

Lung Cancer Incidence Trends by Histology Type among Asian American, Native Hawaiian, and Pacific Islander Populations in the United States, 1990–2010

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Abstract

Background: Lung cancer is one of the leading cancer sites diagnosed among Asian Americans, Pacific Islanders, and Native Hawaiians (AANHPI). To better understand the patterns of lung cancer incidence among AANHPIs, we examined the incidence trends of five histologic cell types of lung cancer across ten AANHPI populations in comparison with non-Hispanic Whites.

Methods: Lung cancer incidence data from 1990 through 2010 were obtained from 13 U.S. population-based cancer registries. Age-adjusted histologic cell-type-specific incidence rates and 95% confidence intervals were calculated. Joinpoint regression models and annual percentage change (APC) statistics were used to characterize the magnitude and direction of trends.

Results: From 1990 through 2010, incidence rates of adenocarcinoma increased significantly for Filipino and Korean women with a 2.6% and 3.0% annual percentage increase, respectively. More recently, a significant rise in the incidence of adenocarcinoma was observed for Chinese men (1996–2010; APC = 1.3%). Squamous cell carcinoma (SCC) increased 2.4% per year among Japanese women. For SCC, small cell lung carcinoma, large cell and other specified carcinoma, and unspecified types, stable or decreasing trends were observed in most AANHPI groups and non-Hispanic Whites.

Conclusions: AANHPIs demonstrate a range in the burden of lung cancer across histologies and specific populations.

Impact: These findings illustrate the importance of disaggregating AANHPIs into their specific populations. The rise in incidence of adenocarcinoma and SCC among certain AANHPIs demonstrates the need for research into non-tobacco associated risk factors for these populations and targeted efforts for tobacco prevention.

See all the articles in this CEBP Focus section, "Cancer in Asian and Pacific Islander Populations."
Cancer Epidemiol Biomarkers Prev; 23(11); 2250–65. ©2014 AACR.

Introduction

Asian Americans are the fastest growing racial/ethnic group in the United States (1–3), reaching more than 17

million in the 2010 Census (2, 3). In the first nationwide report of cancer incidence trends among specific Asian American populations, our group identified lung cancer as one of the top four cancers diagnosed among these populations from 1990 through 2008 (4). Lung cancer was consistently the leading cancer diagnosis among Kampuchean men and the third ranking cancer diagnosed among Chinese, Filipina, and Japanese women (4). Moreover, although non-Hispanic Whites (NHW) demonstrated a decline in the incidence of lung cancer, such a decline was not observed in any Asian American population. Notably, increasing incidence trends of lung cancer were observed among South Asian men and Filipina and Korean women (4).

Native Hawaiians and Pacific Islanders are a small but growing population in the United States (5). Lung cancer was among the top three cancer sites in these populations from 1990 through 2008 (6). Although both Native Hawaiian men and women demonstrated steady declines in the incidence rates of lung cancer

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Note: Supplementary data for this article are available at *Cancer Epidemiology, Biomarkers & Prevention* Online (<http://cebp.aacrjournals.org/>).

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doi: 10.1158/1055-9965.EPI-14-0493

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(6), Native Hawaiian and Samoan men consistently displayed higher incidence rates in comparison with NHW (6).

It is well known that tumor histology plays an important role in lung cancer etiology and prognosis. The incidence rates of the histologic subtypes vary (7–10) due to differences in exposure of smoking and other lung carcinogens. Because of decreased smoking behavior, from 1992 through 2005, the overall incidence trends of squamous cell carcinoma (SCC), lung adenocarcinoma, and small cell carcinoma declined in the United States, with more rapid declines observed for SCC than adenocarcinoma (11). Yet, there is little information on these detailed histologic trends across specific racial/ethnic populations. This is particularly relevant for Asian American, Native Hawaiian, and Pacific Islander (AANHPI) populations such as Koreans, Vietnamese, and Samoans, who have persistently high prevalence of smoking (12, 13), and for particular AANHPI women, such as Chinese women, who have an exceedingly low prevalence of smoking yet a high burden of lung adenocarcinoma (14).

To further understand the patterns of lung cancer incidence across AANHPIs, we examined the incidence trends of lung cancer by five histologic cell types across ten AANHPI populations by gender. The assembly of nationwide population-based histologic-specific incidence data by the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program enables a high quality and comprehensive investigation across these important populations with varying incidence rates of disease.

Materials and Methods

Cancer incidence data

Cancer incidence data for all invasive lung cancers (excluding mesothelioma, Kaposi Sarcoma, and lymphomas and leukemias) during the 21-year period from 1990 through 2010 were obtained from 13 U.S. population-based SEER cancer registries (Table 1). Histologic cell types were classified as defined by Lewis and colleagues (15) for small cell lung cancer ("SCLC"), adenocarcinoma, "SCC", large cell and other specified carcinoma ("LC+OSC"), and unspecified malignant neoplasms ("unspecified"). A total of 100 AANHPI cases and 1,475 NHW cases specified as a noncarcinoma or seemed to be a metastasis were excluded. The SEER registries cover 50.4% of the Asian American population and 66.5% of the NHPI population (16).

SEER data on race and Hispanic ethnicity were generally based on patients' medical records (17, 18). AANHPIs were included in this analysis regardless of Hispanic ethnicity. Information on birthplace and surname was used when a specific race designation was lacking (19). Nonetheless, approximately 4.7% (increase of 0.16% in 1990 to 7.4% in 2010) of the AANHPI lung

cancer cases were classified as "other Asian; Asian, not otherwise specified" and could not be included in a specific AANHPI category. Asian Indians and Pakistanis were combined on the basis of SEER coding.

Population data

Detailed population data for AANHPI populations are available from decennial U.S. censuses. Individuals could report a single race in the 1990 Census and multiple races in the 2000 and 2010 Censuses; due to this incompatibility, we developed the following methodology for producing a consistent set of denominators. April 1, 1990, April 1, 2000, and April 1, 2010 Census population distributions by age, sex, and detailed AANHPI race/ethnicity of a given geography were applied as percentages to the mid-year (July) estimates to yield estimates for the AANHPI populations. Because the 1990 Census did not publish county-level population counts for Pakistanis, we used the 1990 public-use microdata samples (20). The April 2000 and April 2010 estimates were derived by calculating an average of the single race alone count (i.e., those who self-identified with one AANHPI population) and the count for single race alone or in combination with other race(s). Intercensal estimates were developed from linear interpolation between the three censuses. Because of the high percentage of AANHPIs of mixed ethnicity in Hawaii, as well as concerns that the NH population has been undercounted in previous censuses, the Hawaii Tumor Registry has developed improved population estimates derived from sample survey data collected by the Hawaii Department of Health (21). These estimates were used for the Hawaii populations for 1990 through 2005 and estimated for 2006–2010 based on linear projections from the 2000 through 2005 data.

County-level population estimates were used for sub-state SEER regions. The Census Bureau does not disclose race/ethnic-specific population counts below 100 for any geographic area (22). When Census population data were suppressed for an AANHPI population for an entire registry, the registry was excluded from rate calculations for that particular group. When population data were suppressed for some counties within a multicounty metropolitan region, rates were calculated for the remaining counties with available population data (Supplementary Table S1). Population counts for each AANHPI population by SEER region for the three censal years are shown in Table 1.

Statistical analysis

Lung cancer histologic cell-type-specific incidence rates and 95% confidence intervals (CI) were calculated as cases per 100,000 persons and age-adjusted to the 2000 U.S. standard population using SEER*Stat software (<http://seer.cancer.gov/seerstat/>). Rates were suppressed for case counts <10 (23). Annual

Table 1. Annual population estimates and percentages, nativity, and language for each Asian American, Native Hawaiian, Pacific Islander population, and non-Hispanic Whites by SEER Registry Geographic Region and Census Year (1990, 2000, and 2010)

	1990										2000												
	White non-Hispanic	Chinese	Japanese	Filipino	Vietnamese	Korean	Native Hawaiian	Kampuchean	Laotian	Samoan	Asian Indian, Pakistani	White non-Hispanic	Chinese	Japanese	Filipino	Vietnamese	Korean	Native Hawaiian	Kampuchean	Laotian	Samoan	Asian Indian, Pakistani	
All SEER regions	38,062,478	943,014	660,378	1,040,610	345,004	391,190	248,722	89,112	81,419	49,684	319,350												
California ^a	44.9%	78.4%	49.5%	73.9%	85.8%	69.8%	14.6%	81.2%	75.7%	68.2%	56.8%												
Connecticut	7.2%	1.2%	<1%	<1%	1.2%	1.4%	<1%	2.0%	3.8%	<1%	4.1%												
Atlanta (metropolitan)	3.7%	1.0%	<1%	<1%	1.7%	2.5%	<1%	2.3%	3.6%	<1%	2.5%												
Hawaii	<1%	7.3%	39.7%	14.7%	1.6%	5.2%	82.4%	<1%	2.1%	19.6%	<1%												
Iowa	7.0%	<1%	<1%	<1%	<1%	1.2%	<1%	<1%	4.1%	<1%	1.1%												
Detroit (metropolitan)	7.4%	1.0%	<1%	<1%	<1%	1.7%	<1%	<1%	1.1%	<1%	5.7%												
New Jersey	15.1%	6.4%	2.7%	5.2%	2.2%	10.1%	<1%	<1%	<1%	<1%	27.6%												
New Mexico	2.0%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%												
Utah	4.1%	<1%	1.0%	<1%	<1%	<1%	<1%	<1%	2.2%	3.3%	<1%												
Seattle (Puget Sound)	7.7%	3.3%	4.6%	4.0%	4.9%	7.0%	1.7%	11.8%	6.1%	7.9%	1.7%												
2000																							
% Foreign-born ^b	—	63.9%	29.2%	55.8%	73.5%	69.9%	1.9%	64.4%	65.8%	16.6%	73.0%												
% Limited English ^{c, d}	—	45.0%	20.7%	20.5%	60.5%	46.0%	3.3%	52.6%	51.6%	16.2%	23.9%												
All SEER regions	37,943,386	1,396,938	660,856	1,420,523	591,877	557,799	293,023	100,909	85,658	75,620	685,041												
California ^a	43.1%	75.6%	52.2%	71.6%	79.3%	65.2%	13.9%	77.2%	70.9%	58.2%	53.2%												
Connecticut	7.0%	1.5%	<1%	<1%	1.4%	1.4%	<1%	2.6%	3.6%	<1%	4.1%												
Atlanta (metropolitan)	4.0%	1.6%	<1%	<1%	4.1%	3.9%	<1%	2.8%	4.0%	<1%	4.2%												
Hawaii	<1%	6.4%	34.6%	14.1%	1.5%	5.1%	81.8%	<1%	2.5%	21.4%	<1%												
Iowa	7.2%	<1%	<1%	<1%	1.3%	1.0%	<1%	<1%	5.2%	<1%	<1%												
Detroit (metropolitan)	7.3%	1.3%	1.1%	1.0%	<1%	1.6%	<1%	<1%	1.4%	<1%	6.6%												
New Jersey	14.9%	7.6%	2.6%	6.4%	2.7%	12.2%	<1%	<1%	<1%	<1%	27.8%												
New Mexico	2.2%	<1%	<1%	<1%	0.6%	<1%	<1%	<1%	<1%	<1%	<1%												
Utah	5.1%	<1%	1.2%	<1%	1.1%	<1%	<1%	1.5%	2.9%	7.4%	<1%												
Seattle (Puget Sound)	8.6%	4.4%	6.0%	5.1%	7.3%	8.4%	2.4%	14.0%	8.4%	10.9%	2.6%												

(Continued on the following page)

Table 1. Annual population estimates and percentages, nativity, and language for each Asian American, Native Hawaiian, Pacific Islander population, and non-Hispanic Whites by SEER Registry Geographic Region and Census Year (1990, 2000, and 2010) (Cont'd)

	2010										
	White non-Hispanic	Chinese	Japanese	Filipino	Vietnamese	Korean	Native Hawaiian	Kampuchean	Laotian	Samoan	Asian Indian, Pakistani
% Foreign-born ^b	—	61.2%	27.4%	52.8%	63.6%	64.6%	1.3%	55.3%	54.4%	10.4%	69.5%
% Limited English ^{c,d}	—	41.0%	17.3%	18.2%	50.3%	40.9%	1.7%	41.7%	40.0%	11.7%	22.2%
All SEER regions	36,786,858	1,764,410	715,300	1,793,997	788,310	729,707	392,188	125,941	92,331	95,658	1,179,826
California ^a	42.1%	77.0%	49.3%	74.8%	78.3%	65.9%	12.3%	75.1%	69.4%	53.3%	51.9%
Connecticut	7.0%	1.9%	<1%	<1%	1.3%	1.5%	<1%	2.4%	4.0%	<1%	4.7%
Atlanta (metropolitan)	3.8%	2.0%	<1%	<1%	4.4%	5.6%	<1%	3.0%	4.0%	<1%	4.3%
Hawaii	<1%	2.4%	37.5%	9.5%	1.5%	1.0%	83.1%	<1%	2.4%	19.1%	<1%
Iowa	7.4%	<1%	<1%	<1%	1.1%	<1%	<1%	<1%	5.7%	<1%	1.1%
Detroit (metropolitan)	6.9%	1.3%	1.1%	1.0%	<1%	1.5%	<1%	<1%	<1%	<1%	5.5%
New Jersey	14.4%	8.1%	2.3%	6.7%	2.8%	13.4%	<1%	1.2%	<1%	<1%	28.0%
New Mexico	2.3%	<1%	<1%	<1%	0.6%	<1%	<1%	<1%	<1%	<1%	<1%
Utah	6.1%	<1%	1.3%	<1%	1.1%	<1%	1.1%	1.7%	3.1%	11.3%	<1%
Seattle (Puget Sound)	9.2%	5.5%	6.2%	5.7%	8.0%	8.9%	2.3%	15.2%	9.2%	14.8%	4.1%
New Mexico	2.2%	<1%	<1%	<1%	0.6%	<1%	<1%	<1%	<1%	<1%	<1%
Utah	5.1%	<1%	1.2%	<1%	1.1%	<1%	<1%	1.5%	2.9%	7.4%	<1%
Seattle (Puget Sound)	8.6%	4.4%	6.0%	5.1%	7.3%	8.4%	2.4%	14.0%	8.4%	10.9%	2.6%

^aIncluding Los Angeles, San Francisco/Oakland and San Jose/Monterey, and the Greater California registries.^bSource: U.S. Census Bureau, Census 2000 Summary File 4, Matrices PCT38 (language), and PCT43 (nativity) for Asian detailed group or Native Hawaiian and Other Pacific Islander alone or in any combination; Chinese definition includes Taiwanese.^cSource: U.S. Census Bureau, 2006–2010 American Community Survey for Asian detailed group or Native Hawaiian and Other Pacific Islander alone or in any combination; Chinese definition includes Taiwanese.^dSpeak English less than "very well"; among population 5 years and over.

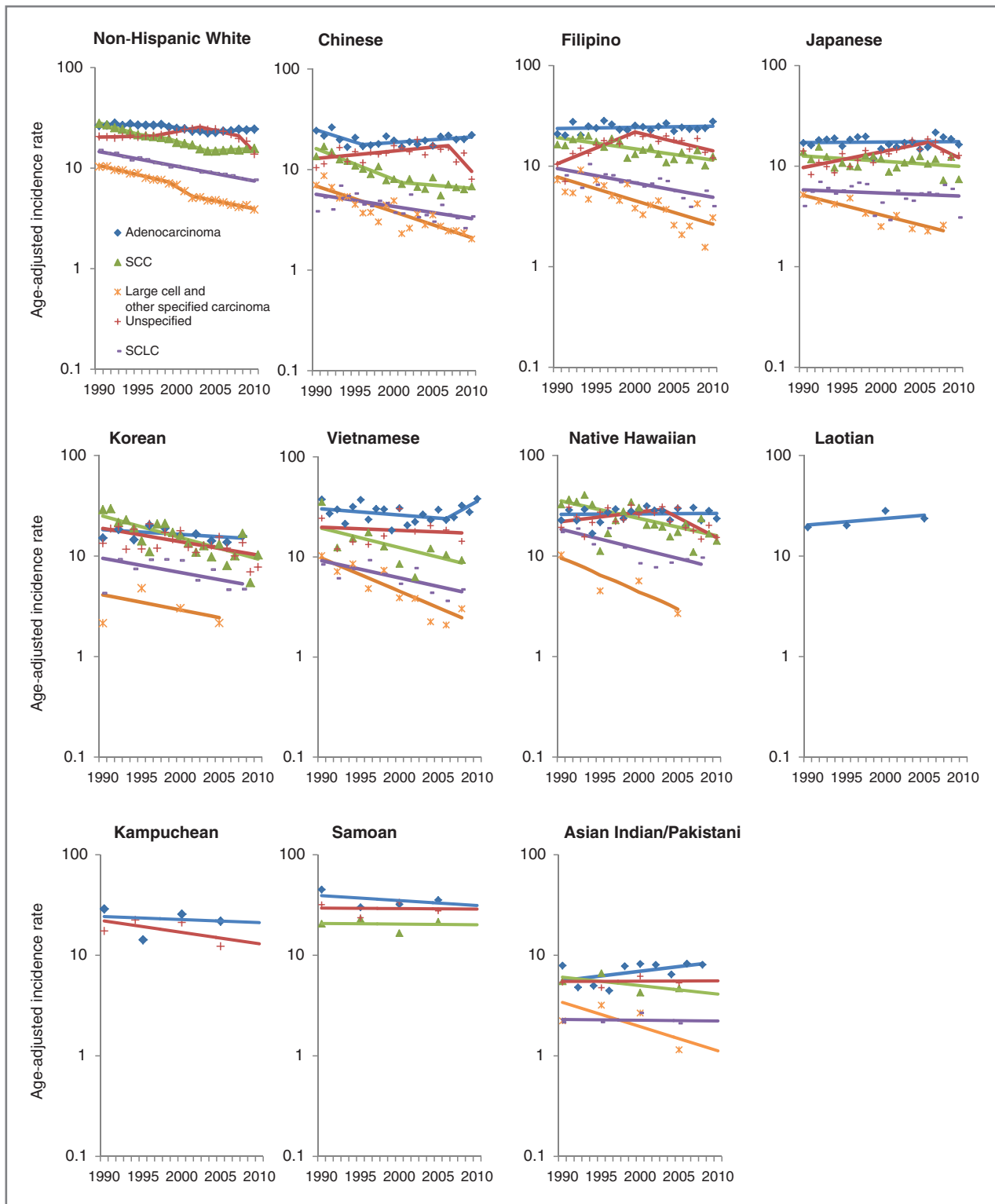


Figure 1. Male trends of lung cancer incidence rates and APC by race/ethnicity and histological cell type, 1990–2010, United States.

rates are shown graphically as trends (24, 25), except for smaller groups, where 2 or 5 year averaged rates are shown (Figs. 1 and 2). Joinpoint regression models

and annual percentage change (APC) statistics (two-sided *P* values) were used to characterize the magnitude and direction of trends (26). A maximum of

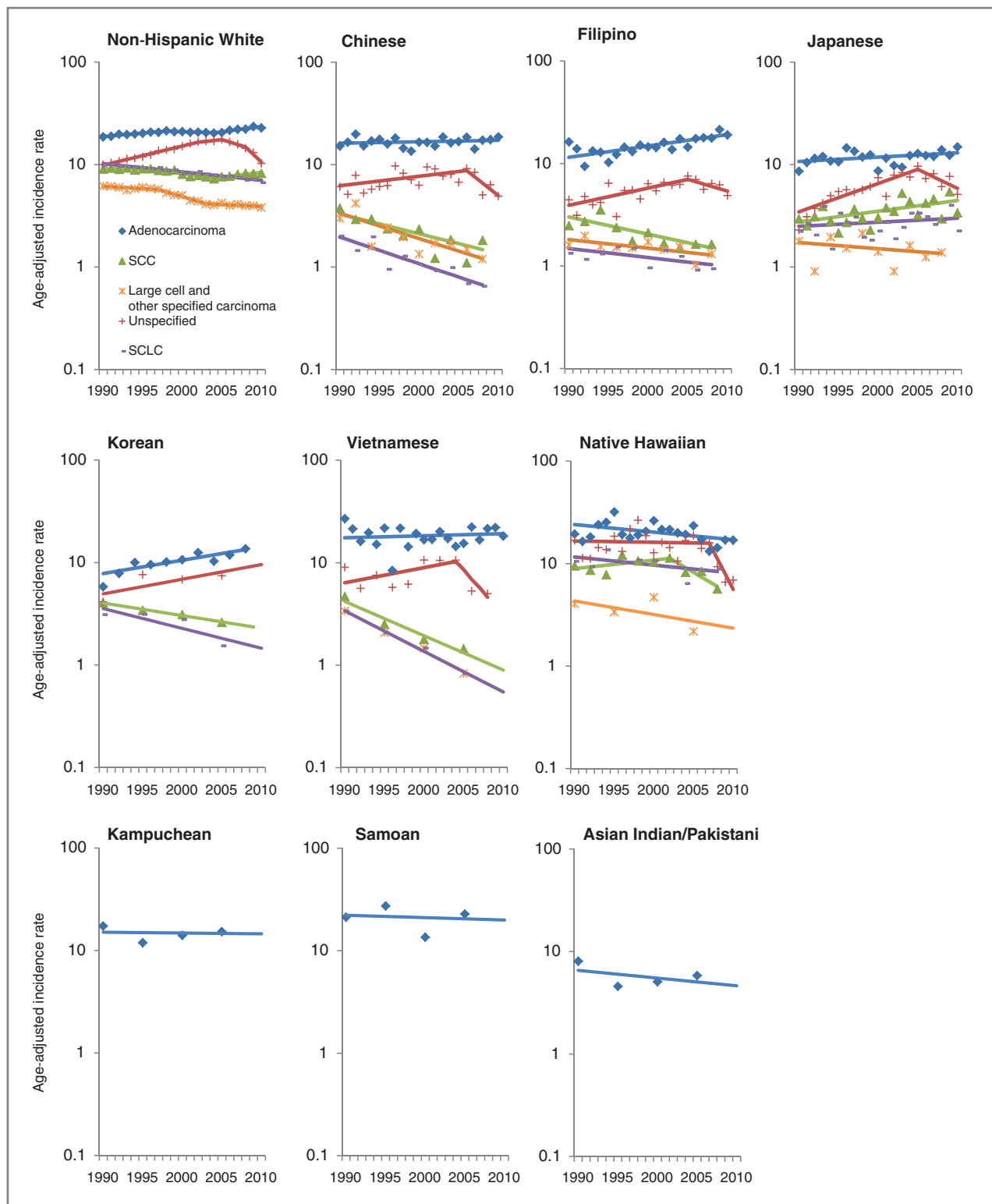


Figure 2. Female trends of lung cancer incidence rates and APC by race/ethnicity and histologic cell type, 1990–2010, United States.

three joinpoints were allowed on the basis of single year data. Plots of rate estimates and trend lines produced by the joinpoint analysis are shown in

semi-logarithmic scale and 2:1 $y:x$ axis aspect ratio for comparison of trends by histology among populations (24, 25).

Results

Characteristics of lung cancer cases

Table 2 describes the characteristics of incident lung cancer cases diagnosed from 1990 through 2010. With the exception of Japanese and native Hawaiians, the majority of cases were diagnosed in California. Adenocarcinoma was the most common histologic cell type, followed by unspecified types and SCC across all racial/ethnic groups.

Lung cancer incidence trends in males

Among NHW men, incidence rates for most histologic cell types declined overall, with the exceptions of SCC and adenocarcinoma, which showed a slight upward trend after 2004 (Fig. 1; Table 3). SCLC showed a significantly steady -3.3% (95% CI, -3.5 to -3.1) decline per year, while rates for LC+OSC showed a -4.1% (95% CI, -4.8 to -3.5) decrease per year from 1990 through 1999, followed by a steep decline of -10.3% (95% CI, -18 to -2.4) per year from 1999 through 2002, and then slowing down to -3.5% (95% CI, -4.5 to -2.5) decrease per year thereafter. Unlike trends for other histologic cell types, rates for unspecified types were stable from 1990 through 1997, then increased 3.5% (95% CI, 2.2 to 4.8) per year from 1997 through 2003, followed by a decrease of -4.0% (95% CI, -5.7 to -2.3) per year from 2003 to 2008, and then a much steeper decrease of -17% (95% CI, -22 to -11) per year from 2008 through 2010.

Overall, lung cancer incidence trends in Chinese men declined during the period 1990–2010, with the exception of a slight 1.3% increase (95% CI, 0 to 2.5) in adenocarcinoma from 1996 through 2010. Rates of unspecified types declined dramatically by -18% per year (95% CI, -34.5 to 3.0) from 2007 through 2010. For SCC, incidence rates also declined overall, with the steepest decline observed from 1990 through 2001 (APC = -6.8 ; 95% CI, -9 to -4.6). Chinese men also experienced a significant annual decrease of SCLC (APC 1990–2010 = -2.7 ; 95% CI, -4.1 to -1.3) and a more striking decrease in LC+OSC (APC 1990–2010 = -5.7 ; 95% CI, -7.1 to -4.4).

For Filipino men, trends in adenocarcinoma were stable; however, incidence of unspecified types increased significantly from 1990 through 2000 (APC = 7.5 ; 95% CI, 3.9 to 11.4) and declined sharply from 2000 through 2010 (APC = -4.2 ; 95% CI, -6.7 to -1.6). From 1990 through 2010, Filipino men also experienced a statistically significant annual decrease in SCC (APC = -2.5 ; 95% CI, -3.5 to -1.6), SCLC (APC = -3.3 ; 95% CI, -4.4 to -2.1), and LC+OSC (APC = -5.3 ; 95% CI, -7.2 to -3.3).

Although Japanese men experienced stable rates of adenocarcinoma from 1990 through 2010, they experienced a statistically significant -4.4% (95% CI, -6.1 to -2.7) annual decrease in LC+OSC. Incidence rates of unspecified types showed a divergent trend unlike those seen in the other four histologic cell types, with a statistically significant increase of 3.7% (95% CI, 1.8 to 5.5) per year from 1990 through 2006 followed by a nonsignificant decrease of -8.3% per year from 2006 through 2010.

Overall, incidence rates in Korean men significantly declined for two of five histologic cell types from 1990 through 2010, with a -3.0% (95% CI, -4.7 to -1.2) annual decrease for unspecified types and a -4.8% (95% CI, -6.7 to -2.8) annual decrease for SCC.

During 1990–2010, Vietnamese men experienced marked declines in SCC (APC = -4.3 ; 95% CI, -7.9 to -0.7), SCLC (APC = -3.9 ; 95% CI, -6.5 to -1.2), and LC+OSC (APC = -7.3 ; 95% CI, -10 to -4.4). From 2006 through 2010, a large, nonsignificant increase in the incidence rate of adenocarcinoma was observed in Vietnamese men (APC = 11.0 ; 95% CI, -1.5 to 24.2). For native Hawaiian men, incidence rates for adenocarcinoma were stable. However, they experienced declining trends for unspecified types (APC 2003–2010 = -8.8 ; 95% CI, -15 to -2.1), SCC (APC 1990–2010 = -3.9 ; 95% CI, -5.8 to -2.0), and SCLC (APC 1990–2010 = -4.3 ; 95% CI, -6.7 to -1.9). Histologic data for Laotian men were sparse for all cell types and are not shown in Fig. 1 and Table 3, except for adenocarcinoma, whose rates showed a nonsignificant increase from 1990 through 2010. In contrast, Kampuchean men experienced slight decreasing trends in adenocarcinoma and unspecified types (albeit insignificant). Samoan men also experienced a nonsignificant decreasing trend in rates of adenocarcinoma, but stable rates in unspecified types and SCC. Although Asian Indian/Pakistani men had stable rates of unspecified types and SCLC, they experienced a nonsignificant annual decrease of -1.9% (95% CI, -8.7 to 5.3) in SCC, an annual decrease of -5.4% (95% CI, -21 to -13) in LC+OSC, and a nonsignificant annual increase of 2.2% (95% CI, -0.2 to 4.7) for adenocarcinoma from 1990 through 2010.

Lung cancer incidence trends in females

Among NHW women, adenocarcinoma and SCC were the only histologic cell types to show overall increasing trends from 1990 through 2010 (Fig. 2; Table 4). Incidence rates for adenocarcinoma increased 1.5% (95% CI, 1.0 – 2.1) per year from 1990 through 1998, appeared stable 1998–2004, then increased again from 2004 through 2010 (APC = 2.3% ; 95% CI, 1.5 – 3.1). Rates for SCC decreased -2.5% (95% CI, -3.5 to -1.6) per year from 1996 through 2004 and increased 2.2% (95% CI, 0.9 – 3.4) per year from 2004 through 2010. Rates for unspecified types showed the largest decline of all histologic cell types, significantly decreasing -15.6% (95% CI, -20 to -10) per year from 2008 through 2010.

From 1990 through 2010, Chinese women experienced statistically significant decreases in incidence rates of three histologic cell types: -5.8% (95% CI, -7.8 to -3.8) annual decrease for SCLC, -4.3% (95% CI, -6.8 to -1.8) annual decrease for SCC, and -5.5% (95% CI, -8.2 to -2.7) annual decrease for LC+OSC. Trends in rates for adenocarcinoma were relatively stable (APC = 0.3 ; 95% CI, -0.4 to 1.1).

For Filipino women, trends showed increasing rates for adenocarcinoma (APC 1990–2010 = 2.6 ; 95% CI, 1.7 – 3.5) and unspecified types (APC 1990–2005 = 4.0 ; 95% CI, 1.7 –

Table 2. Characteristics of incident lung cancer cases by Asian American, Native Hawaiian, Pacific Islander population, and non-Hispanic Whites and sex, 1990–2010^a

Characteristics	NHW	Chinese		Japanese		Filipino		Vietnamese		Korean		Native Hawaiian		Kampuchean		Laotian		Samoa		Asian Indian, Pakistani	
		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Total	622,974	9,847	7,092	10,457	3,513	2,884	2,800	374	376	453	1,162										
Men	333,540	5,817	4,018	6,801	2,334	1,695	1,598	234	263	300	800										
Year of diagnosis																					
1990–1992	51,732 (15.5)	633 (10.9)	523 (13)	680 (10)	155 (7.4)	164 (9.7)	215 (13.5)	20 (8.6)	33 (12.6)	36 (12)	47 (5.9)										
1993–1995	49,842 (14.9)	666 (11.5)	531 (13.2)	841 (12.4)	217 (11.8)	175 (10.3)	200 (12.5)	30 (12.8)	33 (12.6)	33 (11)	57 (7.1)										
1996–1998	48,811 (14.6)	690 (11.9)	603 (15)	950 (14)	272 (14.7)	241 (14.2)	218 (13.6)	34 (14.5)	26 (9.9)	35 (11.7)	78 (9.8)										
1999–2001	47,841 (14.3)	806 (13.9)	529 (13.2)	1,011 (14.9)	325 (8.8)	258 (15.2)	243 (15.2)	34 (14.5)	38 (14.5)	45 (15)	112 (14)										
2002–2004	45,914 (13.8)	919 (15.8)	613 (15.3)	1,104 (16.2)	356 (17.7)	254 (15)	226 (14.1)	42 (18)	43 (16.4)	43 (14.3)	150 (18.8)										
2005–2007	45,430 (13.6)	1,058 (18.2)	643 (16)	1,068 (15.7)	456 (17.7)	287 (16.9)	237 (14.8)	28 (12)	38 (14.5)	48 (16)	164 (20.5)										
2008–2010	43,970 (13.2)	1,045 (18)	576 (14.3)	1,147 (16.9)	553 (22.1)	316 (18.6)	259 (16.2)	46 (19.7)	52 (19.8)	60 (20)	192 (24)										
SEER registry region																					
California	145,799 (43.7)	4,606 (79.2)	1,587 (39.5)	4,722 (69.4)	1,953 (75)	1,166 (68.8)	123 (7.7)	194 (82.9)	197 (74.9)	169 (56.3)	371 (46.4)										
Connecticut	25,448 (7.6)	49 (0.8)	<5 (0.1)	32 (0.5)	15 (2.9)	7 (0.4)	<5 (0.1)	6 (2.6)	<5 (1.5)	0 (0)	40 (5)										
Atlanta (metro)	10,272 (3.1)	37 (0.6)	9 (0.2)	10 (0.2)	66 (0)	33 (2)	0 (0)	<5 (1.3)	8 (3)	0 (0)	33 (4.1)										
Hawaii	2,328 (0.7)	537 (9.2)	2,216 (55.2)	1,409 (20.7)	31 (8.8)	173 (10.2)	1,424 (89.1)	0 (0)	11 (4.2)	101 (33.7)	0 (0)										
Iowa	27,327 (8.2)	7 (0.1)	0 (0)	<5 (0.1)	28 (0)	6 (0.4)	0 (0)	0 (0)	14 (5.3)	<5 (0.3)	8 (1)										
Detroit (metro)	27,835 (8.4)	78 (1.3)	14 (0.4)	41 (0.6)	<5 (0)	19 (1.1)	0 (0)	<5 (0.4)	<5 (1.5)	0 (0)	56 (7)										
New Jersey	55,470 (16.6)	253 (4.4)	33 (0.8)	295 (4.3)	36 (0)	161 (9.5)	16 (1)	0 (0)	<5 (0.8)	0 (0)	256 (32)										
New Mexico	7,215 (2.2)	12 (0.2)	<5 (0.1)	<5 (0)	7 (0)	<5 (0.1)	<5 (0.2)	0 (0)	0 (0)	0 (0)	12 (1.5)										
Utah	5,732 (1.7)	19 (0.3)	16 (0.4)	<5 (0)	22 (1.5)	<5 (0.2)	<5 (0.2)	0 (0)	<5 (1.1)	<5 (0.7)	0 (0)										
Seattle (Puget Sound)	26,114 (7.8)	219 (3.8)	135 (3.4)	284 (4.2)	172 (11.8)	125 (7.4)	28 (1.8)	30 (12.8)	20 (7.6)	27 (9)	24 (3)										
Age at diagnosis, y																					
<54	30,548 (9.2)	554 (9.5)	242 (6)	731 (10.8)	478 (17.7)	188 (11.1)	254 (15.9)	41 (17.5)	56 (21.3)	59 (19.7)	169 (21.1)										
55–64	69,293 (20.8)	988 (17)	557 (13.9)	1,551 (22.8)	561 (35.3)	374 (22.1)	468 (29.3)	49 (20.9)	62 (23.6)	106 (35.3)	195 (24.4)										
65–74	116,546 (34.9)	1,914 (32.9)	1,332 (33.2)	2,410 (35.4)	736 (36.8)	571 (33.7)	544 (34)	75 (32.1)	67 (25.5)	96 (32)	245 (30.6)										
75–84	94,570 (28.4)	1,791 (30.8)	1,445 (36)	1,668 (24.5)	465 (10.3)	452 (26.7)	292 (18.3)	60 (25.6)	67 (25.5)	36 (12)	158 (19.8)										
85+ years	22,583 (6.8)	570 (9.8)	442 (11)	441 (6.5)	94 (0)	110 (6.5)	40 (2.5)	9 (3.9)	11 (4.2)	<5 (1)	33 (4.1)										

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Table 2. Characteristics of incident lung cancer cases by Asian American, Native Hawaiian, Pacific Islander population, and non-Hispanic Whites and sex, 1990–2010^a (Cont'd)

Characteristics	NHW	Chinese		Japanese		Filipino		Vietnamese		Korean		Native Hawaiian		Kampuchean		Laotian		Samoan		Asian Indian, Pakistani	
		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Men	333,540	5,817	4,018	6,801	2,334	1,695	1,598	263	300	800											
Tumor histology																					
Adenocarcinoma	102,584 (30.8)	2,368 (40.7)	1,381 (34.4)	2,559 (37.6)	1,036 (0)	549 (32.4)	470 (29.4)	96 (41)	96 (36.5)	100 (33.3)	306 (38.3)										
Squamous cell	77,138 (23.1)	976 (16.8)	901 (22.4)	1,454 (21.4)	374 (0)	462 (27.3)	404 (25.3)	44 (18.8)	41 (15.6)	65 (21.7)	158 (19.8)										
LC + OSC	26,958 (8.1)	428 (7.4)	271 (6.7)	458 (6.7)	162 (0)	100 (5.9)	98 (6.1)	17 (7.3)	17 (6.5)	25 (8.3)	77 (9.6)										
NOS	83,670 (25.1)	1,571 (27)	1,037 (25.8)	1,650 (24.3)	569 (0)	367 (21.7)	409 (25.6)	59 (25.2)	72 (27.4)	79 (26.3)	172 (21.5)										
Small cell	43,190 (12.9)	474 (8.1)	428 (10.7)	680 (10)	193 (0)	217 (12.8)	217 (13.6)	18 (7.7)	37 (14.1)	31 (10.3)	87 (10.9)										
Stage at presentation ^a																					
Localized	47,515 (14.3)	810 (13.9)	594 (14.8)	885 (13)	332 (13.2)	214 (12.6)	229 (14.3)	20 (8.6)	14 (5.3)	27 (9)	116 (14.5)										
Regional	69,256 (20.8)	1,241 (21.3)	989 (24.6)	1,474 (21.7)	501 (19.1)	372 (22)	401 (25.1)	45 (19.2)	42 (16)	74 (24.7)	179 (22.4)										
Distant	139,635 (41.9)	2,988 (51.4)	1,980 (49.3)	3,553 (52.2)	1,253 (54.4)	830 (49)	832 (52.1)	136 (58.1)	157 (59.7)	166 (55.3)	363 (45.4)										
Unstaged	45,447 (13.6)	598 (10.3)	386 (9.6)	693 (10.2)	206 (13.2)	176 (10.4)	128 (8)	29 (12.4)	49 (18.6)	28 (9.3)	66 (8.3)										
Missing	31,687 (9.5)	180 (3.1)	69 (1.7)	196 (2.9)	42 (0)	103 (6.1)	8 (0.5)	<5 (1.7)	<5 (0.4)	5 (1.7)	76 (9.5)										
Women	289,434	4,030	3,074	3,656	1,179	1,189	1,202	140	113	153	362										
Year of diagnosis																					
1990–1992	37,200 (12.9)	383 (9.5)	271 (8.8)	284 (7.8)	85 (7.2)	77 (6.5)	116 (9.7)	14 (10)	10 (8.9)	16 (10.5)	19 (5.3)										
1993–1995	39,174 (13.5)	402 (10)	356 (11.6)	321 (8.8)	97 (8.2)	93 (7.8)	150 (12.5)	12 (8.6)	7 (6.2)	13 (8.5)	26 (7.2)										
1996–1998	41,491 (14.3)	494 (12.3)	422 (13.7)	380 (10.4)	115 (9.8)	144 (12.1)	154 (12.8)	17 (12.1)	15 (13.3)	24 (15.7)	35 (9.7)										
1999–2001	42,063 (14.5)	547 (13.6)	422 (13.7)	491 (13.4)	163 (13.8)	175 (14.7)	179 (14.9)	17 (12.1)	29 (25.7)	21 (13.7)	47 (13)										
2002–2004	42,864 (14.8)	659 (16.4)	483 (15.7)	607 (16.6)	215 (18.2)	199 (16.7)	200 (16.6)	19 (13.6)	18 (15.9)	20 (13.1)	62 (17.1)										
2005–2007	43,823 (15.1)	747 (18.5)	555 (18.1)	707 (19.3)	231 (19.6)	224 (18.8)	212 (17.6)	28 (20)	18 (15.9)	36 (23.5)	84 (23.2)										
2008–2010	42,819 (14.8)	798 (19.8)	565 (18.4)	866 (23.7)	273 (23.2)	277 (23.3)	191 (15.9)	33 (23.6)	16 (14.2)	23 (15)	89 (24.6)										

(Continued on the following page)

Table 2. Characteristics of incident lung cancer cases by Asian American, Native Hawaiian, Pacific Islander population, and non-Hispanic Whites and sex, 1990–2010^a (Cont'd)

Characteristics	NHW	Chinese		Japanese		Filipino		Vietnamese		Korean		Native Hawaiian		Kampuchean		Laotian		Samoan		Asian Indian, Pakistani	
		No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Women	289,434	4,030	3,074	3,656	1,179	1,189	1,202	140	113	153	362										
SEER registry region																					
California	131,786 (45.5)	3,211 (79.7)	1,459 (47.5)	2,512 (68.7)	1,005 (85.2)	711 (59.8)	101 (8.4)	117 (83.6)	92 (81.4)	65 (42.5)	189 (52.2)										
Connecticut	23,011 (8)	25 (0.6)	16 (0.5)	23 (0.6)	11 (0.9)	13 (1.1)	<5 (0.1)	6 (4.3)	<5 (2.7)	0 (0)	8 (2.2)										
Atlanta (metro)	8,611 (3)	25 (0.6)	14 (0.5)	7 (0.2)	21 (1.8)	25 (2.1)	0 (0)	<5 (1.4)	<5 (1.8)	0 (0)	10 (2.8)										
Hawaii	1,677 (0.6)	377 (9.4)	1,242 (40.4)	696 (19)	21 (1.8)	177 (14.9)	1,072 (89.2)	0 (0)	<5 (1.8)	60 (39.2)	0 (0)										
Iowa	18,775 (6.5)	5 (0.1)	17 (0.6)	9 (0.3)	5 (0.4)	5 (0.4)	<5 (0.2)	0 (0)	<5 (3.5)	0 (0)	<5 (0.6)										
Detroit (metro)	23,728 (8.2)	37 (0.9)	18 (0.6)	39 (1.1)	8 (0.7)	16 (1.4)	0 (0)	0 (0)	<5 (0.9)	0 (0)	15 (4.1)										
New Jersey	49,011 (16.9)	179 (4.4)	60 (2)	200 (5.5)	19 (1.6)	95 (8)	9 (0.8)	0 (0)	0 (0)	0 (0)	126 (34.8)										
New Mexico	5,638 (2)	6 (0.2)	19 (0.6)	7 (0.2)	<5 (0.3)	5 (0.4)	0 (0)	0 (0)	<5 (0.9)	0 (0)	<5 (0.3)										
Utah	3,748 (1.3)	10 (0.3)	20 (0.7)	<5 (0.1)	<5 (0.3)	<5 (0.3)	<5 (0.2)	<5 (0.7)	<5 (0.9)	<5 (2.6)	0 (0)										
Seattle (Puget Sound)	23,449 (8.1)	155 (3.9)	209 (6.8)	159 (4.4)	82 (7)	139 (11.7)	15 (1.3)	14 (10)	7 (6.2)	24 (15.7)	11 (3)										
Age at diagnosis, y																					
<54	28,034 (9.7)	564 (14)	177 (5.8)	613 (16.8)	242 (20.5)	195 (16.4)	174 (14.5)	37 (26.4)	25 (22.1)	43 (28.1)	78 (21.6)										
55–64	56,041 (19.4)	632 (15.7)	512 (16.7)	777 (21.3)	273 (23.2)	260 (21.9)	335 (27.9)	35 (25)	32 (28.3)	40 (26.1)	85 (23.5)										
65–74	95,962 (33.2)	1,154 (28.6)	1,090 (35.5)	1,140 (31.2)	309 (26.2)	355 (29.9)	418 (34.8)	32 (22.9)	24 (21.2)	38 (24.8)	102 (28.2)										
75–84	85,157 (29.4)	1,173 (29.1)	982 (32)	875 (23.9)	270 (22.9)	268 (22.5)	215 (17.9)	28 (20)	23 (20.4)	27 (17.7)	83 (22.9)										
85+ years	24,240 (8.4)	507 (12.6)	313 (10.2)	251 (6.9)	85 (7.2)	111 (9.3)	60 (5)	8 (5.7)	9 (8)	5 (3.3)	14 (3.9)										
Tumor histology																					
Adenocarcinoma	104,947 (36.3)	2,378 (59)	1,383 (45)	2,249 (61.5)	734 (62.3)	567 (47.7)	424 (35.3)	86 (61.4)	61 (54)	71 (46.4)	204 (56.4)										
Squamous cell	43,056 (14.9)	283 (7)	434 (14.1)	278 (7.6)	81 (6.9)	150 (12.6)	191 (15.9)	13 (9.3)	11 (9.7)	13 (8.5)	33 (9.1)										
LC + OSC	24,401 (8.4)	259 (6.4)	172 (5.6)	216 (5.9)	65 (5.5)	58 (4.9)	74 (6.2)	8 (5.7)	7 (6.2)	9 (5.9)	36 (9.9)										
NOS	74,526 (25.7)	967 (24)	755 (24.6)	735 (20.1)	249 (21.1)	296 (24.9)	301 (25)	27 (19.3)	29 (25.7)	47 (30.7)	79 (21.8)										
Small cell	42,504 (14.7)	143 (3.5)	330 (10.7)	178 (4.9)	50 (4.2)	118 (9.9)	212 (17.6)	6 (4.3)	5 (4.4)	13 (8.5)	10 (2.8)										
Stage at presentation^a																					
Localized	50,684 (17.5)	597 (14.8)	539 (17.5)	607 (16.6)	160 (13.6)	185 (15.6)	191 (15.9)	18 (12.9)	11 (9.7)	13 (8.5)	58 (16)										
Regional	58,433 (20.2)	733 (18.2)	690 (22.5)	685 (18.7)	174 (14.8)	231 (19.4)	308 (25.6)	24 (17.1)	17 (15)	23 (15)	64 (17.7)										
Distant	115,689 (40)	2,194 (54.4)	1,533 (49.9)	1,957 (53.5)	695 (59)	613 (51.6)	619 (51.5)	76 (54.3)	66 (58.4)	101 (66)	173 (47.8)										
Unstaged	39,944 (13.8)	407 (10.1)	258 (8.4)	312 (8.5)	130 (11)	120 (10.1)	79 (6.6)	16 (11.4)	18 (15.9)	14 (9.2)	35 (9.7)										
Missing	24,684 (8.5)	99 (2.5)	54 (1.8)	95 (2.6)	20 (1.7)	40 (3.4)	5 (0.4)	6 (4.3)	<5 (0.9)	<5 (1.3)	32 (8.8)										

^aCounts less than five cases are suppressed for privacy consideration.

Table 3. Male trends of lung cancer incidence rates and APC by race/ethnicity and histologic cell type, 1990–2010, United States

SCLC	Adenocarcinoma		SCC		LC and OSC		Unspecified	
	Year	APC (95% CI)	Year	APC (95% CI)	Year	APC (95% CI)	Year	APC (95% CI)
NHW	1990–2010	-3.3 ^a (-3.5 to -3.1)	1990–1995	-5.1 ^a (-5.8 to -4.3)	1990–1999	-4.1 ^a (-4.8 to -3.5)	1990–1997	0.3 (-0.5 to 1.2)
	1998–2004	-2.9 ^a (-4 to -1.7)	1995–1999	-2.6 ^a (-4.5 to -0.7)	1999–2002	-10.3 ^a (-18 to -2.4)	1997–2003	3.5 ^a (2.2 to 4.8)
	2004–2010	1.5 ^a (0.7 to 2.4)	1999–2004	-5.4 ^a (-6.7 to -4.2)	2002–2010	-3.5 ^a (-4.5 to -2.5)	2003–2008	-4.0 ^a (-5.7 to -2.3)
			2004–2010	1.0 ^a (0.3 to 1.7)			2008–2010	-17 ^a (-22 to -11)
Chinese	1990–2010	-2.7 ^a (-4.1 to -1.3)	1990–2001	-6.8 ^a (-9 to -4.6)	1990–2010	-5.7 ^a (-7.1 to -4.4)	1990–2007	1.8 (0 to 3.6)
	1996–2010	1.3 ^a (0 to 2.5)	2001–2010	-1.4 (-4.3 to 1.5)			2007–2010	-18 (-34 to 3.0)
Filipino	1990–2010	-3.3 ^a (-4.4 to -2.1)	1990–2010	-2.5 ^a (-3.5 to -1.6)	1990–2010	-5.3 ^a (-7.2 to -3.3)	1990–2000	7.5 ^a (3.9 to 11.4)
							2000–2010	-4.2 ^a (-6.7 to -1.6)
Japanese	1990–2010	-0.7 (-2.4 to 1.1)	1990–2010	-1.2 (-2.4 to 0.1)	1990–2010 ^b	-4.4 ^a (-6.1 to -2.7)	1990–2006	3.7 ^a (1.8 to 5.5)
							2006–2010	-8.3 (-19 to 3.7)
Korean	1990–2010 ^b	-3.2 (-6.5 to 0.3)	1990–2010	-4.8 ^a (-6.7 to -2.8)	1990–2010 ^c	-3.4 (-19 to 15)	1990–2010	-3.0 ^a (-4.7 to -1.2)
Vietnamese	1990–2010 ^b	-3.9 ^a (-6.5 to -1.2)	1990–2010 ^b	-4.3 ^a (-7.9 to -0.7)	1990–2010 ^b	-7.3 ^a (-10 to -4.4)	1990–2010 ^b	-0.7 (-4.7 to 3.4)
	2006–2010	11 (-1.5 to 24.2)						
Native Hawaiian	1990–2010 ^b	-4.3 ^a (-6.7 to -1.9)	1990–2010	-3.9 ^a (-5.8 to -2.0)	1990–2010 ^c	-7.5 (-18 to 3.8)	1990–2003	2.2 (-1.1 to 5.6)
							2003–2010	-8.8 ^a (-15 to -2.1)
Laotian	1990–2010 ^c	1.5 (-4.7 to 8.1)						
Kampuchean	1990–2010 ^c	-0.7 (-11 to 11)					1990–2010 ^c	-2.7 (-13 to 9.2)
Samoan	1990–2010 ^c	-1.1 (-7.4 to 5.5)	1990–2010 ^c	-0.1 (-6.5 to 6.6)			1990–2010 ^c	-0.1 (-7.3 to 7.7)
Asian Indian/Pakistani	1990–2010 ^c	-0.2 (-5.7 to 5.6)	1990–2010 ^b	2.2 (-0.2 to 4.7)	1990–2010 ^c	-5.4 (-21 to 13)	1990–2010 ^c	0.1 (-5.0 to 5.4)

^aThe 95% CI for the APC does not include zero ($P < 0.05$).

^bJoinpoint and observed rates are based on 2-year groups.

^cJoinpoint and observed rates are based on 5-year groups.

Table 4. Female trends of lung cancer incidence rates and APC by race/ethnicity and histologic cell type, 1990–2010, United States

SCLC	Adenocarcinoma	SCC	LC and OSC	Unspecified
NHW	1990–2010	1.5 ^a (1 to 2.1)	1990–1996 0 (-1.2 to 1.2)	1990–2002 4.4 ^a (4 to 4.8)
	1998–2004	-0.7 (-1.7 to 0.4)	1996–2004 -2.5 ^a (-3.5 to -1.6)	2002–2005 2.0 (-3.0 to 7.2)
	2004–2010	2.3 ^a (1.5 to 3.1)	2004–2010 2.2 ^a (0.9 to 3.4)	2005–2008 -5.4 ^a (-10 to -0.5)
Chinese	1990–2008 ^b	0.3 (-0.4 to 1.1)	1990–2008 ^b -4.3 ^a (-6.8 to -1.8)	1990–2006 2.2 (-0.2 to 4.6)
	1990–2010			2006–2010 -13.1 (-24.7 to 0.2)
Filipino	1990–2010	2.6 ^a (1.7 to 3.5)	1990–2008 ^b -3.8 ^a (-5.8 to -1.8)	1990–2005 4.0 ^a (1.7 to 6.3)
				2005–2010 -5.1 (-11.9 to 2.3)
Japanese	1990–2010	1.0 (-0.1 to 2)	1990–2010 ^b 2.4 ^a (0.7 to 4.2)	1990–2005 6.6 ^a (4.2 to 9)
				2005–2010 -8.2 (-16 to 0.1)
Korean	1990–2010 ^b	3.0 ^a (1.6 to 4.4)	1990–2010 ^c -2.8 ^a (-3.7 to -1.9)	1990–2010 ^c 1.8 (-5.7 to 10)
Vietnamese	1990–2010	0.5 (-1.1 to 2.1)	1990–2010 ^c -7.3 ^a (-12 to -2.3)	1990–2004 ^b 3.5 (-2.8 to 10)
				2004–2010 -18 (-40.7 to 13)
Native Hawaiian	1990–2010	-1.7 ^a (-3.1 to -0.2)	1990–2002 ^b 1.9 (-2.9 to 7.1)	1990–2007 -0.3 (-2.9 to 2.5)
			2002–2010 -10 (-20 to 1.2)	2007–2010 -29.2 (-52 to 4.2)
Kampuchean	1990–2010 ^c	-0.2 (-5.9 to 5.8)		
Samoan	1990–2010 ^c	-0.5 (-13 to 14)		
Asian Indian/Pakistani	1990–2010 ^c	-0.4 (-8.6 to 8.5)		

^aThe 95% CI for the APC does not include zero ($P < 0.05$).^bJoinpoint and observed rates are based on 2-year groups.^cJoinpoint and observed rates are based on 5-year groups.

6.3), and decreasing rates for SCC (APC = -3.8 ; 95% CI, -5.8 to -1.8).

For Japanese women, slight increasing trends were observed for adenocarcinoma and SCLC, whereas decreasing trends were observed for LC+OSC (albeit insignificant). For unspecified types, rates significantly increased 6.6% (95% CI, 4.2 to -9) per year from 1990 through 2005 but showed a nonsignificant -8.2% (95% CI, -16 to 0.1) decrease per year from 2005 through 2010. Rates for SCC significantly increased 2.4% (95% CI, 0.7 to 4.2) per year from 1990 through 2010.

Like Filipino women, Korean women experienced a statistically significant increase in adenocarcinoma from 1990 through 2010 (APC = 3.0; 95% CI, 1.6 to 4.4) and decreasing rates for SCC (APC = -2.8 ; 95% CI, -3.7 to -1.9). For Vietnamese women, trends in incidence rates significantly declined for three histologic cell types from 1990 through 2010: SCLC (APC = -8.7 ; 95% CI, -11 to -6.4), SCC (APC = -7.3 ; 95% CI, -12 to -2.3), and LC+OSC (APC = -6.8 ; 95% CI, -11 to -2). Incidence rates for adenocarcinoma were otherwise stable (APC = 0.5; 95% CI, -1.1 to 2.1).

Native Hawaiian women were the only AANHPI population to experience a statistically significant decline in adenocarcinoma with a -1.7% decrease in incidence per year (95% CI, -3.1 to -0.2) from 1990 through 2010. Rates for all other histologic types showed nonsignificant declines during this period.

For Kampuchean, Samoan, and Asian Indian/Pakistani women, there were too few cases to show trends in incidence rates for most histologic cell types, except for adenocarcinoma, whose trends were stable for these populations from 1990 to 2010.

Summary of trends by histologic cell type

Overall, incidence trends of adenocarcinoma increased in Chinese men and in Filipino and Korean women, decreased in NH women, and remained stable in Chinese women.

For unspecified types, the trends in rates for men started increasing in 1990 but showed a marked decline in Filipinos, native Hawaiians, and NHWs in the years thereafter, with the decline beginning in 2000 for Filipino men, in 2003 for NH men, and in 2003 for NHW men. Korean men experienced a slow and steady decline in unspecified types during 1990–2010. Similar to men, trends in unspecified types for women significantly increased in Filipino, Japanese, and NHW women from 1990 through the mid-2000s, followed by a significant decline thereafter in NHW women.

For SCC, overall trends were declining or stable in men and women across all AANHPI populations, with the exception of increasing rates of SCC in Japanese women. SCLC trends were also declining or stable in men and women across all AANHPI groups and NHWs, with the greatest declines observed in Vietnamese women and NH men.

Finally, trends in LC+OSC showed modest declines among all histology cell types for almost all AANHPI populations in men and women.

Discussion

Using 21 years of cancer incidence data from SEER, this study is the first to present population-based data describing detailed trends in lung cancer incidence by histologic cell type across ten AANHPI populations. Although lung cancer incidence has declined overall in the United States and worldwide in men, with stable rates in women, findings from this study show marked differences in trends by histologic cell type across AANHPI populations. We observed notable significant increases in adenocarcinoma in Filipino and Korean women, similar to NHW women, and increases in SCC among Japanese women, whereas trends in rates for other histologic cell types (unspecified, SCC, SCLC, and LC+OCS) were declining or stable in most AANHPI populations and NHWs. More recently, rates of adenocarcinoma also appeared to be slightly increasing in Chinese and NHW men. These findings suggest the importance of disaggregating data among AANHPI populations to identify vulnerable groups who may experience disparate trends, thus aiding public health prevention efforts to target those groups in greatest need.

The steadily increased trend of adenocarcinoma among Chinese men since 1996, the dramatically increasing trend among Vietnamese men (albeit not statistically significant), the significantly increased rates among Filipino and Korean women, and the stable rates among Chinese women point to the growing burden of adenocarcinoma among these Asian American populations. Data on Asian countries from the International Agency for Research on Cancer (Volumes VII–Volume IX from 1988–2002) indicate large increases in the incidence trends of lung adenocarcinoma for Chinese men (APC = 7.0) and Filipino and Korean women (APC = 8.1 and 3.6, respectively), while a somewhat stable trend was estimated (APC = 1.0) for Chinese women (data not shown). These data from Asia also point to the growing burden of lung adenocarcinoma among these particular Asian populations.

Possible reasons underlying the trends demonstrated here may be due to the persistence of exposure to lung cancer carcinogens among these AANHPI populations. Adenocarcinoma is more weakly associated with smoking than other histologic cell types such as SCC and SCLC (27, 28), indicating that other exposures are particularly relevant for this cell type as well as genetic susceptibility (29–32). Interestingly, the increasing incidence rates of adenocarcinoma were seen among some of the more recent Asian American immigrants to the United States—Vietnamese, Laotian, and Asian Indian/Pakistani men and Filipino and Korean women. It is possible that higher prevalence of exposures found among immigrant groups (33, 34) that have been linked to adenocarcinoma such as preexisting tuberculosis infection (35) may play a role in the increasing rates of disease. On the basis of the

2002–2005 National Survey on Drug Use and Health, the prevalence of smoking varied greatly between Asian American men and women (12). For men, the prevalence of smoking within the past 30 days was 16.1% in Chinese men and 33.5% in Vietnamese men (12). For women, the prevalence of smoking within the past 30 days was highest in Korean women at 20.1% out of six Asian American populations followed by Filipinas at 10.4%, and was low among other groups (12). Acculturation, the process by which foreign-born individuals adopt values, customs, attitudes, and behaviors of the mainstream culture (36, 37), has been reported to differentially influence smoking behavior among Asian American men and women (38). This has important implications on the underlying factors affecting lung cancer development among these populations. In particular, a meta-analysis study reported that acculturated Asian American men were roughly 50% less likely to smoke than less acculturated men (38). In contrast, acculturated Asian American women were five times more likely to smoke than less acculturated women (38). Our previous work confirms this pattern as we have reported lower rates of smoking in U.S.-born Asian American men in comparison with foreign-born Asian American men, yet an opposite pattern by nativity was seen for Asian American women (39). This suggestion that acculturation may have beneficial effects on smoking behavior in Asian American men yet a harmful effect in Asian American women (38, 39) is an important consideration for future etiologic and tobacco prevention studies of lung cancer among Asian Americans.

The rise in adenocarcinoma rates may be due to other contributing factors such as second hand tobacco smoke, diet and cooking methods, and previous lung diseases as highlighted by studies conducted in Asia, and particularly in epidemiologic studies of Asian women given their lower rates of smoking and higher rates of lung cancer (40–42). Among never smoking Chinese women, environmental tobacco smoke from the home or workplace and the use of coal for household heating and cooking, which is a source of carcinogenic polycyclic aromatic hydrocarbons, were estimated to account for 25% and nearly 20% of lung cancer cases, respectively (43). Previous lung diseases contribute to a significant proportion of lung cancer in Chinese never-smokers, with tuberculosis accounting for a greater proportion of the burden of lung cancer in China (43). Although these studies in Asia provide important insight on the risk factors for lung cancer among Asian populations, the prevalence of these factors is likely considerably lower among the Asian American population in the United States. Previous work conducted among AANHPIs from Hawaii observed an increased risk of lung cancer unrelated to smoking among Chinese women, indicating that other etiologic factors may be responsible and additional investigation is needed (44). Conducting etiologic studies of lung cancer risk among AANHPIs is an important research priority given the

growing Asian American population, our limited knowledge of the underlying risk factors, and as this report exemplifies, their steady and increasing trends of adenocarcinoma in specific populations.

The steady decline in rates of LC+OSC was consistent for men and women across nearly all AANHPI populations. The decline in LC+OSC was greatest among Vietnamese men, whose prevalence of smoking is among the highest of all racial/ethnic groups (12), and may be correlated with declining prevalence of smoking in California (45).

For unspecified types, incidence trends seemed to increase among most AANHPIs through the 1990s and 2000s, with a marked decline beginning around the early- to mid-2000s. Such a notable trend around a similar timeframe across most populations suggests the possibility of a systematic change in coding practices that may lead to improved specificity of unspecified types to being coded to more specific histologic cell types. Indeed, beginning with bevacizumab in 2005 (46), the development of lung cancer therapeutic agents restricted to specific histologies has led to an increased emphasis of histologic subtyping and a focused effort to reduce histologically unspecified diagnoses. However, this divergent trend was not observed for Vietnamese, Korean, Kampuchean, Samoan, and Asian Indian/Pakistani men or Korean women. Continued surveillance in trends of unspecified histologic cell types after 2010, given the new classification codes issued in 2011 (47), may provide further insight into explanations for these trends.

It has been suggested that these changes in histology practices and coding systems for unspecified types may result in artifactual trends in histologic specific cell types such as the increasing trends for adenocarcinoma and SCC starting around 2005 (48). In our study, the declining trends in unspecified types (~2000s) did not correspond with the increasing trends for adenocarcinoma and SCC (mostly 1990–2010), indicating our findings may not be largely biased by such changes in histologic diagnosis.

There are several caveats worth noting. First, because data on race/ethnicity are primarily derived from medical records (17), they may be misclassified; however, prior research shows low to moderate misclassification for AANHPIs, highest among Vietnamese and South Asians (sensitivity < 50%) but >75% sensitivity among other Asian American populations (17, 49–55). Second, rates may be underestimated because of exclusion of cases coded as "Asian, not otherwise specified." Third, there may be errors associated with the inter-censal annual population estimates (56). Fourth, small case and denominator counts in some groups lead to unstable rates and potential trends that could not be detected. Finally, many of these patterns could be attributable to cohort changes in acculturation over time, which could not be assessed.

Despite these potential limitations, this report based on robust national data covering more than half of the Asian American population and two-thirds of the NHIPI population, provides important insight on contemporary

histologic cell-type-specific lung cancer trends among ten AANHPI populations in the United States, serving as a basis of critical evidence to inform future research and health policies. Although the declines in adenocarcinoma among most groups of AANHPI males mirror the trends seen among NHW males, the increasing trends among Filipino and Korean females and Chinese men are of particular concern. Also, the increase in SCC among Japanese females is of concern. These results point to areas where targeted preventive efforts for tobacco prevention and control can be undertaken now in public health, policy, and clinical arenas. Furthermore, given the low smoking prevalence among specific Asian American females and few known lung cancer risk factors in U.S. never-smoker populations, additional research of etiologic factors, focused especially on these ethnic groups of Asian American females, may elucidate knowledge and progress against lung cancer among never smokers.

Disclosure of Potential Conflicts of Interest

S.L. Gomez reports receiving a commercial research grant from Genentech. No potential conflicts of interest were disclosed by the other authors.

Disclaimer

The ideas and opinions expressed herein are those of the authors, and endorsement by the State of California, the California Department of Health Services, the NCI, or the Centers for Disease Control and Prevention or their contractors and subcontractors is not intended nor should be inferred.

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Acknowledgments

The authors thank Dr. Clayton Schupp and Meg McKinley for their contributions.

Funding Support

This work was supported by the Stanford Cancer Institute (to S. Glaser). 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 HHSN261201000140C awarded to the Cancer Prevention Institute of California, contract HHSN261201000035C awarded to the University of Southern California, and contract HHSN261201000034C awarded to the Public Health Institute; and the Centers for Disease Control and Prevention's National Program of Cancer Registries, under agreement #1U58 DP000807-01 awarded to the Public Health Institute.

Received May 4, 2014; revised July 3, 2014; accepted July 21, 2014; published online November 3, 2014.

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Cancer Epidemiol Biomarkers Prev 2014;23:2250-2265.

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