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Disentangling Racial, Ethnic and Socioeconomic Disparities in Treatment for Colorectal Cancer

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Abstract

Background: Colorectal cancer (CRC) is curable if diagnosed early and treated properly. Black and Hispanic CRC patients are more likely to experience treatment delays, and/or receive lower standards of care. Socioeconomic deprivation may contribute to these disparities, but this has not been extensively quantified. We studied the interrelationship between patient race/ethnicity and neighborhood socioeconomic status (nSES) on receipt of timely appropriate treatment among CRC patients in California.

Methods: 26,870 White, Black, and Hispanic patients diagnosed with stage I-III CRC (2009-2013) in the California Cancer Registry were included. Logistic regression models were used to examine the association of race/ethnicity and nSES with three outcomes: undertreatment, >60-day treatment delay, and >90-day treatment delay. Joint effect models and mediation analysis were used to explore the interrelationships between race/ethnicity and nSES.

Results: Hispanics and Blacks were at increased risk for undertreatment (Black OR=1.39, 95%CI=1.23-1.57; Hispanic OR=1.17, 95%CI=1.08-1.27), and treatment delay (Black/60-day OR=1.78, 95%CI=1.57-2.02; Hispanic/60-day OR=1.50, 95%CI=1.38-1.64), compared to Whites. Of the total effect (OR=1.15, 95%CI=1.07-1.24) of non-white race on undertreatment, 45.71% was explained by nSES.

Conclusion: Lower nSES patients of any race were at substantially higher risk for undertreatment and treatment delay, and racial/ethnic disparities are reduced or eliminated among non-white patients living in the highest SES neighborhoods. Racial and ethnic disparities persisted after accounting for neighborhood socioeconomic status, and between the two, race/ethnicity explained a larger portion of the total effects.

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Conflicts of Interest: The authors declare no potential conflicts of interest.

Impact: This research improves our understanding of how socioeconomic deprivation contributes to racial/ethnic disparities in colorectal cancer.

Keywords

GASTROINTESTINAL CANCERS/Colorectal cancer; DESCRIPTIVE STUDIES/Cancer Disparities; SURGICAL ONCOLOGY/SURGICAL ONCOLOGY; RADIATION ONCOLOGY/ RADIATION ONCOLOGY; CHEMOTHERAPY/CHEMOTHERAPY

INTRODUCTION

Colorectal Cancer (CRC) is the third most commonly diagnosed cancer in the United States (U.S.)[1]. Only 39% of CRC patients are diagnosed at a localized stage, for which the 5-year survival rate is about 90%[2]. Incidence and mortality from colorectal cancer have declined in recent decades thanks to increased screening and scientific advances in treatment. However, improvements have not been equal for all groups[3,4]. Minority and socioeconomically disadvantaged cancer patients are at an increased risk for later stage at diagnosis due to screening non-attendance, longer diagnostic intervals, treatment delay, and nonadherence to proper treatment, all of which can lead to poorer cancer outcomes and reduced survival[5-8]. Compared to non-Hispanic white patients, age- and stage-adjusted, cancer-specific mortality among patients with colorectal cancer has been shown to be 24% higher among black men and 19% higher among black women; Hispanic men and women were not shown to be at significantly higher risk[9]. CRC-specific and overall mortality is also disproportionately higher among people with a lower socioeconomic status[10].

The National Comprehensive Cancer Network (NCCN) Clinical Practice Guidelines are the most widely recognized and used guidelines in oncology clinical policy around the world. These evidence-based, consensus-driven guidelines were developed to ensure clinicians can provide their patients with preventative, diagnostic, and supportive services that lead to the best outcomes[11]. Prompt treatment is believed to improve survival in CRC patients, and treatment should be initiated as soon as possible after diagnosis[12]. Previous research has considered failure to initiate treatment within 60 or 90 days to be treatment delay[13].

Mechanisms that contribute to disparities in receipt of timely and appropriate care for cancer arise from factors at the patient-, provider- and health system-level. Minority and immigrant patients face cultural and language barriers, lower health literacy, as well provider implicit bias [14-18]. Socioeconomic disparities result from both neighborhood-level contextual factors such as access to quality healthcare services and lack of health-promoting resources, and individual-level factors such as lack of employer-provided health insurance or having a usual health care provider, as well as availability of time to attend appointments.

However, poorer quality care has also been observed by race and ethnicity among individuals with adequate health insurance[14-18]. Socioeconomic barriers could interact with (moderate) or explain (mediate) some, or all, of the racial/ethnic disparities in receipt high quality care. While several studies have described racial and ethnic disparities in treatment for colorectal cancer, no previous study has disentangled the relative contribution of SES in these disparities. The objective of this study was to investigate the interrelationship between

patient race/ethnicity and neighborhood socioeconomic status (nSES) on outcomes reflecting two dimensions of care quality for CRC: receipt of appropriate treatment and timely initiation of treatment among those who are properly treated.

METHODS

Data Source

The California Cancer Registry (CCR) is California's statewide population-based cancer surveillance program administered by the California Department of Public Health's Chronic Disease Surveillance and Research Branch[19]. By law, all occurrences of cancer among Californians are required to be reported to the CCR, ensuring the population is representative of all of California[19]. CCR variables include patient demographics, geocoded residence at the time of diagnosis, and tumor characteristics including stage, and receipt of surgery, chemotherapy and radiation. Residential urbanicity based on the 2010 U.S. census was assigned to each patient at the census block group level.

This study was reviewed and approved by Institutional Review Boards (IRBs) at San Diego State University, the University of California San Diego, and the California Department of Public Health Committee for the Protection of Human Subjects (the statewide IRB that grants permissions to use data from the CCR).

Study Population

Patients diagnosed with first primary stage I, II, or III cancers of the colon or rectum (excluding cancers of the rectosigmoid junction), as defined by the American Joint Committee of Cancer 7th edition, diagnosed between 2009 and 2013, and alive at the time of diagnosis were included in the initial study population (N=44,697). Patients diagnosed with stage II colon cancer (n=12,036) were excluded because treatment guidelines for stage II colon cancer differ by high versus low risk, a variable not available in the tumor registry. All Asian American, Native Hawaiian and Pacific Islander groups as well as American Indians (n=4,457) were excluded due to insufficient samples sizes to allow for stratification by nSES. Patients belonging to the following groups were also excluded because of insufficient sample sizes: 2+ races (n=734); Transsexual or Transgender (n=11). Our final study population included 26,870 patients.

Variable Definitions

The primary outcome was timely, guideline concordant treatment (GCT) according to the 2016 NCCN guidelines[20]. Deviation from GCT was defined three ways: 1) Undertreatment: receiving less than the minimum site- and stage-specific recommended treatment by NCCN, 2) >60 day treatment delay: first definitive therapy (surgery, chemotherapy or radiation) initiated more than 60 days after the date of diagnosis, and 3) >90 day treatment delay: first definitive therapy initiated more than 90 days after the date of diagnosis (Figure 1).

The independent variables of interest were patient race/ethnicity and neighborhood socioeconomic status (nSES). Race in the CCR is abstracted from the medical records. Ethnicity in the CCR is derived using the North American Association of Central Cancer

Registries (NAACCR) Hispanic-Latino Identification Algorithm which uses a combination of last name, maiden name, Spanish/Hispanic Origin, Birthplace Country, primary race, sex, and Indian Health Service (HIS) linkage[21]. Race and Ethnicity were combined as non-Hispanic White (NHW), non-Hispanic Black (NHB), and Hispanic (including those who identify as white or black race). While Individual-level SES is unavailable in the CCR, nSES, a contextual measure of deprivation, is classified by the CCR using a multi-component composite score based on demographic, social, economic, and housing data collected through the American Community Survey[22] at the block-group level.

Covariates for confounding control included cancer site (colon or rectum), stage at diagnosis (local, regional, or remote), year of diagnosis, biological sex, age at diagnosis, insurance type at diagnosis (not insured, private insurance, Medicaid, Medicare, military, or other/not otherwise specified), marital status at diagnosis (single/never married, married or domestic partner, separated or divorced, or widowed), whether or not the reporting facility with the earliest date of admission had an ACOS-approved cancer program, and residential urbanicity (metro, urban, rural). All covariates were selected a priori based on variables shown to be associated with receipt of GCT in published literature[23-26].

To classify treatment delays, full dates for diagnosis, surgery, radiation, and chemotherapy were required. Of our 26,870 patients, 2,976 (11.08%) had an incomplete date (month and year) of diagnosis, surgery, radiation, and/or chemotherapy. The middle of the month was imputed for these incomplete dates. Of our 26,870 patients, 1,794 (6.68%) had either a missing date (completely missing or only year) or missing covariate information (Supplementary Table 1). To resolve this, we used multiple imputation (PROC MI) using SAS version 9.4 (SAS Institute, Cary, NC) with 7 imputed datasets, a valid statistical procedure for recovering missing data to create complete datasets that can then be analyzed through standard procedures[27].

Statistical Analysis

All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

Descriptive statistics were used to describe our population overall, and the prevalence of undertreatment and treatment delay by patient race/ethnicity and nSES. An intercept-only (empty) outcome model was used to evaluate block group as a potential cluster variable.

To explore the influence of our two primary exposure variables: race/ethnicity and nSES on each of our three outcomes: undertreatment, >60-day treatment delay and >90-day treatment delay, we ran a series of adjusted, moderated, and mediated models . These models are distinct in how they handle our primary exposure variables, but similar in choice of model fit and covariates for control.

In our adjusted models, Model 1 was minimally adjusted for age, sex, cancer site, stage, and year of diagnosis. Model 2 was further adjusted for marital status, cancer program, residence, payer, and mutually adjusted for race/ethnicity (in nSES models), and nSES (in race/ethnicity models). In our moderation models, we used logistic regression models to estimate the joint effect of race/ethnicity and nSES (treated as a composite variable), using

NHWs living in the highest nSES as the reference group, with control for all of the model 2 adjustment variables. This joint effect model is similar to adjusted model 2, but the use of a composite exposure variable allowed for an interaction between race/ethnicity and nSES.

To investigate the mediating effect of nSES on racial/ethnic disparities, we used a mediation analysis technique developed by VanderWeele et al.[28,29] to estimate the effect of non-white race/ethnicity on undertreatment, >60-day treatment delay, and >90-day treatment delay, as mediated by lower (Q1-Q2) vs higher (Q3-Q5) nSES. The mediation analysis allows us to quantify the direct and "mediated" effects. The mediation models estimate the natural direct effect (NDE), natural indirect effect (NIE), and the total effect (TE). The TE is the effect of non-white race/ethnicity on undertreatment and treatment delay. Some or all the TE could be explained by our mediator, nSES, and the TE can be split into two components: the NDE and the NIE. The NDE expresses the effect of non-white race/ethnicity on undertreatment and treatment delay, after removing (adjusting for) the effect of nSES. The NIE expresses how much of the effect of non-white race/ethnicity on undertreatment and treatment delay is mediated through nSES. The % mediated is the total effect of non-white race/ethnicity on undertreatment and treatment delay that is explained by nSES. The parameter estimates and confidence intervals were obtained using PROC CAUSALMED and PROC MIANALYZE to combine imputed datasets. We used a logistic model, adjusted for site, stage, year of diagnosis, sex, age, marital status, cancer program, residence, and payer, with standard errors calculated via the bootstrap method, resulting in effect interpretation on the odds ratio scale[28,29].

Statistical significance was assessed at $p<0.05$.

RESULTS

The study population (N=26,870) was 70.3% NHW, 7.7% NHB, and 22.0% Hispanic. Rectal cancer accounted for 31.7% of tumors, with lower prevalence among NHBs (25.1%) and higher prevalence among Hispanics (35.7%). Hispanic patients were younger, on average than NHWs and NHBs. Hispanic and NHB patients had lower neighborhood socioeconomic status, with 53.3% of NHBs and 57.0% of Hispanics classified as lowest or lower-middle nSES, compared to only 26.7% of NHWs. Hispanic patients were more likely to be uninsured (3.4%) or be covered by Medicaid (12.3%) compared to NHWs (1.1% uninsured; 3.7% Medicaid) and NHBs (1.8% uninsured; 9.1% Medicaid). NHB patients were less likely to be treated at ACOS-approved cancer centers (39.3%) compared to Hispanics (49.0%) and NHWs (52.6%). NHB patients were less often married (39.9%) compared to NHWs (53.6%) and Hispanics (55.1%). Most patients lived in metropolitan areas, with only 4.0% of NHWs and <1% of NHBs or Hispanics residing in urban or rural geographies (Table 1).

Overall, 25.9% of patients were classified as undertreated, 26.02% NHWs, 26.94% of NHBs, and 25.27% of Hispanics. >60-day treatment delay was experienced by 12.9% of all patients, 11.7% of NHWs, 17.0% of NHBs, and 15.5% of Hispanics. >90-day treatment delay was experienced by 7.1% of all patients, 6.5% of NHWs, 9.2% of NHBs and 8.1% of Hispanics. Undertreatment was experienced most often by the lowest quintile nSES, and

least by the highest quintile (30.8% to 22.5%, respectively). >60-day treatment delay ranged from 17.2% in the lowest quintile nSES to 9.3% in the highest and >90-day treatment delay ranged from 10.4% in the lowest quintile nSES to 4.6% in the highest.

In empty models, census block group accounted for < 5% of the outcome variance, and therefore was not included as a cluster variable. In minimally adjusted models NHB (OR=1.39, 95% CI=1.23-1.57) and Hispanic (OR=1.17, 95% CI=1.08-1.27) patients had increased odds of undertreatment compared to NHWs. In model 2, after adjustment for nSES and other suspected intermediate variables, the odds ratios were attenuated for NHBs (OR=1.16, 95% CI=1.02-1.31) and nullified for Hispanics (OR=1.01, 95% CI=0.93-1.10). Treatment delay outcomes were more strongly associated with race/ethnicity; with both NHBs (>60-day OR=1.78, 95% CI=1.57-2.02; >90-day OR=1.73, 95% CI=1.46-2.04) and Hispanics (>60-day OR=1.50, 95% CI=1.38-1.64; >90-day OR=1.47, 95% CI=1.31-1.64) at increased odds in minimally adjusted models. These positive associations were attenuated, but persisted, even after full adjustment in model 2. In minimally adjusted models, compared to highest quintile nSES, lowest (OR=1.84, 95% CI=1.77-1.91), lower-middle (OR=1.44, 95% CI=1.39-1.50), middle (OR=1.34, 95% CI=1.29-1.39), and upper-middle (OR=1.15, 95% CI=1.10-1.19) quintile nSES patients had increased odds of undertreatment, linearly increasing with decreasing nSES. These positive associations were attenuated, but persisted, after full adjustment in model 2. The treatment delay outcome was also more strongly associated with nSES with evidence of a linear trend: with lowest quintile nSES (>60-day OR=2.10, 95% CI=1.86-2.37; >90-day OR=2.59, 95% CI=2.21-3.04), lower-middle (>60-day OR=1.71, 95% CI=1.52-1.93; >90-day OR=1.89, 95% CI=1.60-2.22), middle (>60-day OR=1.42, 95% CI=1.26-1.61; >90-day OR=1.64, 95% CI=1.40-1.93), and upper-middle (>60-day OR=1.34, 95% CI=1.19-1.51; >90-day OR=1.38, 95% CI=1.17-1.62) quintile nSES at increased odds in minimally adjusted models. Like the race effect models, these positive associations were attenuated, but persisted, after full adjustment in model 2 (Table 3).

In our joint effects analysis (Table 4), compared to NHWs in the highest quintile nSES, NHWs, NHBs, and Hispanics in the lowest (NHW OR = 1.55, 95% CI=1.35-1.78; NHB OR = 1.78, 95% CI=1.43-2.20; Hispanic OR = 1.53, 95% CI=1.33-1.77), lower-middle (NHW OR = 1.29, 95% CI=1.14-1.45; NHB OR = 1.33, 95% CI=1.04-1.69; Hispanic OR = 1.32, 95% CI=1.13-1.54), and middle (NHW OR = 1.23, 95% CI=1.10-1.37; NHB OR = 1.61, 95% CI=1.23-2.10; Hispanic OR = 1.26, 95% CI=1.06-1.50) quintile nSES, as well as NHBs in the upper-middle (OR=1.44, 95% CI=1.07-1.95) quintile nSES, had increased odds of undertreatment. These racial/ethnic disparities in undertreatment are attenuated for NHWs and Hispanics in the upper-middle quintile nSES and nullified for NHBs and Hispanics in the highest quintile nSES. Treatment delay effects were stronger than those for undertreatment, especially for >90-day delay. Compared to NHWs in the highest quintile nSES, NHWs, NHBs, and Hispanics in the lowest, lower-middle, middle, and upper-middle quintile nSES had marked increased odds of 90- and 60-day treatment delays. However, these racial/ethnic disparities in treatment delay were nullified for NHBs in the highest quintile nSES. We observed a linear trend of increasing risk of undertreatment and delay with increasing nSES in NHWs and Hispanics, but not in NHBs.

For the mediation analysis, we estimated the total effect of non-white race on undertreatment (OR=1.15, 95% CI=1.07-1.24), >60-day delay (OR=1.49, 95% CI=1.37-1.61), and >90-day delay (OR=1.43; 95% CI=1.28-1.60). Being in the lower or lowest quintiles of nSES explained 45.71% of the effect of non-white race on undertreatment, 22.69% of the effect on 60-day delay, and 31.97% of the effect on 90-day delay (Table 5).

DISCUSSION

The objective of this study was to investigate the interrelationship between patient race/ethnicity and socioeconomic status on receipt of high-quality care for CRC in California. Our study rests on the premise that GCT has been shown to improve survival. Therefore, understanding mechanism that lead to improved GCT may lead to improved survival among CRC patients. We were interested in examining disparities in two distinct measures of care quality - receipt of all recommended treatment (in the correct order) and timeliness of treatment initiation - and quantifying the contribution of socioeconomic deprivation on the racial and ethnic differences for each measure. To our knowledge, this is the first study to extensively quantify the contribution of SES in racial/ethnic disparities in receipt of timely appropriate treatment.

In our minimally adjusted models, Hispanics and NHBs were at increased risk for undertreatment and treatment delay. After further adjustment with nSES, these associations were attenuated. nSES was an important risk factor for both undertreatment and treatment delay with lowest SES patients being twice as likely to experience >90-day treatment delay compared to the highest SES groups. Our joint effects analysis revealed that lower nSES patients of any race were at substantially higher risk for undertreatment and treatment delay, and that racial/ethnic disparities are reduced or eliminated among non-white patients living in the highest SES neighborhoods. Our mediation analysis revealed that lower nSES explained 46% of undertreatment among non-white patients, 23% of 60-day and 32% of 90-day treatment delay. This is a key finding. Racial and ethnic disparities persisted after accounting for neighborhood socioeconomic status, and between the two, race/ethnicity explained a larger portion of the total effects.

In line with our findings, several studies have shown that although most CRC patients do receive proper treatment, blacks had lower rates of consultation, and among those who were consulted, received surgery, chemotherapy, and radiation less often than whites[23-25,30]. Furthermore, considering only NCCN centers, 90% of stage II-III rectal cancer patients received proper treatment but only 81% received that treatment within 9 months.[31]

Poor quality of care contributes to reduced survival for cancer patients. Recently, Oh et al. examined 15-year trends in survival disparities by race/ethnicity and nSES using the same dataset as our study[3]. They observed that, while racial and ethnic disparities in survival are improving over time, there were no changes in disparities by nSES and increasing disparities by health insurance status. Also, a 2018 study using CCR data revealed through a mediation analysis that 16% to 30% of the effect of race/ethnicity on survival was explained through stage at diagnosis, leaving a larger portion attributable to race/ethnicity[32].

Barriers in receipt of health care and preventative services include financial barriers (inadequate health insurance, low personal income, and high poverty rates), physical barriers (lack of transportation and geographic access to health care facilities), and personal barriers (cultural and linguistic factors, discrimination, and provider bias)[14]. The top four barriers identified within the Latino community were low knowledge and awareness of CRC, language barriers, lack of insurance, and undocumented legal status; additional barriers included seeking healthcare only when sick, fatalism, denial that CRC can occur, other needs more pressing than preventative care, and use of home remedies rather than biomedical care[33].

Disparities in CRC patients' access to early detection services, receipt of timely and high-quality care, and survival can be explained, at least in part, by socioeconomic inequalities present within and between racial and ethnic groups. A 2006 paper using CCR data found that after adjustment, later stage diagnosis was more likely among Hispanics relative to NHWs and among persons in the two lowest SES quintiles relative to the highest quintile[34]. Two recent studies revealed, using SEER and the National Cancer Database, that patients with lower SES were less likely to receive any recommended treatment and that there was a higher rate of nonadherence in Medicaid, Medicare, and uninsured patients[35,26]. Furthermore, within each ethnic group, patients with high SES experienced longer survival times compared to middle and low SES patients[36]. Previous research has agreed that patients with lower SES and subsequently a lack of health insurance or non-private insurance, are more likely to not receive proper care, which is consistent with our findings.

Possible reasons why minorities experience undertreatment and treatment delays include it was recommended less often, patient refusal, and higher prevalence of comorbidities[23,30,20]. Discrimination was observed in a 2012 study examining CRC screening practices and found that general practitioners were less likely to recommend screening to immigrants and most reported that immigrants were less likely to participate[37]. Furthermore, physicians whose patients are primarily minorities have been found to have less training and expertise in performing screening procedures, less access to clinical resources, and receive less insurance reimbursements[38].

Others before us have observed that racial/ethnic disparities are only partially explained by patient SES[39-40]. Especially among Hispanics, CRC disparities have been attributed to language barriers. A 2014 study found differences in CRC screening attendance between English- versus Spanish-speaking Hispanics[40]. A study that took place in North Carolina concluded that Hispanics appear to be aware and interested in screening but culturally and linguistically appropriate programs to address barriers such as lack of access to resources, including lack of tailored CRC information, cost uncertainty, and stigma are needed[41]. Our study was unable to address language barriers, but we believe it would be important to include in future research of CRC treatment disparities.

nSES is generally considered to be a contextual variable, capturing a patient's environment and access to healthcare, among other factors [22]. A block group is the smallest geographic unit of aggregation published by the census and contains between 250 and 550 housing units. Thus, to the extent that neighbors are similar in terms of their education and income

levels, neighborhood-level SES may be representative of individual-level SES.[42] However, both individual-level and neighborhood-level SES have been shown to be important contributors of health, with both distinct and shared mechanistic pathways.[43,44]. We also accounted for Medicaid insurance, which may be a better proxy for individual deprivation but could be situational in nature rather than an accurate reflection of socioeconomic position. We observed that 6% of patients overall (9% for Blacks and 12% for Hispanics) were covered by Medicaid, which includes some, but not all the patients classified as living in the lowest quintile SES neighborhoods. Thus, for the interpretation of our results, fully adjusted models for neighborhood SES reflect a contextual interpretation of SES, while holding individual-level deprivation constant.

This study included limitations that should be kept in mind. We classified GCT only based on information available in the CCR. For example, patient comorbidity information is not available, and the CCR does not track information about the adequacy of tumor resection, both of which could result in outcome misclassification, on a patient-by-patient basis. The degree of this misclassification could depend on race/ethnicity, as minorities have a higher prevalence of comorbidities than NHWs and are less often treated at the highest quality care facilities. Furthermore, CCR does not provide specific information on surgical techniques, radiation dose and fractionation, chemotherapy agents, and schedules, which are all components of GCT. Meaning, our measurement of GCT is susceptible to misclassification that is expected to be independent of race/ethnicity, resulting in attenuated results. Also, we used multiple imputation to address missing data which is a possible source of uncertainty. As missing data was more common in non-Hispanic Blacks and Hispanics, compared to non-Hispanic Whites, we believed the potential source of uncertainty outweighed the consequence of biasing our study population by only using complete case analysis[45]. Finally, our study does not include Asian American patients, a heterogenous population for which some, but not all, members are considered disadvantaged minorities in California. This decision was made to avoid inappropriate aggregation[46-49] of Asian Americans in the absence of large enough sample sizes to investigate care outcomes for the specific Asian ethnicities of interest. Our study was not designed to evaluate socioeconomic and racial disparities in cancer screening, cancer incidence, or cancer-related mortality but these are important areas for future research questions.

In summary, the racial and ethnic disparities that exist in receipt of GCT can be partially explained by contextual socioeconomic inequalities present within and between racial and ethnic groups. Researchers and clinicians should focus their attention to minority and lower income communities that need additional health resources. These health resources might include education targeted to communities determined to be at higher risk for undertreatment or treatment delay, health material and communication development for patients with lower health literacy that accounts for linguistic factors, and additional healthcare facilities to increase access to health care in areas with insufficient resources or located far from the nearest resources. Additionally, a continued effort needs to be made to eliminate discrimination and provider bias.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. Colon Cancer Cases Rising Among Young Adults. 2016.
2. Society. AC. Colorectal Cancer Facts & Figures 2017-2019. In: Society AAC, ed2017.
3. Oh D, Santiago-Rodríguez E, Canchola A, Ellis L, Tao L, Gomez S. Changes in Colorectal Cancer 5-Year Survival Disparities in California, 1997-2014. Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology. 2020;29(6).
4. Siegel R, Miller K, Goding-Sauer A, et al. Colorectal cancer statistics, 2020. CA: a cancer journal for clinicians. 2020;70(3).
5. Xu M, Kelly A, Kushi L, Reed M, Koh H, Spiegelman D. Impact of the Affordable Care Act on Colorectal Cancer Outcomes: A Systematic Review. American journal of preventive medicine. 2020;58(4).
6. Tørring M, Frydenberg M, Hamilton W, Hansen R, Lautrup M, Vedsted P. Diagnostic interval and mortality in colorectal cancer: U-shaped association demonstrated for three different datasets. Journal of clinical epidemiology. 2012;65(6).
7. Clegg L, Li F, Hankey B, Chu K, Edwards B. Cancer survival among US whites and minorities: a SEER (Surveillance, Epidemiology, and End Results) Program population-based study. Archives of internal medicine. 2002;162(17).
8. Cancer Facts & Figures for Hispanics/Latinos 2015-2017. Atlanta: American Cancer Society; 2015: American Cancer Society;2015.
9. Ellis L, Canchola AJ, Spiegel D, Ladabaum U, Haile R, Gomez SL. Racial and Ethnic Disparities in Cancer Survival: The Contribution of Tumor, Sociodemographic, Institutional, and Neighborhood Characteristics. In: J Clin Oncol. Vol 36.2018:25–33. [PubMed: 29035642]
10. CN M, P B. Impact of socioeconomic status on incidence, mortality, and survival of colorectal cancer patients: a systematic review. Gastrointestinal endoscopy. 2014;80(1).
11. About the NCCN Clinical Practice Guidelines in Oncology (NCCN GuidelinesÂ®). https://www.nccn.org/professionals/. Published 2016. Accessed.
12. Terhaar sive D, Oort FA, van der Hulst RW, et al. Does delay in diagnosing colorectal cancer in symptomatic patients affect tumor stage and survival? A population-based observational study. In: BMC Cancer. Vol 10.2010:332. [PubMed: 20584274]
13. El-Serag HB. Lagtimes in diagnosis and treatment of colorectal cancer: determinants and association with cancer stage and survival - WATTACHERIL - 2008 - Alimentary Pharmacology & Therapeutics - Wiley Online Library. 2018.
14. Escarce J, Kapur K. Access to and Quality of Health Care. In: National Research Council (US) Panel on Hispanics in the United States. Washington (DC): National Academies Press (US); 2016.

15. Gomez S, O'Malley C, Stroup A, Shema S, Satariano W. Longitudinal, population-based study of racial/ethnic differences in colorectal cancer survival: impact of neighborhood socioeconomic status, treatment and comorbidity. BMC cancer. 2007;7.
16. Ward E, is Managing Director SR, Department of Epidemiology and Surveillance Research, American Cancer Society, Atlanta GA, Halpern M, et al. Association of Insurance with Cancer Care Utilization and Outcomes. CA: A Cancer Journal for Clinicians. 2018;58(1):9–31.
17. Laiyemo A, Doubeni C, Pinsky P, et al. Race and colorectal cancer disparities: health-care utilization vs different cancer susceptibilities. Journal of the National Cancer Institute. 2010;102(8).
18. Wan N, Zhan FB, Lu Y, Tiefenbacher JP. Access to healthcare and disparities in colorectal cancer survival in Texas. Health & place. 2012;18(2):321–329. [PubMed: 22118939]
19. California So. California Cancer Registry. http://www.ccrcal.org/. Published 2016. Accessed.
20. NCCN Clinical Practice Guidelines in Oncology. https://www.nccn.org/professionals/physician_gls/f_guidelines_nojava.asp. Published 2016. Accessed.
21. Gomez SL, Le GM, West DW, Satariano WA, O'Connor L. Hospital Policy and Practice Regarding the Collection of Data on Race, Ethnicity, and Birthplace. https://doiorg/102105/AJPH93101685. 2011.
22. Yang J SC, Harrati A, Clarke C, Keegan THM, Gomez SL. Developing an area-based socioeconomic measure from American Community Survey data. Cancer Prevention Institute of California. 2014.
23. Le H, Ziogas A, Lipkin SM, Zell JA. Effects of socioeconomic status and treatment disparities in colorectal cancer survival. Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology. 2008;17(8):1950–1962.
24. Simpson DR, Martínez ME, Gupta S, et al. Racial Disparity in Consultation, Treatment, and the Impact on Survival in Metastatic Colorectal Cancer. J Natl Cancer Inst. 2013;105(23):1814–1820. [PubMed: 24231453]
25. Demissie K, Oluwole OO, Balasubramanian BA, Osinubi OO, August D, Rhoads GG. Racial differences in the treatment of colorectal cancer: a comparison of surgical and radiation therapy between Whites and Blacks. Annals of epidemiology. 2004;14(3):215–221. [PubMed: 15036226]
26. Popescu I, Schrag D, Ang A, Wong M. Racial/Ethnic and Socioeconomic Differences in Colorectal and Breast Cancer Treatment Quality: The Role of Physician-level Variations in Care. Medical care. 2016;54(8):780–788. [PubMed: 27326547]
27. Rubin DB, Department of Statistics HU. Multiple Imputation for Nonresponse in Surveys. 1987.
28. Valeri L, Vanderweele TJ. Mediation analysis allowing for exposure-mediator interactions and causal interpretation: theoretical assumptions and implementation with SAS and SPSS macros. Psychological methods. 2013;18(2):137–150. [PubMed: 23379553]
29. Vanderweele TJ, Vansteelandt S. Odds ratios for mediation analysis for a dichotomous outcome. Am J Epidemiol. 2010;172(12):1339–1348. [PubMed: 21036955]
30. Polite BN, Dignam JJ, Olopade OI. Colorectal cancer model of health disparities: understanding mortality differences in minority populations. Journal of clinical oncology : official journal of the American Society of Clinical Oncology. 2006;24(14):2179–2187. [PubMed: 16682737]
31. Romanus D, Weiser MR, Skibber JM, et al. Concordance with NCCN Colorectal Cancer Guidelines and ASCO/NCCN Quality Measures: an NCCN institutional analysis. Journal of the National Comprehensive Cancer Network : JNCCN. 2009;7(8):895–904. [PubMed: 19755049]
32. Ellis L ea. Racial and Ethnic Disparities in Cancer Survival: The Contribution of Tumor, Sociodemographic, Institutional, and Neighborhood Characteristics. - PubMed - NCBI. 2018.
33. Natale-Pereira A, Marks J, Vega M, Mouzon D, Hudson SV, Salas-Lopez D. Barriers and facilitators for colorectal cancer screening practices in the Latino community: perspectives from community leaders. Cancer control : journal of the Moffitt Cancer Center. 2008;15(2):157–165. [PubMed: 18376383]
34. Pollack LA, Gotway CA, Bates JH, et al. Use of the spatial scan statistic to identify geographic variations in late stage colorectal cancer in California (United States). Cancer causes & control : CCC. 2006;17(4):449–457. [PubMed: 16596297]

35. Boland GM, Chang GJ, Haynes AB, et al. Association between adherence to National Comprehensive Cancer Network treatment guidelines and improved survival in patients with colon cancer. Cancer. 2013;119(8):1593–1601. [PubMed: 23280510]
36. Lee W, Nelson R, Mailey B, Duldulao MP, Garcia-Aguilar J, Kim J. Socioeconomic factors impact colon cancer outcomes in diverse patient populations. Journal of gastrointestinal surgery : official journal of the Society for Surgery of the Alimentary Tract. 2012;16(4):692–704. [PubMed: 22258868]
37. Koo JH, You MY, Liu K, et al. Colorectal cancer screening practise is influenced by ethnicity of medical practitioner and patient. Journal of gastroenterology and hepatology. 2012;27(2):390–396. [PubMed: 21793910]
38. Reschovsky JD, O'Malley AS. Do primary care physicians treating minority patients report problems delivering high-quality care? Health affairs (Project Hope). 2008;27(3):w222–231. [PubMed: 18430747]
39. Jerant AF, Fenton JJ, Franks P. Determinants of racial/ethnic colorectal cancer screening disparities. Archives of internal medicine. 2008;168(12):1317–1324. [PubMed: 18574089]
40. Liss DT, Baker DW. Understanding current racial/ethnic disparities in colorectal cancer screening in the United States: the contribution of socioeconomic status and access to care. Am J Prev Med. 2014;46(3):228–236. [PubMed: 24512861]
41. Martens CE, Crutchfield TM, Laping JL, et al. Why Wait Until Our Community Gets Cancer?: Exploring CRC Screening Barriers and Facilitators in the Spanish-Speaking Community in North Carolina. Journal of cancer education : the official journal of the American Association for Cancer Education. 2016;31(4):652–659. [PubMed: 26264390]
42. CENSUS USDoCEaSABOT. Geographic Areas Reference Manual. In:1994.
43. Winkleby M, Cubbin C, Ahn D. Effect of cross-level interaction between individual and neighborhood socioeconomic status on adult mortality rates. American journal of public health. 2006;96(12).
44. Robert SA. SOCIOECONOMIC POSITION AND HEALTH: The Independent Contribution of Community Socioeconomic Context1. https://doiorg/101146/annurevsoc251489. 2003.
45. Sterne JAC, White IR, Carlin JB, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. 2009.
46. Gordon NP, Lin TY, Rau J, Lo JC. Aggregation of Asian-American subgroups masks meaningful differences in health and health risks among Asian ethnicities: an electronic health record based cohort study. BMC Public Health. 2019;19(1):1–14. [PubMed: 30606151]
47. Islam N, Khan S, Kwon S, Jang D, Ro M, Trinh-Shevrin C. Methodological issues in the collection, analysis, and reporting of granular data in Asian American populations: historical challenges and potential solutions. Journal of health care for the poor and underserved. 2010;21(4).
48. Ghosh C Healthy People 2010 and Asian Americans/Pacific Islanders: Defining a Baseline of Information. https://doiorg/102105/AJPH93122093. 2011.
49. Holland A, Palaniappan L. Problems with the collection and interpretation of Asian-American health data: omission, aggregation, and extrapolation. Annals of epidemiology. 2012;22(6).

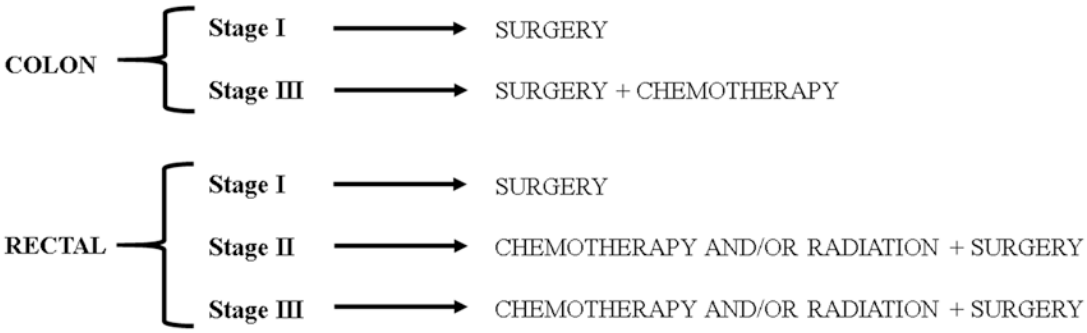

Figure 1.

Colorectal cancer site- and stage-specific recommended treatment from the 2016 National Comprehensive Cancer Network (NCCN) guidelines. To determine whether each patient received the minimum recommended treatment based on the data provided in the California Cancer Registry (CCR): for tumors of the colon, the minimum required for stage I was surgery and for stage III was surgery + chemotherapy; stage II was excluded because treatment guidelines differ by high versus low risk, a variable not available in the CCR. For tumors of the rectum, the minimum required for stage I was surgery and for stage II and stage III was chemotherapy and/or radiation + surgery.

Table 1.

Clinical and Sociodemographic Characteristics of the Study Population, overall and stratified by Race/Ethnicity

		Race/Ethnicity		
	All (N=26,870)	**Non-Hispanic White (N=18,895)**	**Non-Hispanic Black (N=2,075)**	**Hispanic (N=5,900)**
Cancer Site				
Colon	18,361 (68.3%)	13,010 (68.9%)	1,555 (74.9%)	3,796 (64.3%)
Rectal	8,509 (31.7%)	5,885 (31.2%)	520 (25.1%)	2,104 (35.7%)
Cancer Stage at Diagnosis				
I	12,254 (45.6%)	8,797 (46.6%)	997 (48.1%)	2,460 (41.7%)
II	2,113 (7.9%)	1,439 (7.6%)	117 (5.6%)	557 (9.4%)
III	12,503 (46.5%)	8,659 (45.8%)	961 (46.3%)	2,883 (48.9%)
Year of diagnosis				
2009	5,531 (20.6%)	4,037 (21.4%)	435 (21.0%)	1,059 (18.0%)
2010	5,539 (20.6%)	3,941 (20.9%)	429 (20.7%)	1,169 (19.8%)
2011	5,339 (19.9%)	3,704 (19.6%)	399 (19.2%)	1,236 (21.0%)
2012	5,229 (19.5%)	3,654 (19.3%)	383 (18.5%)	1,192 (20.2%)
2013	5,232 (19.5%)	3,559 (18.8%)	429 (20.7%)	1,244 (21.1%)
Sex				
Male	13,758 (51.2%)	9,679 (51.2%)	991 (47.8%)	3,088 (52.3%)
Female	13,112 (48.8%)	9,216 (48.8%)	1,084 (52.2%)	2,812 (47.7%)
Age groups				
Under 50	2,805 (10.4%)	1,615 (8.6%)	206 (9.9%)	984 (16.7%)
50 through 59	5,507 (20.5%)	3,528 (18.7%)	497 (24.0%)	1,482 (25.1%)
60 through 69	6,495 (24.2%)	4,460 (23.6%)	589 (28.4%)	1,446 (24.5%)
70 through 79	6,419 (23.9%)	4,725 (25.0%)	515 (24.8%)	1,179 (20.0%)
80 or over	5,644 (21.0%)	4,567 (24.2%)	268 (12.9%)	809 (13.7%)
Neighborhood Social Economic Status (nSES)				
Lowest SES	4,219 (15.7%)	1,820 (9.6%)	599 (28.9%)	1,800 (30.5%)
Lower-middle SES	5,299 (19.7%)	3,230 (17.1%)	508 (24.5%)	1,561 (26.5%)

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		Race/Ethnicity		
	All (N=26,870)	**Non-Hispanic White (N=18,895)**	**Non-Hispanic Black (N=2,075)**	**Hispanic (N=5,900)**
Middle SES	5,641 (21.0%)	4,050 (21.4%)	419 (20.2%)	1,172 (19.9%)
Upper-middle SES	5,837 (21.7%)	4,635 (24.5%)	333 (16.1%)	869 (14.7%)
Highest SES	5,874 (21.9%)	5,160 (27.3%)	216 (10.4%)	498 (8.4%)
Payer				
Not insured	447 (1.7%)	207 (1.1%)	37 (1.8%)	203 (3.4%)
insured, NOS	950 (3.5%)	675 (3.6%)	45 (2.2%)	230 (3.9%)
Private Insurance	12,502 (46.5%)	8,821 (46.7%)	1,054 (50.8%)	2,627 (44.5%)
Medicaid	1,603 (6.0%)	691 (3.7%)	188 (9.1%)	724 (12.3%)
Medicare	10,587 (39.4%)	8,047 (42.6%)	686 (33.1%)	1,854 (31.4%)
TRICARE, military, or VA	101 (0.4%)	79 (0.4%)	11 (0.5%)	11 (0.2%)
Other or NOS	338 (1.3%)	133 (0.7%)	38 (1.8%)	167 (2.8%)
Missing *	342 (1.3%)	242 (1.3%)	16 (0.8%)	84 (1.4%)
ACOS-approved cancer program				
Approved	13,637 (50.8%)	9,930 (52.6%)	816 (39.3%)	2,891 (49.0%)
Not approved	13,184 (49.1%)	8,924 (47.2%)	1,254 (60.4%)	3,006 (51.0%)
Missing *	49 (0.2%)	41 (0.2%)	5 (0.2%)	3 (0.1%)
Marital Status at diagnosis				
Single	4,388 (16.3%)	2,774 (14.7%)	557 (26.8%)	1,057 (17.9%)
Married or Partnered	14,257 (53.1%)	10,167 (53.8%)	829 (40.0%)	3,261 (55.3%)
Separated or Divorced	2,776 (10.3%)	1,925 (10.2%)	272 (13.1%)	579 (9.8%)
Widowed	4,114 (15.3%)	3,144 (16.6%)	267 (12.9%)	703 (11.9%)
Missing *	1,335 (5.0%)	885 (4.7%)	150 (7.2%)	300 (5.01%)
Residence County Geography				
Metro	26,048 (96.9%)	18,134 (96.0%)	2,069 (99.7%)	5,845 (99.1%)
Urban or Rural	822 (3.1%)	761 (4.0%)	6 (0.30%)	55 (0.9%)

* Missing information imputed using MI

Table 2.

Receipt of appropriate and timely treatment, by race/ethnicity and nSES.

	Undertreated		>60 Day Treatment Delay		>90 Day Treatment Delay		Incomplete Dates
	Yes	No	Yes	No	Yes	No	
All Patients	6,964 (25.92%)	19,906 (74.08%)	3,476 (12.94%)	23,220 (86.42%)	1,896 (7.06%)	24,800 (92.3%)	174 (0.65%)
Race/Ethnicity							
Non-Hispanic White	4,916 (26.02%)	13,979 (73.98%)	2,209 (11.69%)	16,579 (87.74%)	1,225 (6.48%)	17,563 (92.95%)	107 (0.57%)
Non-Hispanic Black	557 (26.84%)	1,518 (73.16%)	352 (16.96%)	1,707 (82.27%)	191 (9.20%)	1,868 (90.02%)	16 (0.77%)
Hispanic	1,491 (25.27%)	4,409 (74.73%)	915 (15.51%)	4,934 (83.63%)	480 (8.14%)	5,369 (91.00%)	51 (0.86%)
Neighborhood Socioeconomic Status							
Lowest SES	1,298 (30.77%)	2,921 (69.23%)	726 (17.21%)	3,464 (82.1%)	437 (10.36%)	3,753 (88.95%)	29 (0.69%)
Lower-middle SES	1,420 (26.80%)	3,879 (73.20%)	782 (14.76%)	4,476 (84.47%)	427 (8.06%)	4,831 (91.17%)	41 (0.77%)
Middle SES	1,501 (26.61%)	4,140 (73.39%)	716 (12.69%)	4,885 (86.60%)	404 (7.16%)	5,197 (92.13%)	40 (0.71%)
Upper-middle SES	1,424 (24.40%)	4,413 (75.60%)	704 (12.06%)	5,102 (87.41%)	358 (6.13%)	5,448 (93.34%)	31 (0.53%)
Highest SES	1,321 (22.49%)	4,553 (77.51%)	548 (9.33%)	5,293 (90.11%)	270 (4.60%)	5,571 (94.84%)	33 (0.56%)

Table 3.

Multivariable Logistic Regressions of Race/Ethnicity on timely receipt of appropriate treatment

	Model 1[a]	Model 2[b]
Race/Ethnicity	**Undertreatment**	
Non-Hispanic White	1.00	1.00
Non-Hispanic Black	1.39 (1.23, 1.57)	1.16 (1.02, 1.31)
Hispanic	1.17 (1.08, 1.27)	1.01 (0.93, 1.10)
Neighborhood Socioeconomic Status		
Lowest SES	1.84 (1.77, 1.91)	1.55 (1.38, 1.73)
Lower-middle SES	1.44 (1.39, 1.50)	1.29 (1.16, 1.43)
Middle SES	1.34 (1.29, 1.39)	1.25 (1.13, 1.39)
Upper-middle SES	1.15 (1.10, 1.19)	1.11 (1.00, 1.22)
Highest SES	1.00	1.00
Race/Ethnicity	**>60 Day Treatment Delay**	
Non-Hispanic White	1.00	1.00
Non-Hispanic Black	1.78 (1.57, 2.02)	1.52 (1.34, 1.74)
Hispanic	1.50 (1.38, 1.64)	1.27 (1.16, 1.40)
Neighborhood Socioeconomic Status		
Lowest SES	2.10 (1.86, 2.37)	1.63 (1.43, 1.86)
Lower-middle SES	1.71 (1.52, 1.93)	1.48 (1.30, 1.67)
Middle SES	1.42 (1.26, 1.61)	1.30 (1.15, 1.47)
Upper-middle SES	1.34 (1.19, 1.51)	1.28 (1.14, 1.45)
Highest SES	1.00	1.00
Race/Ethnicity	**>90 Day Treatment Delay**	
Non-Hispanic White	1.00	1.00
Non-Hispanic Black	1.73 (1.46, 2.04)	1.38 (1.16, 1.64)
Hispanic	1.47 (1.31, 1.64)	1.17 (1.03, 1.32)
Neighborhood Socioeconomic Status		
Lowest SES	2.59 (2.21, 3.04)	1.99 (1.68, 2.36)
Lower-middle SES	1.89 (1.60, 2.22)	1.60 (1.36, 1.90)
Middle SES	1.64 (1.40, 1.93)	1.48 (1.26, 1.75)
Upper-middle SES	1.38 (1.17, 1.62)	1.31 (1.11, 1.55)
Highest SES	1.00	1.00

[a] Adjusted for age, sex, cancer site, stage, and year of diagnosis.

[b] Adjusted for age, sex, cancer site, stage, and year of diagnosis, marital status, ACOS approved cancer program, residence, payer, and mutually adjusted for race/ethnicity (in nSES models), and nSES (in race/ethnicity models).

Table 4.

Joint Effects of Race/Ethnicity and nSES on timely receipt of appropriate treatment

	Non-Hispanic White (N= 18,895)	Non-Hispanic Black (N = 2,075)	Hispanic (N = 5,900)
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
	Undertreatment		
Lowest SES	1.55 (1.35, 1.78)	1.78 (1.43, 2.20)	1.53 (1.33, 1.77)
Lower-middle SES	1.29 (1.14, 1.45)	1.33 (1.04, 1.69)	1.32 (1.13, 1.54)
Middle SES	1.23 (1.10, 1.37)	1.61 (1.23, 2.10)	1.26 (1.06, 1.50)
Upper-middle SES	1.09 (0.97, 1.21)	1.44 (1.07, 1.95)	1.11 (0.91, 1.36)
Highest SES	1	1.00 (0.68, 1.46)	0.97 (0.75, 1.26)
	>60 Day Treatment Delay		
Lowest SES	1.69 (1.43, 1.99)	2.72 (2.17, 3.42)	1.96 (1.66, 2.31)
Lower-middle SES	1.50 (1.30, 1.73)	2.07 (1.59, 2.68)	1.90 (1.60, 2.26)
Middle SES	1.25 (1.09, 1.44)	2.15 (1.62, 2.84)	1.83 (1.51, 2.22)
Upper-middle SES	1.31 (1.15, 1.50)	2.05 (1.48, 2.85)	1.47 (1.17, 1.84)
Highest SES	1	1.01 (0.61, 1.66)	1.56 (1.16, 2.08)
	>90 Day Treatment Delay		
Lowest SES	2.12 (1.72, 2.62)	2.86 (2.14, 3.82)	2.23 (1.79, 2.76)
Lower-middle SES	1.65 (1.36, 2.01)	2.02 (1.43, 2.86)	1.92 (1.52, 2.43)
Middle SES	1.45 (1.21, 1.75)	2.56 (1.80, 3.64)	1.81 (1.39, 2.35)
Upper-middle SES	1.34 (1.12, 1.61)	1.64 (1.01, 2.66)	1.55 (1.14, 2.11)
Highest SES	1	1.14 (0.59, 2.20)	1.51 (1.00, 2.26)

Multivariable Logistic Regression adjusting for colorectal cancer type, stage at diagnosis, year of diagnosis, sex, age, marital status, cancer program, residence, and payer.

Table 5.

Mediation Analysis

	Undertreatment	>60 Day Treatment Delay	>90 Day Treatment Delay
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**
Natural Direct Effect	1.08 (1.00, 1.17)	1.38 (1.26, 1.50)	1.29 (1.16, 1.5)
Natural Indirect Effect	1.06 (1.04, 1.09)	1.08 (1.05, 1.11)	1.11 (1.07, 1.14)
Total Effect	1.15 (1.07, 1.24)	1.49 (1.37, 1.61)	1.43 (1.28, 1.60)
% Mediated	45.71% (24.97%, 94.42%)	22.69% (15.39%, 31.82%)	31.97% (20.97%, 44.17%)

Mediation analysis to identify the effect of non-white ethnicity on 60- and 90-day guideline concordant treatment and timely treatment as mediated by low (Q1-Q2) vs high (Q3-Q5) nSES