

# Geographical Disparities and Trends in Prevalence of Metastatic Colorectal Cancer in the United States

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## Abstract

**Background:** Metastatic colorectal cancer (mCRC) remains a major public health challenge in the United States, with notable disparities in regional prevalence and outcomes. The Southern U.S. has consistently demonstrated higher rates of advanced-stage diagnoses, potentially reflecting healthcare access and socioeconomic inequities. **Methods:** A retrospective cohort study was conducted using the National Inpatient Sample (NIS) from 2016-2019. Adults with mCRC were identified using ICD-10 codes (C18.8, C18.9, C18.2, C18.4, C18.6, C18.7). Patients were stratified into four U.S. Census regions. Chi-square tests assessed regional differences in mCRC prevalence, and temporal trends were analyzed using the delta method. Statistical significance was set at  $p < 0.05$ . **Results:** Among 56,570 mCRC patients, the Southern region had the highest disease burden (39.71%), increasing from 39.56% in 2016 to 40.64% in 2019. The Western region showed a 9.5% rise, while the Northeast and Midwest declined by 8.3% and 4.96%, respectively. These findings align with national cancer data showing slower declines in colorectal cancer incidence in the South. **Conclusions:** Significant geographical disparities persist in metastatic colon cancer prevalence, with the South exhibiting the highest and rising burden. Socioeconomic disadvantages, healthcare access barriers, and limited Medicaid expansion are likely to contribute to these trends. Regional and policy interventions targeting prevention and early detection are urgently needed.

## Keywords

Metastatic Colorectal Cancer, Regional Health Disparities, Southern United States, Healthcare Access Inequities, Rural Cancer Care, Inpatient

## 1. Introduction

Metastatic colorectal cancer (mCRC), or stage IV colorectal cancer, occurs when primary cancer originating in the colon or rectum spreads to distant organs such as the liver, lungs, or peritoneum. At this stage, colorectal cancer is considered advanced and is associated with significantly worse survival outcomes compared to earlier stages of the disease. mCRC typically requires a combination of treatment modalities, including chemotherapy, immunotherapy, targeted therapies, and, in some cases, surgery. Despite advances in treatment strategies, survival rates for stage IV colorectal cancer remain dismal, underscoring the critical need for early detection and improved access to care [1].

In the United States, colorectal cancer (CRC) is the third most commonly diagnosed cancer and the second leading cause of cancer-related deaths among both men and women [2] [3]. Each year, approximately 150,000 new cases of CRC are diagnosed, with 15% - 20% of these cases identified at the metastatic stage [3] [4]. Between 2016 and 2019, an estimated 30,000 to 40,000 cases of mCRC were diagnosed annually, reflecting a broader issue of increasing metastatic disease burden [2]. Although national declines in CRC incidence due to widespread screening programs have contributed to improved outcomes, significant disparities persist in disease burden and outcomes based on geographic location, socioeconomic status, race, and healthcare access [5]-[7].

The Southern United States stands out as a region disproportionately affected by these disparities. Lower adoption of Medicaid expansion across many Southern states has exacerbated inequalities in cancer care, as Medicaid provides essential coverage for low-income populations who are at greater risk of late-stage cancer diagnoses [8] [9]. Furthermore, the South experiences higher rates of chronic conditions such as obesity, diabetes, and hypertension, all of which are associated with increased colorectal cancer risk and poorer outcomes [10]. These underlying health issues, combined with limited healthcare infrastructure, significantly hinder early detection and effective management of colorectal cancer.

The role of funding in colorectal cancer research and treatment cannot be overstated. Despite its high incidence and mortality rates, CRC receives comparatively less research funding than cancers such as breast, lung, and leukemia, resulting in fewer clinical trials and fewer therapeutic innovations [11]. This lack of investment contributes to poorer survival outcomes in regions where healthcare systems are already burdened. Indeed, the high burden of mCRC, associated with poor prognosis and elevated healthcare costs, presents a substantial challenge to both patients and healthcare systems [12].

Beyond direct healthcare barriers, regional factors such as lower health literacy, poverty, and reduced access to oncology services contribute to worse outcomes

for CRC patients in the South [13] [14]. Disparities in cancer screening access between rural and non-rural communities further compound delayed diagnosis and advanced-stage presentation [15]. These challenges have contributed to the emergence of “chemotherapy deserts,” defined as areas with limited access to oncology services, further deepening regional disparities in cancer care [16].

The present study aims to assess the prevalence and temporal trends of mCRC across four major U.S. regions, Northeast, Midwest, South, and West, using a nationally representative inpatient dataset from 2016 to 2019. We hypothesize that the Southern United States will demonstrate the highest prevalence of mCRC and show rising trends in metastatic diagnoses, driven by structural and systemic disparities in healthcare delivery. Understanding these regional trends is essential for informing public health strategies and health policy decisions aimed at reducing the burden of mCRC, improving early detection, and ultimately enhancing survival outcomes for patients with colorectal cancer.

## 2. Materials & Methods

This retrospective cohort study utilized data from the National Inpatient Sample (NIS), a publicly available, nationally representative database of hospitalized inpatient encounters across the United States. The NIS captures discharge-level data from inpatient hospitalizations and does not include outpatient or community-based cases. Accordingly, all prevalence estimates in this study reflect the burden of mCRC among hospitalized patients. The NIS database was queried to identify all adult patients diagnosed with mCRC from 2016 to 2019, a four-year period selected to ensure consistency in diagnostic coding following the implementation of the ICD-10 coding system in 2015. A total of 56,570 patients diagnosed with mCRC during this time frame were included in the analysis. The cohort was stratified based on the four U.S. Census Bureau-defined regions:

- **Northeast** (Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York, Pennsylvania);
- **Midwest** (Illinois, Indiana, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota);
- **South** (Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, District of Columbia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma, Texas); and
- **West** (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming, Alaska, California, Hawaii, Oregon, Washington), as defined by the U.S. Census Bureau.

### 2.1. Primary and Secondary Outcomes

The primary outcome of this study was to assess the regional prevalence of mCRC across the four U.S. Census regions from 2016 to 2019. Prevalence rates were calculated annually for each region, and statistical significance of regional differences was evaluated using chi-square tests. These tests were conducted to determine

whether the observed differences in prevalence between regions were statistically significant. A p-value of less than 0.05 was considered statistically significant. It is important to note that the National Inpatient Sample captures inpatient hospital encounters only; therefore, the prevalence reported in this study represents inpatient prevalence rather than overall population prevalence.

The secondary outcome was to examine the temporal trends in the prevalence of mCRC within each region over the study period. The focus was on identifying whether there were any significant changes in prevalence over time (2016-2019), and whether certain regions exhibited increasing or decreasing trends in the burden of mCRC. To analyze these trends, the delta method was employed, which calculates the annual change in prevalence (e.g., 2016 to 2017, 2017 to 2018, 2018 to 2019). This method allowed for an assessment of the direction and magnitude of temporal variations in the prevalence of mCRC across regions.

## **2.2. Inclusion and Exclusion Criteria**

To ensure the accuracy and consistency of the diagnoses, we applied several measures to mitigate diagnostic ambiguity. First, only patients diagnosed with mCRC, as defined by the ICD-10 codes (C18.8, C18.9, C18.2, C18.4, C18.6, C18.7), were included. These codes specifically identify patients with metastatic disease, thus excluding cases of non-mCRC. The use of the ICD-10 coding system, which became the standard in 2015, ensured uniform diagnostic criteria throughout the study period, minimizing variability due to shifts in coding practices. Patients with non-mCRC were explicitly excluded to further reduce the risk of misclassification.

## **2.3. Statistical Analysis**

To evaluate temporal trends in mCRC prevalence from 2016 to 2019, the delta method was used to estimate year-to-year changes in regional prevalence proportions. Annual prevalence for each U.S. Census region was first calculated as the proportion of inpatient admissions with mCRC relative to total mCRC admissions nationwide for that year. The delta method was then applied to approximate the change in prevalence between consecutive years (2016-2017, 2017-2018, and 2018-2019) by estimating the difference between prevalence proportions across adjacent years. These annual changes were subsequently summed up to obtain the overall change in prevalence across the study period. The reported percentage changes from 2016 to 2019 represent the cumulative relative change in prevalence derived from these year-to-year delta estimates rather than a single crude comparison between the first and last study years.

## **2.4. Ethical Considerations**

This study utilized de-identified patient data obtained from the NIS database, which is publicly available and anonymized in accordance with the Health Insurance Portability and Accountability Act (HIPAA) guidelines. Given the use of anonymized data and the absence of direct patient contact, the study was exempt

from institutional review board (IRB) approval. All methods adhered to ethical standards for the use of secondary data in research.

### 3. Results

A total of 56,570 inpatient hospitalizations involving mCRC were identified in the National Inpatient Sample from 2016 to 2019. The regional distribution of mCRC hospitalizations demonstrated consistent disparities across the four U.S. Census regions over the study period.

#### 3.1. Regional Distribution of mCRC Hospitalizations

Across all study years, the Southern region accounted for the largest proportion of mCRC hospitalizations, representing 39.72% of cases overall. The Midwest comprised 22.03%, followed by the Northeast (19.45%) and the West (18.80%).

In 2016, regional proportions were highest in the South (39.56%), followed by the Midwest (22.40%), Northeast (20.14%), and West (17.90%). Similar patterns persisted throughout the study period, with the Southern region consistently contributing the largest share of inpatient mCRC cases annually (**Table 1**).

**Table 1.** Regional distribution of metastatic colorectal cancer hospitalizations in the United States, 2016-2019.

Calendar Year	Region				Total (n)
	Northeast (n, %)	Midwest (n, %)	South (n, %)	West (n, %)	
2016	2761 (20.14%)	3071 (22.40%)	5423 (39.56%)	2454 (17.90%)	13,709
2017	2710 (19.62%)	3099 (22.43%)	5418 (39.22%)	2587 (18.73%)	13,814
2018	2790 (19.66%)	3129 (22.05%)	5590 (39.39%)	2681 (18.89%)	14,190
2019	2744 (18.47%)	3163 (21.29%)	6038 (40.64%)	2912 (19.60%)	14,857
Total	11,006	12,463	22,470	10,635	56,570
Total %	19.45%	22.03%	39.72%	18.80%	100%

#### 3.2. Temporal Trends by Region (2016-2019)

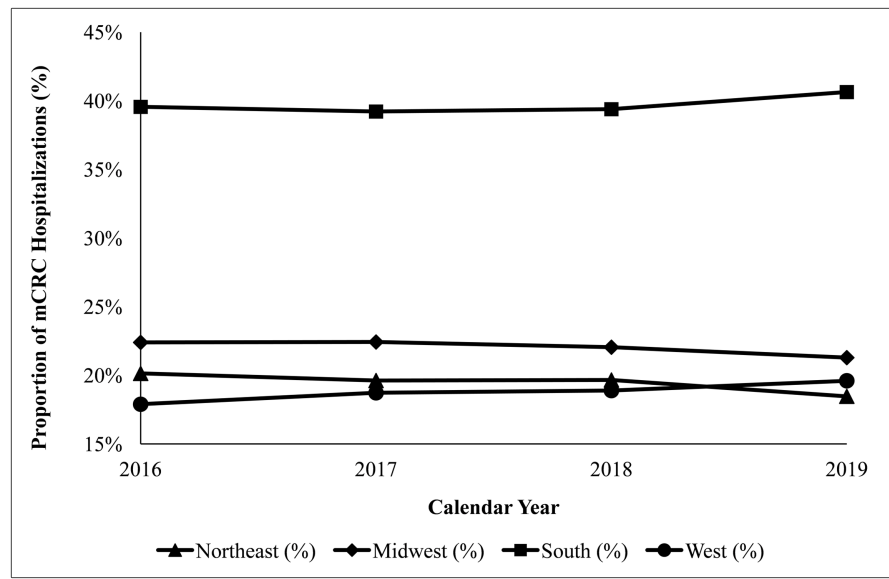
Between 2016 and 2019, distinct temporal trends in the regional distribution of mCRC hospitalizations were observed (**Figure 1**). The Southern region demonstrated a gradual increase in its proportional burden, rising from 39.56% in 2016 to 40.64% in 2019. The Western region also showed an upward trend, with its share increasing from 17.90% to 19.60% over the same period. In contrast, the Northeastern and Midwestern regions experienced relative declines in the proportion of mCRC hospitalizations. The Northeast decreased from 20.14% in 2016 to 18.47% in 2019, while the Midwest declined from 22.40% to 21.29%.

#### 3.3. Year-to-Year Change Analysis

Year-over-year analysis using the delta method demonstrated a cumulative rela-

tive increase in the proportion of mCRC hospitalizations in the Southern (+2.74%) and Western (+9.50%) regions from 2016 to 2019. Conversely, the Northeast (-8.30%) and Midwest (-4.96%) exhibited cumulative relative decreases in mCRC hospitalization proportions across the study period.

Annual hospitalization counts increased over time in all regions, reflecting overall growth in total mCRC inpatient admissions nationally; however, the relative contribution of each region shifted as described above.



**Figure 1.** Trends in the proportional distribution of inpatient metastatic colorectal cancer hospitalizations across U.S. census regions, 2016-2019.

#### 4. Discussion

The rising prevalence of mCRC in the Southern United States represents a complex public health challenge, underscored by persistent regional disparities and systemic barriers to healthcare access. National data from the Centers for Disease Control and Prevention and prior studies have consistently identified the South as a region with poorer colorectal cancer outcomes, and the findings of the present study further support these concerns [17] [18]. Unlike previous research that has primarily focused on population-level incidence and mortality trends, this study quantifies the inpatient burden of mCRC by region, demonstrating that the South experiences a disproportionately high share of hospital admissions for advanced disease.

The sustained dominance of the Southern region in mCRC hospitalizations aligns with national epidemiologic data demonstrating slower declines in colorectal cancer incidence in this region. Surveillance, Epidemiology, and End Results data indicate that the average annual percent change in colorectal cancer incidence was lowest in the South (-2.1%) compared with the Northeast (-2.9%), Midwest (-2.4%), and West (-2.3%). This slower rate of decline likely contributes to the persistently elevated burden of metastatic disease observed in Southern inpatient settings. Longitudinal analyses of early-onset colorectal cancer further

support these findings, showing that while incidence has increased nationwide, the South maintains the highest baseline incidence and a comparatively gradual rise in cases.

In addition to trends observed in the South, the Western region demonstrated the largest relative increase in inpatient mCRC prevalence during the study period. This pattern may reflect demographic shifts, including population growth and migration, rising early-onset colorectal cancer incidence, and disparities affecting rural, migrant, and socioeconomically disadvantaged populations. Expanding urbanization without proportional growth in oncology infrastructure may further increase reliance on inpatient care for advanced disease. Prior studies have reported increasing colorectal cancer incidence among younger and underserved populations in Western states, potentially contributing to higher rates of metastatic inpatient presentations.

Several factors likely contribute to these persistent regional disparities. Access to colorectal cancer screening, early detection, and timely treatment remains uneven across the United States. Many Southern states have historically lagged in Medicaid expansion and other public health initiatives, contributing to delayed diagnoses and poorer cancer outcomes [9]. Rural communities are particularly affected, as limited access to specialty and oncology care has been associated with later-stage colorectal cancer presentation and worse survival outcomes [19]. These findings reflect broader rural-urban disparities that have been observed across multiple cancer types.

Insurance coverage gaps also play a substantial role in regional disparities in mCRC outcomes. Individuals who are uninsured or underinsured are more likely to be diagnosed at advanced stages and to receive less aggressive treatment, particularly in Southern states with historically lower rates of insurance coverage and Medicaid expansion [9] [16]. Structural barriers, including poverty, limited transportation, and reduced access to specialty care, further restrict timely cancer diagnosis and treatment, disproportionately affecting underserved and rural populations [14] [20]. These findings are consistent with national analyses demonstrating that disparities in healthcare access, insurance status, and socioeconomic conditions influence cancer screening utilization, stage at diagnosis, and overall outcomes [6] [7].

Additional factors unique to the Southern United States may further contribute to the sustained burden of mCRC. Health literacy remains lower in the region, and reduced health literacy has been associated with decreased adherence to recommended cancer screening guidelines [21]. Limited access to oncology services, including the emergence of so-called “chemotherapy deserts,” continues to pose a major barrier to timely diagnosis and treatment [19]. Moreover, hospital closures in rural Southern counties have further restricted access to both primary and specialty care, disproportionately affecting low-income and minority populations already at elevated risk for advanced-stage disease [22].

Demographic and lifestyle factors may further intensify the regional burden of mCRC in the South. Population growth and internal migration have increased

demand for healthcare services, often outpacing expansion of healthcare infrastructure in underserved areas [20]. The region also experiences higher rates of obesity, tobacco use, and physical inactivity, which are well-established risk factors for colorectal cancer incidence and mortality [16]. Together, these factors are likely to contribute to delayed diagnosis and the persistence of regional disparities in advanced-stage disease.

Policy context is also critical to understanding regional differences in mCRC outcomes. Although the Affordable Care Act improved access to preventive services in Medicaid expansion states, many Southern states delayed expansion or did not expand at all. Evidence suggests that Medicaid expansion is associated with improved cancer screening uptake, earlier stage at diagnosis, and better cancer outcomes, underscoring the role of policy decisions in shaping regional cancer disparities [9].

Taken together, these findings illustrate a broad and interconnected set of structural, socioeconomic, and healthcare access barriers contributing to the high and rising inpatient burden of mCRC in the Southern United States. Addressing these challenges will require coordinated strategies to expand healthcare access, strengthen early detection and screening programs, improve health literacy, and support rural healthcare systems.

## 5. Conclusions

This study demonstrates that the Southern United States bears a disproportionately high inpatient burden of mCRC, reinforcing longstanding evidence of regional disparities in colorectal cancer outcomes [17] [18]. By focusing on hospitalization burden rather than population-level incidence alone, this analysis provides novel insight into the strain placed on healthcare systems managing advanced disease.

Hospitals in high-burden regions face increased clinical complexity, resource utilization, and financial strain [11]. Without improvements in early detection and outpatient management, inpatient systems in the South may continue to experience escalating pressure from advanced-stage presentations.

These findings highlight the need for region-specific strategies that prioritize earlier diagnosis, improved care coordination, and strengthened healthcare in high-risk areas. Policy-level interventions, including expanded insurance coverage and targeted investment in oncology services, may play a critical role in mitigating regional disparities and reducing the inpatient burden of mCRC [9] [20].

In summary, addressing geographic inequities in mCRC will require coordinated efforts across healthcare delivery, public health policy, and cancer surveillance systems. Without targeted action, regional disparities in advanced-stage disease and hospitalization burden are likely to persist.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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