicare	0.53 (0.47–0.59)	**<.001**	0.97 (0.56–1.68)	.916	0.95 (0.55–1.65)	.855
Medicaid	0.63 (0.49–0.80)	**<.001**	1.46 (0.67–3.16)	.339	1.46 (0.66–3.20)	.350
Uninsured	0.63 (0.43–0.91)	**.014**	1.37 (0.46–4.14)	.573	1.28 (0.42–3.93)	.661
Income						
≥ $63 000	Reference	…	Reference	…	Reference	…
< $63 000	0.79 (0.71–0.89)	**<.001**	1.35 (0.85–2.15)	.202	1.38 (0.77–2.47)	.274
Educational attainment *						
<7%	Reference	…	Reference	…	Reference	…
7%-20%	0.92 (0.80–1.04)	.187	1.02 (0.62–1.68)	.934	0.83 (0.46–1.50)	.538
≥21%	0.76 (0.64–0.91)	**.003**	1.25 (0.66–2.39)	.495	0.92 (0.41–2.05)	.836
Demographics						
Sex						
Female	Reference	…	…	…	Reference	…
Male	1.08 (0.97–1.21)	.167			1.16 (0.76–1.77)	.485
Age	0.96 (0.96–0.97)	**<.001**	…	…	1.00 (0.97–1.02)	.796
Charlson-Deyo score						
0	Reference	…	…	…	Reference	…
1	0.84 (0.73–0.97)	**.015**			0.78 (0.47–1.32)	.114
2	0.50 (0.41–0.62)	**<.001**			0.50 (0.21–1.18)	.361
Clinicopathologic factors						

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	Univariate analysis		Individual multivariable analyses		Final multivariable analysis	
Variable	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**	**OR (95% CI)**	***P* value**
AJCC analytic stage						
1	Reference	…			Reference	…
2	2.72 (2.38–3.11)	**<.001**	…	…	1.60 (0.98–2.62)	**.006**
3	2.58 (2.21–3.01)	**<.001**			1.22 (0.67–2.21)	**.002**
Tumor size (cm)						
0–3	Reference	…			Reference	-
>3–5	0.98 (0.83–1.16)	.798	…	…	0.99 (0.55–1.79)	.986
>5–8	0.78 (0.65–0.92)	**.004**			0.99 (0.55–1.78)	.977
>8	0.97 (0.82–1.15)	.712			0.48 (0.23–1.03)	.059
Tumor grade						
Well differentiated	Reference	…			Reference	…
Moderately differentiated	1.17 (0.97–1.42)	.104	…	…	0.78 (0.40–1.56)	.488
Poorly/undifferentiated	1.44 (1.18–1.77)	**<.001**			1.03 (0.50–2.11)	.945
Not determined	1.44 (1.16–1.79)	**.001**			1.46 (0.68–3.12)	.327
Treatment						
Resection status						
R0	Reference	…			Reference	…
R1/R2	2.57 (2.23–2.96)	**<.001**			4.16 (2.61–6.64)	**<.001**
Unknown	1.07 (0.87–1.32)	.517			1.81 (0.88–3.72)	.104
Facility type						
Academic/research program	Reference	…			Reference	…
Nonacademic/research program	1.17 (1.04–1.31)	**.010**	…	…	1.60 (1.03–2.50)	**.038**
Facility location						
Northeast	Reference	…			Reference	…
South	0.67 (0.57–0.78)	**<.001**	…	…	0.60 (0.33–1.08)	.087
Midwest	0.69 (0.59–0.82)	**<.001**			0.71 (0.38–1.32)	.277
West	0.80 (0.67–0.96)	**.018**			0.62 (0.31–1.24)	.178

Abbreviation: AJCC, American Joint Committee on Cancer; CI, confidence interval; OR, odds ratio.

Bolded values represent statistically significant $P < .05$.

* % in zip code without high-school diploma.

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