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ABSTRACT

Context: Colorectal cancer (CRC) surgical treatment delay (TD) has been associated with mortality and morbidity; however, disparities by TD profiles are unknown.

Objectives: This study aimed to identify CRC patient profiles of surgical TD while accounting for differences in sociodemographic, health insurance, and geographic characteristics.

Design: We used latent class analysis (LCA) on 2005-2015 Tennessee Cancer Registry data of CRC patients and observed indicators that included sex/gender, age at diagnosis, marital status (single/married/divorced/widowed), race (White/Black/other), health insurance type, and geographic residence (non-Appalachian/Appalachian).

Setting: The state of Tennessee in the United States that included both Appalachian and non-Appalachian counties.

Participants: Adult (18 years or older) CRC patients (N = 35 412) who were diagnosed and surgically treated for in situ (n = 1286) and malignant CRC (n = 34 126).

Main Outcome Measure: The distal outcome of TD was categorized as 30 days or less and more than 30 days from diagnosis to surgical treatment.

Results: Our LCA identified a 4-class solution and a 3-class solution for in situ and malignant profiles, respectively. The highest in situ CRC patient risk profile was female, White, aged 75 to 84 years, widowed, and used public health insurance when compared with respective profiles. The highest malignant CRC patient risk profile was male, Black, both single/never married and divorced/separated, resided in non-Appalachian county, and used public health insurance when compared with respective profiles. The highest risk profiles of in situ and malignant patients had a TD likelihood of 19.3% and 29.4%, respectively.

Conclusions: While our findings are not meant for diagnostic purposes, we found that Blacks had lower TD with in situ CRC. The opposite was found in the malignant profiles where Blacks had the highest TD. Although TD is not a definitive marker of survival, we observed that non-Appalachian underserved/underrepresented groups were overrepresented in the highest TD profiles. The observed disparities could be indicative of intervenable risk.

KEY WORDS: cancer health disparities, colorectal cancer, latent class analysis, person-centered approach, treatment delay

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Approximately 53 200 individuals will die from colorectal cancer (CRC) in the United States in 2020, second only to lung cancer.[1] While declines in CRC incidence and mortality rates have been observed in the United States[1,2] due to

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improvements in early detection and treatment, as well as changes in lifestyle behaviors such as decreased tobacco use, disparities in outcomes continue to exist by race/ethnicity and socioeconomic status (SES).[3-7] Studies have found disparities when comparing Black with White patients, as Black patients were more likely to be diagnosed with an advanced stage of CRC and less likely to receive treatment.[8-10] Cancer health disparities could be attributable to early diagnosis of cancer and treatment initiation that may impact patient survival and quality of life.[11,12] According to the American Cancer Society,[13] the 5-year relative survival rate for early-stage CRC is around 90%; yet, only 4 of 10 patients with CRC are detected at this stage. This high level of survival rate for patients with early stage of CRC suggests the importance of early detection and treatment of CRC.

Treatment delay (TD) refers to the time from CRC diagnosis to initiation of surgical treatment and has been associated as a predictor of survival that affects a substantial proportion of patients with CRC.[14-16] A variety of factors stemming from patient characteristics, practitioners' expertise, the health care referral system, tumor biology, chemical toxicities from chemotherapy, and clinical course have been well-documented as complex underlying reasons for TD.[14,15,17] Nonetheless, studies focusing on the impact of TD on CRC mortality and survival have reported inconsistent results.[15,18-25] For instance, in a systematic review by Hangaard Hansen et al,[26] 4 of the 5 studies on colon cancer delays showed no association between TD and overall survival. Earlier studies investigating the influence of diagnostic and therapeutic delays concluded that, taken together, longer CRC delays were not associated with better prognosis.[27] When colon and rectal cancers are analyzed separately, however, statistically significant relationships exist between diagnosis and TDs.[28]

Studies have indicated that TD is associated with unfavorable outcomes, especially when diagnosis-to-treatment intervals (DTIs) are taken into account.[22-24] The inconsistencies in TD findings could be attributed to variations in DTIs,[15,18,19,23,24] including differences in sample sizes and stratification by cancer staging,[15] surgical complications,[18] comorbidities during treatment,[18,20] waiting time,[18] and geographic residence.[29-31] Lee et al[15] examined the effect of length of time from diagnosis to treatment on CRC survival in newly diagnosed patients using the Taiwan Cancer Registry Database and found consistent decrease in survival with increasing TD across all CRC stages (I-IV). Pruitt et al[25] assessed the association between diagnosis and TDs on all-cause CRC-specific death using Surveillance, Epidemiology, and End Results (SEER) data and Medicare claims files to conclude that TD up to 120 days did not increase the risk of death. Conversely, a systematic review and meta-analysis by Hanna et al[32] found that a 4-week delay in cancer treatment was associated with increased mortality across various treatment modalities, including surgery, for colon and rectum cancer. Using the South Australian clinical registry to examine the association between time to treatment of CRC and survival, Roder et al[18] reported better survival within 2 years for diagnosis to treatment of more than 30 days than of 30 days or less.

Furthermore, when considering CRC patients in the US state of Tennessee, there are some generalizable factors such as social determinants that affect timing and access to treatment to the Appalachian region.[33] Tennessee has a unique geographical context, that is, Appalachia and subsequent regions, with limited studies having found a complex relationship with cancer incidence and mortality.[34] For instance, while cancer mortality has been found to be in decline in the United States in general, disparities have been found in Appalachian regions where rural Appalachia had the highest cancer incidence compared with urban non-Appalachian areas.[30] Specifically in the Appalachian regions (ie, Northern, Central, Southern), CRC incidence was found to be higher than the rest of the US.[29] Yet, there are regional variations of cancer incidence within the Appalachian region, in particular with the Central and Southern regions, of which Tennessee is part of but not included.[29] Cancer health disparities also occur within Appalachian and between Appalachian regions.[29,30,35]

Cancer disparities can be accounted for the Appalachian regions by geographic and ecological characteristics such as residence and neighborhood, as well as availability and health care access disparities that include diagnostic and treatment services, health insurance type, and recommendations leading to cancer TD in addition to the social determinants of health.[30,36,37] While TD does not generally equate to increased mortality, surgical TD may be associated with CRC disparities by increased morbidity and decreased quality of life.[38-40] Moreover, little is known about Tennessee and CRC TD, as such our purpose was not to make a clinical recommendation but to identify subgroup profiles of TD and possible social determinants within profiles. To fill this critical knowledge gap, the objective of this study was to apply latent class analysis (LCA) to comprehensively identify disparities and assess the profiles of CRC patients who experience surgical TD using the Tennessee Cancer Registry (TCR) data. LCA is a person-centered approach that allows the

identification of individual group profiles based on a set of observed factors. Using LCA, we identified and compared risk profiles of surgical TD in both in situ and malignant CRC patients while accounting for differences in sociodemographic and health insurance characteristics.

Methods

Tennessee Cancer Registry and study population

The TCR is located within the Tennessee Department of Health (TDH) and is dedicated to collecting comprehensive information on all patients diagnosed with and/or treated for cancer in the state (https://www.tn.gov/health/health-program-areas/tcr.html). The TCR is a gold-certified registry by the North American Association of Central Cancer Registries (NAACCR), indicating it has met the highest national standards of data completeness and quality. It has maintained these high standards of data completeness and quality since 2005.

The study population included Tennessee residents 18 years or older with a primary confirmed CRC diagnosis according to *ICD-O-3* (*International Classification of Diseases for Oncology, Third Edition*) codes (ie, C180-189, C199, C209, C260), who had surgical treatment, and were reported to the TCR between January 1, 2005, and December 31, 2015. The population-based sample (N = 35 412) included in situ (n = 1286) and malignant (n = 34 126) CRC subsamples. The TDH Institutional Review Board (IRB) approved the research protocol on February 1, 2018 (TDH-IRB 1057486), and all analytical coding is available upon request. Data used for this analysis are restricted but available by request to the TDH TCR (https://www.tn.gov/education/data/data-downloads/request-data.html). All analytical files are available by request. The National Institutes of Health, Intramural Research Program IRB, Human Research Protections Program, Office of Human Subjects Research Protections, determined that our protocol did not involve human subjects and was excluded from IRB review (18-NIMHD-00722).

Measures

Outcomes: In situ and malignant colorectal cancer surgical treatment delay

On the basis of the literature,[15,18,41] the distal outcome of TD was categorized as (1) 30 days or less, and (2) more than 30 days since diagnosis using date of diagnosis of disease to the beginning of surgical treatment. This approach provides a less biased model because algorithms, not the researcher, group variables into classes or risk subgroups based on the similar characteristics.

Latent variable of colorectal cancer delay using sociodemographic characteristics

The latent construct of CRC TD included sociodemographic characteristics obtained from the TCR were sex/gender, age, marital status, health insurance type, race, and county of residence. While sex/gender was assessed as a dichotomous variable (male and female), age was assessed as a categorical variable based on the US Preventive Services Task Force recommendations for CRC screening age (ie, <50, 50-74, 75-84, and ≥85 years).[42] Marital status was categorized as single/never married, married/common law, divorced/separated, and widow/widower. Health insurance was based on whether the patient had no insurance/self-paid, public insurance (eg, Medicaid, Medicare), or private insurance (eg, Preferred Provider Organization, Health Maintenance Organization). Race was classified as White, Black, or other. Other race included Asian or Pacific Islander and American Indian/Native Alaskan. Place of residence was categorized into 2 groups on whether patient resided in an Appalachian or non-Appalachian county.

Latent class/statistical analysis

A model comparison approach was used to determine the number of classes. We created multiple models (ie, 2-, 3-, 4-, 5-class solutions for in situ cases and up to 4-class solutions for malignant cases) that helped select the best model for interpretation. Model fit comparisons were based on the following criteria: (1) Bayesian information criterion (BIC); (2) sample size–adjusted BIC (ssa-BIC); and (3) high entropy (ie, the acceptable quality of classification, and a clear indication for separation of classes).[43] All LCAs were conducted using Mplus version 8.4 (Muthén & Muthén, Los Angeles, California). See Table 1 for more detail. The classes were named on the basis of the relative surgical TD categories (ie, ≤30 and >30 days) from CRC diagnosis to surgical treatment initiation.

Results

Patient sociodemographic characteristics

A total of 35 415 in situ and malignant CRC patients were included. A majority of the cases were malignant (96.3%) at the time of diagnosis (Table 2). Most in situ patients were White (84.4%), male (53.9%), aged 50 to 74 years (69.6%), married (62.0%),

TABLE 1
Latent Class Analysis of Colorectal Cancer Delay Group Model Fit Comparisons

	In Situ CRC (N = 1 286)			Malignant CRC (N = 34 126)		
	BIC	ssa-BIC	Entropy	BIC	ssa-BIC	Entropy
1-Class solution	11 816.06	11 774.76	. . .	345 575.23	345 533.92	. . .
2-Class solution	11 571.62	11 485.86	0.677	334 940.54	334 854.73	0.637
3-Class solution	11 572.93	11 442.69	0.612	331 683.83	331 553.54	0.706
4-Class solution	11 600.16	11 425.46	0.672	. . .	. . .	. . .

Abbreviations: BIC, Bayesian information criterion; CRC, colorectal cancer; ssa-BIC, sample size–adjusted Bayesian information criterion.

with health insurance (70.2%), and residing in Appalachian county. The characteristics of malignant CRC patients are similar to in situ CRC patients except that the majority of them resided in non-Appalachian county. See Table 2 for further details.

TABLE 2
Descriptive Statistics of *In Situ* and Malignant Samples (N = 35 415)

	In situ (N = 1 286)		Malignant (N = 34 126)	
	n	%	n	%
Sex/gender				
Male	693	53.9	17 631	51.7
Female	593	46.1	16 492	48.3
Age at diagnosis				
<50 y	95	7.4	3 743	11.0
50-74 y	895	69.6	20 899	61.2
75-84 y	235	18.3	7 015	20.6
≥85 y	61	4.7	2 469	7.2
Marital status				
Single/never married	103	11.2	3 785	14.0
Married/common law	570	62.0	15 416	57.0
Divorced/separated	98	10.7	2 820	10.4
Widow/widower	149	16.2	5 034	18.6
Health insurance type				
No insurance/self-pay	21	1.8	1 466	4.7
Public insurance	810	70.2	21 259	68.8
Private Insurance	323	28.0	8 169	26.4
Race				
White	1 085	84.4	28 628	83.9
Black	190	14.8	5 059	14.8
Other	11	0.9	439	1.3
County of residence				
Non-Appalachian	634	49.3	18 114	53.1
Appalachian	652	50.7	15 994	46.9
Treatment delay				
≤30 d	1 087	84.5	26 136	76.6
>30 d	199	15.5	7 990	23.4

Latent class analysis on in situ subgroups treatment delay

As seen in Table 3, TD among in situ CRC patients revealed a 4-class solution with entropy of 0.67 (N = 1286). Class 1, or the lowest TD in situ profile, constitutes 45% of the subsample. This subgroup had high conditional probabilities of being 50 to 74 years of age at the time of diagnosis (85.4%), married/in a common law marriage (68.6%), mostly White (94.9%), male (55.7%), and more likely to have private health insurance (50.5%). In addition, this profile had a high probability of residing in an Appalachian county (53.9%). Class 1 also had the lowest conditional probability to experience TD of more than 30 days (12.4%).

Class 2, or the medium-low TD in situ profile, was exclusively Black (100%) and had high conditional probabilities of being between 50 and 74 years of age, being female (52.2%), and have public health insurance (58.3%). This class had the highest conditional probabilities of being single/never married (33.1%), divorced/separated (17.3%), and residing in a non-Appalachian county (87.0%) compared with all in situ profiles. This class represented 10% of the patient profiles and had a 16.5% likelihood to experience TD of more than 30 days.

In situ class 3, or the medium-high TD in situ profile (32% of subsample), with a 17.8% likelihood of TD of more than 30 days, had the highest conditional probabilities of being male (67.8%), married (83.7%), and 50 to 74 years old (61.6%) at the time of diagnosis with public health insurance (95.5%). Class 3 had the highest conditional probabilities of being White (95.2%) and residing in an Appalachian county (57.5%).

Class 4, or the highest TD in situ profile (13% of subsample), had a 19.3% likelihood of delaying treatment for more than 30 days. This profile group had the highest conditional probabilities of being female (82.4%), aged 75 to 84 years (50.1%) and 85 years and older (24.0%), widow/widowed (94.3%), and had public health insurance (95.6%) compared with

TABLE 3
Treatment Delay Conditional Probabilities of *In Situ* CRC Patients (N = 1286)[a]

	Class 1: Lowest Treatment Delay (N = 575; 45%)	Class 2: Medium-Low Treatment Delay (N = 133; 10%)	Class 3: Medium-High Treatment Delay (N = 409; 32%)	Class 4: Highest Treatment Delay (N = 169; 13%)
Sex/gender				
Male	0.557	0.478	0.678	0.176
Female	0.443	0.522	0.322	0.824
Age				
<50 y	0.146	0.102	0.000	0.000
50-74 y	0.854	0.859	0.616	0.259
75-84 y	0.000	0.039	0.338	0.501
≥85 y	0.000	0.000	0.046	0.240
Marital status				
Single, never married	0.127	0.331	0.067	0.018
Married/common law	0.686	0.482	0.837	0.000
Divorced/separated	0.162	0.173	0.043	0.039
Widow/widower	0.025	0.015	0.052	0.943
Health insurance				
No insurance/self-pay	0.033	0.036	0.000	0.002
Public insurance	0.462	0.583	0.955	0.956
Private insurance	0.505	0.381	0.045	0.041
Race				
White	0.949	0.000	0.952	0.809
Black	0.035	1.000	0.048	0.181
Other	0.016	0.000	0.000	0.010
County of residence				
Non-Appalachian	0.461	0.870	0.425	0.509
Appalachian	0.539	0.130	0.575	0.491
Treatment delay				
≤30 d	0.876	0.835	0.822	0.807
>30 d	0.124	0.165	0.178	0.193

Abbreviation: CRC, colorectal cancer.

[a] *Conditional probabilities range from 0 to 1 where the lighter to darker shades indicate an increasing likelihood.*

all in situ profiles. Class 4 had high conditional possibilities of being White (80.9%), followed by Black (18.1%), and living in either a non-Appalachian county (50.9%) or an Appalachian county (49.1%). See Table 3 for all conditional probabilities.

Latent class analysis on malignant subgroups treatment delay

A 3-class solution with an entropy of 0.71 (N = 34 126) was the best-fitting model for the malignant CRC TD analysis (Table 4). Class 1, or the lowest TD malignant profile (57% of subsample), had a 20.6% likelihood to delay surgical treatment for more than 30 days from diagnosis. Malignant class 1 profile had the highest conditional probabilities of being White (97.5%), male (60.0%), between 50 and 74 years of age (80.0%), married (70.9%), on private health insurance (41.6%), and residing in Appalachian county (53.9%).

Class 2, or the medium TD malignant profile (31% of subsample), had a 25.4% likelihood to delay surgery (>30 days). This class had the highest conditional probabilities of being female (60.4%), between 75 and 84 years of age (50.5%), a widow/widower (47.9%), and on public health insurance (96.5%). This profile had high conditional probabilities of being White (90.0%).

TABLE 4
Treatment Delay Conditional Probabilities of Malignant CRC Patients (N = 34 126)[a]

	Class 1: Lowest Treatment Delay (N = 19 534; 57%)	Class 2: Medium Treatment Delay (N = 10 607; 31%)	Class 3: Highest Treatment Delay (N = 3985; 12%)
Sex/gender			
Male	0.600	0.396	0.525
Female	0.400	0.604	0.475
Age			
<50 y	0.169	0.000	0.186
50 to 74 y	0.800	0.301	0.748
75-84	0.030	0.505	0.056
≥85 y	0.002	0.194	0.010
Marital status			
Single, never married	0.141	0.055	0.372
Married/common law	0.709	0.420	0.405
Divorced/separated	0.130	0.046	0.161
Widow/widower	0.020	0.479	0.063
Health insurance			
No insurance/self-pay	0.063	0.001	0.116
Public insurance	0.521	0.965	0.589
Private Insurance	0.416	0.034	0.296
Race			
White	0.975	0.900	0.102
Black	0.012	0.094	0.867
Other	0.013	0.006	0.032
County of residence			
Non-Appalachian	0.461	0.499	0.913
Appalachian	0.539	0.501	0.087
Treatment delay			
≤30 d	0.794	0.746	0.706
>30 d	0.206	0.254	0.294

Abbreviation: CRC, colorectal cancer.

[a] *Conditional probabilities range from 0 to 1 where the lighter to darker shades indicate an increasing likelihood.*

Class 3, or the highest TD malignant profile, represented 12% of the subsample, with a 29.4% likelihood of TD (>30 days). This profile had the highest conditional probabilities of being both single/never married (37.2%) and divorced/separated (16.1%), Black (86.7%), having no health insurance or were self-pay (11.6%), and residing in a non-Appalachian county (91.3%). Malignant class 3 profile had high conditional probabilities of being 50 to 74 years old (74.8%) and on public health insurance (58.9%). See Table 4 for all conditional probabilities. The Figure provides a comparison of the distal outcomes of TD by patients with in situ and malignant CRC.

Discussion

Racial/ethnic disparities in CRC incidence, mortality, and survival vary significantly across the United States. It is not clear whether early initiation of treatment (≤30 days) improves survival outcomes. Although a systematic review of 40 studies that assessed the influence of therapeutic delay on CRC indicated that the majority of the findings did not observe a relationship between early treatment initiation and survival,[27] few studies exist to understand the problem. This study applied LCA, a person-centered method, to identify risk profiles of surgical TD among in situ and malignant CRC cohorts diagnosed

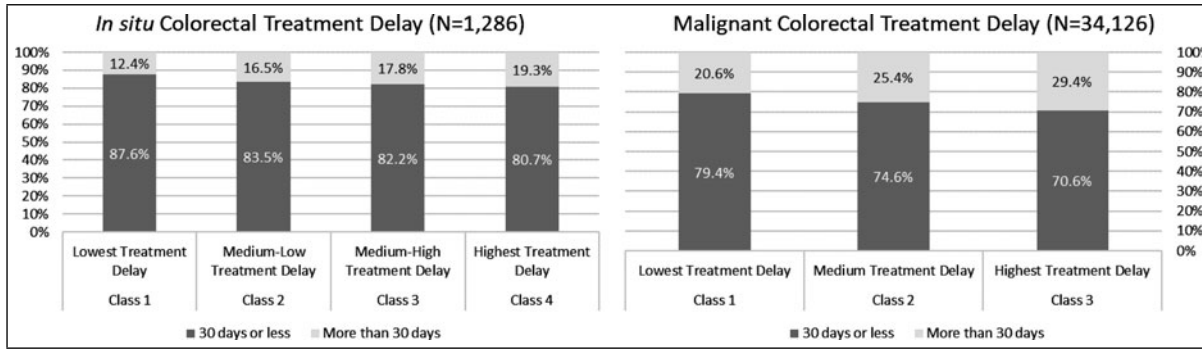

FIGURE Treatment Delay Comparison of Patients With In Situ or Malignant Colorectal Cancer

from 2005 to 2015 in Tennessee. Our definition for TD (>30 days) is consistent with other studies.[14-16] The analysis of more than 35 000 patients showed substantial differences in TD between in situ and malignant CRC patients with regard to age, sex/gender, race, and Appalachian residence. Our LCA identified 4 in situ and 3 malignant risk profiles of CRC surgical TD among patients.

We identified among patients with CRC most likely to TD for more than 30 days were women 50 years or older, widowed, and on public health insurance with in situ diagnosis compared with those with a malignant diagnosis who were Black, between 50 and 74 years of age, on public health insurance, and residing in non-Appalachian counties (Tables 3 and 4). Conversely, patient profiles with lowest risk or TD of 30 days or less among in situ and malignant CRC patients were similar. That is, both in situ and malignant class 1 patients were predominantly male, aged 50 to 74 years, married/common law partnership, and White. Nuanced differences were observed in private health insurance; however, both had the highest conditional probabilities within their respective cancer staging.

Regarding the in situ CRC-specific stage profiles, class 1 had the lowest risk of TD, which contrasted the highest TD risk profile of class 4 that was predominantly White widowed women, aged 75 to 84 years, and on public health insurance (Table 3). This is in stark contrast to patient profiles with malignant CRC in which the highest TD risk profile was among Blacks (Table 4). Moreover, among the risk profiles of patients with malignant CRC, the medium surgical TD was that of White women widows on public health insurance and between 75 and 84 years of age. As such, our findings not only identified similarities and differences between patients with in situ and malignant CRC but also observed racial and gender disparities in surgical TD. These findings are in line with prior studies reporting that Black patients compared with Whites experienced longer time to TD and are unlikely to receive recommended treatment due to differences in health insurance coverage.[41,44,45]

Consistent with our results on single/never married and widowed experiencing delay (Tables 3 and 4), previous research has shown that differences in CRC TD depend on many factors, including SES, access to care, and family support/background.[10,17,45-47] Tramontano et al[10] found significantly lower treatment recipients among patients with CRC who were non-Hispanic Blacks, unmarried, and of low SES. In addition, non-Hispanic Blacks and stage IV patients had the highest relative cost ratios for surgery, radiation, and chemotherapy treatments during all treatment phases.[10] Hines and Markossian[47] also reported that Blacks had a 40% increased odds of late-stage CRC diagnosis, a 50% decreased odds of having surgery for colon cancer, and a 67% decreased odds of receiving surgery for rectal cancer compared with Whites. Tawk et al[3] also reported increased odds of late-stage CRC in non-Hispanic Blacks, uninsured, and Medicaid patients. Furthermore, lack of social networks and support system, a prominent concern for widowed and older patients, has been reported to be associated with TD and poor prognosis due to their inability to discuss symptoms and receive encouragement and health advice/support from family and friends.[17,48,49] Evidence indicates that disparities exist in cancer incidence, treatment quality, mortality, and survival between Black and White despite the mixed findings on the association between DTIs and CRC outcomes.[4,6,7,41,45] A recent study from Tennessee showed that Blacks were less likely than Whites to receive CRC adjuvant treatment,[41] while an earlier report did not find the relationship between race and treatment outcome.[50]

While CRC outcomes may not be predicted by surgical TD, we still identified disparities by way of surgical TD profiles. These profiles were marked by a constellation of social determinants and the Appalachian/non-Appalachian divide. Currently,

there is a large gap in the cancer incidence literature for Tennessee, especially while accounting for the Appalachian regions within. Through our findings, we can best adapt existing CRC prevention programs in Tennessee to address the possible determinants that affect patients in providing access to quality health care in order to mitigate surgical TD. Possible interventions to improve access could include patient navigation and personalized medical care to include cultural empathy and appropriate health literacy. In addition, we can identify possible areas within Tennessee that need further exploration and examination to understand the true context and disparities of CRC. For instance, in the current study, we found Black residents in non-Appalachian Tennessee with public insurance who had malignant CRC waited more than 30 days to receive treatment. As such, a public health priority is to understand the role of social determinants in the non-Appalachian as well as Appalachian contexts in Tennessee, thereby identifying and examining the disparities propagating TD within subpopulations.

Moreover, we propose to further focus on the Appalachian and non-Appalachian CRC TD disparity to understand the nuanced differences between those regions in the context of urban, rural, and remote areas. Prior studies in Appalachian states have found that cancer incidence and mortality are disproportionate in non-Appalachian areas when compared with Appalachian areas, and vice versa (eg, prostate cancer).[35] Future studies will explore this association in greater detail in Tennessee to help inform possible CRC interventions and preventive programs. We will specifically identify CRC patient survivorship profiles once data are made available by the TDH. The purpose of which will be to compare whether TD profiles are similar or dissimilar by survivorship as well as identify disparities by survivorship. In this manner, we can identify what observed indicators may be salient in targeting TD and improving survivorship for Tennessee's patients with CRC to mitigate disparities and improve quality of life.

While we observed possible inequities due to geography and race, to meaningfully address CRC health disparities and inequities, we must go beyond Census Bureau categories of race/ethnicity. Biomarker data in the geographic context of socioeconomic and ecological factors would be critical to understand the dynamic relationship of person-level interaction to cancer outcomes. Data on behavioral and health risk factors, as well as comorbidities, would also be beneficial to identify higher at-risk groups, as well as improve our ability to identify risk profiles to further personalized medicine and treatment. Future policies regarding cancer registries should include more holistic data collection to understand risk in context to prevent cancer health disparities to move toward health equity. By collecting CRC data contextually, we can move from linearized categorizations and assessments to targeted person-centered risk profiles and preventive care.

Limitations

This study is among the first to examine TD patient profiles within in situ and malignant CRC groups using LCA. Furthermore, it adds to the current limited knowledge on CRC surgical TD by assessing and identifying risk profiles of patients in a unique geographical region, currently not covered in the SEER program.[51] Although this study using standard and validated measures involved a large population of CRC patients not in the SEER program, there were few limitations. First, we were limited by the retrospective administrative variables available to us. For instance, cancer registries do not collect vital measures of SES data such as income and education, and quality of treatment received by patients. In addition, some demographic variables collected may not be up to date since these variables are only collected at the time of diagnosis. Furthermore, despite the large sample size, the results may not be generalizable to

Implications for Policy & Practice

Our analyses revealed disparities in both in situ and malignant CRC patients; however, the disparity was more apparent among malignant CRC patients than in situ CRC patients. Cancer control and prevention, as well as care providers, in Tennessee should be mindful that:

- Blacks, public insurance holders, and non-Appalachian residents had the highest likelihood of TD in malignant CRC patients, while White widowed females residing in Appalachian and non-Appalachian counties, 75 years or older, and public insurance holders had the highest likelihood of TD among in situ CRC patients.
- These disparities in CRC surgical TD may explain differences in health outcomes among Blacks who are most at risk and while structural factors, clinical care, and treatment outcomes may play a role in these delays, they were not available for analysis.
- The use of person-centered approaches can help public health researchers better detect cancer risk profiles/subgroups, and the underlying determinants of health that may be often overlooked, to help tailor interventional programs for specific risk profiles and efficiently/efficaciously address CRC disparities.

other regions or the entire US population because the data are from the TCR covering only residents of Tennessee. Nevertheless, the findings are important because they provide a better understanding of cancer health disparities within profiles of CRC TD in Tennessee.

Conclusion

While our findings are not meant for diagnostic purposes, we found that Blacks were lower in TD with in situ CRC; yet, the opposite was found in the malignant profiles where they had the highest TD. Although TD is not a definitive marker of survival, we observed that underserved/underrepresented groups are overrepresented in the highest TD profiles. The observed disparities could be indicative of intervenable risk, whereby person-centered approaches in conjunction with cancer registry data can help in the development of effective and efficacious prevention programs.

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