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Research Article

Cancer Epidemiology, Biomarkers & Prevention

The Burden of Cancer in Asian Americans: A Report of National Mortality Trends by Asian Ethnicity

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Abstract

Background: Asian Americans (AA) are the fastest growing U.S. population, and when properly distinguished by their ethnic origins, exhibit substantial heterogeneity in socioeconomic status, health behaviors, and health outcomes. Cancer is the second leading cause of death in the United States, yet trends and current patterns in the mortality burden of cancer among AA ethnic groups have not been documented.

Methods: We report age-adjusted rates, standardized mortality ratios, and modeled trends in cancer-related mortality in the following AA ethnicities: Asian Indians, Chinese, Filipinos, Japanese, Koreans, and Vietnamese, from 2003 to 2011, with non-Hispanic whites (NHW) as the reference population.

Results: For most cancer sites, AAs had lower cancer mortality than NHWs; however, mortality patterns were heterogeneous across AA ethnicities. Stomach and liver cancer mortality was very high, particularly among Chinese, Koreans, and Vietnamese, for whom these two cancer types combined accounted for 15% to 25% of cancer deaths, but less than 5% of cancer deaths in NHWs. In AA women, lung cancer was a leading cause of death, but (unlike males and NHW females) rates did not decline over the study period.

Conclusions: Ethnicity-specific analyses are critical to understanding the national burden of cancer among the heterogeneous AA population.

Impact: Our findings highlight the need for disaggregated reporting of cancer statistics in AAs and warrant consideration of tailored screening programs for liver and gastric cancers. *Cancer Epidemiol Biomarkers Prev; 25(10); 1371–82. ©2016 AACR.*

Introduction

Surpassing Hispanics as the most rapidly growing racial/ethnic group in the United States, Asian Americans (AA) currently number nearly 17.3 million, representing 5.6% of the U.S. population (1), and that number is expected to exceed 40 million by 2050 (2). As a single category, AAs exhibit tremendous heterogeneity, reflective not only of their >30 countries of origin and >100 languages, but also in their immigration trends, cultural diversity, and degree of acculturation, socioeconomic status, insurance coverage, health beliefs, use of health services, diets, body size, and lifestyles (3–6). Because of clustering of AA ethnicities into certain occupations and neighborhoods, the environments where AAs live and work can also vary greatly (e.g., air pollution, workplace chemicals, built environment; refs. 7, 8). All these factors can greatly impact the cancer mortality burden in these populations.

Recent publications based on the Surveillance, Epidemiology, and End Results (SEER) program have improved our understanding of cancer incidence (9) and cancer survival (10) by AA ethnicity. However, as Asian ethnic subgroups were only recently disaggregated on death records in many states, an updated, comprehensive report of national cancer mortality patterns and trends by disaggregated AA ethnicity has yet to be published. To fill this knowledge gap, we report AA ethnicity–specific cancer mortality rates and, for the first time, mortality trends during the years 2003 to 2011.

Materials and Methods

Study data

The new version of the U.S. death certificate, implemented starting in 2003, collects detailed Asian ethnicity for six major subgroups (Asian Indian, Chinese, Filipino, Japanese, Korean, and Vietnamese) in predefined checkboxes. These subgroups

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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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make up about 85% of all AAs in the United States according to the 2010 U.S. Census. Until its release, only 7 U.S. states (California, Hawaii, Illinois, New Jersey, New York, Texas, and Washington), chosen in 1977 because they housed two thirds of the nation's AAs, collected detailed Asian ethnicity. In 2010, 64% of AAs lived in these states, which are also among the most urban in the nation. However, many other states experienced tremendous growth in their AA populations in the last decade (1). Between 2003 and 2011, 33 additional states (Supplementary Table S1) adopted the new version of the U.S. Standard Certificate of Death and began reporting AA deaths in all six categories. We obtained data on cancer-related deaths from 2003 to 2011 for a total of 41 states from the National Center for Health Statistics (NCHS) mortality records.

Year of death, age, sex, and race/ethnicity of the decedent, location of death, and the underlying cause of death (disease or injury that initiated the events resulting in death) were identified from death certificate data. "Underlying cause of death" was coded by NCHS using International Classification of Diseases, 10th revision (ICD-10; specific codes are provided in Supplementary Table S2). We chose 10 cancer sites based on their overall contribution to AA mortality burden from 2003 to 2011: stomach, colon and rectum, pancreas, liver, lung and bronchus, female breast, ovary, prostate, non-Hodgkin lymphoma (NHL), and leukemia. These 10 sites make up 75% of the cancer-related deaths in AAs between 2003 and 2011. Statistics calculated for "all cancer sites" include the aforementioned sites as well as all other sites not mentioned.

The study population included 85,616 AA decedents who were identified on their death certificates (usually by the next of kin or the medical examiner) as Asian Indian, Chinese, Filipino, Japanese, Korean or Vietnamese, and 4,116,783 non-Hispanic white (NHW) decedents, to serve as a comparison group. Blacks, Hispanics, Native Hawaiians and Pacific Islanders, and any AA decedents reported as more than one ethnicity or as "Other Asian," were not included in the current study. Statistics calculated for "aggregate Asians" pertain to the six aforementioned subgroups combined.

Statistical analysis

The 2003 version death certificate was not adopted at the same time for all states in our sample. To accommodate this, we introduced each state into the numerator and denominator only after they adopted the new form (Supplementary Table S1). To estimate denominator population counts for the study period, we used linear interpolation and extrapolation based on age-specific population counts from the 2000 and 2010 Census. We calculated three statistics for each stratum, as defined by cancer site, sex, and ethnicity: proportional cancer mortality (PCM), age-adjusted mortality rates (AMR), and standardized mortality ratios (SMR). PCM was calculated as the stratum-specific proportion of all cancer deaths. AMRs and 95% confidence intervals (CI; ref. 11) were calculated as deaths per 100,000 persons for the combined 9-year study period, 2003 to 2011, and were obtained by applying the stratum-specific mortality rates to the standard age distribution of the 2000 U.S. Census population. AMRs were standardized using the same reference population, so site-specific rates are comparable across ethnicities. Rates based on small death counts tend to have poor reliability (12) and can threaten confidentiality of decedents; therefore, we did not report any AMRs based on any count of <16 deaths (13). Indirectly standardized mortality ratios (SMR) were calculated as the ratio of the stratum-specific deaths to the expected number of stratum-specific deaths, the latter of which were estimated by applying the NHW (reference population) mortality rate rates to the stratum-specific age distribution. The SMR was chosen as the relative measure because it is the minimum variance estimator of the common rate ratio, a property that is advantageous when death counts are small (14). Each SMR is weighted by the stratum-specific age distribution and not a standard distribution, so they may be used to compare site-specific mortality within any given ethnicity, but not between ethnicities. Trends for cancer-related mortality were described via joinpoint regression analysis (15), which involves fitting a series of joined straight lines on a log scale to the trends in the annual (2-year or 3-year when annual death counts were too low) age-adjusted rates (16). Line segments are connected at "joinpoints," which denote a statistically significant ($P \leq 0.05$) change in trend. The tests of significance use a Monte Carlo permutation method (i.e., it finds "the best fit" line for each segment). A maximum of one joinpoint (two line segments) was allowed for each model due to our limited follow-up time. Once the line segments were established, the estimated annual percent change (APC) was used to describe and test the statistical significance of the trends. Direct and indirect age adjustment was performed using PROC STDRATE in SAS version 9.3 (SAS Institute), joinpoint regressions were fit using the SEER*Stat software (17), and all figures were created using Microsoft Excel.

Results

We ranked the top 5 cancers by proportion of total cancer deaths by ethnicity and found that lung cancer accounted for the highest mortality burden in all male subgroups and all female subgroups with the exception of Asian Indians and Filipinas, both of which ranked breast cancer as the highest (Table 1). For all ethnicities (including NHW), the following cancers accounted for more than 40% of all cancer mortality: lung, female breast, colorectal, liver, and stomach (Fig. 1). However, AAs die from cancer of any site at about 60% the rate of NHWs (Table 2). Among AAs, Korean males (SMR, 0.69; 95% CI, 0.67–0.71) and Japanese females (SMR, 0.70; 95% CI, 0.68–0.71) had the highest overall cancer mortality. Asian Indians have the lowest overall cancer mortality rates (male SMR, 0.35; 95% CI, 0.34–0.36; female SMR, 0.41; 95% CI, 0.39–0.42). Trend analysis (Figs. 2 and 3) revealed that all ethnicity-specific AA mortality rates of cancer at any site were either stable or declining during the study period.

Cancers of the digestive system

Stomach cancer accounted for approximately 10% to 15% of Korean and 5% to 10% of Chinese, Japanese, and Vietnamese cancer deaths but <2% of NHW cancer deaths. Compared with NHWs, AA mortality rates were high, especially for Koreans (male SMR, 5.42; 95% CI, 5.01–5.83; female SMR, 5.90; 95% CI, 5.40–6.40) and Japanese (male SMR, 3.20; 95% CI, 2.93–3.46; female SMR, 3.34; 95% CI, 3.06–3.63). Asian Indians had the lowest rates (male SMR, 0.84; 95% CI, 0.71–0.97; female SMR, 1.14; 95% CI, 0.92–1.36). Stomach cancer mortality rates decreased in AA populations, with significant trends for Japanese males (APC, −3.1; 95% CI, −5.1 to −1), Chinese males (APC, −2.3; 95% CI, −4.4 to −0.2), Korean females (APC, −4.4; 95% CI, −6.5 to −2.4), Japanese females (APC, −4.6; 95% CI, −8.3–0.8), and

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Table 1. Top 5 sites of cancer-related mortality, ranked as a proportion of all cancer deaths, by race/ethnicity (2003–2011)

Male (rank)	NHW	Aggregate Asian	Asian Indian	Chinese	Filipino	Japanese	Korean	Vietnamese
1	Lung 31.0%	Lung 26.8%	Lung 19.0%	Lung 28.13%	Lung 30.7%	Lung 23.9%	Lung 22.8%	Lung 28.1%
2	Prostate 9.2%	Colorectal 10.5%	Colorectal 8.3%	Liver 11.7%	Colorectal 10.8%	Colorectal 13.1%	Stomach 14.6%	Liver 22.3%
3	Colorectal 9.1%	Liver 10.3%	Prostate 8.1%	Colorectal 10.4%	Prostate 8.9%	Prostate 8.9%	Liver 12.9%	Colorectal 7.9%
4	Pancreas 5.8%	Pancreas 6.3%	Pancreas 7.0%	Stomach 6.5%	Liver 7.6%	Stomach 8.8%	Colorectal 11.0%	Stomach 6.5%
5	Leukemia 4.4%	Prostate 6.3%	Leukemia 6.3%	Pancreas 5.9%	Pancreas 5.7%	Pancreas 8.4%	Pancreas 7.4%	Pancreas 4.4%
Female (rank)	**NHW**	**Aggregate Asian**	**Asian Indian**	**Chinese**	**Filipino**	**Japanese**	**Korean**	**Vietnamese**
1	Lung 27.3%	Lung 19.6%	Breast 19.8%	Lung 22.2%	Breast 19.5%	Lung 21.4%	Lung 18.5%	Lung 21.7%
2	Breast 14.6%	Breast 13.7%	Ovary 9.7%	Breast 11.8%	Lung 18.1%	Colorectal 12.9%	Stomach 11.6%	Breast 10.3%
3	Colorectal 9.6%	Colorectal 10.8%	Lung 9.3%	Colorectal 11.9%	Colorectal 9.0%	Breast 10.7%	Colorectal 11.4%	Colorectal 9.6%
4	Pancreas 6.2%	Pancreas 7.5%	Colorectal 6.8%	Pancreas 7.2%	Pancreas 6.7%	Pancreas 9.6%	Pancreas 8.2%	Liver 9.3%
5	Ovary 5.6%	Stomach 5.6%	Pancreas 5.9%	Stomach 5.4%	Ovary 6.0%	Stomach 6.5%	Liver 7.2%	Stomach 6.3%

Chinese females (APC, −4.2; 95% CI, −6.5 to −1.9). Complete APC statistics are provided in Supplementary Tables S3 and S4.

Liver cancer accounted for 22% of Vietnamese male, 12% of Chinese male, and 10% of Vietnamese female cancer deaths, and it ranked in the top 5 sites of cancer-related death for Korean males and females and Filipino males. Among NHWs, the corresponding percentages are <2.5% (data not shown). In both males and females, the highest AA liver cancer mortality rates were for Vietnamese (male SMR, 4.76; 95% CI, 4.46–5.06; female SMR, 4.06; 95% CI, 3.58–4.54) and Koreans (male SMR, 3.09; 95% CI, 2.84–3.34; female SMR, 4.03; 95% CI, 3.60–4.46). Asian Indians had the lowest rates of liver cancer mortality among all study decedents (AA or NHW; male SMR, 0.63; 95% CI, 0.55–0.72; female SMR, 0.86; 95% CI, 0.66–1.06). Trends indicate that AA liver cancer mortality rates were generally decreasing and significant for Korean males (APC, −5.9; 95% CI, −10.1 to −1.6), Chinese females (APC, −4.8; 95% CI, −8.7 to −0.7), and Japanese females (APC, −4.5; 95% CI, −8.8–0).

Colorectal cancer accounted for about 10% of NHW cancer deaths, 9% to 11% of most AA cancer deaths, and 13% for Japanese. Adjusted rates of mortality from colorectal cancer were slightly lower for AAs than for NHW, but the differences were not as large as those detected in other cancers. Japanese males and females had the highest rates of colorectal cancer among AAs (male SMR, 0.95; 95% CI, 0.89–1.01; female SMR, 0.93; 95% CI, 0.87–0.99), followed by Koreans (male SMR, 0.84; 95% CI, 0.76–0.91; female SMR, 0.84; 95% CI, 0.77–0.91). Asian Indians had the lowest rates of colorectal cancer mortality (male SMR, 0.32; 95% CI, 0.28–0.35; female SMR, 0.33; 95% CI, 0.29–0.38). Colorectal cancer mortality trends in NHWs were declining in both men and women, but no statistically significant decreases were identified in any AA ethnic group.

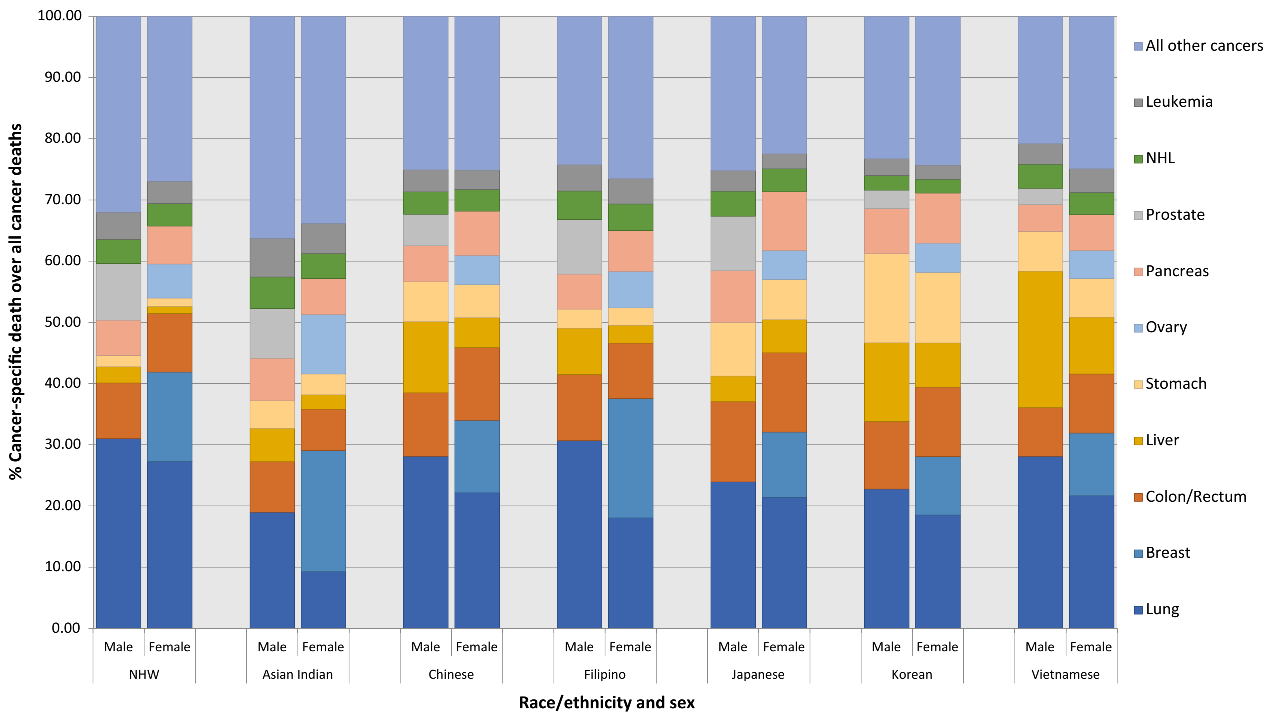

Figure 1.
Proportionate cancer mortality by race/ethnicity and sex, 2003 to 2011.

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Table 2. AA cancer mortality statistics by cancer site, ranked by (directly) age-adjusted mortality rates

Rank	Race/Ethnicity	Count	Age-adjusted rate per 100,000 (95% CI)	SMR (95% CI)	Rank	Race/Ethnicity	Count	Age-adjusted rate per 100,000 (95% CI)	SMR (95% CI)
All cancer sites - Male (2003–2011)					**All cancer sites - Female (2003–2011)**				
1	NHW	2,144,938	221.8 (221.5–222.1)	1.00	1	NHW	1,971,845	155.9 (155.7–156.1)	1.00
2	Korean	4,592	155.2 (150.3–160.1)	0.69 (0.67–0.71)	2	Japanese	8,177	106.7 (104.3–109.1)	0.70 (0.68–0.71)
3	Japanese	6,588	145.8 (142.3–149.4)	0.67 (0.65–0.68)	3	Korean	4,623	101.1 (98.0–104.1)	0.63 (0.62–0.65)
4	Chinese	15,124	135.9 (133.7–138.1)	0.60 (0.59–0.61)	4	Chinese	12,578	91.0 (89.4–92.6)	0.58 (0.57–0.59)
5	Aggregate Asian	43,879	131.7 (130.5–133.0)	0.58 (0.58–0.59)	5	Aggregate Asian	41,737	90.7 (89.9–91.6)	0.57 (0.57–0.58)
6	Filipino	9,526	131.6 (128.8–134.3)	0.58 (0.57–0.60)	6	Filipino	10,360	87.0 (85.2–88.7)	0.56 (0.55–0.57)
7	Vietnamese	4,447	129.9 (125.6–134.2)	0.63 (0.61–0.64)	7	Vietnamese	2,947	78.1 (75.1–81.2)	0.49 (0.47–0.51)
8	Asian Indian	3,602	80.8 (77.6–84.0)	0.35 (0.34–0.36)	8	Asian Indian	3,052	64.3 (61.7–66.8)	0.41 (0.39–0.42)
Stomach cancer - Male (2003–2011)					**Stomach cancer - Female (2003–2011)**				
Rank	**Race/Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**	**Rank**	**Race/Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**
1	Korean	668	21.6 (19.8–23.4)	5.42 (5.01–5.83)	1	Korean	534	11.7 (10.6–12.7)	5.90 (5.40–6.40)
2	Japanese	579	12.7 (11.7–13.8)	3.20 (2.93–3.46)	2	Japanese	535	6.7 (6.1–7.3)	3.34 (3.06–3.63)
3	Aggregate Asian	2,970	9.0 (8.6–9.3)	2.13 (2.06–2.21)	3	Vietnamese	185	5.2 (4.4–6.0)	2.51 (2.15–2.87)
4	Chinese	978	8.8 (8.3–9.4)	2.11 (1.98–2.24)	4	Aggregate Asian	2,326	5.1 (4.9–5.4)	2.52 (2.41–2.62)
5	Vietnamese	288	8.5 (7.4–9.6)	2.19 (1.94–2.44)	5	Chinese	676	4.9 (4.5–5.2)	2.41 (2.23–2.59)
6	Filipino	296	4.2 (3.7–4.7)	0.99 (0.88–1.10)	6	Filipino	292	2.5 (2.2–2.8)	1.28 (1.13–1.42)
7	NHW	39,151	4.1 (4.0–4.1)	1.00	7	Asian Indian	104	2.2 (1.7–2.7)	1.14 (0.92–1.36)
8	Asian Indian	161	3.2 (2.6–3.8)	0.84 (0.71–0.97)	8	NHW	26,449	2.0 (2.0–2.1)	1.00
Colorectal cancer - Male (2003–2011)					**Colorectal cancer - Female (2003–2011)**				
Rank	**Race/Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**	**Rank**	**Race/Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**
1	NHW	195,021	20.3 (20.2–20.4)	1.00	1	NHW	188,320	14.3 (14.2–14.3)	1.00
2	Japanese	863	19.3 (18.0–20.6)	0.95 (0.89–1.01)	2	Japanese	1,058	13.7 (12.8–14.6)	0.93 (0.87–0.99)
3	Korean	507	17.4 (15.8–19.1)	0.84 (0.76–0.91)	3	Korean	525	11.9 (10.9–13.0)	0.84 (0.77–0.91)
4	Chinese	1,568	14.1 (13.4–14.9)	0.68 (0.65–0.72)	4	Chinese	1,491	10.9 (10.3–11.5)	0.76 (0.72–0.80)
5	Filipino	1,027	13.8 (12.9–14.7)	0.69 (0.65–0.74)	5	Aggregate Asian	4,499	10.0 (9.7–10.3)	0.70 (0.68–0.72)
6	Aggregate Asian	4,615	13.8 (13.4–14.2)	0.67 (0.65–0.69)	6	Filipino	935	8.2 (7.7–8.8)	0.59 (0.55–0.62)
7	Vietnamese	353	10.0 (8.8–11.2)	0.55 (0.49–0.61)	7	Vietnamese	284	7.7 (6.7–8.7)	0.56 (0.49–0.62)
8	Asian Indian	297	6.5 (5.6–7.5)	0.32 (0.28–0.35)	8	Asian Indian	206	4.5 (3.8–5.2)	0.33 (0.29–0.38)
Liver cancer - Male (2003–2011)					**Liver cancer - Female (2003–2011)**				
Rank	**Race/Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**	**Rank**	**Race/Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**
1	Vietnamese	992	26.2 (24.4–28.0)	4.76 (4.46–5.05)	1	Vietnamese	274	8.3 (7.3–9.4)	4.06 (3.58–4.54)
2	Korean	590	18.2 (16.6–19.8)	3.09 (2.84–3.34)	2	Korean	333	7.8 (6.9–8.7)	4.03 (3.60–4.46)
3	Chinese	1,762	14.5 (13.8–15.2)	2.55 (2.43–2.67)	3	Japanese	444	5.6 (5.1–6.1)	3.15 (2.85–3.44)
4	Aggregate Asian	4,539	12.2 (11.9–12.6)	2.15 (2.09–2.22)	4	Chinese	621	4.7 (4.3–5.0)	2.47 (2.27–2.66)
5	Filipino	721	8.8 (8.2–9.5)	1.57 (1.45–1.68)	5	Aggregate Asian	2,046	4.7 (4.5–4.9)	2.45 (2.34–2.55)
6	Japanese	277	6.2 (5.5–7.0)	1.13 (1.00–1.26)	6	Filipino	303	2.7 (2.4–3.1)	1.44 (1.28–1.61)
7	NHW	56,773	5.6 (5.5–5.6)	1.00	7	NHW	23,393	1.8 (1.8–1.9)	1.00
8	Asian Indian	197	4.1 (3.4–4.8)	0.63 (0.55–0.72)	8	Asian Indian	71	1.6 (1.2–2.0)	0.86 (0.66–1.06)

(Continued on the following page)

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Table 2. AA cancer mortality statistics by cancer site, ranked by (directly) age-adjusted mortality rates (Cont'd)

Pancreatic cancer - Male (2003–2011)					Pancreatic cancer - Female (2003–2011)				
Rank	**Race/ Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**	**Rank**	**Race/ Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**
1	NHW	124,173	12.6 (12.5–12.7)	1.00	1	Japanese	784	9.8 (9.1–10.5)	1.05 (0.98–1.13)
2	Japanese	554	12.2 (11.2–13.2)	0.99 (0.91–1.07)	2	NHW	122,410	9.4 (9.4–9.5)	1.00
3	Korean	339	11.0 (9.7–12.3)	0.86 (0.77–0.95)	3	Korean	378	8.5 (7.6–9.4)	0.89 (0.80–0.98)
4	Aggregate Asian	2,779	8.4 (8.0–8.7)	0.63 (0.61–0.65)	4	Aggregate Asian	3,115	7.0 (6.8–7.3)	0.72 (0.70–0.75)
5	Chinese	893	8.1 (7.5–8.6)	0.61 (0.57–0.65)	5	Chinese	910	6.8 (6.4–7.3)	0.70 (0.66–0.75)
6	Filipino	545	7.4 (6.8–8.1)	0.57 (0.52–0.62)	6	Filipino	692	6.2 (5.7–6.7)	0.64 (0.59–0.69)
7	Vietnamese	197	6.3 (5.3–7.3)	0.47 (0.40–0.53)	7	Vietnamese	172	4.9 (4.1–5.7)	0.50 (0.43–0.58)
8	Asian Indian	251	5.8 (4.9–6.7)	0.41 (0.36–0.46)	8	Asian Indian	179	4.1 (3.5–4.8)	0.43 (0.37–0.50)
Lung cancer - Male (2003–2011)					**Lung cancer - Female (2003–2011)**				
Rank	**Race/ Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**	**Rank**	**Race/ Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**
1	NHW	665,259	67.4 (67.3–67.6)	1.00	1	NHW	537,826	42.9 (42.8–43.0)	1.00
2	Filipino	2,926	39.9 (38.4–41.4)	0.57 (0.55–0.59)	2	Japanese	1,752	22.2 (21.1–23.2)	0.54 (0.52–0.57)
3	Chinese	4,255	38.8 (37.6–40.0)	0.55 (0.53–0.56)	3	Chinese	2,786	20.5 (19.8–21.3)	0.47 (0.45–0.48)
4	Korean	1,046	37.7 (35.2–40.2)	0.50 (0.47–0.53)	4	Korean	857	19.3 (17.9–20.6)	0.42 (0.39–0.45)
5	Vietnamese	1,251	37.6 (35.2–39.9)	0.56 (0.53–0.59)	5	Aggregate Asian	8,188	18.2 (17.8–18.6)	0.41 (0.40–0.42)
6	Aggregate Asian	11,739	35.7 (35.0–36.4)	0.50 (0.49–0.51)	6	Vietnamese	639	17.0 (15.6–18.5)	0.39 (0.36–0.42)
7	Japanese	1,577	35.2 (33.5–37.0)	0.53 (0.51–0.56)	7	Filipino	1,871	16.1 (15.3–16.8)	0.36 (0.35–0.38)
8	Asian Indian	684	15.7 (14.3–17.1)	0.21 (0.20–0.23)	8	Asian Indian	283	6.7 (5.8–7.5)	0.14 (0.12–0.16)
NHL - Male (2003–2011)					**NHL - Female (2003–2011)**				
Rank	**Race/ Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**	**Rank**	**Race/ Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**
1	NHW	84,690	8.9 (8.9–9.0)	1.00	1	NHW	72,715	5.5 (5.5–5.6)	1.00
2	Filipino	444	6.4 (5.8–7.0)	0.70 (0.63–0.76)	2	Filipino	446	4.0 (3.6–4.4)	0.74 (0.67–0.81)
3	Japanese	270	5.9 (5.2–6.6)	0.68 (0.60–0.76)	3	Japanese	306	3.7 (3.3–4.2)	0.68 (0.60–0.76)
4	Aggregate Asian	1,736	5.3 (5.1–5.6)	0.59 (0.56–0.61)	4	Aggregate Asian	1,534	3.5 (3.3–3.6)	0.62 (0.59–0.66)
5	Vietnamese	175	5.1 (4.3–6.0)	0.64 (0.54–0.73)	5	Chinese	445	3.3 (3.0–3.7)	0.60 (0.54–0.65)
6	Chinese	552	5.0 (4.6–5.5)	0.55 (0.51–0.60)	6	Asian Indian	125	3.1 (2.5–3.7)	0.54 (0.45–0.64)
7	Asian Indian	185	4.4 (3.6–5.2)	0.46 (0.40–0.53)	7	Vietnamese	107	2.9 (2.4–3.5)	0.56 (0.46–0.67)
8	Korean	110	3.6 (2.9–4.4)	0.42 (0.34–0.50)	8	Korean	105	2.4 (1.9–2.9)	0.44 (0.36–0.53)
Leukemia - Male (2003–2011)					**Leukemia - female (2003–2011)**				
Rank	**Race/ Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**	**Rank**	**Race/ Ethnicity**	**Count**	**Age-adjusted rate per 100,000 (95% CI)**	**SMR (95% CI)**
1	NHW	95,118	10.1 (10.1–10.2)	1.00	1	NHW	71,484	5.6 (5.6–5.7)	1.00
2	Filipino	409	5.6 (5.1–6.2)	0.57 (0.52–0.63)	2	Filipino	434	3.8 (3.5–4.2)	0.70 (0.64–0.77)
3	Japanese	223	5.1 (4.4–5.8)	0.50 (0.43–0.56)	3	Asian Indian	150	3.1 (2.5–3.7)	0.58 (0.48–0.67)
4	Aggregate Asian	1,683	5.0 (4.7–5.2)	0.50 (0.48–0.53)	4	Aggregate Asian	1,403	3.1 (2.9–3.2)	0.56 (0.53–0.59)
5	Chinese	547	4.9 (4.5–5.4)	0.49 (0.45–0.53)	5	Chinese	397	2.9 (2.6–3.2)	0.52 (0.47–0.57)
6	Vietnamese	150	4.8 (3.9–5.6)	0.48 (0.40–0.56)	6	Vietnamese	114	2.9 (2.3–3.4)	0.56 (0.46–0.66)
7	Asian Indian	228	4.4 (3.7–5.1)	0.50 (0.43–0.56)	7	Japanese	201	2.7 (2.3–3.1)	0.47 (0.40–0.53)
8	Korean	126	3.9 (3.2–4.7)	0.43 (0.35–0.50)	8	Korean	107	2.2 (1.8–2.7)	0.43 (0.35–0.52)

(Continued on the following page)

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Table 2. AA cancer mortality statistics by cancer site, ranked by (directly) age-adjusted mortality rates (Cont'd)

Female Breast cancer (2003–2011)					Ovarian cancer (2003–2011)				
Rank	Race/ Ethnicity	Count	Age-adjusted rate per 100,000 (95% CI)	SMR (95% CI)	Rank	Race/ Ethnicity	Count	Age-adjusted rate per 100,000 (95% CI)	SMR (95% CI)
1	NHW	288,068	23.3 (23.2–23.4)	1.00	1	NHW	109,900	8.8 (8.8–8.9)	1.0
2	Filipino	2,023	15.2 (14.5–15.9)	0.70 (0.67–0.73)	2	Asian Indian	297	5.8 (5.1–6.6)	0.50 (0.41–0.59)
3	Japanese	872	12.7 (11.8–13.6)	0.53 (0.49–0.56)	3	Japanese	388	5.5 (4.9–6.0)	0.50 (0.41–0.59)
4	Aggregate Asian	5,736	11.5 (11.2–11.8)	0.51 (0.49–0.52)	4	Filipino	621	4.9 (4.5–5.3)	0.49 (0.43–0.55)
5	Asian Indian	605	11.1 (10.1–12.1)	0.49 (0.45–0.53)	5	Aggregate Asian	2,266	4.7 (4.5–4.9)	0.44 (0.41–0.47)
6	Chinese	1,493	9.9 (9.4–10.4)	0.44 (0.42–0.46)	6	Korean	220	4.4 (3.8–5.0)	0.40 (0.31–0.49)
7	Korean	441	8.1 (7.4–8.9)	0.38 (0.35–0.42)	7	Chinese	604	4.2 (3.8–4.5)	0.39 (0.34–0.44)
8	Vietnamese	302	6.6 (5.8–7.4)	0.31 (0.27–0.34)	8	Vietnamese	136	3.1 (2.6–3.7)	0.32 (0.24–0.40)

Prostate cancer (2003–2011)				
Rank	Race/ Ethnicity	Count	Age-adjusted rate per 100,000 (95% CI)	SMR (95% CI)
1	NHW	198,182	22.1 (22.0–22.2)	1.00
2	Filipino	849	14.6 (13.5–15.6)	0.65 (0.61–0.69)
3	Japanese	587	12.0 (11.0–13.0)	0.56 (0.51–0.60)
4	Asian Indian	293	10.3 (8.9–11.6)	0.44 (0.39–0.49)
5	Aggregate Asian	2,765	10.1 (9.7–10.5)	0.44 (0.43–0.46)
6	Chinese	781	8.2 (7.6–8.7)	0.36 (0.33–0.38)
7	Korean	138	6.5 (5.4–7.7)	0.27 (0.23–0.32)
8	Vietnamese	117	5.1 (4.1–6.1)	0.23 (0.19–0.27)

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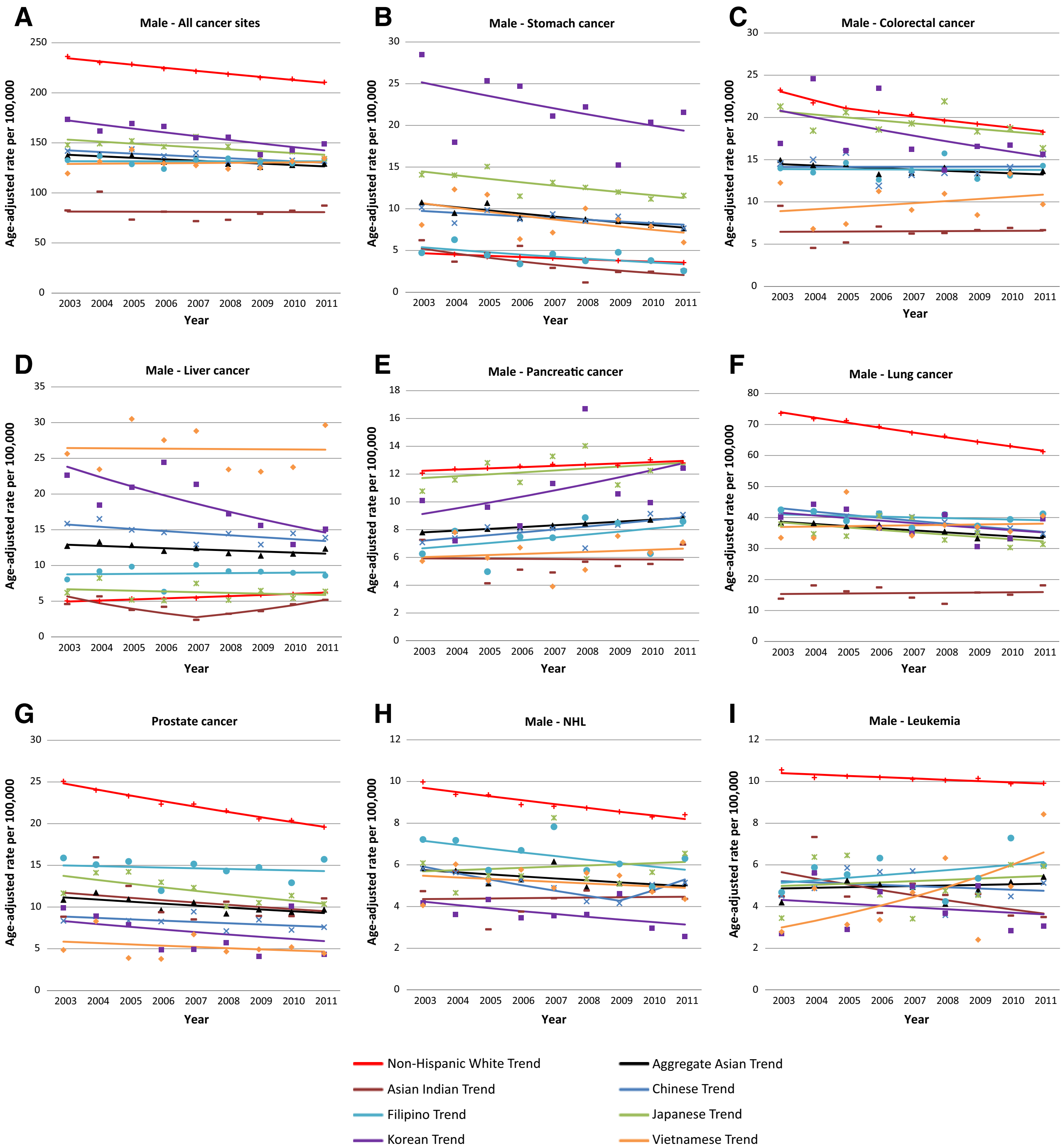

Figure 2.
Cancer mortality trends (men, 2003–2011; **A–I**).

Pancreatic cancer mortality rates were highest for Japanese and Koreans. Death rates from pancreatic cancer among Japanese were similar to NHWs (male SMR, 0.99; 95% CI, 0.91–1.07; female SMR, 1.07; 95% CI, 0.98–1.13). Trends for Japanese pancreatic cancer mortality (males and females) were stable or slightly decreasing. Male Korean pancreatic cancer mortality increased (APC, 4.3; 95% CI, −3.3–12.4), and pancreatic cancer mortality rates in Chinese (APC, 3.3; 95% CI, −0.5–7.2) also appeared to rise.

Lung cancer

Lung cancer was the leading cause of cancer-related mortality among males for all AA ethnicities, and for Chinese, Japanese, and Vietnamese women. For Filipino (AMR, 39.9; 95% CI, 38.4–41.4)

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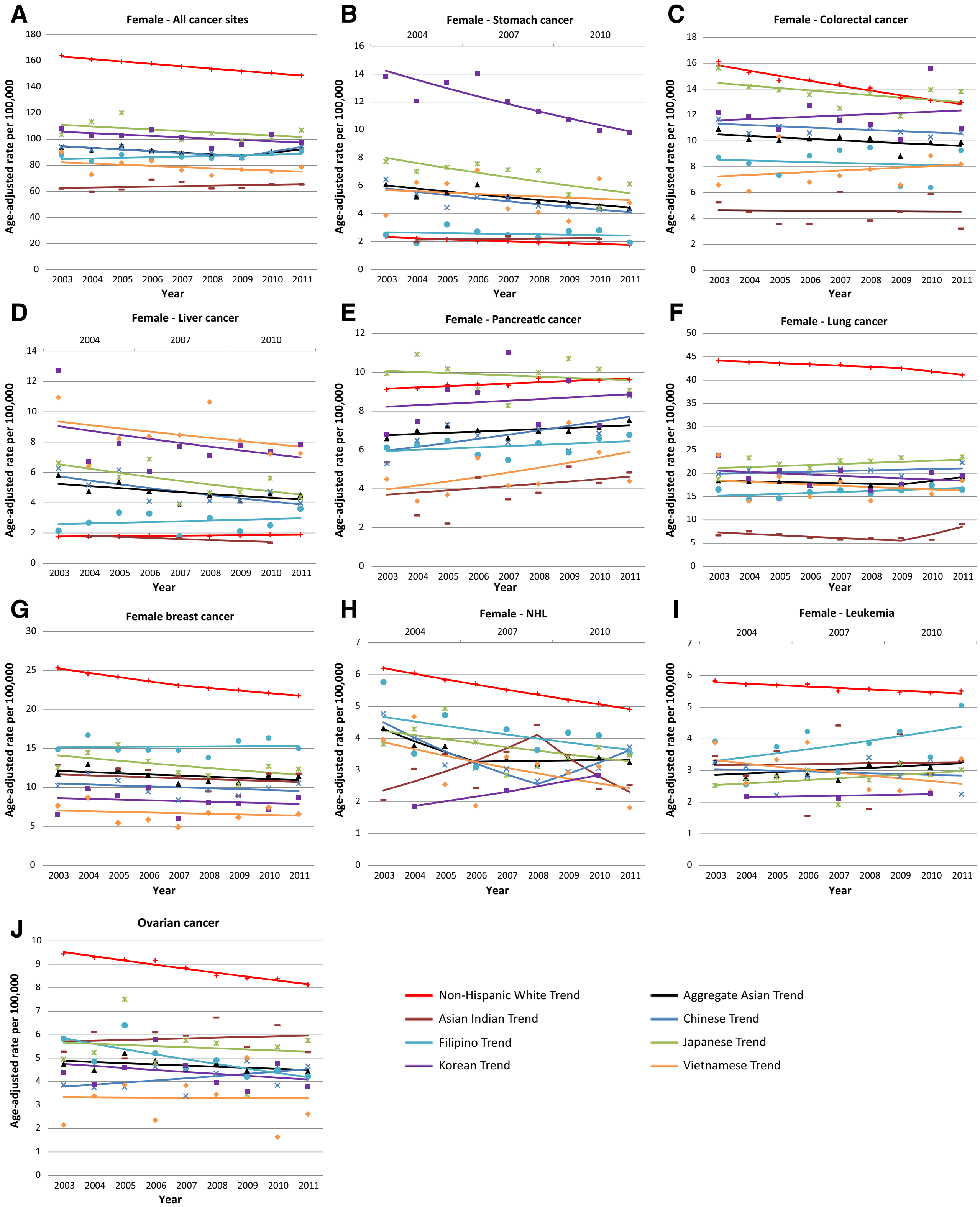

Figure 3.
Cancer mortality trends (women, 2003–2011; **A–J**).

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and Chinese (AMR, 38.8; 95% CI, 37.6–40.0) men, lung cancer accounted for approximately 30% of all cancer-related deaths. However, compared with NHWs, the mortality burden for male lung cancer in most AA ethnicities is about half, and in females, it was one half to one third. Asian Indians of both sexes had markedly lower lung cancer mortality rates than NHWs (SMR males, 0.21; 95% CI, 0.20–0.23; SMR females, 0.14; 95% CI, 0.12–0.16) and all other AA ethnicities. In trend analyses, male lung cancer was either stable or declining in all AA groups. However, lung cancer in females did not reflect the same declining patterns; we identified nonsignificant positive APCs for Chinese, Filipina, and Japanese women.

Female breast and ovarian cancers

Compared with other AA ethnicities, Filipinas had the highest rates of breast cancer mortality, but their mortality rates are still lower than those of NHWs (SMR, 0.7; 95% CI, 0.67–0.73). Notably though, breast cancer deaths accounted for 19.5% of all Filipina cancer deaths, relative to 14.6% in NHW women. Most of the other AA subgroups died from breast cancer at about 50% the rate of NHWs, including Asian Indians (SMR, 0.49; 95% CI, 0.45–0.53). In Asian Indians however, breast cancer was the leading cause of female cancer death, accounting for 19.8% of all cancer deaths. The lowest female breast cancer mortality rates were in Vietnamese (SMR, 0.31; 95% CI, 0.27–0.34). Death from female breast cancer was decreasing in NHW women, but we did not identify any statistically significant decreasing trends among AAs.

The rate of ovarian cancer mortality in NHW women was 8.8 (AMR), 95% CI, 8.8–8.9. All AA groups died at half that rate or less. Asian Indians and Japanese had the highest ovarian mortality rates (SMR, 0.50; 95% CI, 0.41–0.59), while Vietnamese had the lowest (SMR, 0.32; 95% CI, 0.24–0.40). Notably, ovarian cancer death accounted for 10% of female Asian Indian cancer mortality; this is about twice the proportion in NHW women.

Prostate cancer

In NHW males, prostate cancer was the second leading cause of death, behind lung cancer. In most of the AA ethnicities, it was ranked third. Aggregate Asian rates of prostate cancer mortality were lower than NHWs, but the proportion of total cancer-related deaths were similar between NHWs and AAs (8%–9%). Filipino men had the highest rates of prostate cancer mortality (SMR, 0.65; 95% CI, 0.61–0.69), while Vietnamese men had the lowest (SMR, 0.23; 95% CI, 0.19–0.27). We detected slightly downward sloping trends in all AA ethnicities for prostate cancer mortality.

Lymphoma and leukemias

Relative to NHWs, AAs aggregated had lower NHL mortality rates (aggregate Asian male SMR, 0.59; 95% CI, 0.65–0.61; aggregate Asian female SMR, 0.62; 95% CI, 0.59–0.66). Among AAs, Filipinos had the highest rates of NHL mortality (male AMR, 6.4; 95% CI, 5.8–7.0; female AMR, 4.0; 95% CI, 3.6–4.4), while Koreans had the lowest (male AMR, 3.6; 95% CI, 2.9–4.4; female AMR, 2.4; 95% CI, 1.9–2.9).

Like many other cancers that rank higher in NHW mortality, leukemia death rates were low in AA men and women, and the rates were generally homogenous across ethnicities (aggregate Asian SMR male, 0.50; 95% CI, 0.48–0.53; aggregate Asian female SMR, 0.56; 95% CI, 0.53–0.59). In Asian Indian men, leukemia ranked fifth in the leading cause of cancer-related mortality and accounted for 6% of all cancer deaths. Trend analysis revealed significant decreasing rates in NHWs (male APC, −0.6; 95% CI, −0.9 to −0.3; female APC, −0.8; 95% CI, −1.1 to −0.5) and Asian Indian males (APC, −5.3; 95% CI, −10.3–0.1).

Discussion

Our study is the first to provide a comprehensive report of the contemporary mortality burden across 10 major cancer sites for the six largest AA ethnic populations. Prior to this work, the only cancer mortality data for AA populations were reported by Miller and colleagues based on data from 1998 to 2002 from seven U.S. states (18). Consistent with these earlier patterns, we found that, for most cancer sites, AAs as an aggregated group have lower mortality burden than NHWs, with overall cancer mortality rates one half to one third those of NHWs. As the first to examine mortality trends among AA ethnic groups, we found overall cancer mortality rates to be decreasing in both male and female AAs when data are aggregated across all ethnic groups. However, patterns of cancer-related mortality are heterogeneous across AA ethnicities, highlighting the need for disaggregation in reporting. Stomach and liver cancer mortality burden, specifically, is very high for AAs, particularly among Chinese, Koreans, and Vietnamese, for whom these two cancer types combined accounted for 15% to 25% of cancer deaths, but less than 5% of cancer deaths in NHWs. Among women, breast cancer was also especially burdensome for Filipinas and Asian Indians, and AA female lung cancer rates were not declining, and even increasing in some AA females in recent years, despite the introduction and uptake of nationwide antismoking legislation.

In line with our findings, Gomez and colleagues (9) used SEER data to show that between 2004 and 2008, liver cancer was in the top 5 most diagnosed cancers among Americans of Chinese, Koreans, and Vietnamese descent (both sexes) and in Japanese American men, and that from 1990 to 2008, trends of liver cancer incidence are increasing in Filipino and Vietnamese American men. They also reported that stomach cancer was among the 5 most diagnosed cancers in Japanese American men and women, and in Korean American men, with increasing trends apparent for Japanese American men. For women, their analysis indicated that breast cancer is the most commonly diagnosed cancer among all AA ethnicities, with incidence rates increasing for Asian Indians, Chinese, Filipina, Korean, and Vietnamese women. Trinh and colleagues (10) also analyzed SEER case data, from 1990 to 2008, and found that rates of cause-specific mortality among eight AA ethnicities were consistently lower than NHW patients for lung, breast, prostate, and colorectal cancers, but their study did not include survival from infection-related cancers.

Cancer mortality is a function of the incidence rate in the population of interest as well as survival after diagnosis. Heterogeneity in cancer incidence is multifaceted, and site-specific attributable risk factors are often higher in one group than another. Survival may vary between racial and ethnic groups as well; survival is impacted by early detection and treatment, both of which are related to access to health care and socio-economic status. Between-ethnicity heterogeneity in cancer statistics may reflect some genetic variation; however, prior studies comparing cancer incidence rates between U.S.- and foreign-born AAs, as well as between Asians in Asia with AAs, support the idea that lifestyle

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and environmental factors generally have larger impacts on cancer burden than population genetics (19–22). Reflecting cancer burden as multifactorial public health concern, the following paragraphs include discussion of etiology and prevention strategies that are relevant to the AA populations.

The higher rates of gastric cancer mortality we observed in Koreans and Japanese may warrant consideration of heightened screening efforts in these groups. Population-based gastric cancer screening programs using radiographic or endoscopic techniques are established in Japan and South Korea, where gastric cancer incidence is very high (23, 24). The effectiveness of these programs is debated, but reductions in gastric cancer mortality have been achieved in Asian countries nonetheless, primarily attributable to efforts to treat infections with *Helicobacter pylori* (*H. pylori*), one of the most important causal factors in gastric carcinogenesis. *H. pylori* infection has been classified by International Agency for Research on Cancer (IARC) as a group 1 carcinogen (25), and their 2014 report recommended eradication of *H. pylori* as the best primary preventive measure for gastric cancer (26). More recent screening efforts in China and Taiwan have focused on early-age detection and treatment of *H. pylori* infections. Results from an initial 15-year trial in China demonstrated significant reduction of gastric cancer in asymptomatic subjects, and a larger nationwide trial is under way (27). According to the NCI's recommendations, there is no evidence that gastric cancer screening would result in a decrease in mortality in areas with relatively low incidence of the disease (28). However, given the high mortality burden of gastric cancer in some AA populations, the recommendations from IARC and successes demonstrated in Asian countries may warrant further evaluation of ethnicity-specific screening guidelines.

The higher rates of liver cancer mortality we observed in Vietnamese and Korean populations offer an important opportunity to enhance screening efforts for hepatitis B and C in high-risk communities. While AAs make up 5.8% of the US population, they represent more than half of the 1.4 million Americans infected with chronic hepatitis B (CHB) virus (HBV), an important predisposing factor for hepatocellular carcinoma, which is the most common cancer of the liver (29). CHB prevalence rates for AAs vary by ethnicity: as high as 12% to 13% in Chinese and Vietnamese, 5% to 7% in Koreans and Filipinos (30); however, less than 50% of at-risk AAs know their HBV status. CHB prevention has been successful in younger AAs via childhood vaccination initiatives, but AA adults, especially those in underserved communities, remain a high priority for screening. Hepatitis C screening is not routinely recommended for Asian immigrants in the United States (31) but should be considered as treatment with a highly curative therapy is now available. Having disaggregated data by ethnicity allows for more precise targeted screening and control efforts that employ culture-specific approaches (32).

We also observed noteworthy trends and burden for female mortality from lung and breast cancers. Smoking, a major health concern for many Americans, is associated with approximately 75% of lung cancer diagnoses; however, an estimated 70% of female AA lung cancers occur in never smokers (33). Patterns in histologic subtypes may provide evidence of smoking status in population-level statistics, as squamous cell carcinoma (SCC) is more commonly associated with tobacco use than adenocarcinoma (34, 35). Cheng and colleagues (36) examined 20-year incidence rates of AA female lung cancer and found marked differences in histology by ethnicity, with increasing trends of SCC in Japanese women and increasing trends in adenocarcinoma for Filipinas and Korean women. Along with our findings, this may highlight a need for targeted smoking prevention campaigns, but ways to prevent nonsmoking lung cancer remain unclear. As of 2013, screening for lung cancer by low-dose CT is recommended for heavy, current, or recent smokers (37). However AA females, who are predominantly nonsmokers, may not be targeted by these guidelines. Furthermore, oncogenic driver mutations, which serve as the basis for precision therapy for lung cancer, are not well characterized by smoking status. A recent prospective study with a mix of smoking and nonsmoking Asians identified some key differences in these patients' mutation profiles (38), but much additional work is needed, including prospective studies of populations with ethnic heterogeneity and variation in smoking behaviors. Breast cancer is a screening-detectable cancer, but effective intervention requires access and use of health care, which has been found to be heterogonous across Asian subgroups. The AA patient–physician relationship is an important way to encourage healthy living habits that prevent cancer, such as diet, exercise, and regular primary care visits (39, 40).

Limitations

This study is based on death records, and any inaccuracies could result in misclassification, which is a known limitation in Asian populations (41). Place of birth is recorded on the death certificate, but not by the census, so we are unable to provide rates by decedent nativity, which would be particularly useful for this study. In addition, direct age-adjusted rates may be less reliable in sparse data; therefore, we suppressed rates with counts less than 16 and also reported SMRs that do not suffer the same limitations. Nine years is a short follow-up time, and our analysis was modified to accommodate state-by-state gradual adoption of the new death certificate. By including AA groups in the denominator only when deaths were reported, yearly estimates should be approximately unbiased with more uncertainty in earlier years, but there is a possibility of geographic time bias in trend results if the later adopting states had markedly different mortality rates than the earlier ones.

Impact

In his 2016 State of the Union address, President Barack Obama announced a new national initiative aimed at finding a cure to cancer (42). Intrinsic to this effort is the need for a comprehensive understanding of the burden of cancer, especially as it pertains to U.S. populations that are experiencing rapid growth and those that are heterogeneous in levels of education and access to health services; here, we have focused on Asians, but this also describes other diverse American groups, such as our Hispanic populations. Cancer has surpassed cardiovascular disease as the leading cause of death for most AA ethnicities (43), and in this first ever trend analysis of ethnicity-specific AA cancer mortality, we have highlighted cancers of substantial burden that have potential screening mechanisms (e.g., liver, stomach) as well as cancers of less understood etiology (e.g., breast, nonsmoking lung cancer) that are disproportionately killing Americans of Asian descent. While the new format of death certificate is still in its early stages of adoption, even short-term mortality trends can be important for alerting to potential problems and establishing a call to action, as seen in recent media coverage of unexpected spikes in mortality for middle-aged NHW men (44). Echoing the objectives of the precision medicine initiative (45), national prevention efforts may benefit from the adoption of ethnicity-specific cancer screening recommendations that take into consideration heterogeneity of cancer etiology as well as varying incidence and mortality patterns. We believe that this study highlights the importance of capturing and considering distinct Asian ethnicity in census data, disease surveillance, and vital statistics data, as well as medical records, and research studies. Currently in the United States, there are no cohorts with sufficient sample sizes to allow disaggregation of AA ethnicity for longitudinal analyses of cancer risk factors, but there is clearly a critical need for such a data resource.

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.

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Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): C.A. Thompson, S.L. Gomez, K. Kapphahn, A.S. Bhatt, H.A. Wakelee, M.I. Patel, M.R. Cullen, L.P. Palaniappan
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