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Descriptive Epidemiology

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Introduction

Cancer was the eighth leading cause of death in the United States (US) in 1900 [1], but has been the second leading cause of death, after heart disease, during the last half of the twentieth century, accounting for approximately one in every four deaths [2]. Despite its prevalence throughout history, the recording of cancer incidence at the population level has only been available in the US since the mid-1970s.

Cancer Surveillance in the US

Cancer surveillance is the systematic collection and analysis of data about cancer diagnoses, including information about the patient (e.g., date of birth, sex, race), the tumor (e.g., site of origin, stage, histology), and the initial course of treatment. Cancer registration is useful to the public health in many important ways. These data are used to measure cancer occurrence in the population, including incidence, mortality, survival, and patterns of care; to plan and evaluate cancer control programs; to prioritize the allocation of healthcare resources; and to advance population-based epidemiologic and health services research. Population-based cancer statistics can also be used to corroborate medical hypotheses. For example, the rapid rise and fall of endometrial cancer incidence rates that mirrored the rise and fall in the use of unopposed estrogen as menopausal hormone therapy affirmed the association between estrogen and endometrial cancer risk [3,4]. Likewise, the dramatic 7% decline in breast cancer incidence from 2002 to 2003 reflects the abrupt decrease in menopausal hormone use after the Women's Health Initiative study reported its association with increased breast cancer risk [5,6].

The coverage and quality of cancer surveillance data have improved greatly over time. The current system of cancer registration in the US involves hospital registries, which furnish data for the evaluation of care within the hospital, and population-based registries, which are usually associated with state health departments or related institutions. Hospital registries also serve as the primary data source for central state registries. The cancer registrar carries the major responsibility for data collection and other day-to-day registry operations [7]. As patients are increasingly being diagnosed and treated in outpatient settings, case finding by cancer registrars at central registries has expanded to other medical facilities, including physician offices, pathology laboratories, and freestanding treatment centers.

Registry operations and the quality of the data collected by the registrar are guided by standards established by the Commission on Cancer (CoC) of the American College of Surgeons, the Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute (NCI), the National Program of Cancer Registries (NPCR) of the Centers for Disease Control and Prevention (CDC), the American Joint Committee on Cancer (AJCC), and the North American Association of Central Cancer Registries (NAACCR).

Surveillance, Epidemiology, and End Results Program

The NCI's SEER Program was established as a result of the National Cancer Act of 1971, which mandated the collection, analysis, and dissemination of data to aid in the prevention, treatment, and diagnosis of cancer in the US [8]. Case ascertainment began on January 1, 1973. The original catchment area, known as SEER 9, covered 9% of the US population and included registries in five states (Connecticut, Iowa, New Mexico, Utah, and Hawaii) and four metropolitan areas (Detroit, Michigan; San Francisco–Oakland, California; Atlanta, Georgia; and Seattle–Puget Sound, Washington). The SEER 9 data are the only source for long-term, population-based cancer incidence and survival trends in the US. The SEER program expanded over

The American Cancer Society's Principles of Oncology: Prevention to Survivorship, First Edition. Edited by The American Cancer Society.

time to include 18 registries covering 28% of the population, including 26% of African Americans, 38% of Hispanics, 44% of American Indians and Alaska Natives, 50% of Asians, and 67% of Hawaiian/Pacific Islanders [9]. Since its inception, quality control has been an integral component of the SEER program, which is considered the gold standard for cancer registration around the world. Cancer incidence and survival data from SEER and cancer mortality data from the National Center for Health Statistics are published annually in the *SEER Cancer Statistics Review*.

National Program of Cancer Registries

In 1992, Congress enacted the Cancer Registries Amendment Act to establish the NPCR at the CDC [10]. At the time this legislation was passed, 10 states had no cancer registry and most states with registries lacked the resources necessary to achieve minimum reporting standards. Today, NPCR supports central cancer registries in 45 states, the District of Columbia, Puerto Rico, and the US Pacific Island Jurisdictions [11]. Together, the SEER Program and NPCR collect and disseminate data that approaches 100% coverage of the US population.

North American Association of Central Cancer Registries

The NAACCR was established in 1987 as an umbrella organization to provide support to cancer registries and tumor registrars in the US and Canada. The organization works collaboratively with government agencies, professional associations, and private and nonprofit organizations toward the compatibility of cancer registry data. The NAACCR sets reporting standards, certifies central registries based on data quality criteria, and aggregates and distributes surveillance data for epidemiologic research. Registry-specific and combined national cancer incidence rates for the US have been published annually in *Cancer Incidence in North America* (*CINA*) for the past 26 years.

National Cancer Data Base

In contrast to population-based SEER and NPCR registries, the National Cancer Data Base (NCDB) is a hospital-based registry jointly sponsored by the American Cancer Society and the American College of Surgeons. The NCDB includes approximately 70% of all cancer diagnoses in the US from more than 1,400 hospitals accredited by the American College of Surgeons' CoC [12]. The database was established in 1989 and now contains more than 26 million records. One of the primary purposes of the NCDB is to provide information back to CoC treatment facilities about their quality of care. Additionally, the NCDB is a rich data source for cancer epidemiologists who study outcomes because it contains standardized data on patient demographics and insurance status; cancer type, histology, and staging; and first course of treatment. However, these data are somewhat limited for research purposes because they are not representative of the general population and because cancer cases that tend to be diagnosed and treated in nonhospital settings (e.g., melanoma and prostate cancer) are less likely to be captured.

National Center for Health Statistics

The National Center for Health Statistics (NCHS) is an agency within the CDC that serves as the principal repository for vital and health statistics in the US. State legislation requires that death certificates be completed for all deaths, and federal legislation requires national collection and reporting of deaths. Causes of death and other patient information are reported by certifying physicians on standard death certificates filed in the states and then processed and consolidated by the NCHS. For cancer mortality statistics, the underlying cause of death is classified according to the procedures specified by the World Health Organization's International Classification of Diseases (ICD) codes, which are periodically updated and currently in the 10th revision.

Measuring the Cancer Burden

The key measures for describing the occurrence of cancer are prevalence, incidence, mortality, and survival. Incidence and mortality data are also used by American Cancer Society researchers to estimate the number of new cancer cases and cancer deaths that will occur in the US in the current year [13,14]. These estimates are useful because cancer incidence and death data lag 2–4 years behind the current year due to the time required for collection, compilation, quality control, and dissemination. While these model-based projections are not informative for tracking temporal trends, they provide an estimate of the contemporary cancer burden and are widely cited by researchers, cancer control advocates, and public health planners.

Prevalence

Cancer prevalence refers to the number of individuals living in a population with a previous cancer diagnosis. It is a mixture of new and pre-existing cases, and thus is a function of incidence and survival. Population prevalence may be estimated for diagnoses within a specified time period (limited-duration) or for all diagnoses (complete). The complete prevalence estimate is often referred to as the number of cancer survivors.

Incidence

Cancer incidence is the number of newly diagnosed cases during a specified time period in a defined population. It is usually expressed as an annual rate per 100,000 population such that the numerator is the number of new cancer cases and the denominator is the size of the population at risk. For example, the denominator for cancers that only occur in one sex is the sex-specific population. Sometimes the appropriate denominator is not straightforward. For example, the population at risk for uterine cancer is not the entire female population, but the fraction of women (approximately 80%) who have not had a hysterectomy (surgical removal of the uterus). Routine reporting of uterine cancer incidence rates typically fail to account for hysterectomy and thus substantially underestimate the burden of this disease [15].

Cancer registry data are corrected and updated over time due to delays or errors in case reporting. To account for the effect of

reporting delays on registry data, NCI and NAACCR provide delay-adjusted rates. Delay-adjustment has the largest effect on data in the most recent time period for cancers that are frequently diagnosed in outpatient settings, such as melanoma, leukemia, and prostate cancer [16]. For example, leukemia incidence rates in the most recent reporting year are 14% higher after delay-adjustment [8]. Cancer incidence rates presented in this chapter were adjusted for delays in reporting whenever possible.

Mortality

Cancer mortality refers to the number of individuals who die from cancer during a specified time period in a defined population. Like incidence, it is typically expressed as an annual rate per 100,000 population such that the numerator is the number of cancer deaths in a given year and the denominator is the population size. The cancer death rate represents the risk of death among the entire population as opposed to the risk specifically among cancer patients. Therefore, it is a function of both incidence and survival.

Cancer death rates are calculated based on information obtained from death certificates, including age at death, sex, place of residence, and underlying cause of death. On the US Standard Certificate of Death, the underlying cause of death is the disease or injury that initiated the chain of events leading to death, as opposed to the final disease condition. For example, the death of a patient who died from sepsis as a result of lung cancer would be coded as lung cancer. The accuracy of death certificate data depends on the cause of death (e.g., rapidly fatal diseases are recorded more accurately) and the physician who records the death (e.g., attending physician versus the coroner).

Age Standardization

The risk of cancer diagnosis or death increases exponentially with age. For this reason, cancer-related vital statistics are conventionally reported as either age-specific or age-standardized rates. Age-standardized rates have been weighted to a common population age distribution to eliminate the effect of age on cancer rates and allow valid comparison between populations with different age structures. For example, without age-standardization, the risk of cancer appears much higher in Florida (572 per 100,000) than in Alaska (370 per 100,000) because Florida has a much older population. However, after age adjustment, the incidence rates in these states are quite similar (438 versus 432 per 100,000, respectively). Current cancer incidence and death rates for the US are generally weighted to the 2000 US standard population [17] unless they are being compared to international rates, when the world standard population is used.

Survival

The cancer survival rate is the percentage of patients who are alive at a specified time following cancer diagnosis, usually 5 years. There are several different methods of calculating survival. Observed survival represents overall survival and includes death from cancer as well as other causes. Relative survival is the ratio of the proportion of survivors in a cohort of cancer patients to the proportion of expected survivors in a comparable group of cancer-free individuals [18]. For example, a relative survival rate of 100% indicates that the likelihood of survival after a cancer diagnosis is the same as survival in the general population. Cancer-specific survival is the probability of surviving cancer in the absence of other causes of death [19]. Relative and cancer-specific survival are measures of net survival because they estimate cancer survival in the absence of death from other causes.

Relative survival is the measure most often presented in cancer surveillance reports because it is useful for tracking trends and comparing survival between populations. It is typically expressed as a 5-year rate, although it may be presented for 10 or even 15 years postdiagnosis for less fatal cancers.

Although survival rates are useful for monitoring progress in the early detection and treatment of cancer, they have several limitations and should be interpreted with caution. First, they do not reflect the most recent advances in treatment because they are based on the experiences of patients who were diagnosed several years ago due to both the lag time in data reporting (typically 2–4 years) and the necessity for sufficient follow-up time. Second, survival statistics are not useful for predicting individual prognosis because factors that strongly influence survival, such as treatment protocols, comorbidities, and biological and behavioral differences in tumor and patient characteristics, cannot be controlled. Third, survival rates for cancers with early detection practices (e.g., prostate, breast) are subject to lead time bias, as discussed in Chapter 11 [20]. This bias, for example, is reflected in the 5-year relative survival rate for prostate cancer in the US, which increased from 68% in the mid-1970s to nearly 100% since around 2000 [8,21].

Lifetime, Relative, and Attributable Risk

Epidemiologists use the word *risk* in several ways. Lifetime risk refers to the probability that an individual will be diagnosed with or die from cancer over the course of a lifetime. For example, in the US, the lifetime risk of developing lung cancer is approximately one in 14 for men and one in 17 for women [8]. Risk can also be assessed for particular age groups; for instance, one in 29 women who are cancer-free at age 59 will develop breast cancer by age 69 [2].

Relative risk in cancer studies measures the strength of the relationship between a specific risk factor and cancer by comparing risk among persons with a specific trait or exposure to risk among persons without the trait or exposure. For example, the relative risk of lung cancer death among smokers is 26 for women and 25 for men [22]; in other words, smoking increases the risk of dying from lung cancer about 25-fold. Most relative risks are not this large, however.

Attributable risk, or attributable fraction, refers to the contribution of a particular exposure or trait to the cancer burden. In other words, it is the difference in the disease burden between exposed and unexposed populations who are similar in other respects. For example, an analysis of smoking-attributable mortality (SAM) found that 83% of lung cancer deaths in men in 2011 were attributable to smoking [23].

Cancer Occurrence Patterns in the US

Prevalence

The NCI estimates that there were 15.5 million Americans with a history of cancer alive on January 1, 2016, a number that will grow to about 20 million by 2026 [24]. The number of survivors is growing rapidly because of advances in the early detection and treatment of cancer, which have lengthened survival times, as well as the growth and aging of the population. Almost half of cancer survivors are 70 years of age or older. The most common diagnoses among male survivors are prostate or colorectal cancer, while among women they are breast or uterine corpus cancers.

Incidence

In the US, the lifetime risk of developing cancer is slightly less than one in two for men and a little more than one in three for women [8]. An estimated 1,688,780 persons received a new cancer diagnosis in 2017 [2]. Historically, the occurrence of cancer has increased over time; however, from about 2000 to 2013, incidence rates decreased in men and were stable in women (Figure 1.1). The four most common cancer types – prostate, female breast, lung and bronchus, and colorectal – account for about half of all new cancer cases and thus strongly influence overall trends (Figure 1.2).

Cancer incidence trends reflect changes in behavior and medical practice. For example, much of the rise in male cancer incidence rates between 1975 and 1992 was due to increased detection of clinically asymptomatic prostate cancer, first via transurethral resection of the prostate (TURP) [25] and later via prostate-specific antigen (PSA) testing [26]. In less than two decades, prostate cancer incidence rates more than doubled, from 94 cases per 100,000 men in 1975 to 237 cases per 100,000 men in 1992 [8]; rates subsequently fell rapidly as the proportion of men undergoing a first PSA test diminished [27] (Figure 1.3).

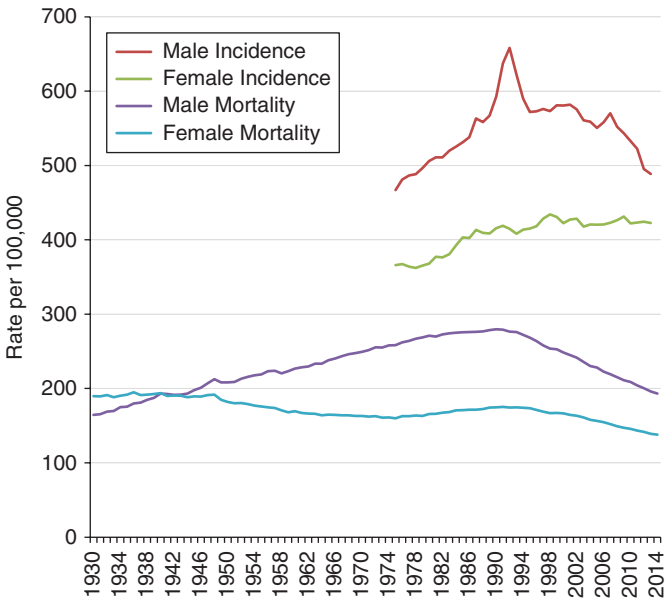

Figure 1.1 Long-term trends in age-adjusted cancer incidence and death rates, 1930–2014. *Source:* Incidence – Surveillance, Epidemiology, and End Results Program (SEER) 9 registries (San Francisco, Connecticut, Detroit, Hawaii, Iowa, New Mexico, Seattle, Utah, and Atlanta), November 2015 submission, National Cancer Institute. Rates were adjusted for delays in reporting. Mortality – US Mortality Volumes 1930–1959; US Mortality Data 1960–2014, National Center for Health Statistics, Centers for Disease Control and Prevention.

Cancer incidence trends have also been strongly influenced by tobacco use. Most (80%) lung cancers in the US are due to smoking [23]. As a result of the smoking epidemic, lung cancer among men catapulted from a rare disease to the most commonly diagnosed cancer during the first half of the twentieth century [28,29]. Lung cancer rates and trends vary by sex because of historic differences in smoking patterns between men and women; smoking prevalence peaked at 65% around 1950 among men and at 38% around 1960 among women [30]. The lag period between peak population smoking prevalence and peak lung cancer rates is 30–40 years. Circa 1930, lung cancer rates began a long period of increase that peaked in the 1980s in men and around 2005 in women (Figures 1.3 and 1.4) [8]. During the most recent 5 years of data (2009–2013), lung cancer incidence rates declined annually by 2.9% in men and 1.4% in women.

Breast cancer is the most commonly diagnosed cancer among women (Figure 1.2). Breast cancer incidence rates increased rapidly from 1980 to 1987 because of increased diagnosis of asymptomatic tumors due to the widespread dissemination of mammography screening (Figure 1.4) [31]. Breast cancer rates have also been influenced over time by changes in reproductive patterns (e.g., later age at first birth, fewer births) that often accompany economic growth and are associated with an increased risk of breast cancer. Incidence rates gradually increased by 0.4% per year from 2004 to 2013, driven by trends in non-White women [8].

Cancers located in the colon or rectum are the third most commonly diagnosed cancers in both men and women (Figure 1.2). Colorectal cancer is one of only two cancer types (cervical cancer is the other) that can be prevented with screening. Screening prevents colorectal cancer by detecting and allowing for the removal of adenomatous polyps, from which most malignancies in the colorectum develop [32,33]. Colorectal cancer incidence rates have been decreasing since the mid-1980s, with similar patterns for men and women [8]. It has been estimated that half of this decline is due to changes in risk factors and half is due to colorectal cancer screening [34]. However, the recent acceleration in the pace of decline has been attributed primarily to increased colonoscopy uptake [34,35].

Survival and Mortality

Advances in cancer screening strategies and targeted therapies have greatly improved cancer outcomes. Over the past 70 years, the 5-year relative survival rate for cancer has more than doubled, from 24% in men and 33% in women for diagnoses between 1935 and 1940 [28] to 67% in both sexes for diagnoses between 2006 and 2012 [8]. Still, one in four men and one in five women will die from cancer [36], the equivalent of approximately 600,920 people in 2017 [2]. The median age of death from cancer is 72 years [8].

Estimated New Cases*

	Males			Females		
Prostate	161,360	19%		Breast	252,710	30%
Lung & bronchus	116,990	14%		Lung & bronchus	105,510	12%
Colon & rectum	71,420	9%		Colon & rectum	64,010	8%
Urinary bladder	60,490	7%		Uterine corpus	61,380	7%
Melanoma of the skin	52,170	6%		Thyroid	42,470	5%
Kidney & renal pelvis	40,610	5%		Melanoma of the skin	34,940	4%
Non-Hodgkin lymphoma	40,080	5%		Non-Hodgkin lymphoma	32,160	4%
Leukemia	36,290	4%		Leukemia	25,840	3%
Oral cavity & pharynx	35,720	4%		Pancreas	25,700	3%
Liver & intrahepatic bile duct	29,200	3%		Kidney & renal pelvis	23,380	3%
All Sites	**836,150**	**100%**		**All Sites**	**852,630**	**100%**

Estimated Deaths

	Males			Females		
Lung & bronchus	84,590	27%		Lung & bronchus	71,280	25%
Colon & rectum	27,150	9%		Breast	40,610	14%
Prostate	26,730	8%		Colon & rectum	23,110	8%
Pancreas	22,300	7%		Pancreas	20,790	7%
Liver & intrahepatic bile duct	19,610	6%		Ovary	14,080	5%
Leukemia	14,300	4%		Uterine corpus	10,920	4%
Esophagus	12,720	4%		Leukemia	10,200	4%
Urinary bladder	12,240	4%		Liver & intrahepatic bile duct	9,310	3%
Non-Hodgkin lymphoma	11,450	4%		Non-Hodgkin lymphoma	8,690	3%
Brain & other nervous system	9,620	3%		Brain & other nervous system	7,080	3%
All Sites	**318,420**	**100%**		**All Sites**	**282,500**	**100%**

Figure 1.2 Leading new cancer cases and deaths in the US in 2017. Ranking is based on modeled projections and may differ from the most recent observed data. *Estimates are rounded to the nearest 10 and cases exclude basal cell and squamous cell skin cancers and *in situ* carcinoma except urinary bladder. *Source:* Siegel *et al.*[2]. Reproduced with permission of John Wiley & Sons.

Notable improvements in 5-year relative survival rates over the past three decades have occurred among both Whites and Blacks (Table 1.1). Advances in treatment have resulted in particularly dramatic improvement in survival for most types of leukemia. For example, in large part due to the discovery of the targeted drug imatinib, the 5-year relative survival rate for chronic myeloid leukemia increased from 31% for cases diagnosed between 1990 and 1992 to 66% for diagnoses between 2006 and 2012 [8,37]. Survival rates for some cancers, such as lung and pancreas, have been slow to improve.

Currently cancer death rates among men are about 40% higher than those among women, although historically rates were higher among women (Figure 1.1). Cancer death rates among men increased 70% from 1930 to 1990, but have since declined by 31%. Cancer death rates among women have been less variable, declining by 21% since 1991.

Lung cancer is the leading cause of cancer death among both men and women, accounting for more than one-quarter of all cancer deaths in the US (Figure 1.2). Lung cancer death rates among men increased 21-fold from 1930 to 1990 as a result of the smoking epidemic, although they have since decreased by 43% (Figure 1.5). Similarly, lung cancer death rates among women increased 16-fold before beginning to drop in 2003 (Figure 1.6) [8]. Due to few early symptoms, the majority (57%) of lung cancer cases are diagnosed at a distant stage, for which the 5-year relative survival rate is 4%. For the 16% of cases diagnosed at a localized stage, survival increases to 55%.

Breast cancer is the second leading cause of cancer death among women, accounting for 14% of all female cancer deaths (Figure 1.2). Breast cancer death rates fluctuated little from 1930 to 1989, but have since decreased by 38% [8] (Figure 1.6). Approximately half of this decline has been attributed to

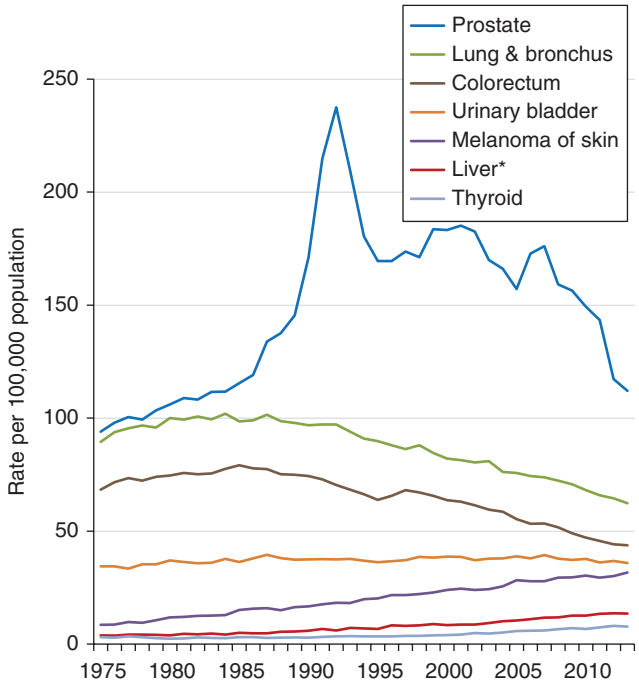

Figure 1.3 Long-term trends in age-adjusted cancer incidence rates among men, 1975–2013. *Source:* Surveillance, Epidemiology, and End Results Program (SEER) 9 registries (San Francisco, Connecticut, Detroit, Hawaii, Iowa, New Mexico, Seattle, Utah, and Atlanta), November 2015 submission. Rates were adjusted for delays in reporting. *Includes intrahepatic bile duct.

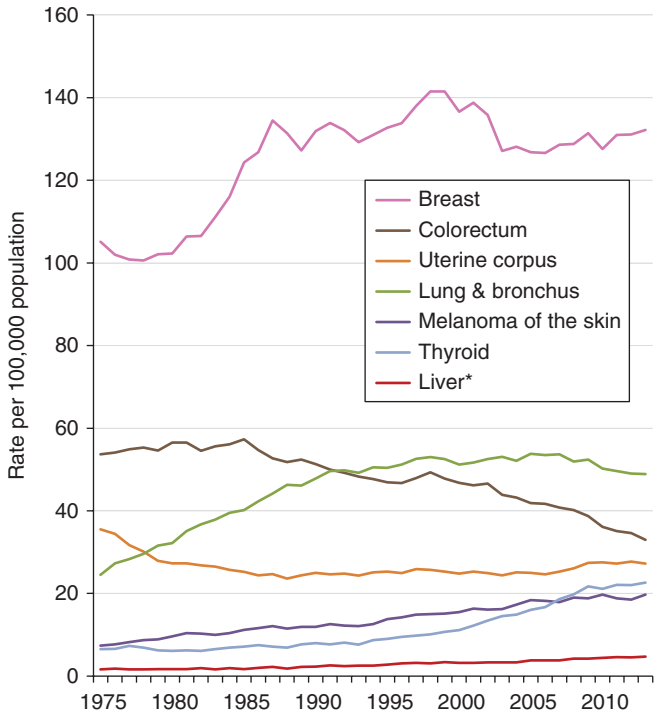

Figure 1.4 Long-term trends in age-adjusted cancer incidence rates among women, 1975–2013. *Source:* Surveillance, Epidemiology, and End Results Program (SEER) 9 registries (San Francisco, Connecticut, Detroit, Hawaii, Iowa, New Mexico, Seattle, Utah, and Atlanta), November 2015 submission. Rates were adjusted for delays in reporting. *Includes intrahepatic bile duct.

mammography screening and half to improvements in adjuvant treatment [38]. Most breast cancers (61%) are diagnosed at a localized stage, for which the 5-year relative survival rate is 99%; survival drops to 85% or 26% for women whose cancer has reached a regional or distant stage, respectively, by the time of diagnosis [8].

Prostate cancer accounts for about 8% of male cancer deaths (Figure 1.2). Prostate cancer death rates increased during the first half of the twentieth century, were relatively stable for several decades, then rose and fell concurrently with the distinct peak in incidence rates associated with widespread uptake of PSA testing (Figure 1.5). This rapid rise and fall in mortality rates is thought to be a result of attribution bias: deaths due to other causes mistakenly attributed to prostate cancer on death certificates because of a prevalent prostate cancer diagnosis [39]. However, the continued decrease since the mid-1990s is likely to be real and due to advances in both primary and salvage treatments, as well as early detection, although results from randomized clinical trials evaluating the efficacy of PSA testing have been equivocal [40,41]. Prostate cancer death rates decreased by 3.4% per year from 2010 to 2014 [8]. Ninety-two percent of prostate cancer patients are diagnosed at a localized or regional stage, for which the 5-year relative survival rate approaches 100%.

Colorectal cancer accounts for 8–9% of all cancer deaths in men and women (Figure 1.2). Colorectal cancer death rates have been declining since around 1950 among women and since the mid-1980s among men (Figures 1.5 and 1.6). Mortality declines from 1975 to 2000 have been attributed to screening (53%), changes in risk factors (35%), and improvements in treatment (12%) [34]. From 2010 to 2014, death rates declined by 2.5% per year among men and 2.8% per year among women [8]. Although several different screening tests effectively diagnose colorectal cancer early, less than half (39%) of patients are diagnosed with local stage disease, for which 5-year relative survival is 90% [8]. One in five colorectal cancer patients is still diagnosed with distant stage disease, for which the 5-year survival rate is just 14%; for those diagnosed with regional stage disease, 5-year survival is 71%.

Demographic and Geographic Patterns

The occurrence of cancer is strongly influenced by demographic characteristics, including age, sex, race, socioeconomic status, and place of residence. One of the strongest risk factors for cancer is increasing age. This is primarily because 10 or more years usually pass between exposure to external factors and detectable cancer. Between 2009 and 2013, slightly more than half (53%) of new cancer cases and 69% of cancer deaths occurred among individuals who were age 65 years or older [8]. Sex also influences cancer risk; the lifetime probability of developing cancer is slightly higher for men than for women – 41% versus 38% between 2011 and 2013. Reasons for this disparity are not completely understood, but are likely related to differences in risk factor behaviors, hormone exposure, and healthcare utilization [42].

Race and ethnicity substantially modify cancer risk (Table 1.2 and Table 1.3). Of the five major racial and ethnic groups in the US (non-Hispanic White, non-Hispanic Black, Asian/Pacific Islander, American Indian/Alaska Native, and Hispanic), Black

Table 1.1 Trends in 5-year relative survival rates[1] (%) by race, US, 1975–2012.

	All races			White			Black		
	1975–77	1987–89	2006–12	1975–77	1987–89	2006–2012	1975–77	1987–89	2006–12
All sites	49	55	69	50	57	70	39	43	63
Brain and other nervous system	22	29	35	22	28	33	25	32	44
Breast (female)	75	84	91	76	85	92	62	71	82
Colon and rectum	50	60	66	50	60	67	45	52	59
Esophagus	5	9	21	6	11	22	4	7	13
Hodgkin lymphoma	72	79	89	72	80	89	70	72	86
Kidney and renal pelvis	50	57	75	50	57	75	49	55	75
Larynx	66	66	62	67	67	64	58	56	52
Leukemia	34	43	63	35	44	64	33	35	58
Liver and intrahepatic bile duct	3	5	18	3	6	18	2	3	13
Lung and bronchus	12	13	19	12	13	19	11	11	16
Melanoma of the skin	82	88	93	82	88	93	57[2]	79[2]	69
Myeloma	25	27	50	24	27	50	29	30	52
Non-Hodgkin lymphoma	47	51	73	47	51	74	49	46	65
Oral cavity and pharynx	53	54	67	54	56	69	36	34	47
Ovary	36	38	46	35	38	46	42	34	38
Pancreas	3	4	9	3	3	9	2	6	8
Prostate	68	83	99	69	84	>99	61	71	97
Stomach	15	20	31	14	18	30	16	19	30
Testis	83	95	97	83	95	97	73[2,3]	88	90
Thyroid	92	94	98	92	94	99	90	92	97
Urinary bladder	72	79	79	73	80	79	50	63	66
Uterine cervix	69	70	69	70	73	71	65	57	58
Uterine corpus	87	82	83	88	84	86	60	57	66

Source: Howlader *et al.* [8].

[1] Rates are adjusted for normal life expectancy and are based on cases diagnosed in the SEER 9 areas from 1975 to 1977, 1987 to 1989, and 2006 to 2012, all followed through 2013.

[2] The standard error is between 5 and 10 percentage points.

[3] Survival rate is for cases diagnosed from 1978 to 1980.

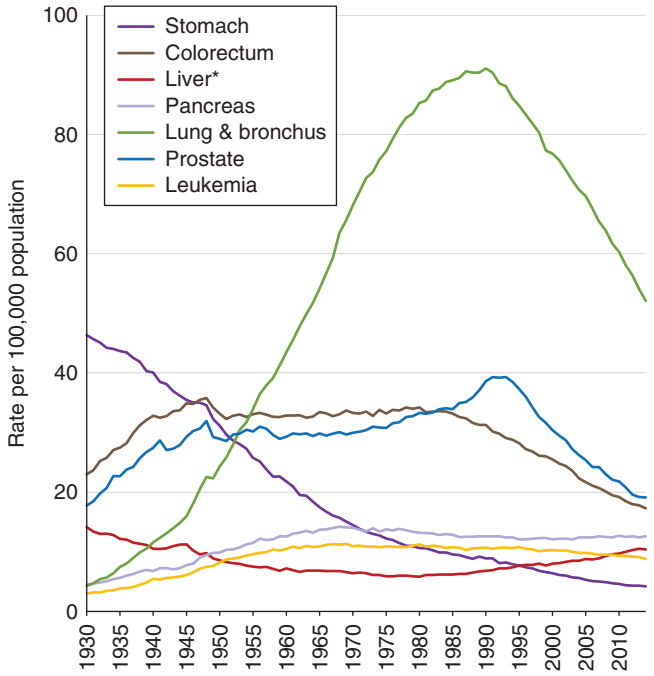

Figure 1.5 Long-term trends in age-adjusted male cancer death rates by site, 1930–2014. *Source:* US Mortality Volumes 1930–1959; US Mortality Data 1960–2014, National Center for Health Statistics, Centers for Disease Control and Prevention. *Includes intrahepatic bile duct.

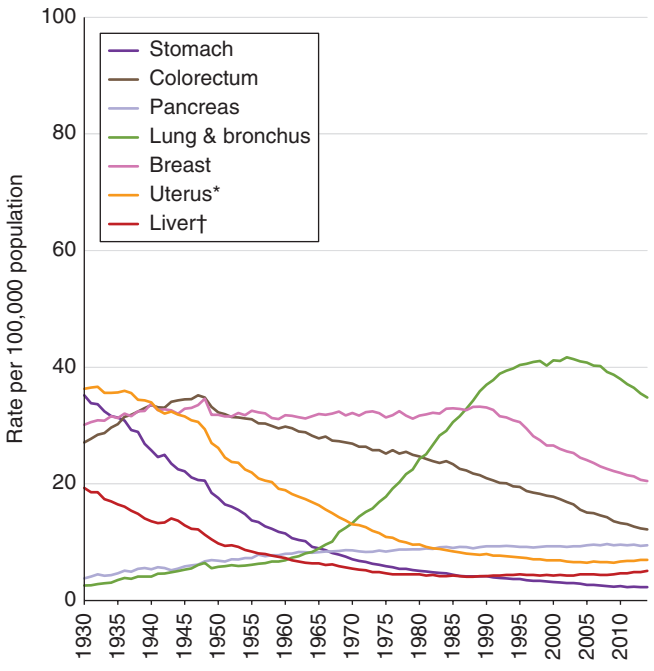

Figure 1.6 Long-term trends in age-adjusted female cancer death rates by site, 1930–2014. *Source:* US Mortality Volumes 1930–1959; US Mortality Data 1960–2014, National Center for Health Statistics, Centers for Disease Control and Prevention. *Uterus refers to uterine corpus and uterine cervix combined. †Includes intrahepatic bile duct.

men have the highest overall rates of cancer incidence and death and Black females have the lowest survival rates [8]. Racial inequalities in the cancer burden primarily reflect obstacles to receiving healthcare services related to cancer prevention, early detection, and high-quality treatment, as opposed to biological differences [43].

While Americans of Asian, Hispanic, or American Indian descent generally have lower rates than non-Hispanic Whites or Blacks for the most common cancers, they have a higher burden of cancers related to infectious agents, such as cancers of the liver (hepatitis B and C viruses), stomach (*Helicobacter pylori*), and cervix (human papillomavirus) [2]. Factors that contribute to this disparity include a higher prevalence of cancer-related infections in immigrant countries of origin for Hispanics and Asian/Pacific Islanders [44] and lower rates of screening for cervical cancer [41]. In addition, some groups of American Indians and Alaska Natives have substantially higher rates of lung and kidney cancers, which is thought to reflect the higher prevalence of risk factors for these cancers, such as smoking, obesity, hypertension, and end-stage renal disease [45]. It is important to note that because cancer surveillance data in the US are reported for very broadly defined racial and ethnic categories, important differences in the cancer burden within groups is masked. For example, the age-adjusted cancer death rate among Cuban men is approximately 15% higher than that among Mexican men [46]. In addition, race misclassification among American Indians and Alaska Natives continues to be a challenge in accurately measuring the cancer burden in this population.

Poverty is the driving factor for the majority of health inequalities in the US. Members of minority populations are substantially more likely than Whites to be economically disadvantaged; in 2015, 24% of Blacks and 21% of Hispanics lived in poverty compared to 9% of non-Hispanic Whites [47]. Importantly, however, persons of lower socioeconomic status have disproportionately higher cancer death rates than those who are more affluent, regardless of race or ethnicity. One study estimated that eliminating socioeconomic disparities would prevent twice as many premature cancer deaths as eliminating racial disparities [48].

Cancer rates also vary geographically. For example, male lung cancer incidence rates from 2009 to 2013 ranged from 34 (cases per 100,000 men) in Utah to 118 in Kentucky [2]. Lung cancer shows the largest geographic variation of any cancer type because it is driven by historical smoking prevalence, which varies dramatically by state [49]. In 2015, smoking prevalence ranged from 9% in Utah to 26% in Kentucky and West Virginia [50]. State smoking prevalence is influenced by differences in state and local tobacco control activities, tobacco industry marketing, and social norms about tobacco use.

Conclusion

Cancer is a major public health problem in the US, as well as many other parts of the world. Cancer surveillance is essential for monitoring the cancer burden; identifying high-risk populations; quantifying progress in prevention, early detection, and

Table 1.2 Incidence rates by site, race, and ethnicity, US, 2009–2013.[1]

	All races combined	Non-Hispanic White	Non-Hispanic Black	Asian/Pacific Islander	American Indian/ Alaska Native[2]	Hispanic
All sites						
Male	512.1	519.3	577.3	310.2	426.7	398.1
Female	418.5	436.0	408.5	287.1	387.3	329.6
Breast (female)	123.3	128.3	125.1	89.3	98.1	91.7
Colorectum						
Male	46.9	46.1	58.3	37.8	51.4	42.8
Female	35.6	35.2	42.7	27.8	41.2	29.8
Kidney and renal pelvis						
Male	21.7	21.9	24.4	10.8	29.9	20.7
Female	11.3	11.3	13.0	4.8	17.6	11.9
Liver and intrahepatic bile duct						
Male	11.8	9.7	16.9	20.4	18.5	19.4
Female	4.0	3.3	5.0	7.6	8.9	7.5
Lung and bronchus						
Male	75.0	77.7	90.8	46.6	71.3	42.2
Female	53.5	58.2	51.0	28.3	56.2	25.6
Prostate	123.2	114.8	198.4	63.5	85.1	104.9
Stomach						
Male	9.2	7.8	14.7	14.4	11.2	13.1
Female	4.6	3.5	7.9	8.4	6.5	7.8
Uterine cervix	7.6	7.0	9.8	6.1	9.7	9.9

Source: Siegel *et al.* [2]. Reproduced with permission of John Wiley & Sons.
Hispanic origin is not mutually exclusive from Asian/Pacific Islander or American Indian/Alaska Native.
[1] Rates are per 100,000 population and age adjusted to the 2000 US standard population.
[2] Data based on Indian Health Service Contract Health Service Delivery Areas and exclude data from Kansas.

Table 1.3 Death rates by site, race, and ethnicity, US, 2010–2014.[1]

	All races combined	Non-Hispanic White	Non-Hispanic Black	Asian/Pacific Islander	American Indian/ Alaska Native[2]	Hispanic
All sites						
Male	200.4	204.0	253.4	122.7	183.6	142.5
Female	141.5	145.5	165.9	88.8	129.1	97.7
Breast (female)	21.2	21.1	30.0	11.3	14.1	14.4
Colorectum						
Male	17.7	17.3	25.9	12.4	19.5	15.0
Female	12.4	12.3	16.9	8.8	14.0	9.2
Kidney and renal pelvis						
Male	5.6	5.8	5.7	2.7	8.9	4.9
Female	2.4	2.5	2.5	1.1	4.2	2.3
Liver and intrahepatic bile duct						
Male	9.2	8.0	13.3	14.3	14.9	13.1
Female	3.7	3.3	4.6	6.1	6.8	5.8
Lung and bronchus						
Male	55.9	58.3	69.8	31.7	46.2	27.3
Female	36.3	39.8	35.5	18.0	30.8	13.4
Prostate	20.0	18.7	42.8	8.8	19.4	16.5
Stomach						
Male	4.4	3.4	8.7	7.1	7.5	6.9
Female	2.3	1.7	4.2	4.3	3.8	4.1
Uterine cervix	2.3	2.1	3.9	1.7	2.8	2.6

Source: Siegel *et al.* [2]. Reproduced with permission of John Wiley & Sons.
Hispanic origin is not mutually exclusive from Asian/Pacific Islander or American Indian/Alaska Native.
[1] Rates are per 100,000 population and age adjusted to the 2000 US standard population.
[2] Data based on Indian Health Service Contract Health Service Delivery Areas.

treatment strategies; and informing cancer control programs. Descriptive cancer epidemiology research has also greatly contributed to the current understanding of cancer. The foundation of cancer surveillance is population-based cancer registration. The expansion in population coverage of high-quality cancer data collection in the US, from 9% in the mid-1970s to almost 100% today, is a major public health milestone. This achievement has the potential to further reduce the cancer burden by facilitating widespread, targeted interventions at the community level, where health inequalities arise.

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