Racial Differences in Cardiovascular Burden and Outcomes in Colorectal Cancer: Insights from the National Inpatient Sample

Analysis for RCOP NIS Gastro1

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## Preamble:

* **Reference Papers:**
  1. [Haidar et al. (2024)](https://doi.org/10.1016/j.amjcard.2024.10.003)
  2. [Mekhaimar et al. (2020)](https://doi.org/10.1007/s10741-020-10012-6)
* **Study Objective**: This study aims to examine racial differences in the cardiovascular disease (CVD) burden among U.S. patients hospitalized with colorectal cancer (CRC) and to evaluate the impact of these differences on in-hospital outcomes, including mortality, length of stay, and healthcare costs.
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all inpatient admissions with a primary diagnosis of colorectal cancer and a secondary diagnosis of cardiovascular comorbidities, defined as the presence of one or more of the following conditions: myocardial infarction, cardiac dysrhythmia, coronary artery disease, heart failure, hypertension, or stroke.
* **Primary Outcomes**:
  + In-hospital all-cause mortality
  + Total hospital length of stay (days)
  + Total charge, inflation adjusted to 2020 ($)
* **Statistical Analysis**: Multiple logistic and linear regression to evaluate the independent associations of race with in-hospital outcomes, adjusted for cardiovascular conditions and other potential confounders, including:
  + Demographics: Age, sex, residential income, and insurance payer.
  + Cardiovascular Comorbidities: Myocardial infarction, cardiac dysrhythmia, coronary artery disease, heart failure, hypertension, and stroke
  + Colorectal Cancer-Specific Variables: Cancer location within the colorectal region.
  + Hospital Characteristics: Hospital region, bed size, location, and teaching status.
  + Comorbidities: Charlson comorbidity index.
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

## Baseline Table:

| **Characteristic** | **White** N = 166,730*1* | **Asian or Pacific Islander** N = 7,755*1* | **Black** N = 31,920*1* | **Hispanic** N = 19,370*1* | **Other** N = 6,945*1* | **p-value***2* |
| --- | --- | --- | --- | --- | --- | --- |
| Age, y | 71 (12) | 69 (13) | 66 (12) | 67 (13) | 67 (13) | <0.001 |
| Sex |  |  |  |  |  | <0.001 |
| Female | 77,170 (46%) | 3,380 (44%) | 15,890 (50%) | 8,510 (44%) | 3,235 (47%) |  |
| Male | 89,560 (54%) | 4,375 (56%) | 16,030 (50%) | 10,860 (56%) | 3,710 (53%) |  |
| Colorectal cancer location |  |  |  |  |  | <0.001 |
| Anus and anal canal | 3,390 (2.0%) | 70 (0.9%) | 815 (2.6%) | 480 (2.5%) | 145 (2.1%) |  |
| Colon | 122,475 (73%) | 5,075 (65%) | 23,905 (75%) | 13,325 (69%) | 4,835 (70%) |  |
| Rectosigmoid junction | 14,260 (8.6%) | 910 (12%) | 2,950 (9.2%) | 2,035 (11%) | 755 (11%) |  |
| Rectum | 26,605 (16%) | 1,700 (22%) | 4,250 (13%) | 3,530 (18%) | 1,210 (17%) |  |
| Myocardial infarction | 15,690 (9.4%) | 455 (5.9%) | 1,710 (5.4%) | 1,040 (5.4%) | 440 (6.3%) | <0.001 |
| Cardiac dysrhythmia | 52,970 (32%) | 1,620 (21%) | 6,800 (21%) | 4,185 (22%) | 1,790 (26%) | <0.001 |
| Coronary artery disease | 41,105 (25%) | 1,260 (16%) | 4,515 (14%) | 3,235 (17%) | 1,320 (19%) | <0.001 |
| Heart failure | 27,355 (16%) | 690 (8.9%) | 4,620 (14%) | 2,165 (11%) | 860 (12%) | <0.001 |
| Hypertension | 147,260 (88%) | 7,075 (91%) | 30,020 (94%) | 17,630 (91%) | 6,060 (87%) | <0.001 |
| Stroke | 2,800 (1.7%) | 65 (0.8%) | 390 (1.2%) | 180 (0.9%) | 75 (1.1%) | <0.001 |
| Metastasis | 49,765 (30%) | 2,720 (35%) | 12,630 (40%) | 6,360 (33%) | 2,460 (35%) | <0.001 |
| Charlson comorbidity index | 4.67 (2.40) | 4.69 (2.35) | 5.16 (2.55) | 4.74 (2.41) | 4.82 (2.43) | <0.001 |
| Residential income |  |  |  |  |  | <0.001 |
| $1 - $51,999 | 39,220 (24%) | 915 (12%) | 15,915 (51%) | 7,010 (37%) | 1,920 (28%) |  |
| $52,000 - $65,999 | 46,785 (28%) | 1,450 (19%) | 6,900 (22%) | 4,940 (26%) | 1,415 (21%) |  |
| $66,000 - $87,999 | 42,240 (26%) | 1,965 (26%) | 5,190 (17%) | 4,285 (22%) | 1,570 (23%) |  |
| $88,000 or more | 36,160 (22%) | 3,310 (43%) | 3,320 (11%) | 2,815 (15%) | 1,850 (27%) |  |
| Insurance |  |  |  |  |  | <0.001 |
| Private | 41,485 (25%) | 2,470 (32%) | 9,190 (29%) | 5,615 (29%) | 2,120 (31%) |  |
| Medicaid | 8,320 (5.0%) | 1,025 (13%) | 4,325 (14%) | 3,115 (16%) | 930 (13%) |  |
| Medicare | 113,940 (68%) | 4,145 (53%) | 17,710 (56%) | 10,225 (53%) | 3,655 (53%) |  |
| Other | 2,890 (1.7%) | 115 (1.5%) | 655 (2.1%) | 405 (2.1%) | 230 (3.3%) |  |
| Hospital region |  |  |  |  |  | <0.001 |
| Midwest | 43,420 (26%) | 650 (8.4%) | 5,960 (19%) | 1,095 (5.7%) | 845 (12%) |  |
| Northeast | 32,705 (20%) | 1,435 (19%) | 5,170 (16%) | 2,955 (15%) | 1,815 (26%) |  |
| South | 63,730 (38%) | 1,380 (18%) | 18,190 (57%) | 8,430 (44%) | 2,590 (37%) |  |
| West | 26,875 (16%) | 4,290 (55%) | 2,600 (8.1%) | 6,890 (36%) | 1,695 (24%) |  |
| Hospital bedsize |  |  |  |  |  | 0.004 |
| Large | 86,295 (52%) | 4,510 (58%) | 16,925 (53%) | 9,850 (51%) | 3,900 (56%) |  |
| Medium | 47,925 (29%) | 2,025 (26%) | 9,280 (29%) | 6,060 (31%) | 1,895 (27%) |  |
| Small | 32,510 (19%) | 1,220 (16%) | 5,715 (18%) | 3,460 (18%) | 1,150 (17%) |  |
| Hospital location/teaching status |  |  |  |  |  | <0.001 |
| Rural | 16,000 (9.6%) | 100 (1.3%) | 1,755 (5.5%) | 355 (1.8%) | 375 (5.4%) |  |
| Urban, non-teaching | 30,285 (18%) | 1,505 (19%) | 4,065 (13%) | 3,795 (20%) | 1,270 (18%) |  |
| Urban, teaching | 120,445 (72%) | 6,150 (79%) | 26,100 (82%) | 15,220 (79%) | 5,300 (76%) |  |
| *1*Mean (SD); n (%) | | | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | | | |

## Outcomes Table:

| **Characteristic** | **White** N = 166,730*1* | **Asian or Pacific Islander** N = 7,755*1* | **Black** N = 31,920*1* | **Hispanic** N = 19,370*1* | **Other** N = 6,945*1* | **p-value***2* |
| --- | --- | --- | --- | --- | --- | --- |
| Died during hospitalization | 4,430 (2.7%) | 215 (2.8%) | 1,000 (3.1%) | 470 (2.4%) | 175 (2.5%) | 0.3 |
| Length of stay (days) | 5.0 (3.0, 9.0) | 5.0 (3.0, 8.0) | 6.0 (3.0, 10.0) | 5.0 (3.0, 9.0) | 5.0 (3.0, 9.0) | <0.001 |
| Inflation-adjusted total charge ($) | 71,567 (44,838, 118,326) | 86,930 (53,614, 144,241) | 73,846 (43,893, 124,692) | 95,817 (58,191, 159,174) | 83,056 (48,949, 146,527) | <0.001 |
| *1*n (%); Median (Q1, Q3) | | | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | | | |

## Multivariable Logistic Regression:

### All-Cause Mortality:

| **Characteristic** | **OR***1* | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.32 | 0.94, 1.85 | 0.11 |
| Black | 1.33 | 1.12, 1.58 | 0.001 |
| Hispanic | 1.06 | 0.84, 1.34 | 0.6 |
| Other | 0.93 | 0.60, 1.43 | 0.7 |
| Colorectal cancer location |  |  |  |
| Anus and anal canal | — | — |  |
| Colon | 0.98 | 0.62, 1.55 | >0.9 |
| Rectosigmoid junction | 1.19 | 0.73, 1.94 | 0.5 |
| Rectum | 0.72 | 0.44, 1.17 | 0.2 |
| Myocardial infarction |  |  |  |
| No | — | — |  |
| Yes | 1.55 | 1.26, 1.90 | <0.001 |
| Cardiac dysrhythmia |  |  |  |
| No | — | — |  |
| Yes | 1.87 | 1.62, 2.15 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | 0.68 | 0.58, 0.80 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.34 | 1.14, 1.59 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.51 | 0.43, 0.59 | <0.001 |
| Stroke |  |  |  |
| No | — | — |  |
| Yes | 2.65 | 1.99, 3.54 | <0.001 |
| Age, y | 1.03 | 1.02, 1.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.16 | 1.03, 1.31 | 0.017 |
| Metastasis |  |  |  |
| No | — | — |  |
| Yes | 1.80 | 1.48, 2.19 | <0.001 |
| Charlson comorbidity index | 1.15 | 1.11, 1.20 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 0.94 | 0.79, 1.11 | 0.5 |
| $66,000 - $87,999 | 0.97 | 0.82, 1.14 | 0.7 |
| $88,000 or more | 0.85 | 0.70, 1.02 | 0.077 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 1.27 | 0.96, 1.68 | 0.092 |
| Medicare | 1.03 | 0.86, 1.24 | 0.8 |
| Other | 3.01 | 2.14, 4.22 | <0.001 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 1.48 | 1.14, 1.93 | 0.003 |
| South | 1.10 | 0.93, 1.31 | 0.3 |
| West | 1.21 | 0.98, 1.48 | 0.072 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | 1.25 | 1.09, 1.44 | 0.002 |
| Small | 1.49 | 1.16, 1.92 | 0.002 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 0.93 | 0.73, 1.18 | 0.5 |
| Urban, teaching | 0.72 | 0.58, 0.90 | 0.004 |
| *1*OR = Odds Ratio, CI = Confidence Interval | | | |

## Multivariable Linear Regression:

### Length of Stay:

| **Characteristic** | **Beta** | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 0.28 | -0.15, 0.71 | 0.2 |
| Black | 0.97 | 0.74, 1.2 | <0.001 |
| Hispanic | 0.37 | 0.10, 0.64 | 0.006 |
| Other | 0.71 | 0.21, 1.2 | 0.005 |
| Colorectal cancer location |  |  |  |
| Anus and anal canal | — | — |  |
| Colon | -1.4 | -2.0, -0.77 | <0.001 |
| Rectosigmoid junction | -1.1 | -1.8, -0.48 | <0.001 |
| Rectum | -1.1 | -1.8, -0.50 | <0.001 |
| Myocardial infarction |  |  |  |
| No | — | — |  |
| Yes | -0.20 | -0.48, 0.07 | 0.2 |
| Cardiac dysrhythmia |  |  |  |
| No | — | — |  |
| Yes | 1.9 | 1.7, 2.1 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | -0.69 | -0.87, -0.51 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.5 | 1.2, 1.7 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -1.3 | -1.5, -0.97 | <0.001 |
| Stroke |  |  |  |
| No | — | — |  |
| Yes | 2.2 | 1.5, 2.9 | <0.001 |
| Age, y | 0.02 | 0.02, 0.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 0.09 | -0.04, 0.22 | 0.2 |
| Metastasis |  |  |  |
| No | — | — |  |
| Yes | -0.14 | -0.39, 0.12 | 0.3 |
| Charlson comorbidity index | 0.34 | 0.28, 0.39 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | -0.02 | -0.20, 0.15 | 0.8 |
| $66,000 - $87,999 | -0.28 | -0.47, -0.10 | 0.002 |
| $88,000 or more | -0.42 | -0.63, -0.21 | <0.001 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 2.0 | 1.6, 2.4 | <0.001 |
| Medicare | 0.24 | 0.06, 0.42 | 0.010 |
| Other | 0.15 | -0.28, 0.58 | 0.5 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 0.80 | 0.54, 1.0 | <0.001 |
| South | 0.48 | 0.31, 0.65 | <0.001 |
| West | 0.01 | -0.20, 0.21 | >0.9 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | -0.19 | -0.36, -0.03 | 0.021 |
| Small | -0.29 | -0.50, -0.08 | 0.006 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 0.75 | 0.50, 0.99 | <0.001 |
| Urban, teaching | 0.68 | 0.47, 0.89 | <0.001 |
| *1*CI = Confidence Interval | | | |

### Inflation Adjusted Total Charge:

| **Characteristic** | **Beta** | **95% CI***1* | **p-value** |
| --- | --- | --- | --- |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 9,743 | 2,107, 17,379 | 0.012 |
| Black | 4,695 | 1,424, 7,966 | 0.005 |
| Hispanic | 20,281 | 14,787, 25,776 | <0.001 |
| Other | 15,939 | 6,839, 25,038 | <0.001 |
| Colorectal cancer location |  |  |  |
| Anus and anal canal | — | — |  |
| Colon | -2,929 | -11,307, 5,450 | 0.5 |
| Rectosigmoid junction | 472 | -8,657, 9,601 | >0.9 |
| Rectum | 1,814 | -6,742, 10,370 | 0.7 |
| Myocardial infarction |  |  |  |
| No | — | — |  |
| Yes | 392 | -3,986, 4,770 | 0.9 |
| Cardiac dysrhythmia |  |  |  |
| No | — | — |  |
| Yes | 26,330 | 23,603, 29,057 | <0.001 |
| Coronary artery disease |  |  |  |
| No | — | — |  |
| Yes | -7,186 | -9,972, -4,400 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 15,915 | 11,942, 19,887 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | -13,092 | -17,635, -8,549 | <0.001 |
| Stroke |  |  |  |
| No | — | — |  |
| Yes | 38,823 | 26,328, 51,319 | <0.001 |
| Age, y | -356 | -471, -240 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 4,633 | 2,630, 6,637 | <0.001 |
| Metastasis |  |  |  |
| No | — | — |  |
| Yes | -11,055 | -15,039, -7,070 | <0.001 |
| Charlson comorbidity index | 3,448 | 2,591, 4,304 | <0.001 |
| Residential income |  |  |  |
| $1 - $51,999 | — | — |  |
| $52,000 - $65,999 | 421 | -2,424, 3,265 | 0.8 |
| $66,000 - $87,999 | -3,616 | -6,715, -517 | 0.022 |
| $88,000 or more | 19 | -3,907, 3,945 | >0.9 |
| Insurance |  |  |  |
| Private | — | — |  |
| Medicaid | 12,087 | 6,487, 17,686 | <0.001 |
| Medicare | 5,825 | 2,776, 8,874 | <0.001 |
| Other | -4,575 | -11,690, 2,540 | 0.2 |
| Hospital region |  |  |  |
| Midwest | — | — |  |
| Northeast | 17,580 | 13,030, 22,130 | <0.001 |
| South | 17,990 | 14,686, 21,293 | <0.001 |
| West | 48,541 | 43,020, 54,062 | <0.001 |
| Hospital bedsize |  |  |  |
| Large | — | — |  |
| Medium | -4,815 | -8,567, -1,062 | 0.012 |
| Small | -12,600 | -16,212, -8,989 | <0.001 |
| Hospital location/teaching status |  |  |  |
| Rural | — | — |  |
| Urban, non-teaching | 36,851 | 32,724, 40,978 | <0.001 |
| Urban, teaching | 34,066 | 30,745, 37,388 | <0.001 |
| *1*CI = Confidence Interval | | | |