Demographics, distance to gastrointestinal specialists, and social deprivation are associated with advanced stage of gastrointestinal cancer diagnosis

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Abstract

Background Gastrointestinal (GI) luminal cancers can be detected at early stages by endoscopic procedures. Place-based factors, such as social deprivation and distance to specialist care, are under-investigated with regard to the stage of diagnosis.

Methods This was a retrospective cohort study among persons ≥18 years of age in the Florida Cancer Data System, a population-based cancer incidence registry. We included persons diagnosed with esophageal cancer, gastric canceror colorectal cancer, with at least 1 measure of geographic location during the period January 1, 1981, to December 31, 2016. Multivariate multinomial logistic regression was used to identify factors associated with the stage of diagnosis, including social deprivation and proximity to GI care.

Results Among 379,054 persons, the median age was 71 years, and 54% were male. Distant stage disease was significantly less likely than local stage in those of non-Hispanic/Latino ethnicity (odds ratio [OR] 0.92, 95% confidence interval [CI] 0.89-0.94, P<0.001). Distant disease was more likely in African Americans (OR 1.30, 95%CI 1.26-1.34) and Asians (OR 1.41, 95%CI 1.27-1.56, P<0.001), with each 5-min increase in travel time to specialists, (OR 1.02, 95%CI 1.01-1.02, P<0.001), and with each 10-point increase in Social Deprivation Index (OR 1.01, 95%CI 1.01-1.02, P<0.001).

Conclusions A greater distance from care and living in areas with increased deprivation are associated with an advanced stage of diagnosis and should be recipients of policy-driven efforts to improve access to care. That the strongest risk factors include minority race and ethnicity underlines the complexity of healthcare disparities.

Keywords Gastrointestinal cancer, disparities, access to care

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Introduction

Gastrointestinal (GI) cancers are the second leading cause of cancer death in the United States (US) [1]. Luminal cancers, including esophageal (EC), gastric (GC), and colorectal (CRC) cancers, are usually detected on endoscopic evaluation. The US Preventive Services Task Force recommends CRC screening in all adults between ages 45 and 75, as it has shown a substantial reduction in long-term CRC risk and mortality—though prior to this, screening was recommended to begin at age 50 [2]. However, adherence to CRC screening recommendations is suboptimal, with over 30% of patients not up to date with screening [3]. There are clear disparities in colorectal screening, with racial and ethnic minorities, foreign-born individuals, those with relatively poor medical access, and those with a disadvantaged socioeconomic status displaying lower rates of screening [4,5]. Upper GI cancers, such as esophageal and gastric cancers, are often detected at late stages, and 5-year survival is poor [6,7]. To combat this, recent guidelines have established screening recommendations for those at high risk of EC, and there are ongoing efforts to identify persons at high risk of gastric cancer [8,9].

Early detection of malignancy is the goal of cancer control and screening programs, as identification of disease in the early stages is associated with better outcomes. While access to healthcare is complex, place-based factors and social determinants of health, including specialist density, insurance status and poverty, have been associated with mortality from GI cancers [10]. GI luminal cancers are unique among cancers in that detection is possible by endoscopic procedures. This provides an opportunity for screening and surveillance, as well as diagnostic evaluation for symptomatic persons, but endoscopic procedures also require specialist and procedural availability, in addition to insurance coverage for what are otherwise financially burdensome procedures. Accordingly, access to care, and social and structural determinants of health are likely to impact the ability to undergo endoscopic procedures and facilitate early detection of GI luminal cancers.

Recent efforts have highlighted the importance of geographic and social determinants of health across the cancer continuum. This includes consideration of geographic disparities [11,12]. Advances in geospatial analyses allow for sophisticated approaches to explore disparities associated with place-based factors, and represent opportunities to guide outreach and engagement for communities at risk [13,14]. As noted above, social determinants of health are associated with poor outcomes in cancer diagnosis and outcomes. Deprivation indices are multidimensional geographic indices that reflect health care access and health outcomes at small geographic levels, and are more strongly associated with health outcomes than measures of poverty alone [15]. Previous studies have shown an inverse association with cancer survival and cancer screening rates [16,17]. Here, we aimed to evaluate the association between stage of diagnosis and under-investigated multi-level determinants of health, including individual, social and place-based factors. We hypothesized that social and structural determinants of health are associated with the stage of detection of GI luminal cancers.

Materials and methods

We conducted a retrospective cohort study of patients in the Florida Cancer Data System (FCDS) who had been diagnosed with 1 of the 3 GI luminal cancers of interest: EC, GC, or CRC during the period January 1, 1981, to December 31, 2016. FCDS is the single largest population-based cancer incidence registry in the nation, with approximately 2.3 million cancer records (96% are histologically confirmed), and the data form part of the Centers for Disease Control and Prevention National Program of Cancer Registries and the North American Association of Central Cancer Registries.

Study outcome and variables

The primary outcome was the stage at diagnosis of 1 of the 3 GI cancers of interest: EC, GC, or CRC. We included persons aged ≥18 years with a new diagnosis of EC, GC or CRC from within the FCDS system, with at least 1 measure of geographic location (census tract or zip code at diagnosis). We excluded those with insufficient information to determine the primary site, stage, or location at diagnosis. In cases where participants had multiple primaries, we included only the first cancer of interest. We included additional covariates: age at diagnosis, sex, race, ethnicity, tobacco use, insurance status at diagnosis, and marital status.

The location of residence at diagnosis was used to create 3 additional variables: 1) deprivation index; 2) proximity to GI specialists (number of board-certified GI doctors), in miles; and 3) proximity to nearest endoscopy centers (inpatient or outpatient), in miles. The Social Deprivation Index (SDI) is a composite measure of area level deprivation based on 7 demographic characteristics collected in the American Community Survey. The SDI is quantified from 1-100, and higher SDI scores are associated with poor access and poor health outcomes. Using publicly available American Hospital Association data (inpatient endoscopy capability), American Board of Internal Medicine data (board certified GI listings), and publicly available Joint Commission and Centers for Medicare & Medicaid Services accredited ambulatory surgery centers that provide endoscopy (ambulatory endoscopy), we determined the patients' proximity to GI specialists (board-certified GI doctors) and to endoscopy centers. These data were accessed for 2022. Geocoding was used to identify distance and time to GI specialists and endoscopy centers, using ArcGIS 10.8 (Esri, West Redlands, CA).

Statistical analysis

We first examined the distribution of each covariate using counts, percentages, and medians and interquartile ranges, comparing persons who developed each cancer, and for each cancer, comparing those who were diagnosed with local, regional and distant stage cancers. We then performed a multinomial logistic regression (local, regional, distant stage) for all cancers. We began with a univariate model to evaluate which variables were associated with the outcome. We retained all covariates associated with outcome, then performed backward selection for confounding (retained if $P<0.05$ and/or if covariates confounded another exposure by 10% in either direction), with consideration of clinically relevant variables that were not retained. A sensitivity analysis was conducted, evaluating only persons aged 50-75 years (persons who would fall under prior US Preventive Services Task Force screening recommendations for CRC) [18]. These ages were chosen for all 3 luminal cancers, as these persons were likely to undergo discussion of screening strategies with a healthcare professional with special attention to GI symptoms and family history. This study was approved by the Institutional Review Board of the University of Miami.

Results

We identified 379,054 persons who had been diagnosed with 1 of the 3 GI luminal cancers. These include 24,954 (6.6%) with EC, 39,271 (10.4%) with GC, and 314,829 (83.1%) with CRC. Table 1 depicts the cohort characteristics. The median age in diagnosis was 68 years (interquartile range [IQR] 60-75) for EC, 71 (IQR 61-78) for GC and 71 (IQR 62-79) for CRC. Male sex was more common in EC (19,074, 76.4%), compared to GC (24,624, 62.7%) and CRC (162,280, 51.5%). Among all cancers, most patients identified as White, (338,189, 89.2%), and 38,256 (10.1%) reported Hispanic/Latino ethnicity. Median travel time to a GI specialist was 5.3 min (IQR 3.4-8.1; upper quartile was 8.1-46), median time to an endoscopy center was 6.4 min (IQR 4.2-8.8; upper quartile was 8.8-27.8), and median SDI was 54 (IQR 31-76). Distant stage disease was diagnosed in 8,710 (34.9%) with EC, 13,982 (35.6%) with GC, and 57,711 (18.3%) with CRC.

Multinomial logistic regression

Table 2 depicts the results of the multinomial regression. Distant stage disease was significantly less likely than local stage in females (odds ratio [OR] 0.85, 95% confidence interval [CI] 0.84-0.87), younger persons (OR 0.98, 95%CI 0.98-0.98), married persons (OR 0.81, 95%CI 0.80-0.83), those with private insurance (OR 0.80, 95%CI 0.78-0.82), and those of non-Hispanic/Latino ethnicity (OR 0.92, 95%CI 0.89-0.94) (P<0.001 for all). Distant disease was more likely in African Americans (OR 1.30, 95%CI 1.26-1.34) and Asians (OR 1.41, 95%CI 1.27-1.56, P<0.001). For each 5-min increase in travel time to a GI specialist, there were increased odds of being diagnosed with distant disease: OR 1.02, 95%CI 1.01-1.02, P<0.001. For each 10-point increase in neighborhood SDI, there were increased odds of being diagnosed with distant disease: OR 1.01, 95%CI 1.01-1.02, P<0.001.

Similar factors were associated with regional stage at diagnosis, as compared to local stage. Most notably, Asian race was associated with a higher risk (OR 1.28, 95%CI 1.17-1.40), while non-Hispanic/Latino ethnicity (OR 0.92, 95%CI 0.90-0.94) was associated with a lower risk. For each 5-min increase in travel time to GI specialist, there were increased odds of being diagnosed with distant disease: OR 1.00, 95%CI 0.99-1.00, P<0.001. For each 10-point increase in neighborhood SDI, there were increased odds of being diagnosed with distant disease: OR 1.01, 95%CI 1.01-1.01, P<0.001.

Fig. 1 depicts the adjusted odds of developing regional or distant stage disease. Among both regional and distant stage disease, factors such as being married, not using tobacco and having private insurance were associated with a lower risk of being diagnosed with later stages of disease. Fig. 2 displays a map of the state, depicting SDI values, and locations of endoscopy centers and GI specialists. A sensitivity analysis was conducted, evaluating only persons aged 50-75 years. Findings and point estimates were similar to the primary analysis and are depicted in Table 3. Finally, a *post hoc* analysis evaluated only those diagnosed between 2006-2016, given the wide period of inclusion. These findings were also similar to the primary analysis and are presented in Supplementary Table 1.

Table 1 Cohort characteristics

Characteristics	All cancers (n=379,054)	Esophagus (n=24,954)	Gastric (n=39,271)	Colon (n=314,829)
Age at cancer diagnosis, years, median (IQR)	71 (62-79)	68 (60-75)	71 (61-78)	71 (62-79)
Male sex, n (%)	205,978 (54.3%)	19,074 (76.4%)	24,624 (62.7%)	162,280 (51.5%)
Race, n (%)				
White	338,189 (89.2%)	21,664 (86.8%)	32,335 (82.3%)	284,190 (90.3%)
African-American	34,946 (9.2%)	3,016 (12.1%)	6,006 (15.3%)	25,924 (8.2%)
American Indian/Alaskan Native	208 (0.1%)	19 (0.1%)	41 (0.1%)	148 (0.1%)
Asian	2605 (0.7%)	122 (0.5%)	495 (1.3%)	1988 (0.6%)
Other/Unknown	3106 (0.8%)	133 (0.5%)	394 (1.0%)	2579 (0.8%)
Hispanic/Latino ethnicity, n (%)	38,256 (10.1%)	1618 (6.5%)	5,330 (13.6%)	31,308 (9.9%)
Married, n (%)	222,243 (58.6%)	14,865 (59.6%)	23,566 (60.0%)	183,812 (58.4%)
Tobacco user at diagnosis, n (%)	55,526 (14.6%)	7,005 (28.1%)	6,693 (17.0%)	41,828 (13.3%)
Private insurance, n (%)	60,827 (16.0%)	4,107 (16.5%)	5,972 (15,2%)	50,748 (16.1%)
SDI score, median (IQR)	54 (31-76)	53 (30-76)	57 (33-80)	53 (31-75)
Travel time to GI (min), median (IQR)	5.3 (3.4-8.1)	5.4 (3.5-8.6)	5.3 (3.4-8.0)	5.3 (3.3-8.0)
Travel time to endoscopy center (min), median (IQR)	6.4 (4.2-8.8)	6.4 (4.3-9.3)	6.3 (4.3-8.9)	6.3 (4.1-8.8)
Stage, n (%)				
Local	147,476 (38.9%)	7,440 (29.8%)	10,163 (25.9%)	129,873 (41.3%)
Regional	151,175 (39.9%)	8,804 (35.3%)	15,126 (38.5%)	127,245 (40.4%)
Distant	80,403 (21.2%)	8,710 (34.9%)	13,982 (35.6%)	57,711 (18.3%)

IQR, interquartile range; SDI, social deprivation index

Table 2 Multinomial logistic regression

Variables	OR (95%CI)	P-value for difference among groups
Regional stage at diagnosis (compared to local)		
Age at diagnosis	0.99 (0.99-1.00)	<0.001
Female sex	0.99 (0.97-1.00)	<0.001
Race (reference White)		<0.001
African-American	1.02 (0.99-1.05)	
American Indian/Alaskan Native	1.28 (0.92-1.79)	
Asian	1.28 (1.17-1.40)	
Other/Unknown	0.73 (0.67-0.80)	
Non-Hispanic/Latino Ethnicity	0.92 (0.90-0.94)	<0.001
Married (reference single)	0.94 (0.92-0.95)	<0.001
Tobacco use at diagnosis (reference No)	1.20 (1.17-1.22)	<0.001
SDI (per 10-point increase in deprivation)	1.01 (1.01-1.01)	<0.001
Travel time to GI specialist (per 5-min increase)	1.00 (0.99-1.00)	<0.001
Private insurance	0.87 (0.85-0.89)	<0.001
Distant stage at diagnosis (compared to local)		
Age at diagnosis	0.98 (0.98-0.98)	<0.001
Female sex	0.85 (0.84-0.87)	<0.001
Race (reference White)		<0.001
African-American	1.30 (1.26-1.34)	
American Indian/Alaskan Native	1.23 (0.84-1.81)	
Asian	1.41 (1.27-1.56)	
Other/Unknown	0.77 (0.69-0.85)	
Non-Hispanic/Latino ethnicity	0.92 (0.89-0.94)	<0.001
Married (reference single)	0.81 (0.80-0.83)	<0.001
Tobacco use at diagnosis (reference No)	1.28 (1.25-1.32)	<0.001
SDI (per 10-point increase in deprivation)	1.01 (1.01-1.02)	<0.001
Travel time to GI specialist (per 5-min increase)	1.02 (1.01-1.02)	<0.001
Private insurance	0.80 (0.78-0.82)	<0.001

OR, odds ratio; CI, confidence interval; GI, gastrointestinal; SDI, social deprivation index

Discussion

In this study, we use contemporary, individual-level data with granular characteristics to evaluate the association between social and structural determinants of health and stage of detection of GI luminal cancers. We demonstrate that increasing distance to care and living in areas associated with increased deprivation are associated with more advanced stages of diagnosis of GI luminal cancers. Other significant factors include lacking private insurance, being unmarried or a smoker, and being of older age. However, the strongest risk factors include being of non-White race and ethnicity.

This work builds on prior studies utilizing place-based analyses to identify disparities in care. There are well-known discrepancies in terms of geographic location and socioeconomic status and stage of diagnosis of CRC, which has been presumed to be related to screening uptake [19-21]. There is also an association between geographic distance from the treating facility (once diagnosed with cancer) and poor outcomes [22,23]. Distance to care has previously been shown to be important for non-cancer-related healthcare interactions as well, including endoscopic outcomes and other resource-intensive processes, such as organ transplantation [10,24]. The strength of our study is in providing a unique perspective by accounting for multiple factors of interest within the same model, and focusing on factors that would facilitate early detection. Our use of deprivation indices and evaluation of specialist density and proximity to endoscopic centers is a particular strength, as GI luminal cancer diagnosis can be facilitated through specialist visits and/or endoscopic procedures [25]. Considering these within 1 model (as we do here) is critical to highlighting and understanding the complexities when it comes to healthcare barriers.

We demonstrate that worsening deprivation is associated with a later stage of diagnosis of GI luminal cancers. These findings underline that deprivation indices are an actionable tool that can guide policy change and help target intervention to areas that would benefit from healthcare infrastructure. Deprivation is a well-known risk factor for poor health outcomes [26]. Other similar scores exist, such as the social vulnerability index, which identifies areas with the least infrastructure, fewest resources and least access to health care [27,28]. Since we have these tools in hand and readily available, they should serve as methods to guide healthcare investment into communities with high depravation indices. We further demonstrate that distance to specialty care and procedures are crucial factors. Endoscopic procedures require a specialist with the infrastructure (anesthesia/sedation, instruments, support staff) to conduct the procedures. As we seek to mitigate disparities, targeted allocation of providers or endoscopy centers to these underserved areas could improve cancer survival by facilitating earlier detection.

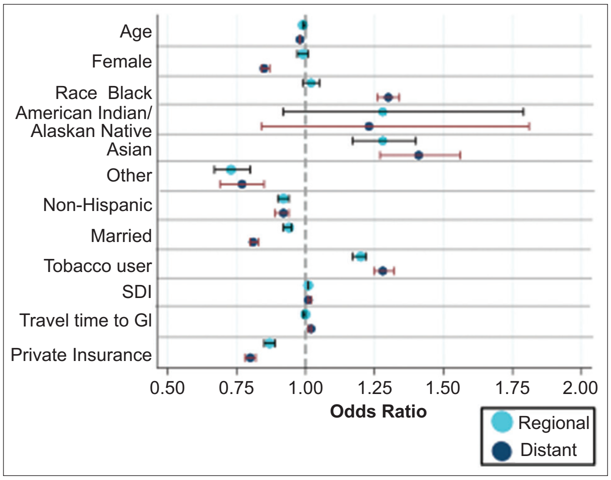

Figure 1 Odds ratios of diagnosis of regional or distant disease, adjusted multinomial logistic regression
SDI, social deprivation index; GI, gastrointestinal care

Among our most important findings is that being of minority race or ethnicity is associated with a later stage of diagnosis. It is well known that belonging to a racial or ethnic minority has been shown to have an association with a later stage of diagnosis for EC [29], GC [30], and CRC [31,32]. In addition, geographic location and socioeconomic status are associated with the stage of diagnosis, and these findings can be mistakenly conflated in the way they potentially relate to screening and healthcare uptake [19-21]. For example, it is

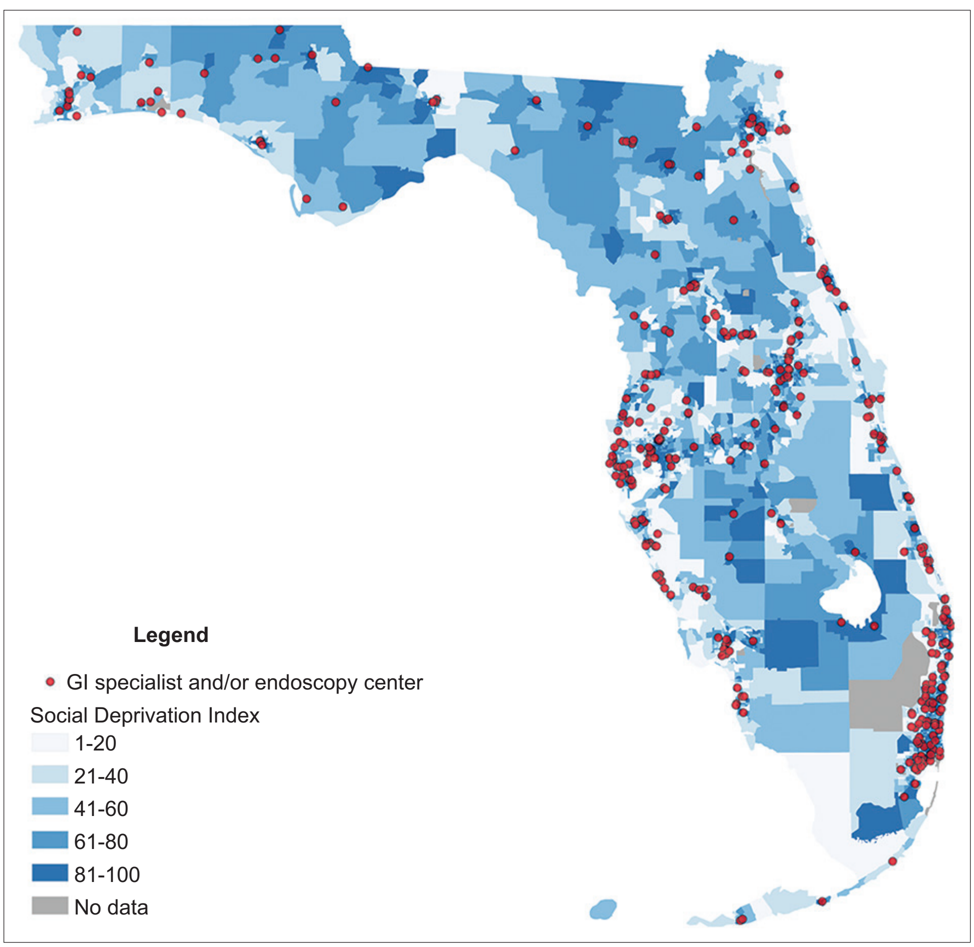

Figure 2 Map of Florida depicting social deprivation indices and locations of endoscopy centers and gastrointestinal specialists

Table 3 Multinomial logistic regression, among those aged 50-75 years

Variables	OR (95%CI)	P-value for difference among groups
Regional stage at diagnosis (compared to local)		
Age at diagnosis	0.99 (0.99-1.00)	<0.001
Female sex	0.97 (0.95-0.99)	<0.001
Race (reference White)		<0.001
African-American	1.02 (0.99-1.06)	
American Indian/Alaskan Native	1.23 (0.82-1.85)	
Asian	1.31 (1.17-1.46)	
Other/Unknown	0.70 (0.62-0.78)	
Non-Hispanic/Latino ethnicity	0.91 (0.88-0.94)	<0.001
Married (reference single)	0.95 (0.93-0.97)	<0.001
Tobacco use at diagnosis (reference No)	1.21 (1.18-1.25)	<0.001
SDI (per 10-point increase in deprivation)	1.01 (1.01-1.02)	0.006
Travel time to GI specialist (per 5-min increase)	0.99 (0.99-1.00)	0.008
Private insurance	0.85 (0.83-0.87)	<0.001
Distant stage at diagnosis (compared to local)		
Age at diagnosis	0.97 (0.97-0.98)	<0.001
Female sex	0.82 (0.80-0.84)	<0.001
Race (reference White)		<0.001
African-American	1.26 (1.21-1.31)	
American Indian/Alaskan Native	1.31 (0.3-2.08)	
Asian	1.37 (1.21-1.57)	
Other/Unknown	0.77 (0.67-0.88)	
Non-Hispanic/Latino ethnicity	0.94 (0.90-0.98)	<0.001
Married (reference single)	0.80 (0.78-0.82)	<0.001
Tobacco use at diagnosis (reference No)	1.31 (1.27-1.35)	<0.001
SDI (per 10-point increase in deprivation)	1.02 (1.01-1.02)	0.006
Travel time to GI specialist (per 5-min increase)	1.01 (1.01-1.02)	0.008
Private insurance	0.76 (0.74-0.79)	<0.001

OR, odds ratio; CI, confidence interval; GI, gastrointestinal; SDI, social deprivation index

well-established that Black Americans are diagnosed at later stages for CRC, while Asian Americans tend to have earlier stages of diagnosis of GC [33,34]. Social determinants of health, including access to care, have been posited as possible reasons, but disentangling the various factors is infrequently mentioned in the literature. That we adjusted for multiple factors (demographics, insurance, place-based, deprivation indices) and continue to find such a high risk of a later stage of diagnosis among minorities is striking. This is important, as it shows that 1) there are complexities in healthcare delivery that pose barriers to mitigating disparities, and 2) further investigation is needed to elucidate other possible biological, social, and environmental mechanisms to explain the higher risk of distant stage diagnosis.

The remainder of our findings are similar to those in the pre-existing literature. Increasing age may be associated with an earlier stage of detection since age is a strong risk factor for malignancy, thus prompting earlier endoscopic evaluation of symptoms, or may represent different tumor biology in cancers impacting younger ages [35,36]. Ongoing tobacco use has been associated with distant stage disease across cancer types [37]. GC does not have effective screening and surveillance modalities for US patients, and EC's screening uptake is still in its nascency, which may help explain their later detection as compared to CRC [38-41]. Insurance status, too, is well known to have an impact on healthcare outcomes, and a recent study showed late-stage cancer diagnoses are common among Medicaid patients [42]. The previous literature has also demonstrated the importance of healthcare coverage, particularly private insurance, and to a lesser degree, Medicare, on improved cancer outcomes [43,44]. Marital status is an interesting predictor of cancer outcomes. A 2022 study demonstrates that married patients have superior survival after GC diagnosis, compared to those who are single or separated, suggesting that social support provides beneficial outcomes regarding early detection, treatment and survival [45].

This study had several limitations. As a retrospective study, we cannot account for all possible confounders, including relevant oncologic risk factors, such as *Helicobacter pylori* infection, appropriate screening uptake in CRC, or prior Barrett's in EC Barret's in EC [46,47]. While SDI is associated with healthcare access and outcomes, it may not always reflect an individual's situation (including income), though geographic deprivation indices are a novel and promising measure. Our study evaluates specialist care but does not incorporate primary care. Accordingly, noninvasive testing or evaluation by non-specialists would not be captured, though SDI includes this to a degree. Geographic distance alone does not capture all barriers to care, such as the unique challenges in urban versus rural settings, though other studies have previously shown discrepancies [48]. So, while travel time may be the closest available approximation, it does not capture issues with transportation and does not include public transport. There may be misclassification of data, though the FCDS is a high-fidelity granular incident database that conforms to standards for completeness, timeliness and data quality, as set forth by the North American Association of Central Registries (NAACCR), the American College of Surgeons, Commission on Cancer (ACOS/COC), and the Surveillance, Epidemiology and End Results (SEER) reporting program of the National Cancer Institute (NCI). There are also some gaps in the data. For example, a large proportion of cases lacked payer information. However, across each cancer, these were not significantly different between stages, and therefore advanced statistical techniques such as multiple imputation were not performed. Our results regarding payer status are also consistent with previous studies, limiting the impact of these deficiencies [43,44]. We included all histology subtypes, as endoscopic evaluation would not differentially identify one over the others. Our sensitivity analysis was limited to those between ages 50-75 years, as this age group would fall under US Preventive Services Task Force screening recommendations for CRC [18]. These ages were chosen for all 3 luminal cancers, as these persons were likely to undergo discussion of screening strategies with a healthcare professional, with special attention to GI symptoms and family history. Recently, some societies have expanded the lower bound of CRC screening to age 45, but this was not the case in 2016 (end of our inclusion period). Finally, while we included endoscopy centers and board-certified GI doctors, these are dynamic situations, and nuances in availability or openings would not be captured in this study. For example, if a gastroenterology or endoscopy center closed during the period, or was unavailable for procedures, this would not be captured in this study; however, this should not be significantly different than in other similar studies.

Our study builds on recent efforts to highlight how geographic and social circumstances can impact cancer outcomes. Identifying discrete areas or characteristics that are associated with worse outcomes, including stage of diagnosis, provides an actionable target to improve cancer outcomes. We demonstrate that a greater distance from care and living in areas associated with increased deprivation are associated with more advanced stages of diagnosis of GI luminal cancers. Barriers to healthcare are myriad and complex. They include geospatial, financial, socioeconomic, demographic and educational aspects. Given their interrelated nature, it is not easy to address isolated barriers. Yet it remains of the utmost importance to consider how structural and social determinants of health can be used to improve outcomes. Studies such as this allow us to identify areas that are burdened by a later stage of diagnosis (and therefore poorer cancer outcomes), and may ideally serve as guides for where to target investment in healthcare [49]. Most importantly, we find that, even after adjusting for factors that have been posited to explain discrepancies, including living in areas with less healthcare infrastructure or having more barriers to care, minority persons still are at risk of a later stage of diagnosis compared to non-minorities. This serves to underline the complexity of healthcare disparities and the urgent need to understand how to better deliver care in order to mitigate disparities and improve cancer outcomes.

Summary Box

What is already known:

- Access to care involves multi-level determinants of health, including individual, social, and place-based factors
- Recent efforts have highlighted the importance of geographic and social determinants of health across the cancer continuum
- Gastrointestinal (GI) luminal cancers can be detected at early stages by endoscopic procedures, but it is unknown how place-based factors and social determinants of health impact the stage of GI cancer diagnosis

What the new findings are:

- We evaluated the association between social and structural determinants of health and stage of detection of GI luminal cancers
- In this retrospective cohort study, a greater distance from care and living in areas associated with increased deprivation were associated with more advanced stages of diagnosis of GI luminal cancers, but the strongest risk factors include being of non-White race and ethnicity
- Identifying discrete areas or characteristics that are associated with worse outcomes provides an actionable target to improve cancer outcomes, but barriers to healthcare are complex, and further study is needed to mitigate cancer disparities among minorities

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Supplementary material

Supplementary Table 1 Multinomial logistic regression, among those diagnosed between 2006-2016

Variables	OR (95%CI)	P-value for difference among groups
Regional stage at diagnosis (compared to local)		
Age at diagnosis	0.99 (0.99-1.00)	<0.001
Female sex	0.96 (0.93-0.99)	<0.001
Race (reference White)		<0.001
African-American	1.00 (0.96-1.05)	
American Indian/Alaskan Native	1.38 (0.92-2.08)	
Asian	1.29 (1.14-1.45)	
Other/Unknown	0.78 (0.70-0.87)	
Non-Hispanic/Latino ethnicity	0.88 (0.84-0.91)	<0.001
Married (reference single)	0.91 (0.8900.94)	<0.001
Tobacco use at diagnosis (reference No)	1.14 (1.09-1.19)	<0.001
SDI (per 10-point increase in deprivation)	1.09 (0.99-1.00)	0.6174
Travel time to GI specialist (per 5-min increase)	1.01 (1.00-1.02)	0.1242
Private insurance	0.93 (0.90-0.97)	<0.001
Distant stage at diagnosis (compared to local)		
Age at diagnosis	0.99 (0.98-0.98)	<0.001
Female sex	0.92 (0.89-0.95)	<0.001
Race (reference White)		<0.001
African-American	1.15 (1.09-1.20)	
American Indian/Alaskan Native	1.06 (0.66-1.72)	
Asian	1.35 (1.18-1.54)	
Other/Unknown	0.77 (0.68-0.88)	
Non-Hispanic/Latino ethnicity	0.95 (0.91-0.99)	0.0262
Married (reference single)	0.83 (0.80-0.86)	<0.001
Tobacco use at diagnosis (reference No)	1.31 (1.27-1.35)	<0.001
SDI (per 10-point increase in deprivation)	1.19 (1.14-1.24)	<0.001
Travel time to GI specialist (per 5-min increase)	1.02 (1.01-1.03)	<0.001
Private insurance	0.79 (0.76-0.82)	<0.001

OR, odds ratio; CI, confidence interval; GI, gastrointestinal; SDI, social deprivation index