

Cancer Incidence and Mortality Patterns Among Chinese Americans

Lihua Liu, Dennis Deapen, and Anna H. Wu

Abstract Chinese is the largest Asian ethnic group in the USA with four million individuals accounting for 23.1 % of the total Asian Americans and 1.3 % of the total US population. Given its large population size and the long history of migration to many countries throughout the world, Chinese immigrants are a valuable resource for epidemiologic investigations of cancer and other diseases to identify environmental and lifestyle risk factors and to understand the interactions between genetics and environment in disease etiology. Using data from population-based cancer registries, this chapter examines the sex-specific cancer incidence and mortality rates of common cancers among Chinese Americans and their relative risks as compared to whites or non-Hispanic (NH) whites. Comparisons of incidence trends and age-specific patterns by cancer type between Chinese Americans and Chinese in China are also provided. For most of the cancers examined, Chinese Americans have lower incidence and mortality rates than the NH whites, but they have substantially higher risk for nasopharyngeal, liver, and stomach cancers and slightly higher risk of gallbladder cancer. Except for lung and colorectal cancer, Chinese Americans display intermediate-risk level between the US whites and Chinese in China. The cancer experience of Chinese Americans highlights the significance of environmental and lifestyle factors in cancer development.

Keywords Chinese American • Cancer • Immigrant • Incidence • Mortality • Trend • Rate ratio

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History of Chinese Migration to the USA

Chinese immigration to the USA dates back to the 1820s, according to the official US government records [1]. The first wave of a significant number of Chinese immigrants to the USA arrived in California during the 1850s to join the Gold Rush [2]. More came when the Central Pacific Railroad recruited large number of laborers throughout the 1860s until the railroad's completion in 1869. The number of Chinese seeking permanent legal resident status rose from 32 in the 1840s to 133,139 in the 1870s [1]. The early Chinese immigrants were mostly young uneducated men from the Guangdong province in southern China [3]. Demographic data on Chinese in the USA have been collected since the 1860 US population census.

The Chinese Exclusion Act of 1882, as a result of increasing anti-Chinese racial tension coupled with economic depression that started in 1873, effectively ended the immigration of Chinese laborers. The number of Chinese in the USA gradually decreased as many of the immigrants returned home or left for more hospitable places. However, the repeal of the Chinese Exclusion Act of 1943 granted naturalization rights to foreign-born Chinese and established an immigration quota for China. The Immigration and Nationality Act of 1965 abolished racial discrimination in immigration law, beginning a period of renewed Chinese immigration to the USA. The economic reform and Open Door Policy adopted by the Chinese government in the late 1970s resulted in record numbers of young well-educated Chinese students coming to the USA seeking higher education. As the Chinese economy grew, increasing numbers of Chinese emigrate to the USA through business, investment, family reunification, and a variety of venues, besides education. In addition to mainland China, Chinese immigrants may also originate from Taiwan, Hong Kong, Macau, and other regions of the world.

According to the 2010 census, there were 3.5 million Chinese of single race and 0.5 million of multirace living in the USA [4]. Chinese is the largest detailed Asian American group, accounting for 23.1 % of the total Asian Americans and 1.3 % of the total US population. After Spanish, Chinese was the most widely spoken non-English language in the country, with 2.9 million people speaking it at home in 2011 [5]. The number of Chinese speakers in the USA has more than quadrupled since 1980. Among the nation's Chinese speakers, only 44 % reported speaking English "very well." The Chinese-speaking population was found heavily concentrated in the New York, Los Angeles, and San Francisco metro areas [5]. The number of Chinese speakers includes those speaking any of the many Chinese dialects, such as Mandarin and Cantonese.

In comparison to other Asian Americans and the white population, Chinese Americans generally have lower unemployment rate (4.4 % unemployment rate, as compared to 5.2 % for all Asians and 6.5 % for whites), higher median earnings (median weekly earnings in 2013 of \$1093, as compared to \$987 for Asian Americans and Pacific Islanders (APIs) and \$865 for whites), higher levels of education (56.8 % of age 25 and older are college graduate, as compared to 53.4 % of all Asians and 31.9 % of whites), but also higher poverty rate (15.2 % during 2000–2012, as compared to 13.0 % for APIs and 13.6 % for whites) [6].

History of Studying Cancer Among Chinese Americans

With its large population size and the long history of migration to many countries throughout the world, Chinese immigrants have been recognized as a valuable resource for epidemiologic investigations of cancer and other diseases to identify environmental and behavioral risk factors and to understand the interactions between genetics and environment in disease etiology.

The first systematic national study of cancer occurrence among Chinese Americans was published by Smith and colleagues in 1956 using the cancer mortality data of 1949–1952 [7]. It documented the different cancer risk profiles of Chinese in the USA as compared to the US whites, confirming findings from the few analyses of clinical and autopsy materials reported prior to that time [8]. Studies of cancer patterns among Chinese Americans in the 1950s and 1960s relied on cancer mortality data that were collected consistently through vital statistics with birthplace information of the deceased [7–9]. Those early mortality-based studies were limited by the relatively small number of Chinese deaths in the older age groups and showed the typical male dominance and origin of the early Chinese migrants from southern China [10].

In contrast to cancer mortality data that capture deaths caused by a specific cancer, cancer incidence data record new cases of cancer diagnosis in a given year. Incidence data provide information that is not captured in mortality data. The National Cancer Institute (NCI) conducted three National Cancer Surveys at three points in time, 1937–1939, 1947–1948, and 1969–1971, providing estimates of cancer incidence rates and establishing the field of modern cancer epidemiology [11]. However, cancer incidence data were not systematically collected in the USA until 1973 by the Surveillance, Epidemiology, and End Results (SEER) program that was established by the NCI, as a result of the National Cancer Act of 1971 [12]. Information specific to cancer incidence among Chinese Americans was not systematically available in a meaningful volume until the 1970s through the population-based SEER registries.

The SEER program and its registries have consistently contributed data to the international cancer statistical reports, such as Cancer Incidence in Five Continents (CI5) series that provide internationally comparable cancer incidence information among countries and populations of the world [13]. Although the SEER registries collect detailed racial/ethnic information on cancer patients, the lack of official annual population estimates with corresponding racial/ethnic classification limited the examination of cancer risk specifically among Chinese and other disaggregated Asian American ethnic groups in the SEER program as a whole. However, SEER registries in San Francisco and Los Angeles have had long tradition in monitoring cancer incidence among the large Chinese American communities in their catchment areas.

The SEER registry in Los Angeles, the Los Angeles Cancer Surveillance Program (LACSP), is a population-based cancer registry established in 1972 at the University of Southern California and joined the SEER in 1992. The LACSP is located in the most populous and racially/ethnically diverse county in the country, the Los Angeles County, California. According to the 2010 population census,

nearly 0.4 million Chinese lived in the catchment area of LACSP consisting of 12 % of the national total of Chinese Americans. LACSP is the only US registry that has continuously contributed to CI5 cancer incidence data of Chinese and other Asian Americans in Los Angeles, making the comparison of cancer incidence trends between Asians living in the USA and elsewhere possible.

As a result of the growing Asian American population, the increasing interest in and awareness of the heterogeneous cancer burdens among Asian subgroups; SEER has made significant strides in developing necessary population estimates and reporting cancer incidence and mortality statistics among the fast-growing AAPI populations [14–16].

Data Sources and Methods

For this chapter, we utilized a variety of data sources to present a contemporary overview of cancer risk patterns among Chinese Americans. These data sources include recently published information based on SEER registry data, special data files from SEER program, international cancer data in the CI5 series published by the International Association of Cancer Registries (IACR), and up-to-date Chinese-specific cancer information from the LACSP.

Previously Published SEER Data

Using SEER data of 14 registries from 1998 to 2002, Miller et al. (2008) reported the age-adjusted (2000 US standard population) overall and cancer site-specific incidence and mortality rates among specific AAPI populations in the USA in comparison with those of NH whites [14]. We extracted the Chinese-specific case counts and age-adjusted rates by sex and cancer site, along with those of NH whites, and compiled for incidence (Table 1) and mortality (Table 2). The cancer sites in each table are sorted and ranked by the rates from high to low. We also calculated the rate

Table 1 Site-specific cancer incidence counts and age-adjusted (2000 US standard) rates and rate ratios by sex among Chinese Americans and NH Whites, SEER registries, 1998–2002

	Chinese American		NH White		Incidence
	Cases	Rate	Cases	Rate	Rate ratio
Men					
All sites	9,175	348.8	649,731	587.0	0.6
Prostate	2,209	84.8	189,678	170.0	0.5
Colorectal	1,400	54.0	71,656	65.6	0.8
Lung	1,340	53.0	98,625	89.2	0.6
Liver	666	24.0	7,445	6.7	3.6

Table 1 (continued)

	Chinese American		NH White		Incidence
	Cases	Rate	Cases	Rate	Rate ratio
Stomach	461	18.3	10,797	9.9	1.8
Bladder	389	15.7	46,682	43.0	0.4
Non-Hodgkin's Lymphoma	401	14.8	27,294	24.6	0.6
Pancreas	243	9.8	14,220	13.0	0.8
Nasopharynx	277	8.9	717	0.6	14.8
Leukemia	231	8.7	18,718	17.3	0.5
Kidney	192	7.2	19,671	17.5	0.4
Oral	166	6.2	18,462	16.2	0.4
Esophagus	124	4.5	9,079	8.1	0.6
Brain and nervous system	123	4.3	9,893	8.9	0.5
Thyroid	96	3.2	4,996	4.3	0.7
Larynx	78	3.0	8,101	7.1	0.4
Myeloma	74	2.7	7,264	6.6	0.4
Testis	57	1.7	7,816	7.0	0.2
Hodgkin's Lymphoma	40	1.3	3,833	3.5	0.4
Melanoma	35	1.2	32,981	29.3	0.0
Gallbladder	24	0.9	768	0.7	1.3
Women					
All sites	8,817	270.4	617,158	448.5	0.6
Breast	2,652	77.6	195,231	145.2	0.5
Colorectal	1,257	40.2	70,298	47.6	0.8
Lung	923	29.7	83,387	59.0	0.5
Corpus uteri	406	12	35,224	26.0	0.5
Stomach	344	11.1	6,430	4.3	2.6
Thyroid	358	10.0	14,103	11.8	0.8
Ovary	335	10.0	20,736	15.3	0.7
Non-Hodgkin's Lymphoma	316	10.0	24,177	17.2	0.6
Liver	258	8.2	3,689	2.6	3.2
Pancreas	209	6.8	14,520	9.8	0.7
Leukemia	188	5.9	13,800	10.0	0.6
Cervix uteri	193	5.6	9,930	8.1	0.7
Bladder	133	4.4	15,480	10.6	0.4
Kidney	126	4.0	11,787	8.5	0.5
Oral	119	3.6	8,996	6.5	0.6
Nasopharynx	125	3.5	315	0.2	17.5
Brain and nervous system	90	2.7	7,911	6.2	0.4
Myeloma	76	2.5	5,986	4.1	0.6
Gallbladder	41	1.3	1,754	1.2	1.1
Esophagus	32	1.0	3,067	2.1	0.5
Melanoma	32	1.0	24,455	19.3	0.1
Hodgkin's Lymphoma	22	0.7	3,348	2.9	0.2

Source of data: Miller AB et al., Cancer Causes Control 2008; 19:227–256. Appendix 1.

Table 2 Site-specific cancer mortality counts and age-adjusted (2000 US standard) rates and rate ratios by sex among Chinese Americans and NH Whites, SEER registries, 1998–2002

	Chinese American		NH White		Mortality
	Deaths	Rate	Deaths	Rate	Rate ratio
Men					
All sites	5,807	167.8	349,031	241.3	0.7
Lung	1,603	47.0	106,623	72.2	0.7
Liver	761	20.3	9,091	6.1	3.3
Colorectal	657	19.5	35,261	24.6	0.8
Stomach	404	11.7	8,395	5.8	2.0
Prostate	292	10.4	37,137	27.7	0.4
Pancreas	291	8.5	18,399	12.6	0.7
Leukemia	216	6.1	15,119	10.6	0.6
Non-Hodgkin's Lymphoma	205	6.0	15,368	10.6	0.6
Nasopharynx	192	4.5	383	0.3	15.0
Esophagus	134	3.8	11,536	7.7	0.5
Bladder	109	3.6	11,682	8.4	0.4
Kidney	102	2.9	9,135	6.2	0.5
Brain and nervous system	94	2.5	9,477	6.3	0.4
Oral	65	1.8	5,605	3.7	0.5
Myeloma	58	1.7	6,454	4.5	0.4
Larynx	33	0.9	3,316	2.2	0.4
Gallbladder	24	0.7	683	0.5	1.4
Melanoma	21	0.6	6,998	4.7	0.1
Women					
All sites	4,537	107.7	341,117	171.7	0.6
Lung	984	23.8	87,084	44.5	0.5
Colorectal	524	12.8	36,430	17.3	0.7
Breast	564	12.3	53,534	27.8	0.4
Liver	308	7.4	5,546	2.7	2.7
Stomach	305	7.3	5,930	2.8	2.6
Pancreas	273	6.7	19,471	9.5	0.7
Ovary	229	5.2	18,962	9.8	0.5
Non-Hodgkin's Lymphoma	172	4.1	14,024	6.8	0.6
Leukemia	132	3.1	12,132	6.0	0.5
Cervix uteri	93	2.2	4,206	2.4	0.9
Corpus uteri	89	2.1	8,368	4.2	0.5
Brain and nervous system	81	1.8	7,602	4.2	0.4
Kidney	63	1.6	5,611	2.8	0.6
Nasopharynx	65	1.4	245	0.1	14.0
Myeloma	49	1.2	5,948	2.9	0.4
Esophagus	45	1.1	3,766	1.8	0.6
Bladder	38	1.0	5,228	2.4	0.4
Oral	34	0.8	3,142	1.6	0.5
Gallbladder	28	0.7	1,675	0.8	0.9
Thyroid	20	0.5	917	0.5	1.0

Source of data: Miller AB et al., Cancer Causes Control 2008; 19:227–256. Appendix 2.

ratio in each table of the Chinese rate in relation to that of the NH whites by cancer site. In Fig. 1, we combined the rate ratios from Tables 1 and 2 by sex to illustrate the differences or similarities in relative cancer risk between Chinese and NH whites by cancer site using both incidence and mortality data.

Updated SEER Data

Using SEER data of 13 registries from 1990 to 2008, Gomez et al. (2013) published the trends in age-adjusted (2000 US standard population) cancer incidence rates for disaggregated Asian American subgroups, including Chinese and NH whites [15]. While they provided more recent data than Miller et al., it only included the top five cancer sites in each Asian-American subgroup. Taking advantage of the availability of the same database that produced the Gomez et al. report [17], for this chapter, we calculated the age-adjusted (2000 US standard population) cancer incidence rates for Chinese Americans during the period of 2004–2008 for the same cancer sites included in the Miller et al. 2008 article by sex, along with those of NH whites for comparison purposes. The results are shown in Table 3. The rate ratios showing the relative risk of Chinese Americans in relation to NH whites are also provided in Table 3. Because the Miller et al. 2008 study and Gomez et al. 2013 study included different time periods and slightly different SEER registries, the incidence rates generated by the two databases are not directly comparable. Nonetheless, in Fig. 2, we compared the incidence-based rate ratios from these two papers to examine any changes in cancer risk patterns over time from 1998–2002 to 2004–2008.

To provide more recent cancer trends, we used recently released data from SEER to update the cancer incidence rates published in the CI5 series for white population in SEER nine registries, and data from LACSP for Chinese Americans in Los Angeles County. We used the same 1960 world standard population, as used in CI5, and extended the age-adjusted incidence rates to 2012 by sex, year, and cancer site, in order to be compared with the trends data from China as published in CI5.

International Cancer Data

To provide a comparison of cancer risk between Chinese Americans and Chinese in China, we utilized the data published in the CI5. The CI5 series of monographs are results of long-standing collaboration between the International Agency for Research on Cancer (IARC) and the IACR. The CI5 is published every 5 years and is a valuable resource for cancer incidence around the world. The CI5 databases provide access to detailed information on the incidence of cancer as recorded and reported by cancer registries (regional or national) worldwide. The most recent CI5 Volume X covers the time period of 2003–2007, containing average age-specific and age-adjusted (1960 world standard population) site-specific cancer incidence rates by sex for each reporting registry/population [18]. CI5 also offers online

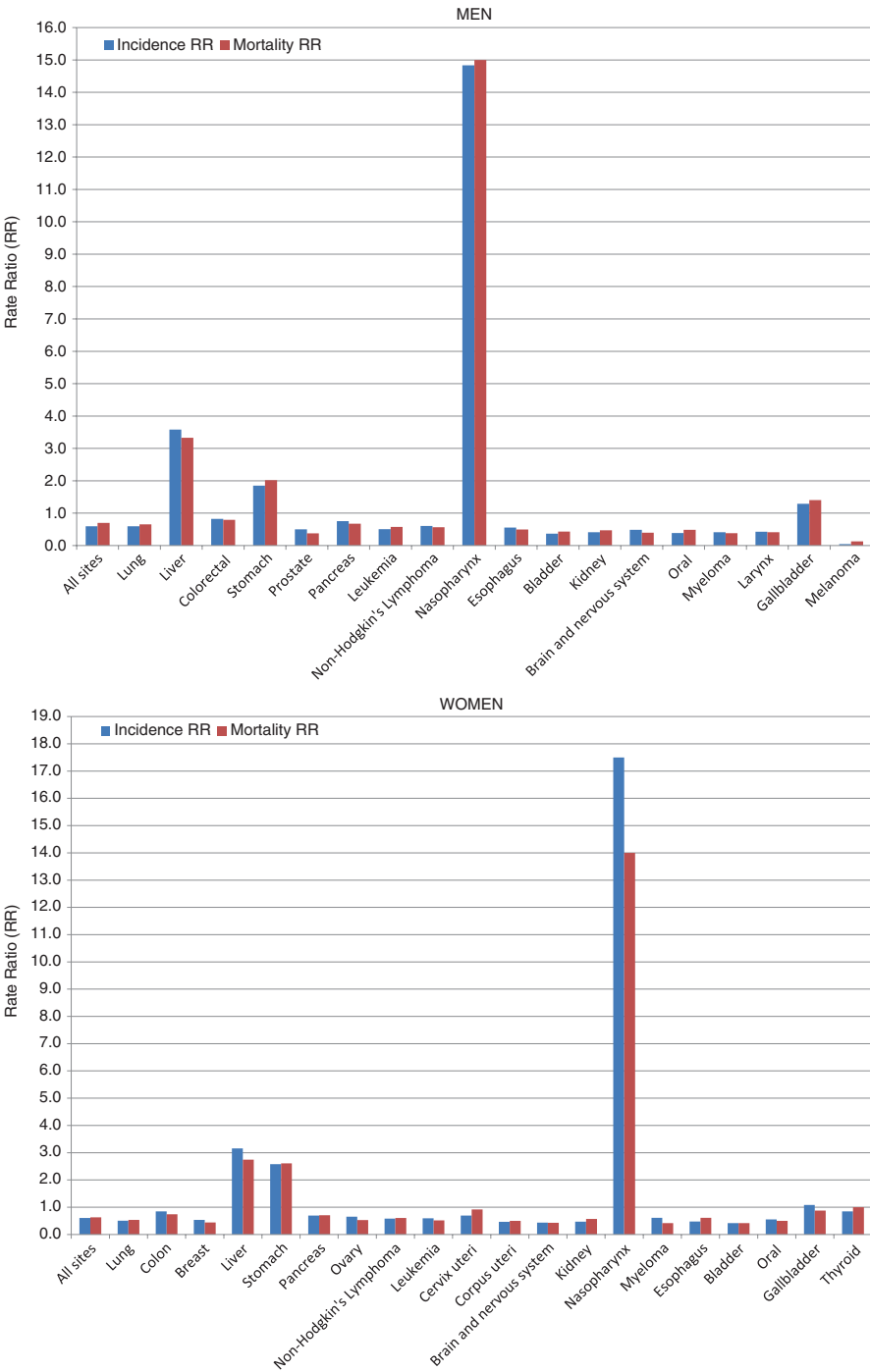


Fig. 1 Comparison of incidence-based rate ratios and mortality-based rate ratios between Chinese Americans and NH whites by cancer site and sex, 1998–2002 (as shown in Tables 1 and 2)

Table 3 Site-specific cancer incidence counts and age-adjusted (2000 US standard) rates and rate ratios by sex among Chinese Americans and NH Whites, SEER registries, 2004–2008

	Chinese American		NH White		Incidence
	Cases	Rate	Cases	Rate	Rate ratio
Men					
All sites	10,705	320.9	572,704	560.2	0.6
Prostate	2,488	74.9	162,504	154.7	0.5
Lung and bronchus	1,678	52.0	74,729	74.0	0.7
Colon and rectum	1,410	42.1	54,752	54.0	0.8
Liver	845	24.1	8,301	7.7	3.1
Stomach	524	16.3	8,832	8.7	1.9
Urinary bladder	506	16.0	43,592	43.8	0.4
Non-Hodgkin Lymphoma	505	14.9	26,059	25.8	0.6
Oral cavity and pharynx	497	13.6	18,112	17.0	0.8
Pancreas	301	9.3	14,086	13.8	0.7
Kidney and renal pelvis	290	8.5	20,888	20.1	0.4
Leukemia	267	7.9	17,055	17.3	0.5
Nasopharynx	282	7.4	590	0.6	12.3
Esophagus	144	4.5	8,722	8.4	0.5
Brain and other nervous system	132	3.7	8,990	9.0	0.4
Thyroid	138	3.6	6,676	6.5	0.6
Myeloma	99	3.1	7,035	6.9	0.4
Larynx	58	1.8	6,050	5.8	0.3
Testis	71	1.7	6,834	7.5	0.2
Melanoma of the skin	43	1.2	37,884	37.1	0.0
Gallbladder	36	1.2	696	0.7	1.7
Hodgkin Lymphoma	34	1.0	3,446	3.6	0.3
Women					
All Sites	11,103	263.4	538,349	440.0	0.6
Breast	3,477	78.8	162,591	135.3	0.6
Colon and rectum	1,447	35.7	53,352	40.6	0.9
Lung and bronchus	1,207	29.9	72,103	56.6	0.5
Corpus uteri	621	14.3	32,452	26.3	0.5
Thyroid	549	12.2	18,712	18.2	0.7
Non-Hodgkin Lymphoma	387	9.4	21,939	17.5	0.5
Stomach	366	9.1	5,058	3.8	2.4
Ovary	352	8.0	17,035	13.9	0.6
Liver	311	7.8	2,898	2.3	3.4
Pancreas	289	7.3	14,013	10.5	0.7
Oral cavity and pharynx	245	5.7	8,119	6.6	0.9
Leukemia	214	5.3	12,586	10.3	0.5
Kidney and renal pelvis	200	4.9	12,288	10.0	0.5
Cervix uteri	209	4.6	6,968	6.8	0.7
Urinary bladder	169	4.3	13,895	10.5	0.4

(continued)

Table 3 (continued)

	Chinese American		NH White		Incidence
	Cases	Rate	Cases	Rate	Rate ratio
Nasopharynx	127	2.8	289	0.2	14.0
Brain and other nervous system	104	2.5	7,006	6.3	0.4
Myeloma	77	1.9	5,249	4.0	0.5
Gallbladder	49	1.2	1,515	1.1	1.1
Esophagus	48	1.2	2,576	2.0	0.6
Melanoma of the skin	43	1.0	27,020	24.3	0.0
Hodgkin Lymphoma	34	0.8	2,996	3.1	0.3

Source of data: Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence—SEER 11, plus Greater CA and NJ, Nov 2010 Sub (1990–2008) detailed API plus White Non-Hispanic—projected from populations, National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released June 2011 (updated 10/28/2011), based on the November 2010 submission

analysis tools, CI5plus, for time trends up to 2007 and age-specific curves by time period for selected cancer registries/populations [19]. The LACSP is the only US registry that has consistently reported Chinese American cancer information to CI5 and thus included in the CI5plus. Among the three Chinese cancer registries included in CI5plus, we chose as a comparison the data from China's Shanghai registry for its long history of participation in CI5, large population size, representativeness of urban China, and high-quality data.

We downloaded from CI5plus the China-Shanghai registry annual age-adjusted (1960 world standard population) incidence rates by sex and cancer site for 1988–2007, in order to be compared with current data for whites from SEER (nine registries) and Chinese Americans from LACSP (Figs. 3 and 4). Figures 3 and 4 contain the comparisons of age-specific incidence rates by sex and cancer site for 2003–2007 between Chinese in Los Angeles and Chinese in Shanghai with reference to US whites, as downloaded from the CI5plus online analysis tool.

Cancer Incidence and Mortality Patterns Among Chinese Americans

Overview

Chinese Americans, as compared to NH whites, have lower risk in both cancer incidence (Tables 1 and 3) and mortality (Table 2) for all cancers combined and for many specific cancer sites, regardless of sex. However, their risk for cancers of the nasopharynx, liver, and stomach is noticeably much higher than the NH whites. The relative risk patterns by cancer site between Chinese Americans and NH whites are quite similar in either incidence or mortality data (Fig. 1).

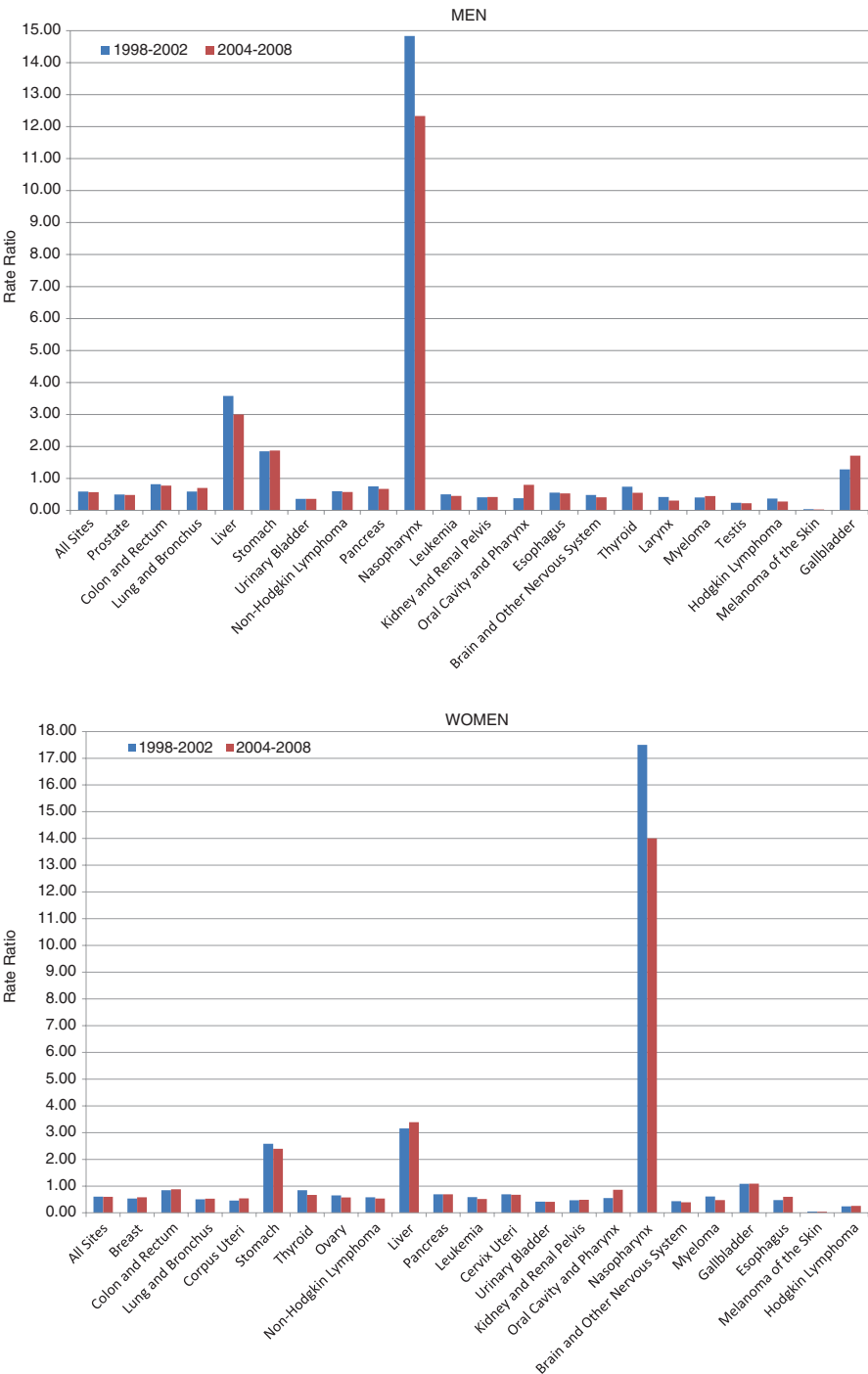


Fig. 2 Comparison of incidence-based rate ratios between Chinese Americans and NH whites by cancer site and sex over time, 1998–2002 vs. 2004–2008 (as shown in Tables 1 and 3)

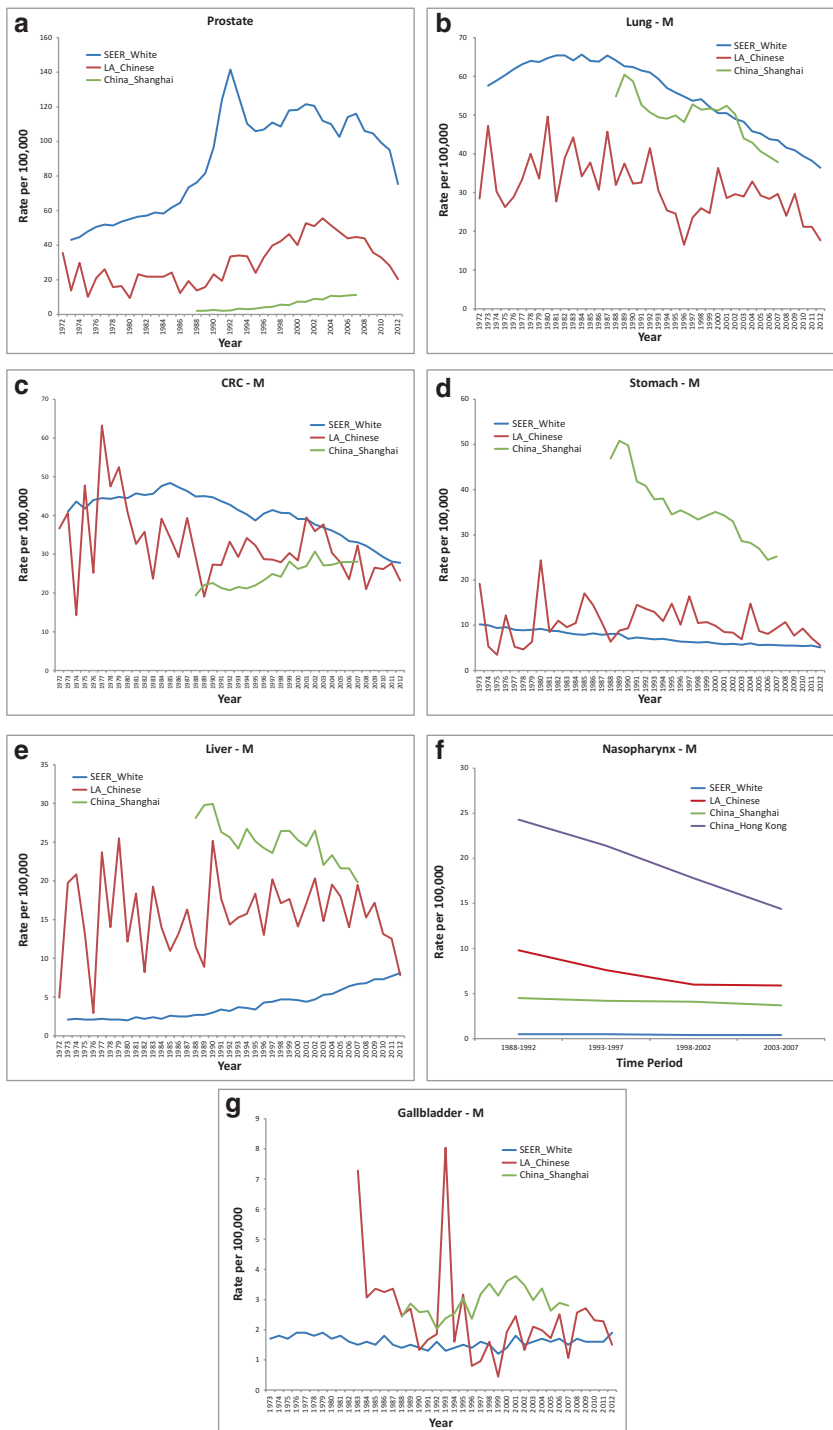


Fig. 3 Time trends of age-adjusted (world population) incidence rates by cancer site among US whites, Chinese in Los Angeles, and Chinese in China-Shanghai, men

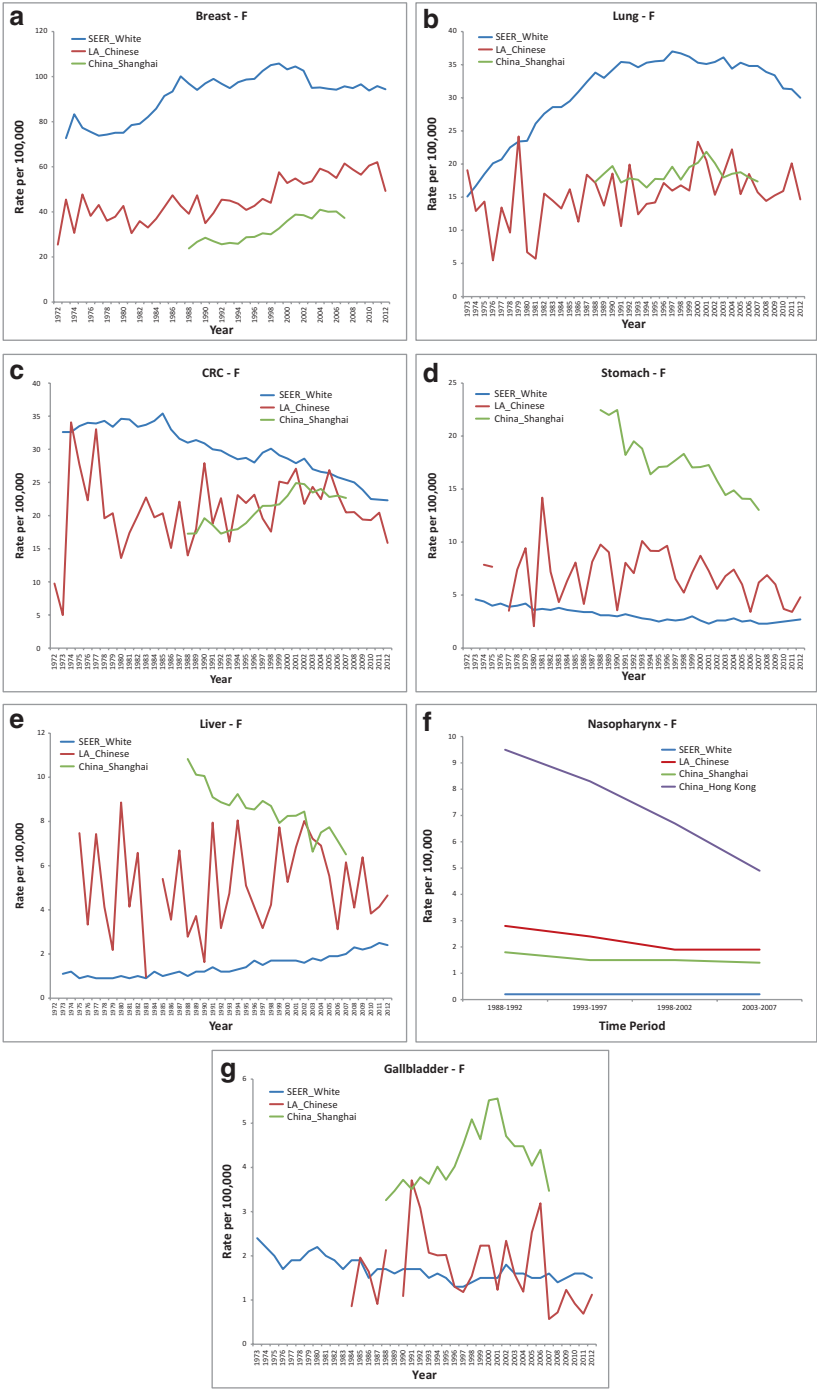


Fig. 4 Time trends of age-adjusted (world population) incidence rates by cancer site among US whites, Chinese in Los Angeles, and Chinese in China-Shanghai, women

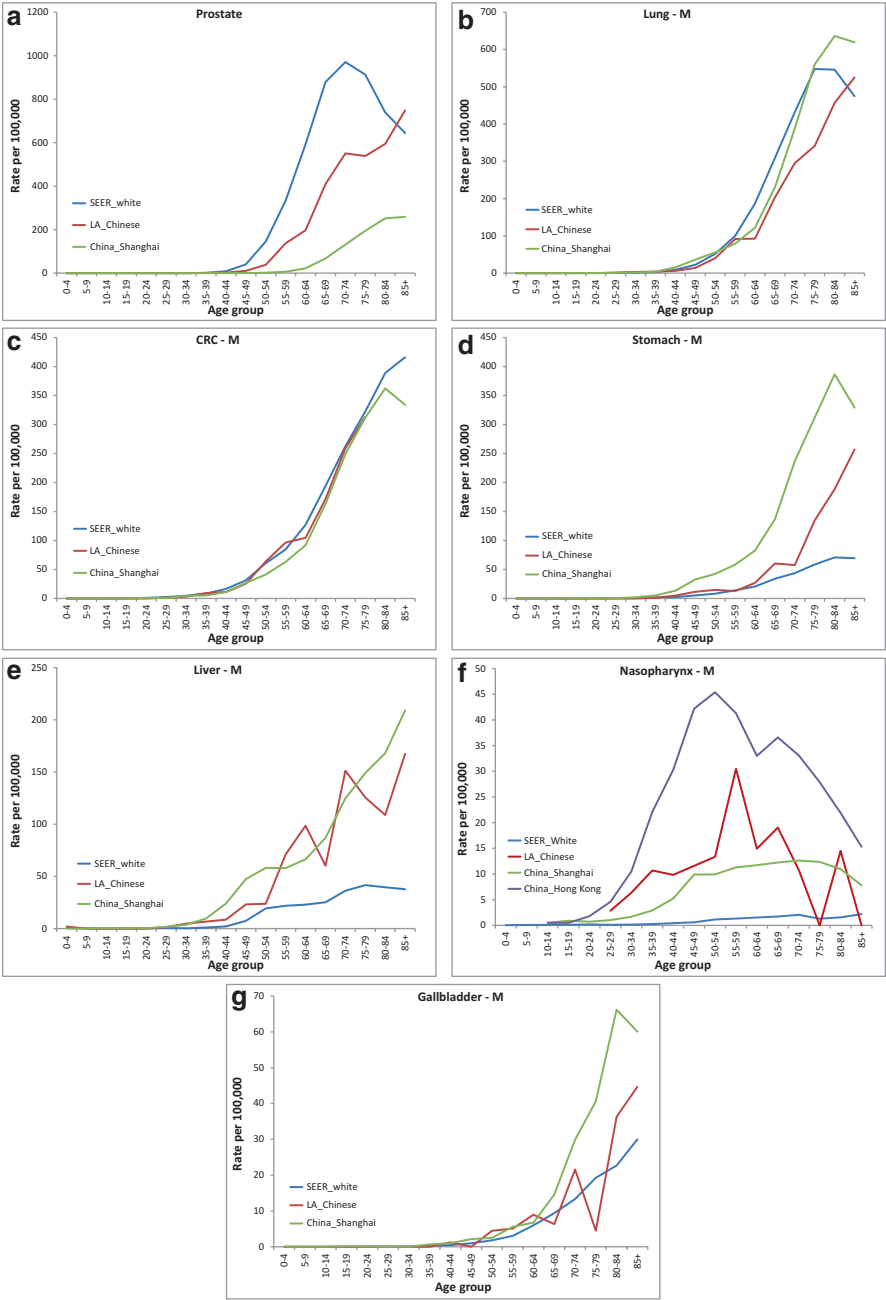


Fig. 5 Age-specific incidence rates by cancer site among US whites, Chinese in Los Angeles, and Chinese in China-Shanghai, men, 2003–2007

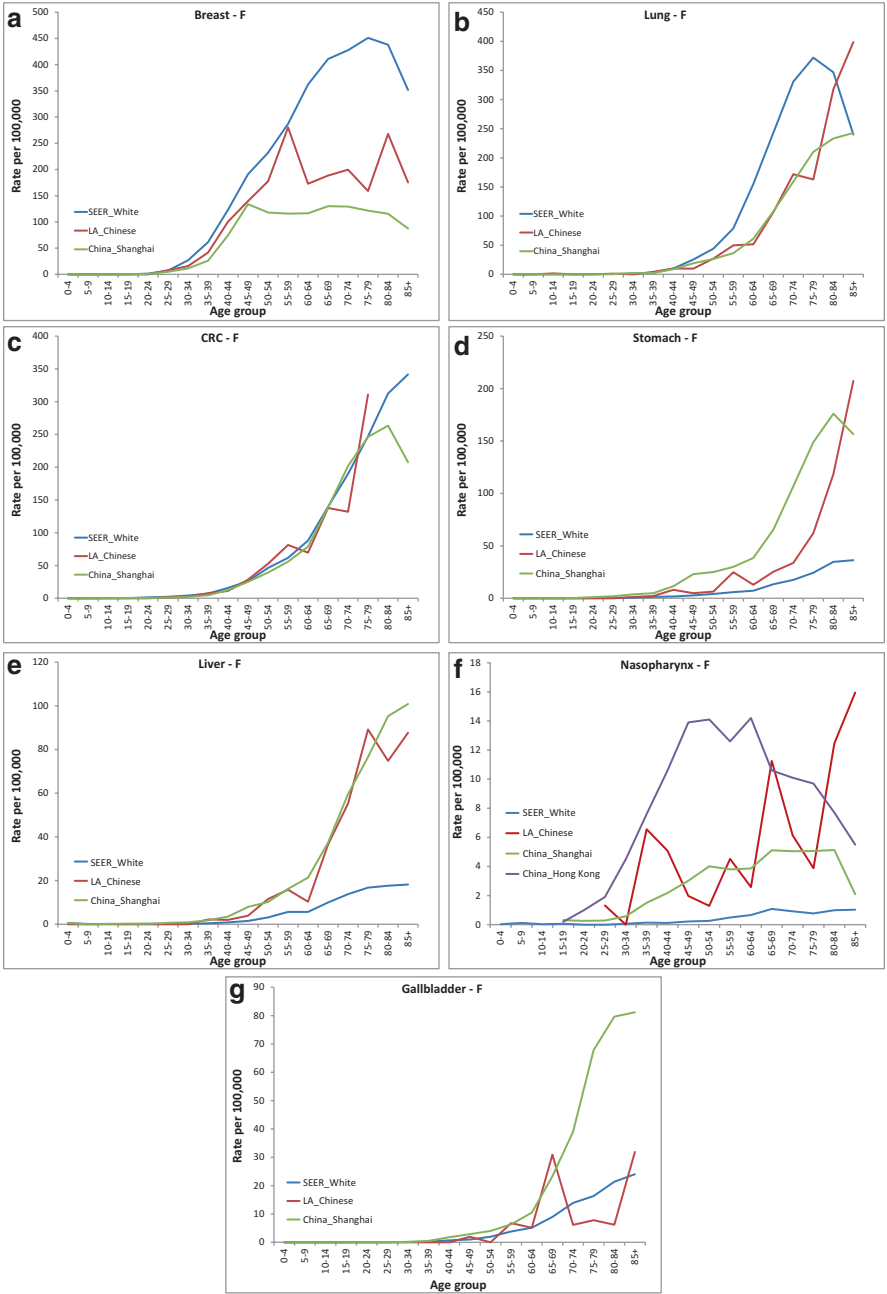


Fig. 6 Age-specific incidence rates by cancer site among US whites, Chinese in Los Angeles, and Chinese in China-Shanghai, women, 2003–2007

Incidence

According to the data published by Miller et al. (2008) for 1998–2002 (Table 1) using SEER registry data [14], the age-adjusted (2000 US standard population) incidence rate (AAIR) among Chinese Americans for all sites combined was 348.8/100,000 in men and 270.4/100,000 in women, about 40 % lower than the AAIR of NH white men or women. The top three most common cancer sites among Chinese-American men were cancers of the prostate, colon and rectum, and lung and bronchus, which was similar to NH white men but with 20–50 % lower AAIRs. The most common cancer among Chinese-American women was breast, followed by colon and rectum and lung. As in men, Chinese-American women also share the same top three most common cancer sites with their NH white counterparts, but with lower risk (50 % lower for breast, 20 % lower for colorectal, and 50 % lower for lung).

In contrast, Chinese Americans had higher AAIRs than NH whites for nasopharyngeal cancer (NPC) (14.8 times in men and 17.5 times in women), liver cancer (3.6 times in men and 3.2 times in women), stomach cancer (1.8 times in men and 2.6 times in women), and gallbladder cancer (1.3 times in men and 1.1 times in women) (Table 1).

More recent SEER data for Chinese Americans during 2004–2008 showed slight decrease in AAIR overall and some changes in site-specific AAIRs (either increasing or decreasing) (Table 3). But due to the differences in cancer and population data between the two different studies, the AAIR estimates are not directly comparable. However, the rate ratios between Chinese Americans and NH whites by sex and cancer site for 2004–2008 reveal very similar patterns as for 1998–2002 (Fig. 2).

Mortality

Cancer of the lung and bronchus is the deadliest for both Chinese Americans and NH whites in both men and women (Table 2), but the age-adjusted (2000 US standard population) mortality rate (AAMR) among Chinese-American men (47.0/100,000) is about 30 % lower than the rate among NH white men (72.2/100,000), while the AAMR for Chinese-American women (23.8/100,000) is about 50 % lower than that of the NH white women (44.5/100,000). Similar to NH whites, colorectal, prostate, and breast are among the top five most common causes of cancer deaths in Chinese-Americans. Unlike NH whites, liver and stomach cancer rank among the top five cancers with higher cancer mortality among Chinese-Americans regardless of sex.

Similar to cancer incidence, as compared to NH whites, Chinese Americans have higher mortality due to nasopharyngeal cancer (15.0 times in men and 14.0 in women), liver cancer (3.3 times in men and 2.7 times in women), stomach cancer (2.0 times in men and 2.6 times in women), and gallbladder cancer (1.4 times in men and 0.9 times in women). For the remaining cancer sites, as well as for all cancer sites combined, Chinese Americans have markedly lower AAMR than NH whites.

The sex-site-specific rate ratios in Chinese Americans relative to NH whites based on incidence closely resemble those based on mortality (Fig. 1).

Incidence Trends and Age Patterns

In the following, we examine the age-adjusted (1960 world standard population) incidence trends and age-specific incidence patterns for the top three most common cancers in Chinese Americans, as well as cancers that show higher risk among Chinese Americans than US whites.

Breast Cancer

Breast cancer is the most commonly diagnosed cancer among Chinese-American women (Table 3). Incidence rate among Chinese in LA has been rising since the 1980s (Fig. 4a); current rates are 60 % of that of the US white women. Rates in Chinese-American women are intermediate across age groups as compared to women in Shanghai and US white women. The differences in rates are particularly pronounced in postmenopausal years. Unlike US whites, breast cancer incidence among Chinese Americans plateaued after menopause, similar to the pattern in Shanghai (Fig. 6a).

Increasing breast cancer risk among Chinese-American women has been reported previously [14, 15, 20, 21]. Acculturation and adoption of Western lifestyles among immigrant Chinese and in many developing countries including China are likely to explain the rising incidence [22–25]. Specifically, the fall in number of births, low physical activity level, and obesity were results of urbanization and westernization that are directly linked with the increase in breast cancer risk in China in recent decades [25–27]. The much higher incidence rates for postmenopausal than premenopausal breast cancer among Chinese in LA as compared to Chinese in Shanghai point to the stronger impact of environmental changes associated with immigration and acculturation on postmenopausal disease and support the suggestion that postmenopausal breast cancer risk is modifiable [28–30].

Prostate Cancer

Prostate cancer is the most common cancer diagnosed in Chinese-American men (Table 3). The incidence trend for Chinese men in LA rose throughout the 1990s and peaked around 2003 before the subsequent downward trend started around 2012 returning to the incidence level observed in the 1980s (Fig. 3a). These changes are clearly associated with the FDA approval of the PSA testing in 1986 and subsequent widespread PSA screening for prostate cancer [32]. However, there was about a 10-year delay in the rise and peaking of the incidence rate among Chinese men in LA

as compared to the rates of white men which rose sharply since 1986 and peaked around 2002. Chinese men in Shanghai experienced a steady increasing trend in prostate cancer incidence starting in late 1990. The rise in prostate cancer risk occurred at slightly different ages; rates markedly increased around ages 45–49 among Chinese men in LA, compared to ages 40–45 for white men and ages 55–59 for Chinese men in Shanghai (Fig. 5a). While prostate cancer incidence was highest and peaked at ages 70–74 and then declined in US white men, rates among Chinese men in LA continue to increase with increasing age and surpassed the risk in white men at ages 85+.

The higher prostate cancer risk among Chinese men in LA as compared to Chinese men in Shanghai may be explained, in part, by more widespread PSA screening in the USA [31–33]. Although Western diet (i.e., high calcium, processed meat, milk, and dairy products) has been linked with increased prostate cancer risk [34], while consumption of green tea and soy foods has been associated with decreased prostate cancer risk [35, 36], the evidence for a role of dietary factors in explaining east-west differences in incidence is weak. The consistently lower incidence rate in Chinese American men as compared to white men likely underlines the genetic and etiologic differences between the two populations [37–41].

Lung Cancer

Lung cancer is the second most common cancer among Chinese-American men and third most common cancer among Chinese-American women (Table 3). Lung cancer incidence is lower among Chinese men in LA compared to US white men and Chinese men in Shanghai; all share a similar declining trend in incidence rate (Fig. 3b). Lung cancer risk was lower in Chinese men in LA than US white men across all ages, particularly after age 60 (Fig. 5b). Chinese women in LA and those in Shanghai have comparable rates, which are about half of that of US white women. Rates in all three groups are beginning to decrease (Fig. 4b). The age-specific lung cancer incidence rates are also similar between Chinese women in LA and their counterparts in Shanghai, which are lower than those of US white women, until around 80 years of age (Fig. 6b).

Prevalence of current smokers is low among Chinese Americans with 16.1 % in men and 4.9 % in women, compared to 40.0 % and 26.6 % in US white men and women [42]. Acculturation appeared to have opposite effects on smoking behaviors in immigrant Asian men and women. Smoking rate tends to decrease with acculturation among men but increase with acculturation among women [43], which may partly explain the lower lung cancer risk among Chinese men in LA than Chinese men in Shanghai and the comparable risk level among women between the two locations. Lung cancer incidence in Chinese women appeared to be unusually high given that most were never smokers [44–47]. Besides active smoking, other risk factors, including secondhand smoking, environmental pollution, cooking methods, diet, previous lung diseases, and reproductive and genetic factors, have been implicated [48–57]. The complex risk patterns and disparate trends of lung cancer among subpopulation groups warrant continued surveillance and research among diverse populations [58, 59].

Colorectal Cancer (CRC)

Cancer of the colon and rectum ranks third in Chinese-American men and second among Chinese-American women (Table 3). Compared to NH whites, the risk of developing CRC is about 20 % lower in Chinese-American men and 10 % lower in Chinese-American women (Table 3). With the steady decline in CRC risk among US whites since the 1980s, the risk difference between Chinese Americans and their white counterparts is narrowing in recent years (Figs. 3c and 4c). Chinese in LA and Shanghai and US whites displayed very similar age-specific risk patterns (Figs. 5c and 6c).

Risk of CRC is strongly associated with familial and lifestyle factors [60–64]. Economic development and adoption of Western lifestyle have resulted in the rising incidence of CRC and other cancers in China [65, 66]. Screening has been credited as having considerable impact on the steady reduction in CRC incidence and mortality in the USA since the late 1980s [67]. Differences in access to CRC screening have contributed to the risk disparities among different population groups stratified by racial and socioeconomic characteristics [68–70]. Chinese-Americans are known to underutilize CRC screening [71–73]. Research has shown that education programs specifically designed to address cultural characteristics can significantly improve CRC screening among Chinese-Americans [74].

Stomach Cancer

Stomach cancer is one of the cancers that Chinese-Americans are at higher risk than NH whites; this is particularly striking after age 70 (Figs. 5d and 6d). Chinese-American men and women are 1.9–2.4 times more likely than NH whites to be diagnosed with stomach cancer (Table 3). Stomach cancer incidence rates for Chinese men in LA are about two-thirds lower than rates of Shanghai Chinese men in recent years (Fig. 3d); these differences are observed across all age groups. Risk patterns in women are similar to those in men. Rates in US whites as well as Chinese in LA are declining steadily (Fig. 4d).

The effect of migration on stomach cancer risk reduction among Japanese Americans has been well documented [75–77]. The much lower stomach cancer risk among Chinese in LA than in Shanghai can largely be explained by the lower prevalence of stomach cancer risk factors in the USA, such as *Helicobacter pylori* (*H. pylori*) infection, tobacco consumption, and certain dietary patterns, as well as better food preservation [78–85].

Liver Cancer

Compared to NH whites, liver cancer incidence is 3.1 times higher in Chinese-American men and 3.4 times higher in Chinese-American women (Table 3). In both sexes, the age-adjusted liver cancer risk for Chinese in LA is intermediate between those of Chinese in Shanghai and US whites. In contrast to the clear steady declining

incidence among Shanghai Chinese, risk trends appear to be on the rise among US whites and stabilizing among Chinese in LA (Figs. 3e and 4e). Chinese in LA and in Shanghai display almost identical age-specific liver cancer incidence rates that are much higher than those of US whites across all ages, especially in older age groups (Figs. 5e and 6e).

Chronic infection with hepatitis B virus (HBV) causes more than half of liver cancer cases worldwide [86, 87]. While HBV is rare (1 %) in NH whites, 11.5–21.4 % of Chinese Americans carry the virus [88–90]. HBV carriers have much higher risk of developing liver cancer than noncarriers. HBV vaccination has proven to be very effective in reducing liver cancer risk and contributed to the sustained decline in liver cancer incidence around the world, especially in high-risk regions including China [91]. However, studies have shown that knowledge of the relationship between HBV and liver cancer and participation in HBV screening are both low among Chinese-Americans. Over 50 % of Chinese Americans never had HBV test, and about one-third had been vaccinated [92–94]. There are other risk factors of liver cancer including alcohol-related liver diseases, smoking, obesity, diabetes, and infection with hepatitis C virus (HCV) [95–97]. Unlike HBV, currently, there is no vaccination available for HCV. The increase in liver cancer incidence rates among US whites is likely related to the increasing HCV infection in the population [88, 98].

Nasopharyngeal Cancer (NPC)

NPC is a rare cancer worldwide. It ranks as 12th and 16th as the most common cancer among Chinese-American men and women, respectively. However, the incidence rates of NPC among Chinese Americans are 12.3 times higher than NH white men and 14.0 times higher than NH white women (Table 3). Chinese men and women in LA have higher incidence of NPC than both US whites and Chinese in Shanghai, but their risk is lower than that of Chinese in Hong Kong. These risk differentials likely reflect the striking high-risk patterns of NPC in China, particularly in southern coastal China. Incidence of NPC in LA Chinese declined throughout the 1990s and appeared to have now stabilized (Figs. 3f and 4f). The age-specific NPC incidence pattern in Chinese men in LA differs from that of US white men and Chinese men in Shanghai, but resembles that of Chinese men in Hong Kong; incidence peaks between ages 50 and 60. Interestingly, NPC risk appears to continue to increase with age among Chinese women in LA (Figs. 5f and 6f).

Nasopharyngeal cancer is a prevalent disease in southern China, particularly among the Cantonese living in Hong Kong and Guangdong province. Southern Chinese who migrated to low-risk regions still retain a much higher incidence rate compared to local populations [99–102]. But the risk seems to decrease with longer duration of residence and with succeeding generations [103–105]. Such decline in risk may also be attributable to a mixture of Chinese immigrants originating from high- as well as low-risk areas in China [100]. The incidence rates of NPC in China and other high-risk regions have been declining in the past decades, which seem to

be associated with rapid economic development in the regions [106–109]. Well-established risk factors for NPC include Epstein-Barr virus (EBV), consumption of salt-preserved fish (particularly during weaning) and vegetables, family history of NPC, tobacco and alcohol consumption, and certain genotypes [99–102]. Despite the strong indication that both environmental factors and genetic traits contribute to the development of this cancer, understanding of its complex etiology is incomplete. Current strategies to reduce the risk of NPC include reducing the consumption of salt-preserved fish and other preserved foods, smoking cessation, reduction of alcohol use, and increase intake of fresh fruits and vegetables.

Gallbladder Cancer

Although generally considered a rare disease, gallbladder cancer has widely varied risk patterns around the world. The incidence rates are low in the USA and most Western and Mediterranean European countries, but high in Asia and Latin America [13]. It is one of the four cancers that Chinese-Americans are at higher risk in incidence than NH whites, more so in men (30 % higher) than in women (10 % higher) (Table 1 and Fig. 1). Regardless of sex, Chinese in LA have much lower incidence rates than Chinese in Shanghai, similar to the NH whites (Figs. 3g and 4g). While incidence in China showed a notable decline in the beginning of the 2000s, it remained relatively stable in the USA. Higher gallbladder cancer risk among Chinese in Shanghai than US whites is consistent across age in both men and women. Between ages 50 and 65, gallbladder cancer risk among Chinese men in LA is comparable to that of Chinese men in Shanghai, higher than that of US white men. The risk reduction for Chinese in LA, as compared to Chinese in Shanghai, seems to occur after age 70 in both sexes (Figs. 5g and 6g).

The risk factors of gallbladder cancer include gallstone, chronic gallbladder inflammation, gallbladder polyps, tobacco use, obesity, and diabetes [110–113]. A family history of gallstone and other gallbladder diseases increases the risk of developing gallbladder cancer [114, 115]. Environmental exposures to heavy metals and radon [116, 117] and a diet high in fried and oily foods have also been implicated in gallbladder cancer incidence [118–120]. The progression of gallbladder cancer is frequently rapid and silent, resulting in late diagnosis and dismal prognosis. Studying the risk variation in different populations, especially immigrants from high-risk regions, will aid identification of genetic and environmental risk factors, early detection, and development of primary prevention strategies to conquer this fatal disease.

Summary

Chinese-Americans demonstrate distinctive cancer risk patterns that are different from the white or NH white population. Although for most of the cancers examined Chinese-Americans have lower incidence and mortality rates than the NH whites,

their risk for nasopharyngeal cancer, liver cancer, and stomach cancer is substantially higher, in addition to their slightly higher risk of gallbladder cancer. Except lung and colorectal cancer, Chinese Americans display intermediate-risk level between the US whites and Chinese in China, highlighting the significance of environmental and lifestyle factors in cancer development. Among Chinese-American men, liver cancer incidence seems to be stabilizing. Among women, risk is climbing for breast cancer, lung cancer, and even possibly liver cancer. Continued effort to monitor the cancer trends and develop effective cancer control programs in this special population is both necessary and important. The unique age-specific risk patterns by cancer type among Chinese Americans may offer clues for generating etiologic hypothesis. Focused research on specific racial/ethnic populations with migration history is likely to offer new understanding and opportunities in the fight against cancer.

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References

1. United States Department of Homeland Security (2013) Yearbook of immigration statistics: 2012. U.S. Department of Homeland Security, Office of Immigration Statistics, Washington. http://www.dhs.gov/sites/default/files/publications/ois_yb_2012.pdf. Accessed 25 June 2015
2. Kwong P, Miscevic D (2005) Chinese America. The New Press, New York, p 44. ISBN 1-56584-962-0
3. Iris Chang (2003) The Chinese in America. Penguin Books, New York, pp 34–35. ISBN 0-670-03123-2
4. Hoeffel EM, Rastogi S, Kim MO, Shahid H (2012) The Asian population: 2010. 2010 census briefs. U.S. Census Bureau, Suitland, <http://www.census.gov/prod/cen2010/briefs/c2010br-11.pdf>. Accessed 25 June 2015
5. Ryan C (2013) Language use in the United States: 2011. American community survey reports. U.S. Census Bureau, Suitland, <http://www.census.gov/prod/2013pubs/acs-22.pdf>. Accessed 25 June 2015
6. United States Department of Labor (2014). The economic status of Asian Americans and Pacific Islanders in the Wake of the Great Recession. http://www.dol.gov/_sec/media/reports/20140828-AAPI.pdf. Accessed 25 June 2015
7. Smith LR (1956) Recorded and expected mortality among the Chinese of Hawaii and the United States with special reference to cancer. *J Natl Cancer Inst* 17(5):667–676
8. King H, Haenszel W (1973) Cancer mortality among foreign- and native-born Chinese in the United States. *J Chronic Dis* 26:623–646
9. Fraumeni JF, Mason TJ (1974) Cancer mortality among Chinese Americans, 1950–69. *J Natl Cancer Inst* 52(3):659–665
10. King H, Li JY, Locke FB, Pollack ES, Tu JT (1985) Patterns of site-specific displacement in cancer mortality among migrants: the Chinese in the United States. *Am J Public Health* 75(3):237–242

11. Lilienfeld DE (2008) Harold Fred Dorn and the First National Cancer Survey (1937–1939): the founding of modern cancer epidemiology. *Am J Public Health* 98:2150–2158. doi:10.2105/AJPH.2007.117440
12. Howlader N et al (eds) (2013). SEER Cancer Statistics Review, 1975–2010. National Cancer Institute, Bethesda. http://seer.cancer.gov/csr/1975_2010/, based on November 2012 SEER data submission, posted to the SEER web site, April 2013
13. International Agency for Research on Cancer. CI5Plus. <http://ci5.iarc.fr/CI5plus/Default.aspx>. Accessed 25 June 2015
14. Miller BA, Chu KC, Hankey BF, Ries LA (2008) Cancer incidence and mortality patterns among specific Asian and Pacific Islander populations in the U.S. *Cancer Causes Control* 19(3):227–256
15. Gomez SL, Noone AM, Lichtensztajn DY, Scoppa S, Gibson JT, Liu L, Morris C, Kwong S, Fish K, Wilkens L, Goodman M, Deapen D, Miller BA (2013) Cancer incidence trends among Asian American populations in the United States, 1990–2008. *J Natl Cancer Inst* 105(15):1096–1110
16. Liu L, Noone AM, Gomez SL, Scoppa S, Gibson JT, Lichtensztajn D, Fish K, Goodman M, Wilkens L, Morris C, Kwong S, Deapen D, Miller BA (2013) Cancer Incidence Trends among Native Hawaiians and Other Pacific Islanders in the U.S., 1990–2008. *J Natl Cancer Inst* 105(15):1086–1095
17. Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence — SEER 11, plus Greater CA and NJ, Nov 2010 Sub (1990–2008) detailed API plus White Non-Hispanic—pops projected from populations, National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released June 2011 (updated 10/28/2011), based on the November 2010 submission
18. International Agency for Research on Cancer. CI5: Cancer in five continents. <http://ci5.iarc.fr/Default.aspx>. Accessed 31 May 2015
19. International Agency for Research on Cancer. CI5plus: Cancer in Five Continents Time Trends. <http://ci5.iarc.fr/CI5plus/Pages/online.aspx>. Accessed 31 May 2015
20. Deapen D, Liu L, Perkins C, Bernstein L, Ross RK (2002) Rapidly rising breast cancer incidence rates among Asian-American women. *Int J Cancer* 99:747–750
21. Liu L, Zhang J, Wu AH, Pike MC, Deapen D (2012) Invasive breast cancer incidence trends by detailed race/ethnicity and age. *Int J Cancer* 130(2):395–404
22. Ferlay J, Shin HR, Bray F, Forman D, Mathers C, Parkin DM (2010) Cancer incidence and mortality worldwide: IARC Cancer Base No.10. GLOBOCAN 2008. International Agency for Research on Cancer, Lyon
23. Fan L, Strasser-Weippl K, Li JJ, St Louis J, Finkelstein DM, Yu KD, Chen WQ, Shao ZM, Goss PE (2014) Breast cancer in China. *Lancet Oncol* 15(7):e279–e289. doi:10.1016/S1470-2045(13)70567-9
24. Fan L, Zheng Y, Yu KD et al (2009) Breast cancer in a transitional society over 18 years: trends and present status in Shanghai, China. *Breast Cancer Res Treat* 117:409–416
25. Linos E, Spanos D, Rosner BA et al (2008) Effects of reproductive and demographic changes on breast cancer incidence in China: a modeling analysis. *J Natl Cancer Inst* 100:1352–1360
26. Zhang Q, Liu LY, Wang F, Mu K, Yu ZG (2012) The changes in female physical and childbearing characteristics in China and potential association with risk of breast cancer. *BMC Public Health* 12:368. doi:10.1186/1471-2458-12-368
27. Turati F, La Vecchia C (2012) Risk factors for breast cancer in China: similarities and differences with western populations. *Arch Med Sci* 8:179–182
28. Bertucci F, Birnbaum D (2008) Reasons for breast cancer heterogeneity. *J Biol* 7(2):6. doi:10.1186/jbiol67
29. Rose DP, Vona-Davis L (2010) Interaction between menopausal status and obesity in affecting breast cancer risk. *Maturitas* 66(1):33–38
30. Hemminki K, Försti A, Sundquist J, Mousavi S (2011) Preventable breast cancer is post-menopausal. *Breast Cancer Res Treat* 125:163–167

31. De Angelis D, Rittenhouse HG, Mikolajczyk SD, Shamel LB, Semjonow A (2007) Twenty years of PSA: from prostate antigen to tumor marker. *Rev Urol* 9(3):113–123
32. Sirovich BE, Schwartz LM, Woloshin S (2003) Screening men for prostate and colorectal cancer in the United States: does practice reflect the evidence? *JAMA* 289:1414–1420
33. Zhang L, Wu S, Guo LR, Zhao XJ (2009) Diagnostic strategies and the incidence of prostate cancer: reasons for the low reported incidence of prostate cancer in China. *Asian J Androl* 11(1):9–13
34. World Cancer Research Fund / American Institute for Cancer Research (2007) Food, nutrition, physical activity, and the prevention of cancer: a global perspective. AICR, Washington, pp 305–309. http://www.aicr.org/assets/docs/pdf/reports/Second_Expert_Report.pdf. Accessed 31 May 2015
35. Zheng J, Yang B, Huang T, Yu Y, Yang J, Li D (2011) Green tea and black tea consumption and prostate cancer risk: an exploratory meta-analysis of observational studies. *Nutr Cancer* 63(5):663–672. doi:10.1080/01635581.2011.570895
36. Yan L, Spitznagel EL (2009) Soy consumption and prostate cancer risk in men: a revisit of a meta-analysis. *Am J Clin Nutr* 89(4):1155–1163. doi:10.3945/ajcn.2008.27029
37. Sim HG, Cheng CWS (2005) Changing demography of prostate cancer in Asia. *Eur J Cancer* 41(6):834–845
38. Ito K (2014) Prostate cancer in Asian men. *Nat Rev Urol* 11:197–212
39. McCracken M, Olsen M, Chen MS Jr, Jemal A, Thun M et al (2007) Cancer incidence, mortality, and associated risk factors among Asian Americans of Chinese, Filipino, Vietnamese, Korean, and Japanese ethnicities. *CA Cancer J Clin* 57:190–205
40. Kamangar F, Dores GM, Anderson WF (2006) Patterns of cancer incidence, mortality, and prevalence across five continents: defining priorities to reduce cancer disparities in different geographic regions of the world. *J Clin Oncol* 24:2137–2150
41. Ye DW, Li CL (2007) Epidemiological trends of prostate cancer: retrospect and prospect. *China Clin Oncol* 17:177–180
42. Caraballo RS, Yee SL, Gfroerer J, Mirza SA (2008) Adult tobacco use among racial and ethnic groups living in the United States, 2002–2005. *Prev Chronic Dis* 5:A78
43. Choi S, Rankin S, Stewart A, Oka R (2008) Effects of acculturation on smoking behavior in Asian Americans: a meta-analysis. *J Cardiovasc Nurs* 23:67–73
44. Epplein M, Schwartz SM, Potter JD, Weiss NS (2005) Smoking-adjusted lung cancer incidence among Asian-Americans (United States). *Cancer Causes Control* 16:1085–1090
45. Le Marchand L, Wilkens LR, Kolonel LN (1992) Ethnic differences in the lung cancer risk associated with smoking. *Cancer Epidemiol Biomarkers Prev* 1:103–107
46. Torok S, Hegedus B, Laszlo V, Hoda MA, Ghanim B, Berger W et al (2011) Lung cancer in never smokers. *Future Oncol* 7:1195–1211
47. Zhou W, Christiani DC (2011) East meets West: ethnic differences in epidemiology and clinical behaviors of lung cancer between East Asians and Caucasians. *Chin J Cancer* 30:287–292
48. Osann KE (1991) Lung cancer in women: the importance of smoking, family history of cancer, and medical history of respiratory disease. *Cancer Res* 51:4893–4897
49. Samet JM, Avila-Tang E, Boffetta P, Hannan LM, Olivo-Marston S, Thun MJ et al (2009) Lung cancer in never smokers: clinical epidemiology and environmental risk factors. *Clin Cancer Res* 15:5626–5645
50. Seow A, Poh WT, Teh M, Eng P, Wang YT, Tan WC et al (2000) Fumes from meat cooking and lung cancer risk in Chinese women. *Cancer Epidemiol Biomarkers Prev* 9:1215–1221
51. Subramanian J, Govindan R (2007) Lung cancer in never smokers: a review. *J Clin Oncol* 25:561–570
52. Vineis P, Hoek G, Krzyzanowski M, Vigna-Taglianti F, Veglia F, Airoldi L et al (2007) Lung cancers attributable to environmental tobacco smoke and air pollution in non-smokers in different European countries: a prospective study. *Environ Health* 6:7. doi:10.1186/1476-069X-6-7
53. Xu ZY, Blot WJ, Xiao HP, Wu A, Feng YP, Stone BJ et al (1989) Smoking, air pollution, and the high rates of lung cancer in Shenyang, China. *J Natl Cancer Inst* 81:1800–1806

54. Lim WY, Chen Y, Chuah KL, Eng P, Leong SS, Lim E et al (2012) Female reproductive factors, gene polymorphisms in the estrogen metabolism pathway, and risk of lung cancer in Chinese women. *Am J Epidemiol* 175:492–503
55. Zhao B, Seow A, Lee EJ, Poh WT, Teh M, Eng P et al (2001) Dietary isothiocyanates, glutathione S-transferase-M1, -T1 polymorphisms and lung cancer risk among Chinese women in Singapore. *Cancer Epidemiol Biomarkers Prev* 10:1063–1067
56. Lim WY, Chuah KL, Eng P, Leong SS, Lim E, Lim TK et al (2011) Meat consumption and risk of lung cancer among never-smoking women. *Nutr Cancer* 63:850–859
57. Lim WY, Chen Y, Ali SM, Chuah KL, Eng P, Leong SS et al (2011) Polymorphisms in inflammatory pathway genes, host factors and lung cancer risk in Chinese female never-smokers. *Carcinogenesis* 32:522–529
58. Gomez SL, Yang J, Lin SW, McCusker M, Sandler A, Cheng I, Wakelee HA, Patel MI, Clarke CA (2015) Incidence trends of lung cancer by immigration status among Chinese Americans. *Cancer Epidemiol Biomarkers Prev* 24(8):1157–1164. doi:10.1158/1055-9965
59. Cheng I, Le GM, Noone AM, Gali K, Patel M, Haile RW et al (2014) Lung cancer incidence trends by histology type among Asian American, Native Hawaiian, and Pacific Islander populations in the United States, 1990–2010. *Cancer Epidemiol Biomarkers Prev* 23:2250–2265
60. Johns LE, Houlston RS (2001) A systematic review and meta analysis of familial colorectal cancer risk. *Am J Gastroenterol* 96:2992–3003
61. Butterworth AS, Higgins JP, Pharoah P (2006) Relative and absolute risk of colorectal cancer for individuals with a family history: a meta-analysis. *Eur J Cancer* 42:216–227
62. Lynch HT, de la Chapelle A (2003) Hereditary colorectal cancer. *N Engl J Med* 348:919–932
63. Larsson SC, Wolk A (2007) Obesity and colon and rectal cancer risk: a meta-analysis of prospective studies. *Am J Clin Nutr* 86:556–565
64. Wang Y, Jacobs EJ, Patel AV et al (2008) A prospective study of waist circumference and body mass index in relation to colorectal cancer incidence. *Cancer Causes Control* 19:783–792
65. Chen W, Zheng R, Zeng H, Zhang S, He J (2015) Annual report on status of cancer in China, 2011. *Chin J Cancer Res*. doi:10.3978/j.issn.1000-9604.2015.01.06
66. Sung JJ, Lau JY, Goh KL, Leung WK (2005) Increasing incidence of colorectal cancer in Asia: implications for screening. *Lancet Oncol* 6:871–876
67. Zauber AG, Lansdorp-Vogelaar I, Knudsen AB, Wilschut J, van Ballegooijen M, Kuntz KM (2008) Evaluating test strategies for colorectal cancer screening: a decision analysis for the U.S. Preventive Services Task Force. *Ann Intern Med* 149:659–669
68. Zapka J (2008) Innovative provider—and health system-directed approaches to improving colorectal cancer screening delivery. *Med Care* 46(9 suppl 1):S62–S67
69. Wu X, Cokkinides V, Chen VW et al (2006) Associations of subsite-specific colorectal cancer incidence rates and stage of disease at diagnosis with county-level poverty, by race and sex. *Cancer* 107(5 suppl):1121–1117
70. Edwards BK et al (2010) Annual report to the nation on the status of cancer, 1975–2006, featuring colorectal cancer trends and impact of interventions (risk factors, screening, and treatment) to reduce future rates. *Cancer* 116:544–573
71. Felix-Aaron K, Moy E, Kang M, Patel M, Chesley FD, Clancy C (2005) Variation in quality of men's health care by race/ethnicity and social class. *Med Care* 43(3 Suppl):I72–I81
72. Sun WY, Basch CE, Wolf RL, Li XJ (2004) Factors associated with colorectal cancer screening among Chinese-Americans. *Prev Med* 39:323–329
73. Tang TS, Solomon LJ, McCracken LM (2001) Barriers to fecal occult blood testing and sigmoidoscopy among older Chinese-American women. *Cancer Pract* 9:277–282
74. Tu SP, Taylor V, Yasui Y, Chun A, Yip MP, Acorda E, Li L, Bastani R (2006) Promoting culturally appropriate colorectal cancer screening through a health educator: a randomized controlled trial. *Cancer* 107(5):959–966
75. Haenszel W, Kurihara M (1968) Studies of Japanese migrants. I mortality from cancer and other diseases among Japanese in the United States. *Natl Cancer Inst* 40(1):43–68

76. Kolonel LN, Hinds MW, Hankin JH (1980) Cancer patterns among migrant and native-born Japanese in Hawaii in relation to smoking, drinking, and dietary habits. In: Gelboin HV (ed) *Genetics and environmental factors in experimental and human cancer*. University Park Press, Baltimore, pp 327–340
77. Maskarinec G, Noh JJ (2004) The effect of migration on cancer incidence among Japanese in Hawaii. *Ethn Dis* 14:431–439
78. Peleteiro B, La Vecchia C, Lunet N (2012) The role of *Helicobacter pylori* infection in the web of gastric cancer causation. *Eur J Cancer Prev* 21(2):118–125
79. Bertuccio P, Chatenoud L, Levi F, Praud D, Ferlay J, Negri E, Malvezzi M, La Vecchia C (2009) Recent patterns in gastric cancer: a global overview. *Int J Cancer* 125:666–673
80. Yamaguchi N, Kakizoe T (2001) Synergistic interaction between *Helicobacter pylori* gastritis and diet in gastric cancer. *Lancet Oncol* 2(2):88–94
81. Lee SA, Kang D, Shim KN, Choe JW, Hong WS, Choi H (2003) Effect of diet and *Helicobacter pylori* infection to the risk of early gastric cancer. *J Epidemiol* 13(3):162–168
82. Ladeiras-Lopes R, Pereira AK, Nogueira A, Pinheiro-Torres T, Pinto I, Santos-Pereira R, Lunet N (2008) Smoking and gastric cancer: systematic review and meta-analysis of cohort studies. *Cancer Causes Control* 19:689–701
83. Shikata K, Doi Y, Yonemoto K, Arima H, Ninomiya T, Kubo M, Tanizaki Y, Matsumoto T, Iida M, Kiyohara Y (2008) Population-based prospective study of the combined influence of cigarette smoking and *Helicobacter pylori* infection on gastric cancer incidence: the Hisayama Study. *Am J Epidemiol* 168:1409–1415
84. Bertuccio P, Rosato V, Andreano A, Ferraroni M, Decarli A, Edefonti V, La Vecchia C (2013) Dietary patterns and gastric cancer risk: a systematic review and meta-analysis. *Ann Oncol* 24:1450–1458
85. Park B, Shin A, Park SK, Ko KP, Ma SH, Lee EH, Gwack J, Jung EJ, Cho LY, Yang JJ, Yoo KY (2011) Ecological study for refrigerator use, salt, vegetable, and fruit intakes, and gastric cancer. *Cancer Causes Control* 22(11):1497–1502. doi:10.1007/s10552-011-9823-7
86. Parkin DM (2006) The global health burden of infection-associated cancers in the year 2002. *Int J Cancer* 118(12):3030–3044
87. El-Serag HB (2012) Epidemiology of viral hepatitis and hepatocellular carcinoma. *Gastroenterology* 142(6):1264–1273
88. IOM (Institute of Medicine) (2010) *Hepatitis and liver cancer: a National Strategy for Prevention and Control of Hepatitis B and C*. The National Academies Press, Washington, <http://www.cdc.gov/hepatitis/PDFs/IOM-HepatitisAndLiverCancerReport.pdf>. Accessed 31 May 2015
89. Centers for Disease Control and Prevention (2006) Screening for chronic hepatitis B among Asian/Pacific Islander populations—New York City, 2005. *MMWR Morb Mortal Wkly Rep* 55(18):505–509
90. Chao S, Lee PV, Praong W, Su J, So S (2004) High prevalence of chronic hepatitis B (HBV) infection in adult Chinese Americans living in California. *Hepatology* 40(Suppl 1):717A
91. Gao S, Yang WS, Bray F, Va P, Zhang W, Gao J et al (2012) Declining rates of hepatocellular carcinoma in urban Shanghai: incidence trends in 1976–2005. *Eur J Epidemiol* 27(1):39–46
92. Strong C, Lee S, Tanaka M, Juon HS (2012) Ethnic differences in prevalence and barriers of HBV screening and vaccination among Asian Americans. *J Community Health* 37:1071–1080
93. Taylor VM, Tu SP, Woodall E et al (2006) Hepatitis B knowledge and practices among Chinese immigrants to the United States. *Asian Pac J Cancer Prev* 7(2):313–317
94. Thompson MJ, Taylor VM, Jackson JC, Yasui Y, Kuniyuki A, Tu SP, Hislop TG (2002) Hepatitis B knowledge and practices among Chinese American women in Seattle, Washington. *J Cancer Educ* 17:222–226
95. Shih WL, Chang HC, Liaw YF, Lin SM, Lee SD, Chen PJ et al (2012) Influences of tobacco and alcohol use on hepatocellular carcinoma survival. *Int J Cancer* 131(11):2612–2621
96. Ezzati M, Riboli E (2013) Behavioral and dietary risk factors for noncommunicable diseases. *N Engl J Med* 369(10):954–964

97. Chuang SC, La Vecchia C, Boffetta P (2009) Liver cancer: descriptive epidemiology and risk factors other than HBV and HCV infection. *Cancer Lett* 286(1):9–14
98. Zhang Y, Ren JS, Shi JF, Li N, Wang YT, Qu C, Zhang Y, Dai M (2015) International trends in primary liver cancer incidence from 1973 to 2007. *BMC Cancer* 15:94. doi:10.1186/s12885-015-1113-4
99. Tsao SW, Yip YL, Tsang CM, Pang PS, Lau VM, Zhang G, Lo KW (2014) Etiological factors of nasopharyngeal carcinoma. *Oral Oncol* 50(5):330–338. doi:10.1016/j.oraloncology.2014.02.006
100. Chang ET, Adami HO (2006) The enigmatic epidemiology of nasopharyngeal carcinoma. *Cancer Epidemiol Biomarkers Prev* 15(10):1765–1777
101. Lo KW, To KF, Huang DP (2004) Focus on nasopharyngeal carcinoma. *Cancer Cell* 5(5):423–428
102. Yu MC, Yuan JM (2002) Epidemiology of nasopharyngeal carcinoma. *Semin Cancer Biol* 12(6):421–429
103. Warnakulasuriya KA, Johnson NW, Linklater KM, Bell J (1999) Cancer of mouth, pharynx and nasopharynx in Asian and Chinese immigrants resident in Thames regions. *Oral Oncol* 35:471–475
104. McCredie M, Williams S, Coates M (1999) Cancer mortality in East and Southeast Asian migrants to New South Wales, Australia, 1975–1995. *Br J Cancer* 79:1277–1282
105. Buell P (1974) The effect of migration on the risk of nasopharyngeal cancer among Chinese. *Cancer Res* 34:1189–1191
106. Jia WH, Huang QH, Liao J, Ye W, Shugart YY, Liu Q et al (2006) Trends in incidence and mortality of nasopharyngeal carcinoma over a 20–25 year period (1978/1983–2002) in Sihui and Cangwu counties in southern China. *BMC Cancer* 6:178
107. Cao SM, Simons MJ, Qian CN (2011) The prevalence and prevention of nasopharyngeal carcinoma in China. *Chin J Cancer* 30:114–119
108. Hsu C, Shen YC, Cheng CC, Hong RL, Chang CJ, Cheng AL (2006) Difference in the incidence trend of nasopharyngeal and oropharyngeal carcinomas in Taiwan: implication from age-period-cohort analysis. *Cancer Epidemiol Biomarkers Prev* 15(5):856–861
109. Singapore Cancer Registry (2010) Trends in cancer incidence in Singapore 1968–2007. Singapore Cancer Registry Report No. 7. https://www.nrdo.gov.sg/docs/librariesprovider3/Publications-Cancer/inc_report_v8.pdf?sfvrsn=0. Accessed 2 Feb 2016
110. Misra S, Chaturvedi A, Misra NC, Sharma ID (2003) Carcinoma of the gallbladder. *Lancet Oncol* 4:167–176
111. Pandey M (2003) Risk factors for gallbladder cancer: a reappraisal. *Eur J Cancer Prev* 12:15–24
112. Hundal R, Shaffer EA (2014) Gallbladder cancer: epidemiology and outcome. *Clin Epidemiol* 6:99–109. doi:10.2147/CLEP.S37357
113. Lai CH, Lau WY (2008) Gallbladder cancer—a comprehensive review. *Surgeon* 6:101–110
114. Dutta U, Nagi B, Garg PK, Sinha SK, Singh K, Tandon RK (2005) Patients with gallstones develop gallbladder cancer at an earlier age. *Eur J Cancer Prev* 14(4):381–385
115. Hsing AW, Bai Y, Andreotti G et al (2007) Family history of gallstones and the risk of biliary tract cancer and gallstones: a population-based study. *Int J Cancer* 121:832–838
116. Pandey M (2006) Environmental pollutants in gallbladder carcinogenesis. *J Surg Oncol* 93(8):640–643
117. Darby SC, Whitley E, Howe GR, Hutchings SJ, Kusiak RA, Lubin JH et al (1995) Radon and cancers other than lung cancer in underground miners: a collaborative analysis of 11 studies. *J Natl Cancer Inst* 87(5):378–384
118. Rai A, Mohapatra SC, Shukla HS (2004) A review of association of dietary factors in gallbladder cancer. *Indian J Cancer* 41:147–151
119. Jain K, Sreenivas V, Velpandian T, Kapil U, Garg PK (2012) Risk factors for gallbladder cancer: a case-control study. *Int J Cancer* 132(7):1660–1666
120. Kato K, Akai S, Tominaya KS, Kato J (1989) A case control study of biliary tract cancer in Niigata Prefecture, Japan. *Jpn J Cancer Res* 80:932–938

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