Published in final edited form as:
Cancer Epidemiol Biomarkers Prev. 2009 August ; 18(8): 2248–2255. doi: 10.1158/1055-9965.EPI-09-0332.

Uncovering disparities in survival after non-small-cell lung cancer among Asian/Pacific Islander ethnic populations in California

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Abstract

Asians may have better survival after non-small-cell lung cancer (NSCLC) than non-Asians. However, it is unknown whether survival varies among the heterogeneous U.S. Asian/Pacific Islander (API) populations. Therefore, this study aimed to quantify survival differences among APIs with NSCLC. Differences in overall and disease-specific survival were analyzed in the California Cancer Registry among 16,577 API patients diagnosed with incident NSCLC between 1988 and 2007. Adjusted hazard ratios (HRs) with 95% confidence intervals (CIs) were estimated using Cox proportional hazards regression models with separate baseline hazards by disease stage. Despite better overall and disease-specific survival among APIs compared with non-Hispanic Whites, differences were evident across API populations. Among women, Japanese (overall survival HR=1.16, 95% CI=1.06–1.27) and APIs other than those in the six largest ethnic groups ("other APIs"; HR=1.19, 95% CI=1.07–1.33) had significantly poorer overall and disease-specific survival than Chinese. By contrast, South Asian women had significantly better survival than Chinese (HR=0.79, 95% CI=0.63–0.97). Among men, Japanese (HR=1.15, 95% CI=1.07–1.24), Vietnamese (HR=1.07, 95% CI=1.00–1.16), and other APIs (HR=1.18, 95% CI=1.08–1.28) had significantly poorer overall and disease-specific survival than Chinese. Other factors independently associated with poorer survival were lower neighborhood SES, involvement with a non-university-teaching hospital, unmarried status, older age, and earlier year of diagnosis. APIs have significant ethnic differences in NSCLC survival that may be related to disparate lifestyles, biology, and especially health care access or use. To reduce the nationwide burden of lung cancer mortality, it is critical to identify and ameliorate hidden survival disparities such as those among APIs.

Keywords

non-small-cell lung cancer; survival; Asian Americans; Pacific Islanders; ethnic groups

Introduction

Lung cancer, of which 80–90% is non-small-cell lung cancer (NSCLC), has been the leading cause of cancer death in the U.S since the late 1960's (1), with median survival below 8 months

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for disease stages III and IV (2). However, lung cancer mortality and survival rates vary markedly by race and ethnicity (1), such that the public health burden of the disease differs by population subgroup. Although randomized clinical trials (3–6) and some population-based studies (2,7–9) have pointed to better survival among Asian NSCLC patients compared with non-Asian patients, little is known about NSCLC survival differences among specific Asian and Pacific Islander (API) ethnic groups. Given the wide variation in English fluency, education, culture, immigration history, and socioeconomic status (SES) among API ethnic groups in the U.S. (10), these groups most likely have differential access to health care, including cancer diagnosis and treatment. Differences in treatment and stage at diagnosis, in turn, are largely responsible for other, well-documented racial/ethnic disparities in survival after NSCLC (11,12). In a hospital-based study, Finlay et al. found that foreign-born Chinese and Vietnamese lung cancer patients had more advanced stage at presentation, longer duration of pre-diagnosis symptoms, and poorer 2-year survival compared with non-Asian patients in the Boston, Massachusetts, area (13). These disparities were likely attributable in part to language barriers and cultural resistance to western medical care (13)—issues that vary in prevalence by API ethnicity and nativity (10).[1]

The U.S. API population is highly diverse according to acculturation, socioeconomic status (SES), and cultural beliefs and practices regarding health care. According to the 2000 U.S. Census, among the six largest API ethnic groups (Chinese, Filipino, Asian Indian, Vietnamese, Korean, and Japanese), the percentage of individuals who spoke English less than "well" varied between 6% for Filipinos and 31% for Vietnamese; the percentage of adults aged 25 and over with less than a high school education ranged from 9% for Japanese to 38% for Vietnamese; and the percentage of individuals living below poverty status ranged from 6% for Filipinos to 15% for Koreans and 16% for Vietnamese (10). Furthermore, in California in 2007, the percentage of individuals without current health insurance varied between 3% for Japanese and 31% for Koreans.[1]

Given this substantial heterogeneity, we hypothesized that NSCLC survival varies significantly and independently by API ethnicity, SES, and nativity. We took advantage of data available for APIs in California, the state with the largest API population in the U.S. (14), to look in detail at differences in survival after NSCLC among API ethnic groups. Documenting such disparities is necessary for developing ethnically and culturally tailored ways to reduce them.

Materials and methods

Study population

Eligible patients were all California residents diagnosed between January 1, 1988, and December 31, 2007, with first primary, incident, microscopically confirmed, invasive non-small-cell carcinoma of the lung and bronchus (International Classification of Diseases for Oncology, Third Edition [ICD-O-3] site codes 340–343, 348–349, morphology codes 8000–8576, excluding 8041–8045 [small cell carcinoma] (15)). Patients were reported by state mandate to the California Cancer Registry (CCR), which routinely collects patient data on age at diagnosis, sex, race/ethnicity, summary stage, treatment modality within the first four months after diagnosis, vital status as of December 2007 (determined by the CCR through hospital follow-up and linkages to vital status and other databases), and, for the deceased, the underlying cause of death.

For this analysis, we used data from medical records (16) to classify API patients as Chinese, Japanese, Filipino, Korean, South Asian, Vietnamese, or other API (including 15%

[1]California Health Interview Survey. www.chis.ucla.edu

Cambodians, 14% Laotians, 12% Samoans, 10% native Hawaiians, and more than 10 other API ethnic groups), as well as non-Hispanic Whites (as a reference group). If race was coded as "Asian, not otherwise specified," the North American Association of Central Cancer Registries (NAACCR) API Identification Algorithm (17), which identifies race based on surname, maiden name (for women), and/or birthplace, was used to classify patients into more specific API groups, if possible. Likewise, if Hispanic ethnicity was unspecified, the NAACCR Hispanic Identification Algorithm (18) was used to classify patients as non-Hispanic.

After exclusion of patients with missing or invalid survival time, including those diagnosed on the death certificate or at autopsy (*N*=907) there were 173,781 eligible NSCLC patients, including 16,577 API patients, included in this analysis. The study protocol was approved by the Institutional Review Board of the Northern California Cancer Center.

Neighborhood socioeconomic status

Because SES information is not collected for individual patients by cancer registries, we determined neighborhood-level SES according to patient residence at diagnosis using an index that combines census block-group averages of education, income, occupation, and cost of living, as described previously (19). Information on neighborhood SES was available for 97% of API patients whose residential address at diagnosis could be coded at the census block group level; patients with missing block group information (3%) were randomly assigned to a block group within their county of residence. Neighborhood SES was classified into quintiles based on the distribution of the SES index in the statewide population, then combined into lower SES (quintiles 1, 2, and 3) or higher SES (quintiles 4 and 5).

Nativity

Information on country of birth was available for 77% of API patients. For the remaining 23% of API patients with unknown country of birth, the first five digits of the Social Security number (SSN), indicating the year of issuance, were used along with date of birth to calculate age of issuance and thereby impute nativity (20,21). We have previously found that imputed nativity based on age of SSN issuance, compared with self-reported nativity, has 84% sensitivity and 80% specificity for classifying foreign birthplace when API patients who received their SSN at or after age 25 years are imputed as being foreign-born, and those who received their SSN before age 25 are imputed as being U.S.-born (22).

Statistical analysis

Follow-up was measured in months from the date of diagnosis until the date of death from any cause (for overall survival), the date of death from lung cancer (for lung-cancer-specific survival, in which patients who died from other causes were censored at the time of death), the date of last known contact, or the end of the study (December 31, 2007), whichever occurred earliest. Of the 3,196 API patients who were alive at the end of the study period, 87% had a follow-up date within two years of the study end date. Recentness of follow-up did not differ significantly by SES, but Filipinos, South Asians, Vietnamese, and other APIs, as well as foreign-born APIs overall, had fewer than 90% of patients with follow-up within two years, whereas Chinese, Japanese, and Koreans had over 90% with recent follow-up (chi-square $P<0.001$).

Multivariate Cox models proportional hazards models with separate baseline hazards by summary stage at diagnosis were used to estimate hazard ratios (HRs) with 95% confidence intervals (CIs) for all-cause or lung-cancer specific mortality. Men and women were analyzed separately due to well-known sex differences in survival with NSCLC (23,24). Models were adjusted for potential confounders that were selected based on univariate associations with survival, change-in-estimate criteria, and prior knowledge. These variables included age

(continuous), ethnicity (with Chinese, the largest API ethnic group in California, as the reference group), year of diagnosis (continuous), tumor histology (adenocarcinoma [ICD-O-3 morphology codes 8140–8239, 8260–8550]; bronchioloalveolar carcinoma [8250–54]; squamous cell carcinoma [8050–52, 8070–76]; large cell carcinoma [8012, 8013, 8022, 8030, 8031]; other non-small-cell carcinoma [8030–8035, 8046–8576]; or undifferentiated/other histology [8000, 8010, 8020, 8046]), marital status (married or unknown [2%], single/never married, or separated/divorced/widowed), neighborhood SES (lower or higher SES), case reporting to the CCR by a university teaching hospital (yes or no),[2] and initial treatment with surgery (yes or no/unknown), radiotherapy (yes or no/unknown), or chemotherapy (yes or no/unknown). We lacked specific data on therapy with epidermal growth factor (EGFR) tyrosine kinase inhibitors, a class of drugs with significant activity in Asian NSCLC patients that became available near the end of our analysis period (2003).

The proportional hazards assumption was assessed by visual inspection of the survival curves (log (-log) of the survival distribution function by log (months)) and tests for time-dependency. Because associations with treatment varied over time, we included interactions between time and surgery, radiotherapy, and chemotherapy. Exploratory secondary analyses to evaluate effect modification were conducted using separate Cox models stratified by summary stage at diagnosis. Tumor-node-metastasis (TNM) stage and histologic grade were not considered because they were not available for a large proportion of cases. Analyses were conducted using SAS version 9.1.3 software (SAS Institute Inc., Cary, NC).

Results

The demographic and disease characteristics of all 16,577 API patients with NSCLC are shown in Tables 1 (women) and 2 (men). Due in part to the large sample size, nearly all characteristics, including age at diagnosis, differed statistically significantly by ethnic group in univariate analyses ($P<0.05$), with the exceptions of chemotherapy among women ($P=0.34$) and radiotherapy among men ($P=0.38$). The higher proportion of Filipinos, Koreans, South Asians, and Vietnamese diagnosed in more recent years is likely related to later waves of immigration, which are also reflected by the higher foreign-born percentage in these ethnic groups. Overall, API women were more likely than men to be diagnosed with adenocarcinoma (53% vs. 40%, respectively) or bronchioloalveolar carcinoma (8% vs. 4%), and less likely to be diagnosed with squamous cell carcinoma (10% vs. 24%). Women were also somewhat more likely than men to undergo surgery as an initial course of treatment (25% vs. 22%) and less likely to undergo radiotherapy (36% vs. 42%). However, the distribution of stage at diagnosis did not vary appreciably by sex.

Among both women and men, Chinese, Filipinos, and Vietnamese were more likely than Japanese, Koreans, South Asians, and other APIs to be diagnosed with adenocarcinoma, and less likely to be diagnosed with squamous cell carcinoma (Tables 1 and 2). Japanese (56%) and South Asian women (53%) were less likely than women in other API ethnic groups (>60%) to be diagnosed with distant-stage NSCLC and, correspondingly, the same groups were somewhat more likely to undergo surgery as a first course of treatment. By contrast, among men, the most striking difference was that APIs other than those in the six largest ethnic groups ("other APIs") were more likely to be diagnosed with distant-stage NSCLC and less likely to undergo surgery.

The median follow-up time of the 16,577 API patients with NSCLC was 7 months for deceased patients ($N=13,193$) and 24 months for non-deceased patients ($N=3,384$). Among women, unadjusted 2-year overall survival rates were lowest for other APIs (30%), followed by

[2]California Cancer Registry. http://www.ccrcal.org/brochure/reportng.pdf

Vietnamese (31%), Chinese, Japanese, and Koreans (33%), Filipinas (36%), and South Asians (45%). Among men, unadjusted 2-year overall survival rates were likewise lowest for other APIs (20%), followed by Filipinos and Koreans (24%), Japanese (25%), and Chinese, South Asians, and Vietnamese (27%).

As a group, all APIs combined had significantly better overall and disease-specific survival after NSCLC diagnosis, compared with non-Hispanic Whites (HR for overall survival=0.79 [95% CI: 0.76–0.81] for women; HR=0.83 [95% CI: 0.81–0.85] for men). However, there was statistically significant heterogeneity in survival among API ethnic groups after adjustment for age at diagnosis, year of diagnosis, marital status, neighborhood-level SES, case reporting by a university teaching hospital, tumor histology, and initial treatment with surgery, radiotherapy, or chemotherapy (Tables 3 and 4). Among women with NSCLC, Japanese and other APIs had significantly worse overall survival than Chinese, whereas South Asians had significantly better survival (Table 3). Overall survival was comparable among Filipina, Korean, Vietnamese, and Chinese women. Among men with NSCLC, Japanese, Vietnamese, and other APIs had significantly worse overall survival than Chinese, whereas Koreans had marginally worse survival, and Filipinos and South Asians had comparable survival (Table 4). Removing treatment (surgery, radiotherapy, and chemotherapy) from the multivariate models did not appreciably affect the results (data not shown). Results for disease-specific survival were similar to those for overall survival (data not shown), as 78% of deceased patients died of lung cancer.

Besides ethnicity, several other factors were significantly associated with overall and disease-specific survival after NSCLC diagnosis in APIs. Among both women and men, older age at diagnosis, never-married status, and squamous cell, large cell, or undifferentiated/other histology were associated with significantly decreased survival, whereas more recent year of diagnosis, higher SES, and case reporting by a university teaching hospital were associated with significantly increased survival (Tables 3 and 4). Among men only, separated/widowed/divorced status and “other” NSCLC histology were also associated with significantly poorer survival. Nativity was not associated with overall or disease-specific survival in API women or men after adjusting for ethnic group (data not shown). Because models were adjusted for interactions between treatment and time, distinct HRs for surgery, radiotherapy, and chemotherapy could not be estimated. However, in models stratified by period of diagnosis (1998–2000 vs. 2001–2007), having undergone surgery was significantly associated with 3- to 4-fold better survival among women and men, with stronger effects in the later time period; chemotherapy was significantly associated with 1.4- to 2-fold better survival, with stronger effects in the later time period; and radiotherapy was not associated with a substantial difference in survival during either period (data not shown).

In exploratory analyses of stage-specific overall survival after NSCLC diagnosis, results did not change markedly, although ethnic differences in survival were most prominent for distant-stage disease (i.e., the majority of cases). As before, the HR was above 1.0 for Japanese and other API women, and below 1.0 for South Asian women, relative to Chinese women, with localized, regional, or distant disease; and the HR was above 1.0 for Japanese, Korean, Vietnamese, and other API men, relative to Chinese men, with regional or distant disease (data not shown). However, analyses of localized and regional disease were constrained by small sample size. Results were similar in analyses limited to the most recent 10 years of the study period, with Japanese and other APIs having significantly poorer survival than Chinese women and men (data not shown).

Discussion

Current literature shows that APIs in aggregate have more favorable survival after NSCLC diagnosis, compared with other racial/ethnic groups (2–9). However, studies that disaggregate health statistics for this heterogeneous group have shown dramatic variations in health status and disease rates among ethnic groups (25). Indeed, our findings reveal significant survival differences after NSCLC diagnosis among API ethnic groups, suggesting that survival statistics combining Asians or APIs into a single group are uninformative for quantifying the burden of lung cancer among APIs, and certainly for guiding public health and clinical practice. In particular, among API women in California, South Asians, Chinese, Koreans, Filipinas, and Vietnamese had more favorable survival, whereas Japanese and other APIs had relatively poorer survival. Among API men, Chinese, Filipinos, and South Asians had relatively better survival, whereas Vietnamese, Koreans, Japanese, and other APIs had relatively worse survival. These differences persisted even after accounting for variation in nativity patterns, neighborhood SES, age, stage, and other prognostic factors.

The poorer survival among the “other API” group in our study may reflect lower SES and access to health care, given that this group was mainly composed of Asian ethnic groups (e.g., Cambodians, Laotians, and Samoans) with generally lower SES (10). Lower SES may also explain the decreased survival among Vietnamese men (10). In our study population, living in neighborhoods of relatively higher SES was associated with slightly improved survival. Because other racial/ethnic disparities in cancer survival, such as those between Blacks and Whites, appear to be due largely to differences in treatment and stage at diagnosis (11,12), which in turn are highly dependent on SES and access to health care (26), it is likely that the ethnic disparities observed in our study were likewise due chiefly to differential access. Although we adjusted for neighborhood-level SES based on residential address at diagnosis, we did not have information on individual-level measures of SES, such as education and income. While neighborhood-level and individual-level SES are correlated (27), the two groups of measures capture different types of exposures that are independently associated with health outcomes (28). Thus, our estimates of ethnic differences in survival after NSCLC diagnosis do not account for unmeasured differences in individual-level SES or other measures of access to health care. Adjusting for such measures might attenuate most of the observed survival differences.

The poorer survival among Japanese women and men, by contrast, is probably not due to lower SES and health care access. According to biennial California Health Interview Survey (CHIS) data from 2001 through 2007, Japanese consistently had higher SES (measured by education, income, and poverty level) and access to health care (measured by health insurance status and delay of care) than other API ethnic groups.[1] The Japanese American population has been established in the U.S. for more than a century and has adopted many elements of a westernized lifestyle (29, 30); in 2001–2003, 82% of Japanese men and 70% of Japanese women in California were U.S.-born, compared with <35% of men and women in other Asian ethnic groups.[1] Thus, it is possible that factors we could not assess in our study, including typical western behaviors and comorbidities, that contribute to poorer NSCLC survival among non-Hispanic Whites may be responsible for the relatively lower survival among Japanese observed in our study. Of note, among Japanese men and women in California, increased acculturation is associated with a lower prevalence of cigarette smoking (31). Our results in California contrast with the excellent survival among Japanese NSCLC patients in Japan, where studies have routinely showed better survival than among Japanese Americans (5,6).

It is also conceivable that part of the observed ethnic differences in survival was due to biological differences among API ethnic groups, although the impact of biology is probably less than that of access to care. Randomized clinical trials of the EGFR tyrosine kinase

inhibitors gefitinib (3) and erlotinib (4) (which were approved by the FDA in 2003 and 2004, respectively, with restrictions later placed on gefitinib) found that NSCLC patients of East Asian background had significantly better treatment response than non-Asians, likely due predominantly to the higher prevalence of EGFR tyrosine kinase domain activating mutations among East Asians (32–34). There may be ethnic variation among APIs in the prevalence of these mutations (35–38) and other genetic polymorphisms that affect treatment response or NSCLC survival. However, the frequency of such mutations in specific API ethnic groups has not been extensively studied. Because our study period spanned the years 1988 through 2007, only a small percentage of patients at the end of this period would have been exposed to these drugs. However, it has been noted that patients with mutations in the EGFR tyrosine kinase domain have a survival advantage over those without the mutations, regardless of therapy (35); therefore, ethnic differences in the prevalence of such mutations may have affected survival throughout the study period. Our findings are consistent with those of two population-based studies that found significantly better overall survival among Asians than non-Hispanic Whites or Blacks with early-stage NSCLC in California (7) or advanced-stage NSCLC in the U.S. (2). Study population differences, including SES, English fluency, and recentness of immigration, may explain why our results contrast with those of a clinic-based study in Boston, where Asian immigrants with lung cancer had significantly poorer 2-year survival than non-Asians (13). However, none of these studies examined whether survival varied among API ethnic groups. Our results also agree with those of Ou et al., who found that lower neighborhood-level SES and unmarried status were associated with worse survival after stage I NSCLC in all racial/ethnic groups in California (7,39). Whereas Ou et al. observed that survival with stage I NSCLC did not improve significantly over time in California overall (7), we detected a significant secular improvement in survival with all stages of NSCLC among APIs. We additionally examined the role of selected hospital characteristics, and found that patients reported to the CCR by a university teaching hospital had significantly better survival, possibly suggesting greater access to more appropriate staging or therapeutic options at such hospitals.

Another important consideration for interpreting these findings is the lack of cancer registry data on patient smoking status, given that smoking is a known prognostic factor for NSCLC (40,41). According to CHIS, there is substantial variation among Asian ethnic groups with respect to current smoking status, with Vietnamese men being the most likely of Asian men to be current cigarette smokers (average of 2001–2007 CHIS results=33%), followed closely by Koreans (31%), then Filipinos (23%), other Asians (20%), Chinese (15%), Japanese (14%), and South Asians (13%).[1] Among Asian women, by contrast, Japanese women were the most likely to be current cigarette smokers (11%), followed by Koreans (10%), other Asians (7%), Filipinas (6%), Chinese (3%), South Asians (3%), and Vietnamese (1%). Of note, 87% of all Asian women combined were lifetime never-smokers.[1]

However, these prevalence patterns do not closely follow the patterns of NSCLC survival observed in our study, with Japanese and other Asians having the worst survival among Asian ethnic groups. Moreover, they do not strictly parallel the observed ethnic distribution of histologic subtype, as the ethnic groups most likely to have adenocarcinoma (which is more common among never and former smokers) and least likely to have squamous cell carcinoma (which is more common among heavy smokers) (42) were Filipinos, Vietnamese, and Chinese. By contrast, we and others (43) found that women were more likely than men to be diagnosed with adenocarcinoma, mirroring their lower prevalence of smoking. However, ethnicity-specific smoking patterns assessed by CHIS in the general Asian population may not match such patterns among Asian lung cancer patients. While it is known that the proportion of non-smoking-associated lung cancer is higher among APIs overall (9), differences among API ethnic groups have not, to our knowledge, been investigated.

Other limitations of our study include the lack of detailed or complete data on stage, treatment, and behavioral, environmental, and genetic factors that may influence survival after NSCLC diagnosis, as well as the reduced sample size for stratified analyses (e.g., by stage or nativity). We were also unable to examine differences in quality of life after NSCLC diagnosis, which does not equate with duration of survival. On the other hand, our study offered considerable strengths, most importantly, its unparalleled setting in a population-based cancer registry that includes all NSCLC lung cancer patients diagnosed over a 19-year time period in California, where the large and diverse API population (14) enables robust survival comparisons among six distinct API ethnic groups. In addition, the uniform collection of survival data for all cases minimized bias due to differential follow-up. Thus, our results can be generalized to a broader population than previous studies that were not population-based or were limited to a subset of patients with availability of certain data.

In summary, we found that although APIs combined have relatively better survival than non-Hispanic Whites with NSCLC, there are considerable survival disparities among API ethnic groups. Recently, the Lung Cancer Mortality Reduction Act of 2008 (S. 3187) was introduced in the U.S. Senate to implement a comprehensive interagency program to make lung cancer mortality reduction a national public health priority (44). Although the bill emphasizes the importance of reducing the "burden of lung cancer on minority and rural populations," the only disparity specifically mentioned is the high incidence rate of lung cancer among African Americans. Our findings indicate that certain API ethnic groups suffer disproportionately from lung cancer mortality, and that APIs should not be overlooked in the national effort to eliminate lung cancer disparities. Studies with patient information on health care access, treatment decision-making, lifestyle, and other potential prognostic influences can help to identify areas where public-health actions can remediate these disparities.

Acknowledgments

The authors thank Ms. Rita Leung, Ms. Laura McClure, and Dr. Tim Miller for their help with this manuscript.

Financial support

The collection of cancer incidence data used in this study was supported by the California Department of Health Services as part of the statewide cancer reporting program mandated by California Health and Safety Code Section 103885; the National Cancer Institute's Surveillance, Epidemiology and End Results Program under contract N01-PC-35136 awarded to the Northern California Cancer Center, and contract N02-PC-15105 awarded to the Public Health Institute; and the Centers for Disease Control and Prevention's National Program of Cancer Registries, under agreement #U55/CCR921930-02 awarded to the Public Health Institute. The ideas and opinions expressed herein are those of the author(s) and endorsement by the State of California, Department of Health Services, the National Cancer Institute, and the Centers for Disease Control and Prevention or their contractors and subcontractors is not intended nor should be inferred.

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Table 1

Demographic and disease characteristics of Asian/Pacific Islander (API) women in California diagnosed with non-small-cell lung cancer in 1988–2007

Characteristic	Chinese *N*=2,139	Japanese *N* =886	Filipina *N*=1,597	Korean *N*=413	South Asian *N* =134	Vietnamese *N* =660	Other API *N*=558
Age at diagnosis (years)							
<50	195 (9%)	33 (4%)	217 (14%)	37 (9%)	14 (10%)	102 (15%)	90 (16%)
50–59	300 (14%)	128 (14%)	282 (18%)	77 (19%)	27 (20%)	119 (18%)	127 (23%)
60–69	483 (23%)	270 (30%)	404 (25%)	107 (26%)	41 (31%)	172 (26%)	133 (24%)
70–79	711 (33%)	313 (35%)	486 (30%)	128 (31%)	41 (31%)	171 (26%)	155 (28%)
80+	450 (21%)	142 (16%)	208 (13%)	64 (15%)	11 (8%)	96 (15%)	53 (9%)
Mean (standard deviation)	68.8 (13.0)	69.0 (10.6)	65.5 (13.1)	66.8 (12.7)	64.9 (12.9)	64.5 (14.0)	63.4 (12.8)
Year of diagnosis							
1988–1997	815 (38%)	353 (40%)	542 (34%)	130 (31%)	38 (28%)	183 (28%)	185 (33%)
1998–2007	1,324 (62%)	533 (60%)	1,055 (66%)	283 (69%)	96 (72%)	477 (72%)	373 (67%)
Marital status							
Married	1,237 (58%)	473 (53%)	858 (54%)	201 (49%)	76 (57%)	365 (55%)	276 (49%)
Never married	146 (7%)	66 (7%)	130 (8%)	45 (11%)	6 (4%)	62 (9%)	60 (11%)
Separated/widowed/divorced	715 (33%)	329 (37%)	580 (36%)	155 (38%)	47 (35%)	203 (31%)	212 (38%)
Unknown	41 (2%)	18 (2%)	29 (2%)	12 (3%)	5 (4%)	30 (5%)	10 (2%)
Neighborhood socioeconomic status							
Lower (quintiles 1, 2, 3)	989 (46%)	450 (51%)	904 (57%)	246 (60%)	52 (39%)	392 (59%)	353 (63%)
Higher (quintiles 4, 5)	1,150 (54%)	436 (49%)	693 (43%)	167 (40%)	82 (61%)	268 (41%)	205 (37%)
Nativity							
Foreign-born	1,886 (88%)	481 (54%)	1,502 (94%)	399 (97%)	122 (91%)	648 (98%)	386 (69%)
U.S.-born	253 (12%)	405 (46%)	95 (6%)	14 (3%)	12 (9%)	12 (2%)	172 (31%)
University teaching hospital							
No	1,954 (91%)	847 (96%)	1,487 (93%)	372 (90%)	121 (90%)	600 (91%)	525 (94%)
Yes	185 (9%)	39 (4%)	110 (7%)	41 (10%)	13 (10%)	60 (9%)	33 (6%)
Tumor histology							
Adenocarcinoma	1,169 (55%)	400 (45%)	919 (58%)	209 (51%)	67 (50%)	376 (57%)	266 (48%)
Squamous cell carcinoma	165 (8%)	150 (17%)	136 (9%)	64 (15%)	16 (12%)	52 (8%)	78 (14%)
Large cell carcinoma	152 (7%)	47 (5%)	76 (5%)	16 (4%)	2 (1%)	26 (4%)	35 (6%)
Bronchioloalveolar carcinoma	182 (9%)	70 (8%)	152 (10%)	38 (9%)	10 (7%)	54 (8%)	31 (6%)
Other non-small-cell carcinoma	257 (12%)	118 (13%)	180 (11%)	48 (12%)	26 (19%)	86 (13%)	91 (16%)
Undifferentiated/other	214 (10%)	101 (11%)	134 (8%)	38 (9%)	13 (10%)	66 (10%)	57 (10%)
Summary stage at diagnosis							
Localized	267 (12%)	146 (16%)	252 (16%)	49 (12%)	29 (22%)	87 (13%)	76 (14%)
Regional	392 (18%)	195 (22%)	285 (18%)	67 (16%)	25 (19%)	90 (14%)	104 (19%)
Remote	1,343 (63%)	496 (56%)	981 (61%)	257 (62%)	71 (53%)	443 (67%)	340 (61%)
Unknown	137 (6%)	49 (6%)	79 (5%)	40 (10%)	9 (7%)	40 (6%)	38 (7%)
Surgery							
No	1,628 (76%)	634 (72%)	1,174 (74%)	310 (75%)	94 (70%)	525 (80%)	435 (78%)
Yes	511 (24%)	252 (28%)	423 (26%)	103 (25%)	40 (30%)	135 (20%)	123 (22%)
Radiotherapy							
No	1,323 (62%)	536 (60%)	1,048 (66%)	282 (68%)	88 (66%)	441 (67%)	349 (63%)
Yes	816 (38%)	350 (40%)	549 (34%)	131 (32%)	46 (34%)	219 (33%)	209 (37%)
Chemotherapy							
No	1,335 (62%)	548 (62%)	997 (62%)	283 (69%)	85 (63%)	418 (63%)	358 (64%)
Yes	804 (38%)	338 (38%)	600 (38%)	130 (31%)	49 (37%)	242 (37%)	200 (36%)

Table 2

Demographic and disease characteristics of Asian/Pacific Islander (API) men in California diagnosed with non-small-cell lung cancer in 1988–2007

Characteristic	Ethnic group						
	Chinese *N*=3,036	Japanese *N*=1,063	Filipino *N*=3,109	Korean *N*=700	South Asian *N*=239	Vietnamese *N*=1,269	Other API *N* =774
Age at diagnosis (years)							
<50	186 (6%)	47 (4%)	210 (7%)	54 (8%)	39 (16%)	171 (13%)	91 (12%)
50–59	404 (13%)	127 (12%)	514 (17%)	109 (16%)	43 (18%)	264 (21%)	173 (22%)
60–69	807 (27%)	276 (26%)	994 (32%)	224 (32%)	74 (31%)	352 (28%)	237 (31%)
70–79	1,105 (36%)	433 (41%)	1,013 (33%)	211 (30%)	60 (25%)	375 (30%)	182 (24%)
80+	534 (18%)	180 (17%)	378 (12%)	102 (15%)	23 (10%)	107 (8%)	91 (12%)
Mean (standard deviation)	69.1 (11.4)	69.8 (10.8)	67.1 (11.0)	67.3 (11.4)	63.4 (12.9)	64.0 (12.4)	64.3 (12.2)
Year of diagnosis							
1988–1997	1,222 (40%)	510 (48%)	1,324 (43%)	278 (40%)	65 (27%)	435 (34%)	304 (39%)
1998–2007	1,814 (60%)	553 (52%)	1,785 (57%)	422 (60%)	174 (73%)	834 (66%)	470 (61%)
Marital status							
Married	2,410 (79%)	776 (73%)	2,490 (80%)	573 (82%)	193 (81%)	978 (77%)	574 (74%)
Never married	202 (7%)	140 (13%)	180 (6%)	48 (7%)	15 (6%)	114 (9%)	76 (10%)
Separated/widowed/divorced	356 (12%)	130 (12%)	384 (12%)	65 (9%)	24 (10%)	147 (12%)	99 (13%)
Unknown	68 (2%)	17 (2%)	55 (2%)	14 (2%)	7 (3%)	30 (2%)	25 (3%)
Neighborhood socioeconomic status							
Lower (quintiles 1, 2, 3)	1,582 (52%)	519 (49%)	1,907 (61%)	413 (59%)	111 (46%)	879 (69%)	571 (74%)
Higher (quintiles 4, 5)	1,454 (48%)	544 (51%)	1,202 (39%)	287 (41%)	128 (54%)	390 (31%)	203 (26%)
Nativity							
Foreign-born	2,683 (88%)	251 (24%)	2,969 (95%)	683 (98%)	220 (92%)	1,242 (98%)	628 (81%)
U.S.-born	353 (12%)	812 (76%)	140 (5%)	17 (2%)	19 (8%)	27 (2%)	146 (19%)
University teaching hospital							
No	2,799 (92%)	996 (94%)	2,909 (94%)	618 (88%)	217 (91%)	1,138 (90%)	705 (91%)
Yes	237 (8%)	67 (6%)	200 (6%)	82 (12%)	22 (9%)	131 (10%)	69 (9%)
Tumor histology							
Adenocarcinoma	1,222 (40%)	391 (37%)	1,233 (40%)	238 (34%)	89 (37%)	559 (44%)	298 (39%)
Squamous cell carcinoma	627 (21%)	293 (28%)	790 (25%)	234 (33%)	63 (26%)	263 (21%)	179 (23%)
Large cell carcinoma	236 (8%)	89 (8%)	207 (7%)	40 (6%)	12 (5%)	84 (7%)	69 (9%)
Bronchioloalveolar carcinoma	137 (5%)	36 (3%)	125 (4%)	24 (3%)	13 (5%)	52 (4%)	28 (4%)
Other non-small-cell carcinoma	417 (14%)	122 (11%)	359 (12%)	76 (11%)	38 (16%)	166 (13%)	86 (11%)
Undifferentiated/other	397 (13%)	132 (12%)	395 (13%)	88 (13%)	24 (10%)	145 (11%)	114 (15%)
Summary stage at diagnosis							
Localized	419 (14%)	151 (14%)	394 (13%)	83 (12%)	34 (14%)	181 (14%)	77 (10%)
Regional	602 (20%)	237 (22%)	643 (21%)	165 (24%)	56 (23%)	273 (22%)	143 (18%)
Remote	1,777 (59%)	605 (57%)	1,847 (59%)	392 (56%)	131 (55%)	756 (60%)	485 (63%)
Unknown	238 (8%)	70 (7%)	225 (7%)	60 (9%)	18 (8%)	59 (5%)	69 (9%)
Surgery							
No	2,381 (78%)	766 (72%)	2,513 (81%)	525 (75%)	190 (79%)	967 (76%)	656 (85%)
Yes	655 (22%)	297 (28%)	596 (19%)	175 (25%)	49 (21%)	302 (24%)	118 (15%)
Radiotherapy							
No	1,764 (58%)	594 (56%)	1,794 (58%)	427 (61%)	129 (54%)	741 (58%)	452 (58%)
Yes	1,272 (42%)	469 (44%)	1,315 (42%)	273 (39%)	110 (46%)	528 (42%)	322 (42%)
Chemotherapy							
No	1,954 (64%)	692 (65%)	2,062 (66%)	465 (66%)	140 (59%)	775 (61%)	526 (68%)
Yes	1,082 (36%)	371 (35%)	1,047 (34%)	235 (34%)	99 (41%)	494 (39%)	248 (32%)

Table 3

Multivariate hazard ratios (HR) with 95% confidence intervals (CI) for associations with overall survival after non-small-cell lung cancer diagnosis in California API women, 1988–2007

Characteristic	HR	95% CI
Age at diagnosis		
10-year increase	1.11	(1.08–1.14)
Race/ethnicity		
Chinese	1.00	reference
Filipina	1.05	(0.98–1.14)
Japanese	1.16	(1.06–1.27)
Korean	1.02	(0.90, 1.15)
South Asian	0.79	(0.63–0.97)
Vietnamese	1.05	(0.95–1.16)
Other API	1.19	(1.07–1.33)
Year of diagnosis		
10-year increase	0.75	(0.71–0.80)
Marital status		
Married/unknown	1.00	reference
Never married	1.17	(1.05–1.30)
Separated/widowed/divorced	1.05	(0.98–1.12)
Neighborhood socioeconomic status		
Lower (quintiles 1, 2, 3)	1.00	reference
Higher (quintiles 4, 5)	0.94	(0.89, 1.00)
University teaching hospital		
No	1.00	reference
Yes	0.84	(0.75–0.94)
Tumor histology		
Adenocarcinoma	1.00	reference
Squamous cell carcinoma	1.18	(1.07–1.29)
Large cell carcinoma	1.19	(1.05–1.34)
Bronchioloalveolar carcinoma	0.92	(0.81, 1.04)
Other non-small-cell carcinoma	1.07	(0.97–1.18)
Undifferentiated/other	1.13	(1.03–1.25)

* HRs are mutually adjusted for all variables shown, as well as initial treatment with surgery (yes/no), radiotherapy (yes/no), or chemotherapy (yes/no), and treatment-by-time interactions; separate baseline hazards were estimated by stage at diagnosis.

Table 4

Multivariate hazard ratios (HR) with 95% confidence intervals (CI) for associations with overall survival after non-small-cell lung cancer diagnosis in California API men, 1988–2007

Characteristic	HR*	95% CI
Age at diagnosis		
10-year increase	1.12	(1.10–1.14)
Race/ethnicity		
Chinese	1.00	reference
Filipino	1.04	(0.98–1.10)
Japanese	1.15	(1.07–1.24)
Korean	1.09	(0.99–1.19)
South Asian	1.10	(0.95–1.28)
Vietnamese	1.07	(1.00–1.16)
Other API	1.18	(1.08–1.28)
Year of diagnosis		
10-year increase	0.87	(0.83–0.91)
Marital status		
Married/unknown	1.00	reference
Never married	1.08	(1.00–1.18)
Separated/widowed/divorced	1.12	(1.05–1.20)
Neighborhood socioeconomic status		
Lower (quintiles 1, 2, 3)	1.00	reference
Higher (quintiles 4, 5)	0.92	(0.88–0.96)
University teaching hospital		
No	1.00	reference
Yes	0.85	(0.78–0.92)
Tumor histology		
Adenocarcinoma	1.00	reference
Squamous cell carcinoma	1.13	(1.06–1.19)
Large cell carcinoma	1.17	(1.07–1.27)
Bronchioloalveolar carcinoma	0.90	(0.79–1.02)
Other non-small-cell carcinoma	1.14	(1.06–1.23)
Undifferentiated/other	1.15	(1.07–1.23)

*HRs are mutually adjusted for all variables shown, as well as initial treatment with surgery (yes/no), radiotherapy (yes/no), or chemotherapy (yes/no), and treatment-by-time interactions; separate baseline hazards were estimated by stage at diagnosis.