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Annual Report to the Nation on the Status of Cancer, 1973–1996, With a Special Section on Lung Cancer and Tobacco Smoking

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Annual Report to the Nation on the Status of Cancer, 1973–1996, With a Special Section on Lung Cancer and Tobacco Smoking

Phyllis A. Wingo, Lynn A. G. Ries, Gary A. Giovino, Daniel S. Miller, Harry M. Rosenberg, Donald R. Shopland, Michael J. Thun, Brenda K. Edwards

Background: **The American Cancer Society, the National Cancer Institute (NCI), and the Centers for Disease Control and Prevention (CDC), including the National Center for Health Statistics (NCHS), provide the second annual report to the nation on progress in cancer prevention and control, with a special section on lung cancer and tobacco smoking.** ***Methods:*** **Age-adjusted rates (using the 1970 U.S. standard population) were based on cancer incidence data from NCI and underlying cause of death data compiled by NCHS. The prevalence of tobacco use was derived from CDC surveys. Reported *P* values are two-sided.** ***Results:*** **From 1990 through 1996, cancer incidence (−0.9% per year; *P* = .16) and cancer death (−0.6% per year; *P* = .001) rates for all sites combined decreased. Among the 10 leading cancer incidence sites, statistically significant decreases in incidence rates were seen in males for leukemia and cancers of the lung, colon/rectum, urinary bladder, and oral cavity and pharynx. Except for lung cancer, incidence rates for these cancers also declined in females. Among the 10 leading cancer mortality sites, statistically significant decreases in cancer death rates were seen for cancers of the male lung, female breast, the prostate, male pancreas, and male brain and, for both sexes, cancers of the colon/rectum and stomach. Age-specific analyses of lung cancer revealed that rates in males first declined at younger ages and then for each older age group successively over time; rates in females appeared to be in the early stages of following the same pattern, with rates decreasing for women aged 40–59 years.** ***Conclusions:*** **The declines in cancer incidence and death rates, particularly for lung cancer, are encouraging. However, unless recent upward trends in smoking among adolescents can be reversed, the lung cancer rates that are currently declining in the United States may rise again. [J Natl Cancer Inst 1999;91:675–90]**

On the 25th anniversary of the National Cancer Act in 1996, the American Cancer Society (ACS), the Centers for Disease Control and Prevention (CDC), which includes the National Center for Health Statistics (NCHS), and the National Cancer Institute (NCI) reported the first sustained decline in cancer mortality since national record-keeping was instituted in the 1930s *(1–5)*. These organizations continue to collaborate, monitor cancer statistics, and produce an annual report to the nation on progress related to cancer prevention and control in the United States.

This second report updates and confirms the continuing declines in cancer incidence and death rates in the United States and presents detailed information on the occurrence of lung cancer, the leading cause of cancer death, and on tobacco smoking in adults and youth. This report also includes cancer incidence and death rates in five populations: whites, blacks, Asian and Pacific Islanders, American Indians/Alaska Natives, and Hispanics.

Subjects and Methods

All statistics presented in this report are available at the following internet address:

www-seer.ims.nci.nih.gov

Additional data, such as annual and age-specific rates and trends, are also available at this address or may be accessed on the Surveillance, Epidemiology, and End Results[1] (SEER) CD-ROM that may be obtained through the internet address.

Cancer Cases

Information on newly diagnosed cancer cases occurring in the United States is based on data collected by the NCI's SEER Program *(5).* Briefly, the SEER Program collects cancer incidence data from 11 population-based registries, including five states (Connecticut, Hawaii, Iowa, New Mexico, and Utah) and six standard metropolitan statistical areas (Atlanta, Detroit, Los Angeles, San Francisco–Oakland, San Jose–Monterey, and Seattle–Puget Sound), representing approximately 14% of the U.S. population. Cancer incidence data for Alaska Natives from Alaska are also included. Estimates of cancer incidence rates and trends for the total United States are frequently based on SEER data; for this analysis, we use incident cancer cases diagnosed from 1973 through 1996 *(6).* The second edition of the International Classification of Diseases for Oncology (ICDO-2) groupings for the specific cancer sites included in this report have been published previously *(5,6).*

Cancer Deaths

Information on cancer deaths in the United States is based on causes of death reported by the certifying physicians on death certificates filed in state vital statistics offices. The mortality information is processed and consolidated into a national database by the NCHS [*(7);* unpublished data]. The underlying cause of death is selected for tabulation following the procedures specified by the World

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See "Notes" following "References."

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Health Organization in the current *Manual of the International Statistical Classification of Diseases, Injuries, and Causes of Death* (ICD). For the period from 1950 through 1957, the sixth revision (ICD-6) is used *(8);* for the period from 1958 through 1967, the seventh revision (ICD-7) is used *(9);* for the period from 1968 through 1978, the eighth revision (ICDA-8) is used *(10);* and for the period from 1979 through 1996, the ninth revision (ICD-9) is used *(11)*. For analyses of long-term trends in lung cancer death rates during the period from 1950 through 1996, deaths from cancer of the lung and bronchus also include deaths from cancer of the trachea and pleura. To ensure comparability between the ICDA-8 and ICD-9 codes, ICDA-8 codes on individual records are converted to ICD-9 codes by applying a conversion algorithm used by the NCI, and the ICD-9 codes are categorized according to SEER site groupings *(5)*.

Cancer Incidence and Death Rates

We use resident population estimates for each year from the U.S. Bureau of the Census *(12)* to compute age-adjusted cancer incidence and death rates; population data for whites are adjusted slightly for an overcount of whites in Hawaii (Hawaii Department of Public Health: unpublished data). Because information about Hispanic origin is collected separately from race, persons categorized as Hispanic are not mutually exclusive from whites, blacks, American Indians/Alaska Natives, and Asian and Pacific Islanders.

Rates are expressed as per 100 000 population and are age adjusted by the direct method to the 1970 U.S. standard million population. All rates in this report are based on at least 25 cases or deaths. For cancer sites that pertain only to males or females, rates are based on sex-specific data. The term "all sites" refers to all cancer sites combined, not just to the aggregate of sites included in each figure. Specific abbreviations include not otherwise specified (NOS) and intrahepatic bile duct (IBD).

For cancer incidence rates, the denominators are county-level population data for the geographic areas that participate in the SEER Program. Cancer incidence rates for American Indians/Alaska Natives are based on data from Alaska plus all SEER registries.

For cancer death rates, the denominators are population data for the total United States, except for Hispanic data. Cancer death rates for Hispanics include cancer deaths that occurred in all states except Connecticut, Louisiana, New Hampshire, and Oklahoma, which are omitted because of the absence of comparable data on Hispanic origin. Cancer death rates for American Indians/Alaska Natives include data from all states.

Annual Percent Change

The annual percent change (APC) is estimated by fitting a regression line to the natural logarithm of the rates by use of calendar year as a regressor variable; i.e., $y = mx + b$, where $y = \ln$ (rate) and $x =$ calendar year. Then, the estimated APC $= 100 \times (e^m - 1)$. Testing the hypothesis that the APC is equal to zero is equivalent to testing the hypothesis that the slope of the line in the above equation is equal to zero, i.e., that the rate is not increasing or decreasing. The hypothesis test statistic uses the t distribution of m/SE_m, where SE is the standard error of m and the number of degrees of freedom is equal to the number of calendar years minus 2 *(13)*. The calculation assumes that rates increase or decrease at a constant rate over time, although the validity of this assumption has not been assessed. Statistical significance is assessed by use of two-sided $P = .05$.

Prevalence of Tobacco Smoking

The prevalence of tobacco smoking is based on data collected by the CDC and state departments of health and education in three surveys: the National Health Interview Survey (NHIS), the Behavioral Risk Factor Surveillance System (BRFSS), and the Youth Risk Behavior Surveillance System (YRBSS) *(14–18)*. NHIS is a continuous nationwide sample survey of the civilian, noninstitutionalized population that is conducted by NCHS *(14)*. Questions on Hispanic origin were added to existing questions on race in 1978. From 1992 through 1995, current cigarette smoking prevalence included persons who reported having smoked at least 100 cigarettes in their lifetime and who reported now smoking every day or on some days. Before 1992, current smokers included persons who had smoked at least 100 cigarettes in their lifetime and who reported smoking now.

BRFSS is an ongoing system of surveys conducted by state health departments in cooperation with the CDC to collect risk factor information and monitor the effects of interventions over time *(15)*. Every month, each state uses random-digit-dialing telephone methods to select a probability sample of its civilian, noninstitutionalized adult population with telephones *(15,16)*. In 1997, all 50 states and the District of Columbia randomly selected a sample of adults aged 18 years and older who had telephones. BRFSS estimates for the total United States are based on data from 50 states plus the District of Columbia. Of note, BRFSS estimates presented in this report for the total United States do not agree exactly with NHIS estimates for the total United States for two reasons: 1) different survey designs (telephone versus household) and 2) different survey years. Current cigarette smoking prevalence includes adults 18 years old and older who had ever smoked at least 100 cigarettes in their lifetime and who reported now smoking every day or on some days.

YRBSS consists of biennial, national, state, and local school-based surveys of representative samples of high school students *(17,18)*. The national survey uses a three-stage cluster design, and estimates are weighted to represent students in grades 9–12 in public and private schools in the 50 states and the District of Columbia. The state and local surveys involve a two-stage cluster design and are conducted by state and local education agencies and health departments using uniform sampling methods but with variable data quality; caution, therefore, should be used when making direct comparisons of estimates across states and localities. With an overall response rate of at least 60% and appropriate documentation for each state and locality, survey data are weighted. In 1997, weighted estimates from 24 states and 15 cities can be generalized to all public school students in grades 9–12 in their respective jurisdictions. Data from nine states and two cities are not weighted and, therefore, apply only to the students participating in those surveys. Current smoking prevalence includes students in grades 9–12 who smoked cigarettes on at least one of 30 days preceding the survey.

RESULTS

Update

SEER cancer incidence. For all cancer sites combined, SEER incidence rates decreased (−0.9% per year; $P = .16$) from 1990 through 1996 (Fig.1), although the trend did not achieve statistical significance. SEER incidence rates appeared to peak in 1992 and decreased on average −2.2% per year between 1992 and 1996 ($P = .001$). The incidence rate for males decreased on average −4.1% per year ($P = .001$) from the high of 536.4 per 100 000 in 1992 to 454.6 per 100 000 in 1996. The highest cancer incidence rate for females occurred in 1991 (351.4 per 100 000); between 1991 and 1996, cancer incidence rates for females declined on average −0.4% per year ($P = .079$).

Among the 10 leading cancer incidence sites, rates among males were decreasing for cancers of the prostate, lung, colon/rectum, urinary bladder, and oral cavity and pharynx and for leukemia (Fig. 1). From 1990 through 1996, the decreasing trends were statistically significant for all of these sites except prostate. Prostate cancer incidence rates peaked in 1992 at 190.8 per 100 000 and declined on average −8.5% per year from 1992 through 1996 ($P = .007$). Trends in male lung cancer are discussed in more detail in the special section on lung cancer and tobacco smoking. Colorectal cancer incidence rates in males began decreasing in the mid-1980s with a peak of 63.0 per 100 000 in 1985; rates declined on average −2.0% per year between 1985 and 1996 ($P<.001$).

In females, incidence rates decreased for cancers of the colon/rectum, urinary bladder, and oral cavity and pharynx and for leukemia from 1990 through 1996 (Fig. 1). However, only the decreasing trend in colorectal cancer was statistically significant. Rates of colorectal cancer among females (45.3 per 100 000 in 1985) peaked in the same year as those among males. From 1985 through 1996, colorectal cancer incidence rates decreased on average −1.8% per year among females ($P<.001$). Incidence rates for female breast cancer have remained approximately

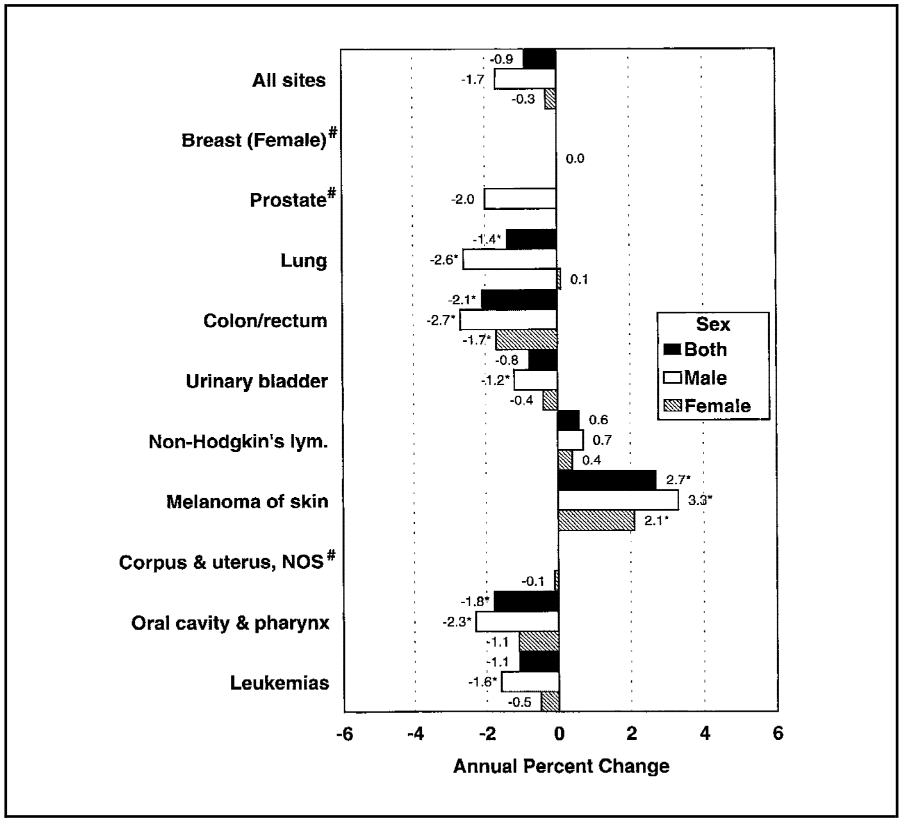


Fig. 1. Annual percent change (APC) in Surveillance, Epidemiology, and End Results (SEER)[1] incidence rates:[+] top 10 sites, by sex, all ages, all races, 1990–1996. [1]*See* "Notes" section for explanation of SEER (*see also* text); [+]incidence rates are age adjusted to the 1970 U.S. standard million population; [#]APC is based on sex-specific rates; *APC is statistically significantly different from zero (two-sided *P*<.05). lym. = lymphoma; NOS = not otherwise specified.

level from 1990 through 1996, unlike the trend of increasing rates that occurred from 1977 through 1987. Trends in female lung cancer are discussed in the special section on lung cancer and tobacco smoking.

From 1990 through 1996, incidence rates for non-Hodgkin's lymphoma and melanoma continued to increase, while the incidence rate for uterine corpus and uterus NOS cancer was approximately level (Fig. 1). Incidence rates for non-Hodgkin's lymphoma increased on average +0.6% per year, although the trend was not statistically significant. This average annual percent increase was statistically significantly lower than that observed for the period from 1973 through 1979 (+3.0% per year; *P* = .001) and for the 1980s (+3.7% per year; *P*<.001). Trends in melanoma incidence rates, however, increased substantially from 1990 through 1996 (+2.7% per year; *P*<.001). The average APC for the 1990s was not appreciably different from that observed for the 1980s (+3.1% per year; *P*<.001) but was substantially lower than the +6.1% increase per year (*P*<.001) observed for the period from 1973 through 1979.

The trends in cancer incidence rates varied by sex and age at diagnosis (Fig. 2). From 1990 through 1996, the largest annual decreases in incidence rates for all sites combined occurred in males who were 25–44 years old and males who were 75 years old and older at diagnosis. Age-specific trends in females were less remarkable, and the largest and only statistically significant trend was a decline among those 35–44 years old.

From 1990 through 1996, the four leading cancer incidence sites for the racial and ethnic populations included in this report were lung and bronchus, prostate, female breast, and colon/rectum (Fig. 3), which together ac-

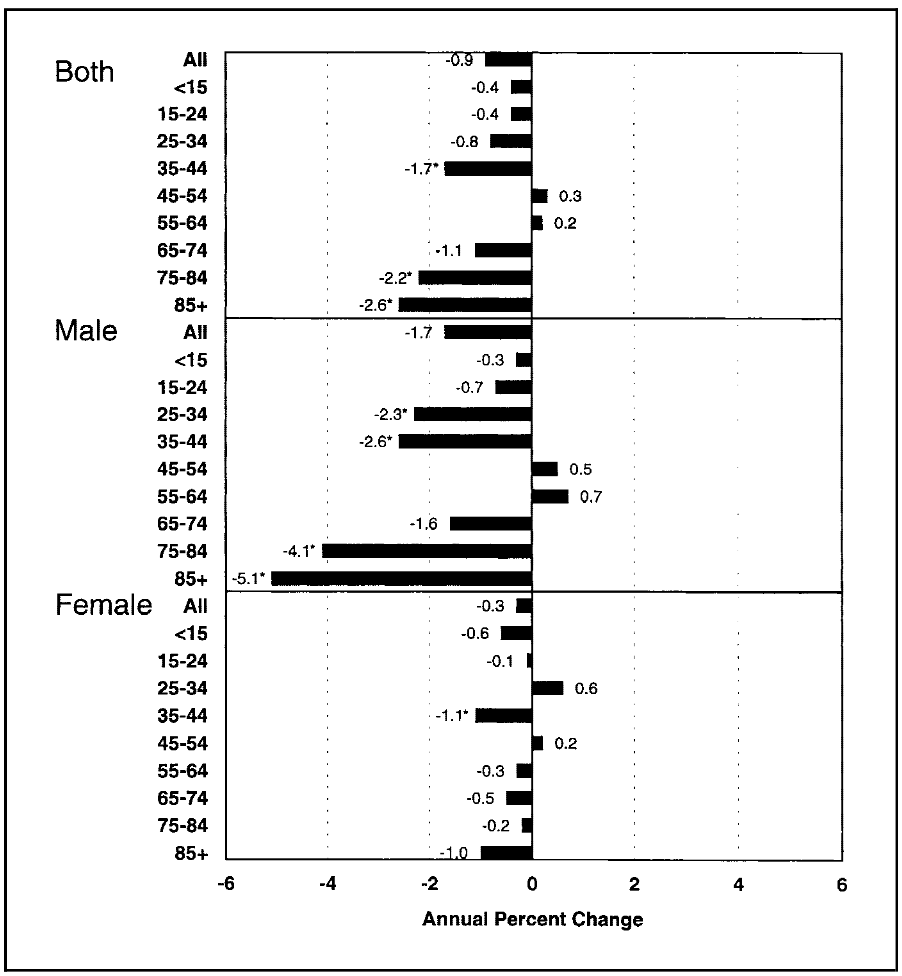


Fig. 2. Annual percent change (APC) in Surveillance, Epidemiology, and End Results (SEER)[1] incidence rates[+] by sex and age, all sites, all races, 1990–1996. [1]*See* "Notes" section for explanation of SEER (*see also* text); [+]incidence rates are age adjusted by 5-year age groups to the 1970 U.S. standard million population; *APC is statistically significantly different from zero (two-sided *P*<.05).

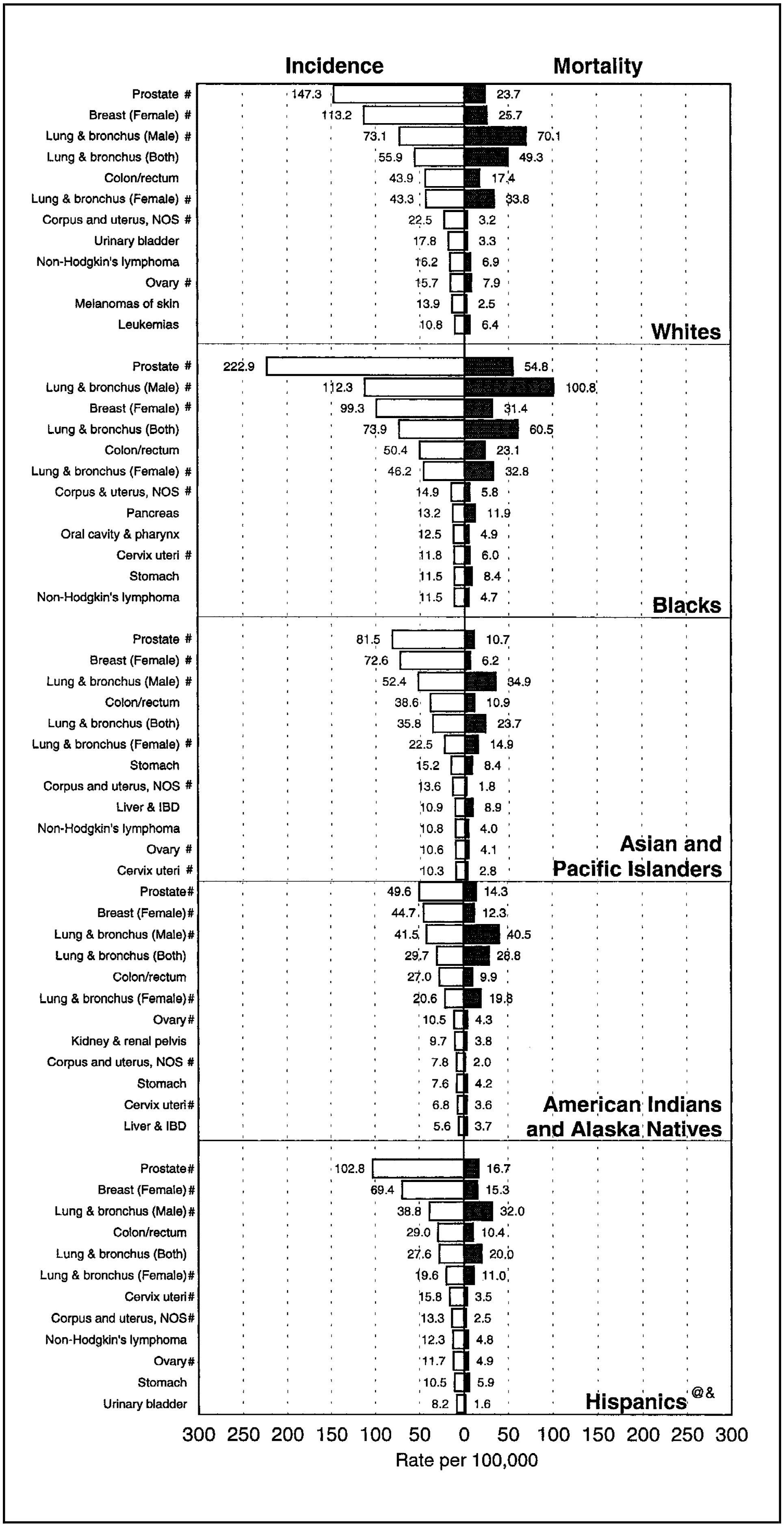
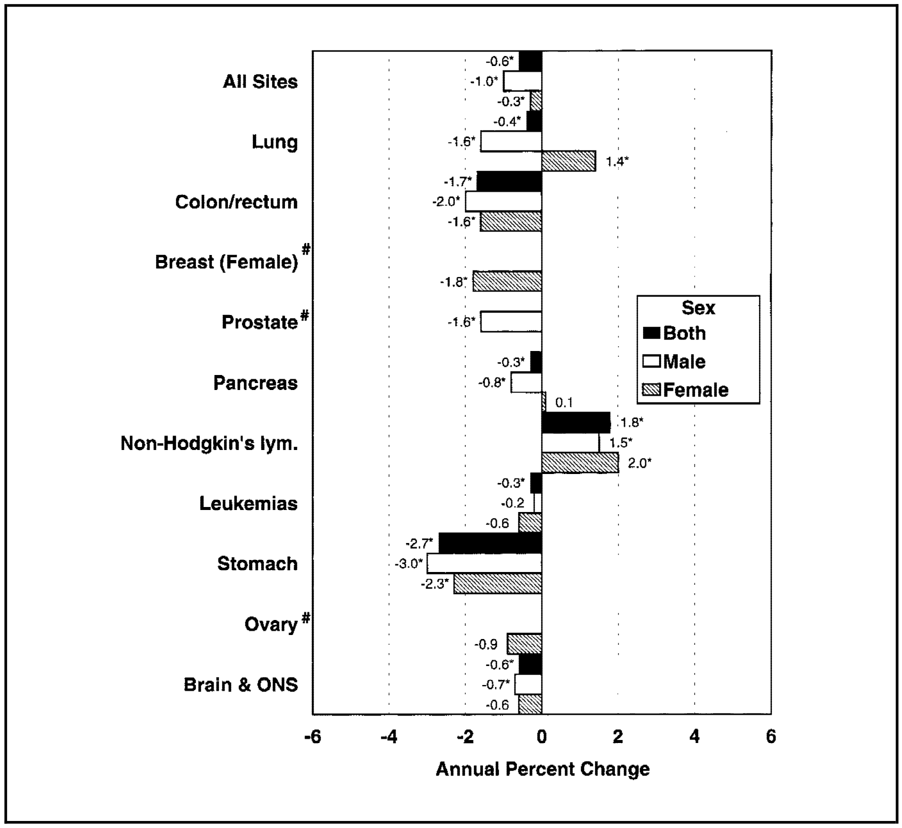


Fig. 3. Surveillance, Epidemiology, and End Results (SEER)[1] incidence and U.S. cancer death rates:[+] top 10 sites, by race and ethnicity, 1990–1996. [1]*See* “Notes” section for explanation of SEER (*see also* text); [+]rates are per 100 000 persons and age adjusted to the 1970 U.S. standard million population; [#]rates are based on sex-specific data; [@]Hispanic is not mutually exclusive from whites, blacks, American Indians/Alaska Natives, and Asian and Pacific Islanders; [&]death rates exclude deaths that occurred in Connecticut, Louisiana, New Hampshire, and Oklahoma. NOS = not otherwise specified; IBD = intrahepatic bile duct.

count for approximately 54% of all new diagnoses *(19)*. Examination of incidence rates for these four sites by race and ethnicity revealed that, except for female breast cancer, blacks had higher incidence rates than the other racial and ethnic populations. Although cancer of the uterine corpus and uterus NOS was common to all five racial and ethnic groups among the top 10 incidence sites, some sites tended to be unique to a specific population. For example, melanoma and leukemia were among the top 10 incidence sites only in whites, cancers of the pancreas and oral cavity and pharynx were among the top 10 sites only in blacks, liver cancer was among the top 10 sites only in Asian and Pacific Islanders and American Indians/Alaska Natives, cancer of the kidney and renal pelvis was among the top 10 sites only in American Indians/Alaska Natives, and bladder cancer was among the top 10 sites only in whites and Hispanics.

U.S. cancer mortality. From 1990 through 1996, cancer death rates for all sites combined decreased (−0.6% per year; $P = .001$) (Fig. 4). Cancer death rates peaked in 1991 at 173.4 per 100 000 and, from 1991 through 1996, decreased statistically significantly on average −0.7% per year ($P = .002$). Male cancer death rates peaked in 1990 at 220.8 per 100 000, and female death rates peaked 1 year later at 142.2 per 100 000. The decreasing trends from the peak years were on average −1.0% per year from 1990 through 1996 for males and −0.4% per year from 1991 through 1996 for females. Cancer death rates were decreasing for all 10 leading cancer mortality sites, except for non-Hodgkin’s lymphoma and female lung cancer. From 1990 through 1996, non-Hodgkin’s lym-

Fig. 4. Annual percent change (APC) in U.S. cancer death rates:⁺ top 10 sites, by sex, all ages, all races, 1990–1996. ⁺Death rates are age adjusted to the 1970 U.S. standard million population; #APC is based on sex-specific rates; *APC is statistically significantly different from zero (two-sided $P<.05$). lym. = lymphoma; ONS = other nervous system.



phoma death rates continued to increase (+1.8% per year; $P = .001$) but at a slower pace than in the 1980s (+2.4% per year; $P<.001$). A lower annual percent increase in non-Hodgkin's lymphoma death rates occurred entirely among males; more specifically, the average APC from 1990 through 1996 among males (+1.5% per year) was statistically significantly lower than the average APC during the 1980s (+2.7% per year). In contrast, the average APC among females was +2.0% per year for both time periods. Trends in lung cancer death rates are discussed in detail in the special section on lung cancer and tobacco smoking.

From 1990 through 1996, statistically significant declines in cancer death rates among males were observed for cancers of the lung, colon/rectum, prostate, pancreas, stomach, and brain and other nervous system. Prostate cancer death rates peaked in 1991 at 26.7 per 100 000; rates decreased significantly on average −2.1% per year from 1991 through 1996. Colorectal cancer death rates in males peaked in 1978 and declined statistically significantly on average −1.3% per year from then through 1996.

Statistically significant declines in female cancer death rates were observed during the 1990s for cancers of the colon/rectum, breast, and stomach. Colorectal cancer death rates in females have been declining since the late 1940s *(19).* Breast cancer death rates were approximately stable from the 1950s to 1989 when rates began to decline. From 1989 through 1996, breast cancer death rates decreased statistically significantly on average −1.7% per year.

Trends in cancer death rates varied by sex and age. From 1990 through 1996, the average APC in cancer death rates was statistically significantly decreasing for males of all ages except for those who were at least 85 years old at death (Fig. 5). Unlike trends

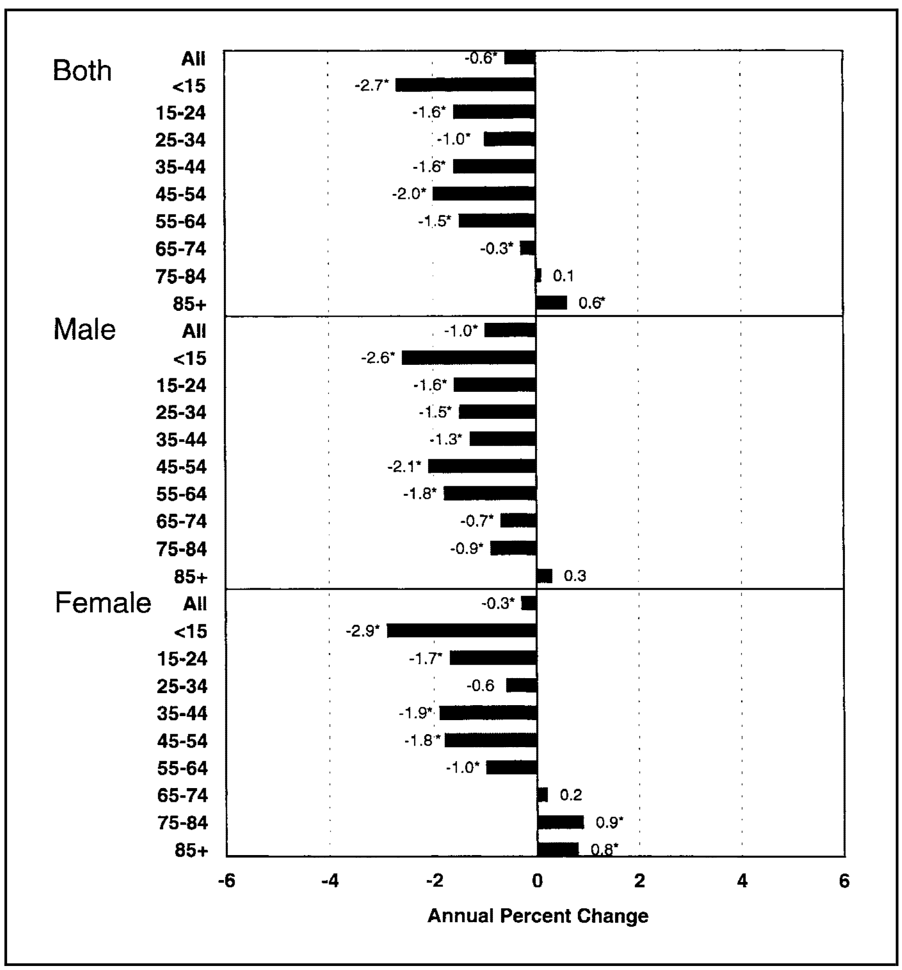


Fig. 5. Annual percent change (APC) in U.S. cancer death rates⁺ by sex and age, all sites, all races, 1990–1996. ⁺Death rates are age adjusted by 5-year age groups to the 1970 U.S. standard million population; *APC is statistically significantly different from zero (two-sided $P<.05$).

Fig. 6. Cancer of the lung and bronchus: Surveillance, Epidemiology, and End Results (SEER)[1] incidence rates[+] by sex and age, 1973–1996. [1]*See* "Notes" section for explanation of SEER (*see also* text); [+]incidence rates are adjusted by 5-year age groups to the 1970 U.S. standard million population.

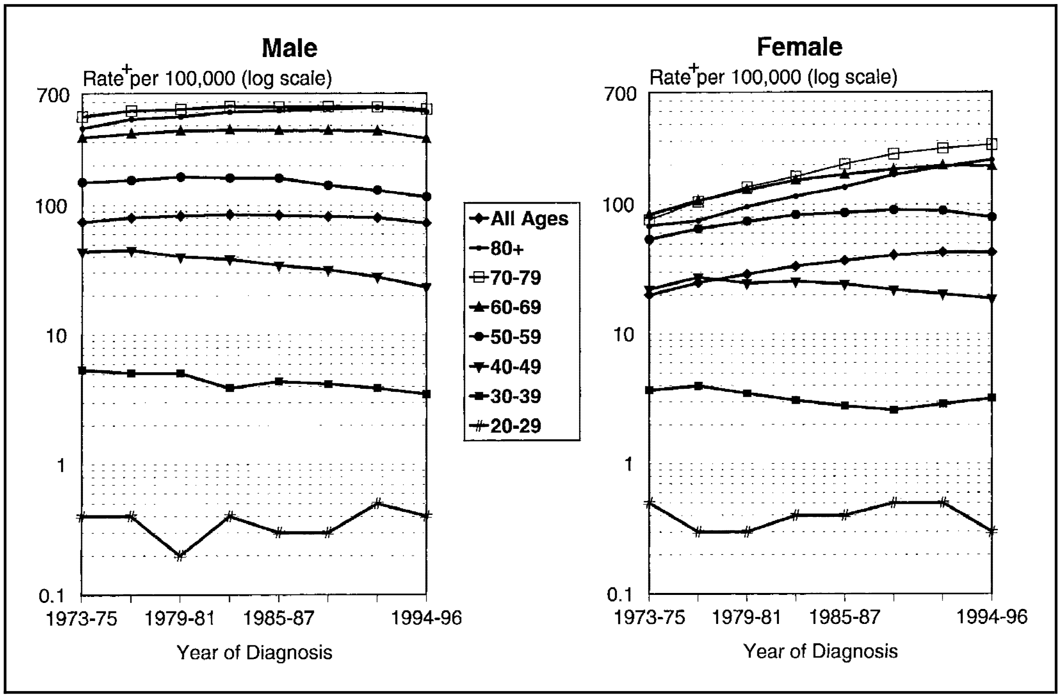
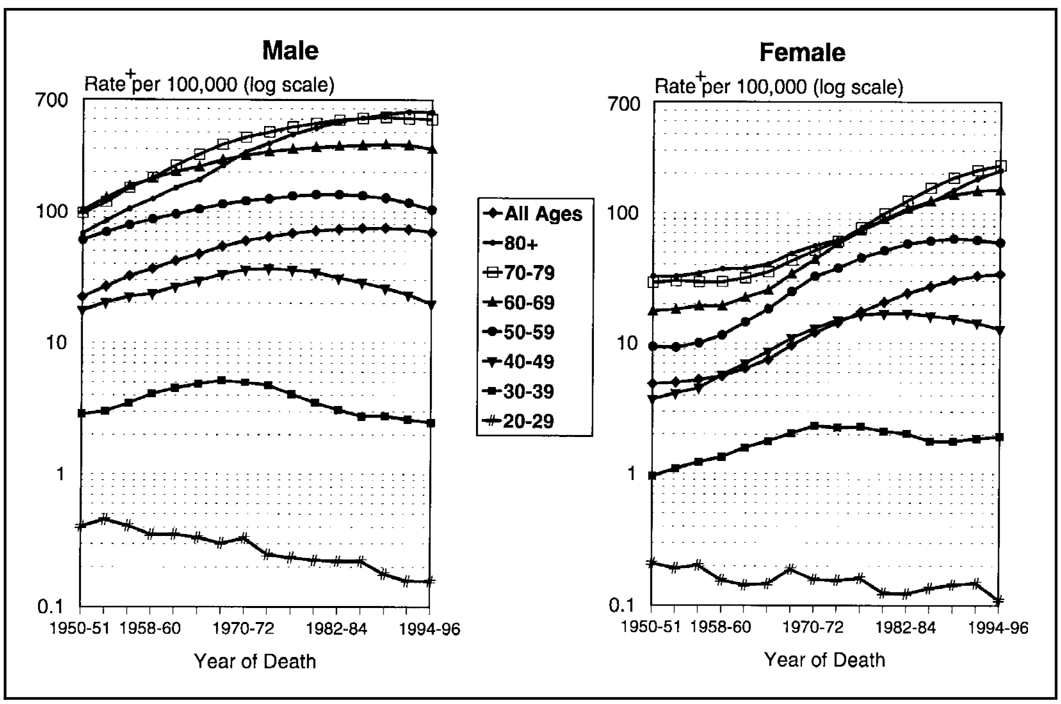


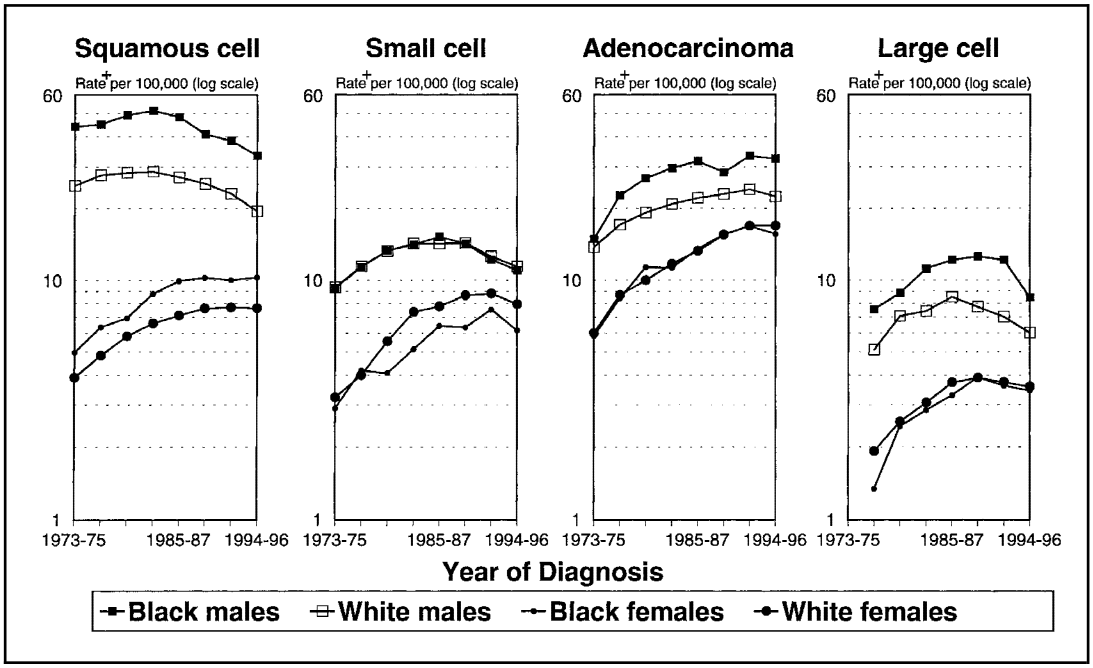
Fig. 7. Cancer of the lung and bronchus (including trachea and pleura): U.S. death rates[+] by sex and age, 1950–1996. [+]Death rates are adjusted by 5-year age groups to the 1970 standard million population.



among males, trends among females were statistically significantly decreasing only for those who were younger than age 65 (Fig. 5). The only exceptions were females aged 25–34 years at death, whose cancer death rate was declining—but the decline did not achieve statistical significance—and females aged 65 years and older, whose cancer death rates were increasing.

More than half of all cancer deaths involved cancers of the lung, female breast, prostate, or colon and rectum *(19)*. The top four causes of cancer death in the United States from 1990 through 1996 for the racial and ethnic groups included in this report, except Asian and Pacific Islanders, involved the same sites as for incidence (Fig. 3). Among Asian and Pacific Islanders, cancer of the liver and IBD, instead of female breast cancer, ranked among the four leading causes of cancer death. Examination of cancer death rates for each of these sites by race and ethnicity revealed that blacks had higher cancer death rates than whites, Asian and Pacific Islanders, American Indians/Alaska Natives, or Hispanics. Among the leading cancer mortality sites, deaths due to leukemia and to cancers of the stomach and ovary were common to all five racial and ethnic groups (data not shown). Otherwise, the leading cancer mortality sites varied by racial and ethnic groups. For example, brain and other nervous system cancers were among the leading cancer mortality sites only in whites (data not shown), esophageal cancer and

Fig. 8. Cancer of the lung and bronchus: Surveillance, Epidemiology, and End Results (SEER)[1] incidence rates[+] by histologic type, sex, race, and ethnicity, all ages, 1973–1996. [1]*See* "Notes" section for explanation of SEER (*see also* text); [+]rates are age adjusted to the 1970 U.S. standard million population; rates are based on 3-year groups except for the first group of large-cell data, which is based on data from 1977 through 1978.



multiple myeloma were among the leading causes of cancer death only in blacks (data not shown), cancer of the uterine cervix was among the leading cancer mortality sites only in blacks and American Indians/Alaska Natives, and cancer of the kidney and the renal pelvis was among the leading cancer mortality sites only in American Indians/Alaska Natives (data not shown).

Special Section on Lung Cancer and Tobacco Smoking

Lung cancer incidence and mortality. The lung is the number 1 cancer mortality site overall and is one of the top four incidence sites for each racial and ethnic group (Fig. 3). The incidence rates from 1990 through 1996 varied widely by race and ethnicity, from a high of 73.9 per 100 000 among blacks to 27.6 per 100 000 among Hispanics (Fig. 3). While the overall rate for American Indians/Alaska Natives is also low (29.7 per 100 000), it obscures the wide range in rates by geographic area from a low of 10.3 per 100 000 among American Indians in New Mexico to a high of 76.4 per 100 000 among American Indians/Alaska Natives in Alaska (data not shown), which is even higher than the rate for blacks.

From 1990 through 1996, the declines in male lung cancer incidence and death rates were statistically significant (on average −2.6% and −1.6% per year, respectively) (Figs. 1 and 4). Male lung cancer incidence rates peaked in 1984 (86.5 per 100 000) and decreased on average −1.4% per year from 1984 through 1996 (P<.001). Male lung cancer death rates peaked in 1990 at 75.2 per 100 000. From 1994 through 1996, male lung cancer incidence and death rates were lower than in the period from 1991 through 1993 for all age groups (Figs. 6 and 7) and all histologic types (Fig. 8).

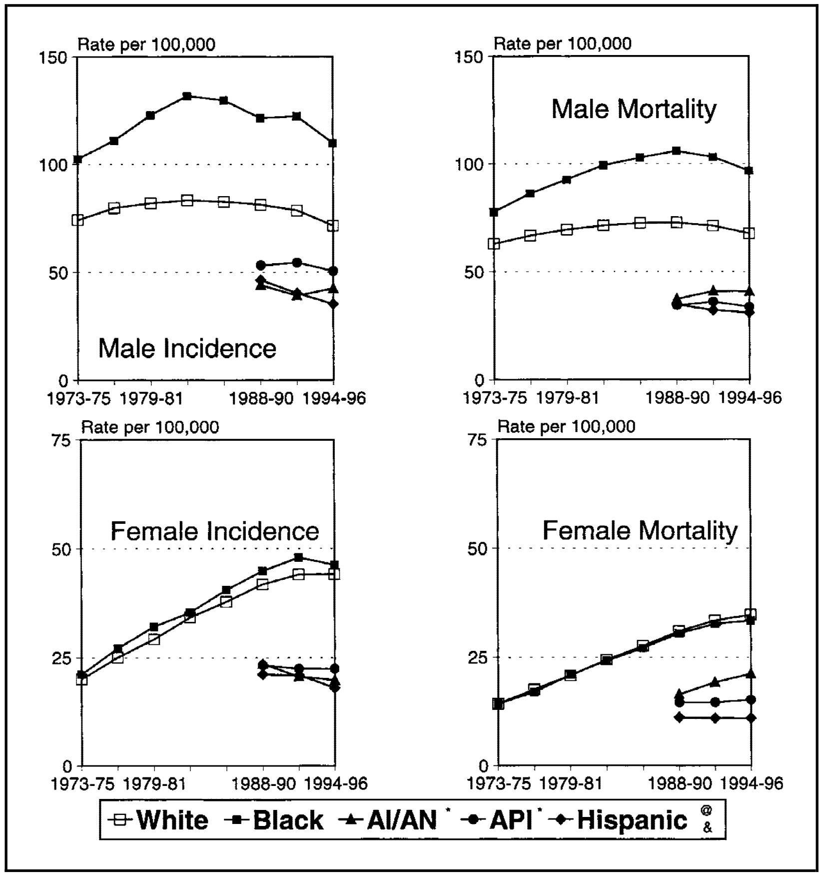
Further analyses by age revealed that, historically, lung cancer incidence rates initially began to decline in men diagnosed before age 50 years and then peaked and declined for each older age group in succession over time (Figs. 6 and 7). The earliest declines in male lung cancer incidence rates occurred among men diagnosed at ages 20–49 years in the mid- to late 1970s. Lung cancer incidence rates peaked in the period from 1979 through 1981 for males 50–59 years old at diagnosis, in the mid-1980s for males 60–79 years old, and in the early 1990s for males 80 years old and older. Age-specific death rates for male lung cancer followed temporal patterns similar to those for incidence, but peak years generally occurred later than for incidence (Fig. 7).

Declines by histologic type in males were also remarkable (Fig. 8). Large declines occurred among men who had squamous cell carcinoma and small-cell carcinoma, the histologic types most strongly associated with cigarette smoking *(20,21).* The rates for these histologic types have been decreasing since the early to mid-1980s for both black and white males (Fig. 8). Similarly, large-cell lung carcinoma has been decreasing among white males since the mid-1980s and among black males more recently (Fig. 8). Finally, rates of adenocarcinoma of the lung, which may be associated with using so-called "low tar" cigarettes *(22,23),* may have peaked in the early 1990s in males (Fig. 8). When these histology-specific trends over time were examined separately for men younger and older than age 65 years, the decreases were most pronounced among the younger men for all histologic types.

From 1990 through 1996, male lung cancer rates were decreasing in all racial and ethnic groups except American Indians/Alaska Natives (Fig. 9). The decreases in incidence rates were statistically significant for white and Hispanic males, and the decreases in death rates were statistically significant for white, black, and Hispanic males.

In contrast, overall female lung cancer incidence and death rates were increasing throughout the study period (Figs. 6 and 7). From 1990 through 1996, the average annual percent increase was +0.1% per year for incidence ($P = .70$) and +1.4% per year for mortality ($P < .001$) (Figs. 1 and 4). The average APC in female lung cancer incidence rates has slowed in recent years, and rates may have peaked in 1994 at 43.4 per 100 000. From 1994 through 1996, female lung cancer incidence rates appeared to be decreasing on average −1.3% per year, although this trend was not statistically significant. Female lung cancer death rates did not follow this same pattern.

Fig. 9. Cancer of the lung and bronchus: Surveillance, Epidemiology, and End Results (SEER)[1] incidence and U.S. death rates[+] by sex, race, and ethnicity, 1973–1996. [1]*See* "Notes" section for explanation of SEER (*see also* text); [+]rates are age adjusted to the 1970 U.S. standard million population and are based on 3-year groups except for 1988–1990 for American Indians/Alaska Natives, Asian and Pacific Islanders, and Hispanics, who have data only for 1990; *AI/AN refers to American Indians and Alaska Natives, and API refers to Asian and Pacific Islanders; [@]Hispanic is not mutually exclusive from whites, blacks, American Indians/Alaska Natives, and Asian and Pacific Islanders; [&]Hispanic death rates exclude deaths that occurred in Connecticut, Louisiana, New Hampshire, and Oklahoma.



We further examined female lung cancer incidence and death rates by age to assess whether, historically, the age-specific patterns of declines seen for males were beginning to occur in females. A downturn in female lung cancer incidence rates was most apparent for women aged 40–49 years and 50–59 years; incidence rates for these age groups peaked in the mid-1970s and late 1980s, respectively. From 1990 through 1996, incidence rates for women aged 60–69 years old were approximately level; for older women, they continued to increase (Fig. 6). Age-specific patterns of female lung cancer death rates were similar (Fig. 7).

Analyses of female lung cancer incidence by histologic type revealed that rates of squamous cell lung cancer have been approximately level since the mid-1980s, rates of small-cell lung cancer decreased from 1991 through 1996, rates of adenocarcinoma of the lung continued to increase (although the rate of increase may be slowing), and rates of large-cell lung cancer have been decreasing since the late 1980s (Fig. 8). The histologic patterns of disease were similar for both white and black women over time. Like the histology-specific trends over time in males, all decreases were more pronounced among women younger than age 65 years than among older women.

Finally, we examined trends in female lung cancer by race and ethnicity. From 1990 through 1996, incidence rates appeared to be level among white and Asian and Pacific Islander females and declining in the other racial and ethnic groups (Fig. 9); the only statistically significant decreasing trend was among Hispanic females (−3.2% per year). From 1990 through 1996, lung cancer death rates were statistically significantly increasing for white, black, and American Indian/Alaska Native females (Fig. 9).

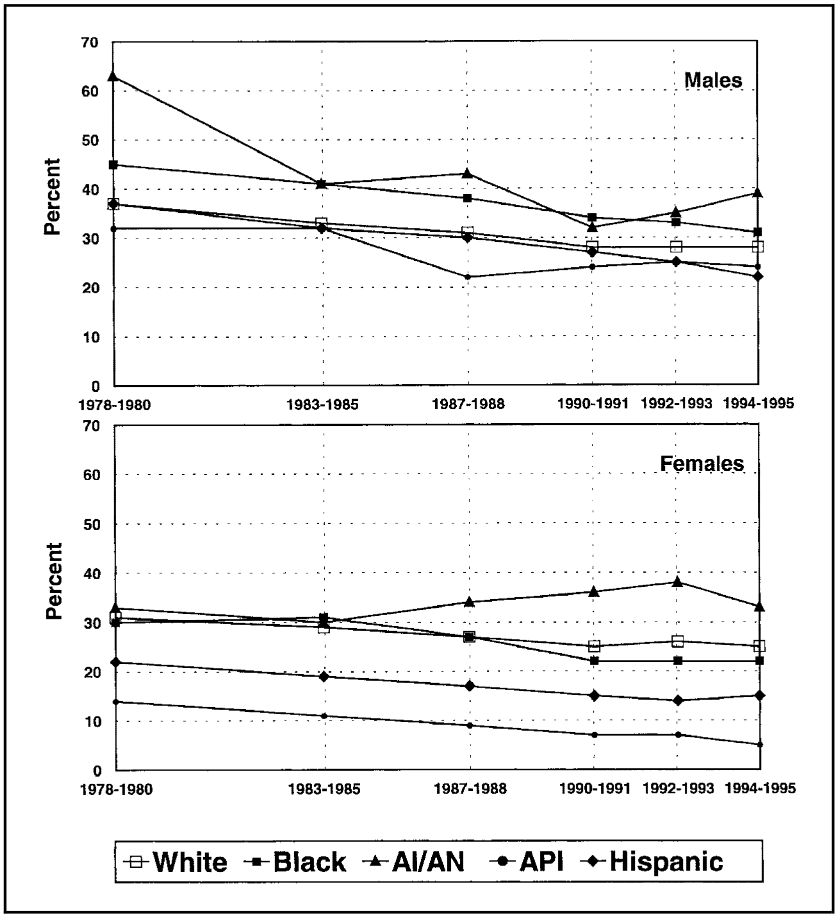
Tobacco smoking. According to the 1995 NHIS, about 47 million adults (24.7%) were current smokers in the United States, either daily (20.1%) or on some days (4.6%) *(14).* Men (27.0%) were more likely to smoke currently than women (22.6%); among racial and ethnic groups, American Indians/Alaska Natives had the highest prevalence (36.2%) and Asian and Pacific Islanders the lowest (16.6%). Smoking prevalence varied eightfold among females (from 4.3% among Asian and Pacific Islanders to 35.4% among American Indians/Alaska Natives) and less than twofold among males (from 21.7% among Hispanics to 37.3% among American Indians/Alaska Natives). The prevalence of current smoking varied inversely with education; high school dropouts had the highest prevalence (41.9% and 33.7% among males and females, respectively), and college graduates had the lowest (14.3% and 13.7% among males and females, respectively).

Although the prevalence of current cigarette use generally decreased over more than 30 years, the pattern of declines varied by sex and by race and ethnicity *(24).* From 1965 to 1985, smoking prevalence declined more rapidly among males than among females; rates in males decreased from 51.9% to 32.6% and in females from 33.9% to 27.9%. From 1985 to 1995, the rate of decline was similar for both sexes; the rate in males decreased from 32.6% to 27.0% and in females from 27.9% to 22.6%. From 1978 through 1995, smoking prevalence declined among blacks, Asians and Pacific Islanders, Hispanics, and whites (Fig. 10) *(25),* although the rate of decline appeared to slow in the 1990s. In contrast, smoking prevalence among American Indians/Alaska Natives did not change appreciably in males from 1983 through 1995 or in females from 1978 through 1995.

Trend analyses from the national YRBSS indicate that cigarette smoking prevalence among high school students in the United States increased statistically significantly from 27.5% in 1991 to 36.4% in 1997 *(17,18).* Prevalence increased from 30.9% to 39.7% among white students, from 12.6% to 22.7% among black students, and from 25.3% to 34.0% among Hispanic students. In 1997, the prevalence of current cigar use was 22.0%, and the overall prevalence of any use of cigarettes, cigars, or smokeless tobacco was 42.7%.

State-specific lung cancer mortality and tobacco smoking. Lung cancer death rates varied widely by state (Table 1). From 1990 through 1996, Kentucky experienced the highest lung cancer death rate for males (103.4 per 100 000), while Nevada had

Fig. 10. Trends in the age-adjusted prevalence of current cigarette smoking among adults, National Health Interview Surveys, United States, 1978–1995. Prevalence is age adjusted to the 1990 U.S. standard population. AI/AN refers to American Indians/Alaskan Natives, and API refers to Asian and Pacific Islanders.



the highest death rate for females (45.8 per 100 000) in the United States. Utah had the lowest lung cancer death rates for both sexes (31.5 per 100 000 among males and 13.9 per 100 000 among females). Lung cancer death rates in males greatly exceeded those in females in all states. From 1990 through 1996, male lung cancer death rates were decreasing in most states, with the largest statistically significant decrease occurring among males in Colorado. Exceptions to the decreasing rates among males occurred in Idaho, Kentucky, and South Dakota; the trends of increasing rates in these three states were not statistically significant. In contrast, female lung cancer death rates were increasing in most states during the same time period, with the largest statistically significant increase occurring in Rhode Island. Only Arizona, California, and Hawaii experienced any decrease in lung cancer death rates among females during this period, and none of these trends was statistically significant.

The prevalence of current smoking among adults in the United States also varied by state (Table 2) *(15)*. In 1997, Kentucky experienced the highest current smoking prevalence in the United States for adult males (33.1%), while Nevada had the highest smoking rates for adult females (29.8%). Utah had the lowest adult smoking rates for males (16.1%) and females (11.5%).

Cigarette use in the 30 days preceding the survey among youth also varied among the states and localities in the United States that provided data (Table 2). In 1997, the prevalence of current smoking among high school students was highest in Kentucky (48.4% for male students and 45.3% for female students) and lowest in Utah (17.4% for male students and 15.0% for female students).

Discussion

SEER Cancer Incidence and U.S. Cancer Mortality

This report confirms continuing declines in cancer incidence and cancer death rates during the 1990s. The decreases in incidence rates were greatest among males and occurred in most of the top 10 incidence sites; exceptions were cancer of the female breast, non-Hodgkin's lymphoma, melanoma, and cancer of the corpus and uterus NOS. Rates for most of the leading cancer mortality sites were declining; exceptions were cancer of the female lung and non-Hodgkin's lymphoma. Decreases in cancer death rates were statistically significant among males for all age groups under the age of 85 years. Among females, cancer death rates were significantly decreasing for women younger than age 65 years but were significantly increasing for women aged 75 years and older. The possible reasons for these decreases have been described previously *(4)*, although some concerns about the completeness of case ascertainment persist, particularly for melanoma and prostate cancer, which are frequently diagnosed in out-of-hospital settings, and for cancers diagnosed through pathology reviews that are conducted out of state instead of within the hospital.

Our study reports cancer incidence and mortality statistics separately for white, black, Asian and Pacific Islander, American Indian/Alaska Native, and Hispanic populations. However, we did not address the occurrence of cancer in rural populations, in populations of low socioeconomic status or low education, or in populations with limited access to health care. Our inclusion of cancer incidence statistics for American Indian/Alaska Native populations is based primarily on residents of New Mexico and Alaska. Cancer rates vary considerably among American Indian *(26)* and Alaska Native *(27)* populations. Alaska Natives, for example, have the highest cancer death rates of all populations served by the Indian Health Service. Lung cancer incidence rates in Alaska Natives have increased substantially since the 1960s and show no evidence of slowing, particularly when smoking behaviors are taken into consideration *(28)*. Between 42% and 46% of Alaska Native men were smoking compared with 26%–27% of non-Alaska Native men; the comparable smoking percentages for Alaska Native and non-Alaska Native women were 36% and 23%, respectively *(29)*.

Continued higher incidence and death rates among some racial and ethnic groups may be an indication that some populations have not benefited equally from cancer prevention and control efforts. Such disparities may be due to multiple factors, such as late stage of disease at diagnosis, barriers to health care access, a history of other diseases, biologic and genetic differ-

Table 1. Cancer of the lung and bronchus, death rates by state, 1990–1996

State	Males, 1990–1996		Females, 1990–1996		Total, 1990–1996	
	Death rates*	APC†	Death rates*	APC†	Death rates*	APC†
Alabama	87.8	−2.1‡	29.8	3.8‡	54.1	−0.3
Alaska	66.3	−1.8	39.8	1.3	52.4	−0.6
Arizona	61.5	−1.2	31.8	−0.1	45.0	−0.7
Arkansas	96.4	−0.7	35.3	0.7	61.8	−0.2
California	57.4	−2.7‡	33.6	−0.3	43.8	−1.6‡
Colorado	51.3	−2.9‡	25.2	0.6	36.3	−1.5‡
Connecticut	60.6	−1.6	32.5	1.5‡	44.0	−0.2
Delaware	84.0	−1.5	42.0	2.9‡	59.9	0.3
District of Columbia	80.2	−1.0	33.7	0.3	52.5	−0.5
Florida	71.4	−1.4‡	35.5	0.7	51.4	−0.5‡
Georgia	88.2	−1.6‡	30.9	1.9‡	54.5	−0.4
Hawaii	46.2	−1.0	22.7	−0.2	33.8	−0.8
Idaho	50.4	0.2	27.6	0.6	37.8	0.5
Illinois	74.2	−1.1‡	33.7	2.3‡	50.7	0.3
Indiana	82.6	−1.2‡	35.8	2.2‡	55.4	0.1
Iowa	67.1	−0.5	29.1	3.1‡	45.2	0.8
Kansas	67.6	−2.0‡	30.0	3.7‡	46.1	0.1
Kentucky	103.4	0.9	41.9	2.0‡	67.9	0.2
Louisiana	95.0	−2.5‡	35.6	1.2	60.5	−1.2
Maine	79.7	−1.2	39.1	2.9‡	56.4	0.6
Maryland	77.0	−2.1‡	38.0	0.9	54.4	−0.8
Massachusetts	66.9	−0.9	35.4	2.4‡	48.2	0.6
Michigan	73.2	−1.2‡	34.3	2.0‡	50.8	0.1
Minnesota	55.3	−1.4‡	28.2	2.9‡	39.7	0.3
Mississippi	91.9	−0.8	30.2	3.1	56.0	0.4
Missouri	82.8	−1.2‡	35.5	2.2‡	55.6	0.1
Montana	58.8	−1.7‡	31.8	1.9	43.7	−0.2
Nebraska	63.6	−1.6	27.2	2.3	42.9	−0.1
Nevada	72.3	−1.9	45.8	0.7	58.0	−0.7
New Hampshire	70.2	−1.7	37.5	3.9‡	51.2	0.7
New Jersey	67.8	−2.4‡	34.1	1.1‡	48.1	−0.9‡
New Mexico	47.6	−2.6	24.5	1.0	34.7	−1.2
New York	63.9	−1.9‡	32.0	0.4	45.2	−0.9‡
North Carolina	85.9	−0.4	30.3	2.8‡	53.5	0.8
North Dakota	56.2	−0.4	25.0	1.6	38.8	0.3
Ohio	79.5	−1.4‡	35.9	2.2‡	54.2	0.0
Oklahoma	84.0	−0.8	34.6	1.6‡	55.7	0.1
Oregon	66.0	−2.5‡	39.3	0.5	50.8	−1.2‡
Pennsylvania	71.9	−1.1‡	32.0	1.1‡	48.7	−0.2
Rhode Island	74.9	−0.2	34.5	4.4‡	51.1	1.6‡
South Carolina	84.8	−1.8‡	29.9	1.8	52.9	−0.6
South Dakota	59.5	2.2	26.4	1.4	41.0	2.0
Tennessee	95.5	−0.9‡	33.6	2.8‡	59.7	0.4
Texas	75.8	−2.0‡	32.7	1.2‡	51.1	−0.8‡
Utah	31.5	−2.6	13.9	2.3	21.7	−0.8
Vermont	68.3	−4.1	34.2	2.9	48.8	−1.3
Virginia	79.8	−1.7‡	33.9	1.6‡	53.1	−0.4
Washington	64.3	−2.4‡	36.8	0.7	48.7	−1.1‡
West Virginia	89.1	−2.0‡	40.3	2.1	60.9	−0.5
Wisconsin	59.8	−1.9‡	28.2	1.6‡	41.8	−0.5
Wyoming	56.5	−1.0	29.8	3.4	41.6	0.7
United States	71.9	−1.6‡	33.2	1.4‡	49.7	−0.4‡

*Per 100 000 and age adjusted to the 1970 U.S. standard million population.
†APC = annual percent change. Based on sex-specific data.
‡APC is significantly different from zero (two-sided *P*<.05).

ences in tumors, health behaviors, and the presence of risk factors. A commitment to reducing morbidity and mortality from cancer in the United States will require concomitant dedication to bridging racial and ethnic disparities related to cancer incidence and mortality. In the future, expanded study of special populations should be possible through analyses of data aggregated for the North American Association of Central Cancer Registries *(30)*. As the number of state cancer registries that contribute data to the North American Association of Central Cancer Registries increases and the quality of registry data improves, more representative data (e.g., Native American and other racial and ethnic populations and populations in the Southeastern United States, Appalachia, and other geographic locations) should become available.

Limitations of Cancer Incidence and Mortality Data

For the primary analyses, we estimated APC statistics for the 1990s. Because these statistics were computed over the time interval from 1990 through 1996, the assumption that rates increased or decreased at a constant rate over time did not apply to both sexes, all sites, or all populations analyzed. There are two issues here: the peak year and whether or not the data are linear

Table 2. Prevalence of current cigarette use in adults and youth, by state, 1997

State	Current cigarette use in adults, %, 1997, BRFSS*			Current cigarette use in youth, %, 1997, YRBSS†		
	Males	Females	Total	Males	Females	Total
Alabama	28.6	21.3	24.7	39.5	32.2	35.8
Alaska	27.4	25.8	26.7			
Arizona	22.1	20.2	21.1			
Arkansas	32.1	25.2	28.5	45.6	40.8	43.2
California	22.4	14.5	18.4	28.6‡	24.8‡	26.6‡
Los Angeles				27.5	25.5	26.5
San Diego				25.5	23.0	24.2
San Francisco				20.2	17.8	19.1
Colorado	24.0	21.2	22.6	35.2‡	38.1‡	36.6‡
Connecticut	21.4	22.2	21.8	34.0	36.5	35.2
Delaware	29.3	24.2	26.6	36.1‡	34.0‡	35.0‡
District of Columbia	22.7	15.5	18.8	24.3	21.3	22.7
Florida	26.0	21.4	23.6	32.8‡	34.4‡	33.6‡
Ft. Lauderdale				25.3	24.7	25.0
Miami				27.0	22.9	25.0
Georgia	25.2	19.9	22.4			
Hawaii	21.4	15.8	18.6	27.4	30.7	29.2
Idaho	21.8	18.0	19.9			
Illinois	25.0	21.6	23.2			
Chicago				27.4	26.2	26.8
Indiana	29.2	23.7	26.3			
Iowa	25.5	20.9	23.1	39.6	35.4	37.5
Kansas	26.8	18.9	22.7			
Kentucky	33.1	28.7	30.8	48.4	45.3	47.0
Louisiana	29.3	20.4	24.6	38.2	34.6	36.4
New Orleans				27.7	18.1	22.6
Maine	25.2	20.4	22.7	37.7	40.8	39.2
Maryland	21.8	19.4	20.6			
Baltimore				23.0‡	16.1‡	19.2‡
Massachusetts	21.8	19.2	20.4	33.0	35.8	34.4
Boston				18.3	19.6	19.0
Michigan	29.6	22.8	26.1	38.2	38.2	38.2
Detroit				24.3	19.8	21.8
Minnesota	24.1	19.8	21.8			
Mississippi	28.3	18.6	23.2	37.6	25.4	31.3
Missouri	31.7	26.0	28.7	39.7	40.8	40.3
Montana	20.8	20.2	20.5	38.8	37.3	38.1
Nebraska	24.4	20.2	22.2			
Nevada	25.7	29.8	27.7	28.3	30.3	29.4
New Hampshire	26.0	23.7	24.8	36.3‡	42.5‡	39.6‡
New Jersey	23.3	19.8	21.5	36.7‡	38.8‡	37.9‡
Jersey City				30.7	28.0	29.4
Newark				25.4‡	23.7‡	24.4‡
New Mexico	21.6	22.6	22.1			
New York	25.0	21.5	23.1	32.7	33.1	32.9
New York City				22.8	23.9	23.4
North Carolina	29.7	22.3	25.8	37.6‡	34.1‡	35.8‡
North Dakota	24.3	20.3	22.2	43.2‡	46.8‡	45.0‡
Ohio	26.4	24.0	25.1	36.9	32.0	34.5
Oklahoma	25.2	24.1	24.6			
Oregon	22.1	19.4	20.7			
Pennsylvania	26.2	22.5	24.3			
Philadelphia				30.6	26.4	28.5
Rhode Island	25.6	23.0	24.2	35.3	35.4	35.4
South Carolina	29.5	17.8	23.4	40.6	36.5	38.6
South Dakota	28.1	20.8	24.3	44.3	43.6	44.0
Tennessee	27.9	26.0	26.9	39.6‡	38.0‡	38.6‡
Texas	28.0	17.5	22.6			
Dallas				27.3	18.0	22.5
Houston				37.3	22.2	29.1
Utah	16.1	11.5	13.7	17.4	15.0	16.4
Vermont	25.1	21.5	23.2	37.8	38.8	38.3
Virginia	26.2	23.1	24.6			

(Table continues)

Table 2 (continued). Prevalence of current cigarette use in adults and youth, by state, 1997

State	Current cigarette use in adults, %, 1997, BRFSS*			Current cigarette use in youth, %, 1997, YRBSS†		
	Males	Females	Total	Males	Females	Total
Washington	25.1	22.7	23.9			
West Virginia	27.1	27.7	27.4	42.4	41.3	41.9
Wisconsin	25.6	21.0	23.2	39.8	31.7	36.0
Wyoming	24.0	24.1	24.0	38.1	36.7	37.4
United States	25.7§	20.7§	23.1§	37.7‖	34.7‖	36.4‖

*BRFSS = Behavioral Risk Factor Surveillance System, adults 18 years old or older who have ever smoked 100 cigarettes in their lifetime and who now smoke everyday or on some days.

†YRBSS = Youth Risk Behavior Surveillance System, students in grades 9–12 who smoked cigarettes on 1 or more days of 30 days preceding the survey.

‡Prevalence estimates are unweighted and apply only to students participating in the survey.

§United States, including Washington, DC.

‖YRBSS = national survey.

throughout the time interval. First, we were unable to choose a single year as the downturn year for the different groups included in the analyses because the peak year differed across groups. For example, female incidence and mortality rates for all sites combined peaked in 1991. By comparison, mortality rates in males peaked in 1990 and incidence rates in 1992. To address the concerns about the linear increase or decrease over time, we also provided trend analyses based on the peak years for the major cancers. Although this approach may have satisfied the required statistical assumptions for these sites, direct comparisons of trends involving different peak years are inappropriate. Second, because the estimated APC statistics based on the time interval from 1990 through 1996 were not linear for all analysis groups, the statistical significance of the *t* test for the beta coefficient may be overstated or understated. There is also some random variation in rates across years. However, trends based on the period from 1990 through 1996 may be compared across the cancer sites, sexes, racial and ethnic populations, and other groups as necessary.

Assessments of the absolute and comparative levels of cancer incidence and death rates by race and ethnicity need to be tempered by the recognition of potential year-to-year random variation in the rates and biases in the basic data. First, the listing of the top 10 sites (Fig. 3) may vary from year to year because of small random differences in rates across sites for a specific racial or ethnic population, particularly for Native Americans. For example, the rate and SE of the incidence rate for all sites combined for American Indians/Alaska Natives are 194.9 per 100 000 (SE = 3.2) compared with 402.9 per 100 000 (SE = 0.4) for whites. Second, biases result from misreporting race and ethnicity and, to a lesser extent, age on the basic records used to collect information on cancer incidence, mortality, and the population at risk *(31–34)*. Rates may be biased because of misreporting on death certificates *(31)* and hospital medical records, which comprise the numerators of the cancer death and incidence rates, respectively, and on censuses and surveys, which comprise the denominators of the rates. Evaluation studies *(32,34)* suggest that the reporting of race for the white and black population is generally reliable. However, biases are serious for the smaller populations, particularly for American Indians *(32,34)*. While these biases affect comparisons among groups at a specified point in time, the trend data for both morbidity and mortality are considered to be relatively reliable.

Lung Cancer and Tobacco Smoking

As much as 90% of all lung cancer is caused by tobacco smoking, including active cigarette smoking, pipe and cigar smoking, and exposure to second-hand smoke *(35,36)*. Other factors, such as exposure to radon and asbestos, also increase risk *(37)*. The epidemic of lung cancer in this century largely reflects birth cohort patterns of active cigarette smoking *(38,39)*. At the turn of the century, lung cancer was a rare disease *(40,41)*. To understand the evolution of the epidemic of lung cancer in this country, one must understand the time during which manufactured cigarettes were introduced, the successive increases in cigarette smoking by generations of first men and then women, and the 20- to 50-year delay between the uptake of regular smoking and the occurrence of lung cancer *(39)*.

The large increase in the consumption of manufactured cigarettes during the first half of the 20th century is best reflected in population consumption data. Per capita consumption increased from approximately 54 cigarettes per adult in 1900 *(42,43)* to a peak of 4345 cigarettes per adult in 1963 *(42,44)*. Cigarettes were an uncommon form of tobacco use early in the century. Of the nearly 7.5 pounds of tobacco consumed per adult in 1900, only 0.16 pound (about 2%) was consumed in the form of mass-produced cigarettes. Factors that contributed to increased consumption of manufactured cigarettes included the introduction of cigarettes blended from flue-cured tobaccos (which facilitated inhalation into the lungs and more efficient absorption of nicotine) *(45)*, such as Camel in 1913, advertising, and a more efficient marketing and distribution network, including the free distribution of cigarettes in World War I and World War II *(44,45)*.

The uptake in cigarette smoking occurred first among men and later among women and then for several decades followed a generational pattern in which successive birth cohorts began smoking at progressively younger ages with a larger proportion of adults becoming smokers *(44)*. Among men born from 1895 through World War II, between 70% and 80% were cigarette smokers some time during their lifetime, and many smoked heavily. In contrast, few women born before 1900 became heavy cigarette smokers, and only about 10%–20% reported ever smoking. The prevalence of smoking in women lagged behind men and reached the peak of 55% in the cohort of women born from 1935 through 1944. In addition, among older birth cohorts, men and women differed substantially by the age at which they started to smoke. For example, among women born prior to 1900, the mean age of initiation was well over age 30 years *(46).* Almost all birth cohorts of males and younger birth cohorts of females began smoking before age 20 years, although the majority of females who started smoking as teenagers began smoking after World War II.

Because experimentation with cigarette smoking and nicotine addiction usually occurs in adolescence or during early adulthood, patterns of smoking behaviors tend to persist as a birth cohort ages. This accounts for the clear birth cohort progression in smoking prevalence and the progression in age-specific lung cancer incidence and death rates 20–50 years later. The patterns of declining lung cancer in males and the leveling off and possible future decline in females as reported in this analysis reflect historical patterns of cigarette smoking, as did the age- and sex-specific increases in lung cancer observed earlier in this century *(38,39).*

Several current trends in tobacco smoking, if unchecked, will worsen the future occurrence of lung cancer. First, the number of adults currently smoking cigarettes in the United States (47 million) remains high *(14),* and adult prevalence has changed little from 1993 to 1997 *(14,47).* Second, increasing trends in tobacco smoking among adolescents during the 1990s can only be considered alarming *(18,48,49),* although data collected in 1998 suggest that prevalence may be declining slightly *(48).* Finally, cigar consumption (mainly large cigars) increased by about 50% from 1993 to 1997, reversing an almost 20-year decline *(50).* Cigar use has regained acceptance among better-educated, upper-income men and women, especially among those 18–34 years old who previously had eschewed cigarettes *(24,50);* in 1997, about one in five high school students smoked cigars *(18).* Cigar smoking can cause lung cancer, as well as oral, esophageal, and laryngeal cancers *(50–52).*

Limitations of Data on Tobacco Smoking

Prevalence estimates of tobacco smoking in adults may have some limitations. Because interviews are conducted by telephone in BRFSS, the estimates of adult tobacco smoking can be generalized only to the population of persons with telephones. However, a recent analysis of NHIS data *(53)* compared responses regarding health risk behaviors from households with telephones with responses from all households in the survey. In 1992, the difference in the prevalence of current cigarette smokers for respondents from all households compared with respondents from telephone households was small (25.4% versus 24.4%, respectively). Another study compared estimates of adult smoking prevalence from BRFSS with personal interviews from the Bureau of the Census Current Population Survey *(54)* that has collected data on smoking prevalence for all 50 states and the District of Columbia in the years 1985, 1989, 1993, and 1996 *(55,56).* In general, findings from the two surveys were similar, although differences were more pronounced in findings for males and blacks and also for Southern states where telephone coverage was lower *(54).* In 1990, according to the U.S. Bureau of the Census *(57),* telephones were present in the homes of 96% of whites, 87% of blacks, 98% of Asians and Pacific Islanders, 77% of American Indians, Eskimos, or Aleuts, and 88% of Hispanics. Differences in telephone coverage are relevant, since cigarette smoking prevalence may be higher in persons from homes without telephones than in persons from homes with telephones *(58).*

Prevalence estimates for tobacco smoking in youth from YRBSS also have limitations. Because state surveys are conducted among public high school students, the estimates can be generalized only to youth attending public school in the respective jurisdictions *(17).* Compared with those enrolled in school, youth who are not in school have higher rates of tobacco use *(59).* However, in 1996, only 6% of persons aged 16–17 years were not enrolled in a high school program and had not completed high school *(60).*

Tobacco Advertising

The tobacco industry has a long history of targeting marketing campaigns to selected groups in the U.S population and abroad. The earliest cigarette-marketing practices were directed at men; however, by 1928, advertising campaigns targeted women, often with themes linking cigarette smoking to weight control *(44).* In 1996, the cigarette industry spent $5.1 billion on advertising and promoting its products to virtually all segments of society *(61).* Special target populations include women *(44,62–64),* racial and ethnic populations *(25,62,65),* and blue-collar workers *(62).* Adolescents are especially susceptible to cigarette marketing *(59,62,66–69).* Brands that are popular among adolescents are more likely than adult brands to be advertised in magazines with high youth readership *(70).*

Cigarette companies have also appealed to health-conscious smokers with so-called “low tar” brand cigarettes *(71).* Tar, nicotine, and carbon monoxide levels in U.S. cigarettes have been determined by the U.S. Federal Trade Commission (FTC) since the mid-1960s and are derived from a fixed, machine-based testing protocol. The FTC testing method, however, does not take into account how smokers adjust their smoking patterns to obtain nicotine from cigarettes. To get their required level of nicotine, smokers of low tar and low nicotine cigarettes tend to take more and longer puffs per cigarette, inhale more deeply, and block ventilation holes on the filters, which thereby negates the reason for their switching to low tar brands *(71).* The increased promotion of cigarettes yielding 15 mg tar or less (as measured by the FTC method) was followed by an increased U.S. market share of these products *(61,62)* from 3.6% of all cigarettes sold in 1970 to 44.8% by 1980 *(71)* and 72.7% in 1995 *(61).* Recent studies suggest that smokers’ perceptions of tar yields may be influenced by misleading advertising terms such as “light” and “ultra-light” *(72)* and that mistaken beliefs about low tar brands may reduce intentions to quit *(71,73).* Following the shift to lower tar cigarettes, there was a parallel increase in adenocarcinoma of the lung, which has now become the most common lung cancer type in the United States *(22,23).* The U.S. Department of Health and Human Services, in collaboration with the FTC, is currently conducting a review of the FTC’s testing methods.

Strategies for the Future

Trends of decreasing incidence and death rates for the leading cancer sites are encouraging. However, to meet national goals for reducing the morbidity and mortality due to cancer *(74,75),* increased efforts are needed to identify additional cancer prevention and control strategies, to implement more completely the interventions that have worked well in the past, and to reach all segments of society.

Because lung cancer accounts for approximately 14% of new cancer cases and 28% of cancer deaths each year *(19),* the largest impact can be made through programs and policies that deter smoking initiation, promote cessation, and protect nonsmokers from environmental tobacco smoke *(36,76–80)*. Efforts to prevent initiation include 1) reducing minors' access to and the appeal of tobacco products, 2) widely disseminating effective school-based tobacco use prevention curricula, which would optimally be combined with community- and media-based strategies, and 3) increasing the support and involvement of parents *(49,59,81)*. Raising the cost of tobacco products can also reduce initiation and promote quitting *(36,59,82)*. In addition, using excise taxes to finance community interventions and mass-media strategies can be especially effective in reducing consumption, as demonstrated in California and Massachusetts *(77,83–85)*. The widespread dissemination of proven quitting strategies, including reimbursement for safe and effective therapies on the part of health care insurers and managed care organizations, can also facilitate quitting *(79,80,86)*. Smoke-free laws and policies protect people from the toxic and carcinogenic chemicals in environmental tobacco smoke and also establish smoke-free air as the norm *(87–89)*. Health professionals need to continue to monitor the patterns, determinants, and consequences of tobacco use. Increased awareness of the activities of tobacco product manufacturers (e.g., product innovations and marketing practices) and related environmental influences (e.g., economics, policy and legislation, and social norms) are needed to facilitate appropriate public health actions. Finally, new advances in genetics may lead to a better understanding of tobacco addiction and ultimately to more effective cessation strategies.

The rapid increase in cigarette smoking that occurred during the first half of this century was responsible for the epidemic of lung and other tobacco-related cancer deaths in the last half of the century, first among men and a generation later among women. Male lung cancer deaths and death rates are now declining, and recent data for women show a slowing in the rate of increase, suggesting an eventual decline in their lung cancer rate as well. While these data are extremely encouraging, several notes of caution are in order. Lung cancer is almost exclusively a smoker's disease, and both incidence and mortality are directly related to the degree of cigarette use that occurs in a population. However, the leveling off of tobacco smoking in the 1990s among adults, the alarming trends among teens, and the increased popularity of cigar use may contribute to higher prevalence of long-term smoking among adults in the future. Specifically, unless steps are taken now to lower adolescent initiation rates dramatically, the current positive trends in lung cancer could reverse, and future cohorts could again experience a rise in lung cancer.

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Notes

[1]*Editor's note:* SEER is a set of geographically defined, population-based central tumor registries in the United States, operated by local nonprofit organizations under contract to the National Cancer Institute (NCI). Each registry annually submits its cases to the NCI on a computer tape. These computer tapes are then edited by the NCI and made available for analysis.

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