Racial disparities in stage-specific gastric cancer: analysis of results from the Surveillance Epidemiology and End Results (SEER) program database

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ABSTRACT

The incidence of gastric cancer is declining in western countries but continues to represent a serious health problem worldwide, especially in Asia and among Asian Americans. This study aimed to investigate ethnic disparities in stage-specific gastric cancer, including differences in incidence, treatment and survival. The cohort study was analyzed using the data set of patients with gastric cancer registered in the Surveillance, Epidemiology, and End Results (SEER) program from 2004 to 2013. Among 54,165 patients with gastric cancer, 38,308 were whites (70.7%), 7546 were blacks (13.9%), 494 were American Indian/Alaskan Natives (0.9%) and 7817 were Asians/Pacific Islanders (14.4%). Variables were patient demographics, disease characteristics, surgery/radiation treatment, overall survival (OS) and cause specific survival (CSS). Asians/Pacific Islanders demonstrated the highest incidence rates for gastric cancer compared with other groups and had the greatest decline in incidence during the study period (13.03 to 9.28 per 100,000/year), as well as the highest percentage of patients with American Joint Committee on Cancer (AJCC) early stage gastric cancer. There were significant differences between groups in treatment across stages I–IV (all p<0.001); Asians/Pacific Islanders had the highest rate of surgery plus radiation (45.1%). Significant differences were found in OS and CSS between groups (p<0.001); OS was highest among Asians/Pacific Islanders. Multivariate analysis revealed that age, race, grade, stage, location, and second primary cancer were valid prognostic factors for survival. Marked ethnic disparities exist in age-adjusted incidence of primary gastric cancer, with significant differences between races in age, gender, histological type, grade, AJCC stage, location, second cancer, treatment and survival.

Significance of this study

What is already known about this subject?

- The incidence of gastric cancer (GC) has been declining over the past years in the USA since the advent of widespread screening for *Helicobacter pylori*.
- GC is shown to be the second most common cause of cancer deaths.
- Asians have a disproportionately greater tumor burden within their proportion of the total population studied, but whites and blacks have a distribution of GC parallel to their proportion.

What are the new findings?

- Asians or Pacific Islanders had the highest percentage of patients with American Joint Committee on Cancer (AJCC) early stage GC.
- Regardless of which stage was identified among patients, Asians/Pacific Islanders were treated actively, primarily with surgery plus radiation therapy.
- Asians/Pacific Islanders were found to have the highest overall survival and cancer-specific survival rates, followed by whites, blacks and American Indian/Alaskan Natives.

How might these results change the focus of research or clinical practice?

- The results of this study may be useful in developing effective strategies to address the issues of ethnic disparities, develop appropriate screening programs, and balance standards of care for GC among given populations.

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INTRODUCTION

The incidence of gastric cancer (GC) has been declining over the past five decades in the USA and other western countries since the advent of widespread screening for *Helicobacter pylori*.[1] However, GC continues to represent a serious health problem worldwide, and is shown to be the second most common cause of cancer deaths.[2] More than 600,000 cases are reported annually.[3] GC incidence is reported to be consistently and markedly higher in Asian countries such as China, Japan, and Korea.[4 5] In terms of prevalence, Asians have a disproportionately

greater tumor burden within their proportion of the total population studied, but whites and blacks have a distribution of GC parallel to their proportion.[6]

Wide variation is found in non-cardia GC between countries and etiology is considered to be multifactorial; high salt intake, smoking and heavy alcohol consumption are implicated in non-cardia GCs.[4] Risk for second primary tumors is shown to be higher in patients with GC than in the general public; incidence is about 8%, and the most common cancer sites are colorectal (33%), upper respiratory (22%), and urogenital (22%).[7]

Previous studies indicate that the burden of disease may be higher among certain racial groups.[6 8–11] For example, dramatic differences have been shown in incidence rates and trends between Asians/Pacific Islanders and non-Hispanic whites living in the USA.[8] Stomach cancer incidence and mortality rates are shown to be higher among all Asians/Pacific Islanders (Chinese, Filipino, Vietnamese, Korean, and Japanese) studied compared with those of non-Hispanic white patients.[9 12] While survival is <20% overall, Asians in the USA are shown to have the highest incidence of GC and the highest overall survival (OS).[6] However, even though disparities are noted between patients with GC in various ethnic groups, insufficient evidence is available to characterize contributing factors on survival and development of second primary cancers after GC diagnosis among different racial groups. To achieve the goal of health for all, it is critical and necessary to identify health disparities, explore possible contributing factors, and work toward adequate access to diagnosis and treatment to reduce and eliminate disparities. Therefore, the present study aimed to investigate ethnic disparities in stage-specific GC, especially including differences in incidence, second primary cancers, treatment, survival and prognostic factors.

PATIENTS AND METHODS

Data source and ethical considerations

This secondary data analysis was conducted using the database obtained from the population-based Surveillance, Epidemiology, and End Results (SEER) program cancer registry (http://seer.cancer.gov/) research data from 2004 to 2013, released in April 2016 (based on November 2015 submission) in collaboration with the US National Cancer Institute, Division of Cancer Control and Population Sciences (DCCPS) and Surveillance Research Program. The SEER program was established in 1973 by the USA and collects incidence and survival data of patients with malignant tumors from 18 population-based cancer registries in the USA representing ~28% of the population (http://seer.cancer.gov/data/).[6 13] All SEER data are de-identified and analysis of the data does not require Institutional Review Board (IRB) approval or informed consent by all subjects. We obtained permission to access the research data file in the SEER program by National Cancer Institute, USA (reference number 14157-Nov 2015).

Study population

Data of patients with GC included in the SEER study from 2004 to 2013 were extracted by anatomic site (International Classification of Diseases for Oncology (ICD-O) code: C160–169; PRIMSITE=C160-C169) or SEER site groups (SITERWHO=21020). Racial classifications of patients were based on those established for the SEER cancer registry, including four ethnic groups: white, black, American Indian/Alaskan Native, and Asian or Pacific Islander. Other patients with unspecified or unknown racial origins were excluded from this study.

Study design

The variables obtained for each case included patient demographics (race/ethnicity, sex, age at diagnosis), disease characteristics (histology, grade, stage, extent of disease), treatment modalities (type of surgery performed, type of radiation administered, and radiation sequence relative to surgery), and survival status, including OS and cause specific survival (CSS). Cancer staging definitions were based on staging systems unique to the SEER database. Localized cancer was defined as cancers confined to the stomach without transmural invasion; regional cancer was defined as involvement of regional lymph nodes without metastases; and distant cancer was defined as metastatic disease involving distant lymph nodes or organs. Incidence rates were stratified by age. Treatment data included site-specific surgery and radiation therapy. Coding details and rules applied in this study followed the guidelines established by the SEER program (http://seer.cancer.gov/resources/).

Statistical analysis

Comparison of variables between racial groups was tested using analysis of variance for continuous variables and χ^2 test for categorical variables. Continuous variables are represented as mean and SD and categorical data are represented by number (n) and percentage (%). The incidence rate of GC was calculated per 100,000 person years, and direct age adjustment was made to the 2000 US population. The Kaplan-Meier method with log-rank test and Breslow test were used to compare OS and CSS between the racial groups. Univariate and multivariate Cox proportional hazard regression models were built for analysis of prognostic factors for survival outcomes in patients with GC. Variables that showed a tendency of association with OS and CSS ($p<0.05$) in univariate analysis were entered into a multivariate Cox proportional hazard regression model with stepwise selection to investigate independent prognostic factors of OS and CSS. All p values were two-sided and a p value of <0.05 was considered statistically significant. Statistical analyses were performed using the statistical software package SPSS V.22 (IBM, Armonk, New York, USA).

RESULTS

A total of 54,165 patients with primary GC were identified in this study. Among this cohort, racial/ethnic classifications included 38,308 patients classified as white (70.7%), 7546 patients classified as black (13.9%), 494 patients classified as American Indian/Alaskan Native (0.9%) and 7817 patients classified as Asian or Pacific Islander (14.4%).

Incidence

Marked ethnic disparities in age-adjusted incidence were observed. Asians or Pacific Islanders demonstrated the highest incidence rates, followed by blacks, whites and American Indian/Alaskan Natives (figure 1). Between 2004 and 2013, Asians or Pacific Islanders demonstrated the

greatest decline in the incidence of GC (13.03 to 9.28 per 100,000/year).

A comparison of patients' demographics and pathological features stratified by race is shown in table 1. Statistically significant differences were found between racial groups in age, gender, histological type, grade, American Joint Committee on Cancer (AJCC) stage, location, and multiple cancer (all p<0.001). Asians or Pacific Islanders with a mean diagnostic age of 67.62±14.66 years were the eldest among the four racial groups; American Indian/Alaska Natives had the youngest diagnostic age (62.94±14.51). Incidence was higher among men, especially in the white population. The majority of histological types were adenocarcinoma, signet-ring cell carcinoma and carcinoid. American Indian/Alaskan Natives had the lowest percentage of grade I (4.4%), followed by Asians or Pacific Islanders (5.2%). Asians or Pacific Islanders had the highest percentage of patients with AJCC early stage GC (32.8%; 7th edition Washington 2010), while American Indian/Alaskan Natives had the highest percentage of patients with stage IV disease (51.2%; table 1).

Table 2 summarizes the second primary cancer in the different racial groups. Blacks had the highest proportion of second cancers (4.3%), and prostate cancer was the most common occurrence (14.7%), followed by lung and bronchus (14.7%), kidney and renal pelvis (7.6%), breast (7.0%), pancreas (6.7%) and esophagus (3.4%). However, no significant differences were found between groups in time to second cancer (p=0.261).

Treatment

A total of 22,417 (43%) patients with GC did not receive surgery or radiotherapy and only 6614 (12.7%) patients underwent surgery plus radiotherapy. As shown in table 3, significant differences in the treatments were found between the four racial groups across all stages (stages I, II, III and IV; all p<0.001). Asian or Pacific Islander and American Indian/Alaskan Native patients had the highest rates of surgery in stages I (69%) and II (55.1%), respectively. In stage III, Asian or Pacific Islander patients had the highest rate of surgery plus radiation (45.1%). However, a greater percentage of American Indian/Alaskan Native patients did not undergo surgery or radiation compared with any other racial group in stage IV (68.8%; table 3).

Survival

A total of 36,480 patients died during the study period. Significant differences were also found in OS and CSS between the four racial groups (figure 2A,B; log-rank test, p<0.001). Among all racial groups, OS was highest in Asians or Pacific Islanders, followed by whites, blacks and American Indian/Alaskan Natives. However, no differences in OS were found between white and black patients (Breslow test; p=0.122). The median survival time was 19 months for Asian or Pacific Islander patients, 12 months for white and black patients, and 9 months for American Indian/Alaskan Native patients. The 1-year, 3-year, and 5-year survival rates for Asian or Pacific Islander patients were 59.1%, 39.1%, and 32.8%, respectively; 51.1%, 30.3%, and 24.8%, respectively, for white patients; 49%, 30.4% and 24.8%, respectively, for black patients; and 42.6%, 24.8%, and 19.0%, respectively, for American Indian/Alaskan Native patients. CSS was highest among Asians or Pacific Islanders, followed by blacks, whites, and American Indian/Alaskan Natives. The 1-year, 3-year, and 5-year survival rates for Asian or Pacific Islander patients were 63.7%, 46.0%, and 41.5%, respectively; 55.6%, 38.6% and 33.8%, respectively, for black patients; 51.8%,

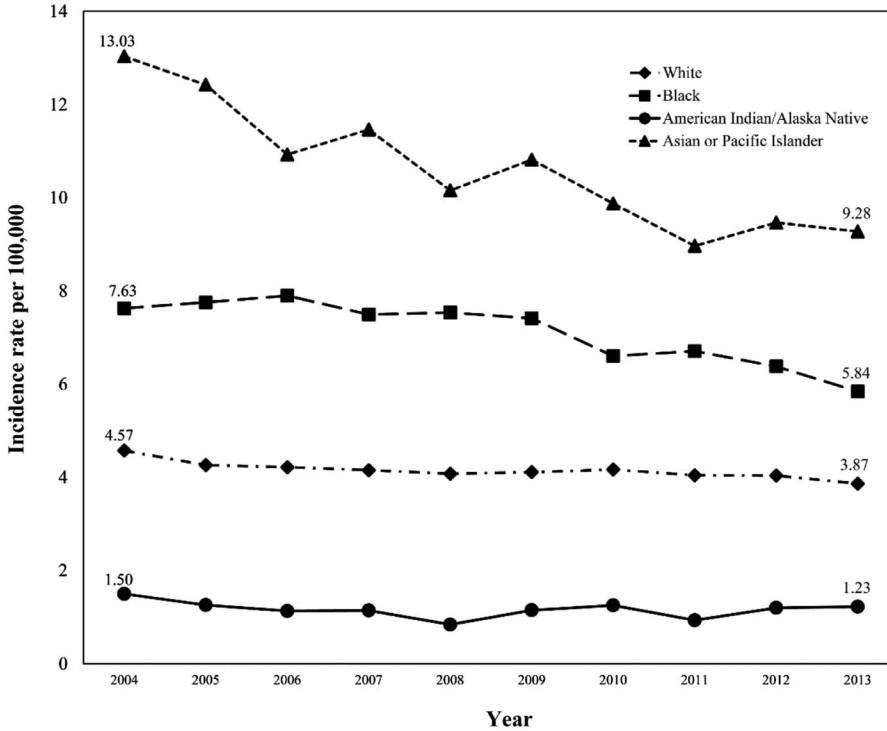


Figure 1 Ethnic disparity in gastric cancer incidence.

Table 1 Patients' demographics and pathological features by race

	White (n=38308)	Black (n=7546)	American Indian/Alaska Native (n=494)	Asian or Pacific Islander (n=7817)	p Value
Diagnostic age (years)	67.14±14.54	65.41±14.49	62.94±14.51	67.62±14.66	<0.001*
Gender, n (%)					
Male	23688 (61.8%)	4195 (56.0%)	294 (59.5%)	4375 (56.0%)	<0.001*
Female	14620 (38.2%)	3351 (44.0%)	200 (40.5%)	3442 (44.0%)	
Histological classification, n (%)					
Epithelial tumors	31512 (82.3%)	5870 (77.8%)	422 (85.4%)	6499 (83.1%)	
Adenocarcinoma	22148 (70.3%)	4140 (70.5%)	296 (70.1%)	4771 (73.4%)	
Papillary adenocarcinoma	62 (0.2%)	23 (0.4%)	2 (0.5%)	7 (0.1%)	
Tubular adenocarcinoma	200 (0.6%)	37 (0.6%)	3 (0.7%)	49 (0.8%)	
Mucinous adenocarcinoma	511 (1.6%)	117 (2.0%)	7 (1.7%)	88 (1.4%)	
Signet-ring cell carcinoma	6484 (20.6%)	1139 (19.4%)	88 (20.9%)	1432 (22.0%)	
Adenosquamous carcinoma	104 (0.3%)	18 (0.3%)	1 (0.2%)	14 (0.2%)	
Squamous cell carcinoma	234 (0.7%)	78 (1.3%)	3 (0.7%)	31 (0.5%)	<0.001*
Small cell carcinoma	60 (0.2%)	11 (0.2%)	0 (0.0%)	9 (0.1%)	
Undifferentiated carcinoma	40 (0.1%)	6 (0.1%)	1 (0.2%)	6 (0.1%)	
Carcinoid	1669 (5.3%)	301 (5.1%)	21 (5.0%)	92 (1.4%)	
Non-epithelial tumors	2007 (5.2%)	728 (9.6%)	12 (2.4%)	402 (5.1%)	
Leiomyosarcoma	38 (1.9%)	4 (1.0%)	0 (0.0%)	4 (1.0%)	
GI stromal tumor	1969 (98.1%)	724 (99.0%)	12 (100%)	398 (99.0%)	
Others	4789 (12.5%)	948 (12.6%)	60 (12.1%)	916 (11.7%)	
Grade, n (%)†					<0.001*
Grade I	2106 (7.4%)	416 (7.7%)	15 (4.4%)	328 (5.2%)	
Grade II	7444 (26.4%)	1542 (28.6%)	85 (25.1%)	1505 (23.9%)	
Grade III	18247 (63.8%)	3269 (60.7%)	230 (67.8%)	4326 (68.6%)	
Grade IV	820 (2.9%)	161 (3.0%)	9 (2.7%)	143 (2.3%)	
AJCC 7 stage, n (%)‡					
0	351 (1.2%)	63 (1.1%)	4 (1.0%)	93 (1.5%)	
I	7880 (26.7%)	1489 (26.9%)	104 (25.9%)	1996 (31.3%)	
II	3765 (12.8%)	679 (12.3%)	51 (12.7%)	780 (12.2%)	<0.001*
III	3497 (11.8%)	692 (12.5%)	37 (9.2%)	876 (13.8%)	
IV	14024 (47.5%)	2618 (47.2%)	206 (51.2%)	2625 (41.2%)	
Location, n (%)§					
Localized	10898 (32.0%)	2205 (33.1%)	126 (28.5%)	2394 (34.0%)	
Regional	9048 (26.6%)	1789 (26.8%)	116 (26.2%)	2201 (31.2%)	<0.001*
Distant	14085 (41.4%)	2669 (40.1%)	200 (45.2%)	2449 (34.8%)	

*Indicates a significant difference among the groups, p<0.05.
†Cell type not determined, not stated or not applicable, n=13,519.
‡Stage unknown or not applicable, n=12335.
§Unstaged—information is not sufficient to assign a stage, n=5985.
AJCC, American Joint Committee on Cancer; GI, gastrointestinal.

Table 2 Summary of second primary cancer by race

	White (n=1560)	Black (n=327)	American Indian/Alaska Native (n=15)	Asian or Pacific Islander (n=261)	p Value
Lung and bronchus	230 (14.7%)	38 (11.6%)	2 (13.3%)	39 (14.9%)	NA*
Prostate	145 (9.3%)	48 (14.7%)	2 (13.3%)	16 (6.1%)	
Kidney and renal pelvis	107 (6.9%)	25 (7.6%)	1 (6.7%)	16 (6.1%)	
Breast	96 (6.2%)	23 (7.0%)	1 (6.7%)	19 (7.3%)	
Esophagus	73 (4.7%)	11 (3.4%)	0 (0.0%)	7 (2.7%)	
Pancreas	56 (3.6%)	22 (6.7%)	0 (0.0%)	12 (4.6%)	
Time to second cancer (years)	1.52±1.97	1.54±2.09	0.51±0.63	1.48±2.04	0.261

*Only describe the main secondary primary cancer prevalence here.

Table 3 Summary of treatments by race in different tumor stage

	White	Black	American Indian/Alaska Native	Asian or Pacific Islander	p Value
Stage 0 (n=491)	n=338	n=58	n=4	n=91	0.077
No surgery and radiation	125 (37.0%)	25 (43.1%)	1 (25.0%)	19 (20.9%)	
Only surgery	207 (61.2%)	31 (53.4%)	3 (75.0%)	71 (78.0%)	
Only radiation	5 (1.5%)	2 (3.4%)	0 (0.0%)	0 (0.0%)	
Surgery+radiation	1 (0.3%)	0 (0.0%)	0 (0.0%)	1 (1.1%)	
Stage I (n=11196)	n=7678	n=1453	n=104	n=1961	<0.001*
No surgery and radiation	1713 (22.3%)	442 (30.4%)	33 (31.7%)	326 (16.6%)	
Only surgery	4203 (54.7%)	791 (54.4%)	50 (48.1%)	1354 (69.0%)	
Only radiation	788 (10.3%)	84 (5.8%)	9 (8.7%)	62 (3.2%)	
Surgery+radiation	974 (12.7%)	136 (9.4%)	12 (11.5%)	219 (11.2%)	
Stage II (n=5148)	n=3670	n=665	n=49	n=764	<0.001*
No surgery and radiation	30 (18.2%)	61 (9.2%)	4 (8.2%)	50 (6.5%)	
Only surgery	1477 (40.2%)	313 (47.1%)	27 (55.1%)	366 (47.9%)	
Only radiation	416 (11.3%)	34 (5.1%)	3 (6.1%)	31 (4.1%)	
Surgery+radiation	1476 (40.2%)	257 (38.6%)	15 (30.6%)	317 (41.5%)	
Stage III (n=4980)	n=3404	n=680	n=36	n=860	<0.001*
No surgery and radiation	431 (12.7%)	110 (16.2%)	2 (5.6%)	57 (6.6%)	
Only surgery	1344 (39.5%)	265 (39.0%)	16 (44.4%)	382 (44.4%)	
Only radiation	312 (9.2%)	59 (8.7%)	4 (11.1%)	33 (3.8%)	
Surgery+radiation	1317 (38.7%)	246 (36.2%)	14 (38.9%)	388 (45.1%)	
Stage IV (n=19062)	n=13725	n=2562	n=202	n=2573	<0.001*
No surgery and radiation	9058 (66.0%)	1704 (66.5%)	139 (68.8%)	1543 (60.0%)	
Only surgery	2113 (15.4%)	442 (17.3%)	24 (11.9%)	566 (22.0%)	
Only radiation	1840 (13.4%)	279 (10.9%)	29 (14.4%)	245 (9.5%)	
Surgery+radiation	714 (5.2%)	137 (5.3%)	10 (5.0%)	219 (8.5%)	

*Indicates a significant difference among the groups, p<0.05.

37.1%, and 32.5%, respectively, for white patients; and 46.9%, 29.2%, and 25.1%, respectively, for American Indian/Alaskan Native patients (figure 2A,B).

Prognostic factors for OS

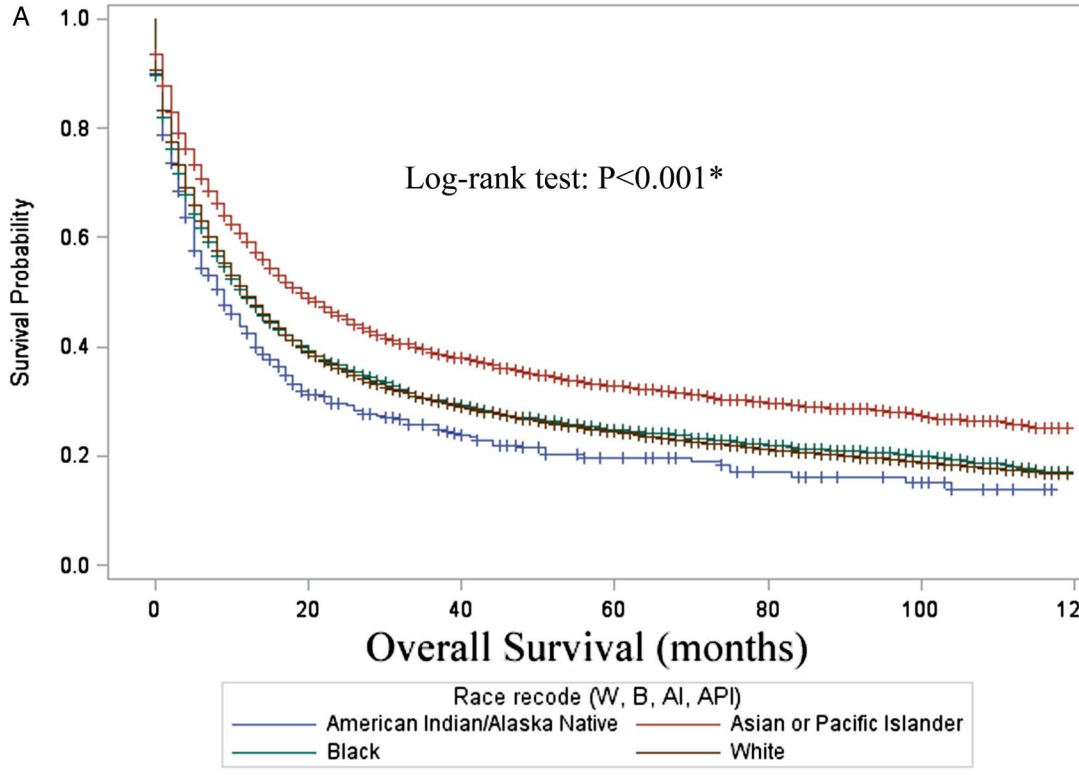
Univariate analysis identified age, race, gender, histological classification, grade, stage, location, second primary cancer, time to second cancer, surgery and radiation as significant prognostic factors for OS among individuals with GC (p<0.05, data not shown). Multivariate analysis with the Cox proportional hazard model revealed that eight variables (age, race, grade, stage, location, second primary cancer, time to second cancer, surgery/radiation) were valid independent prognostic factors for OS. After controlling for those confounding factors, American Indian/Alaskan Natives had poor OS compared with that of white patients (HR 2.215, 95% CI 1.326 to 3.700, p=0.002, table 4), while Asians or Pacific Islanders had similar survival to that of white patients. Older age at diagnosis and more advanced stage or grade of disease at diagnosis were both associated gradually with lower OS. OS rates improved for the occurrence of second primary cancer, later occurrence of second cancer and receiving necessary treatments.

After controlling for confounding factors, the multivariate Cox proportional hazard model revealed that American Indian/Alaskan Natives had poor CSS compared with that of white patients (HR 2.611, 95% CI 1.275 to 5.348; p=0.009, table 4). Unfavorable prognostic effects for CSS included grade III (HR 2.882; 95% CI 1.758 to 4.723; p<0.001); grade IV (HR 3.048; 95% CI 1.516 to 6.128; p=0.002) compared with grade I; regional (HR 1.579; 95% CI 1.134 to 2.198; p=0.007); distant (HR 1.680; 95% CI 1.087 to 2.596; p=0.020) compared with localized; and having second primary cancer (HR 6.325; 95% CI 4.907 to 8.151; p<0.001). Patients who underwent both surgery and radiation had more favorable CSS compared with those not treated with surgery and radiation (HR 0.311, 95% CI 0.230 to 0.420, p<0.001; table 4).

DISCUSSION

In this study, marked ethnic disparities were found in age-adjusted incidence of primary GC, with significant differences between races in age, gender, histological type, grade, AJCC stage, location, second cancer, treatment and survival.

We found that Asians/Pacific Islanders demonstrated the highest incidence rates, followed by blacks, whites and American Indian/Alaskan Natives. However, GC incidence declined more among Asian populations during the study period. Host genetic variation[14–16] and/or lifestyle factors[17 18] may interact with *H. pylori* infection prevalence[19 20] and have been considered as possible carcinogenic factors leading to Asians having a higher incidence of GC. We also found that black patients' incident GCs were in early grade and early stage, which may result in higher risk of second primary cancer in blacks. Prostate cancer and lung cancer were the most common secondary cancers



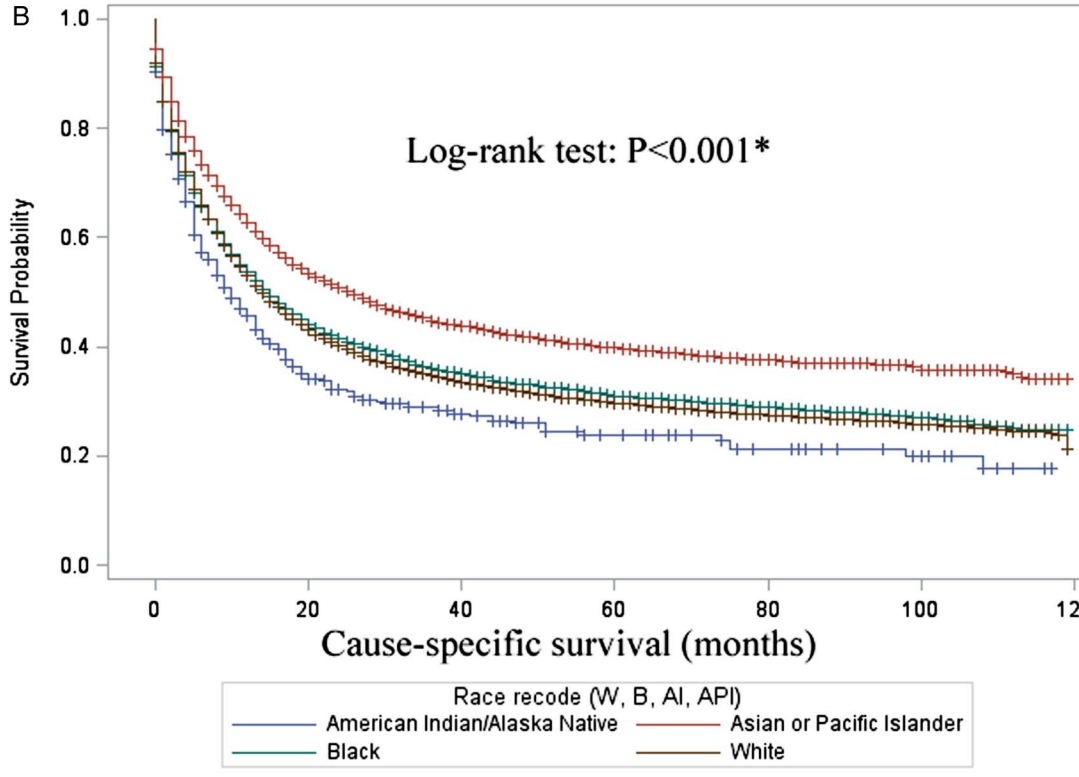


Figure 2 Kaplan-Meier curves of overall survival and cause-specific survival between 2004 and 2013 by race. (A) Overall survival; (B) cause-specific survival.

among the four ethnic groups. These three cancers (gastric, prostate, lung) share the major risk factor of smoking, which may contribute to these results.[21] We also found significant differences in histological types between the ethnic groups but did not find major differences in histopathological reports between ethnic groups in other studies compared with those in this study. However, variations in cancer incidence between ethnic groups suggest that

Table 4 Cox proportional hazard model for overall survival

	Overall survival		Cause-specific survival	
	Adjusted HR (95% CI)	p Value	Adjusted HR (95% CI)	p Value
Diagnostic age (years)	1.016 (1.012 to 1.021)	<0.001*	1.006 (0.999 to 1.013)	0.101
Race				
Black vs white	1.095 (0.960 to 1.249)	0.177	1.059 (0.837 to 1.339)	0.633
American Indian/Alaska Native vs white	2.215 (1.326 to 3.700)	0.002*	2.611 (1.275 to 5.348)	0.009*
Asian or Pacific Islander vs white	0.879 (0.753 to 1.026)	0.103	1.006 (0.777 to 1.302)	0.967
Gender				
Female vs male	0.927 (0.841 to 1.023)	0.130	0.876 (0.733 to 1.046)	0.144
Histological classification				
Non-epithelial tumors vs epithelial tumors	–	–	–	–
Others vs epithelial tumors	0.909 (0.762 to 1.084)	0.289	0.649 (0.453 to 0.930)	0.018*
Grade				
Grade II vs I	1.180 (0.941 to 1.480)	0.152	1.546 (0.929 to 2.574)	0.094
Grade III vs I	1.523 (1.223 to 1.897)	<0.001*	2.882 (1.758 to 4.723)	<0.001*
Grade IV vs I	1.668 (1.156 to 2.406)	0.006*	3.048 (1.516 to 6.128)	0.002*
Stage				
I vs 0	1.489 (0.834 to 2.659)	0.489	1.399 (0.328 to 5.976)	0.650
II vs 0	2.050 (1.112 to 3.779)	0.021*	1.608 (0.363 to 7.129)	0.532
III vs 0	2.489 (1.340 to 4.626)	0.004*	2.309 (0.520 to 10.253)	0.271
IV vs 0	3.004 (1.600 to 5.642)	0.001*	2.547 (0.568 to 11.421)	0.222
Location				
Regional vs localized	1.326 (1.091 to 1.612)	0.005*	1.579 (1.134 to 2.198)	0.007*
Distant vs localized	1.397 (1.071 to 1.823)	0.014*	1.680 (1.087 to 2.596)	0.020*
Second primary cancer				
Yes vs no	0.854 (0.772 to 0.944)	0.002*	6.325 (4.907 to 8.151)	<0.001*
Time to second cancer (years)	0.769 (0.741 to 0.798)	<0.001*	0.750 (0.709 to 0.795)	<0.001*
Treatments				
Surgery vs no surgery and radiation	0.345 (0.301 to 0.397)	<0.001*	0.329 (0.254 to 0.426)	<0.001*
Radiation vs no surgery and radiation	0.639 (0.539 to 0.758)	<0.001*	0.760 (0.565 to 1.023)	0.070
Surgery+radiation vs no surgery and radiation	0.292 (0.244 to 0.350)	<0.001*	0.311 (0.230 to 0.420)	<0.001*

*Indicates significant factors, p<0.05.

separate monitoring of specific populations may help to understand differences in etiology.

Ethnical disparities exist in treatment modalities. Regardless of which stage was identified among patients in this study, Asians/Pacific Islanders were treated actively. Asian countries report superior GC outcomes fairly consistently.[22] If our results among Asian Americans also hold true in native Asian populations, it could possibly explain why the higher incidence of GC in Asian countries has still declined the most since the early 2000s.[5] Surgical resection is first-line treatment for patients with GC, but survival rates after surgery are lower than 2 years without adjuvant radiation.[23] A study of demographic factors associated with not having adjuvant radiotherapy as part of treatment strategy showed that race and socioeconomic factors affected treatment decisions and, in turn, treatment decisions such as omitting adjuvant radiotherapy affected survival.[10] Le[24] indicate that Asian Americans have the highest college or advanced degree attainment rate, higher rate of working in a 'high skill' occupation, and highest family income which may lead to treat aggressively.

In this study, Asians/Pacific Islanders were found to have the highest OS (59%) and CSS rates, which are similar to previous results.[6 25] We believe that early diagnosis (incidence in early stage) and active treatment in Asians were critical to improving survival. Superior rates of survival were found in Asian American patients with GC, explained as a result of unique clinical features, appropriate treatment and possibly cultural differences in lifestyle factors.[25 26] In addition, a study that estimated conditional survival in patients with GC also found that racial disparities that had been pronounced at the time of curative surgery were reduced in long-term follow-up.[25] This may suggest that the influence of race on GC outcomes is less when patients survive longer.

This study has certain limitations, including that it used a secondary database, which limited our control of collected data and how variables were measured and recorded. However, since the SEER tumor registry was found to be generalizable to the US population, the national high-quality database was an important strength of our study, minimizing possible discrepancies and biases. Nevertheless, the SEER database did not include comorbidities, lifestyle and risk factors, environmental exposure, and family history, which we might have preferred to include to help understand treatment choices. In addition, the SEER database did not have information on specific chemotherapy agents or chemoradiation used. Additional studies are needed with longer follow-up at certain time points after surgery, so it can be understood whether and how long ethnic disparities continue after intervention.

CONCLUSIONS

Ethnic disparities exist in the incidence, treatment, and survival of patients with GC. The results of this study may be useful in developing effective strategies to address the issues of ethnic disparities, develop appropriate screening programs, and balance standards of care for GC among given populations.

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