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Trends in Causes of Death among Older Persons in the United States

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Highlights

- *The leading causes of death among older persons ages 65 years and older are:*
 - Heart disease
 - Cancer
 - Stroke
 - Chronic lower respiratory diseases such as emphysema and chronic bronchitis
 - Influenza and pneumonia
 - Alzheimer's disease
 - Diabetes
 - Nephritis, nephrotic syndrome, and nephrosis, which are kidney diseases
 - Accidents (unintentional injuries)
 - Septicemia (blood poisoning)
- *Significant trends in mortality among older persons include:*
 - Dramatic declines in death rates from heart disease and stroke
 - Declines in death rates from cancer—since 1990 for men and since 2000 for women
 - Increases in Alzheimer's disease death rates

This report is one in a series from the National Center for Health Statistics, Centers for Disease Control and Prevention. The series of reports on Aging trends was developed with support from the National Institute on Aging and its purpose is to monitor the health of the aging population. By providing this type of information, we hope to help focus research on the most effective ways to use resources and craft health policy to promote longer, healthier lives. This report presents information on the leading causes of death for older persons in the United States and the recent trends in mortality for this group and is primarily based on data available in the Data Warehouse on Trends in Health and Aging (www.cdc.gov/nchs/agingact.htm).

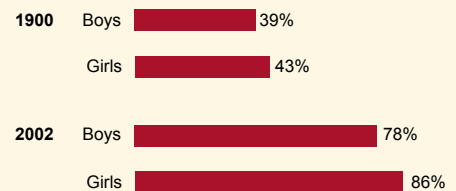
Overview

Since 1900 life expectancy in the United States has dramatically increased, and the principal causes of death have changed. At the beginning of the 20th century, many Americans died young. Most

did not live past the age of 65, their lives often abruptly ended by one of a variety of

deadly infectious diseases. Over time, death rates dropped at all ages, most dramatically for the young. Today, the vast majority of children born in the United States can expect to live through childhood and into their eighth decade or beyond. About three-fourths of all deaths are among persons ages 65 and older. The majority of deaths are caused by chronic conditions such as heart disease, cancer, stroke, diabetes, and Alzheimer's disease. During the 20th century these chronic diseases replaced acute infections as the major causes of death.

Figure 1. Percent of newborns living to age 65: United States



SOURCE: National Center for Health Statistics.

Life expectancy has increased, but will the increase continue?

Will we see major advances in life expectancy in the 21st century? Experts disagree. Some say we cannot continue to reduce mortality at the oldest ages without making dramatic and unforeseen medical advances against such major killers as cardiovascular diseases and cancer.¹⁻³

But others counter that it is not only possible—

other societies like Japan have already achieved significantly higher life expectancies—but likely, as a better educated population increasingly adopt healthier life styles and takes advantage of modern medical technologies.⁴⁻⁷

¹ Fries, JF. Aging, natural death, and the compression of morbidity. *N Engl J Med* 303(3):130-5. 1980.

² Fries, JF. Strategies for reduction of morbidity. *Am J Clin Nutr*. 55(6 Suppl):1257S-1262S. 1992.

³ McCormick J, Skrabanek P. Coronary heart disease is not preventable by population interventions. *Lancet* 2(8615):839-41. 1988.

⁴ Rothenberg R, Lentzner HR, Parker RA. Population aging patterns: The expansion of mortality. *J Gerontol* 46(2):S66-70. 1991.

⁵ Manton KG, Stallard E, Corder L. Changes in morbidity and chronic disability in the U.S. elderly population: Evidence from the 1982, 1984, and 1989 National Long Term Care Surveys. *J Gerontol B Psychol Sci Soc* 50(4): S194-204. 1995.

⁶ Manton KG, Vaupel JW. Survival after the age of 80 in the United States, Sweden, France, England, and Japan. *N Engl J Med* 333(18): 1232-5. 1995.

⁷ Schneider EL, Brody JA. Aging, natural death, and the compression of morbidity: Another view. *N Engl J Med* 309(14):854-6. 1983.

Figure 2. Ten countries with highest life expectancy, 2002

Men		Women	
Japan	77.8	Japan	85.0
Iceland	77.6	Hong Kong, China	82.7
Sweden	77.5	France	82.7
Hong Kong, China	77.2	Spain	82.7
Israel	77.0	Sweden	82.5
Canada	76.6	Switzerland	82.3
Australia	76.4	Australia	82.0
Norway	75.9	Italy	81.9
Cyprus	75.9	Iceland	81.9
Switzerland	75.9	Canada	81.9

NOTE: Life expectancy in the United States was 74.5 years for men and 79.9 years for women. SOURCES: Demographic and Social Statistics (<http://unstats.un.org/unsd/demographic/>). NVSR vol. 53, no. 6 (<http://www.cdc.gov/nchs/products/pubs/pubd/nvsr/nvsr.htm>).

► Age-adjustment of death rates

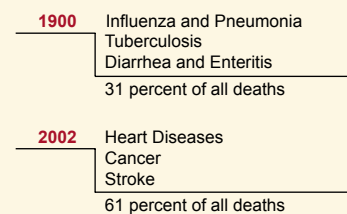
The death rates presented in this report for the population ages 65 and older are age-adjusted to the U.S. standard population in 2000. The age-adjusted rates are calculated using age-specific rates for three age groups: 65-74, 75-84, and 85 and older. Age-adjusted rates eliminate differences in observed rates that result from differences in age composition. They are used to compare rates across demographic groups and over time.

What are the leading causes of death for older Americans?

Chronic diseases are the leading causes of death

Heart disease and cancer have been the two leading causes of death for persons 65 years of age and older for the past two decades, accounting for nearly a million deaths in 2002. Nearly one-third of all deaths among older persons were due to heart disease, including heart attacks and chronic ischemic heart disease. Cancer accounted for about one-fifth of all deaths in that age group.

Figure 3. Top three leading causes of death among persons 65 and older in the United States



SOURCE: Deaths: Leading Causes of 2002. NVSR vol. 53, no.17.

The third leading cause of death for older persons is stroke or cerebrovascular disease, followed by chronic lower respiratory diseases (CLRD), which include chronic bronchitis, emphysema, asthma, and other chronic lower respiratory diseases. The leading causes of death vary among different age, sex, and race and Hispanic origin groups.

Figure 4. Leading causes of death for persons ages 65 years and older by sex, 2002

Cause of death	All		Male		Female	
	Percent all deaths	Rank	Percent all deaths	Rank	Percent all deaths	Rank
Heart disease	31.8	1	31.8	1	31.8	1
Cancer	21.6	2	25.0	2	18.8	2
Stroke	7.9	3	6.5	4	9.1	3
Chronic lower respiratory diseases	6.0	4	6.5	3	5.6	4
Influenza and Pneumonia	3.2	5	3.1	5	3.4	6
Alzheimer's disease	3.2	6	2.1	7	4.1	5
Diabetes	3.0	7	2.9	6	3.1	7
Nephritis, nephrotic syndrome, and nephrosis	1.9	8	2.0	9	1.8	8
Accidents	1.9	9	2.1	8	1.7	9
Septicemia	1.5	10	1.4	10	1.5	10

Figure 5. Leading causes of death for persons ages 65 years and older by age, 2002

Cause of death	65 and older		65-74		75-84		85 and older	
	Percent all deaths	Rank	Percent all deaths	Rank	Percent all deaths	Rank	Percent all deaths	Rank
Heart disease	31.8	1	26.6	2	30.2	1	36.7	1
Cancer	21.6	2	34.2	1	23.6	2	11.6	2
Stroke	7.9	3	5.2	4	7.8	3	9.8	3
Chronic lower respiratory diseases	6.0	4	7.0	3	7.0	4	4.3	6
Influenza and pneumonia	3.2	5	1.6	8	2.8	7	4.7	5
Alzheimer's disease	3.2	6	not in top 10		2.8	6	5.1	4
Diabetes	3.0	7	4.0	5	3.3	5	2.2	7
Nephritis, nephrotic syndrome, and nephrosis	1.9	8	1.7	7	2.0	8	1.9	8
Accidents	1.9	9	1.9	6	1.8	9	1.9	9
Septicemia	1.5	10	1.5	9	1.6	10	1.4	10

Figure 6. Leading causes of death for persons ages 65 years and older by race-Hispanic origin, 2002

Cause of death	All		White		Black		Asian or American Indian		Pacific Islander		Hispanic	
	Percent all deaths	Rank	Percent all deaths	Rank	Percent all deaths	Rank	Percent all deaths	Rank	Percent all deaths	Rank	Percent all deaths	Rank
Heart disease	31.8	1	31.8	1	32.0	1	27.4	1	30.7	1	32.4	1
Cancer	21.6	2	21.5	2	22.7	2	20.6	2	22.9	2	21.0	2
Stroke	7.9	3	7.8	3	8.3	3	6.7	4	10.9	3	7.4	3
Chronic lower respiratory diseases	6.0	4	6.3	4	3.4	5	5.8	5	3.9	6	3.9	5
Influenza and pneumonia	3.2	5	3.3	6	2.7	7	3.6	6	4.1	5	3.5	6
Alzheimer's disease	3.2	6	3.4	5	2.0	9	1.9	9	1.3	10	2.2	7
Diabetes	3.0	7	2.8	7	5.0	4	7.3	3	4.1	4	6.3	4
Nephritis, nephrotic syndrome, and nephrosis	1.9	8	1.8	9	3.1	6	2.2	8	2.0	8	2.0	8
Accidents	1.9	9	1.9	8	not in top 10		2.8	7	2.3	7	1.9	9
Septicemia	1.5	10	1.4	10	2.5	8	1.9	10	not in top 10		not in top 10	

⁸Hoyert DL. Mortality trends for Alzheimer's disease, 1979–91. *Vital Health Stat* 20(28): 1996.

⁹Hoyert DL, Rosenberg HM. Mortality from Alzheimer's disease: An update. *Natl Vital Stat Rep* 47(20): 1–8. 1999.

¹⁰Anderson RN, et al. Comparability of cause of death between ICD–9 and ICD–10: preliminary estimates. *Natl Vital Stat Rep* 49(2):1–32. 2001.

¹¹Bertoni AG, Saydah S, Brancati FL. Diabetes and the risk of infection-related mortality in the United States. *Diabetes Care* 24(6): 1044–9. 2001.

¹²Yoshikawa TT. Antimicrobial resistance and aging: Beginning of the end of the antibiotic era? *J Am Geriatr Soc* 50(7 Suppl):S226–9. 2002.

¹³Shua-Haim J, Ross J. Pneumonia in the Elderly. *Clinical Geriatrics* 8(1). 2000.

Alzheimer's disease and renal diseases (including nephritis, nephritic syndrome, and nephrosis) have gained importance as causes of death among older persons over the past two decades. Alzheimer's disease death rates increased from 1979 to 1988, stabilized for a few years,^{8,9} and then increased gradually from 1992 to 1998. In 1999, after the change of the disease classification system from ICD–9 to ICD–10, nearly all deaths previously classified as presenile dementia shifted into the Alzheimer's disease category. This and other clarifications of the diagnosis increased the number of Alzheimer's deaths in 1999 compared with 1998 by 58 percent.¹⁰ Alzheimer's disease is now among the 10 leading causes of death for older persons.

In 2002, nephritis, nephrotic syndrome, and nephrosis combined were the fifth leading cause of death for older black women and ranked between the 6th and 10th cause of death for other older persons. As a result of the change to ICD–10 in 1999, deaths from end-stage renal disease (ESRD) were classified as a subcategory of renal failure, consequently increasing the number of deaths attributed to nephritis, nephrotic syndrome or nephrosis.

Older adults are vulnerable to common infectious diseases

Although infectious diseases as a group are no longer ranked among the top causes of death for older persons, influenza and pneumonia and septicemia remain among the top 10. In 2002, they were responsible for 4.7 percent, or about 85,500 deaths, among persons 65 years of age and older. In addition, the role that infectious diseases play in morbidity and mortality of older persons is not fully apparent. For instance, diabetes mellitus, which is itself one of the leading causes of death among persons ages 65 and older, also is a predictor of infectious diseases related death.¹¹ In addition, development of drug-resistant infections may lead to further increases in infectious diseases mortality among older persons.¹²

Pneumonia is one of the most serious infections in older adults, especially among men and the oldest old (ages 85 and older) of both sexes. Researchers estimate the 30-day death rate from the onset of pneumonia in elderly patients is from 11 to 70 percent, depending on the type of pneumonia and comorbid conditions.¹³ Although pneumonia death rates dropped 30 percent in 1999, primarily due to the change to ICD–10 classification, influenza and pneumonia combined remain in the top 10 leading causes of death for older persons.

Septicemia ranked as the 10th leading cause of death in older persons in 2002. This disease often occurs as a consequence of other bacterial infections of the urinary tract, skin, or respiratory system. In 1999, ICD–10 changes in classifying the underlying cause of death led to a 19-percent increase in the number of septicemia deaths.

Unintentional injuries remain an important cause of death well into old age

Deaths from unintentional injuries (accidents) are the leading cause of death among children and young adults. And although its relative importance decreases among the elderly, it was responsible for 2 percent, or about 34,000 deaths, in 2002 among people 65 years of age and older. Mortality from accidents is almost twice as high among older men as women. Falls, motor vehicle crashes, suffocation, and burns account for most of the unintentional injury deaths among older persons. For more information, please see the Data Warehouse tables on injury mortality (<http://www.cdc.gov/nchs/agingact.htm>).



For trend data from
NCHS' on-line
Data Warehouse see
[www.cdc.gov/nchs/
agingact.htm](http://www.cdc.gov/nchs/agingact.htm).

► In 2002, **State age-adjusted death rates** for persons ages 65 and older ranged from 3,858 per 100,000 in Hawaii to 5,855 per 100,000 in Kentucky. In addition to Kentucky, the States with the highest mortality for older persons were Mississippi, West Virginia, Alabama, Tennessee, Oklahoma, and Louisiana. The States with the lowest rates in 2002 were Hawaii, Florida, Alaska, Arizona, California, North Dakota, and South Dakota.

Between 1990 and 2002, death rates for older persons decreased in most States. The States with the greatest decline (10–16 percent) in age-adjusted death rates among persons ages 65 and older were Alaska, Delaware, New York, California, Vermont, Hawaii, New Jersey, Maryland, and New Hampshire. Oklahoma, Kansas, Arkansas, Mississippi, Alabama, Missouri, Utah, and Kentucky experienced little change.

Between 1990 and 2002, death rates for **heart disease** for older persons decreased in all States. This decrease in age-adjusted death rates was smallest in the District of Columbia (6 percent) and greatest in Minnesota (35 percent). In 2002, the highest age-adjusted death rates among persons age 65 and older from heart disease (1,800–2,000 per 100,000 population ages 65 and older) were in the District of Columbia, Kentucky, West Virginia, New York, Oklahoma, and Mississippi. The lowest rates (1,065–1,269 per 100,000 population ages 65 and older) were in Alaska, Minnesota, Hawaii, Colorado, Montana, and Utah.

In most States death rates for **cancer** decreased for older persons between 1990 and 2002, especially in Delaware, Hawaii, Vermont, Arizona, Maryland, New Jersey, and New York (10–15 percent). In 2002, State age-adjusted death rates from cancer ranged from 781 per 100,000 population ages 65 and older in Hawaii to 1,240–1,246 per 100,000 population ages 65 and older in Kentucky and the District of Columbia.

In most States age-adjusted death rates for **stroke** decreased for older persons between 1990 and 2002. The greatest declines were in New York, Minnesota, and the District of Columbia (20–25 percent). In 2002, the highest death rate from stroke was in Arkansas (507 per 100,000 population ages 65 and older) and the lowest was in New York (257 per 100,000 population ages 65 and older).

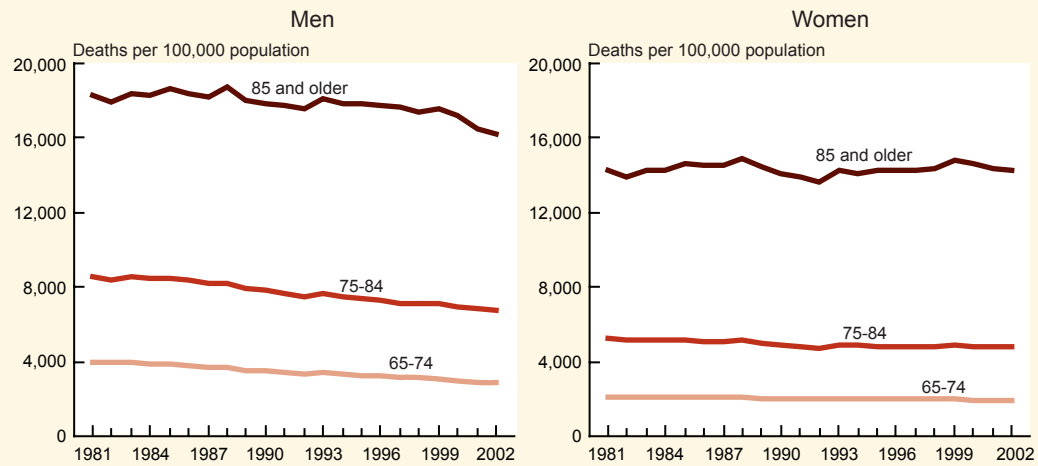
In most States age-adjusted death rates for **diabetes** among persons ages 65 and older increased dramatically from 1990 to 2002. The largest increases, 60–70 percent, were in West Virginia, Minnesota, California, Wyoming, Oregon, and Oklahoma. Only in Alaska, Delaware, Hawaii, Nevada, and Massachusetts have the rates declined. Death rates from diabetes ranged from about 90 per 100,000 older persons in Hawaii and Nevada to 200–240 per 100,000 older persons in New Mexico, the District of Columbia, West Virginia, and Louisiana.

What are the important trends in mortality?

All cause mortality declined for most groups

Between 1990 and 2002, the death rate from all causes decreased for older persons as a whole but not for all subgroups. Over this time, death rates decreased by 12 percent among persons 65–74 years of age and by 7 percent among those 75–84 years of age. The decreases were substantially higher for men than for women in those age groups. Among the 85 and older age group, the all cause death rate increased 1 percent for women and declined about 9 percent for men.

Figure 7. Death rates, by sex and age, 1981-2002



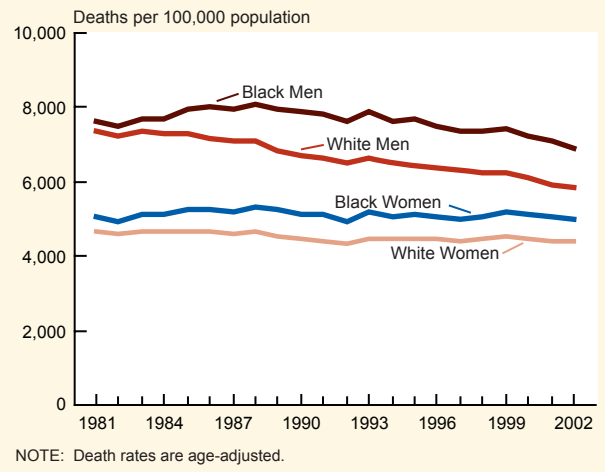
Between 1990 and 2002, among persons 65 years and older the greatest decline in death rates was among men, both black (12 percent) and white (13 percent). Black women experienced a smaller decline (2 percent). The lowest decline was in white women (1 percent). Over this time period, the death rate for older black persons was about 15 percent greater than for older white persons.

Circulatory disease death rates declined

A primary reason for the overall decline in mortality was the decrease in the death rates for heart disease and stroke. From 1990 to 2002, heart disease age-adjusted death rates for persons age 65 and older declined about 24 percent, 27 percent for men and 23 percent for women. Stroke death rates for the same age group declined about 12 percent, 16 percent for men and 10 percent for women.

Over 1990–2002, heart disease death rates decreased more slowly for older black persons than for older white persons (20 percent versus 24 percent). The greatest declines were among white men (27 percent), white women and black men (23 percent for both groups). The smallest decline was among black women (18 percent). Throughout this period, death rates from heart diseases were higher for older black persons than for older white persons. In 2002, the heart disease death rate was 16 percent higher among black than among white persons ages 65 and older.

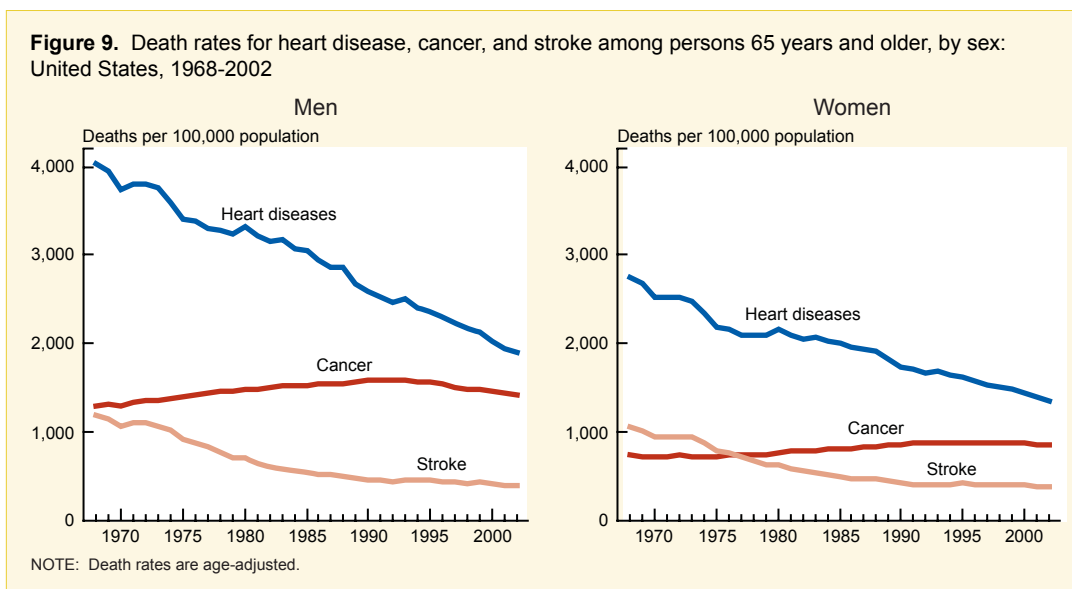
Figure 8. Death rates among persons 65 years and older, by race and sex: United States, 1981-2002



Cancer death rates decreased for men

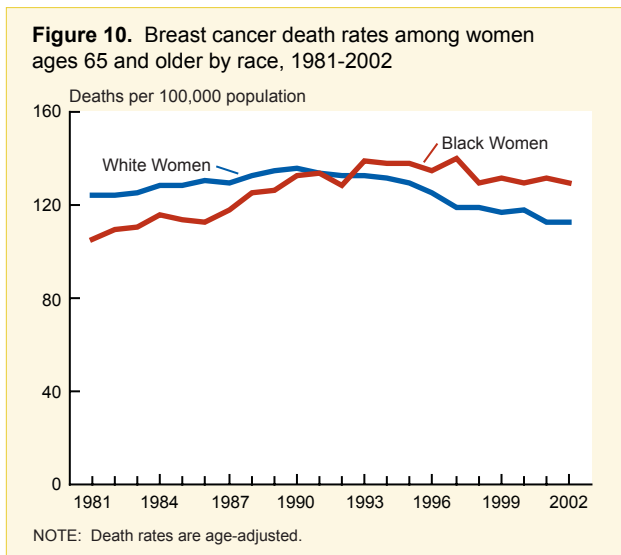
Since 1990, there has been a downward trend in age-adjusted cancer death rates among men (11 percent), but not women. A decrease in cancer mortality for women occurred only for the younger 65–74-year-old age group (4 percent). For women ages 75 years and older death rates from cancer increased by 3–4 percent. Between 2000 and 2002, cancer death rates decreased 2 percent among older women and 4 percent among older men.

¹⁴ American Cancer Society. Cancer facts and figures Pub No 5008.01. 2001.



The changes in cancer mortality varied greatly by type of cancer. For example, trachea, bronchus, and lung cancer death rates, which primarily reflect lung cancer, increased until 1990 and then between 1990 and 2002 decreased 11 percent among older men. However, the rates continued to rise among older women and increased by one-third over the 1990–2002 time period. Nevertheless, the death rate for trachea, bronchus, and lung cancer among men was almost twice the rate among older women.

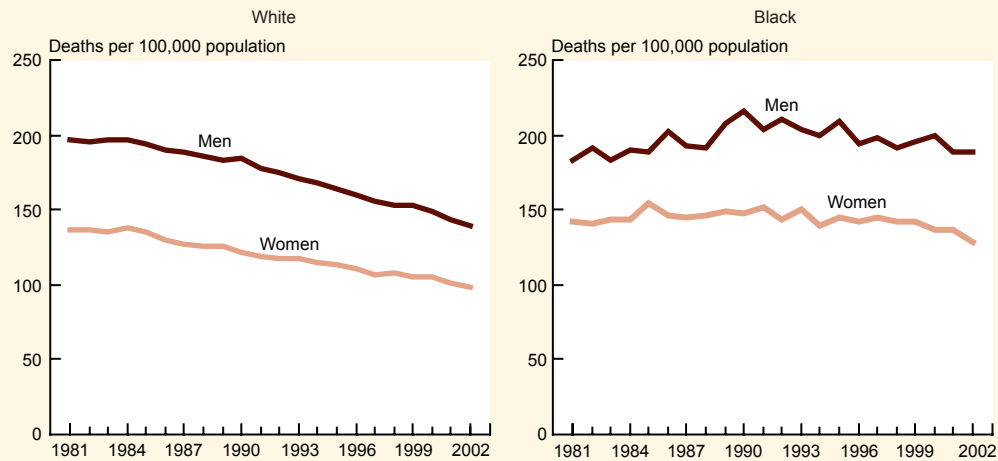
Breast cancer death rates among women increased until 1990 and then decreased between



1990 and 2002 with a greater decrease among older white women (17 percent) than among older black women (2 percent).

For cancer of the colon, rectum and anus, since 1990 there was a significant decrease in the death rates across all groups, but with a smaller decline among older black persons than among older white persons (13 percent compared with 21 percent). This trend is especially important because colon cancer is highly preventable. Screening procedures and early treatment may greatly lower death rates from this disease.¹⁴

Figure 11. Death rates for cancer of colon, rectum, and anus among persons 65 years and older by race and sex, 1981-2002



NOTE: Death rates are age-adjusted.

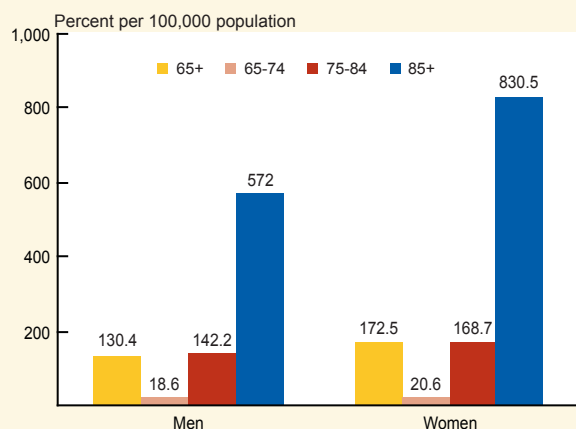
Death rates for unintentional falls have increased; suicide and homicide death rates continue to decrease

Death rates from unintentional falls among older persons have increased since 1993. This trend is more pronounced, and the death rates are higher, for older whites compared with other race-Hispanic origin groups. Suicide rates have decreased 25 percent between 1981 and 2002 among persons ages 65 and older. The suicide rate is higher for older white men than for any other group, including teenagers. After a decade of decreases in homicide rates for older black persons, the rate reached an all time low in 2002 of 11.2 deaths per 100,000. The major mechanism for suicide and homicide was firearms. For more information see the injury mortality tables in the Data Warehouse on Trends in Health and Aging.

► **The International Classification of Diseases (ICD)** is used to code the medical conditions and injuries listed on death certificates. The regulations of the World Health Organization specify that member nations classify and code causes of death in accordance with the current revision of the ICD. The ICD has been revised periodically since 1900 to reflect medical advances in diagnosis of disease to accommodate emerging diseases. Beginning with deaths occurring in 1999, the United States began using the 10th revision of the classification (ICD-10). ICD-10 differs from its predecessor, ICD-9, in several respects. ICD-10 is far more detailed than ICD-9, with about 8,000 categories compared with about 5,000 categories. ICD-10 uses alphanumeric codes compared with numeric codes in ICD-9. In addition, some of the coding rules and rules for selecting the underlying cause of death have been changed. In the Data Warehouse mortality tables (Browser version) you can see the ICD codes for the highlighted cause of death by clicking on the label button at the top of the Beyond 20/20 table. In the latest tables, you will see ICD-9 codes for the years 1979-98 and ICD-10 codes for 1999 onward. In the historical mortality tables (with data for 1968-80), the codes shown are from ICDA-8 for the years 1968-78, and ICD-9 for 1979-80. Click here <http://www.cdc.gov/nchs/datawh/statab/unpubd/comp.htm> to learn about studies of the comparability between ICD revisions.

Alzheimer's disease: a growing problem?

Figure 12. Death rates for Alzheimer's disease among persons ages 65 and older by sex and age, 2002



NOTE: The death rates for age 65+ are age-adjusted.

Alzheimer's disease is a progressive debilitating condition which affects about 4.5 million Americans.^{9,15} Since clarification of the diagnosis in 1999, the Alzheimer's disease death rate has increased consistently by 7–9 percent each year. The risk of dying from this disease increases rapidly with age. Women are about 30 percent more likely to die from Alzheimer's disease than men, and this difference increases with age. Since Alzheimer's disease mortality is associated with older age, its prevalence may increase as longevity increases.

⁹Hoyert DL, Rosenberg HM. Mortality from Alzheimer's disease: An update. *Natl Vital Stat Rep* 47(20): 1–8. 1999.

¹⁵Heber LE, et al. Alzheimer disease in the U.S. population: Prevalence estimates using the 2000 census. *Arch Neurol* 60(8):1119–22. 2003.

¹⁶Fields LE, et al. The burden of adult hypertension in the United States 1999 to 2000: A rising tide. *Hypertension* 44(4):398–404. 2004.

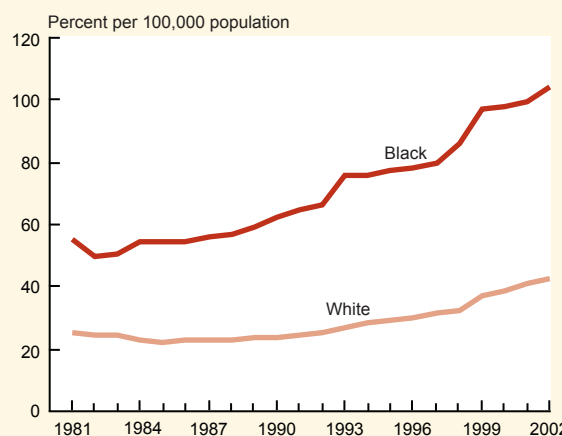
Death rates for essential hypertension and hypertensive renal disease are increasing

Essential hypertension is a major risk factor for cardiovascular disease and a risk factor for other conditions as well. In 2002, essential hypertension and hypertensive renal disease combined were the 10th leading cause of death for older black persons. In 2002, the death rate among older black persons was 2.4 times the rate for older white persons.

This cause of death is most often mentioned on death certificates as a comorbid condition. In 2002 less than 1 percent of all decedents ages 65 and older had essential hypertension or hypertensive renal disease recorded as the underlying cause of death, but 11

percent of all deaths had one of these diseases recorded as a comorbid condition. This cause of death is also important because the prevalence of hypertension among older persons is increasing.¹⁶

Figure 13. Death rates for essential hypertension and hypertensive renal disease among persons ages 65 and older by race, 1981-2002



NOTE: Death rates are age-adjusted.

¹⁷Lanfranco AR, et al. Robotic surgery: A current perspective. *Ann Surg* 239(1):14-21. 2004.

¹⁸Cancer Genome Anatomy Project (<http://cgap.nci.nih.gov/>).

¹⁹The National Cancer Institute. Nanotechnology and cancer (<http://www.cancer.gov/newscenter/nanotech>).

²⁰Stem Cell Information. The official National Institutes of Health resource for stem cell research (http://stemcells.nih.gov/news/nihopps/nihopps_inst.asp).

²¹The National Cancer Institute. President's Cancer Panel (<http://deainfo.nci.nih.gov/advisory/pcp/pcp.htm>).

²²Editors: Graham A; Colditz M, BS, DrPH; DeJong HW, AB, MA, Ph.D.; Hunter DJ, MB, BS, ScD; Trichopoulos MD, Ph.D.; Walter C. Willett, MD, DrPH, Harvard Report on Cancer Prevention vol 1: Causes of Human Cancer Causes and Control. *An International Journal of Studies of Cancer in Human Populations*. Official Journal of the International Association of Cancer Registries, 1996. vol 7 Supplement.

► More about the multiple-cause-of-death system

Good public health policies depend on complete information. By considering not just the single underlying cause of death listed on the death certificate, but also the other accompanying health problems listed on the certificate—the comorbid conditions or associated causes of death—we arrive at a much more complete picture of the true cause of death. These comorbid conditions play an important role in contributing to death.

What happens when we examine multiple-cause-of-death? A number of diseases are more likely to be identified as comorbid conditions present at the time of death rather than as the underlying cause. Of these, the most important are:

Diabetes: In 2002, diabetes was listed as the underlying cause for 54,715 older decedents and as an associated cause in more than twice as many deaths (120,113).

Chronic Lower Respiratory Diseases: In 2002, chronic lower respiratory disease was listed as the underlying cause of death for 108,313 older decedents and for slightly more deaths as an associated cause (112,187).

What are the possibilities for future progress on life expectancy?

Biomedical breakthroughs, technological advances, public health initiatives, and social changes may reduce mortality and increase life expectancy

Historically, most advances in life expectancy have been the consequence of advances in social and economic well-being. However, in the 20th century biomedical and public health advances brought impressive gains, reducing death from infectious diseases through immunization and antibiotic therapy. What factors will determine future trends in life expectancy?

For heart disease, advances in prevention and treatment offer the hope that death rates will continue their four decades of decline. Adopting lifestyle practices that are known to reduce risk factors for heart disease (for example, engaging in regular physical activity, eating a balanced diet) may not be magic bullets, but could reduce the onset of circulatory problems. Developments in preventing and treating heart disease, including medical, pharmaceutical and surgical advances, such as statins and robotics-assisted noninvasive heart surgery,¹⁷ may well reduce or delay deaths from heart disease. However, the increase in obesity and diabetes may lead to an increase or slower declines in death rates.

For cancer, it may be hoped that a better understanding of the genetics of common cancers (the goal of the Cancer Genome Anatomy Project¹⁸ and the development of new drugs may lead to new prevention strategies, targeted screening, and better treatment regimes. Development of nanotechnology tools¹⁹ may lead to early diagnosis and treatment of cancer on the cellular level without harming healthy cells. Recent research on stem cell biology may ultimately improve the specificity and long-term effectiveness of cancer therapy, through the targeting of those cells most responsible for disease progression and metastasis.²⁰ A renovation of the clinical trials system may improve translation of the latest research into patient care and reduce cancer mortality.²¹ However, such efforts may be expected to yield incremental but not dramatic effects on mortality.²²

In summary, as knowledge of disease etiology and medical technology progresses at a rapid pace, the multipronged approach of public health education, screening, and early intervention and treatment of disease may yield positive results. In addition, meaningful reductions in mortality, even at the older ages, could also be achieved by reducing racial, class, and rural or urban disparities. However, unbroken progress toward lengthening our life span is not inevitable. Elderly persons, like children, are particularly vulnerable to epidemics. A major epidemic of influenza or drug-resistant strains of gastrointestinal infections could produce a sharp increase in mortality among the frail elderly and at least temporarily halt the progress in life expectancy. Public health surveillance of known and emerging infections is critical to the long-term health of our aging population.

About the data

Most of the data used in this report are from the NCHS National Vital Statistics publications (<http://www.cdc.gov/nchs/products/pubs/pubd/nvsr/nvsr.htm>) and the Data Warehouse on Trends in Health and Aging (<http://www.cdc.gov/nchs/agingact.htm>). Death rates for persons ages 65 years and older from the latter source are age-adjusted to the U.S. standard population in 2000 in order to eliminate differences in observed rates that result from differences in age composition.

Information on mortality comes from death certificates collected by the States and forwarded to NCHS for processing and publishing. Geographic coverage has been complete since 1933 and the high quality and availability of the data have made death rates an excellent barometer of the health and well-being of a population. However, all data collection systems have limitations, and some of these limitations must be considered when using information to estimate the levels of and trends in, cause-specific mortality in older persons. Here are three examples.

First, changes in the classification, coding conventions, and rules, in the death certificate format or in the training of those who fill out the death certificates may lead to discontinuities in trends in cause of death. For example, when ICD-9 was implemented in 1979, the number of deaths attributed to septicemia jumped abruptly because of changes in the coding conventions. The level eventually stabilized after certifiers received instructions to record more specific causes of death. As another example, in 1989, after the format was changed to include more space to encourage certifiers to provide more complete information, a study found that the mortality trend for some causes of death changed significantly.²³ Similarly, diabetes as a cause of death rapidly increased after instructions on the death certificate included diabetes as an example. This may have reminded certifiers to include this disease on the death certificate.

Second, death certificates for older persons are often incomplete. The completeness of the death certificate depends on the thoroughness of the certifier and on the amount of information available. Studies show that the quality of the decedent's medical history and thus of the physician's report of underlying cause of death diminishes with the age of the deceased. This may be because medical conditions of younger decedents are more acute and directly associated with death. The incompleteness for older decedents may be a particular problem for those dying in long-term care institutions where medical certification is handled with less precision, less is known about the decedents' medical histories, and less diagnostic information is available from laboratory tests and autopsy.^{24,25}

²³Hoyert D, Rosenberg H, MacDorman M. Effect of changes in death certificate format on cause-specific mortality trends, United States, 1979-92. *Death Certification and Mortality Statistics: An International Perspective, Studies on Medical and Population Subjects 64*: 47-58. 2000.

²⁴Feinlieb MF. Proceedings of 1988 International Symposium on Data on Aging. Bethesda, MD. *Vital Health Stat 5 (6)*:1-269. 1991.

²⁵The autopsy, medicine, and mortality statistics. *Vital Health Stat 3 (32)*:1-42. 2001.

²⁶Elo IT, Preston SH. Estimating African-American mortality from inaccurate data. *Demography* 31(3): 427–58. 1994.

Third, the age on the death certificate is sometimes incorrect for older persons. Both under- and over-reporting the age of decedents has been documented, particularly for black decedents and for women.²⁶ This results in death rates that are either too high or too low.

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