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Treatment and Outcomes of Gastric Cancer Among US-Born and Foreign-Born Asians and Pacific Islanders

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Abstract

Purpose—To investigate whether stage at diagnosis, cancer treatments and survival of Asian and Pacific Islander (API) gastric cancer patients in the US vary by birthplace.

Methods—We studied 6454 API and 10,099 non-Hispanic white (NHW) patients diagnosed with gastric cancer from the Surveillance, Epidemiology and End Results Program between 1992 and 2005. In descriptive analyses we compared stage, receipt of adequate lymph node examination (ALNE) and surgery among US-born APIs, foreign-born (FB) APIs and NHWs. Multivariable polytomous logistic and proportional hazards regression models were used to assess differences in cancer stage and survival, respectively, adjusted for clinical and demographic factors.

Results—As a group, APIs were more likely than NHWs to present with earlier-stage diagnoses and receive surgery and ALNE ($p < 0.001$). However, FB [aOR=0.79 (0.73–0.86)] but not US-born APIs [aOR=1.05 (0.92–1.20)] were significantly more likely to present at earlier stages than NHWs. Compared to NHW patients, FB and US-born APIs were more likely to receive surgery [aRR=1.06 (1.03–1.09) and aRR=1.09 (1.03–1.14) respectively] and ALNE [aRR=1.29 (1.19–1.41) and aRR=1.14 (1.00–1.32) respectively]. In fully adjusted models, FB [aHR= 0.86 (0.82–0.90)] but not US-born APIs [(aHR= 0.96 (0.89–1.04)] had more favorable survival than NHWs.

Conclusions—The earlier-stage diagnosis, more complete surgical treatment and improved survival of Asians and Pacific Islanders with gastric cancer may result from less aggressive tumors or more prompt recognition and thorough evaluation of early symptoms. Further study of these factors could improve outcomes for all patients with gastric cancer.

Keywords

gastric cancer outcomes; Asian/Pacific Islanders; birthplace; ethnicity; SEER

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INTRODUCTION

Despite the declining incidence of gastric cancer in the United States in recent decades, this disease remains a major concern. Current estimates suggest that approximately 21,500 new people were diagnosed and 11,000 died from gastric cancer in 2008.¹ The incidence of gastric cancer varies by race and ethnicity, disproportionately affecting Asian and Pacific Islanders (APIs).^{2,3} Compared to their counterparts residing in Asia and the Pacific Islands, API gastric cancer patients residing in the West experience reduced overall survival rates and stage-stratified survival.^{4–8}

Currently, 13 million APIs reside in the US. This number is projected to triple by 2050, making APIs the fastest growing minority group in the US. APIs also comprise the second largest immigrant group, representing 25% of all immigrants.⁹ Given the sizable numbers of US-born and foreign-born APIs, further investigation of their health outcomes is warranted.

Although early migration studies found that mortality due to gastric cancer was higher in immigrant Asians than in whites,^{10,11} more recent evidence indicates that Asian race is associated with superior overall survival.^{12–16} However, previous analyses have not considered whether stage at diagnosis and survival differ by birthplace. Some studies suggest that foreign birth is associated with worse survival for APIs with breast and colorectal cancer.^{17,18} Yet it remains unknown whether birthplace correlates with cancer outcomes for API patients with gastric cancer.

Therefore, we investigated the associations between birthplace and stage at diagnosis, initial treatment, and overall mortality among APIs with gastric cancer, and compared their experiences to Non-Hispanic white (NHW) patients. We further explored differences in survival among the larger API ethnic subgroups including Japanese, Chinese, Koreans, Filipino, Vietnamese, Pacific Islanders and Hawaiian adults.

METHODS

Data Source

We used publicly available data from 6 US cancer registries participating in the Surveillance, Epidemiology and End Results (SEER) Program¹⁹ from 1992–2005. We used data from registries where at least 5% of gastric cancer patients were APIs (Hawaii, Los Angeles, San Francisco/Oakland, San Jose/Monterey, Seattle/Puget Sound and Atlanta). Of all APIs with gastric cancer recorded by the SEER program during these years, 97% of APIs patients resided in these areas. SEER captures all incident cancers (98% case ascertainment) as well as information on patient demographics at diagnosis, cancer characteristics and initial course of treatment, defined as within 4 months of diagnosis from 1973–1998 and within 12 months of diagnosis after 1998. Ascertainment of surgery and radiation therapy by SEER is generally complete.^{20,21} However, chemotherapy ascertainment is known to be incomplete and is not publicly released in SEER data. Vital status is tracked annually and death certificates are used to capture underlying cause of death.

Because we used publicly available, de-identified data, our study was deemed exempt from review by the Institutional Review Board.

Study Sample

NHW and API patients from the 6 registries were eligible for our study if they were ≥ 18 years old when diagnosed with a pathologically confirmed first primary invasive gastric adenocarcinoma between 1992 and 2005 ($n=23,185$). Adenocarcinoma was defined using

International Classification of Disease for Oncology, 3rd edition codes, 8140–8145, 8260–63, 8310, 8323, 8480, 8481, 8490, 8510, 8510, 8560 and 8570–8576.¹³ We excluded 84 cases where the diagnosis was determined from death certificates or autopsy. Our final study sample consisted of 16,553 patients, including 10,099 (61%) NHW and 6454 (39%) API patients.

Race/Ethnicity and Birthplace

Race/ethnicity and birthplace were primary factors of interest. SEER collects information about race/ethnicity largely from chart review. We classified race/ethnicity into 2 categories, NHW and API, which included Chinese, Japanese, Filipino, Hawaiian, Korean, Asian Indian/Pakistani, Vietnamese, Laotian, Hmong, Kampuchean, Thai, Micronesian, Chamorro, Guamanian, Polynesian, Samoan, Tahitian, Tongan, Melanesian, Fiji Islander, New Guinean, and other Asian and Pacific Islander.

We classified birthplace into US-born, foreign-born and unknown. SEER obtains information about birthplace from multiple sources, including medical records, state motor vehicle records, and death certificates. The sensitivity and positive predictive value of birthplace data among APIs has been reported as greater than 90%.^{22,23} Overall, 19% of API patients were missing birthplace data (ranging from 14% of Japanese to 30% of Chinese patients). Therefore, we included API patients with unknown birthplace as a separate group rather than impute birthplace information or exclude them from our analyses. We classified patients as NHW (n=10,099), US-born API (n=1,944), foreign-born API (n=3,253) or API of unknown birthplace (n=1,257).

We did not examine birthplace among NHW patients because it is not well documented in medical records for white patients, and US Census data indicate that only 3.9% of non-Hispanic white individuals in the US are foreign-born.⁹

Finally, recognizing that APIs are a heterogeneous group and that aggregate data may mask important disparities, we examined 6 API ethnic groups with sufficient samples including Japanese (n=2026), Chinese (n=1460), Korean (n=1187), Filipino (n=641), Vietnamese (n=391), Hawaiian (n=290), and Pacific Islanders (n=140). We further explored Japanese, Chinese, Korean and Filipino groups, comparing US-born and foreign-born patients.

Cancer Outcomes

Our two primary outcomes were stage at diagnosis and overall mortality following diagnosis. Because stage using the American Joint Committee on Cancer (AJCC) classification system for patients with gastric cancer is not available in SEER data until 2004, we used the SEER historical staging system (local, regional and distant) in our primary analyses. Additionally, we derived AJCC stage from individual data elements (see Supplemental Data) when available. For this subset (44%), we performed sensitivity analyses to assess the impact of derived AJCC stage on survival. We assessed deaths from all causes and censored observations of patients alive on December 31, 2005 (n=3,478).

Initial Treatment

We examined the association of birthplace with surgical treatment, adequate lymph node examination (ALNE) and radiation therapy. ALNE was defined as examination of at least 15 lymph nodes as suggested by the AJCC.²⁴ Receipt of surgery was dichotomized for analyses investigating the likelihood of surgery, but was categorized in other models as none, partial gastrectomy, total/near gastrectomy or gastrectomy *en bloc*. Patients with unknown surgery status were excluded. In analyses examining ALNE, only patients who

received surgery (n=8,575) and had known lymph node assessment were included (n=8,031). Receipt of radiation was dichotomized for all analyses.

Statistical Analysis

We performed bivariable analyses to evaluate the relationship between race/ethnicity (according to birthplace) and stage at diagnosis, receipt of ALNE, and surgery. To examine differences in stage, we used multivariable ordinal polytomous logistic regression²⁵ and adjusted for covariates previously shown to be associated with stage including sex, age and marital status at diagnosis, geographic location (SEER tumor registry), and year of diagnosis. Patients with unknown stage (n=1,861) were excluded from this analysis. We estimated adjusted odds ratios (aOR) and 95% confidence intervals (CI) for later stage (regional or distal) at diagnosis. We used multivariable logistic regression to examine differences in initial treatment (surgery, ALNE) by race/ethnicity and birthplace after adjusting for characteristics at diagnosis, geographic location, tumor grade and location. Because treatment was relatively common (>10%), we derived adjusted risk ratios (aRR) and 95% CIs using a log binomial regression model.²⁶ Because previous studies have demonstrated geographic variations in cancer care, we further explored the association between race/ethnicity and SEER region for each outcome.

Finally, we computed Kaplan-Meier estimates of overall survival and fit Cox proportional hazards regression models to examine differences in overall survival by race/ethnicity and birthplace after adjustment for the factors listed above, stage and treatment. We present adjusted relative hazard ratios (aHR) and 95% CI; aHR<1.00 indicates longer survival among API patients relative to NHW patients. Because a number of API patients had unknown birthplace, we performed sensitivity analyses by alternatively categorizing API patients of unknown birthplace as US-born APIs then as foreign-born APIs. All statistical analyses were conducted using SAS version 9.1 (SAS Institute, Cary, NC).

RESULTS

The characteristics of patients with gastric cancer are presented in Table 1. APIs were primarily concentrated in Hawaii and California. Compared to NHW patients, APIs were more likely to be female, married, diagnosed at younger ages, have tumors located in the lower third of their stomach, and present at earlier stages of disease and of lower grade (p<0.001). Compared to all other groups, US-born APIs were significantly less likely to have signet ring cell histology.

Among API patients, US-born APIs were less likely to be female, married and diagnosed at younger ages (p<0.05) than foreign-born APIs. US-born APIs were more likely to present with tumors located in the proximal stomach and with lower-grade tumors than foreign-born APIs (p<0.05) (Table 1).

In bivariable analyses, API patients overall and by birthplace were less likely to present with later-stage disease than NHW patients (Table 2). These differences remained significant after adjustment for the API groups, except for US-born APIs.

Table 3 presents relative rates of surgery and ALNE by race/ethnicity and birthplace, adjusted for demographics factors, geographic location, and tumor characteristics. Regardless of birthplace, APIs were more likely than NHW patients to receive surgery and undergo ALNE though the difference between US-born APIs and NHWs was not statistically significant.

Because the proportion of APIs varied substantially across the SEER registries and previous studies have shown geographic variations in cancer care,^{13,27} we further explored regional variations in stage at diagnosis, receipt of surgery, and ALNE (Table 4). We found that in Hawaii where APIs comprised 88.6% of the sample, patients were more likely to be diagnosed at earlier stages and had the highest rates of surgery (60.8%) and ALNE (56.0%). After adjustment, we found no differences in stage at diagnosis across the regions.

We found regional variations in receipt of surgery ($p < 0.001$) across the six registries. In contrast to Hawaii, Atlanta and Seattle/Puget Sound, areas with the lowest proportion of APIs (12.6% and 14.2%, respectively) also had the lowest surgical rates (49.8% and 49.5%, respectively). In each registry, APIs were more likely to receive surgery than NHWs. However, we found no statistically significant interaction between race/ethnicity and SEER area. After adjustment, only patients in Los Angeles were more likely to receive surgery than those in Seattle/Puget Sound [aRR 1.05, (1.01,1.09)]. With the exception of Hawaii, there were small differences in receipt of ALNE across the other registries (range 27.6%–30.2%). After adjustment, only patients in Hawaii [aRR 1.66, (1.49,1.86)] were more likely to receive ALNE than those in Seattle-Puget Sound.

APIs experienced more favorable overall and stage-specific survival compared with NHWs (Figure 1). The median survival was 14 months for API patients and 8 months for NHW patients ($p < 0.0001$). Among API patients, median survival was 14 months for foreign-born and 10 months for US-born patients. Table 5 presents unadjusted and adjusted hazards ratios of overall mortality comparing APIs with NHW patients. After adjustment for demographic and tumor characteristics (Table 5, column 2), APIs had significantly lower mortality than NHW, even after considering birthplace. Further adjustment for differences in treatment (Table 5, column 3) had a modest impact on the observed difference in mortality between NHW patients and API groups, except for US-born APIs where the survival difference compared to NHWs was no longer statistically significant.

In unadjusted analyses, patients in Hawaii and Los Angeles experienced longer survival compared to those in Seattle/Puget Sound. However, these differences were no longer significant after adjustment (data not shown).

We also determined the hazard ratios of overall mortality comparing APIs and NHW patients, substituting derived AJCC stages for the SEER historical staging system in our adjusted models. Although AJCC stage could be derived for only 44% of gastric cancer patients in this study, our findings did not change, foreign-born [aHR=0.86 (0.79–0.94)] but not US-born API patients [aHR=1.01 (0.89–1.14)] experienced significantly longer survival compared to NHW patients.

API patients with unknown birthplace had better survival than the US-born and foreign-born APIs. Thus, in sensitivity analyses that included APIs with unknown birthplace with US-born APIs, the adjusted hazard ratio (including treatment) was 0.81 (95% CI, 0.76–0.86). When APIs with unknown birthplace were included with the foreign-born APIs, this adjusted hazard ratio was 0.80 (95% CI, 0.71–0.85).

For API ethnic groups with sufficient samples, we explored ethnic-variations in overall mortality compare to NHW patients (Figure 2) and found that overall mortality was lower for each ethnic group. After adjustment, differences for Japanese, Chinese, Korean, Filipino, and Vietnamese patients remained statistically significant. Regardless of birthplace, API patients did not experience significantly worse survival outcomes compared with NHW patients (Figure 3). Within API subgroups, adjusted overall survival was more favorable for foreign-born Korean patients than their US-born counterparts, compared to NHW patients.

Overall survival for Chinese patients was more favorable than NHW patients regardless of birthplace.

DISCUSSION

We examined stage at presentation, initial treatment and survival of API gastric cancer patients categorized by birthplace and ethnicity, distinguishing this study from previously published analyses. Compared to NHWs, API gastric cancer patients residing in the US were more likely to present at earlier stages of disease, receive surgery and have an adequate number of lymph nodes examined. API gastric cancer patients as a group, foreign-born patients in particular, and subgroups of Japanese, Chinese, Korean, Filipino, and Vietnamese patients had significantly longer adjusted survival than NHW patients.

This finding of improved survival among API gastric cancer patients as an aggregate group is consistent with other studies^{12–16,28} though it appears that earlier stage at diagnosis and longer survival for foreign-born APIs is limited to gastric cancer patients. Theuer et al¹⁶ also found a survival advantage specific for Asian (mostly foreign-born) patients with gastric cancer in California, but not for Asian patients with colorectal cancer. Previous studies indicate that foreign-born API patients with other malignancies are more likely to present with advanced-stage disease and experience worse survival than their US-born counterparts.^{29,30} For some cancer diagnoses, this may be because foreign-born APIs are less likely to undergo cancer screening^{31,32} perhaps due to inadequate access to care, limited English proficiency, and other cultural factors.^{33–35} Because no formal population screening programs exist in the US for early detection of gastric cancer, disparities in stage at presentation cannot be attributed to differences in screening. However since minorities and immigrants typically have worse access to health care, it is counter-intuitive that API patients with gastric cancer present at earlier stages, particularly for those who are foreign-born. Because gastric cancer is a greater public health concern in Asian countries, APIs may be more aware of symptoms associated with gastric cancer, especially those who have migrated to the United States. Alternatively, physicians may have a lower threshold for recommending endoscopic evaluation of API patients with upper gastrointestinal symptoms due to their greater risk of gastric cancer.

Several studies highlight the impact of appropriate surgery and ALNE on increased survival for patients with gastric cancer. Surgical intervention may extend survival even if performed for palliative purposes.^{36,37} Furthermore, examination of at least 15 lymph nodes correlates with longer survival, presumably due to more accurate staging.^{13,27,38,39} We were surprised to find that API patients were more likely than NHW patients to receive surgery and have the recommended number of lymph nodes assessed. Although surgery and ALNE had only a modest impact on aggregate API survival in our study, differences in initial treatments explained some of the observed survival advantage among US-born APIs compared to NHWs. Findings from our unadjusted analyses raise the possibility that areas with a very high concentration of APIs, such as Hawaii and Los Angeles, may also have a greater cultural awareness such that gastric cancer patients are diagnosed earlier and have higher rates of surgery and ALNE. Future research should examine the characteristics of providers and the hospitals where gastric cancer patients received treatment. API patients, particularly the foreign-born, may seek treatment from clinicians familiar with APIs and who may suspect gastric cancer more readily when API patients present with common symptoms and also provide more aggressive treatment.

Differences in tumor biology according to ethnicity may explain some of the improved survival among API patients. Gastric tumors among API patients may be less aggressive than in other racial groups.^{7,40} We observed significantly longer survival among foreign-

born APIs even though they were as likely as NHWs to have the more aggressive signet-ring cell histology. However, APIs were also more likely to have tumors located in the distal stomach, a characteristic associated with less aggressive disease and more favorable surgical outcomes and survival.⁴¹ This finding is consistent with other studies that have reported a higher prevalence of distal gastric tumors and increased survival for APIs compared with NHWs.^{12,14,16,42,43}

Furthermore, differences in prevalence of distal gastric tumors may be related in part to *Helicobacter pylori* (*H. pylori*) infection, a well-known risk factor, that also correlates with distal gastric adenocarcinoma and not with more aggressive proximal tumors.⁴⁴ The incidence of *H. pylori* infection is higher in Asian countries than in the US. It is possible that foreign-born APIs migrated to the US with *H. pylori* infection, which affected their gastric tumor characteristics and survival.

Recent studies demonstrate differences in E-cadherin expression,⁴⁵ and microsatellite instability,⁴⁶ which may reflect less aggressive gastric tumors in Japanese patients compared to American patients of European descent or British patients. Further investigation of biological differences in gastric tumors by ethnicity is necessary to determine whether biologic characteristics indicate less aggressive disease and therefore superior survival for APIs.

Although not available in SEER, environmental factors such as smoking, alcohol intake, diet and body mass index^{6,47} may also influence survival in patients with gastric cancer. While the prevalence of these risk factors varies substantially by Asian ethnicity; in the US they are generally less prevalent in APIs than NHWs^{3,47-50} and may contribute to survival differences.^{40,51}

Our study has important limitations. We were unable to assess chemotherapy, which may have a positive impact on survival⁵²⁻⁵⁴. However a recent study of gastric cancer patients in the US found that differences in adjuvant therapy use did not explain the survival advantage experienced by APIs.¹²

AJCC staging was unavailable for most of our patients. Therefore, we used the SEER historic staging system. Although this system employs broader stage classifications, the categories are standardized and consistent over time. Furthermore, sensitivity analyses of the subset of cases with AJCC stage did not alter our findings.

Although SEER mandates the collection of birthplace, this variable is often coded as unknown. Rather than excluding patients with unknown birthplace (19% of API cases), we performed sensitivity analyses. Grouping APIs with unknown birthplace as either US-born or foreign-born APIs did not alter our findings.

Among API ethnic groups, there is substantial variation in socioeconomic status (SES) and length of time since immigrating to the US, which may influence ethnic-specific health outcomes. However, these factors are not captured by SEER. Further research should assess the relationship between SES and gastric cancer outcomes. There are also important differences in patterns of immigration among API ethnic groups, with the Japanese having one of the earliest immigration histories while groups such as Chinese have come in waves. In our study, API patients were generally from more affluent ethnic groups with a longer history of US immigration, including Japanese and Filipinos,³ though Vietnamese patients, generally considered a less affluent group with more recent immigration history,³ also demonstrated more favorable survival compared to NHW patients.

In summary, we found that API patients with gastric cancer, particularly those who are foreign-born, present with earlier stages of disease, are more likely to receive surgery and ALNE, and experience significantly longer survival than NHW patients. Although specific to gastric cancer, these results suggest that patients are not always disadvantaged by foreign birth. This conclusion warrants further study to determine whether biological differences or other factors not examined in this study influence survival differences. These results may help guide future interventions for all gastric cancer patients. Furthermore, our study suggests that the survival of NHW gastric cancer patients may be improved with more extensive surgical resection and thorough lymph node assessments.

Condensed Abstract

We demonstrate that Asian and Pacific Islander (API) gastric cancer patients in the US are more likely to receive surgery and adequate lymph node assessment compared to non-Hispanic white patients. Foreign-born, but not US-born API patients also experience significantly more favorable survival outcomes than non-Hispanic white patients, which remained significant even after adjusting for tumor characteristics and treatment.

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REFERENCES

1. Jemal A, Siegel R, Ward E, et al. Cancer statistics, 2008. *CA Cancer J Clin.* 2008; 58:71–96. [PubMed: 18287387]
2. Kamineni A, Williams MA, Schwartz SM, et al. The incidence of gastric carcinoma in Asian migrants to the United States and their descendants. *Cancer Causes Control.* 1999; 0:77–83. [PubMed: 10334646]
3. McCracken M, Olsen M, Chen MS Jr. et al. Cancer incidence, mortality, and associated risk factors among asian americans of chinese, filipino, vietnamese, korean, and Japanese ethnicities. *CA Cancer J Clin.* 2007; 57:190–205. [PubMed: 17626117]
4. Bollschweiler E, Boettcher K, Hoelscher AH, et al. Is the prognosis for Japanese and German patients with gastric cancer really different? *Cancer.* 1993; 71:2918–2925. [PubMed: 8490819]
5. Bonenkamp JJ, van de Velde CJ, Kampschoer GH, et al. Comparison of factors influencing the prognosis of Japanese, German, and Dutch gastric cancer patients. *World J Surg.* 1993; 17:410–414. [PubMed: 8337889]
6. Fuchs CS, Mayer RJ. Gastric carcinoma. *N Engl J Med.* 1995; 333:32–41. [PubMed: 7776992]
7. Hundahl SA, Stemmermann GN, Oishi A. Racial factors cannot explain superior Japanese outcomes in stomach cancer. *Arch Surg.* 1996; 131:170–175. [PubMed: 8611074]
8. Wanebo HJ, Kennedy BJ, Chmiel J, et al. Cancer of the stomach. A patient care study by the American College of Surgeons. *Ann Surg.* 1993; 218:583–592. [PubMed: 8239772]
9. Schmidley, AD. Profile of the foreign-born population in the United States:2000, Current Population Reports, Special Studies. US Census Bureau; Washington, DC: 2001.
10. King H, Locke FB. Cancer mortality among Chinese in the United States. *J Natl Cancer Inst.* 1980; 65:1141–8. [PubMed: 6933245]
11. Locke FB, King H. Cancer mortality risk among Japanese in the United States. *J Natl Cancer Inst.* 1980; 65:1149–1156. [PubMed: 6933246]
12. Al-Refaie WB, Tseng JF, Gay G, et al. The impact of ethnicity on the presentation and prognosis of patients with gastric adenocarcinoma. Results from the National Cancer Data Base. *Cancer.* 2008; 113:461–469. [PubMed: 18553367]

13. Coburn NG, Swallow CJ, Kiss A, et al. Significant regional variation in adequacy of lymph node assessment and survival in gastric cancer. *Cancer*. 2006; 107:2143–2151. [PubMed: 17001662]
14. Gill S, Shah A, Le N, et al. Asian ethnicity-related differences in gastric cancer presentation and outcome among patients treated at a canadian cancer center. *J Clin Oncol*. 2003; 21:2070–2076. [PubMed: 12775731]
15. Theuer CP. Asian gastric cancer patients at a southern California comprehensive cancer center are diagnosed with less advanced disease and have superior stage-stratified survival. *Am Surg*. 2000; 66:821–826. [PubMed: 10993608]
16. Theuer CP, Kurosaki T, Ziogas A, et al. Asian patients with gastric carcinoma in the United States exhibit unique clinical features and superior overall and cancer specific survival rates. *Cancer*. 2000; 89:1883–1892. [PubMed: 11064344]
17. Choe JH, Koepsell TD, Heagerty PJ, et al. Colorectal cancer among Asians and Pacific Islanders in the U.S.: survival disadvantage for the foreign-born. *Cancer Detect Prev*. 2005; 29:361–368. [PubMed: 16081223]
18. Pineda MD, White E, Kristal AR, et al. Asian breast cancer survival in the US: a comparison between Asian immigrants, US-born Asian Americans and Caucasians. *Int J Epidemiol*. 2001; 30:976–982. [PubMed: 11689507]
19. Surveillance, Epidemiology, and End Results (SEER) Program. Public-Use Data (1973–2005). National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, release April 2008 based on the November 2007 submission. Available at <http://www.seer.cancer.gov>
20. Cooper GS, Virnig B, Klabunde CN, et al. Use of SEER-Medicare data for measuring cancer surgery. *Med Care*. 2002; 40:IV, 43–48.
21. Virnig BA, Warren JL, Cooper GS, et al. Studying radiation therapy using SEER-Medicare-linked data. *Med Care*. 2002; 40:IV, 49–54.
22. Lin SS, O'Malley CD, Lui SW. Factors associated with missing birthplace information in a population-based cancer registry. *Ethn Dis*. 2001; 11:598–605. [PubMed: 11763284]
23. Lin SS, Clarke CA, O'Malley CD, et al. Studying cancer incidence and outcomes in immigrants: methodological concerns. *Am J Public Health*. 2002; 92:1757–1759. [PubMed: 12406802]
24. American Joint Committee on Cancer Staging Manual. ed 5th. Lippincott-Raven; Philadelphia, PA: 1997.
25. Hosmer, DW. S. L. Applied logistic regression. ed 2nd. Wiley-Interscience; NY: 2000.
26. Spiegelman D, Hertzmark E. Easy SAS calculations for risk or prevalence ratios and differences. *Am J Epidemiol*. 2005; 162:199–200. [PubMed: 15987728]
27. Baxter NN, Tuttle TM. Inadequacy of lymph node staging in gastric cancer patients: a population-based study. *Ann Surg Oncol*. 2005; 12:981–987. [PubMed: 16244801]
28. Yao JC, Tseng JF, Worah S, et al. Clinicopathologic behavior of gastric adenocarcinoma in Hispanic patients: analysis of a single institution's experience over 15 years. *J Clin Oncol*. 2005; 23:3094–3103. [PubMed: 15860869]
29. Chien C, Morimoto LM, Tom J, et al. Differences in colorectal carcinoma stage and survival by race and ethnicity. *Cancer*. 2005; 104:629–639. [PubMed: 15983985]
30. Chuang SC, Chen W, Hashibe M, et al. Survival rates of invasive breast cancer among ethnic Chinese women born in East Asia and the United States. *Asian Pac J Cancer Prev*. 2006; 7:221–226. [PubMed: 16839213]
31. Goel MS, Wee CC, McCarthy EP, et al. Racial and ethnic disparities in cancer screening: the importance of foreign birth as a barrier to care. *J Gen Intern Med*. 2003; 18:1028–1035. [PubMed: 14687262]
32. Kandula NR, Wen M, Jacobs EA, et al. Low rates of colorectal, cervical, and breast cancer screening in Asian Americans compared with non-Hispanic whites: Cultural influences or access to care? *Cancer*. 2006; 107:184–192. [PubMed: 16721803]
33. Frisbie WP, Cho Y, Hummer RA. Immigration and the health of Asian and Pacific Islander adults in the United States. *Am J Epidemiol*. 2001; 153:372–380. [PubMed: 11207155]
34. Ku L, Matani S. Left out: immigrants' access to health care and insurance. *Health Aff (Millwood)*. 2001; 20:247–256. [PubMed: 11194848]

35. Tanjasiri SP, Tran JH, Kagawa-Singer M, et al. Exploring access to cancer control services for Asian-American and Pacific Islander communities in Southern California. *Ethn Dis.* 2004; 14:S14–S19. [PubMed: 15682767]
36. Carson W, Karakousis C, Douglass H, et al. Results of aggressive treatment of gastric sarcoma. *Ann Surg Oncol.* 1994; 1:244–251. [PubMed: 7531105]
37. Zhang XF, Huang CM, Lu HS, et al. Surgical treatment and prognosis of gastric cancer in 2,613 patients. *World J Gastroenterol.* 2004; 10:3405–3408. [PubMed: 15526356]
38. Schwarz RE, Smith DD. Clinical impact of lymphadenectomy extent in resectable gastric cancer of advanced stage. *Ann Surg Oncol.* 2006; 14:317–328. [PubMed: 17094022]
39. Smith DD, Schwarz RR, Schwarz RE. Impact of total lymph node count on staging and survival after gastrectomy for gastric cancer: data from a large US-population database. *J Clin Oncol.* 2005; 23:7114–7124. [PubMed: 16192595]
40. Sjødahl K, Lu Y, Nilsen TI, et al. Smoking and alcohol drinking in relation to risk of gastric cancer: a population-based, prospective cohort study. *Int J Cancer.* 2007; 120:128–132. [PubMed: 17036324]
41. Ohno S, Tomisaki S, Oiwa H, et al. Clinicopathologic characteristics and outcome of adenocarcinoma of the human gastric cardia in comparison with carcinoma of other regions of the stomach. *J Am Coll Surg.* 1995; 180:577–582. [PubMed: 7749534]
42. Hundahl SA, Phillips JL, Menck HR. The National Cancer Data Base Report on poor survival of U.S. gastric carcinoma patients treated with gastrectomy: Fifth Edition American Joint Committee on Cancer staging, proximal disease, and the “different disease” hypothesis. *Cancer.* 2000; 88:921–932. [PubMed: 10679663]
43. Kim JP, Lee JH, Kim SJ, et al. Clinicopathologic characteristics and prognostic factors in 10 783 patients with gastric cancer. *Gastric Cancer.* 1998; 1:125–133. [PubMed: 11957056]
44. Prinz C, Schwendy S, Voland P. H pylori and gastric cancer: shifting the global burden. *World J Gastroenterol.* 2006; 12:5458–5464. [PubMed: 17006981]
45. Theuer CP, Al-Kuran R, Akiyama Y, et al. Increased epithelial cadherin expression among Japanese intestinal-type gastric cancers compared with specimens from American patients of European descent. *Am Surg.* 2006; 72:332–338. [PubMed: 16676859]
46. Theuer CP, Campbell BS, Peel DJ, et al. Microsatellite instability in Japanese vs European American patients with gastric cancer. *Arch Surg.* 2002; 137:960–965. discussion 965–966. [PubMed: 12146999]
47. Dhar DK, Kubota H, Tachibana M, et al. Body mass index determines the success of lymph node dissection and predicts the outcome of gastric carcinoma patients. *Oncology.* 2000; 59:18–23. [PubMed: 10895061]
48. Summary of National Findings. Rockville, MD: 2002. Results from the 2001 National Household Survey on Drug Abuse: Volume I.
49. Dey AN, Lucas JW. Physical and mental health characteristics of U.S.- and foreign-born adults: United States, 1998–2003. *Adv Data.* 2006; 1–19. [PubMed: 16541709]
50. Tsujinaka T, Sasako M, Yamamoto S, et al. Influence of Overweight on Surgical Complications for Gastric Cancer: Results From a Randomized Control Trial Comparing D2 and Extended Para-aortic D3 Lymphadenectomy (JCOG9501). *Ann Surg Oncol.* 2007; 14:355–361. [PubMed: 17146738]
51. Fujino Y, Mizoue T, Tokui N, et al. Cigarette smoking and mortality due to stomach cancer: findings from the JACC Study. *J Epidemiol.* 2005; 15(Suppl 2):S113–S119. [PubMed: 16127222]
52. Cunningham D, Allum WH, Stenning SP, et al. Perioperative chemotherapy versus surgery alone for resectable gastroesophageal cancer. *N Engl J Med.* 2006; 355:11–20. [PubMed: 16822992]
53. Im, S.; Kim, S.; Kim, J., et al. A phase II trial of perioperative chemotherapy with folinic acid, 5-fluorouracil, and oxliplatin in potentially resectable gastric cancer with regional lymph node metastasis. *Journal of Clinical Oncology*; 2007 ASCO Annual Meeting Proceedings Part I; Chicago, IL. 2007.
54. Macdonald JS, Smalley SR, Benedetti J, et al. Chemoradiotherapy after surgery compared with surgery alone for adenocarcinoma of the stomach or gastroesophageal junction. *N Engl J Med.* 2001; 345:725–30. [PubMed: 11547741]

Figure 1.
Overall unadjusted stage-specific survival of Asian and Pacific Islander groups and non-Hispanic White gastric cancer patients.

Figure 2. Overall survival among Asian and Pacific Islander ethnic groups compared with Non-Hispanic White patients.

Figure 3.
Overall survival of Asian and Pacific Islander ethnic groups by birthplace compared with Non-Hispanic White patients.

Table 1

Demographic and Tumor Characteristics by Race/Ethnicity and Birthplace

	APIs			
	NHW (N=10099) %	US-born (N=1944) %	Foreign-born (N=3253) %	Unknown birthplace N=(1257) %
Demographic Characteristics				
Sex *				
Male	65	63	56	59
Female	35	37	44	41
Age at diagnosis (mean ± sd) *	71 ±13	72 ±12	66 ±15	69 +14
Marital status *				
Married	59	64	69	67
Not married	41	36	31	33
Registry *				
Los Angeles	37	14	49	37
Seattle/Puget Sound	23	3	8	5
San Francisco/Oakland	20	5	19	33
San Jose/Monterey	10	3	11	13
Atlanta	7	<1	2	2
Hawaii	3	75	11	10
Tumor Characteristics				
Location of tumor *				
Cardia and fundus (upper 1/3)	42	16	12	13
Body (middle 1/3)	7	12	9	10
Antrum and Pylorus (lower 1/3)	19	30	37	38
Overlapping region	8	13	10	8
Stomach, lesser, greater curv. NOS [†]	24	29	32	31
Stage at diagnosis *				
Local	20	23	22	31
Regional	32	36	37	33
Distant	36	33	31	24
Unstaged	12	8	10	12
Histology *				
Adenocarcinoma	82	87	77	80
Signet ring cell	18	13	23	20
Tumor grade *				
Well differentiated	3	4	3	5
Moderately differentiated	24	25	22	25
Poorly differentiated	58	61	63	59
Undifferentiated	2	1	2	1
Undetermined	13	9	10	10

*
p<0.001

[†]Not otherwise specified (NOS)

Table 2

Likelihood of Later Stage Presentation by Race/Ethnicity and Birthplace

Race/Ethnicity	Unadjusted Odds Ratio[‡] (95% CI)	Adjusted Odds Ratio^{‡*} (95% CI)
Non-Hispanic White	1.00	1.00
All API	0.76 (0.729–0.78)	0.78 (0.72–0.84)
API by birthplace		
US-born	0.83 (0.76–0.91)	1.05 (0.92–1.20)
Foreign-born	0.82 (0.76–0.89)	0.79 (0.72–0.86)
Unknown	0.55 (0.49–0.62)	0.58 (0.51–0.65)

Odds ratios < 1.00 indicate earlier stage at diagnosis among API compared to non-Hispanic White patients.

[‡] Considering only patients with known stage at diagnosis

^{*} Adjusted for year of diagnosis, age, marital status, sex, SEER registry, tumor location, grade, and histology

Table 3

Likelihood of Receiving Surgery and Adequate Lymph Node Examination by Race/Ethnicity and Birthplace

Race/Ethnicity	Receipt of Surgery	Receipt of Adequate Lymph Node Examination [*]
	Adjusted [†] RR (95% CI)	Adjusted [‡] RR (95% CI)
Non-Hispanic White	1.00	1.00
All API	1.08 (1.05–1.11)	1.24 (1.15–1.33)
API by birthplace		
US-born	1.09 (1.03–1.14)	1.14 (1.00–1.32)
Foreign-born	1.06 (1.03–1.09)	1.29 (1.19–1.41)
Unknown	1.13 (1.09–1.17)	1.21 (1.08–1.37)

^{*} Adjusted for year of diagnosis, age, marital status, sex, SEER registry, tumor location, stage at diagnosis, grade, and histology.

[†] Among the subset of patients who received surgery and known lymph node examination.

[‡] Adjusted for year of diagnosis, age, marital status, sex, registry, tumor location, stage at diagnosis, grade, histology, and type of surgery.

Table 4

Unadjusted Proportions of Early-Stage at Diagnosis, Receipt of Surgery and Adequate Lymph Node Examination by SEER Registry Area

Registry	n	Proportion of APIs in Registry [*] , %	Diagnosed at Stage I [*] , %	Receipt of Surgery [*] , %	Receipt of Adequate Lymph Node Examination [*] , %
Hawaii	2,113	88.6	26.8	60.8	56.0
Los Angeles	5,769	38.5	21.5	55.8	29.8
San Francisco/Oakland	3,007	35.6	21.5	51.7	28.8
San Jose-Monterey	1,489	35.5	21.9	53.4	27.9
Seattle-Puget Sound	2,669	14.2	19.0	49.5	30.2
Atlanta	807	12.6	21.1	49.8	27.6

^{*} p<0.001.

Table 5

Multivariable Analyses of Overall Survival Following Gastric Cancer Diagnosis by Race/Ethnicity and Birthplace

	Unadjusted HR (95% CI)	Adjusted* HR (95% CI)	Treatment Adjusted† HR (95% CI)
Non-Hispanic White	1.00	1.00	1.00
All API	0.70 (0.68–0.73)	0.80 (0.76–0.83)	0.84 (0.80–0.87)
API by birthplace			
US-born	0.86 (0.81–0.90)	0.88 (0.82–0.95)	0.96 (0.89–1.04)
Foreign-born	0.70 (0.66–0.73)	0.83 (0.79–0.87)	0.86 (0.82–0.90)
Unknown	0.52 (0.48–0.56)	0.64 (0.59–0.70)	0.67 (0.62–0.73)

* Adjusted Hazard Ratios (aHR) < 1.00 indicate longer survival time among API patients compared to non-Hispanic White patients. Using proportional hazard regression, aHRs are adjusted for year of diagnosis, age, marital status, sex, SEER registry, stage at diagnosis, tumor location, grade, and histology.

† Further adjusted for treatment (receipt of adequate lymph node examination, radiation therapy, and surgery).