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Annual Report to the Nation on the Status of Cancer, 1975–2014, Featuring Survival

Ahmedin Jemal, Elizabeth M. Ward, Christopher J. Johnson, Kathleen A. Cronin, Jiemin Ma, A. Blythe Ryerson, Angela Mariotto, Andrew J. Lake, Reda Wilson, Recinda L. Sherman, Robert N. Anderson, S. Jane Henley, Betsy A. Kohler, Lynne Penberthy, Eric J. Feuer, Hannah K. Weir

Affiliations of authors: Surveillance and Health Services Research (AJ, JM) and Intramural Research (EMW), American Cancer Society, Atlanta, GA; North American Association of Central Cancer Registries, Springfield, IL (RLS, BAK); Cancer Data Registry of Idaho, Boise, ID (CJJ); Division of Cancer Control and Population Sciences, National Cancer Institute, Bethesda, MD (KAC, AM, LP, EJF); Division of Cancer Prevention and Control, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA (BR, RW, SJH, HKW); Information Management Services, Inc., Rockville, MD (AJL); National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, MD (RNA)

Correspondence to: Ahmedin Jemal, DVM, PhD, Surveillance and Health Services Research, American Cancer Society, 250 Williams St. NW, Atlanta, GA 30303 (e-mail: ajemal@cancer.org).

Abstract

Background: The American Cancer Society (ACS), the Centers for Disease Control and Prevention (CDC), the National Cancer Institute (NCI), and the North American Association of Central Cancer Registries (NAACCR) collaborate to provide annual updates on cancer occurrence and trends in the United States. This Annual Report highlights survival rates.

Methods: Data were from the CDC- and NCI-funded population-based cancer registry programs and compiled by NAACCR. Trends in age-standardized incidence and death rates for all cancers combined and for the leading cancer types by sex were estimated by joinpoint analysis and expressed as annual percent change. We used relative survival ratios and adjusted relative risk of death after a diagnosis of cancer (hazard ratios [HRs]) using Cox regression model to examine changes or differences in survival over time and by sociodemographic factors.

Results: Overall cancer death rates from 2010 to 2014 decreased by 1.8% (95% confidence interval [CI] = –1.8% to –1.8%) per year in men, by 1.4% (95% CI = –1.4% to –1.3%) per year in women, and by 1.6% (95% CI = –2.0% to –1.3%) per year in children. Death rates decreased for 11 of the 16 most common cancer types in men and for 13 of the 18 most common cancer types in women, including lung, colorectal, female breast, and prostate, whereas death rates increased for liver (men and women), pancreas (men), brain (men), and uterine cancers. In contrast, overall incidence rates from 2009 to 2013 decreased by 2.3% (95% CI = –3.1% to –1.4%) per year in men but stabilized in women. For several but not all cancer types, survival statistically significantly improved over time for both early and late-stage diseases. Between 1975 to 1977 and 2006 to 2012, for example, five-year relative survival for distant-stage disease statistically significantly increased from 18.7% (95% CI = 16.9% to 20.6%) to 33.6% (95% CI = 32.2% to 35.0%) for female breast cancer but not for liver cancer (from 1.1%, 95% CI = 0.3% to 2.9%, to 2.3%, 95% CI = 1.6% to 3.2%). Survival varied by race/ethnicity and state. For example, the adjusted relative risk of death for all cancers combined was 33% (HR = 1.33, 95% CI = 1.32 to 1.34) higher in non-Hispanic blacks and 51% (HR = 1.51, 95% CI = 1.46 to 1.56) higher in non-Hispanic American Indians/Alaska Natives compared with non-Hispanic whites.

Conclusions: Cancer death rates continue to decrease in the United States. However, progress in reducing death rates and improving survival is limited for several cancer types, underscoring the need for intensified efforts to discover new strategies for prevention, early detection, and treatment and to apply proven preventive measures broadly and equitably.

The American Cancer Society (ACS), Centers for Disease Control and Prevention (CDC), National Cancer Institute (NCI), and the North American Association of Central Cancer Registries (NAACCR) have collaborated annually since 1998 to provide updates on cancer incidence and mortality patterns in the United States (1–18). Each "Annual Report to the Nation" also features an in-depth analysis of a selected topic, and this year's report features survival by stage, race/ethnicity, and state for common cancers.

In addition to death and incidence rates, survival is an important measure for assessing progress in efforts to improve cancer outcomes (19). As with most disease surveillance measures, the interpretation of survival trends is complicated by changes in screening and detection practices (19,20). In particular, screening may lead to the detection of cases that would not have been detected through clinical manifestation in a lifetime (overdiagnosis) or the detection of cancers that are inherently slow growing (length bias). Screening may also result in earlier diagnosis without changing the date of death, generating apparent improvements in survival without changing the actual course of disease (lead time bias) (21). In this report, we examine temporal changes in overall and stage-specific survival for all races/ethnicities combined and in overall survival by race, and contemporary overall survival by race and ethnicity and state of residence. We interpret these survival statistics in the context of changes in screening, early detection, and treatment.

Methods

Data Sources

Cancer Incidence Data

Population-based cancer incidence data by age, sex, and race/ethnicity were obtained from 39 states and two metropolitan area registries that participate in the CDC's National Program of Cancer Registries (NPCR) and/or the NCI's Surveillance, Epidemiology, and End Results (SEER) program. The data satisfied NAACCR's data quality criteria and represented cases diagnosed from 1999 through 2013, (22) covering 89% of the US population. This database of 41 registries was used to derive all incidence statistics presented in this report, which is the first annual report that has drawn all incidence statistics from a single database. In the past, limitations on the number of high-quality registries extending back in time required estimation of five-year average incidence rates from one set of registries, 10-year trends from a smaller set, and long-term trends from a third even smaller set.

Anatomic site and histology were coded according to the International Classification of Diseases for Oncology (ICD-O) edition in use at the time of diagnosis and were converted to the third edition coding (23) and categorized according to SEER site groups (24). Only cases defined as malignant under ICD-O-2 and ICD-O-3 were included in this report. For solid tumors, stage was categorized as localized, regional, or distant using SEER Summary Stage 2000, which has been used for new cases (incidence) diagnosed in 1998 or later (25). All case counts were adjusted for delay in reporting or corrections (26).

Cancer Mortality Data

Cause of death by age, sex, and race/ethnicity (2000–2014) was based on death certificate information reported to state vital statistics offices and compiled into a national file for the entire United States by the CDC National Center for Health Statistics'

(NCHS') National Vital Statistics System (27). The underlying causes of death were selected according to the International Classification of Disease (ICD) codes and rules in use at the time of death (ICD-8 through ICD-10) and categorized according to SEER causes of death recode to maximize comparability between ICD and ICD-O versions (24).

Race/Ethnicity

Information on race and ethnicity was based on medical records or death certificates. Race is categorized as white, black, Asian and Pacific Islander (API), American Indian/Alaska Native (AI/AN). Race by ethnicity according to Hispanic origin (race/ethnicity) was categorized as non-Hispanic white (NHW), non-Hispanic black (NHB), non-Hispanic Asian and Pacific Islander (NHAPI), non-Hispanic American Indian/Alaska Native (NHAI/AN), and Hispanic. Race and race/ethnicity information for AI/AN, however, is reliable only for geographic areas covered by the Indian Health Service Contract Health Service Delivery Areas (CHSDA) (10,28,29), and thus incidence, mortality, and survival data for American Indians/Alaska Natives are based on these areas. We present data by race and by Hispanic origin for incidence and mortality. Incidence was presented by race and ethnicity separately because delay adjustment factors were not available for the combined race/ethnicity categorization. Cause-specific survival and adjusted risk of cancer death are presented by race/ethnicity; however, relative survival estimates are presented only for race categories where appropriate life tables were available.

Population Data

The population estimates used as the denominators to calculate incidence and death rates were a modification of the intercensal and Vintage 2014 annual times series of July 1, county population estimates by age, sex, race, and Hispanic origin produced by the US Census Bureau's Population Estimates Program, in collaboration with CDC's NCHS and with support from the NCI (30). The estimates incorporate intercensal (for July 1, 2000–2009) and Vintage 2014 (for July 1, 2010–2013) bridged single-race estimates that are derived from the original multiple-race categories in the 2000 and 2010 Censuses (as specified in the 1997 Office of Management and Budget standards for the collection of data on race and ethnicity) (31,32). For most states, population estimates as of July 1 of each year were used to calculate rates that were presumed to reflect the average population of a defined geographic area for a calendar year; however, some adjustments were made to refine these estimates, as has been done in previous reports (16,17,30).

Survival Data

To examine survival over time, by race, and by geographic areas, we used survival data from three databases. We used survival data from 9-SEER cancer registries (covering about 10% of the US population) to examine temporal changes in five-year survival between patients diagnosed from 1975 to 1977 vs 2006 to 2012 and followed through 2013; 1975 was the first year when all nine registries submitted incidence data to SEER. We examined these changes for the 20 most common cancers by race (all races, whites, blacks) and by stage (all races combined only), when stage information was available. We examined differences in contemporary survival for patients diagnosed from 2006 to 2012 by race/ethnicity (NHW, NHB, NHAPI, NHAI/AN, and Hispanic) for the 20 most common cancers using survival data from 18-SEER areas, which cover about 28% of the US

population. We used 33 SEER or NPCR registries compiled by NAACCR (covering 67% of the US population) to examine contemporary survival differences by state of residence for the four most common cancers (lung, colon and rectum, female breast, prostate). These 33 registries (31 states and two metropolitan areas, referred to hereafter as "states") were considered to have sufficient vital status follow-up to conduct survival analyses because they either conducted recent National Death Index (NDI) linkages or they routinely conduct active vital status follow-up of all cases (33).

In all SEER-only-based survival analyses, only first primary cancers were used in the analysis and patients were followed for vital status through December 31, 2013. For the state-specific analysis, which included data from the SEER and NPCR registries, the first site-specific cancer was used in the analysis because of the different starting dates among the registries (34) and patients were followed for vital status through December 31, 2012, because not all registries had complete information on vital status through December 31, 2013. In SEER registries, cancers that were identified by death certificate or autopsy only were excluded, as were patients with no survival time.

Statistical Methods

Incidence and Death Rates and Trends

Cross-sectional incidence (2009–2013) and death (2010–2014) rates for all ages combined were calculated for all cancer sites combined and for the 15 most common cancer sites by sex, race, and Hispanics. These rates were calculated with their 95% confidence intervals using SEER*Stat software, version 8.3.2 (35,36). Incidence rates were delay-adjusted to account for revisions to the case counts in future submissions (http://surveillance.cancer.gov/delay/). Similarly, we calculated overall incidence and death rates for children (0–14 years). All rates were age-standardized to the 2000 US Standard Population and were expressed per 100 000 persons (35). Rates based on fewer than 16 case subjects were deemed to be unstable and were suppressed.

Temporal trends in age-standardized, delay-adjusted cancer incidence (1999–2013) and death (2000–2014) rates were estimated using joinpoint regression (37,38), with a maximum of two joinpoints (three line segments) allowed in each model. The resultant trends were described by the annual percentage change (APC). The five-year average annual percent changes (AAPCs) for 2009 to 2013 (incidence) and for 2010 to 2014 (mortality) were calculated using a weighted average of the slope coefficients of the underlying joinpoint regression line, with weights equal to the length of each segment over the interval. The AAPC was equal to the APC when the AAPC was entirely within the last joinpoint segment (39). Two-sided statistical significance ($P < .05$) for APC and AAPC was determined using a t test for the APC and for the AAPC when it lies entirely within the last joinpoint segment and a z test when the AAPC extends beyond the last joinpoint segment (40). In describing trends, the terms "increase" or "decrease" were used when the slope of the trend (APC or AAPC) was statistically significant; otherwise, terms such as "stable," "nonsignificant increase," and "nonsignificant decrease" were used. Trends based on fewer than 10 case subjects in any of the 15 data years (1999–2013 for incidence and 2000–2014 for mortality) were considered unreliable and were suppressed.

Survival Ratios and Trends

We used relative survival ratios (RSRs) to examine differences and changes in five-year survival over time or across geographic areas. RSR is a measure of excess mortality experienced by cancer patients and is calculated by dividing the observed survival from all causes of death for the patient cohort by the expected survival as estimated by life tables. Relative survival is a theoretical population-based measure representing cancer survival in the absence of other causes of death. We also calculated absolute and relative (proportional) changes in five-year RSRs between cases diagnosed in 1975 to 1977 vs 2006 to 2012 for the 20 most common cancers (all ages, by race) and for select childhood cancers (0–14 years, all races) and by SEER historic stage (localized, regional, and distant). For lymphoma, Ann Arbor staging (stage I, II, III, and IV) (41) was used; z tests were performed to examine if the changes in relative survival over time were statistically significantly different between whites and blacks.

To describe differences in survival for the 20 most common cancers across racial/ethnic groups, we calculated cause-specific survival rather than RSR because reliable life tables are not available for NHAPI and NHAI/AN populations. We also compared the risk of death in NHB, NHAPI, NHAI/AN and Hispanic populations with the NHW population using hazard ratios (HRs). These hazard ratios were calculated using Cox regression models, with a maximum of five years of follow-up and adjusting for sex, age, and summary stage (except for all cancer sites combined and leukemia). No statistically significant violations of proportional hazards assumption were found by testing the interactions between survival time and covariates. This analysis was performed using SAS 9.4 (SAS Institute Inc., Cary, NC). All statistical tests were two-sided, and statistical significance level was set at a P value of less than .05.

For all survival analyses, the survival duration in months was calculated based on complete dates and 60-month survival is reported. For registries conducting active follow-up, survival duration was calculated through the date of last contact (or study cutoff, if earlier). For the remaining registries (those conducting data linkage with the National Death Index [NDI] only), survival duration was calculated through December 31, 2012, with all patients not known to be dead presumed to be alive on that date. For the analyses based only on SEER data, expected survival was estimated from race- and sex-specific life tables for the entire United States. For the analyses by state, expected survival was estimated from life tables matched to the cancer patients by age (0–99 years), sex, year, state, race, and county-level socioeconomic status (SES). Cases were censored at an achieved age of 100 years.

Results

Cancer Incidence Rates for the Most Common Cancers

Figure 1 shows trends from 1999 to 2013 in age- and delay-adjusted incidence rates for all cancer sites combined for men and women. Incidence rates for men decreased throughout the study period, with the decrease accelerating from 0.6% (95% confidence interval [CI] = –0.9% to –0.2%) per year during 1999 to 2008 to 2.3% (95% CI = –3.1% to –1.4%) per year during 2008/2009 to 2013. In contrast, over the same 15-year time period, rates for women remained stable.

Figure 2 presents average annual incidence rates and trends during 2009 to 2013 for the 17 most common cancers in men and 18 most common cancers in women. Among men, incidence rates during 2009 to 2013 decreased statistically significantly for seven of the 17 most common cancers, including
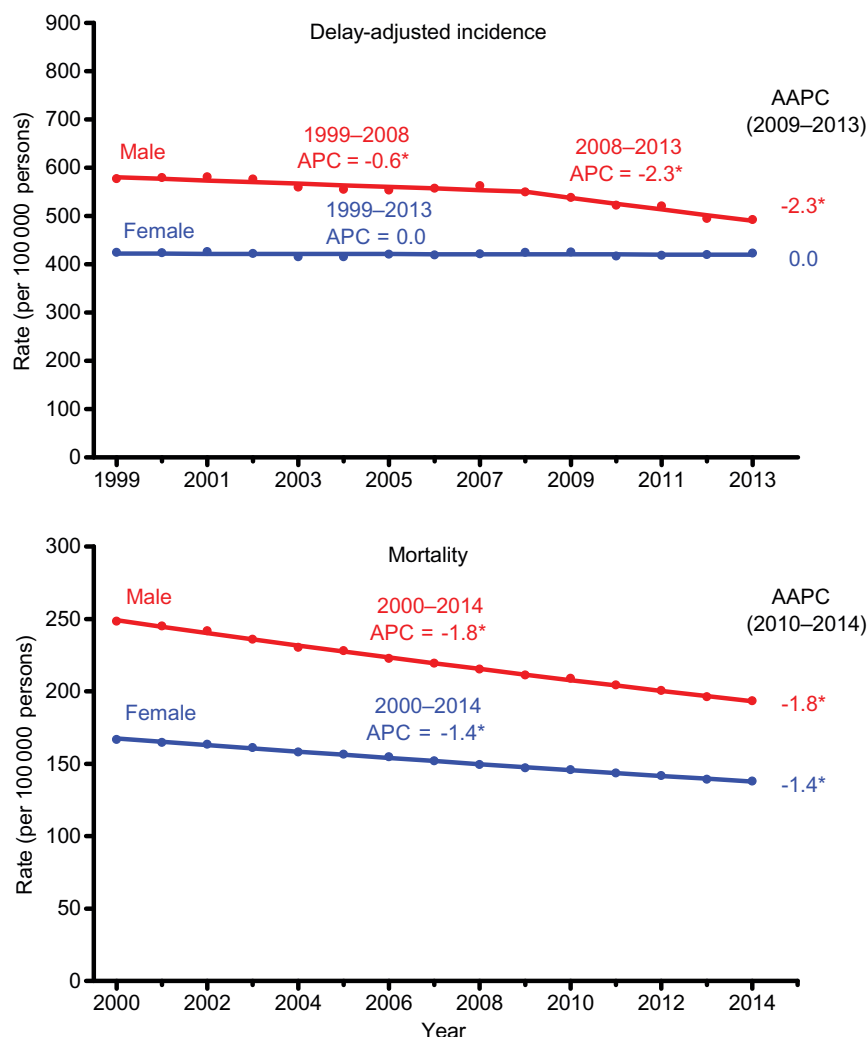
Figure 1. Trends in age-standardized incidence (1999–2013) and death rates (2000–2014) for all cancers combined by sex. Rates were age-standardized to the 2000 US standard population (19 age groups Census P25–1130). **Scattered points** were observed rates; **lines** were fitted rates according to Joinpoint regression. Incidence rates were delay-adjusted and covered 89% of the US population, and mortality covered the entire United States. Registries included for incidence: Alabama, Alaska, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming. AAPC is the average annual percent change and is a weighted average of the annual percent change (APC) over the fixed interval (2009–2013 for incidence, 2010–2014 for mortality) using the underlying joinpoint model for the period of 1999 to 2013 for incidence and the period of 2000 to 2014 for mortality. Joinpoint models with up to two joinpoints are based on rates per 100 000 persons that are age-standardized to the 2000 US standard population (19 age groups Census P25–1130). Joinpoint Regression Program, version 4.2.0.2. June 2015, Statistical Research and Applications Branch, National Cancer Institute. *The APC or AAPC is statistically significantly different from 0 (two-sided *t* test, *P* < .05). AAPC = average annual percent change; APC = annual percent change.

prostate (*P* = .003), lung and bronchus (lung; *P* < .001), colon and rectum (colorectal; *P* < .001), urinary bladder (bladder; *P* < .001), esophagus (*P* < .001), brain and other nervous system (brain; *P* = .005), and larynx (*P* < .001). The largest decline was for prostate cancer, with an average –7.9% (95% CI = –12.2% to –3.3%) decline per year. In contrast, rates increased statistically significantly for seven cancers: melanoma of the skin (melanoma), leukemia, oral cavity and pharynx (oral cavity), pancreas, liver and intrahepatic bile duct (liver), myeloma, and thyroid (*P* < .001, for all) and stabilized for non-Hodgkin lymphoma (NHL), kidney and renal pelvis (kidney), and stomach cancer.

Among women, incidence rates during 2009 to 2013 decreased statistically significantly for seven of the 18 most common cancers: lung (*P* < .001), colorectal (*P* < .001), NHL (*P* = .003), ovary (*P* < .001), bladder (*P* < .001), cervix uteri (cervix; *P* = .001),

and stomach (*P* < .001); however, incidence rates increased statistically significantly for nine cancers: breast (*P* < .03), corpus and uterus not otherwise specified (NOS; uterus; *P* < .001), thyroid (*P* < .001), melanoma (*P* < .01), leukemia (*P* < .001), myeloma (*P* < .001), pancreas (*P* < .001), oral cavity (*P* = .001), and liver (*P* < .001); incidence rates remained unchanged for kidney and brain (Figure 2). Of note is the statistically significant increase of 0.4% (95% CI = 0.1% to 0.8%) per year over the past five years in breast cancer incidence, the most common cancer among women. Liver cancer among women increased by 3.8% (95% CI = 3.4% to 4.1%) per year over the past five years, replacing thyroid cancer as the most rapidly increasing incident cancer among women. For most cancers, the increasing or decreasing trends during 2009 to 2013 in both men and women were continuations of past trends (Supplementary Table 1, available online).
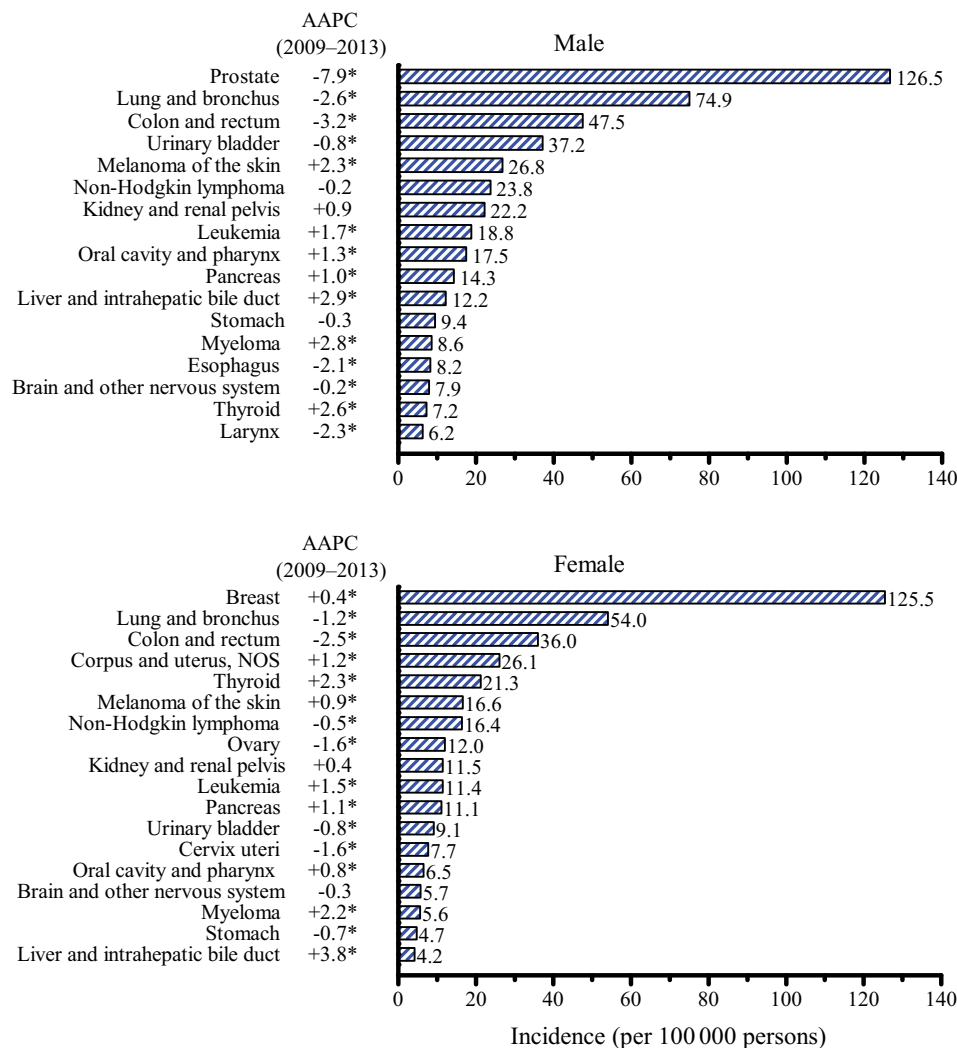
Male

Site	AAPC (2009–2013)	Incidence (per 100 000 persons)
Prostate	-7.9*	126.5
Lung and bronchus	-2.6*	74.9
Colon and rectum	-3.2*	47.5
Urinary bladder	-0.8*	37.2
Melanoma of the skin	+2.3*	26.8
Non-Hodgkin lymphoma	-0.2	23.8
Kidney and renal pelvis	+0.9	22.2
Leukemia	+1.7*	18.8
Oral cavity and pharynx	+1.3*	17.5
Pancreas	+1.0*	14.3
Liver and intrahepatic bile duct	+2.9*	12.2
Stomach	-0.3	9.4
Myeloma	+2.8*	8.6
Esophagus	-2.1*	8.2
Brain and other nervous system	-0.2*	7.9
Thyroid	+2.6*	7.2
Larynx	-2.3*	6.2

Female

Site	AAPC (2009–2013)	Incidence (per 100 000 persons)
Breast	+0.4*	125.5
Lung and bronchus	-1.2*	54.0
Colon and rectum	-2.5*	36.0
Corpus and uterus, NOS	+1.2*	26.1
Thyroid	+2.3*	21.3
Melanoma of the skin	+0.9*	16.6
Non-Hodgkin lymphoma	-0.5*	16.4
Ovary	-1.6*	12.0
Kidney and renal pelvis	+0.4	11.5
Leukemia	+1.5*	11.4
Pancreas	+1.1*	11.1
Urinary bladder	-0.8*	9.1
Cervix uteri	-1.6*	7.7
Oral cavity and pharynx	+0.8*	6.5
Brain and other nervous system	-0.3	5.7
Myeloma	+2.2*	5.6
Stomach	-0.7*	4.7
Liver and intrahepatic bile duct	+3.8*	4.2

Incidence (per 100 000 persons)

Figure 2. Age-standardized incidence rates and recent trends (five years) for the most common cancers by sex. Rates were age-standardized to the 2000 US standard population (19 age groups Census P25–1130) and were delay-adjusted and covered 89% of the US population. Registries included in analyses: Alabama, Alaska, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming. AAPC is the average annual percent change and is a weighted average of the annual percent change (APC) over the fixed interval (2009–2013) using the underlying joinpoint model for the period of 1999 to 2013. Joinpoint models with up to two joinpoints are based on rates per 100 000 persons that are age-standardized to the 2000 US standard population (19 age groups Census P25–1130). Joinpoint Regression Program, version 4.2.0.2. June 2015, Statistical Research and Applications Branch, National Cancer Institute. *The AAPC is statistically significantly different from 0 (two-sided t test or z test, P < .05). AAPC = average annual percent change.

Cancer Death Rates for the Most Common Cancers

Figure 1 also shows trends in death rates for all cancer sites combined from 2000 to 2014 by sex. Death rates decreased statistically significantly from 2000 to 2014 by 1.8% (95% CI = –1.8% to –1.8%) on average per year among men and by 1.4% (95% CI = –1.4% to –1.3%) per year among women. Similarly, overall cancer death rates during the most recent five years (2010 to 2014) decreased by 1.8% (95% CI = –1.8% to –1.8%) per year in men by 1.4% (95% CI = –1.4% to –1.3%) per year in women.

Figure 3 presents average annual death rates and trends during 2010 to 2014 for the 16 most common cancers in men and 18 most common cancers in women. Among men, death rates during this period decreased statistically significantly for 11 of the 16 cancers, including lung by 3.5% (95% CI = –3.9% to –3.2%) per year, prostate by 3.4% (95% CI = –3.6% to –3.2%) per year, and colorectal by 2.5% (95% CI = –2.7% to –2.4%) per year. In contrast, rates

increased statistically significantly for cancers of the liver by 2.6% (95% CI = 2.4% to 2.8%) per year, for pancreas by 0.3% (95% CI = 0.1% to 0.4%) per year, and for brain by 0.5% (95% CI = 0.0% to 1.0%) per year; rates stabilized for bladder and oral cavity cancers. Among women, during the same time period death rates decreased statistically significantly for 13 of the 18 most common cancer types, including lung by 2.0% (95% CI = –2.2% to –1.8%) per year, breast by 1.6% (95% CI = –1.8% to –1.4%) per year, and colorectal by 2.8% (95% CI = –3.0% to –2.7%) per year. In contrast, death rates increased statistically significantly for cancers of the uterus by 2.0% (95% CI = 1.4% to 2.6%) per year and for liver cancer by 3.0% (95% CI = 2.6% to 3.4%) per year; rates remained stable for pancreas, brain, and myeloma. As with the incidence trends, the increase or decrease in death rates for most cancers in both men and women were continuations of past trends (Supplementary Table 2, available online).
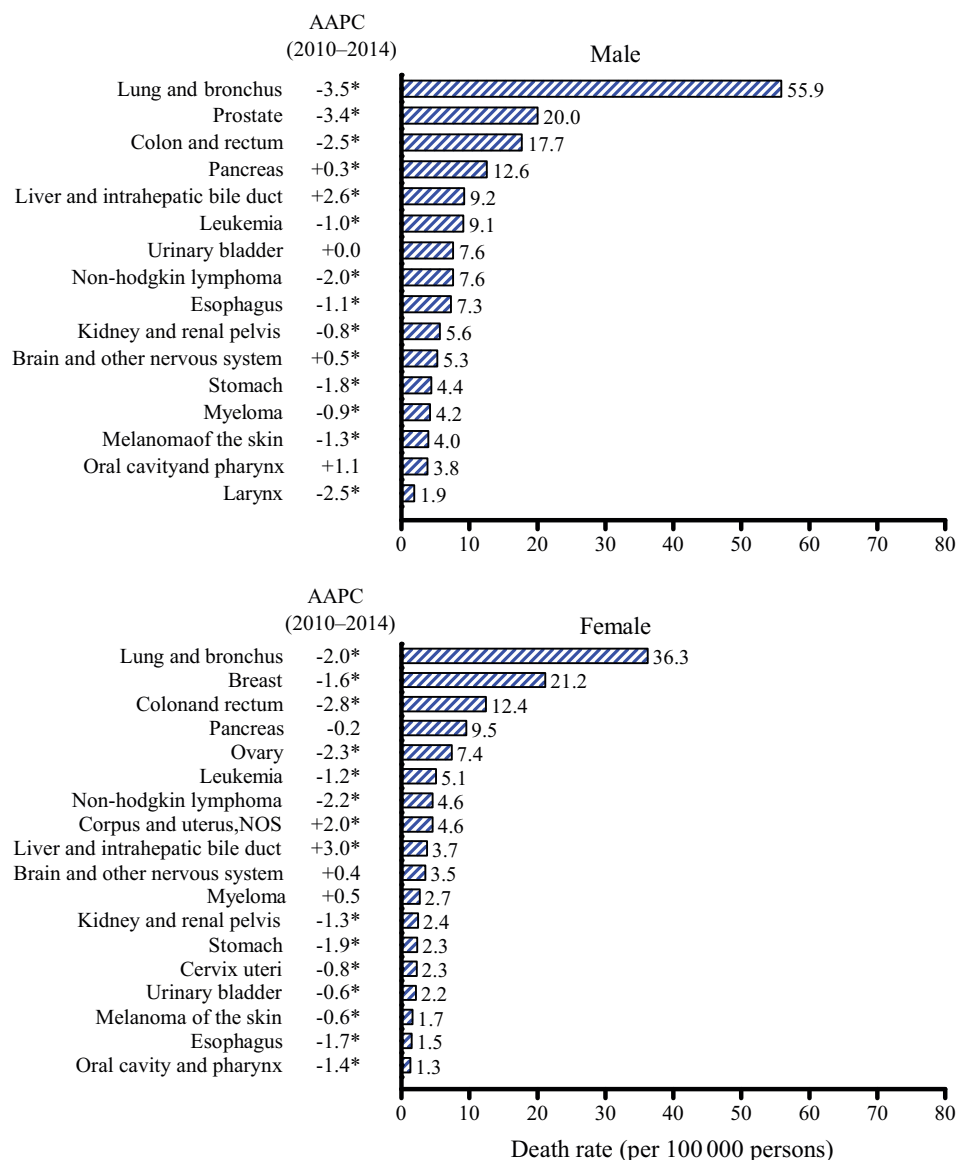
Figure 3. Age-standardized death rates and recent trends (five years) for the most common cancers by sex. Rates were age-standardized to the 2000 US standard population (19 age groups Census P25–1130). AAPC is the average annual percent change and is a weighted average of the annual percent change (APC) over the fixed interval (2010–2014) using the underlying joinpoint model for the period of 2000 to 2014. Joinpoint models with up to two joinpoints are based on rates per 100 000 persons that are age-standardized to the 2000 US standard population (19 age groups Census P25–1130). Joinpoint Regression Program, version 4.2.0.2. June 2015, Statistical Research and Applications Branch, National Cancer Institute. *The AAPC is statistically significantly different from 0 (two-sided t test or z test, P < .05). AAPC = average annual percent change.

Current Cancer Incidence Rates and Trends by Race, Ethnicity, and Sex

Table 1 depicts average annual age-standardized and delay-adjusted incidence rates and trends for the most recent five-year period (2009–2013) by cancer site, sex, race, and ethnicity. Rates for all cancer sites combined in all racial and ethnic groups were higher in men than in women (512.9 vs 420.6 per 100 000). Black men and white women had higher overall cancer incidence rates than any of their racial/ethnic counterparts, whereas API men and women had the lowest rates. In all racial and ethnic groups, prostate cancer in men and breast cancer in women were the most frequent incident cancers, followed by lung cancer and colorectal cancer, except in Hispanics for whom colorectal preceded lung cancer. Rankings for several of the other cancers varied substantially by race and ethnicity in both men and women. Among men, for example, melanoma ranked fifth in white men and 19th in black men, whereas liver cancer ranked 11th in white men and seventh in black men.

Among men, incidence trends during 2009 to 2013 for all cancers combined and for the 20 most common cancers in each racial/ethnic group were generally similar to those of all races combined. Incidence rates decreased statistically significantly for all cancers combined and for the three most common cancers (prostate, lung, and colorectal) in each racial and ethnic group except AI/AN for lung and colorectal; rates also decreased for cancers of the stomach, esophagus, and larynx, except that rates were stable for stomach cancer in whites and for esophagus cancer and larynx cancer in AI/AN. In contrast, incidence

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Table 1. Delay-adjusted incidence rates and fixed-interval trends for 2009 to 2013 for the most common cancers by sex, race, and ethnicity, for areas in the United States with high-quality incidence data*

Sex/cancer site or type†	White‡				Black‡				API‡				AI/AN (CHSDA)‡				Hispanic‡				Non-Hispanic‡			
	Rank	Rate§	AAPC‖	P#	Rank	Rate§	AAPC‖	P#	Rank	Rate§	AAPC‖	P#	Rank	Rate§	AAPC‖	P#	Rank	Rate§	AAPC‖	P#	Rank	Rate§	AAPC‖	P#
All sites¶																								
Both sexes		461.7	−1.1	.007		474.4	−1.4	.001		302.1	−0.4	<.001		420.2	0.0	.76		362.1	−0.7	<.001		469.8	−1.1	<.001
Males		511.2	−2.2	<.001		576.2	−3.1	<.001		318.2	−1.2	<.001		445.1	−0.6	.03		407.0	−2.8	<.001		525.5	−2.2	<.001
Females		427.5	0.0	.60		406.1	0.3	<.001		294.3	0.7	<.001		405.9	0.6	.002		334.8	−0.1	.05		430.2	0.0	.53
Males																								
Prostate	1	118.0	−6.9	.001	1	205.3	−6.0	.001	1	68.1	−7.5	.005	1	93.4	−9.0	.01	1	110.1	−7.9	<.001	1	128.4	−7.8	.004
Lung and bronchus	2	74.8	−2.6	<.001	2	88.2	−3.4	<.001	2	48.0	−1.3	<.001	2	73.9	−0.5	.25	3	43.2	−2.5	<.001	2	77.9	−2.5	<.001
Colon and rectum	3	46.5	−3.3	<.001	3	58.0	−2.7	<.001	3	39.0	−2.2	<.001	3	54.2	−0.7	.17	2	44.2	−3.0	<.001	3	48.0	−3.2	<.001
Urinary bladder	4	39.6	−0.5	<.001	5	20.3	0.7	.32	6	15.9	−0.3	.15	5	21.2	0.1	.81	5	20.8	−1.9	<.001	4	38.7	−0.4	<.001
Melanoma of the skin	5	30.4	2.5	<.001	19	1.1	−0.6	.32	18	1.5	−0.4	.47	12	8.9	2.0	.03	14	5.4	1.0	.15	5	29.2	2.5	<.001
Non-Hodgkin lymphoma	6	24.5	−0.4	.02	6	17.7	0.2	.25	5	16.3	0.3	.25	7	18.4	0.1	.87	6	20.8	−0.1	.64	6	24.1	−0.6	.05
Kidney and renal pelvis	7	22.4	0.6	.005	4	24.4	0.8	.13	9	11.3	2.7	<.001	4	31.7	2.1	.005	7	21.5	0.8	.23	7	22.4	0.9	.10
Leukemia	8	19.5	2.0	<.001	12	14.6	1.1	<.001	10	10.4	0.1	.97	9	12.7	−0.5	.60	8	14.1	0.5	.03	8	19.1	1.8	<.001
Oral cavity and pharynx	9	18.0	1.7	<.001	10	15.0	−2.0	<.001	8	11.3	0.3	.36	8	16.5	1.1	.21	9	11.2	−0.7	.02	9	18.3	1.5	<.001
Pancreas	10	14.2	1.1	<.001	8	17.0	0.5	.01	11	10.4	0.7	.01	10	11.6	0.7	.53	10	12.4	0.6	.02	10	14.5	1.1	<.001
Liver and intrahepatic bile duct	11	11.0	4.2	<.001	7	17.3	3.1	<.001	4	21.1	−0.4	.10	6	18.9	3.6	<.001	7	20.1	0.2	.81	11	11.4	4.0	<.001
Stomach	12	8.6	0.1	.78	11	14.7	−1.8	<.001	7	14.7	−2.9	<.001	11	11.5	−2.3	.03	9	13.4	−2.2	<.001	12	9.0	0.0	.99
Myeloma	15	7.9	2.6	<.001	9	16.5	2.2	<.001	13	5.1	2.6	<.001	13	8.0	1.5	.24	12	8.4	1.6	<.001	14	8.6	2.6	<.001
Esophagus	13	8.6	−1.8	.006	14	7.3	−4.7	<.001	15	3.6	−1.4	.05	14	7.6	−1.7	.21	17	5.1	−3.8	.003	13	8.6	−1.9	.001
Brain and other nervous system	14	8.5	−0.1	.07	15	4.9	0.4	.11	14	4.4	0.3	.36	15	5.9	1.2	.30	13	6.1	−0.5	.006	15	8.3	0.0	.68
Thyroid	16	7.6	2.6	.008	16	3.8	4.9	<.001	12	6.9	5.9	<.001	18	4.3	3.5	.05	15	5.3	4.6	<.001	16	7.5	2.7	.003
Larynx	18	6.1	−2.0	<.001	13	8.6	−3.3	<.001	16	2.3	−2.9	.002	17	5.3	−1.9	.07	16	5.2	−2.9	<.001	17	6.4	−2.1	<.001
Females																								
Breast	1	126.9	0.3	.08	1	125.3	1.2	<.001	1	93.4	1.9	<.001	1	105.4	3.6	.05	1	95.6	0.4	.06	1	129.1	0.5	.01
Lung and bronchus	2	55.7	−1.1	<.001	2	50.7	−0.7	.006	2	28.9	0.4	.01	2	58.3	−1.7	.02	2	26.1	−0.7	.001	2	56.7	−1.1	<.001
Colon and rectum	3	35.2	−2.8	<.001	3	42.5	−3.1	<.001	3	28.7	−4.6	<.001	3	43.7	−1.0	.02	3	30.6	−2.8	<.001	3	36.5	−2.9	<.001
Corpus and uterus, NOS	4	26.6	1.1	<.001	4	25.3	2.3	<.001	5	18.8	2.3	<.001	4	23.9	1.7	.002	4	22.4	2.9	<.001	4	26.4	1.1	<.001
Thyroid	5	22.4	2.1	<.001	6	13.7	6.4	<.001	4	21.5	3.1	<.001	7	14.8	5.7	<.001	5	20.0	2.7	.02	5	21.6	3.1	<.001
Melanoma of the skin	6	19.4	1.2	.004	21	1.0	0.7	.18	18	1.2	−1.1	.14	15	6.3	1.9	.04	17	4.5	0.6	.36	6	18.3	1.1	.008
Non-Hodgkin lymphoma	7	17.0	−0.6	.005	8	12.4	0.7	.001	6	11.0	0.0	.96	6	14.8	0.3	.63	6	15.8	0.1	.50	7	16.5	−0.5	.03
Ovary	8	12.4	−1.6	<.001	11	9.7	−0.5	.01	7	9.4	−0.4	.12	8	11.6	−0.6	.53	8	10.7	−1.3	<.001	8	12.1	−1.6	<.001
Kidney and renal pelvis	10	11.6	0.4	.12	7	12.8	0.0	.98	14	5.1	−1.3	.30	5	18.9	2.0	.007	7	12.4	2.2	<.001	10	11.4	−0.2	.28
Leukemia	9	11.9	1.6	<.001	12	9.4	2.5	<.001	11	6.7	1.2	.003	10	10.2	1.1	.22	9	9.6	0.4	.07	9	11.5	1.8	.001
Pancreas	11	10.8	1.1	<.001	5	14.4	0.7	<.001	8	9.0	0.9	.005	9	10.3	0.3	.77	11	10.5	0.6	<.001	11	11.2	1.1	<.001
Urinary bladder	12	9.7	−0.7	<.001	14	6.8	−0.3	.26	15	3.9	−0.5	.35	15	6.7	2.3	.02	15	5.3	−1.3	.002	12	9.5	−0.7	<.001
Cervix Uteri	13	7.5	−0.9	<.001	10	9.7	−3.7	.008	12	6.3	−2.9	<.001	11	10.1	−5.3	.22	13	10.0	−3.8	<.001	13	7.4	−1.9	.003
Oral cavity and pharynx	14	6.6	1.0	<.001	15	5.3	−0.8	.002	13	5.2	3.5	.14	17	6.2	0.6	.65	14	4.3	−1.7	.18	14	6.7	0.9	<.001
Brain and other nervous system	15	6.2	−0.6	.07	17	3.7	0.0	.85	17	3.2	2.2	.14	16	3.7	−0.2	.91	16	4.7	−1.1	<.001	15	5.9	−0.5	.11

(continued)

Table 1. (continued)

Sex/cancer site or type†	White‡				Black‡				API‡				AI/AN (CHSDA)‡				Hispanic‡				Non-Hispanic‡			
	Rank	Rate§	AAPC||	P#	Rank	Rate§	AAPC||	P#	Rank	Rate§	AAPC||	P#	Rank	Rate§	AAPC||	P#	Rank	Rate§	AAPC||	P#	Rank	Rate§	AAPC||	P#
Myeloma	16	4.9	2.4	<.001	9	12.3	3.6	<.001	16	3.2	0.7	.24	16	6.3	−1.2	.34	14	5.6	0.4	.11	16	5.6	2.1	<.001
Stomach	17	4.1	0.7	.36	13	8.1	−1.2	<.001	9	8.6	−2.5	<.001	14	6.7	−1.4	.15	12	8.0	−1.6	<.001	17	4.4	−0.9	<.001
Liver and intrahepatic bile duct	18	3.8	4.3	<.001	16	5.1	3.7	<.001	10	7.8	−2.6	.03	12	9.1	3.8	.006	13	7.6	2.2	<.001	18	3.9	3.6	<.001

*Source: National Program of Cancer Registries and Surveillance, Epidemiology, and End Results areas reported by the North American Association of Central Cancer Registries as meeting high-quality incidence data standards for the specified time periods. AAPC = average annual percent change; AI/AN = American Indian/Alaska Native; APC = annual percent change; API = Asian/Pacific Islander; CHSDA = IHS Contract Health Services Delivery Area; IHS = Indian Health Service; NAACCR = North American Association of Central Cancer Registries; NOS = not otherwise specified; NPCR = National Program of Cancer Registries; SEER = Surveillance, Epidemiology, and End Results.

†Cancers are sorted in descending order according to sex-specific rates for all races/ethnicities. More than 15 cancers may appear under males and females to include the top 15 cancers in every race/ethnicity group.

‡White, black, API, and AI/AN (CHSDA 2012 counties) include Hispanic and non-Hispanic; the race and ethnicity categories are not mutually exclusive. AI/AN (CHSDA 2012) statistics exclude data from Kansas.

§Rates are per 100 000 persons and were age-standardized to the 2000 US standard population (19 age groups Census P25–1130).

||AAPC is the average annual percent change and is a weighted average of the annual percent change (APC) over the fixed interval 2009 to 2013 using the underlying joinpoint model for the period of 1999 to 2013. Joinpoint models with up to two joinpoints are based on rates per 100 000 persons that are age-standardized to the 2000 US standard population (19 age groups Census P25–1130). Joinpoint Regression Program, version 4.2.0.2. June 2015, Statistical Research and Applications Branch, National Cancer Institute.

¶For all sites, myelodysplastic syndromes are included for the rate calculations but not for the APC calculations; they are excluded from cancer-specific analysis. Ovary excludes borderline tumors.

#AAPC two-sided P value based on t distribution if AAPC interval within one segment; otherwise, AAPC two-sided P value based on normal distribution.

rates increased in each racial and ethnic group for myeloma and for cancers of the pancreas and thyroid, except in AI/AN, in whom rates remained stable. Rates also increased in each racial and ethnic group for leukemia and liver cancer, except that rates remained unchanged for leukemia in API and AI/AN and for liver cancer in API and Hispanics.

Among women, overall cancer incidence rates from 2009 to 2013 increased in blacks, API, and AI/AN but remained stable in whites and Hispanics. Similarly, rates increased for breast cancer in blacks and API, whereas rates remained stable in whites, AI/AN, and Hispanic women. Rates also increased for thyroid, liver, and uterine cancers in all racial and ethnic groups, except that rates decreased for liver cancer in API women. In contrast, during 2009 to 2013, incidence rates decreased for lung cancer and colorectal cancer in all racial and ethnic groups, except that rates increased for lung cancer in API women. As with men, for most cancer sites, trends in incidence rates for women in each racial and ethnic group were similar in direction to those of all women combined.

Current Cancer Death Rates and Trends by Race, Ethnicity, and Sex

Average annual death rates and trends from 2010 to 2014 are presented by cancer site, sex, race, and ethnicity (Table 2). For all cancer sites combined, similar to incidence rates, death rates (per 100 000) were higher among men than women overall (200.4 vs 141.5) and in all racial and ethnic groups. Black men and black women had the highest cancer death rates of any racial or ethnic group. Among men, lung cancer was the leading cause of cancer death in all racial and ethnic groups, followed by prostate and colorectal in black, white, and Hispanic men, liver and colorectal in API men, and colorectal and prostate in AI/AN men. Among women, lung, breast, and colorectal cancer were the leading causes of cancer death in all racial and ethnic groups except Hispanics, in whom breast replaced lung cancer as the leading cause of cancer death.

From 2010 to 2014, death rates declined overall and for the most common cancers (lung, prostate, colorectal, breast) among men and women of all racial and ethnic groups, except for breast cancer among Hispanic women, lung cancer and colorectal cancer among AI/AN men, and colorectal cancer among API and AI/AN women (Table 2). Death rates for most of the other cancer sites declined or were stable among men and women in each racial and ethnic group; exceptions to these patterns were increases for liver cancer in white, black, and Hispanic men and women and AI/AN men, for pancreatic cancer in white men, and for uterine cancer in white, black, API, and Hispanic women.

Cancer Incidence and Mortality Among Children

In children age 0 to 14 years, average annual age-standardized incidence rates (per 100 000) during 2009 to 2013 ranged from 11.5 in AI/AN to 17.1 in whites (Table 3). Average annual age-standardized death rates (per 100 000) during 2010 to 2014 ranged from 1.8 in API (95% CI = 1.6 to 2.0) and AI/AN (95% CI = 1.4 to 2.3) to 2.2 (95% CI = 2.1 to 2.3) in whites. Incidence rates during 2009 to 2013 increased statistically significantly on average by 0.4% (95% CI = 0.1% to 0.7%) to 1.0% (95% CI = 0.3% to 1.6%) per year in each racial and ethnic group, except in AI/AN, in whom rates remained stable. In contrast, death rates during 2010 to 2014 statistically significantly decreased on average by 1.6% (95% CI = −2.0% to −1.3%) per year in all race/ethnicities

Table 2. US cancer death rates and fixed-interval trends from 2010 to 2014 for the most common cancers by sex, race, and ethnicity*

Sex/cancer site or type†	White‡				Black‡				API‡				AI/AN (CHSDA)‡				Hispanic‡				Non-Hispanic‡			
	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶
All sites																								
Both sexes		166.2	-1.4	<.001		194.1	-2.1	<.001		102.9	-1.3	<.001		152.2	-0.8	.001		116.2	-1.3	<.001		170.3	-1.5	<.001
Males		199.7	-1.7	<.001		247.2	-2.7	<.001		122.7	-1.6	<.001		183.6	-0.7	.03		142.5	-1.6	<.001		205.1	-1.7	<.001
Females		141.8	-1.3	<.001		161.7	-1.6	<.001		88.8	-1.0	<.001		129.1	-1.1	<.001		97.7	-1.0	<.001		145.3	-1.3	<.001
Males																								
Lung and bronchus	1	55.8	-3.4	<.001	1	68.0	-3.4	<.001	1	31.7	-3.1	<.001	1	46.2	-0.9	.06	1	27.3	-3.0	<.001	1	58.3	-3.4	<.001
Prostate	2	18.6	-3.3	<.001	2	41.9	-4.2	<.001	4	8.8	-2.9	<.001	3	19.4	-1.9	.007	2	16.5	-3.0	<.001	2	20.3	-3.4	<.001
Colon and rectum	3	17.2	-2.5	<.001	3	25.3	-2.7	<.001	3	12.4	-2.1	<.001	2	19.5	-0.9	.21	3	15.0	-1.5	<.001	3	17.9	-2.5	<.001
Pancreas	4	12.6	0.4	<.001	4	15.0	-0.4	.01	5	8.2	0.1	.73	5	9.8	-1.6	.33	5	9.5	0.1	.79	4	12.8	0.3	<.001
Liver and intrahepatic bile duct	6	8.5	2.7	<.001	5	13.0	2.6	<.001	2	14.3	-0.9	<.001	4	14.9	2.8	.002	4	13.1	1.6	<.001	6	8.9	2.6	<.001
Leukemia	5	9.5	-0.9	<.001	8	7.5	-1.5	<.001	7	5.0	-0.4	.44	8	5.8	-10.0	.09	8	6.1	-0.7	.02	5	9.3	-1.0	<.001
Urinary bladder	7	8.1	0.1	.19	12	5.4	-0.2	.47	10	2.9	-0.1	.85	12	3.6	#	#	11	3.9	-0.8	.08	7	7.9	0.1	.09
Non-Hodgkin lymphoma	8	7.9	-1.9	<.001	10	5.5	-1.8	<.001	8	4.9	-1.7	<.001	9	5.6	-1.3	.22	7	6.2	-0.8	.007	8	7.7	-2.0	<.001
Esophagus	9	7.6	-0.6	<.001	9	6.3	-4.8	<.001	11	2.9	-0.8	.23	10	5.6	-1.5	.20	10	4.0	-0.9	.04	9	7.6	-1.0	<.001
Kidney and renal pelvis	10	5.8	-0.4	.01	11	5.5	-1.0	.001	12	2.7	0.7	.34	6	8.9	-0.9	.31	9	4.9	-1.1	.005	10	5.7	-0.7	<.001
Brain and other nervous system	11	5.7	0.6	.02	15	3.2	0.0	.99	13	2.4	-0.4	.53	14	3.0	1.4	.31	13	3.4	-0.1	.82	11	5.5	0.6	.01
Stomach	14	3.8	-1.9	.001	6	8.6	-3.2	<.001	6	7.1	-4.1	<.001	7	7.5	-2.7	.06	6	6.9	-2.9	<.001	14	4.1	-2.2	<.001
Myeloma	13	4.0	-0.9	<.001	7	7.5	0.1	.90	14	2.1	-5.0	.11	13	3.3	-2.1	.08	12	3.4	-1.2	.01	13	4.3	-0.9	<.001
Melanoma of the skin	12	4.6	-1.1	.03	22	0.5	-0.8	.39	20	0.4	#	#	17	1.4	#	#	17	1.0	0.2	.75	12	4.3	-1.2	.02
Oral cavity and pharynx	15	3.8	1.4	.06	13	5.0	-3.0	<.001	9	2.9	-1.6	.003	11	3.7	-0.8	.52	14	2.4	-0.9	.02	15	4.0	1.2	.08
Larynx	17	1.8	-2.3	<.001	14	3.4	-3.7	<.001	16	0.7	-1.8	.15	15	1.7	#	#	15	1.6	-2.3	<.001	16	1.9	-2.5	<.001
Females																								
Lung and bronchus	1	37.5	-1.9	<.001	1	34.6	-2.0	<.001	1	18.0	-0.4	.02	1	30.8	-1.4	.003	2	13.4	-1.0	<.001	1	38.3	-1.9	<.001
Breast	2	20.6	-1.6	<.001	2	29.2	-1.5	<.001	2	11.3	-1.0	<.001	2	14.1	-3.7	.002	1	14.4	0.5	.46	2	21.8	-1.6	<.001
Colon and rectum	3	12.1	-1.9	.005	3	16.5	-3.3	<.001	3	8.8	-5.1	.07	3	14.0	-0.4	.62	3	9.2	-2.1	<.001	3	12.7	-2.8	<.001
Pancreas	4	9.4	-0.1	.70	4	12.1	-0.3	.70	4	7.3	0.3	.17	4	8.1	0.1	.90	4	7.7	0.0	.82	4	9.7	-0.1	.51
Ovary	5	7.7	-2.4	<.001	6	6.4	-1.4	<.001	6	4.4	-1.1	.002	6	6.2	-1.9	.09	6	5.4	-1.3	<.001	5	7.5	-2.3	<.001
Leukemia	6	5.3	-1.1	<.001	8	4.6	-1.5	<.001	9	3.0	-3.9	.27	10	3.4	-2.1	.12	9	4.0	-0.4	.08	6	5.1	-1.2	<.001
Non-Hodgkin lymphoma	7	4.8	-2.2	<.001	12	3.4	-0.5	.52	8	3.2	-2.0	<.001	11	3.2	-4.6	<.001	7	4.1	-1.9	<.001	8	4.6	-2.1	<.001
Corpus and uterus, NOS	8	4.2	1.8	<.001	5	8.1	2.8	<.001	10	2.9	1.9	<.001	8	3.8	#	#	10	3.6	1.4	.001	7	4.6	2.3	<.001
Liver and intrahepatic bile duct	10	3.5	2.2	<.001	9	4.5	1.7	<.001	5	6.1	-1.0	.04	5	6.8	0.6	.65	5	5.8	1.3	<.001	10	3.6	2.9	<.001
Brain and other nervous system	9	3.8	-0.1	.57	15	2.1	0.0	.98	11	1.8	1.4	.04	14	2.0	#	#	12	2.4	0.1	.80	9	3.6	0.6	.05
Myeloma	12	2.4	-0.2	.52	7	5.5	2.1	.09	13	1.3	-1.8	.04	13	2.7	-1.6	.36	13	2.3	-1.4	.002	11	2.7	-0.1	.95
Kidney and renal pelvis	11	2.5	-1.2	<.001	14	2.4	-1.5	<.001	14	1.1	-0.6	.39	7	4.2	-0.2	.85	14	2.3	-0.3	.51	12	2.4	-1.4	<.001
Stomach	15	2.0	-2.5	<.001	10	4.1	-3.6	<.001	7	4.3	-3.8	<.001	9	3.8	-3.6	.003	8	4.1	-2.3	<.001	15	2.1	-2.9	<.001
Cervix uteri	14	2.1	-0.4	.05	11	3.8	-2.5	<.001	12	1.7	-3.2	<.001	12	2.8	-2.9	.03	11	2.6	-2.1	<.001	13	2.3	-0.6	.02

(continued)

Table 2. (continued)

Sex/cancer site or type†	White‡				Black‡				API‡				AI/AN (CHSDA)‡				Hispanic‡				Non-Hispanic‡			
	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶	Rank	Rate§	AAPC‖	P¶
Urinary bladder	13	2.2	−0.4	.003	13	2.5	−1.4	<.001	16	0.9	−0.6	.43	17	1.4	#	#	15	1.2	−1.1	.05	14	2.2	−0.4	.002
Melanoma of the skin	16	1.9	−0.4	.02	24	0.4	−1.7	.02	22	0.3	1.2	.49	20	0.5	#	#	21	0.6	−0.5	.49	16	1.8	−0.5	.02
Esophagus	17	1.5	−1.1	<.001	16	1.9	−4.5	<.001	19	0.7	−1.8	.06	16	1.7	#	#	19	0.8	−2.4	<.001	17	1.6	−1.5	<.001
Oral cavity and pharynx	18	1.3	−1.3	<.001	18	1.3	−2.4	<.001	15	1.1	−2.3	.006	18	1.1	#	#	18	0.8	−0.7	.26	18	1.4	−1.4	<.001

Source: National Program of Cancer Registries and Surveillance, Epidemiology, and End Results areas reported by the North American Association of Central Cancer Registries as meeting high-quality incidence data standards for the specified time periods.

*Source: National Center for Health Statistics public-use data file for the total United States, 1975–2014. AAPC = average annual percent change; AI/AN = American Indian/Alaska Native; APC = annual percent change; API = Asian/Pacific Islander; CHSDA = IHS Contract Health Services Delivery Area; IHS = Indian Health Service; NAACCR = North American Association of Central Cancer Registries; NOS = not otherwise specified; NPCR = National Program of Cancer Registries; SEER = Surveillance, Epidemiology, and End Results.

†Cancers are sorted in descending order according to sex-specific rates for all races/ethnicities. More than 15 cancers may appear under males and females to include the top 15 cancers in every race/ethnicity group.

‡White, black, API, and AI/AN (CHSDA 2012 counties) include Hispanic and non-Hispanic; the race and ethnicity categories are not mutually exclusive.

§Rates are per 100 000 persons and are age-standardized to the 2000 US standard population (19 age groups: ages <1 year, 1–4 years, 5–9 years, 80–84 years, 85 years; Census publication p. 25–1130; US Bureau of the Census, Current Population Reports, p. 25–1130. Washington, DC: US Government Printing Office; 2000).

‖AAPC is the average annual percent change and is a weighted average of the annual percent change (APC) over the fixed interval 2010 to 2014 using the underlying joinpoint model for the period of 2000 to 2014. Joinpoint models with up to two joinpoints are based on rates per 100 000 persons that are age-standardized to the 2000 US standard population (19 age groups Census P25–1130). Joinpoint Regression Program, version 4.2.0.2. June 2015, Statistical Research and Applications Branch, National Cancer Institute.

¶AAPC two-sided P value based on t distribution if AAPC interval within one segment; otherwise, AAPC two-sided P value based on normal distribution.

#The statistic could not be calculated. The average annual percent change is based on fewer than 10 cases for at least one year within the time interval.

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combined and by 1.5% (95% CI = −1.9% to −1.2%) to 2.6% (95% CI = −4.5% to −0.7%) per year in each racial and ethnic group; the average annual percent change for AI/AN could not be calculated because of sparse data (Table 3).

Survival Ratios and Trends

Table 4 shows changes in relative survival for all cancer sites combined (case-mix adjusted) and for 20 specific sites based on cases diagnosed in 1975 to 1977 and 2006 to 2012. When comparing cases diagnosed during these two time periods, survival increased statistically significantly in the later-diagnosed group for all but two cancer types, cervix and uterus, with the greatest absolute changes (25% or greater) observed for prostate, kidney, NHL, myeloma, and leukemia and the greatest proportional changes (100% or greater) observed for esophagus, stomach, pancreas, liver, and myeloma. Cancers with the lowest five-year relative survival rates for cases diagnosed in 2006 to 2012 were pancreas (8.5%, 95% CI = 8.0% to 9.0%), liver (18.1%, 95% CI = 17.3% to 18.9%), lung (18.7%, 95% CI = 18.4% to 19.1%), esophagus (20.5%, 95% CI = 19.4% to 21.7%), stomach (31.1%, 95% CI = 30.1% to 32.2%), and brain (35%, 95% CI = 34.0% to 36.0%); those with the highest were prostate (99.3%, 95% CI = 99.1% to 99.5%), thyroid (98.3%, 95% CI = 97.9% to 98.6%), melanoma (93.2%, 95% CI = 92.6% to 93.6%), and female breast (90.8%, 95% CI = 90.5% to 91.1%).

When comparing cases diagnosed in 1975 to 1977 vs 2006 to 2012, survival improved substantially in the later-diagnosed group for both early (localized) and late-stage (regional, distant) diseases for most cancer types, including esophagus, colorectal, female breast, and NHL (Supplementary Table 3, available online). Between 1975 to 1977 and 2006 to 2012, cancer types and stages that demonstrated a large absolute gain (20% or greater) in survival included NHL for distant stage, esophagus for localized and regional stages, oral cavity for regional and distant stages, pancreas and liver cancers for local stage, and female breast and colorectal for regional stage. Although improvements in survival for distant-stage disease over the past 30 years generally appeared to be small in absolute terms (<10% absolute gain), they were large in proportionate terms, with survival rates doubling for several cancers (Supplementary Table 3, available online). Between 1975 to 1977 and 2006 to 2012, for example, five-year relative survival for distant-stage disease increased from 5.5% (95% CI = 4.9% to 6.2%) to 13.7% (95% CI = 13.0% to 14.4%) for colorectal cancer and from 18.7% (95% CI = 16.9% to 20.6%) to 33.6% (95% CI = 32.2% to 35.0%) for female breast cancer. However, survival for many distant-stage cancers remained unchanged, for example, liver cancer (1.1%, 95% CI = 0.3% to 2.9%, in 1975–1977 and 2.3%, 95% CI = 1.6% to 3.2%, in 2006–2012).

Figure 4 depicts changes in survival ratios between 1975 to 1977 and 2006 to 2012 by race for all cancer sites combined and for the 20 most common cancers. Survival improved substantially over this time period for both whites and blacks overall (all sites) and for almost all cancer types; however, survival decreased for uterine cancer in whites and cervix and ovary in blacks. The largest absolute increases were observed for prostate cancer (36.7% in blacks and 31.1% in whites), leukemia (29.0% in whites and 24.1% in blacks), NHL (26.8% in whites and 16.5% in blacks), kidney (26.6% in blacks and 24.7% in whites), and myeloma (25.7% in whites and 22.5% in blacks) (Supplementary Table 4, available online). For lung and pancreas cancers, improvements were very limited in both whites

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Table 3. Delay-adjusted childhood cancer incidence rates for areas with high-quality data* and US childhood cancer death rates by sex, race, and ethnicity, and their fixed-interval trends

	Children (age 0–14 years)					
	Incidence (2009–2013)			Mortality (2010–2014)		
Race/ethnicity†	Rate‡	AAPC§	P‖	Rate‡	AAPC§	P‖
All races/ethnicities	16.5	0.8	<.001	2.1	−1.6	<.001
White	17.1	0.7	<.001	2.2	−1.5	<.001
Black	12.9	1.5	<.001	2.0	−1.6	<.001
API	13.6	1.0	.01	1.8	−2.6	.01
AI/AN (CHSDA)¶	11.5	−0.7	.33	1.8	#	#
Hispanic	16.1	0.4	.03	2.1	−2.0	<.001
Non-Hispanic	16.6	1.0	<.001	2.1	−1.6	<.001

*Source: National Program of Cancer Registries and Surveillance, Epidemiology, and End Results areas reported by the North American Association of Central Cancer Registries as meeting high-quality incidence data standards for the specified time periods. AAPC = average annual percent change; AI/AN = American Indian/Alaska Native; APC = annual percent change; API = Asian/Pacific Islander; CHSDA = IHS Contract Health Services Delivery Area; IHS = Indian Health Service; NAACCR = North American Association of Central Cancer Registries; NOS = not otherwise specified; NPCR = National Program of Cancer Registries; SEER = Surveillance, Epidemiology, and End Results.
†White, black, API, and AI/AN (CHSDA 2012 counties) include Hispanic and non-Hispanic; the race and ethnicity categories are not mutually exclusive.
‡Rates are per 100 000 persons and were age-standardized to the 2000 US standard population (19 age groups Census P25–1130).
§AAPC is the average annual percent change and is a weighted average of the annual percent change (APC) over the fixed interval (2009–2013 for incidence; 2010–2014 for mortality) using the underlying joinpoint model for the period of 1999-2013 for incidence and the period of 2000-2014 for mortality. Joinpoint models with up to two joinpoints were based on rates per 100 000 persons that were age-standardized to the 2000 US standard population (19 age groups Census P25–1130). Joinpoint Regression Program, version 4.2.0.2. June 2015, Statistical Research and Applications Branch, National Cancer Institute. Registries included in the incidence rates (2009–2013) and joinpoint models (1999–2013) for all races/ethnicities, white, black, AI/AN, API, Hispanic, and non-Hispanic (41 states): Alabama, Alaska, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, Texas, Utah, Vermont, Washington, West Virginia, Wisconsin, Wyoming.
‖AAPC two-sided P value based on t distribution if AAPC interval within one segment; otherwise, AAPC two-sided P value based on normal distribution.
¶For incidence, AI/AN (CHSDA 2012) statistics exclude data from Kansas.
#The statistic could not be calculated. The average annual percent change is based on fewer than 10 cases for at least one year within the time interval.

Table 4. Changes in 5-year relative survival (%) for the most common cancers, all stages, all ages, SEER 9*, 1975–2012

	5-y relative survival (95% CI)		Change over time (95% CI)	
Cancer site	1975–1977	2006–2012	Absolute, %	Proportional, %
All sites (case-mix adjusted)	50.3 (50.1 to 50.6)	66.4 (66.2 to 66.5)	16.0 (15.7 to 16.3)	31.9 (31.1 to 32.6)
Lung and bronchus	12.2 (11.8 to 12.6)	18.7 (18.4 to 19.1)	6.5 (6.0 to 7.1)	53.6 (47.5 to 59.7)
Colon and rectum	49.8 (49.1 to 50.6)	66.2 (65.7 to 66.7)	16.4 (15.5 to 17.3)	32.9 (30.7 to 35.1)
Breast (female)	74.8 (74.2 to 75.5)	90.8 (90.5 to 91.1)	16.0 (15.3 to 16.7)	21.4 (20.3 to 22.5)
Prostate	67.8 (66.7 to 68.9)	99.3 (99.1 to 99.5)	31.5 (30.4 to 32.6)	46.5 (44.2 to 48.9)
Oral cavity and pharynx	52.5 (51.1 to 54.0)	67.0 (66.1 to 67.9)	14.4 (12.7 to 16.1)	27.4 (23.5 to 31.4)
Esophagus	5.0 (4.0 to 6.2)	20.5 (19.4 to 21.7)	15.5 (13.9 to 17.1)	308.1 (217.6 to 398.6)
Stomach	15.2 (14.1 to 16.3)	31.1 (30.1 to 32.2)	15.9 (14.4 to 17.4)	104.7 (88.2 to 121.1)
Pancreas	2.5 (2.0 to 3.0)	8.5 (8.0 to 9.0)	6.0 (5.3 to 6.7)	244.7 (175.9 to 313.5)
Liver and intrahepatic bile duct	3.4 (2.4 to 4.7)	18.1 (17.3 to 18.9)	14.6 (13.3 to 16.0)	427.6 (251.4 to 603.9)
Urinary bladder	72.3 (70.9 to 73.6)	78.5 (77.7 to 79.2)	6.2 (4.6 to 7.7)	8.5 (6.3 to 10.8)
Kidney and renal pelvis	50.1 (48.1 to 52.0)	74.7 (73.9 to 75.4)	24.6 (22.6 to 26.7)	49.2 (43.3 to 55.1)
Melanoma of the skin	81.9 (80.4 to 83.3)	93.2 (92.6 to 93.6)	11.3 (9.8 to 12.8)	13.8 (11.7 to 15.8)
Cervix uteri	69.1 (67.4 to 70.7)	68.8 (67.4 to 70.2)	−0.3 (−2.4 to 1.8)	−0.4 (−3.5 to 2.7)
Corpus and uterus, NOS	86.9 (86.0 to 87.7)	83.4 (82.7 to 84.0)	−3.5 (−4.6 to −2.4)	−4.0 (−5.3 to −2.8)
Ovary	36.0 (34.5 to 37.6)	46.4 (45.3 to 47.6)	10.4 (8.5 to 12.3)	28.9 (22.5 to 35.3)
Non-Hodgkin lymphoma	46.5 (45.0 to 48.0)	72.6 (71.9 to 73.2)	26.1 (24.4 to 27.7)	56.1 (50.8 to 61.3)
Myeloma	24.6 (22.6 to 26.6)	50.2 (48.9 to 51.6)	25.7 (23.3 to 28.1)	104.5 (87.0 to 122.0)
Leukemia	34.2 (32.8 to 35.5)	62.7 (61.8 to 63.5)	28.5 (26.9 to 30.1)	83.6 (75.9 to 91.2)
Brain and other nervous system	22.4 (21.0 to 23.9)	35.0 (34.0 to 36.0)	12.5 (10.8 to 14.3)	55.9 (44.6 to 67.1)
Thyroid	92.1 (90.7 to 93.3)	98.3 (97.9 to 98.6)	6.1 (4.8 to 7.4)	6.6 (5.1 to 8.2)

*The Surveillance, Epidemiology, and End Results 9 registries are Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, and Utah. CI = confidence interval; NOS = not otherwise specified; SEER = Surveillance, Epidemiology, and End Results.
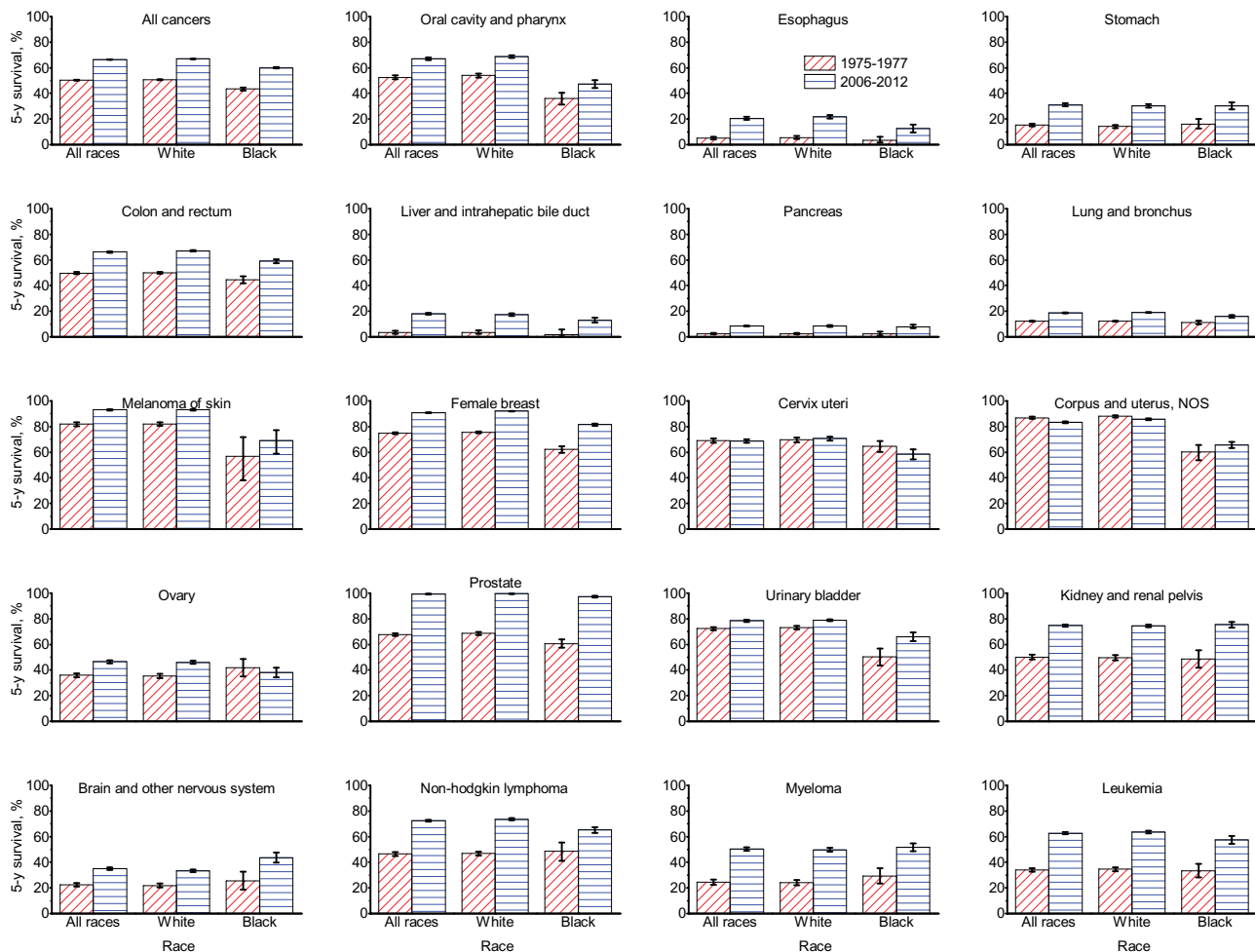
Figure 4. Changes in five-year relative survival by cancer site and race, all ages, SEER 9*, 1975–2012. **Error bars** represent 95% confidence intervals. *The SEER 9 registries are Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, and Utah. NOS = not otherwise specified; SEER = Surveillance, Epidemiology, and End Results.

and blacks. For all sites combined and for most individual cancer types, statistically significant racial disparities (black vs white) in survival rates in 1975 to 1977 persisted in 2006 to 2012. The magnitude of the disparity between the two time periods remained similar for most cancer types, but it widened for cancers of the esophagus, lung and bronchus, ovary, cervix uteri, and NHL, while it narrowed for cancers of the urinary bladder, prostate, and corpus and uterus ($P < .05$ for all) (Supplementary Tables 4 and 5, available online).

Table 5 shows five-year cause-specific survival and adjusted relative risk of cancer death by race/ethnicity in persons diagnosed in 2006 to 2012 for all cancer sites combined and for the 20 most common cancers. The five-year survival for all sites combined was highest for Hispanics (68.2%, 95% CI = 67.9% to 68.4%) and NHW (68.0%, 95% CI = 67.9% to 68.1%), followed by NHAPI (66.7%, 95% CI = 66.4% to 67.0%), NHB (62.8%, 95% CI = 62.6% to 63.0%), and NHAI/AN (60.5%, 95% CI = 59.5% to 61.5%). The adjusted relative risk of death after a diagnosis of cancer (HR) was statistically significantly higher in NHB than NHW for all cancers combined (HR = 1.33, 95% CI = 1.32 to 1.34) and for most cancer sites, with the excess risk most notable for female breast, oral cavity, and uterine cancers and non-Hodgkin lymphoma. Compared with NHW, Hispanics had statistically significantly higher risk of death for 10 of the 20 cancers, most

notably for leukemia, but they have lower risk of death after diagnosis for lung and cervical cancers. Although NHAPI had higher adjusted risk of death than whites for all cancers combined, they had lower risk for 12 of the 20 cancers. However, NHAPI had higher risk of death for oral cavity cancer and for melanoma, NHL, and leukemia. NHAI/AN had a higher risk of death than NHW for all cancers combined (HR = 1.51, 95% CI = 1.46 to 1.56) and for 11 of the 20 cancers, most notably for leukemia and thyroid cancer.

Survival for patients diagnosed with the four most common cancers during 2006 to 2012 varied widely by state in both whites and blacks (Table 6). For example, female breast cancer survival in whites ranged from less than 88.0% in West Virginia and Wyoming to more than 92.0% in Colorado, North Dakota, New Hampshire, and Washington-Seattle; in blacks, it ranged from less than 76.0% in Arizona, Mississippi, and New Mexico to more than 87.0% in New Hampshire and Utah. For colorectal cancer, survival in whites ranged from less than 62.0% in Arizona, Michigan-Detroit, New Mexico, and Wyoming to more than 66.0% in Alaska, Connecticut, Hawaii, New Hampshire, and North Dakota; in blacks, it ranged from 50.1% in Iowa to more than 62.0% in Connecticut and Rhode Island. In general, survival for the four most common cancers tended to be lowest in select Southern and Midwestern states and highest in

Table 5. Five-year cause-specific survival (%) and adjusted relative risk of cancer death by race/ethnicity, SEER 18*, 2006–2012

Cancer site	5-year cause-specific survival (95% CI)					Adjusted relative risk† (95% CI)				
	NHW	NHB	Hispanics	NHAPI	NHAI/AN	NHW	NHB	Hispanics	NHAPI	NHAI/AN
All sites	68.0 (67.9 to 68.1)	62.8 (62.6 to 63.0)	68.2 (67.9 to 68.4)	66.7 (66.4 to 67.0)	60.5 (59.5 to 61.5)	1.00	1.33 (1.32 to 1.34)	1.16 (1.16 to 1.17)	1.10 (1.09 to 1.11)	1.51 (1.46 to 1.56)
Lung and bronchus	20.4 (20.2 to 20.6)	17.2 (16.6 to 17.7)	19.2 (18.4 to 20.0)	22.2 (21.4 to 23.0)	15.9 (13.6 to 18.5)	1.00	1.04 (1.03 to 1.06)	0.95 (0.93 to 0.97)	0.75 (0.73 to 0.76)	1.11 (1.04 to 1.18)
Colon and rectum	65.9 (65.6 to 66.2)	59.9 (59.2 to 60.7)	66.0 (65.2 to 66.7)	69.1 (68.3 to 69.9)	60.0 (56.8 to 63.0)	1.00	1.22 (1.19 to 1.25)	1.02 (1.00 to 1.05)	0.89 (0.86 to 0.92)	1.28 (1.17 to 1.40)
Breast (female)	89.2 (89.0 to 89.3)	80.3 (79.8 to 80.8)	87.8 (87.4 to 88.3)	91.6 (91.2 to 92.0)	85.8 (83.6 to 87.7)	1.00	1.71 (1.66 to 1.76)	1.14 (1.10 to 1.18)	0.84 (0.80 to 0.88)	1.28 (1.11 to 1.47)
Prostate	94.4 (94.3 to 94.5)	93.0 (92.7 to 93.3)	93.3 (93.0 to 93.6)	94.5 (94.0 to 94.9)	89.6 (87.4 to 91.4)	1.00	1.36 (1.31 to 1.42)	1.02 (0.97 to 1.07)	0.72 (0.67 to 0.78)	1.31 (1.08 to 1.58)
Oral cavity and pharynx	69.7 (69.2 to 70.2)	51.1 (49.5 to 52.7)	64.8 (63.1 to 66.5)	69.3 (67.5 to 71.0)	63.4 (57.0 to 69.0)	1.00	1.81 (1.68 to 1.95)	1.25 (1.14 to 1.37)	1.14 (1.02 to 1.27)	1.41 (1.02 to 1.90)
Esophagus	21.8 (21.1 to 22.6)	14.8 (13.0 to 16.7)	19.7 (17.3 to 22.3)	20.0 (16.8 to 23.3)	20.6 (13.3 to 29.1)	1.00	1.34 (1.27 to 1.41)	1.10 (1.03 to 1.17)	0.93 (0.86 to 1.01)	1.20 (0.96 to 1.48)
Stomach	30.8 (30.0 to 31.6)	32.3 (30.7 to 33.8)	30.8 (29.4 to 32.1)	40.3 (38.7 to 41.8)	22.7 (16.9 to 29.1)	1.00	1.04 (1.00 to 1.09)	1.01 (0.97 to 1.05)	0.81 (0.77 to 0.84)	1.35 (1.17 to 1.54)
Pancreas	7.9 (7.6 to 8.2)	8.4 (7.6 to 9.2)	9.2 (8.2 to 10.2)	9.7 (8.6 to 10.9)	8.2 (5.2 to 11.9)	1.00	1.13 (1.10 to 1.16)	1.04 (1.01 to 1.07)	0.93 (0.90 to 0.96)	1.15 (1.02 to 1.29)
Liver and intrahepatic bile duct	20.1 (19.4 to 20.8)	16.3 (15.0 to 17.7)	20.7 (19.6 to 21.9)	27.2 (25.9 to 28.5)	17.5 (13.4 to 22.2)	1.00	1.17 (1.13 to 1.21)	1.02 (0.99 to 1.05)	0.81 (0.78 to 0.84)	1.06 (0.95 to 1.18)
Kidney and renal pelvis	74.9 (74.5 to 75.4)	77.1 (76.1 to 78.2)	76.6 (75.6 to 77.5)	73.6 (71.9 to 75.2)	72.1 (68.0 to 75.7)	1.00	1.24 (1.17 to 1.30)	1.02 (0.97 to 1.07)	0.91 (0.84 to 0.97)	1.06 (0.90 to 1.23)
Urinary bladder	79.0 (78.7 to 79.3)	67.0 (65.4 to 68.6)	77.3 (76.0 to 78.6)	78.9 (77.2 to 80.4)	68.1 (60.7 to 74.4)	1.00	1.42 (1.34 to 1.50)	1.03 (0.97 to 1.10)	0.85 (0.78 to 0.92)	1.24 (0.97 to 1.55)
Melanoma of the skin	89.6 (89.4 to 89.9)	67.1 (61.9 to 71.8)	84.6 (83.0 to 86.0)	75.1 (70.6 to 79.1)	84.8 (78.1 to 89.7)	1.00	1.28 (1.07 to 1.52)	1.21 (1.09 to 1.34)	1.35 (1.12 to 1.61)	1.28 (0.85 to 1.84)
Ovary	45.4 (44.7 to 46.2)	37.9 (35.7 to 40.1)	53.4 (51.5 to 55.2)	57.6 (55.3 to 59.9)	44.9 (36.7 to 52.8)	1.00	1.41 (1.34 to 1.49)	1.11 (1.05 to 1.17)	0.99 (0.92 to 1.06)	1.06 (0.87 to 1.28)
Corpus and uterus NOS	83.7 (83.4 to 84.1)	64.3 (63.0 to 65.7)	81.6 (80.6 to 82.6)	83.8 (82.7 to 84.9)	82.6 (78.0 to 86.3)	1.00	1.78 (1.69 to 1.87)	1.16 (1.09 to 1.23)	1.05 (0.97 to 1.13)	1.42 (1.11 to 1.79)
Cervix uteri	70.0 (69.0 to 70.9)	60.1 (58.0 to 62.0)	74.6 (73.1 to 76.0)	72.0 (69.6 to 74.2)	64.7 (55.9 to 72.2)	1.00	1.29 (1.20 to 1.38)	0.87 (0.81 to 0.93)	0.82 (0.74 to 0.90)	1.36 (1.03 to 1.77)
Myeloma	52.3 (51.4 to 53.3)	55.8 (54.1 to 57.5)	52.8 (50.5 to 55.0)	53.9 (50.7 to 57.0)	56.8 (45.0 to 67.1)	1.00	1.03 (0.98 to 1.08)	1.15 (1.08 to 1.22)	0.98 (0.90 to 1.06)	0.88 (0.65 to 1.16)
Non-Hodgkin lymphoma	72.6 (72.2 to 73.0)	66.7 (65.4 to 67.8)	70.4 (69.5 to 71.4)	69.9 (68.6 to 71.2)	72.3 (67.5 to 76.6)	1.00	1.74 (1.66 to 1.82)	1.42 (1.36 to 1.47)	1.27 (1.21 to 1.34)	1.25 (1.04 to 1.50)
Leukemia	63.3 (62.8 to 63.8)	59.2 (57.6 to 60.8)	63.5 (62.3 to 64.7)	55.4 (53.5 to 57.3)	62.6 (56.6 to 68.0)	1.00	1.38 (1.31 to 1.45)	1.63 (1.56 to 1.70)	1.67 (1.58 to 1.76)	1.52 (1.26 to 1.82)
Brain and other nervous system	32.2 (31.5 to 32.8)	42.4 (40.1 to 44.6)	46.9 (45.2 to 48.5)	42.3 (39.6 to 45.0)	42.1 (33.8 to 50.1)	1.00	1.00 (0.94 to 1.06)	0.97 (0.93 to 1.02)	0.80 (0.75 to 0.86)	0.94 (0.76 to 1.15)
Thyroid	97.3 (97.1 to 97.4)	96.3 (95.6 to 96.9)	97.4 (97.0 to 97.7)	96.6 (96.0 to 97.0)	96.1 (93.2 to 97.8)	1.00	1.33 (1.12 to 1.58)	0.89 (0.77 to 1.02)	0.86 (0.74 to 0.99)	1.86 (0.99 to 3.13)

*The Surveillance, Epidemiology, and End Results 18 registries are Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, Utah, Los Angeles, San Jose-Monterey, Rural Georgia, the Alaska Native Tumor Registry, the Greater California, Kentucky, Louisiana, New Jersey, and Greater Georgia. CI = confidence interval; NHAI/AN = Non-Hispanic American Indian/Alaska Native; NHAPI = Non-Hispanic Asian/Pacific Islander; NHB = Non-Hispanic Black; NHW = Non-Hispanic White; NOS = not otherwise specified; SEER = Surveillance, Epidemiology, and End Results.

†Adjusting for sex, age, and summary stage, except for all sites and leukemia.

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Table 6. Five-year relative survival (%) for common cancers by race for select states, all ages, 2006–2012*

| | 5-y relative survival (95% CI) | | | | | | | | | | | |
| | Colorectal cancer | | | Lung cancer | | | Female breast cancer | | | Prostate cancer | | |
State/Area	All races	White	Black	All races	White	Black	All races	White	Black	All races	White	Black
NAACCR US combined†	63.8 (63.6 to 63.9)	64.3 (64.1 to 64.5)	57.6 (57.1 to 58.1)	19.1 (18.9 to 19.2)	19.3 (19.1 to 19.4)	16.1 (15.8 to 16.4)	88.8 (88.7 to 88.9)	89.9 (89.8 to 90.0)	79.4 (79.0 to 79.8)	97.9 (97.7 to 98.0)	98.0 (97.9 to 98.1)	95.2 (94.9 to 95.5)
Alabama	62.8 (61.6 to 63.9)	64.4 (63.1 to 65.7)	56.9 (54.6 to 59.1)	15.9 (15.2 to 16.5)	16.4 (15.7 to 17.1)	13.1 (11.7 to 14.5)	86.8 (85.9 to 87.6)	89.2 (88.2 to 90.1)	78.6 (76.8 to 80.4)	96.8 (95.9 to 97.5)	96.9 (95.8 to 97.7)	94.4 (92.8 to 95.7)
Alaska	64.8 (61.4 to 68.0)	67.4 (63.4 to 71.1)	‡	17.9 (15.8 to 20.2)	19.4 (16.8 to 22.0)	8.4 (1.8 to 21.7)	87.5 (85.2 to 89.4)	88.9 (86.3 to 91.0)	76.4 (52.6 to 89.4)	96.1 (94.0 to 97.4)	96.4 (94.1 to 97.8)	94.1 (77.8 to 98.5)
Arizona	61.2 (60.0 to 62.3)	60.9 (59.7 to 62.1)	57.4 (50.4 to 63.7)	18.7 (18.0 to 19.4)	18.4 (17.7 to 19.1)	18.4 (14.1 to 23.1)	88.2 (87.5 to 88.9)	88.5 (87.7 to 89.2)	74.9 (69.6 to 79.5)	96.0 (95.2 to 96.6)	95.4 (94.6 to 96.1)	91.3 (87.5 to 94.0)
California	65.0 (64.5 to 65.4)	65.0 (64.5 to 65.5)	57.9 (56.2 to 59.5)	18.5 (18.2 to 18.8)	18.4 (18.0 to 18.7)	14.7 (13.7 to 15.8)	89.6 (89.3 to 89.9)	90.1 (89.8 to 90.4)	79.9 (78.7 to 81.2)	97.1 (96.8 to 97.4)	97.0 (96.6 to 97.3)	95.3 (94.3 to 96.2)
Colorado	65.0 (63.7 to 66.4)	64.9 (63.5 to 66.3)	60.6 (53.7 to 66.8)	20.7 (19.7 to 21.6)	20.5 (19.6 to 21.5)	16.9 (12.6 to 21.8)	92.0 (91.3 to 92.7)	92.0 (91.3 to 92.7)	83.8 (78.6 to 87.8)	99.1 (98.6 to 99.5)	98.2 (97.6 to 98.6)	94.0 (89.6 to 96.6)
Connecticut	66.4 (65.0 to 67.7)	66.1 (64.6 to 67.5)	66.3 (61.7 to 70.6)	22.4 (21.6 to 23.3)	22.5 (21.6 to 23.4)	19.7 (16.5 to 23.0)	90.4 (89.6 to 91.2)	91.1 (90.2 to 91.9)	79.8 (76.0 to 83.0)	97.3 (96.5 to 97.8)	97.3 (96.4 to 97.9)	94.1 (91.0 to 96.1)
Georgia	63.5 (62.6 to 64.4)	65.6 (64.5 to 66.6)	58.2 (56.5 to 59.8)	17.7 (17.2 to 18.2)	18.3 (17.7 to 18.9)	15.4 (14.3 to 16.5)	86.8 (86.2 to 87.3)	89.1 (88.4 to 89.8)	80.3 (79.1 to 81.4)	98.5 (97.9 to 98.9)	99.2 (98.6 to 99.6)	96.7 (95.7 to 97.5)
Hawaii	65.5 (63.5 to 67.5)	70.1 (66.3 to 73.6)	‡	17.4 (15.9 to 18.8)	18.7 (16.0 to 21.5)	10.1 (2.8 to 22.8)	90.6 (89.3 to 91.7)	91.8 (89.0 to 93.9)	81.2 (60.6 to 91.7)	94.0 (92.3 to 95.3)	94.4 (91.3 to 96.4)	‡
Idaho	64.7 (62.3 to 67.0)	64.2 (61.8 to 66.5)	‡	17.5 (16.1 to 19.0)	17.5 (16.1 to 19.0)	‡	89.9 (88.4 to 91.3)	90.1 (88.6 to 91.4)	‡	97.7 (96.1 to 98.6)	97.2 (95.6 to 98.2)	‡
Illinois	64.8 (64.1 to 65.5)	65.6 (64.8 to 66.4)	57.3 (55.5 to 59.1)	20.3 (19.8 to 20.7)	20.3 (19.8 to 20.8)	18.2 (17.1 to 19.4)	88.4 (87.9 to 88.9)	89.4 (88.9 to 89.9)	80.5 (79.0 to 81.8)	98.5 (98.0 to 98.9)	98.7 (98.2 to 99.1)	94.7 (93.4 to 95.8)
Iowa	64.1 (62.7 to 65.5)	64.1 (62.7 to 65.5)	50.1 (38.3 to 60.8)	16.7 (15.9 to 17.5)	16.7 (15.8 to 17.5)	14.5 (9.1 to 20.9)	89.8 (88.8 to 90.7)	89.9 (88.9 to 90.8)	80.6 (71.0 to 87.3)	96.7 (95.6 to 97.5)	96.2 (95.1 to 97.0)	97.2 (87.7 to 99.4)
Kentucky	63.0 (61.8 to 64.2)	63.3 (62.0 to 64.5)	57.8 (53.3 to 62.1)	16.4 (15.9 to 17.0)	16.5 (15.9 to 17.1)	15.7 (13.3 to 18.2)	87.7 (86.9 to 88.5)	88.4 (87.5 to 89.2)	77.8 (73.9 to 81.2)	97.7 (97.0 to 98.3)	97.8 (97.1 to 98.3)	94.8 (91.7 to 96.8)
Louisiana	63.5 (62.3 to 64.7)	65.7 (64.2 to 67.1)	58.6 (56.5 to 60.7)	15.4 (14.7 to 16.1)	16.2 (15.4 to 17.0)	13.3 (12.1 to 14.6)	85.9 (85.0 to 86.8)	89.2 (88.1 to 90.1)	78.2 (76.4 to 79.9)	98.9 (98.1 to 99.4)	99.8 (98.5 to 100.0)	95.9 (94.3 to 97.1)
Maine	64.5 (62.3 to 66.6)	64.1 (61.9 to 66.2)	‡	18.9 (17.7 to 20.2)	18.9 (17.7 to 20.1)	‡	91.6 (90.2 to 92.8)	91.6 (90.2 to 92.8)	‡	98.7 (96.6 to 99.5)	98.3 (96.4 to 99.2)	97.6 (78.9 to 99.7)
Michigan-Detroit	60.4 (59.1 to 61.7)	61.6 (60.1 to 63.2)	55.6 (53.0 to 58.0)	19.3 (18.5 to 20.0)	19.9 (19.0 to 20.8)	16.8 (15.3 to 18.3)	86.7 (85.8 to 87.5)	88.8 (87.8 to 89.7)	78.9 (76.9 to 80.8)	98.4 (97.4 to 99.0)	98.4 (97.2 to 99.1)	96.2 (94.4 to 97.5)
Mississippi	61.3 (59.8 to 62.7)	63.9 (62.0 to 65.7)	56.4 (53.9 to 58.8)	16.7 (15.9 to 17.5)	17.9 (17.0 to 18.9)	12.9 (11.5 to 14.3)	84.6 (83.4 to 85.7)	89.1 (87.7 to 90.3)	75.4 (73.2 to 77.4)	97.9 (96.8 to 98.7)	100.0 (99.2 to 100.0)	93.9 (92.0 to 95.4)
Montana	64.0 (61.3 to 66.6)	65.0 (62.3 to 67.7)	‡	18.4 (16.9 to 20.1)	18.8 (17.2 to 20.5)	‡	90.2 (88.4 to 91.7)	90.6 (88.8 to 92.1)	‡	95.2 (93.2 to 96.6)	95.5 (93.5 to 96.9)	‡
Nebraska	65.1 (63.2 to 67.0)	65.0 (63.0 to 66.9)	58.5 (49.0 to 66.9)	18.1 (17.0 to 19.3)	18.1 (16.9 to 19.3)	16.9 (11.5 to 23.2)	89.6 (88.2 to 90.7)	90.0 (88.6 to 91.2)	79.5 (69.9 to 86.3)	97.1 (95.6 to 98.1)	96.9 (95.4 to 98.0)	95.1 (83.8 to 98.6)
New Hampshire	67.8 (65.4 to 70.0)	67.7 (65.3 to 69.9)	‡	22.2 (20.9 to 23.7)	22.3 (20.9 to 23.7)	‡	93.1 (91.7 to 94.2)	93.2 (91.9 to 94.3)	88.0 (59.5 to 96.9)	99.0 (96.8 to 99.7)	99.2 (96.6 to 99.8)	‡

(continued)

Table 6. (continued)

	5-y relative survival (95% CI)											
	Colorectal cancer			Lung cancer			Female breast cancer			Prostate cancer		
State/Area	All races	White	Black	All races	White	Black	All races	White	Black	All races	White	Black
New Jersey	61.3 (60.4 to 62.2)	62.3 (61.3 to 63.2)	52.4 (49.9 to 54.9)	21.4 (20.8 to 21.9)	22.1 (21.5 to 22.7)	14.8 (13.3 to 16.3)	88.4 (87.8 to 88.9)	89.9 (89.3 to 90.4)	76.7 (74.8 to 78.4)	98.7 (98.1 to 99.1)	99.3 (98.8 to 99.6)	95.1 (93.6 to 96.3)
New Mexico	61.5 (59.5 to 63.4)	61.4 (59.4 to 63.5)	47.2 (31.3 to 61.5)	15.9 (14.6 to 17.2)	15.7 (14.4 to 17.1)	14.1 (6.1 to 25.4)	88.0 (86.7 to 89.2)	88.3 (87.0 to 89.6)	72.3 (56.0 to 83.5)	96.2 (94.8 to 97.2)	96.5 (95.1 to 97.5)	83.4 (69.0 to 91.5)
New York	63.5 (62.9 to 64.1)	63.5 (62.9 to 64.2)	58.8 (57.4 to 60.2)	22.9 (22.5 to 23.3)	22.9 (22.5 to 23.3)	18.9 (17.9 to 20.0)	89.3 (88.9 to 89.6)	90.4 (90.0 to 90.8)	80.6 (79.6 to 81.6)	97.5 (97.1 to 97.8)	98.0 (97.7 to 98.2)	94.3 (93.5 to 95.0)
North Carolina	64.6 (63.8 to 65.5)	65.7 (64.7 to 66.7)	60.3 (58.4 to 62.2)	19.0 (18.5 to 19.5)	19.4 (18.9 to 20.0)	16.8 (15.6 to 18.0)	88.9 (88.4 to 89.5)	90.9 (90.2 to 91.4)	81.1 (79.8 to 82.4)	98.4 (97.8 to 98.8)	99.2 (98.7 to 99.5)	95.8 (94.5 to 96.7)
North Dakota	67.9 (64.8 to 70.8)	68.2 (65.0 to 71.2)	‡	19.6 (17.5 to 21.8)	19.7 (17.6 to 22.0)	‡	92.3 (90.1 to 94.0)	92.4 (90.1 to 94.2)	‡	98.4 (96.5 to 99.3)	98.6 (96.6 to 99.4)	‡
Pennsylvania	63.6 (62.9 to 64.3)	63.9 (63.1 to 64.6)	56.7 (54.4 to 59.0)	19.6 (19.1 to 20.0)	19.5 (19.1 to 20.0)	17.5 (16.2 to 18.9)	88.6 (88.2 to 89.1)	89.5 (89.0 to 90.0)	78.6 (76.8 to 80.3)	99.0 (98.6 to 99.3)	98.7 (98.3 to 99.0)	94.8 (93.2 to 96.0)
Rhode Island	63.9 (61.3 to 66.4)	63.9 (61.2 to 66.4)	63.7 (50.6 to 74.2)	22.0 (20.5 to 23.6)	21.9 (20.4 to 23.5)	22.2 (14.6 to 30.9)	91.0 (89.4 to 92.3)	91.4 (89.8 to 92.8)	80.7 (70.3 to 87.8)	98.1 (96.7 to 98.9)	97.6 (96.0 to 98.5)	96.5 (88.4 to 99.0)
South Carolina	61.8 (60.5 to 63.0)	63.2 (61.7 to 64.6)	56.9 (54.5 to 59.2)	17.7 (17.0 to 18.4)	18.1 (17.4 to 18.9)	15.6 (14.2 to 17.2)	86.9 (86.1 to 87.7)	88.9 (87.9 to 89.8)	80.7 (79.0 to 82.3)	97.9 (97.1 to 98.5)	98.5 (97.6 to 99.1)	95.6 (94.1 to 96.7)
Texas	63.1 (62.5 to 63.7)	63.8 (63.2 to 64.4)	56.0 (54.3 to 57.5)	18.2 (17.8 to 18.6)	18.3 (17.9 to 18.7)	15.4 (14.4 to 16.4)	87.9 (87.5 to 88.3)	89.1 (88.7 to 89.5)	77.6 (76.3 to 78.8)	96.8 (96.4 to 97.2)	96.8 (96.4 to 97.2)	94.0 (92.8 to 94.9)
Utah	65.5 (63.5 to 67.5)	65.9 (63.8 to 68.0)	58.5 (37.3 to 74.7)	17.9 (16.2 to 19.7)	18.2 (16.4 to 20.0)	‡	89.6 (88.3 to 90.8)	89.7 (88.4 to 90.9)	89.6 (63.2 to 97.4)	98.0 (97.0 to 98.7)	98.1 (97.1 to 98.7)	97.5 (85.3 to 99.6)
Washington-Seattle	65.8 (64.5 to 67.1)	65.7 (64.2 to 67.1)	61.4 (54.6 to 67.5)	19.1 (18.4 to 20.0)	19.0 (18.2 to 19.8)	17.0 (13.0 to 21.6)	92.1 (91.4 to 92.8)	92.7 (91.9 to 93.4)	83.1 (77.9 to 87.2)	98.4 (97.7 to 98.9)	98.7 (97.9 to 99.2)	96.1 (92.5 to 98.0)
West Virginia	62.6 (60.9 to 64.3)	62.6 (60.8 to 64.3)	60.9 (50.1 to 70.0)	16.4 (15.5 to 17.3)	16.4 (15.5 to 17.3)	13.0 (8.8 to 18.1)	87.7 (86.4 to 89.0)	87.7 (86.3 to 89.0)	86.2 (77.1 to 91.9)	98.4 (96.5 to 99.3)	98.6 (96.5 to 99.4)	90.7 (80.0 to 95.8)
Wisconsin	64.1 (62.9 to 65.3)	64.5 (63.2 to 65.6)	59.2 (53.8 to 64.2)	18.8 (18.1 to 19.5)	19.1 (18.4 to 19.8)	18.1 (14.9 to 21.5)	90.0 (89.2 to 90.6)	90.4 (89.7 to 91.1)	80.1 (75.8 to 83.7)	97.3 (96.6 to 97.9)	97.7 (96.9 to 98.3)	96.0 (92.0 to 98.0)
Wyoming	59.4 (55.6 to 63.0)	59.7 (55.8 to 63.3)	‡	17.5 (15.1 to 20.0)	17.8 (15.3 to 20.3)	‡	86.7 (83.9 to 89.0)	86.9 (84.0 to 89.2)	‡	99.4 (95.3 to 99.9)	99.5 (94.2 to 100.0)	‡

*Source: National Program of Cancer Registries and Surveillance, Epidemiology, and End Results (SEER) registries as compiled by the North American Association of Central Cancer Registries. First and subsequent primary cancers included, using the first applicable record per patient in each analysis. The survival duration in months was calculated based on complete dates. For registries meeting SEER follow-up standards (SEER registries plus Montana and Wyoming), the survival duration for alive patients was calculated through the date of last contact (or study cutoff, if earlier). For the remaining registries, survival duration for alive patients was calculated through December 31, 2012, with all patients not known to be dead presumed to be alive on this date. CI = confidence interval; NAACCR = North American Association of Central Cancer Registries; NPCR = National Program of Cancer Registries; SEER = Surveillance, Epidemiology, and End Results.

†Thirty-one states plus two metropolitan areas.

‡Statistics are suppressed when fewer than 10 cases were reported for the specific cancer, when the standard error was greater than or equal to 10%, or when the difference of the upper and lower confidence intervals was greater than 40%.
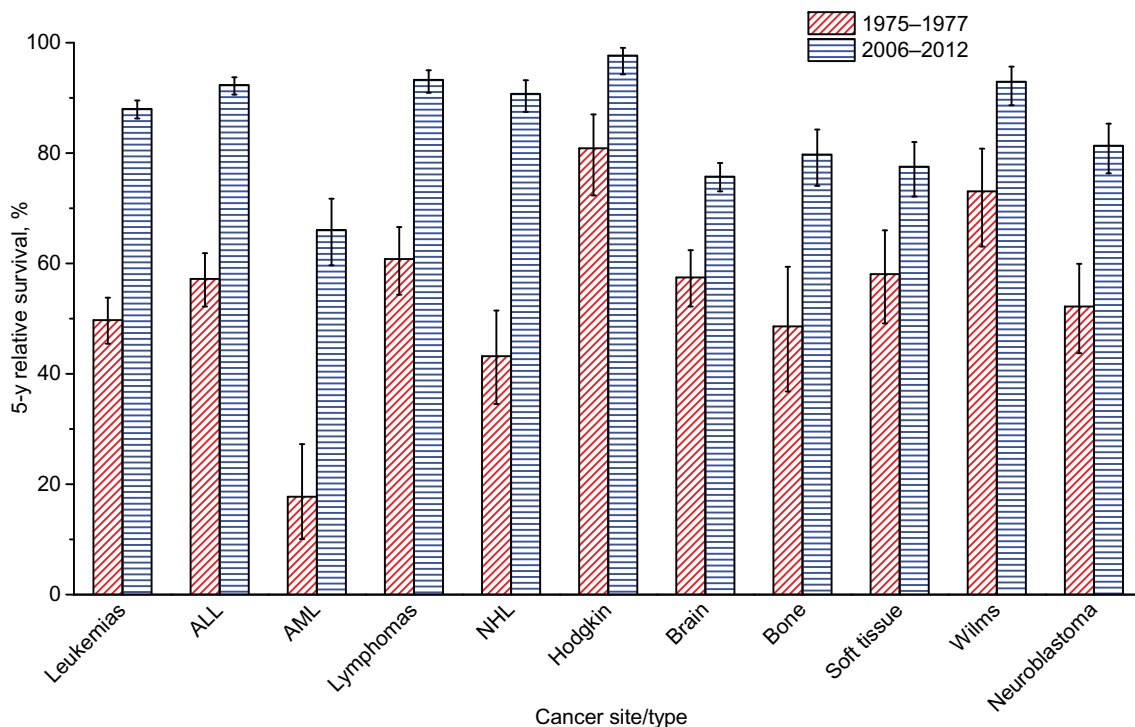
Figure 5. Changes in five-year relative survival for select childhood cancers (0–14 years), SEER 9*, 1975–2012. **Error bars** represent 95% confidence intervals. *The SEER 9 registries are Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, and Utah. ALL = acute lymphoid leukemia; AML = acute myeloid leukemia; NHL = non-Hodgkin lymphoma; SEER = Surveillance, Epidemiology, and End Results.

Northeastern states. Corresponding stage-specific survival data are given in Supplementary Table 7 (available online).

Figure 5 shows five-year survival for select childhood cancers diagnosed during two calendar periods, 1975 to 1977 and 2006 to 2012. Survival improved substantially between the two periods for all cancer types, ranging from an absolute increase of 16.8% (95% CI = 9.2% to 24.3%) for Hodgkin lymphoma to 48.3% (95% CI = 37.7% to 59.0%) for acute myeloid leukemia (Supplementary Table 6, available online). By race, five-year survival for all childhood cancers included in Supplementary Table 6 (available online) increased from 57.9% (95% CI = 55.4% to 60.3%) to 85.3% (95% CI = 84.1% to 86.4%) in white children and from 57.3% (95% CI = 49.3% to 64.5%) to 82.1% (95% CI = 79.0% to 84.9%) in black children. Five-year cancer survival for children of all races diagnosed from 2006 to 2012 ranged from 66.1% (95% CI = 59.7% to 71.7%) for acute myeloid leukemia to 97.7% (95% CI = 94.3% to 99.1%) for Hodgkin lymphoma.

Discussion

Overall cancer death rates continue to decrease in both men and women for all major racial and ethnic groups. Rates decreased for 11 of the 16 most common cancers in men and for 13 of the 18 most common cancers in women, including lung, colorectal, female breast, and prostate cancers. In contrast, death rates increased for liver cancer in men and women, for pancreas cancer and brain cancer in men, and for uterine cancer in women. In contrast to overall mortality trends, overall incidence rates decreased in men but stabilized in women. Incidence rates decreased for seven of the 17 most common cancers in men and seven of the 18 most common cancers in women, including lung and colorectal cancers, whereas rates increased for seven cancers in men and nine cancers in women, including liver, myeloma, melanoma, oral cavity, and thyroid in both men and women and pancreatic cancer in men. Survival increased substantially overall and for both early and late-stage diseases for several but not all cancer sites, and survival varied statistically significantly by race/ethnicity and state.

Factors that have contributed to the continued decrease in cancer death rates overall and for the most common cancers have been described in previous reports (14–18) and include reduced tobacco use, which is a well-established cause of 16 cancer types and accounts for nearly one-third of cancer deaths (42), improved early detection (eg, colorectal, breast, and cervix), and improved treatments for many cancers. In particular, cigarette smoking prevalence among adults over the past 50 years decreased by more than 50% because of public health policies against tobacco and increased awareness about the health hazards of smoking (42). However, there are still about 40 million adult smokers (43), and smoking remains the leading cause of cancer death (42,44–46). These facts underscore the need for expansions of federal and state tobacco control programs and the development of new strategies, such as pricing strategies and plain tobacco packaging to accelerate the reduction in tobacco use (47).

Unlike mortality trends, where increases are generally unfavorable and declines are indicators of progress, increases in incidence may reflect changes in detection practice and may have both positive and negative implications with respect to cancer control (19,20). For example, the continued increase in melanoma and thyroid cancer incidence rates over the past several decades is in part thought to reflect increased diagnostic scrutiny (48–50); however, incidence rates for both cancer types increased for late-stage and large tumors (48,49,51), suggesting the role of underlying risk factors such as increases in

intermittent recreational sun exposures for melanoma (49) and radiation and other unrecognized carcinogens for thyroid cancer (52). Likewise, trends in prostate cancer incidence rates have been affected by changes in the uptake of prostate-specific antigen (PSA) testing. Prostate cancer incidence rates decreased substantially (53,54) following the US Preventive Services Task Force recommendations against routine screening for PSA testing in men age 75 years or older (2008) and in men age 50 years or older (2011) (55,56). In contrast, the continued increase in liver cancer incidence rates is likely due to the high prevalence of chronic hepatitis C virus infection resulting from intravenous drug use by baby boomers during the 1960s to 1980s, as well as the obesity epidemic beginning in the 1980s (18). The obesity epidemic also may have contributed in part to the increases in endometrial, pancreas, and kidney cancer incidence rates (14) because obesity is estimated to account for 49%, 28%, and 24% of the total cases, respectively, in the United States (57).

In contrast to adult cancers, there are few known environmental risk factors for childhood cancers (58). According to the 2016 Cancer Statistics Review; however, the increase in the overall childhood cancer incidence rates during the last five data years (2009–2013) was largely confined to acute lymphocytic leukemia (ALL) and NHL (59), and ALL incidence increased only in Hispanic white children (60). Known and suspected risk factors for ALL include parental smoking during pregnancy, pesticide exposure, high birthweight, and Down syndrome, and for NHL they include Epstein Barr virus and inherited or acquired immunodeficiency (34,58,60–62). However, we could not find data to support that these risk factors may have contributed to the increasing incidence trends in ALL or NHL.

This is the second annual report to include a special section on population-based survival. The previous report compared relative five-year survival for two diagnostic periods (1975–1979 and 1995–2000) and examined risks of dying from cancer, once diagnosed, in each racial and ethnic population compared with non-Hispanic whites (7). This report extends the most recent diagnosis period by 12 years compared with the previous report, includes temporal changes in stage-specific survival, and presents contemporary survival data by race/ethnicity and state. As in the previous report, survival improved over time for almost all cancers at every stage of diagnosis. However, survival remains very low for some cancer sites and for most of the cancer sites diagnosed at distant stage. Disparities in survival by race have persisted over time, and variations in survival by state of residence are evident in recent data. Although increasing survival over time reflects progress in treating many cancer types, survival trends for some cancers must be interpreted with caution due to biases related to screening and early detection (21) and should be interpreted in the broader context of trends in incidence, stage at diagnosis, and mortality (63).

Cancer screening can lengthen the survival interval by moving back the time of diagnosis without changing the eventual date of death (lead time bias), as well as by identifying relatively slow-growing cancers that have good prognoses (length bias) (21). Screening may also lead to overdiagnosis by finding cancers that never would have been clinically detected during the course of the patients' natural lives (21). It is especially important to keep these biases in mind when interpreting survival trends during time periods when screening for particular cancers (eg, female breast cancer and prostate cancer) has been widely implemented in the general population.

Lead time, length bias, and overdiagnosis are also a concern when interpreting survival trends for cancer types for which changes in diagnostic technology or medical care practice have increased the detection of asymptomatic diseases (21). Among the cancers for which screening has been widely implemented in the general population, the greatest absolute increase in five-year relative survival has occurred for prostate cancer, along with the greatest controversies about the benefits of screening and treatment (64). Widespread adoption of PSA screening began in 1987, resulting in a dramatic increase in incidence, and survival trends are thought to have been influenced by lead time bias, length bias, and overdiagnosis (64). In addition to screening-related biases, analysis of prostate cancer survival trends is complicated by inconsistent stage and grade classification over time (65–67). Changes in prostate cancer treatment for which there is evidence of survival benefit include increased use of radical prostatectomy beginning in the 1980s, radiation therapy in combination with androgen deprivation therapy beginning in the mid to late 1990s, and protocols for evaluation and treatment of biochemical recurrence (68). Despite uncertainties about the benefits and harms of prostate cancer screening and which treatment approaches are optimal, it is clear that prostate cancer death rates have declined substantially in the United States since the early 1990s (67). Modeling studies that used survival data from clinical trials and population-based data on incidence and treatment suggest that stage shift due to screening and changes in treatment have contributed to declining prostate cancer mortality (68).

Increases in survival have also been observed since 1975 for breast and colorectal cancer, but have been much more limited for cervical cancer. The introduction of mammography screening in the 1980s and increasing use in the 1990s led to increased detection of localized and smaller breast cancers (69,70); within-stage shifts in tumor size and other prognostic features likely contributed to increased survival for localized and regional disease. Survival for distant-stage breast cancer has also been steadily improving since the early 1990s (71). Concurrent with the introduction of mammography screening, multiple improvements in breast cancer therapy occurred, including the use of hormonal therapies for hormone receptor–positive cancers and multi-agent chemotherapy (72). Modeling studies suggest that both screening and adjuvant therapy contributed to declines in breast cancer mortality (73).

Several colorectal screening modalities have been used since the 1980s, but with much slower population uptake than mammography screening (12,74). Detection of colorectal cancer at an early stage through screening may have contributed in part to the improvement in the overall survival (12). However, much of the improvement likely resulted from treatment advances, including improved surgical care, adjuvant chemotherapy for patients with regional (node-positive) disease (75), resection (surgical removal) of distant disease, and neoadjuvant therapy for rectal cancer (76). Unlike breast and colorectal cancer, there has been little progress in overall cancer survival for cervical cancer during the period studied, in part because Pap test screening had already been widely disseminated by 1987 (77).

For most cancer types for which screening has not been implemented in the general population, changes in long-term survival are easier to interpret, although increases in earlier detection, stage shifts, and changes in staging rules may have influenced some survival trends. For a number of solid tumors where surgery is the primary treatment and surgical mortality is relatively high (eg, esophageal and lung cancer), declines in surgical mortality have likely contributed to improved survival (78). Lower surgical mortality may have been achieved through improvements in anesthesia and supportive care, institution of quality improvement programs, and regionalization of high-risk surgeries (78).

The survival improvements over time highlighted in this report also reflect major advances in systemic therapies for some cancers, including imatinib mesylate for chronic myelogenous leukemia in the early 1990s (79), rituximab for B-cell non-Hodgkin lymphoma in the 1990s (80), and combination of chemotherapies for childhood cancers beginning in the 1960s (81,82). In particular, the continued statistically significant improvements in five-year survival rates for most cancers occurring in children—with over 80% of children surviving five years during recent diagnosis years—have been attributed to the systematic conduct of clinical trials assessing the efficacy of multimodal approaches involving combination chemotherapy, radiotherapy, and/or surgery with increased expertise in supportive care in specialized cancer centers (83). Member institutions of the Children's Oncology Group, a National Cancer Institute supported trials group, care for 90% of children diagnosed with cancer in the United States (61,84) .

In this era of increasingly personalized cancer therapy, it is hoped that dramatic progress in treatment and survival will be observed for other cancer types as well. It may not be possible in this analysis to detect the impact of very recent therapeutic improvements on population survival due to the time lag for case reporting and follow-up in cancer registry data; examples include protein kinase inhibitors for non–small cell lung cancer, colorectal cancer, and chronic myeloid leukemia; anti-angiogenics (which inhibit blood vessel growth) for colorectal and ovarian cancers; and immunotherapy for melanoma and non–small cell lung cancer (85). Such improvements may also be difficult to discern in population-based registry data for therapies that apply only to subsets of patients for a cancer site.

Although five-year survival for most cancers types improved among both blacks and whites over the past 30 or more years, the racial disparities observed for most cancer sites and for all cancer sites combined in the earlier period (1995–1997) for many common cancers have persisted, and they may have increased for prostate cancer and female breast cancer. Much work remains in order to understand the likely multiple causes of these observed differences; however, they may in part reflect differences among racial/ethnic groups in receipt or timeliness of recommended treatments (8,86–90). For example, black women with breast cancer are less likely to receive and adhere to adjuvant chemotherapy and more likely to experience delayed initiation of such therapy (86,91,92). The risk of death in blacks compared with whites was higher overall (all sites) and for the most common cancers in stage-adjusted analyses.

Similarly, compared with whites, AI/AN had higher risk of death for almost all cancer types and Hispanics had higher risk of death for many cancers, which may in part reflect treatment differences (8,93). In contrast, API had lower risk of death than whites for most cancers, including lung, colorectal, prostate, and female breast. While there are limited data showing that receipt of standard cancer treatments is higher in API than in whites, API have higher median income than whites and a higher proportion of persons with college-level education (94). However, higher survival among API and Hispanics need to be interpreted with caution because of known issues related to the follow-up of these patients (95). Further investigation of the factors that contribute to racial/ethnic survival differences is needed.

We also found evidence to suggest geographic differences in survival. For most of the common cancer sites, several northeastern states (eg, Connecticut, New Hampshire, Rhode Island) often had higher survival than elsewhere, whereas several southern states (eg, Alabama, Mississippi) often had lower survival. However, variations in survival by state have to be interpreted with caution as they may reflect differences in population demographics (race, age, ethnicity, and socioeconomic status), cancer screening rates, residents' access to and quality of cancer care, and cancer registration practices that impact case ascertainment, date of diagnosis, and follow-up, and/or other factors (33,96).

Strength and Limitations

This is the first "Annual Report to the Nation" that has used a single database (41 quality certified cancer registries, covering 89% of the US population) to provide all delay-adjusted incidence statistics. In future years, as the number of quality certified registries increases, we hope to cover a larger proportion of the US population and/or present trends using a longer time series. Monitoring cancer incidence trends is one of the most important uses of population-based registry data, and the ability to apply delay adjustment at the national level improves the accuracy and consistency of these results. Similarly, we used a single database (31 state registries and two metropolitan area registries) covering 67% of the US population to analyze survival variations by race/ethnicity and area of residence. High-quality survival data are vital for identifying disparities in cancer treatment and outcomes.

A limitation of this report is that we used the SEER historic stage variable for survival analysis to ensure consistency over time for all cancer sites. The collection of historic stage data by SEER since 1975 has been valuable for understanding long-term trends in incidence, survival, and mortality, but in the past decade it has been increasingly difficult to maintain historically comparable stage data over time. Stage definitions change as new diagnostic procedures are incorporated and American Joint Committee on Cancer staging rules are modified to reflect advances in clinical knowledge. As the collection of increasingly more information will be necessary to create clinically meaningful disease classifications for prognosis and treatment, examining and reporting of long-term survival trends by stage may become difficult or impossible.

On the other hand, the availability of detailed information on stage and other prognostic factors for almost all incident cancers in the United States creates unprecedented opportunities to study the increasing use of new treatments and their impacts on survival in population-based samples. The NCI has created a valuable national resource for such studies by linking SEER registry data to Medicare records to augment data on treatments and comorbidities (97). Ongoing related efforts by the NCI include the development of a new tool, the "SEER Cancer Survival Calculator" (SEER*CSC), to provide information on prognosis of individual patients to help patients and their families and doctors in making difficult decisions about treatment (98,99). In addition, the CDC has invested resources in utilizing NPCR registries for conducting population-based comparative effectiveness research (100) and in making these data available to researchers through NCHS's Research Data Center (http://www.cdc.gov/rdc/index.htm).

Another limitation of this report is misclassification of race/ethnicity information in medical records (incidence), death certificates, and Census. Since 2000, the Census has given respondents the option to self-select multiple race/ethnicity categories, creating incompatibility with race/ethnicity information on medical records and death certificates, which often have single race/ethnicity categories. To address this problem,

the US Census Bureau, in collaboration with CDC's NCHS and NCI, has developed methods to generate single-race population estimates, but with some uncertainties about the population estimates and resultant rates (101). Furthermore, race/ethnicity information on death certificates is underascertained for AI/AN, API, and Hispanics (102), leading to underestimation of cancer rates. In addition, cancer rates for broad racial and ethnic groups (eg, Hispanic and API) may mask important variations in cancer burden by country of origin (103,104).

Finally, as with survival trends, incidence trends need to be interpreted with caution as changes in incidence rates may result from changes in risk factor prevalence, increased or decreased use of screening or diagnostic techniques, or a combination of these. Further, the AAPC was used as a summary measure to average trends in magnitude and direction over the most recent five-year data period using joinpoint regression (39), but one cannot necessarily conclude that rates continue to increase or decrease throughout the five-year period.

Future Directions

Cancer survival, particularly for advanced-stage diseases, is expected to increase markedly in light of recent advances in precision medicine and immunotherapy for late-stage cancers (eg, melanoma, lung cancer) (81,82). Further, the White House's Cancer Moonshot initiative and other similar initiatives to accelerate progress against cancer aim to build on these recent advances and find cures (105,106). However, despite many reasons for optimism about the potential for research to accelerate the development of highly effective treatments, important challenges remain in the access and delivery of cancer care to enable all populations to benefit from treatment advances. Some of the new cancer drugs cost $10 000 per month and are not affordable even by most insured patients because of the high out-of-pocket expenses, which are about 20% of the drug's cost for Medicare-insured patients (107–109). The high cost of cancer treatment dubbed "financial toxicity"(110) has been associated with reduced spending on groceries and clothing, skipped medications and physician appointments to save money, bankruptcy, and mortality (111,112). It has been suggested that if measures are not taken to contain the escalating trend in treatment costs, cancer care in the United States could become less affordable and could impede the very goal of the Affordable Care Act, which is to make high-quality health care accessible to all (113). Cognizant of this problem, the American Society of Clinical Oncology recently developed a conceptual framework for medical oncologists to assess the value of cancer treatment options, with an emphasis on the clinical benefit (efficacy), toxicity (safety), and cost (efficiency) of drugs (113).

To accelerate progress in reducing cancer mortality, we must not only intensify efforts to develop effective targeted therapies and find cures, but also heighten our efforts to broadly and equitably apply proven preventive measures. A large percentage of the reduction in cancer death rates since 1990 has come from preventive measures rather than treatment advances (114–117). For example, Thun and Jemal estimated that reduced tobacco use over the past four decades alone accounted for about 40% of the decrease in overall male cancer death rates from 1991 to 2003 (116). Tobacco use still accounts for nearly 30% of cancer deaths in the United States (44–46), and about 17% of US adults (40 million adults) are current cigarette smokers, with prevalence varying extensively across states (43,118).

Recent reports documented that only North Dakota funded a state tobacco control program at the CDC-recommended level during 2016 and nearly half of the states did not have statewide comprehensive smoke-free laws that ban smoking in bars, restaurants, and workplaces (119,120). Devoting increased resources and enacting laws and regulations to strengthen tobacco control policies at both state and federal levels—such as tobacco product pricing strategies, plain packaging, statewide comprehensive smoke-free laws, and reducing nicotine content in tobacco products to nonaddictive levels (47)—could greatly reduce morbidity and mortality from smoking-related cancers and other smoking-related diseases.

Additional interventions for patient and provider education and outreach programs and interventions aimed at removing barriers to accessing preventive services are needed to increase the low or suboptimal uptake of screening for colorectal cancer (121) and lung cancer (122), human papilloma virus vaccination (123), and testing for hepatitis C virus infection (124). Additional resources are also required to create neighborhoods that encourage physical activity and healthy eating habits and to identify new approaches to prevent and reverse the obesity epidemic (125), which accounts for 15% to 20% of total cancer deaths in the United States (126). Furthermore, more attention and resources are needed for identifying major risk factors for common cancers such as colorectal, breast, and prostate. Also needed are concerted efforts to understand the increasing incidence trends in uterine, female breast, and pancreas cancer, as well as to plan and implement proven preventive measures (57,127).

Conclusions

Overall cancer death rates continue to decrease in the United States, reflecting improvements in prevention, early detection, and treatment. However, progress in reducing mortality and improving survival is limited for several cancers. This requires renewed commitment to redouble our efforts to discover new strategies for prevention, early detection, and treatment and to apply proven interventions broadly and equitably.

Funding

Notes

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