Disparities in clinical and demographic characteristics among Asian/Pacific Islander and Non-Hispanic White newly diagnosed lung cancer patients

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Abstract

Purpose

Racial disparities persist among lung cancer (LC) patients but have not been adequately studied among Asian/Pacific Islander (API) subgroups, which are heterogeneous. This study compared clinical and demographic characteristics at diagnosis of API subgroups and NHW patients.

Methods

NHW and API adults diagnosed with LC were identified from the Surveillance, Epidemiology, and End Results database (1990–2015). API was divided into 8 subgroups: Filipino, Chinese, Japanese, Asian Indian/Pakistani, Korean, Vietnamese, Hawaiian/Pacific Islander, and Other. Multivariable multinomial logistic regression models were used to assess independent associations of clinical and demographic factors with API/subgroup.

Results

There were 522,702 (92.6%) NHW and 41,479 (7.4%) API LC patients. API were significantly younger (OR_{adj} : 0.53, 95% CI: 0.49–0.58 for ≥ 80 vs. ≤ 39 years) than NHW. All subgroups followed a similar trend except Japanese patients. API and subgroups were less often female (OR_{adj} : 0.84, 95% CI: 0.83–0.86), and unmarried (OR_{adj} : 0.71, 95% CI: 0.69–0.74), except for Hawaiian/Pacific Islanders who were more often unmarried. API and subgroups were more frequently diagnosed at a later stage (OR_{adj} : 1.31, 95% CI: 1.27–1.35 for stage IV vs. stage I). API had significantly less squamous cell carcinoma (OR_{adj} : 0.54, 95% CI: 0.52–0.55, compared to adenocarcinoma), with varying effects by subgroup. (range: OR_{adj} [Vietnamese]: 0.37 to OR_{adj} [Hawaiian/Pacific Islander]: 0.89).

Conclusion

At diagnosis, there are significant differences in demographic and clinical characteristics between NHW, API, and API subgroups. Treating API patients as a single population may overlook biological, environmental and behavioral differences that might be beneficial in designing prevention strategies and treatment.

Introduction

Lung and bronchial cancer is among the leading causes of cancer death in the United States[1–3]. The standard of care for treating lung cancer often includes surgery, radiotherapy, and/or chemotherapy. Despite a decrease in the incidence in lung cancer in recent years, racial disparities in disease stage at diagnosis, treatment, and survival continue to persist [4, 5].

Disparities by race have been well documented among Non-Hispanic Whites (NHW), Blacks/African Americans, Hispanics, and Asian Americans and Pacific Islanders (API) [1, 3, 5–8]. However, few studies have assessed these differences among API ethnic subgroups [9–12].

As one of the fastest growing populations in the US, API displays immense heterogeneity, especially when it comes to country of origin, cultural diversity, health behaviors, health outcomes, lifestyle, and socioeconomic status [9, 10]. This heterogeneity is likewise seen in how the burden of lung cancer is distributed across the API ethnic subgroups (ES) [1, 9, 11]. For example, Chang et al. reported that Japanese lung cancer patients in California had significantly worse overall and disease-specific survival rates compared to their Chinese counterparts [12]. Despite the heterogeneity across ES, API patients are frequently treated as one group in research, primarily due to small sample size restrictions [10].

The goal of this study was to assess differences in demographic and clinicopathologic characteristics at lung or bronchial cancer diagnosis between API, ES, and NHW patients. This study drew upon data for NHW and API patients diagnosed with lung and bronchial cancer between from January 1, 1990 and December 31, 2015 from the Surveillance, Epidemiology, and End Results (SEER) Program. The primary aims of this analysis were to identify racial disparities at the time of diagnosis and to determine whether these disparities persisted after adjusting for confounders.

Methods

Data Source and Study Population

SEER is a program funded by the National Cancer Institute (NCI) that compiles cancer incidence and survival information from population based registries, which cover approximately 35% of the population of the United States[13]The database provides data on patient demographics, primary cancer diagnoses, tumor morphology, cancer stage at diagnosis, treatment, and vital status[14]. The dataset is public and de-identified and therefore the study was deemed exempt from institutional review.

For this study, the SEER*Stat software[15] was used to query the SEER 18 registry for all patients diagnosed with lung or bronchial cancer from 1990–2015 ($n = 1,011,282$). NHW and API adults (≥ 18 years) with a microscopically confirmed first or only primary diagnosis of lung or bronchial cancer and a reporting source other than autopsy or death certificate were included ($n = 575,126$). Cases were excluded if only malignant cells in secretions were present, no primary tumor was found, tumor histology was coded as either sarcoma or unspecified malignant neoplasm, or patient underwent surgery of regional and/or distant site/nodes only, as the clinical characterization of these patients was less clear. This resulted in a cohort of 564,181 cases (Fig. 1).

The study population was divided according to race, into NHW and the overall API groups. Based on prior research, API patients were further divided into eight major ethnic subgroups (ES) as follows: Chinese, Japanese, Filipino, Hawaiian/Pacific Islander (including Hawaiian, Samoan, Pacific Islander, Tongan, Fijian, Guamanian, Micronesian, Polynesian, Melanesian, Chamorro, Tahitian, Kampuchean, and New Guinean), Korean, Vietnamese, Asian Indian/Pakistani, and Other (which comprised of Laotian, Hmong, Thai, and Other/Unknown API)[11]

Covariates

Variables of interest included age at diagnosis, sex, marital status, TNM stage, tumor size, tumor grade, and histology. TNM stage was classified using the third (1990–2003) and sixth (2004–2015) editions of the American Joint Cancer Committee on Cancer. Histology was categorized as adenocarcinoma, squamous cell, large cell, other specified non-small cell, (which includes carcinoid tumors, adenoid cystic, mucoepidermoid, adenosquamous, and large cell neuroendocrine carcinomas), non-small cell - not otherwise specified (NOS), and small cell carcinomas according to the guidelines by the International Agency for Research on Cancer[16].

Statistical Analysis

NHW and API patients (both the overall group, and the eight ES) were compared across all demographic and clinicopathologic characteristics using χ^2 tests. Multivariable logistic regression was used to assess the independent association of all covariates with race (API vs. NHW), using odds ratios (OR) and 95% confidence intervals (CI). A multivariable multinomial logistic regression was performed to assess the independent associations between these characteristics and race, using all 8 API ES.

Multivariable analyses were adjusted for age at diagnosis, sex, marital status, TNM stage, and histology. In order to account for changes over time, models were also adjusted for year of diagnosis. Multivariable analyses were conducted on the subset of patients with complete data for the included variables. Because 11.9% of patients were missing stage, a missing category for stage was created, so as not to exclude these patients.

Although tumor size and grade were provided as part of baseline patient characteristics, they were not included in the regression models. As tumor size overlaps with TNM staging[17], we only included TNM stage, as it is the more comprehensive measure. Grade was excluded from regression analysis as it was missing for nearly half of the study population (45.8% vs. 46.2% for NHW vs. overall API), limiting the potential to draw any meaningful conclusions.

All analyses were conducted using SPSS version 26. In all analyses, $p < 0.05$ was considered statistically significant.

Results

There were 564,181 patients included in the study; 522,702 (92.6%) NHW and 41,479 (7.4%) API patients (Table 1). Compared to NHW patients, the overall API group was significantly younger, more often male, married, diagnosed at a later stage, with a larger tumor size, and more likely to have well differentiated tumors, and an adenocarcinoma histology (all $p < 0.0001$).

Table 1
Demographics of Non-Hispanic White and Asian Pacific Islander Patients Diagnosed with Lung or Bronchial Cancer (n = 564,181).

		Non-Hispanic White (n = 522,702)		Asian/Pacific Islander (n = 41,479)		p - value
Variable		n (%)		n (%)		
Age (years)						
	≤ 39	3,673	(0.7)	656	(1.6)	< .0001
	40–49	23,945	(4.6)	2,383	(5.7)	
	50–59	86,830	(16.6)	6,725	(16.2)	
	60–69	163,412	(31.3)	11,858	(28.6)	
	70–79	169,556	(32.4)	13,136	(31.7)	
	≥ 80	75,286	(14.4)	6,721	(16.2)	
Sex						
	Male	281,388	(53.8)	24,621	(59.4)	< .0001
	Female	241,314	(46.2)	16,858	(40.6)	
Marital Status						
	Married/ Domestic Partner	285,009	(54.5)	27,401	(66.1)	< .0001
	Never Married	53,637	(10.3)	3,763	(9.1)	
	Previously Married	164,593	(31.5)	9,105	(22.0)	
	Unknown	19,463	(3.7)	1,210	(2.9)	
TNM Stage						
	I	89,179	(17.1)	6,348	(15.3)	< .0001
	II	19,482	(3.7)	1,366	(3.3)	
	III	129,670	(24.8)	10,758	(25.9)	
	IV	221,352	(42.3)	18,906	(45.6)	
	Unknown	63,019	(12.1)	4,101	(9.9)	
Tumor Size (cm)						
	< 1	6,267	(1.2)	375	(0.9)	< .0001
	1.0-1.9	47,853	(9.2)	3,016	(7.3)	
	2.0-2.9	70,483	(13.5)	5,608	(13.5)	
	3.0-3.9	63,751	(12.2)	5,584	(13.5)	
	4.0-4.9	50,613	(9.7)	4,408	(10.6)	
	5.0-5.9	40,077	(7.7)	3,400	(8.2)	
	≥ 6	89,611	(17.1)	7,307	(17.6)	
	Diffuse (lobe or lung)	839	(0.2)	96	(0.2)	
	Unknown	153,208	(29.3)	11,685	(28.2)	
Grade						
	Well-Differentiated	23,093	(4.4)	2,190	(5.3)	< .0001
	Moderately Differentiated	77,158	(14.8)	6,798	(16.4)	
	Poorly Differentiated	142,052	(27.2)	11,234	(27.1)	
	Undifferentiated	41,231	(7.9)	2,100	(5.1)	
	Unknown	239,168	(45.8)	19,157	(46.2)	
Histology						

	Non-Hispanic White (n = 522,702)		Asian/Pacific Islander (n = 41,479)		p - value
Adenocarcinoma	197,363	(37.8)	21,922	(52.9)	< .0001
Squamous	115,845	(22.2)	6,835	(16.5)	
Large Cell	47,667	(9.1)	3,759	(9.1)	
Other Specified Malignant Carcinoma	18,556	(3.6)	1,098	(2.6)	
Non-Small Cell, NOS	51,471	(9.8)	3,805	(9.2)	
Small Cell	91,800	(17.6)	4,060	(9.8)	

Within the overall API population, there were 9,860 (23.8%) Chinese, 5,832 (14.1%) Japanese, 10,002 (24.1%) Filipino, 4,178 (10.1%) Hawaiian/Pacific Islander, 2,928 (7.1%) Korean, 4,041 (9.7%) Vietnamese, 1,522 (3.7%) Asian Indian/Pakistani, and 3,116 (7.5%) Other API patients (Table 2). The API ES were significantly different on all variables (all $p < 0.0001$). Japanese and Chinese patients were significantly older than other ES (24.1% and 20.9% ≥ 80 years, compared to 8.4–15.2% for other ES), while Asian Indian/Pakistani, Filipino, and Vietnamese patients were the least likely to be female (32.4%, 37.2% and 34.9%, compared to 41.1–47.2% for all other ES). Chinese patients were the most likely to be married (70.4%), while Hawaiian/Pacific Islanders were the least (53.3%). Korean and Hawaiian patients were the most likely to have squamous cell carcinoma (21.8% and 21.4%). While all API ES were more likely to be diagnosed at a later stage, compared to NHW patients, Vietnamese and Asian Indian/Pakistani patients were the most like to present at stage IV (49.4% and 47.7%, compared to 42-46.5% for all other ES).

Table 2
Demographics of Asian/Pacific Islander Patients Diagnosed with Lung or Bronchial Cancer (n = 564,181).

Demographics of Asian/Pacific Islander Patients Diagnosed with Lung or Bronchial Cancer (n = 304,181)															
		Chinese (n = 9,860)		Japanese (n = 5,832)		Filipino (n = 10,002)		Hawaiian/Pacific Islander (n = 4,178)		Korean (n = 2,928)		Vietnamese (n = 4,001)		Asian Indian/Pakistani (n = 1,522)	
Variable		n (%)		n (%)		n (%)		n (%)		n (%)		n (%)		n (%)	
Age (years)															
	≤ 39	146	(1.5)	31	(0.5)	134	(1.3)	59	(1.4)	32	(1.1)	109	(2.7)	65	(4.3)
	40–49	536	(5.4)	135	(2.3)	505	(5.0)	322	(7.7)	160	(5.5)	370	(9.2)	123	(8.1)
	50–59	1,442	(14.6)	540	(9.3)	1,656	(16.6)	937	(22.4)	462	(15.8)	826	(20.4)	273	(18.0)
	60–69	2,457	(24.9)	1,453	(24.9)	3,203	(32.0)	1,392	(33.3)	898	(30.7)	1,162	(28.8)	464	(30.5)
	70–79	3,217	(32.6)	2,268	(38.9)	3,146	(31.5)	1,116	(26.7)	930	(31.8)	1,091	(27.0)	454	(30.0)
	≥ 80	2,062	(20.9)	1,405	(24.1)	1,358	(13.6)	352	(8.4)	446	(15.2)	483	(12.0)	143	(9.4)
Sex															
Male		5,622	(57.0)	3,234	(55.5)	6,286	(62.8)	2,451	(58.7)	1,724	(58.9)	2,629	(65.1)	1,029	(67.6)
Female		4,238	(43.0)	2,598	(44.5)	3,716	(37.2)	1,727	(41.3)	1,204	(41.1)	1,412	(34.9)	493	(32.4)
Marital Status															
Married/Domestic Partner		6,944	(70.4)	3,477	(59.6)	6,924	(69.2)	2,225	(53.3)	1,995	(68.1)	2,763	(68.4)	1,120	(73.6)
Never Married		724	(7.3)	604	(10.4)	728	(7.3)	533	(12.8)	256	(8.7)	452	(11.2)	104	(6.8)
Previously Married		1,911	(19.4)	1,612	(27.6)	2,102	(21.0)	1,281	(30.7)	583	(19.9)	690	(17.1)	241	(15.7)
Unknown		281	(2.8)	139	(2.4)	248	(2.5)	139	(3.3)	94	(3.2)	136	(3.4)	57	(3.7)
TNM Stage															
I		1,501	(15.2)	934	(16.0)	1,484	(14.8)	579	(13.9)	440	(15.0)	629	(15.6)	261	(17.2)
II		302	(3.1)	229	(3.9)	332	(3.3)	125	(3.0)	108	(3.7)	120	(3.0)	44	(2.9)
III		2,490	(25.3)	1,627	(27.9)	2,575	(25.7)	1,185	(28.4)	805	(27.5)	976	(24.2)	351	(22.9)
IV		4,491	(45.5)	2,447	(42.0)	4,673	(46.7)	1,870	(44.8)	1,253	(42.8)	1,998	(49.4)	726	(47.4)
Unknown		1,076	(10.9)	595	(10.2)	938	(9.4)	419	(10.0)	322	(11.0)	318	(7.9)	140	(9.2)
Tumor Size (cm)															
< 1		67	(0.7)	60	(1.0)	96	(1.0)	35	(0.8)	25	(0.9)	29	(0.7)	22	(1.4)
1.0-1.9		719	(7.3)	415	(7.1)	720	(7.2)	271	(6.5)	187	(6.4)	317	(7.8)	124	(8.1)
2.0-2.9		1,388	(14.1)	754	(12.9)	1,372	(13.7)	513	(12.3)	363	(12.4)	548	(13.6)	231	(15.2)
3.0-3.9		1,391	(14.1)	739	(12.7)	1,392	(13.9)	478	(11.4)	408	(13.9)	534	(13.2)	215	(14.2)
4.0-4.9		1,095	(11.1)	618	(10.6)	1,006	(10.1)	444	(10.6)	329	(11.2)	427	(10.6)	160	(10.5)
5.0-5.9		847	(8.6)	468	(8.0)	832	(8.3)	342	(8.2)	219	(7.5)	353	(8.7)	122	(8.0)
≥ 6		1,541	(15.6)	1,133	(19.4)	1,778	(17.8)	858	(20.5)	503	(17.2)	738	(18.3)	251	(16.5)
Diffuse (lobe or lung)		22	(0.2)	12	(0.2)	24	(0.2)	14	(0.3)	2	(0.1)	6	(0.1)	3	(0.2)
Unknown		2,790	(28.3)	1,633	(28.0)	2,782	(27.8)	1,223	(29.3)	892	(30.5)	1,089	(26.9)	394	(25.9)
Grade															
Well-Differentiated		553	(5.6)	241	(4.1)	570	(5.7)	137	(3.3)	154	(5.3)	211	(5.2)	93	(6.1)
Moderately Differentiated		1,655	(16.8)	967	(16.6)	1,632	(16.3)	576	(13.8)	500	(17.1)	673	(16.7)	266	(17.5)
Poorly Differentiated		2,527	(25.6)	1,790	(30.7)	2,659	(26.6)	1,355	(32.4)	808	(27.6)	1,027	(25.4)	343	(22.6)

	Chinese (n = 9,860)		Japanese (n = 5,832)		Filipino (n = 10,002)		Hawaiian/Pacific Islander (n = 4,178)		Korean (n = 2,928)		Vietnamese (n = 4,001)		Asian Indian/Pakistani (n = 1,522)	
Undifferentiated	423	(4.3)	400	(6.9)	475	(4.7)	270	(6.5)	186	(6.4)	180	(4.5)	58	(3.8)
Unknown	4,702	(47.7)	2,434	(41.7)	4,666	(46.7)	1,840	(44.0)	1,280	(43.7)	1,950	(48.3)	762	(50.1)
Histology														
Adenocarcinoma	5,737	(58.2)	2,580	(44.2)	5,415	(54.1)	1,727	(41.3)	1,374	(46.9)	2,452	(60.7)	834	(54.1)
Squamous Cell	1,295	(13.1)	1,187	(20.4)	1,657	(16.6)	893	(21.4)	638	(21.8)	504	(12.5)	240	(15.8)
Large Cell	986	(10.0)	643	(11.0)	862	(8.6)	450	(10.8)	237	(8.1)	281	(7.0)	85	(5.5)
Other Specified Malignant Carcinoma	238	(2.4)	158	(2.7)	255	(2.5)	112	(2.7)	63	(2.2)	98	(2.4)	78	(5.1)
Non-Small Cell, NOS	911	(9.2)	513	(8.8)	894	(8.9)	370	(8.9)	231	(7.9)	428	(10.6)	143	(9.4)
Small Cell	693	(7.0)	751	(12.9)	919	(9.2)	626	(15.0)	385	(13.1)	278	(6.9)	142	(9.3)

Demographics

In the multivariable analysis comparing overall API to NHW patients, (Table 3), API patients were significantly younger (OR_{adj}: 0.53, 95% CI: 0.48–0.58 for ≥ 80 vs. ≤39 years). They were also less likely to be female (OR_{adj}: 0.85, 95% CI: 0.83–0.86). When compared to NHW patients, the API population was significantly less likely to be never or previously married at the time of diagnosis (OR_{adj} [Never Married]: 0.71, 95% CI: 0.68–0.74; OR_{adj} [Previously Married]: 0.60, 95% CI: 0.58–0.61).

Table 3
Independent Associations of Clinical and Demographic Characteristics with Asian/Pacific Islander Ethnicity (n = 543,508).

Variable	API vs. NHW Adjusted OR (95% CI)*
Age (years)	
≤ 39	1.00 (ref)
40–49	0.54 (0.49–0.59)
50–59	0.42 (0.38–0.46)
60–69	0.40 (0.36–0.43)
70–79	0.44 (0.41–0.48)
≥ 80	0.53 (0.48–0.58)
Sex	
Female vs. Male	0.85 (0.83–0.86)
Marital Status	
Married/Domestic Partner	1.00 (Ref)
Never Married	0.71 (0.68–0.74)
Previously Married	0.60 (0.58–0.61)
TNM Stage	
I	1.00 (Ref)
II	1.05 (0.98–1.11)
III	1.31 (1.27–1.36)
IV	1.31 (1.27–1.35)
Unknown	1.11 (1.06–1.16)
Histology	
Adenocarcinoma	1.00 (Ref)
Squamous	0.54 (0.52–0.56)
Large Cell	0.71 (0.69–0.74)
Other Specified Malignant Carcinoma	0.52 (0.49–0.56)
Non-Small Cell, NOS	0.69 (0.66–0.71)
Small Cell	0.40 (0.39–0.41)
*Non-Hispanic White patients serve as the reference category. Adjusted for all listed variables and year of diagnosis.	

Although in many cases the trends of the associations remained similar across the eight API ES, the magnitude of the associations varied, when comparing individual ES to NHW patients (Table 4). Among API ES, Chinese, Filipino, Hawaiian/Pacific Islander, Korean, Vietnamese, Asian Indian/Pakistani, and Other API patients were significantly younger compared to NHW (range of effects: OR_{adj} [Asian Indian/Pakistani]: 0.10, 95% CI: 0.07–0.13 for ≥ 80 vs. ≤39 years; OR_{adj} [Chinese]: 0.79, 95% CI: 0.66–0.94 for ≥ 80 vs. ≤39 years). Japanese patients did not follow this trend and were more likely to be diagnosed with lung or bronchial cancer at an older age (OR_{adj} [Japanese]: 2.84, 95% CI: 1.96–4.12 for ≥ 80 vs. ≤39 years).

When API patients were divided across ES, Filipino, Hawaiian/Pacific Islander, Korean, Vietnamese, and Asian Indian/Pakistani patients were significantly less likely to be female (range of effects: OR_{adj} [Asian Indian/Pakistani]: 0.58, 95% CI: 0.52–0.65; OR_{adj} [Korean]: 0.92, 95% CI: 0.85–0.99). Among Chinese, Japanese, and Other API patients, there was no significant difference in gender when compared to NHW patients in the odds of being female at time of diagnosis (range of effects: OR_{adj} [Chinese]: 0.96, 95% CI: 0.92–1.01; OR_{adj} [Other API]: 1.04, 95% CI: 0.97–1.12).

Chinese, Filipino, Korean, Vietnamese, Asian Indian/Pakistani, and Other API patients were significantly less likely to be never or previously married at diagnosis, compared to being married or in a domestic partnership (range of effects for never married: OR_{adj} [Asian Indian/Pakistani]: 0.40, 95% CI: 0.33–0.49; OR_{adj} [Other API]: 0.83, 95% CI: 0.74–0.94; range of effects for previously married: OR_{adj} [Chinese]: 0.45, 95% CI: 0.43–0.47; OR_{adj} [Other API]: 0.60, 95% CI: 0.55–0.66). Japanese patients were less likely to be previously married than NHW patients, but there was no significant difference in the odds of being never married. Hawaiian/Pacific Islander patients were significantly more likely to be never married (OR_{adj}: 1.15, 95% CI: 1.05–1.27) and previously married at the time of diagnosis (OR_{adj}: 1.16, 95% CI: 1.08–1.24).

Clinicopathologic Characteristics

Overall, API patients were significantly more likely to be diagnosed at a later stage compared to NHW patients (OR_{adj} : 1.31, 95% CI: 1.27–1.35 for stage IV vs. stage I) (Table 3). They were also more likely to be diagnosed with adenocarcinoma and less likely to present with a histology of squamous cell, small cell, or large cell carcinoma (compared to adenocarcinoma: OR_{adj} [squamous]: 0.54, 95% CI: 0.52–0.56; OR_{adj} [small cell]: 0.40, 95% CI: 0.39–0.41; OR_{adj} [large cell]: 0.71, 95% CI: 0.69–0.74).

Similar to demographics, these associations varied by API ES despite similar trends (Table 4). When examined separately, Chinese, Japanese, Filipino, Hawaiian/Pacific Islander, Korean, Vietnamese, and Other API patients were more likely to be diagnosed at both stage III and IV while this effect was only significant for stage IV for Asian Indian/Pakistani patients (range of effects for stage III vs. I: OR_{adj} [Other API]: 1.20, 95% CI: 1.07–1.35; OR_{adj} [Korean]: 1.42, 95% CI: 1.26–1.60; range of effects for stage IV vs. I: OR_{adj} [Asian Indian/Pakistani]: 1.17, 95% CI: 1.01–1.36; OR_{adj} [Filipino]: 1.39, 95% CI: 1.31–1.48).

All API ES were significantly less likely than NHW patients to present with squamous histology, compared to adenocarcinoma (range of effects: OR_{adj} [Chinese]: 0.39, 95% CI: 0.37–0.42; OR_{adj} [Hawaiian/Pacific Islander]: 0.90, 95% CI: 0.83–0.98). There were also large differences in the odds of large cell (range of effects: OR_{adj} [Vietnamese]: 0.58, 95% CI: 0.51–0.66; OR_{adj} [Hawaiian/Pacific Islander]: 0.99, 95% CI: 0.89–1.10) and small cell (range of effects: OR_{adj} [Vietnamese]: 0.25, 95% CI: 0.32–0.47; OR_{adj} [Hawaiian/Pacific Islander]: 0.72, 95% CI: 0.66–0.80) histologies by ES.

Discussion

In this study, using the SEER database, we examined a cohort of 522,702 NHW and 41,479 API lung cancer patients across a 26-year period to identify demographic and clinicopathologic differences at the time of diagnosis. While lung and bronchial cancer has been well documented among the overall API population, individual API ethnic subgroups have not been adequately or extensively studied[10]. Despite growing evidence that the API population is highly heterogeneous, API patients from different ethnic subgroups continue to be studied as a single population entity, thus minimizing any differences in cultural diversity, health practices, lifestyle, health behaviors socioeconomic status, and health outcomes[1, 9–12]. With limited precedent, this is one of the few studies that has examined lung and bronchial cancer among the following eight, heterogeneous API ethnic subgroups: Filipino, Chinese, Japanese, Asian Indian/Pakistani, Korean, Vietnamese, Hawaiian/Pacific Islander, and Other [1, 9–12].

Consistent with prior literature, we demonstrated that the overall API population is younger compared to NHW patients at the time of diagnosis[11, 18, 19]. When API patients were divided according to their ethnic subgroups, this trend was maintained across most ethnicities, but the magnitude of the association varied significantly. In particular, Chinese, Filipino, Hawaiian/Pacific Islander, Korean, and Asian Indian/Pakistani patients were all more likely to be diagnosed at a younger age compared to NHW patients. This was particularly prominent for Hawaiian/Pacific Islander, Vietnamese, and Asian Indian/Pakistani patients. Trends in age among Japanese patients did not mirror the overall API population. Instead, it was the only ethnic subgroup which was more likely to be diagnosed with lung cancer at older ages. A similarly large study of 849,088 patients with lung cancer from the SEER database showed that Hawaiian/Pacific Islander, Vietnamese, and Asian Indian/Pakistani patients having the youngest mean age at diagnosis with Japanese patients having the oldest age at diagnosis[11].

In addition, our study demonstrated ethnic variations in marital status. This is of particular importance, as this has been previously reported to be a significant predictor of survival among lung cancer patients. While the overall API group was more likely to be married than their NHW counterparts, this was not consistent across ethnic subgroups. The trend was particularly prominent among Chinese, Filipino, Korean, Vietnamese, and Asian Indian/Pakistani patients. However, marital status among Hawaiian/Pacific Islander patients did not mirror that of the overall API population. Rather, it was the only group who was more likely to be unmarried. Based on a study of 161,228 small and non-small cell lung cancer patients, being married and/or widowed at diagnosis were independent predictors of improved survival at diagnosis, attributed to the benefits of a social support system on health behaviors, access to healthcare, cancer treatment, and overall physical and mental well-being[20]. Taken together, the differences in marital status presented in this study provides insight into potential differences across ethnic subgroups in terms of social support systems, which may subsequently affect survival[20, 21].

The current study also showed that all API patients were more likely than NHW patients to be diagnosed with adenocarcinoma and less likely to present with squamous cell, small cell, or large carcinomas. Chinese and Vietnamese patients were least likely to be diagnosed with small cell and squamous cell carcinomas, while Hawaiian/Pacific Islander patients, were most likely of the eight ethnic subgroups to present with these histologies. These findings are consistent with prior studies examining lung cancer tumor histology among API patients[18, 22–25]. According to an analysis of lung and bronchial cancer among API patients in California from 1988–2003 by Raz et. al, API patients, especially those from East and Southeast Asia have disproportionately higher risk for adenocarcinoma[22]. While the incidence of adenocarcinoma per 100,000 among the overall API population is 12.1, the incidence is 13.1 among the Chinese, 13.1 among Filipinos, and 17.1 among Vietnamese – the greatest among all API ethnic subgroups[22].

Taken together, the higher burden of adenocarcinoma paired with the younger age at diagnosis among API patients seem to suggest non-smoking related causes as drivers of lung cancer in this population[25–29]. In fact, the incidence of smoking among API patients from 2010–2013 is 10.9% compared to 24.3% for NHW[30]. The incidence is especially low among Chinese (7.6%), Asian Indian (7.6%), and Japanese Americans (10.2%)[30]. Koo and Ho have corroborated this, by observing that in Asian populations, a younger age at diagnosis of lung cancer tends to occur in never-smokers[28]. One possible contributor to these findings might be the higher prevalence of epidermal growth factor (EGFR) mutations observed in the tumors of API patients diagnosed with lung cancer, which has been known an initiator and driver of primarily adenocarcinoma[11, 27, 28, 31–34]. The high rates of adenocarcinoma among Chinese and Vietnamese patients, which was observed in this study, correlates with the high overall EGFR mutation rate in these populations, which is 30.0–50.2% and 40.7–64.2%, respectively[11, 23, 35, 36].

We also demonstrated that the overall API population was more likely to present with advanced lung cancer (stage III and IV) compared to NHW patients. The advance presentation of lung cancer among most API patients, with variations among ethnic subgroups, might suggest that current US screening guidelines for lung cancer might not be appropriately detecting early stage lung cancer among all API patients. As reported by Kumar et al., the National Lung Screening Trial (NLST) screening criteria (screening with low-dose computed tomography (CT) among adults between the ages of 55–74 years with at least 30 pack-year smoking history and are currently smoking or have quit within the past 15 years) is valid among Asian patients despite comprising only 2% of the NLST population[37]. However, broadening of the original NLST screening criteria in both age and smoking history as put forth by the current U.S. Preventive Services Task Force (USPSTF) guidelines would not increase screening rates among Asian patients, as a significant portion of lung cancer occurs primarily in never or light smokers[37, 38]. Rather, given the high rates EGFR mutation among API patients, EGFR mutation analysis among never and light smokers can be a better alternative, since it might be as sensitive but more specific compared to CT in diagnosing lung cancer[37].

In conclusion, our study is one of the few large population studies that has examined lung and bronchial cancer among eight major API ethnic subgroups and spans a 26-year time period and 17 US cancer registries. While prior studies have simply assessed the distribution of demographic and clinicopathologic factors across API ethnic subgroups, this is the only study, based on our literature review, which has assessed the independent associations of these factors with race. Our study further reinforces the heterogeneity of the API population with lung and bronchial cancer. While analysis of API ethnic subgroups revealed largely similar trends in clinical and demographic factors, compared to the overall API population, there was significant variability among ethnic subgroups when individually studied. In other words, demographic and clinicopathologic characteristics significantly differ across subgroups, and none of the eight API ethnicities completely mirrored the overall API population. Ultimately, these findings indicate that treating API patients as a single population may miss crucial biological, environmental and behavioral differences. Instead, it may be beneficial to view these subgroups separately when developing strategies for prevention and efficacious treatment.

This study should be interpreted within the context of its limitations. This was a retrospective study using a population-based database that only contained pre-selected demographic and clinicopathologic variables. We did not have available data for smoking status, family history of lung and/or bronchial cancer, occupational exposure to carcinogens, and driver mutations, such as EGFR, which would provide increased insight into these populations. Furthermore, we did not have any information on their place of birth. It is highly likely that a significant portion of the API population was born and raised outside of the United States. This in turn can possibly affect their cultural, lifestyle, and behavioral practices in comparison to their counterparts who were born and primarily raised in the United States. Future research into these factors, as well as differences in survival among API patients is warranted. Despite limitations, this study contributes to our understanding of the heterogeneity of API patients with lung cancer and highlights how opportunities for better treatment and prevention strategies may be missed when these patients are treated as a single group.

Declarations

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Conflicts of Interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

Availability of Data and Material Data was obtained from the public and de-identified Surveillance, Epidemiology, and End Results (SEER) database. The SEER*Stat software was used to query the SEER 18 registry for all patients diagnosed with lung or bronchial cancer from 1990-2015. All analyses were conducted using SPSS version 26. The study was deemed exempt from institutional review at the Icahn School of Medicine at Mount Sinai.

Authors' Contributions Study design and conception: all authors. Collection and assembly of data: Patel, Alpert, and Taioli. Statistical analysis and interpretation: all authors. Manuscript writing and final approval of manuscript: all authors.

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Figures

Figure 1
Selection criteria.