ONCOLOGY FOR SCIENTISTS

Cancer Epidemiology & Cancer Survivorship

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DEFINITION

Epidemiology is the study of the distribution and determinants of disease frequency in human populations.

Two fundamental assumptions:

- **human disease does not occur at random**
- **human disease has causal and preventive factors that can be identified through systematic investigation**

EPIDEMIOLOGY

Disease frequency

- how many people are getting disease

Distribution of disease

- who is getting disease
- when and where does disease occur

Determinants of disease

- what causes disease

DESCRIPTIVE EPIDEMIOLOGY

Focuses on describing people who develop disease in terms of their personal characteristics and where and when they were exposed to the agent causing the disease.

- Provides a systematic method for characterizing a health problem providing basic data on health, disease, and mortality.
- Ensures understanding of the basic dimensions of a health problem.
- Helps identify populations at higher risk for the health problem in relation to person, place, and time.
- Provides information used for allocation of resources
- Enables development of testable hypotheses

TYPES OF OBSERVATIONAL STUDIES

Descriptive **Epidemiology deals with the questions: Who, What, When, and Where**

No preconceived ideas about relation between exposure and disease, but results can suggest hypothesis that can be tested by analytical studies.

Analytic **Epidemiology deals with the remaining questions: Why and How**

- Case-Control Studies (Retrospective Studies)
- Cohort Studies (Prospective Studies)

STUDY DESIGNS IN CANCER EPIDEMIOLOGY

Exposure  Disease

Descriptive Studies

Exposure  Disease

Case-Control Study (Retrospective)

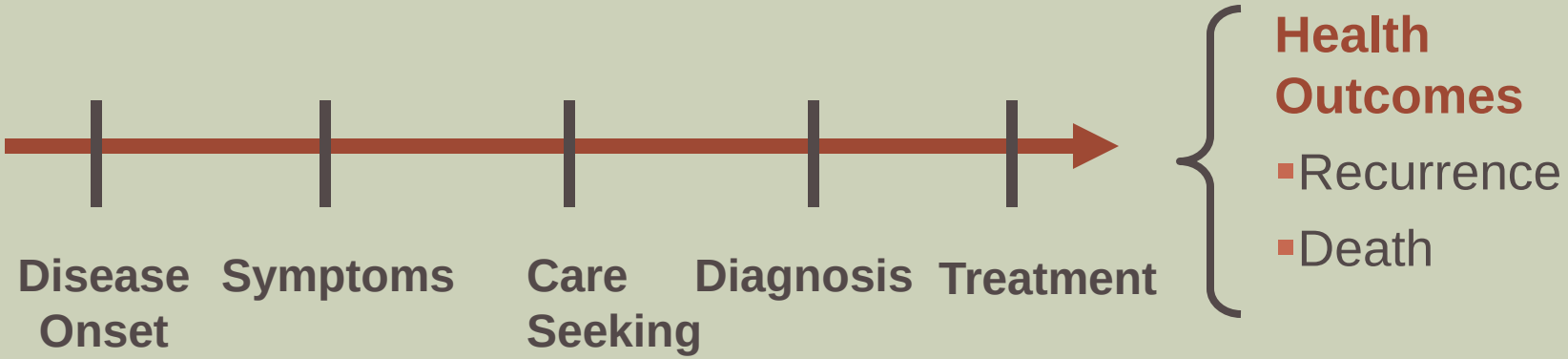
Exposure  Disease

Cohort Study (Prospective)

GOALS OF DESCRIPTIVE EPIDEMIOLOGY

- **Evaluation of trends in health**
  - comparison of populations
- **Basis for planning, provision, and evaluation of health services**
  - public health administration
- **Generation of hypotheses for investigation of disease etiology**
  - analytic epidemiology

NATURAL HISTORY OF CANCER AND RELATED DATA SOURCES



Selected data sources

- **Screening test results**
- **Medical Records**
- **Hospital Records**
- **Cancer Registry**
- **Death Certificates**
- **National Surveys**

CANCER DATA SOURCES

Surveillance Epidemiology and End Results (NCI)

(http://seer.cancer.gov/)

- Primary source of cancer statistics in United States began in 1973
- Collects information on incidence, prevalence, and survival from specific geographic areas representing 28% of US popln.
- Composed of 17 population-based cancer registries (Alaska Native Tumor Registry, Arizona Indians, Cherokee Nation, Connecticut, Detroit, Atlanta, Greater Georgia, Rural Georgia, San Francisco-Oakland, San Jose-Monterey, Greater California, Hawaii, Iowa, Kentucky, Los Angeles, Louisiana, New Jersey, New Mexico, Seattle-Puget Sound, Utah.
- Compiles reports on all these plus cancer mortality for entire country.

CANCER DATA SOURCES

Behavioral Risk Factor Surveillance System (BRFSS) (Centers for Disease Control and Prevention) (http://www.cdc.gov/brfss/)

- World's largest, on-going telephone health survey system, tracking health conditions and risk behaviors in the United States yearly since 1984. More than 350,000 adults are interviewed each year.
- Since 2011, use of a new sampling frame that includes both landline and cell phone households
- Currently, data are collected monthly in all 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam.
- States use BRFSS data to identify emerging health problems, establish and track health objectives, and develop and evaluate public health policies and programs. Many states also use BRFSS data to support health-related legislative efforts.

CANCER PREVENTION

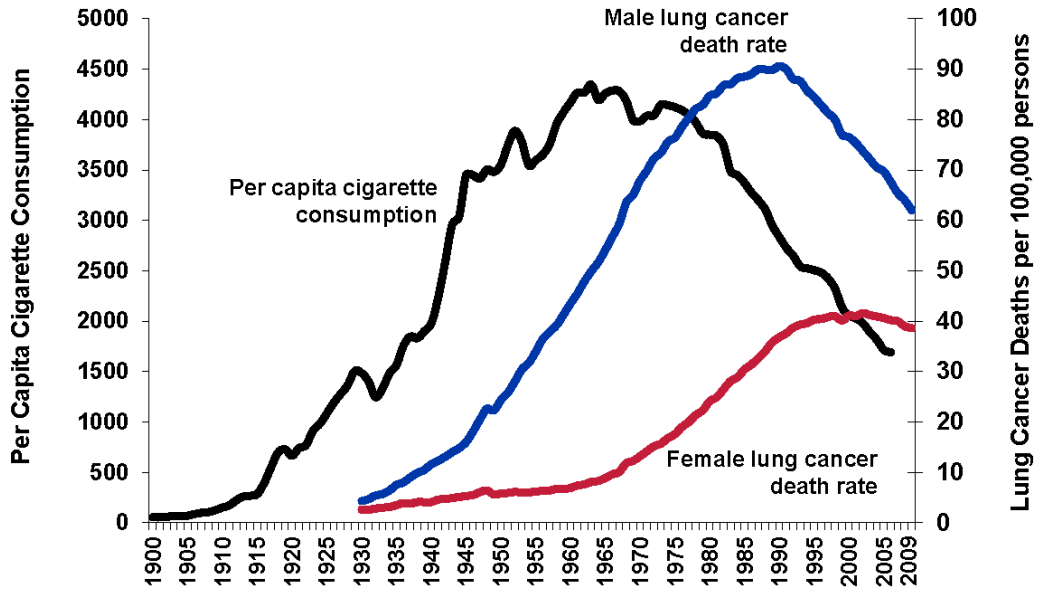
- Cancer caused by a variety of factors over a number of years
- Important to follow national trend data to monitor trends in factors that influence likelihood of getting cancer
- Focus on behavioral factors, environmental, policy/regulatory effects
- Approximately 50-75% of cancer deaths in the US are caused by human behaviors such as smoking, physical inactivity, and poor dietary choices.

TOBACCO USE

- Smoking causes about 30% of all US deaths from cancer and the is single most important risk factor for cancer.
- Cigarette smoking causes cancers of the lung, larynx, mouth, esophagus, pharynx, and bladder. In addition, it plays a role in acute myeloid leukemia and cancers of the pancreas, kidney, cervix, stomach, and liver.

TOBACCO USE IN THE US, 1900-2009

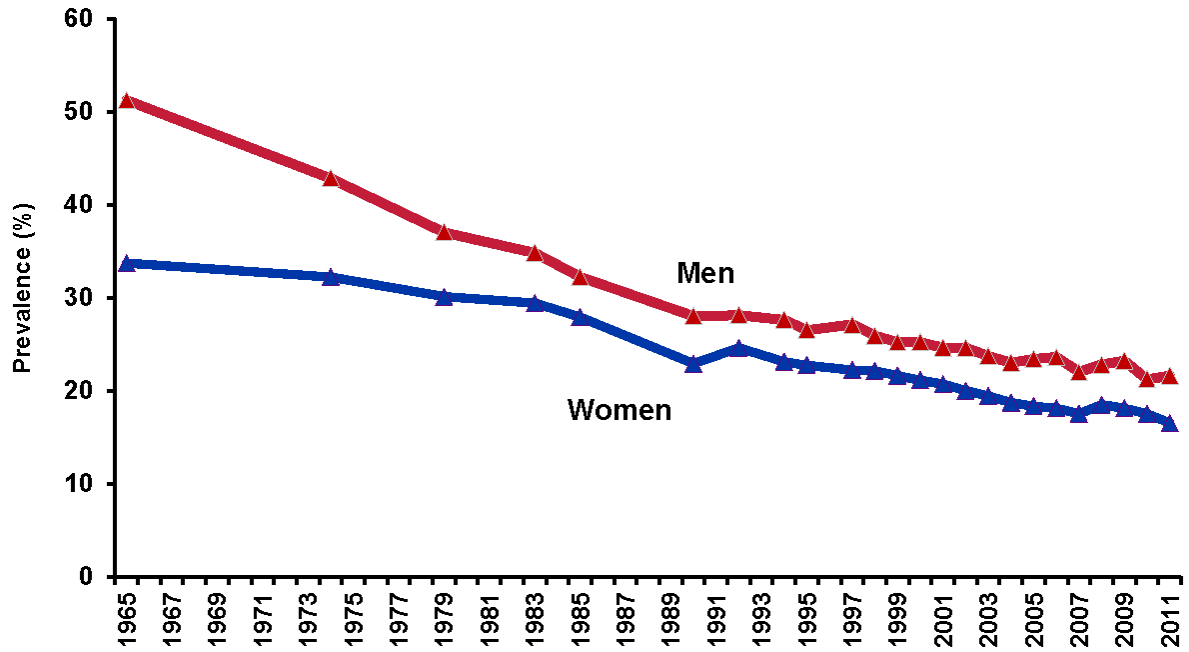
Trends in Tobacco Use and Lung Cancer Death Rates* in the US



*Age-adjusted to 2000 US standard population.

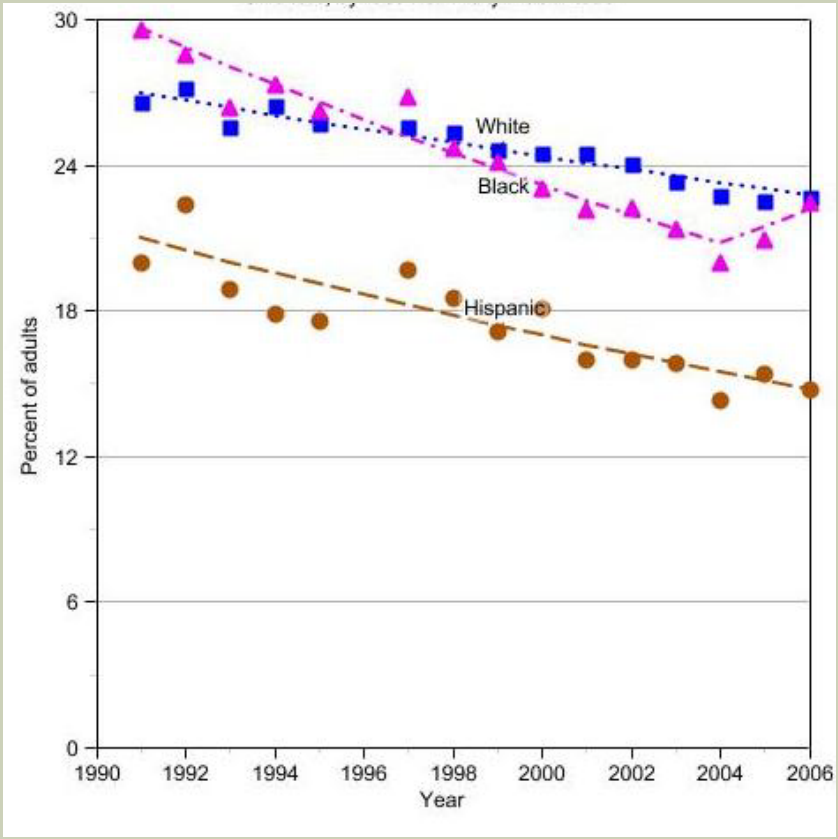
Source: Death rates: US Mortality Data, 1960-2009, US Mortality Volumes, 1930-1959, National Center for Health Statistics, Centers for Disease Control and Prevention. Cigarette consumption: US Department of Agriculture, 1900-2007.

TRENDS IN CIGARETTE SMOKING PREVALENCE* (%), BY SEX, ADULTS 18 AND OLDER, US, 1965-2011



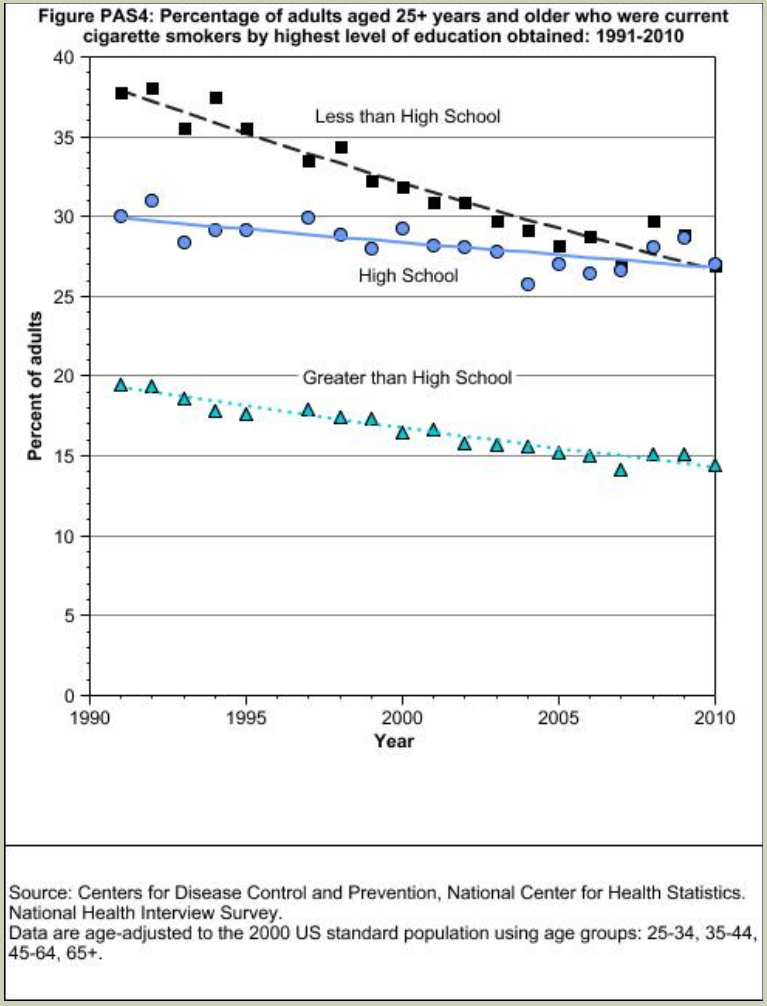
Redesign of survey in 1997 may affect trends. Estimates are age adjusted to the 2000 US standard population.
Source: National Health Interview Survey, National Center for Health Statistics, Centers for Disease Control and Prevention, 2012.

PERCENTAGE OF ADULTS AGED 18 YEARS AND OLDER WHO WERE CURRENT CIGARETTE SMOKERS, 1991-2006

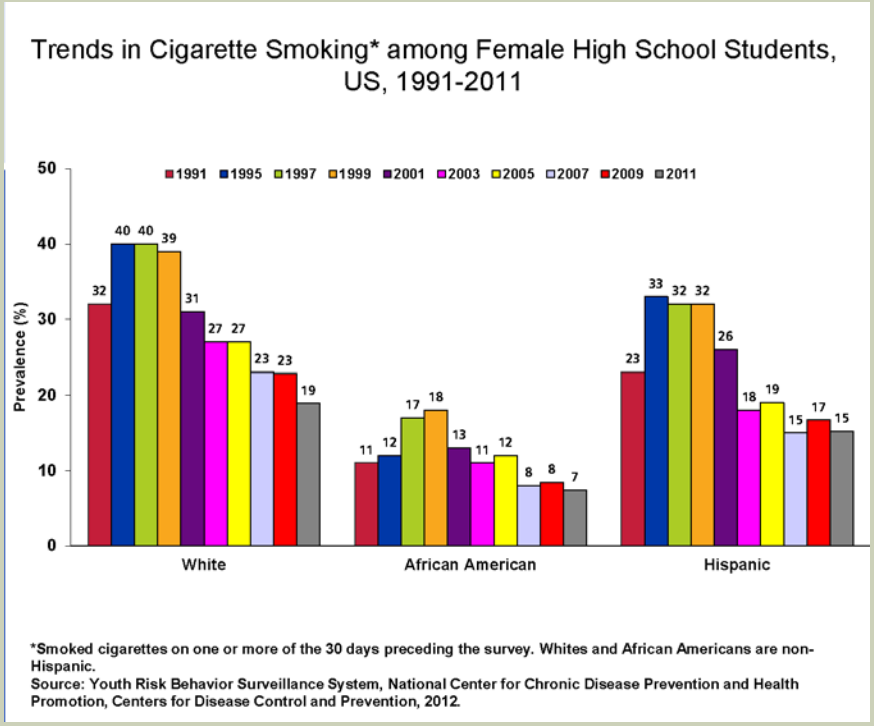


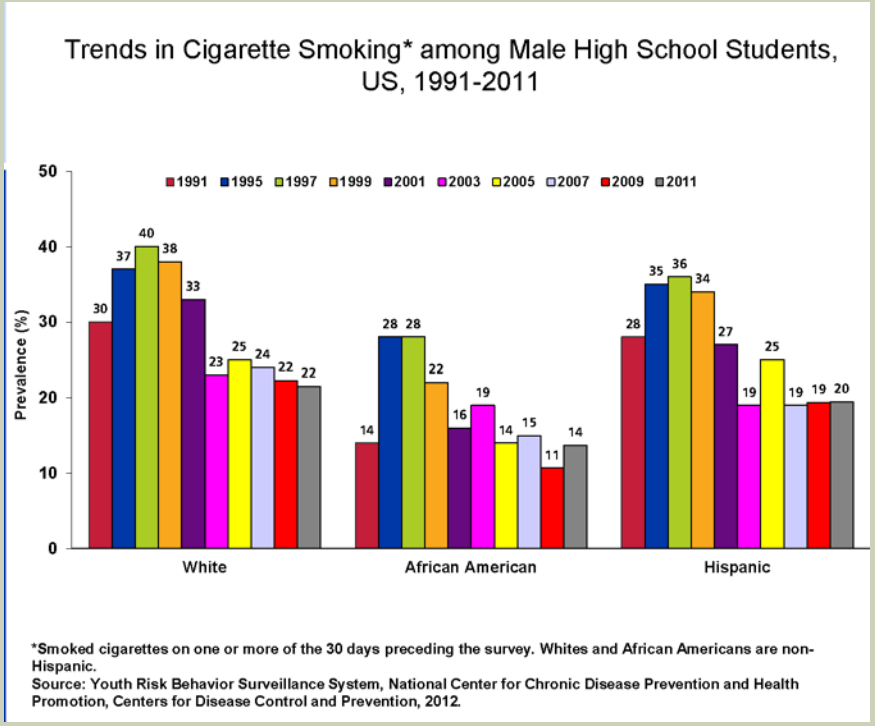
Source: Centers for Disease Control and Prevention, National Center for Health Statistics. National Health Interview Survey.\
Data are age-adjusted to the 2000 standard using age groups: 18-24, 25-34, 35-44, 45-64, 65+. Analysis uses the 2000 Standard Population as defined by NCHS (http://www.cdc.gov/nchs/data/statnt/statnt20.pdf).

PERCENTAGE OF ADULTS AGED 25+ YEARS AND OLDER WHO WERE CURRENT CIGARETTE SMOKERS BY LEVEL OF HIGHEST EDUCATION OBTAINED: 1991-2010.

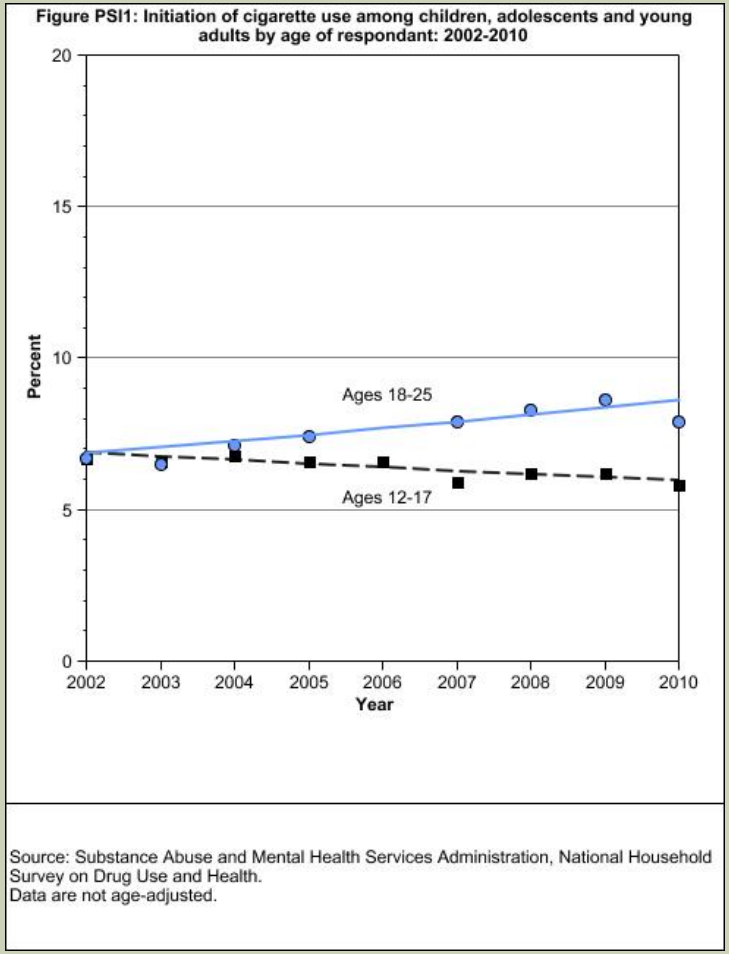


TRENDS IN CIGARETTE SMOKING* AMONG MALE HIGH SCHOOL STUDENTS, US, 1991-2011





INITIATION OF CIGARETTE USE AMONG CHILDREN, ADOLESCENTS, AND YOUNG ADULTS, US, 2002-2010



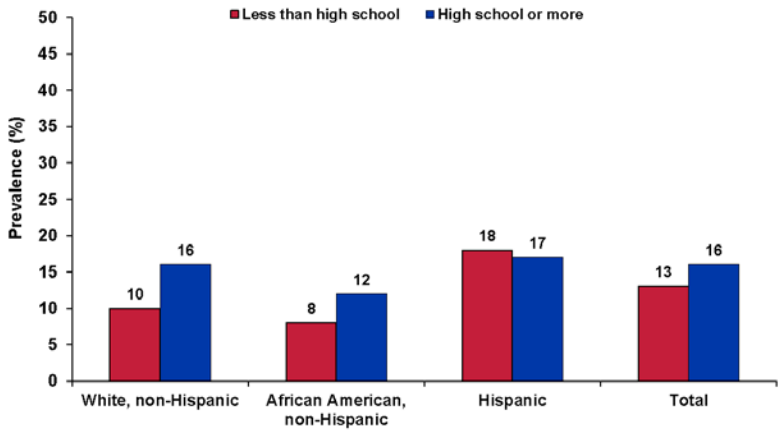
FRUIT AND VEGETABLE CONSUMPTION

- Diets rich in plant foods such as fruits and vegetables are associated with lower risk of cancers of the mouth, pharynx, larynx, esophagus, stomach, lung, and there is some evidence for colon, pancreas, and prostate.
- A diet high in fruits and vegetables helps to reduce calorie intake and may help to control weight.
- 4 to 13 servings of fruits and vegetables daily, depending on energy needs. This includes 2 to 5 servings of fruits and 2 to 8 servings of vegetables, with emphasis on dark-green and orange vegetables and legumes.

VEGETABLE AND FRUIT CONSUMPTION, ADULTS 25 AND OLDER, US, 2011

Vegetables

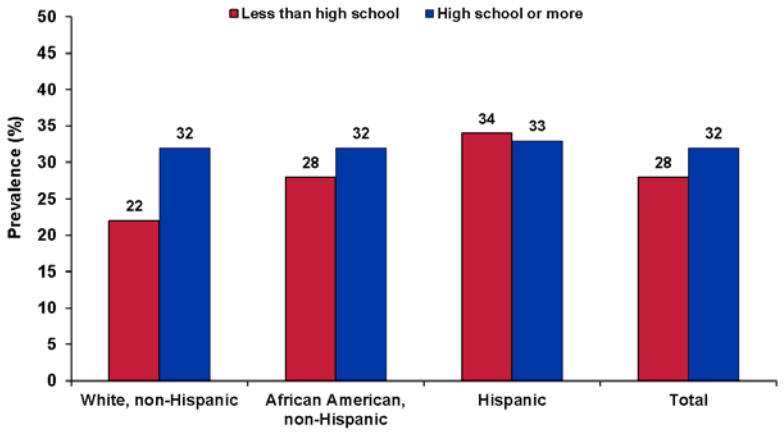
Consumption of Three or More Vegetable Servings by Educational Attainment, Adults 25 and Older, US, 2011



Source: Behavioral Risk Factor Surveillance System, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 2012.

Fruits

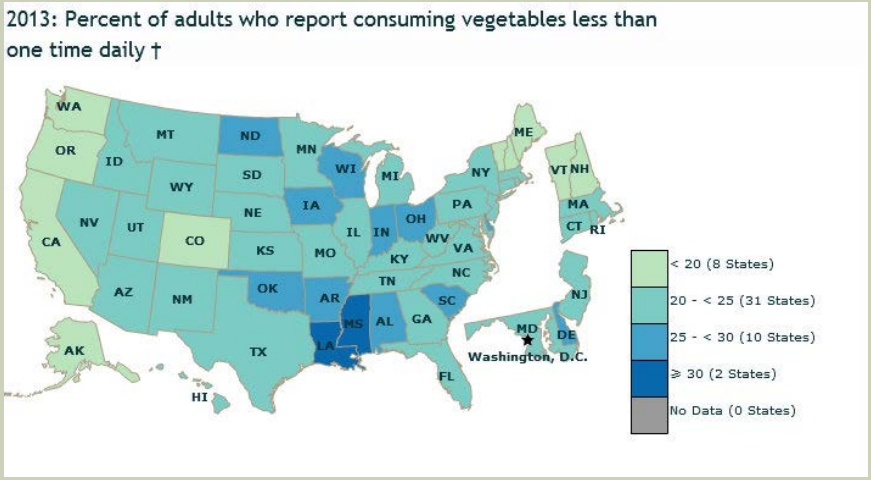
Consumption of Two or More Fruit Servings by Educational Attainment, Adults 25 and Older, US, 2011



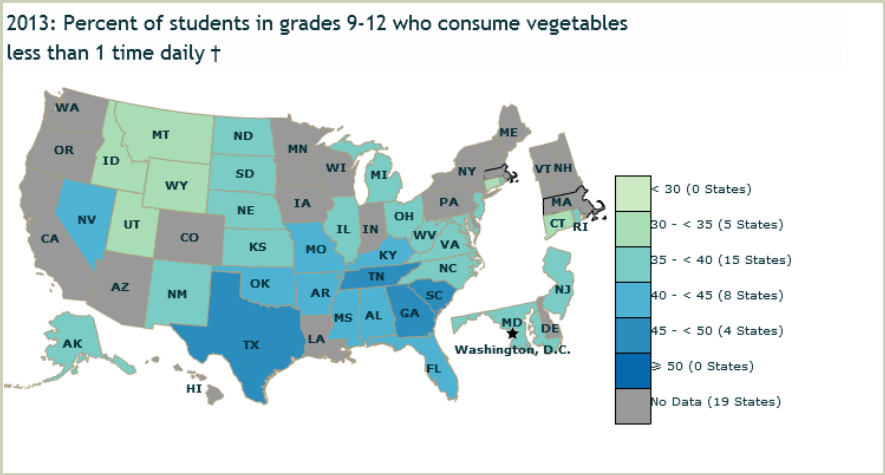
Source: Behavioral Risk Factor Surveillance System, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 2012.

PERCENT OF INDIVIDUALS WHO REPORT CONSUMING VEGETABLES LESS THAN ONE TIME DAILY, 2013

Adults



Adolescents



DEMOGRAPHICS OF FRUIT AND VEGETABLE CONSUMPTION

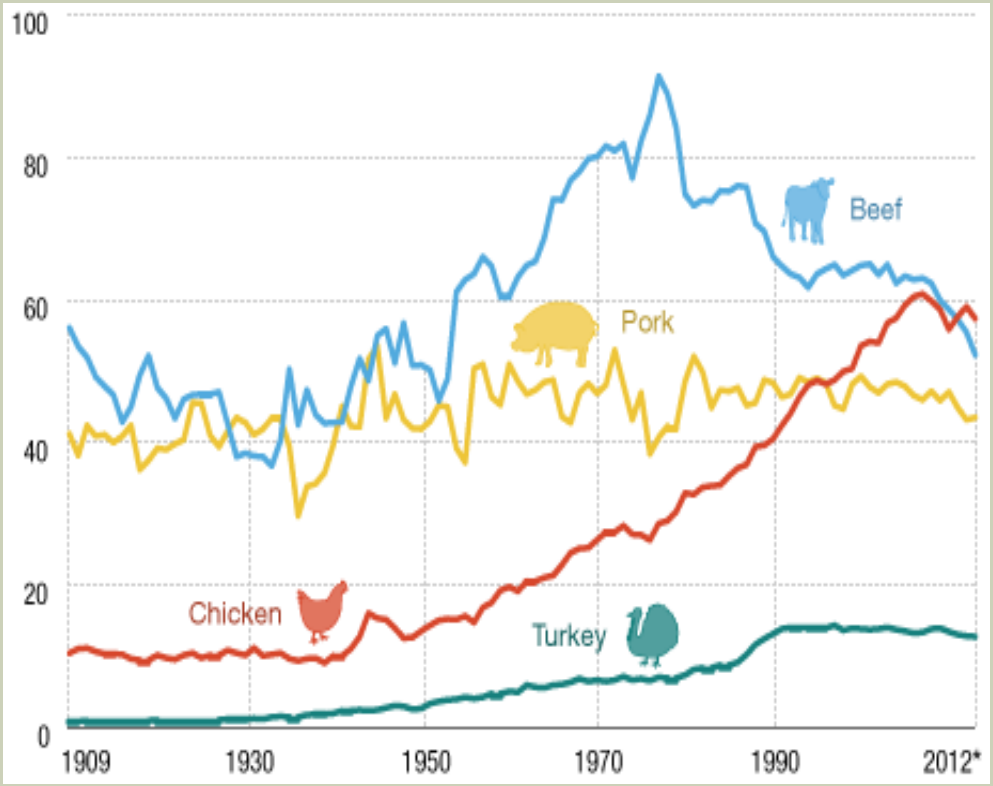
- Fruit consumption is highest among the youngest and oldest segments of the population.
- Total fruit and vegetable consumption tends to increase with age, education and income.
- Among racial and ethnic groups, Blacks have the lowest intake and Mexican Americans have the highest.

RED MEAT AND CANCER

- Red meat/processed meat are associated with increased risk of colorectal cancer, with some evidence for other cancers, such as prostate.
- Some research has suggested that processed, but not fresh meat may increase risk.
- The increased risk may be due to the iron and fat in red meat, and/or the salt and nitrates/nitrites in processed meat.
- Additionally, when meat is cooked at high temperatures, substances are formed that may be mutagenic or carcinogenic.

TRENDS IN MEAT CONSUMPTION

U.S. meat consumption per person, in pounds



Though meat consumption in the U.S. has dropped off slightly in recent years, at 270.7 pounds per person a year, we still eat more meat per person here than in almost any other country on the planet.

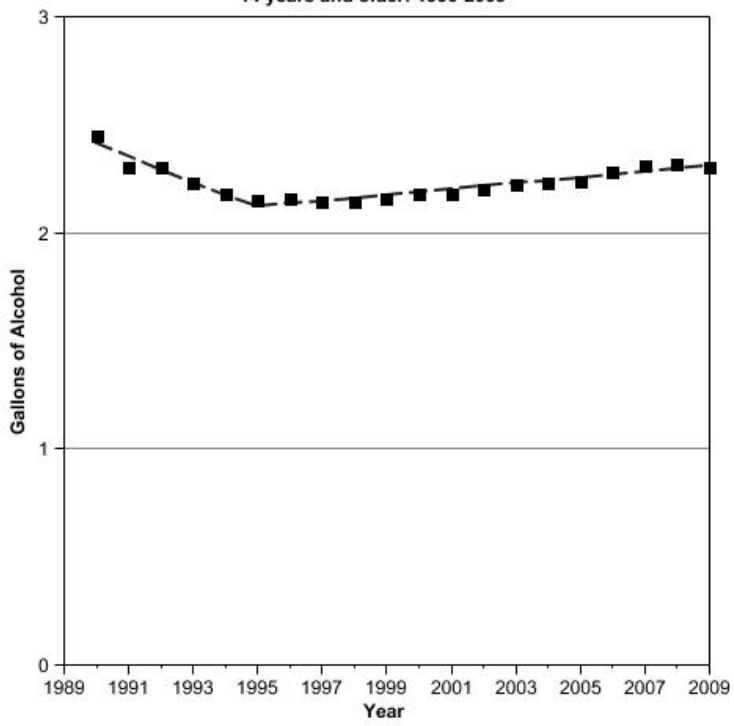
Source: Earth Policy Institute

ALCOHOL

- Alcohol intake increases risk of cancers of the mouth, esophagus, pharynx, larynx, and liver in men and women, and of breast cancer in women. Heavy use may also increase risk of colorectal cancer.
- The earlier long-term, heavy alcohol use begins, the greater the cancer risk.
- Using alcohol with tobacco is riskier than using either one alone because it further increases the chances of getting cancers of the mouth, throat, and esophagus.

ANNUAL PER CAPITA ALCOHOL CONSUMPTION IN GALLONS BY INDIVIDUALS 14 YEARS AND OLDER: 1990-2009

Figure PAC1: Annual per capita alcohol consumption in gallons by individuals aged 14 years and older: 1990-2009



Source : LaVallee, R.A.; and Yi, H. Surveillance Report #92: Apparent Per Capita Alcohol Consumption: National, State, and Regional Trends, 1977-2009. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism, Division of Epidemiology and Prevention Research (August 2011).
Data are not age-adjusted.

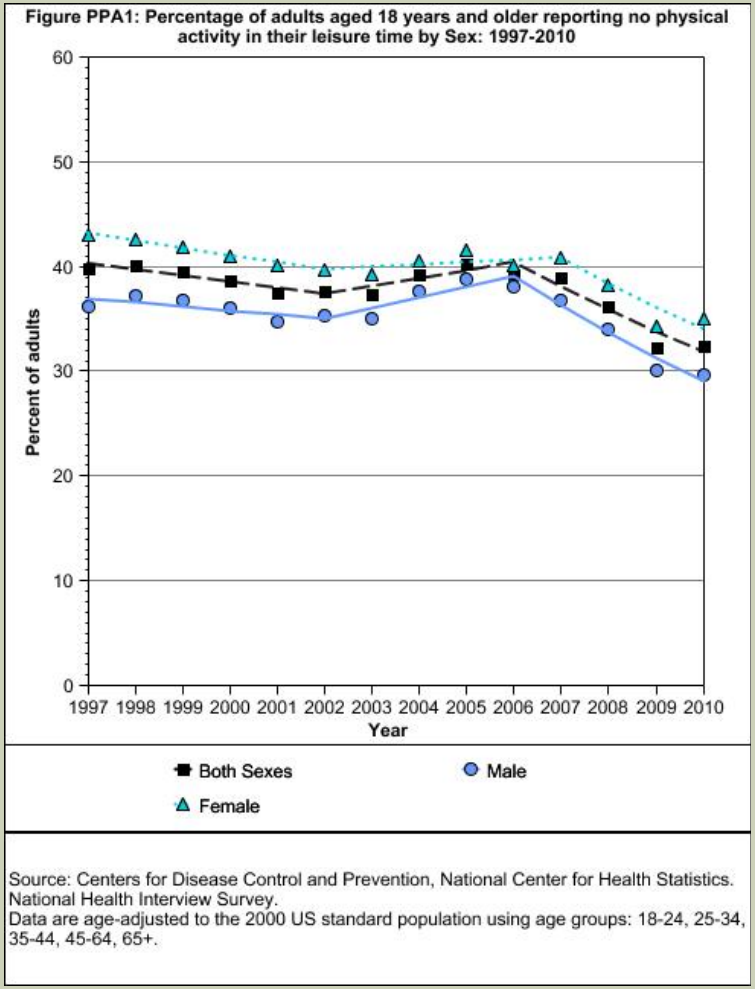
DEMOGRAPHICS OF ALCOHOL CONSUMPTION

- Many people start drinking as early as middle school (aged 13–14 years).
- Among those aged 12–17 years, Whites and Hispanics are more likely than Blacks to use alcohol.
- Among alcohol drinkers, those aged 18–25 years consume greater quantities than any other group.

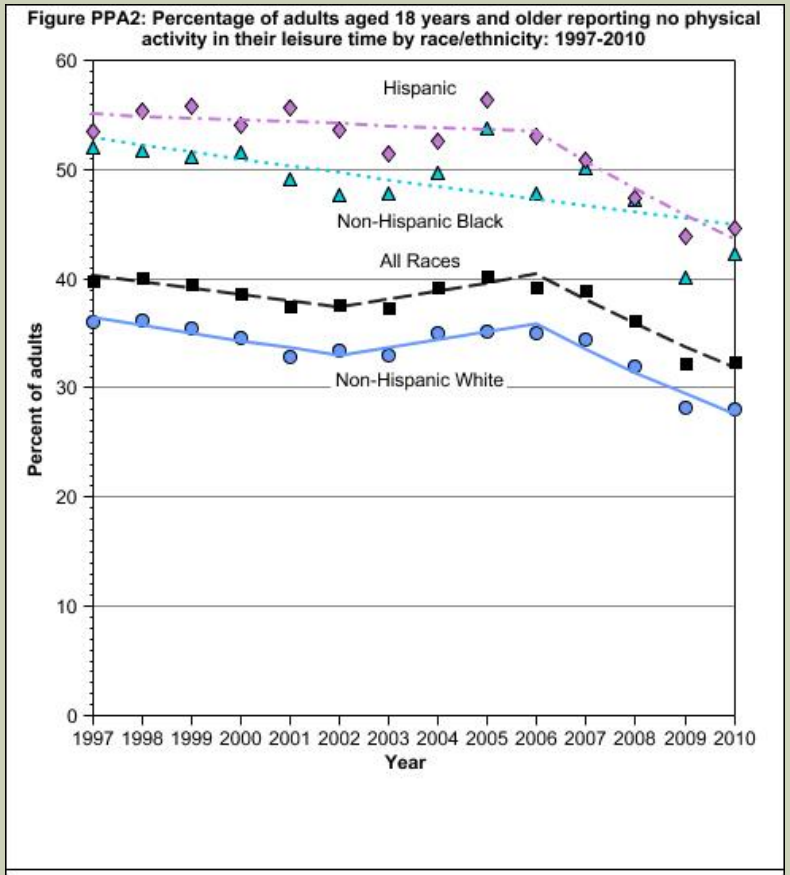
PHYSICAL ACTIVITY

- Physical activity at work or during leisure time is linked to a 30-percent lower risk of getting colon cancer, lower risk of breast cancer, and possibly lung and endometrial cancer.
- Physical activity improves quality of life among cancer patients and survivors. Studies are beginning to explore the potential for physical activity to improve cancer survival.
- Physical activity appears to be effective in reducing the amount of weight gained during and after treatment of breast cancer.

PERCENTAGE OF ADULTS AGED 18 YEARS AND OLDER REPORTING NO PHYSICAL ACTIVITY IN THEIR LEISURE TIME BY SEX: 1997-2010

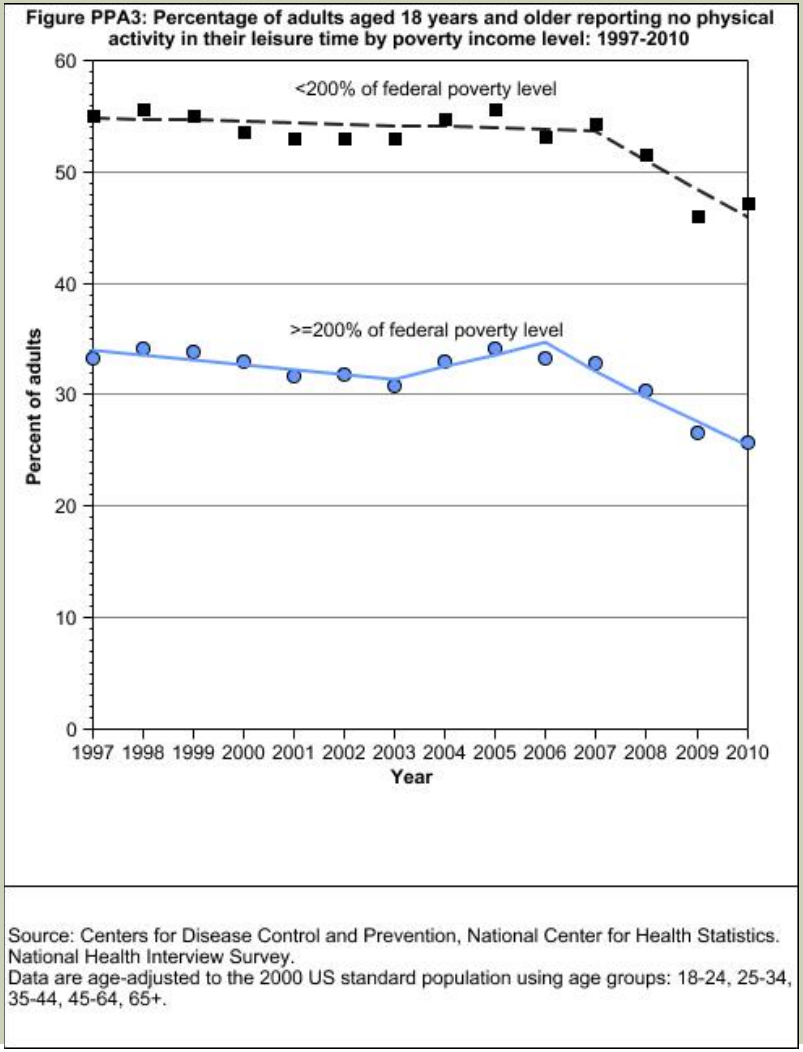


PERCENTAGE OF ADULTS AGED 18 YEARS AND OLDER REPORTING NO PHYSICAL ACTIVITY IN THEIR LEISURE TIME BY RACE/ETHNICITY: 1997-2010

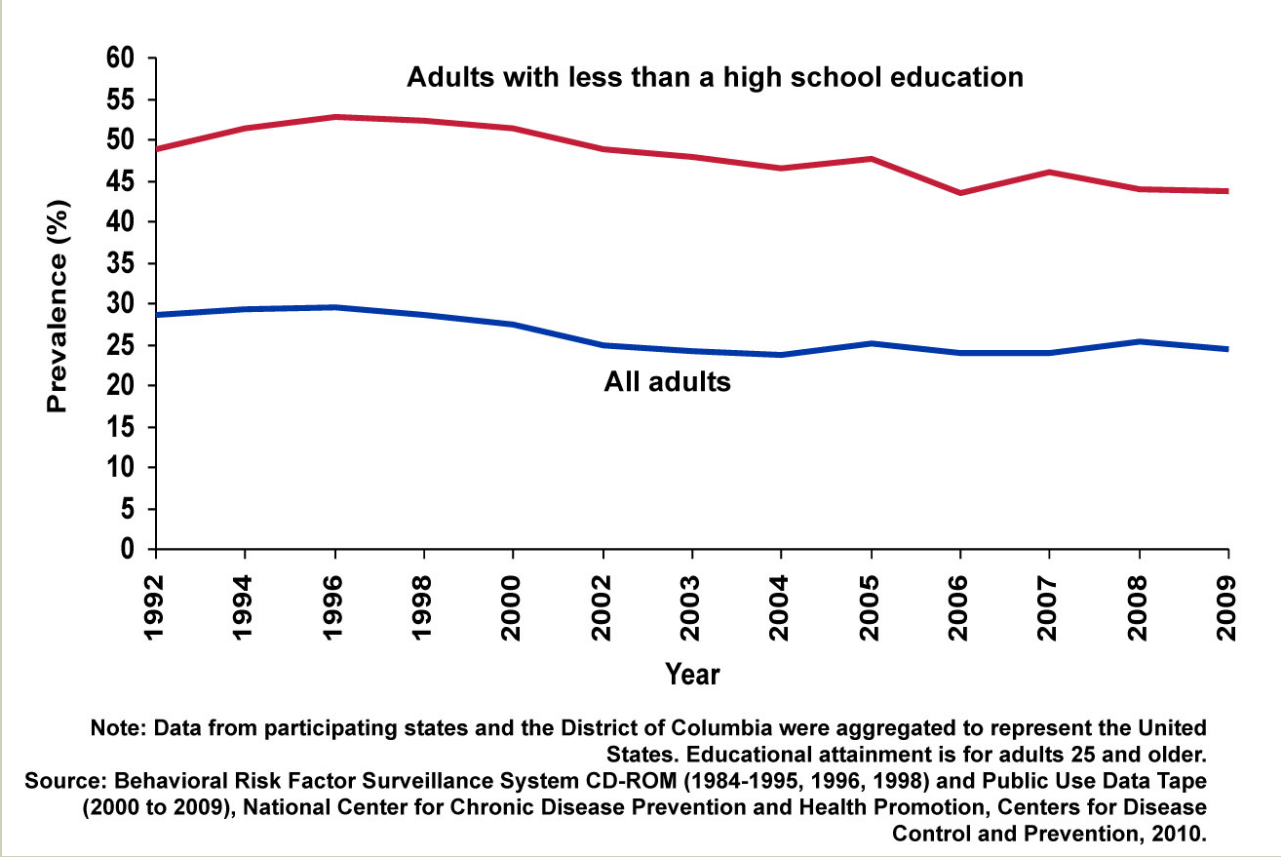


Source: Centers for Disease Control and Prevention, National Center for Health Statistics. National Health Interview Survey.
Data are age-adjusted to the 2000 US standard population using age groups: 18-24, 25-34, 35-44, 45-64, 65+.

PERCENTAGE OF ADULTS AGED 18 YEARS AND OLDER REPORTING NO PHYSICAL ACTIVITY IN THEIR LEISURE TIME BY POVERTY INCOME LEVEL: 1997-2010



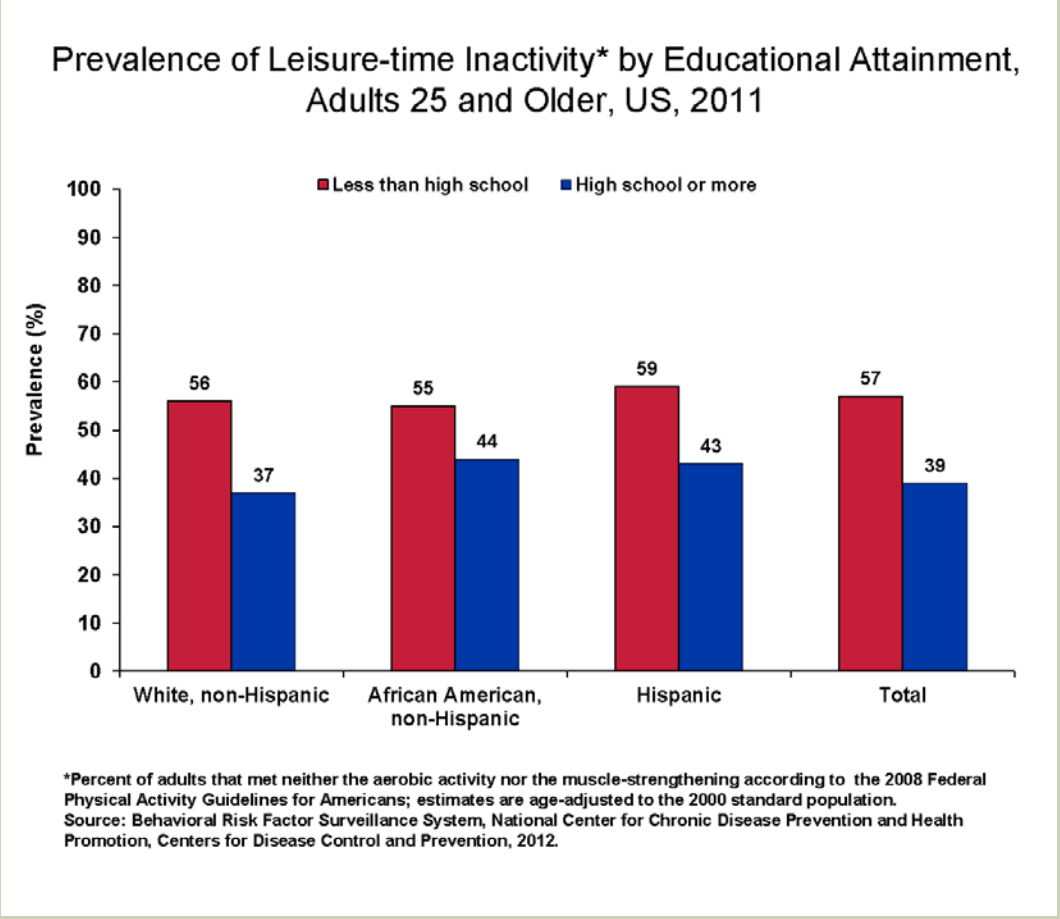
TRENDS IN PREVALENCE (%) OF NO LEISURE-TIME PHYSICAL ACTIVITY, BY EDUCATIONAL ATTAINMENT, ADULTS 18 AND OLDER, US, 1992-2009



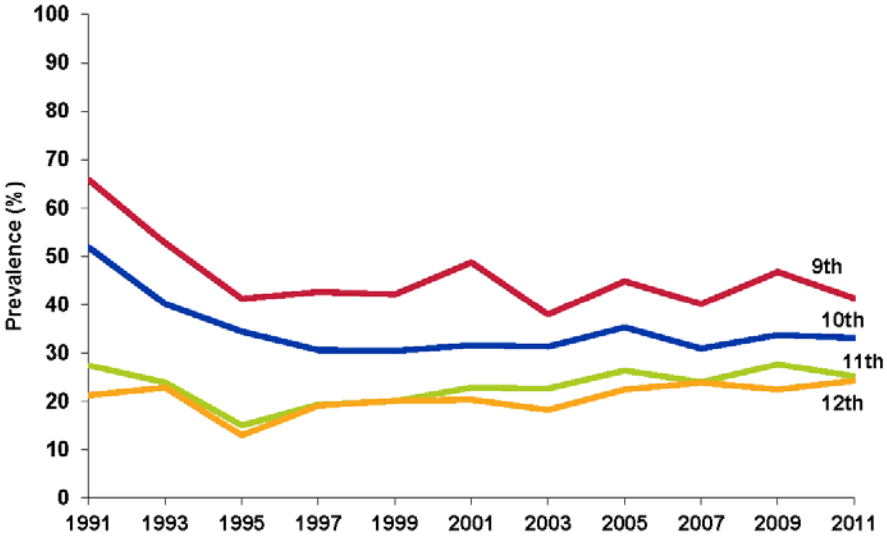
Note: Data from participating states and the District of Columbia were aggregated to represent the United States. Educational attainment is for adults 25 and older.

Source: Behavioral Risk Factor Surveillance System CD-ROM (1984-1995, 1996, 1998) and Public Use Data Tape (2000 to 2009), National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 2010.

PREVALENCE (%) OF LEISURE-TIME INACTIVITY, BY EDUCATIONAL ATTAINMENT, ADULTS 25 AND OLDER, US, 2011



TRENDS IN PREVALENCE (%) OF HIGH SCHOOL STUDENTS ATTENDING PE CLASS DAILY, BY GRADE, US, 1991-2011



Source: Source: Youth Risk Behavior Surveillance System, 1991-2011 National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 2012

DEMOGRAPHICS OF PHYSICAL ACTIVITY

- Women are more likely than men to not engage in leisure-time physical activity.
- Blacks and Hispanics are more likely than Whites, to report no leisure-time physical activity.
- Lack of physical activity also is more common among those with less education and those with lower incomes.
- For youth, physical activity is lower among females, especially Blacks. Also, physical activity decreases as children get older.

OVERWEIGHT AND OBESITY

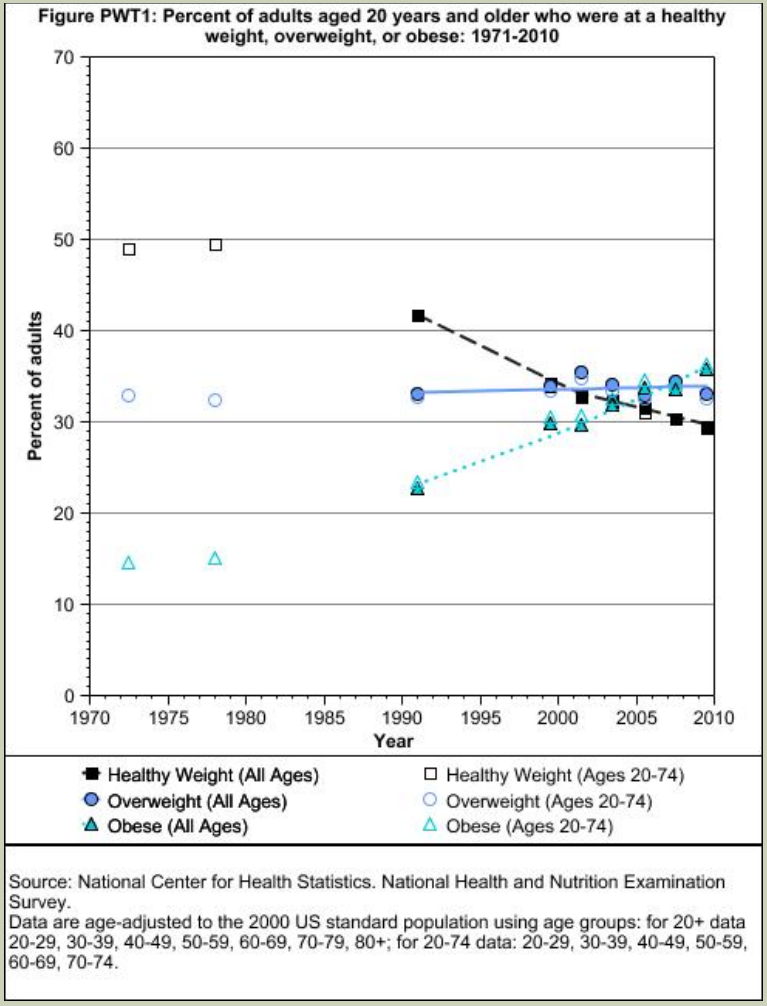
- Obesity associated with increased risk of many common cancers, such as colon, postmenopausal breast, uterine, esophageal, and renal cell cancers.

- Recent studies indicate that obesity and being overweight may increase the risk of death from many cancers, accounting for up to 14 percent of cancer deaths in men and 20 percent of cancer deaths in women.

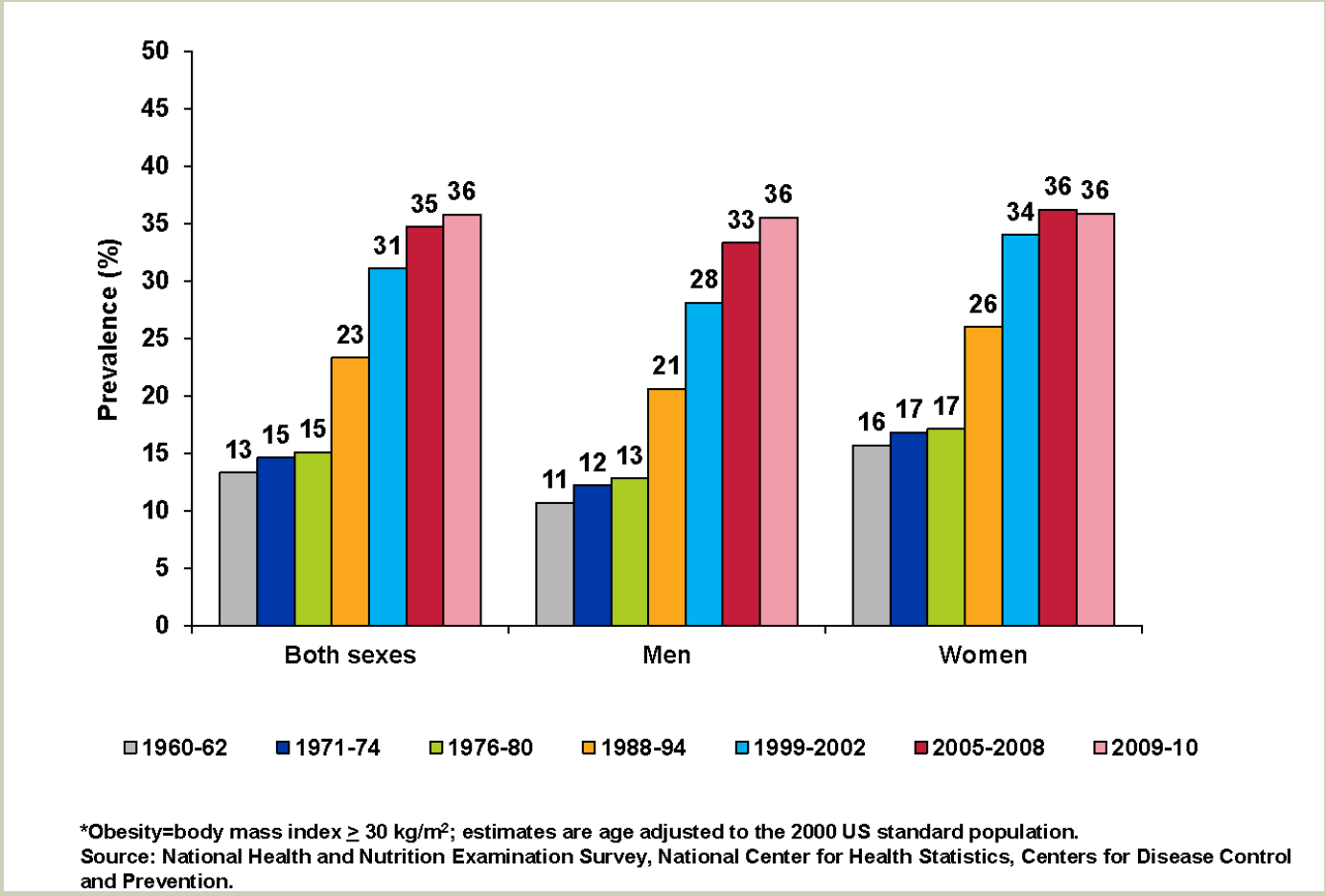
- Weight groups are defined by BMI.

  Healthy weight - BMI between 18.5 and 24.9
  Overweight - BMI between 25.0 and 29.9
  Obese - BMI equal to or greater than 30.0

PERCENTAGE OF ADULTS AGED 20 -74 YEARS WHO WERE AT HEALTHY WEIGHT, OVERWEIGHT, OR OBESE, 1971-2010.

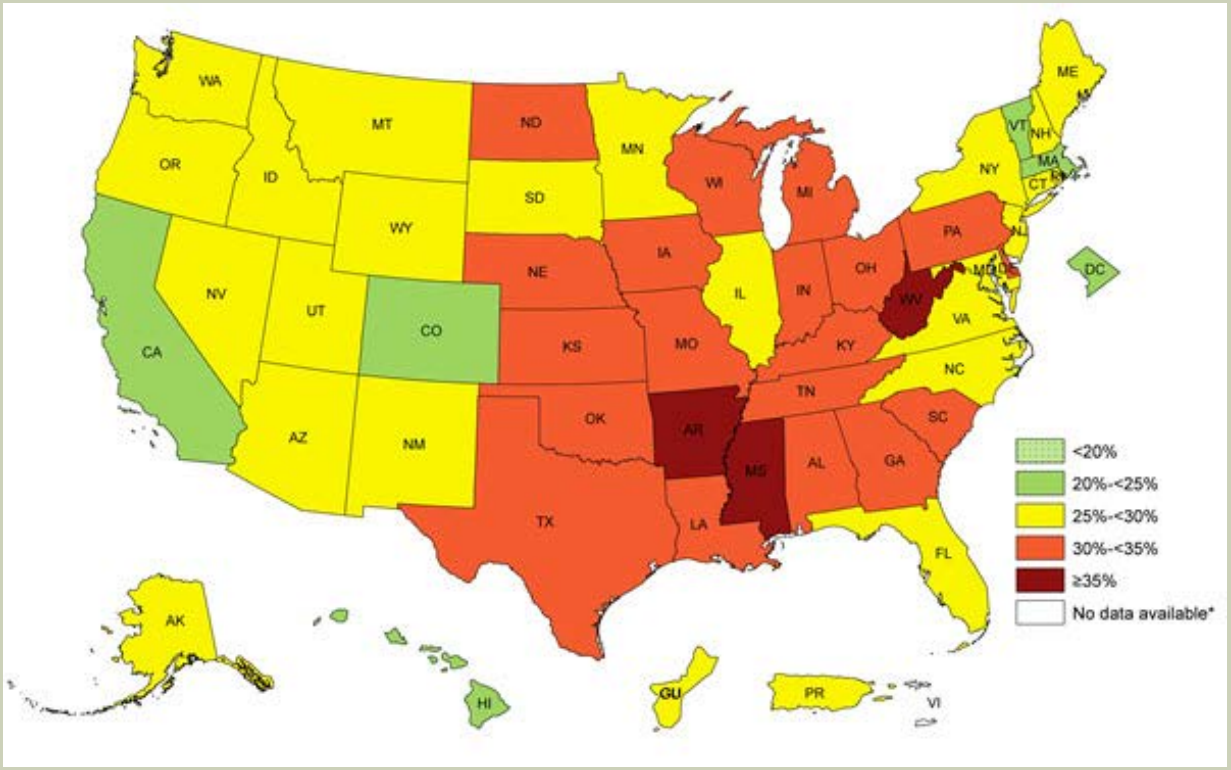


TRENDS IN OBESITY* PREVALENCE (%), BY GENDER, ADULTS AGED 20 TO 74, US, 1960-2010



*Obesity=body mass index ≥ 30 kg/m^2; estimates are age adjusted to the 2000 US standard population.
Source: National Health and Nutrition Examination Survey, National Center for Health Statistics, Centers for Disease Control and Prevention.

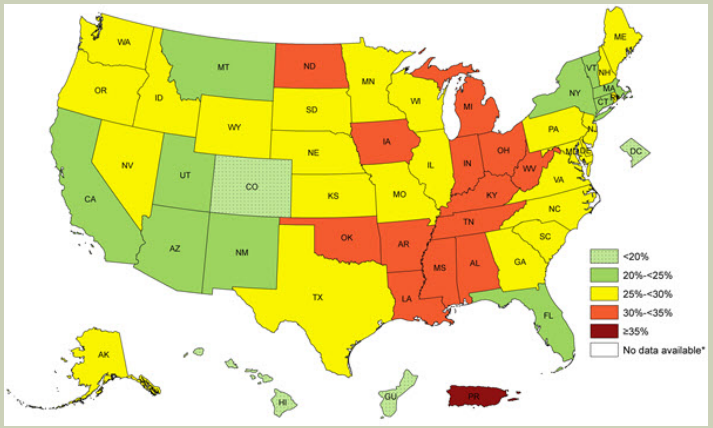
PREVALENCE OF SELF-REPORTED OBESITY AMONG US ADULTS, BRFSS, 2014



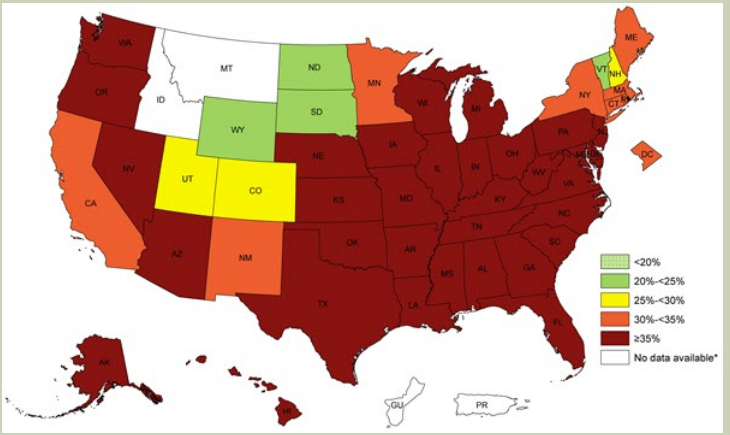
Source: Behavorial Risk Factor Surveillance System, CDC.

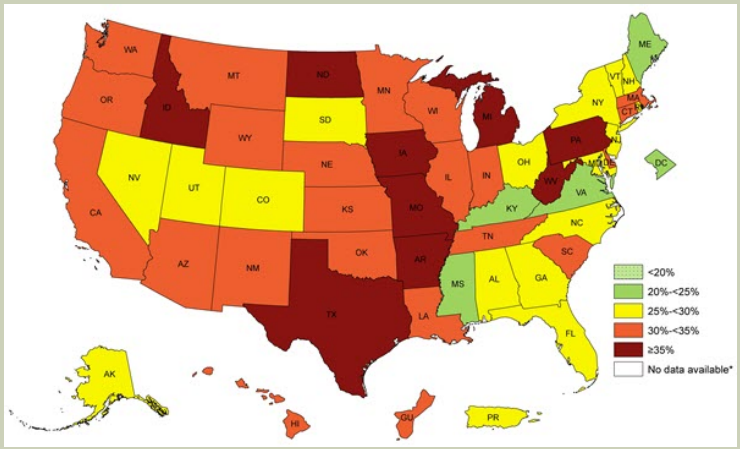
PREVALENCE OF SELF-REPORTED OBESITY AMONG US ADULTS BY RACE, BRFSS, 2012-2014

Non-Hispanic Whites



Non-Hispanic Blacks

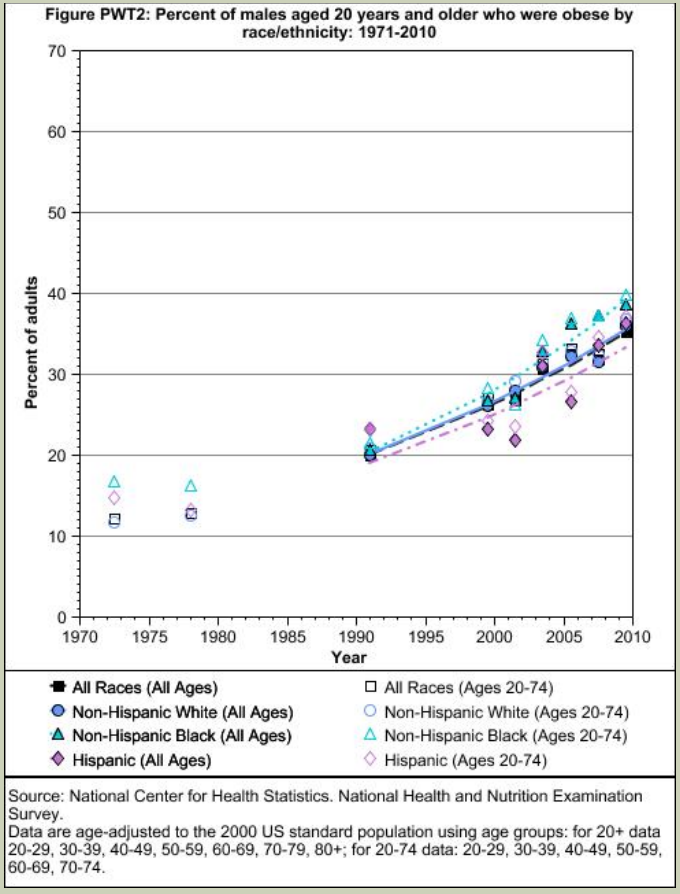




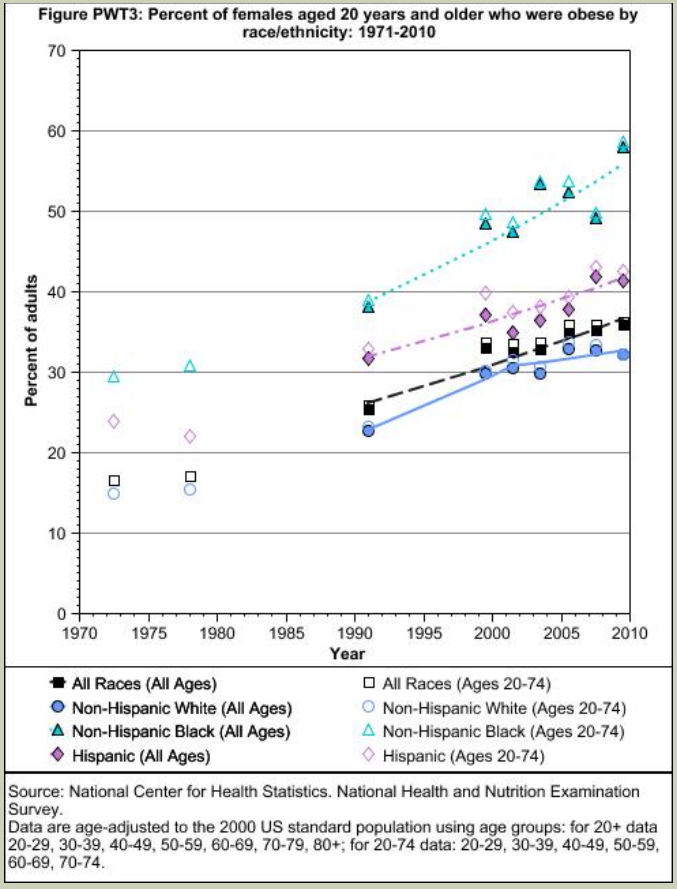
Hispanics

PERCENT OBESE BY RACE/ETHNICITY: 1971-2010

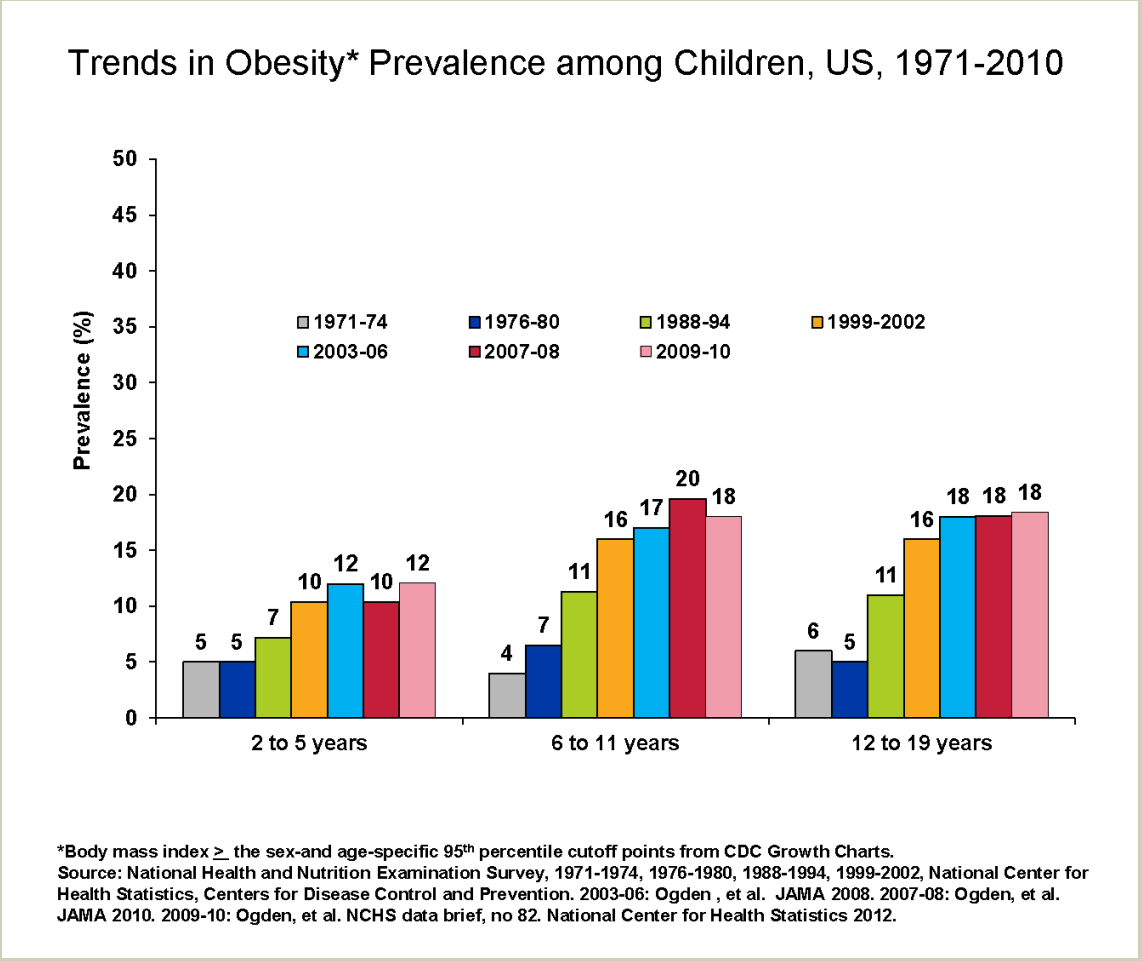
Male



Female



TRENDS IN OBESITY PREVALENCE, CHILDREN AND ADOLESCENTS, US, 1971-2010



*Body mass index ≥ the sex-and age-specific 95th percentile cutoff points from CDC Growth Charts.
Source: National Health and Nutrition Examination Survey, 1971-1974, 1976-1980, 1988-1994, 1999-2002, National Center for Health Statistics, Centers for Disease Control and Prevention. 2003-06: Ogden , et al. JAMA 2008. 2007-08: Ogden, et al. JAMA 2010. 2009-10: Ogden, et al. NCHS data brief, no 82. National Center for Health Statistics 2012.

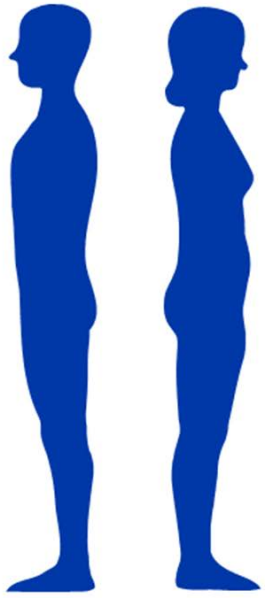
DEMOGRAPHICS OF OBESITY

- Overweight and obesity are most common among Black and Mexican American women. The same patterns are seen for children and teens in these groups.
- Overweight children are more likely to become overweight adults. As with adults, the trend toward excess weight among children has greatly increased in the late 1980s and the 1990s, but has stabilized in recent years.

2015 ESTIMATED US CANCER CASES*

Estimated New Cancer Cases* in the US in 2015

Men 848,200		Women 810,170	
Prostate	26%	29%	Breast
Lung & bronchus	14%	13%	Lung & bronchus
Colon & rectum	8%	8%	Colon & rectum
Urinary bladder	7%	7%	Uterine corpus
Melanoma of skin	5%	6%	Thyroid
Non-Hodgkin lymphoma	5%	4%	Non-Hodgkin lymphoma
Kidney & renal pelvis	5%	4%	Melanoma of skin
Oral cavity & pharynx	4%	3%	Pancreas
Leukemia	4%	3%	Leukemia
Liver & intrahepatic bile duct	3%	3%	Kidney & renal pelvis
All other sites	21%	21%	All other sites



*Excludes basal cell and squamous cell skin cancers and in situ carcinoma except urinary bladder.

LIFETIME PROBABILITY OF DEVELOPING CANCER, MEN, 2009-2011

The Lifetime Probability of Developing Cancer for Men, 2009-2011*

Site	Risk
All sites†	1 in 2
Prostate	1 in 7
Lung & bronchus	1 in 13
Colon & rectum	1 in 21
Urinary bladder‡	1 in 26
Melanoma of the skin§	1 in 34
Non-Hodgkin lymphoma	1 in 42
Kidney & renal pelvis	1 in 49
Leukemia	1 in 59
Oral cavity & pharynx	1 in 65
Pancreas	1 in 66

* For those free of cancer.
† All sites exclude basal cell and squamous cell skin cancers and in situ cancers except urinary bladder.
‡ Includes invasive and in situ cancer cases
§ Statistic for white men.

Source: DevCan: Probability of Developing or Dying of Cancer Software, Version 6.7.1 Statistical Research and Applications Branch, National Cancer Institute, 2014.

LIFETIME PROBABILITY OF DEVELOPING CANCER, WOMEN, US, 2009-2011*

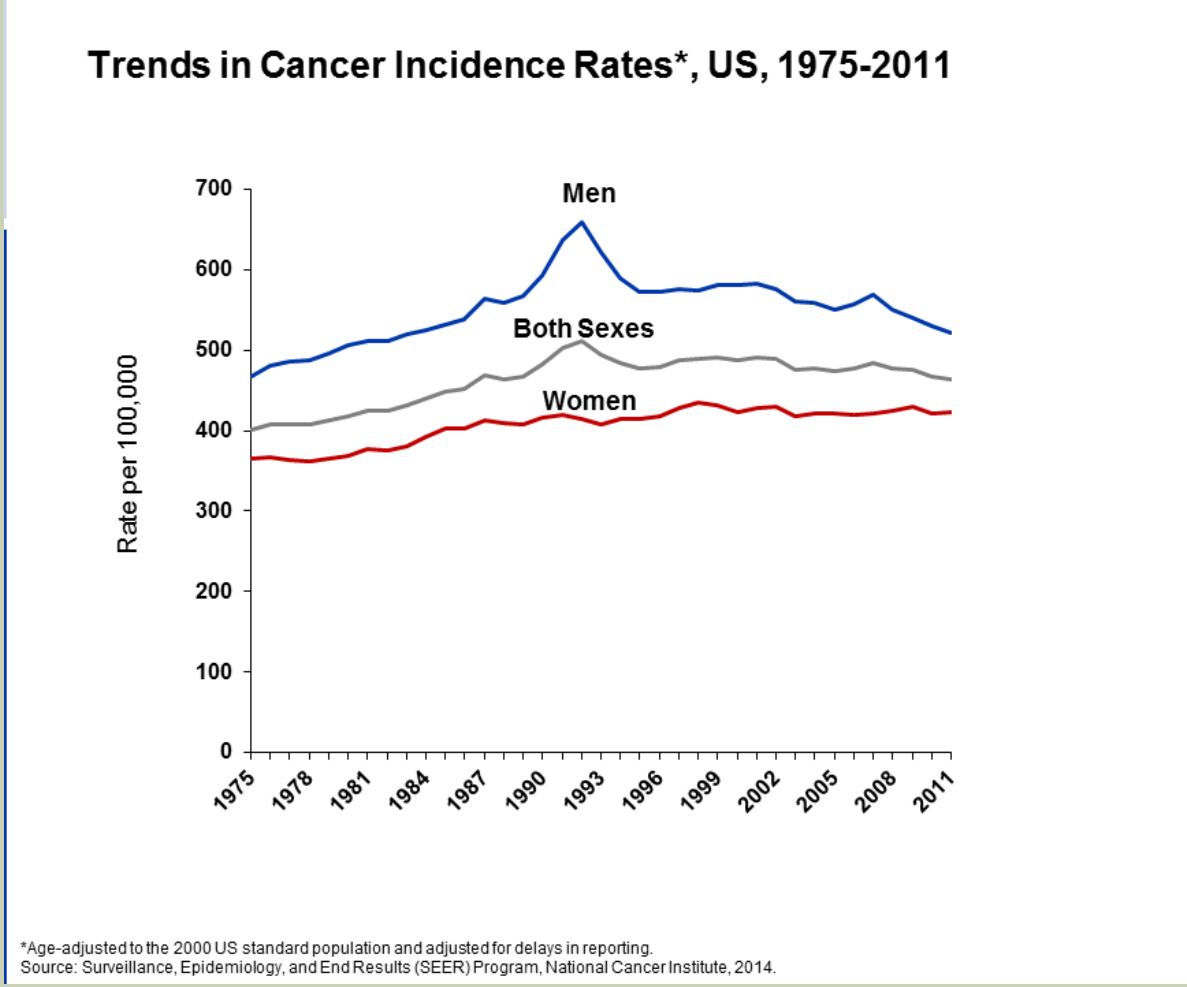
The Lifetime Probability of Developing Cancer for Women, 2009-2011*

Site	Risk
All sites†	1 in 3
Breast	1 in 8
Lung & bronchus	1 in 16
Colon & rectum	1 in 22
Uterine corpus	1 in 37
Non-Hodgkin lymphoma	1 in 52
Melanoma of the skin‡	1 in 53
Thyroid	1 in 60
Pancreas	1 in 67
Ovary	1 in 75
Leukemia	1 in 84

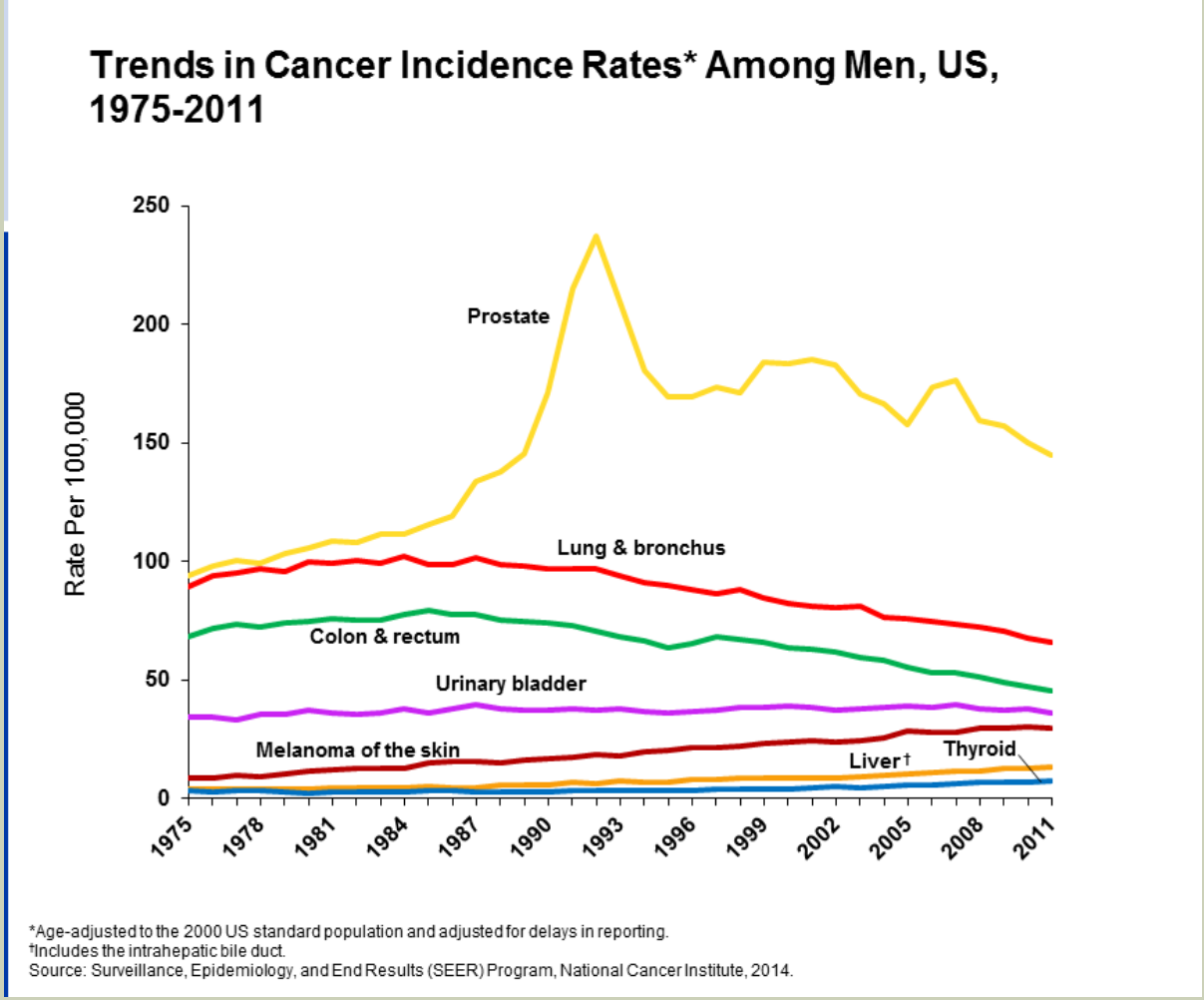
* For those free of cancer.
† All sites exclude basal cell and squamous cell skin cancers and in situ cancers except urinary bladder.
‡ Statistic for white women.

Source: DevCan: Probability of Developing or Dying of Cancer Software, Version 6.7.1 Statistical Research and Applications Branch, National Cancer Institute, 2014.

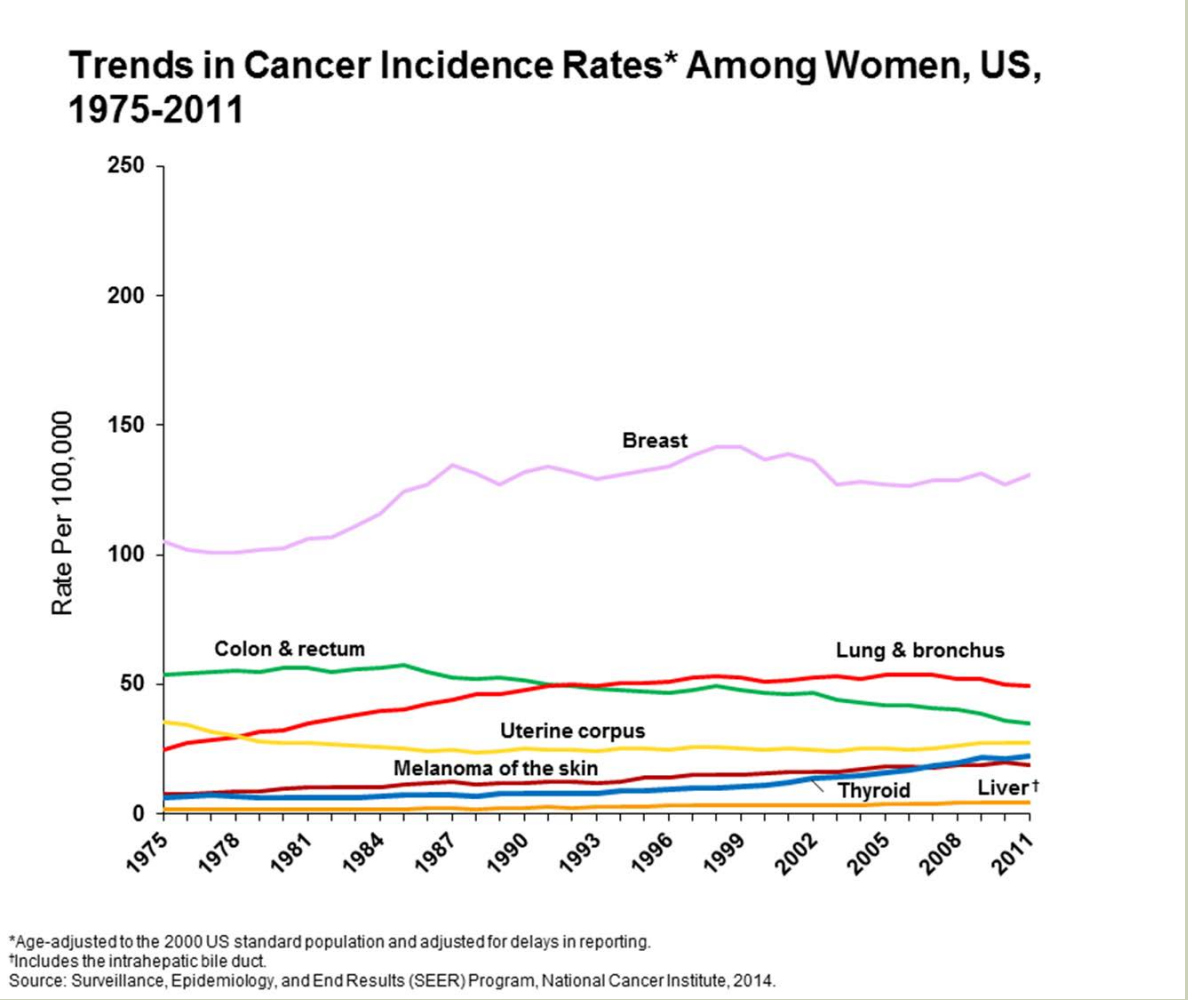
CANCER INCIDENCE RATES* BY SEX, US, 1975-2011



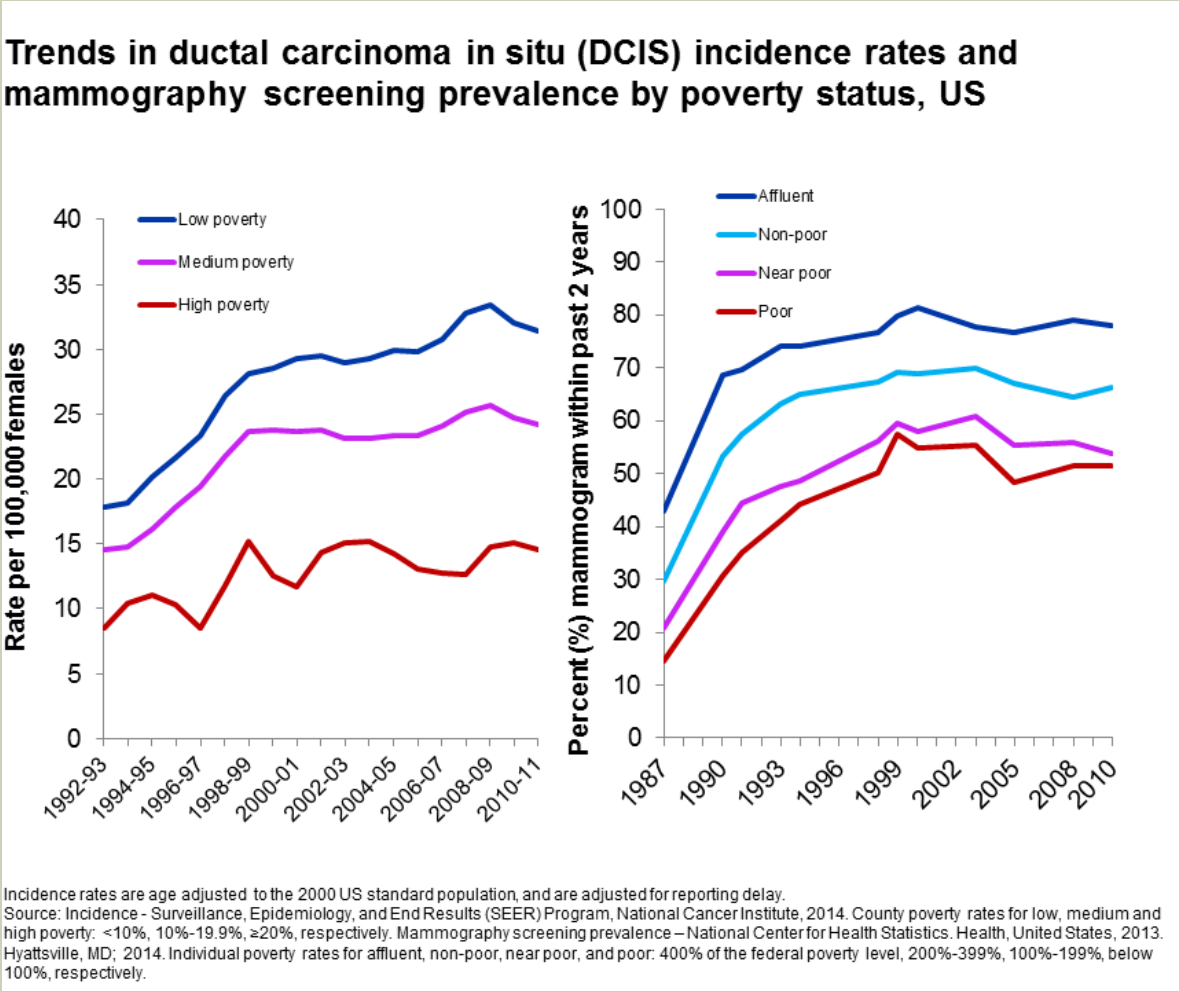
CANCER INCIDENCE RATES* AMONG MEN, US, 1975-2011



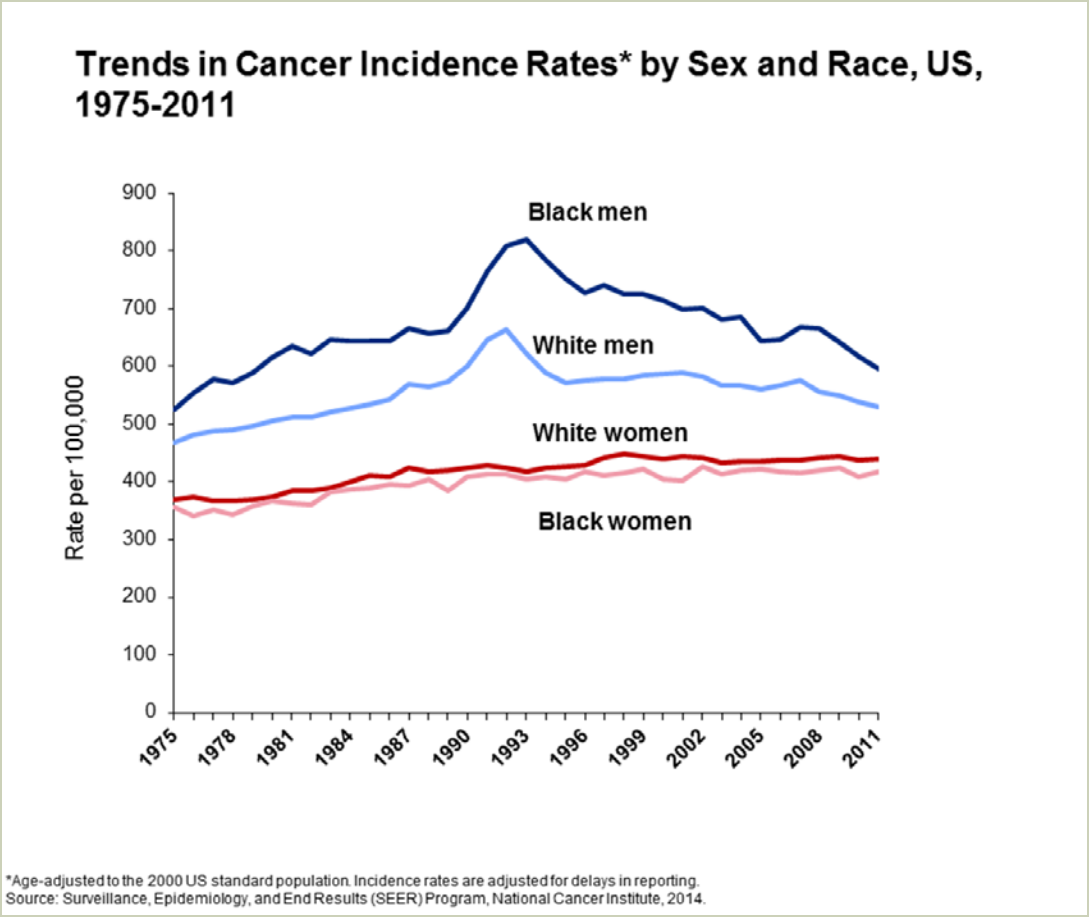
CANCER INCIDENCE RATES* AMONG WOMEN, US, 1975-2011



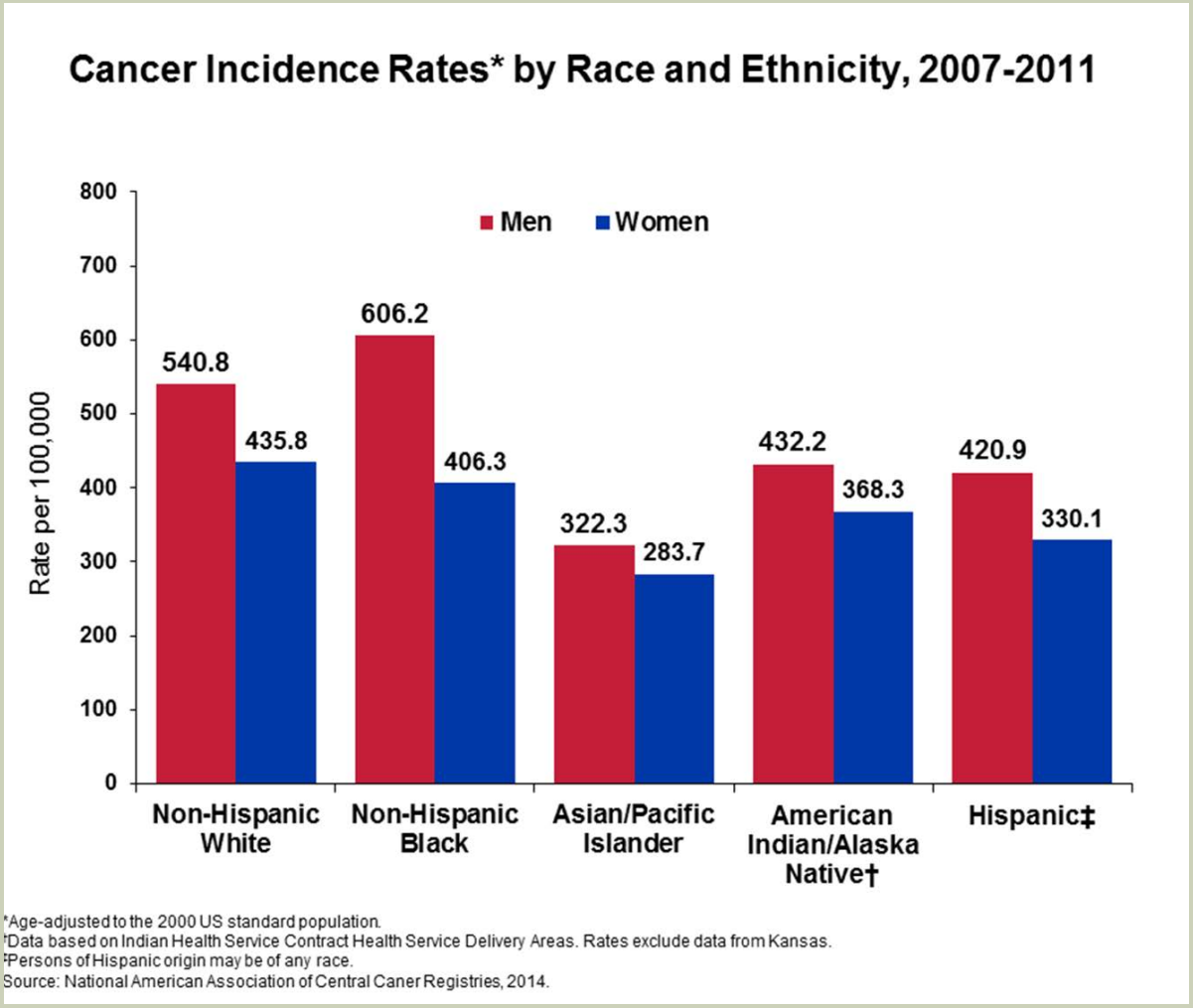
TRENDS IN DUCTAL CARCINOMA IN SITU (DCIS) INCIDENCE RATES AND MAMMOGRAPHY SCREENING PREVALENCE BY POVERTY STATUS



CANCER INCIDENCE RATES* BY SEX AND RACE, US,1975-2011



CANCER INCIDENCE RATES* BY RACE AND ETHNICITY, 2000-2011



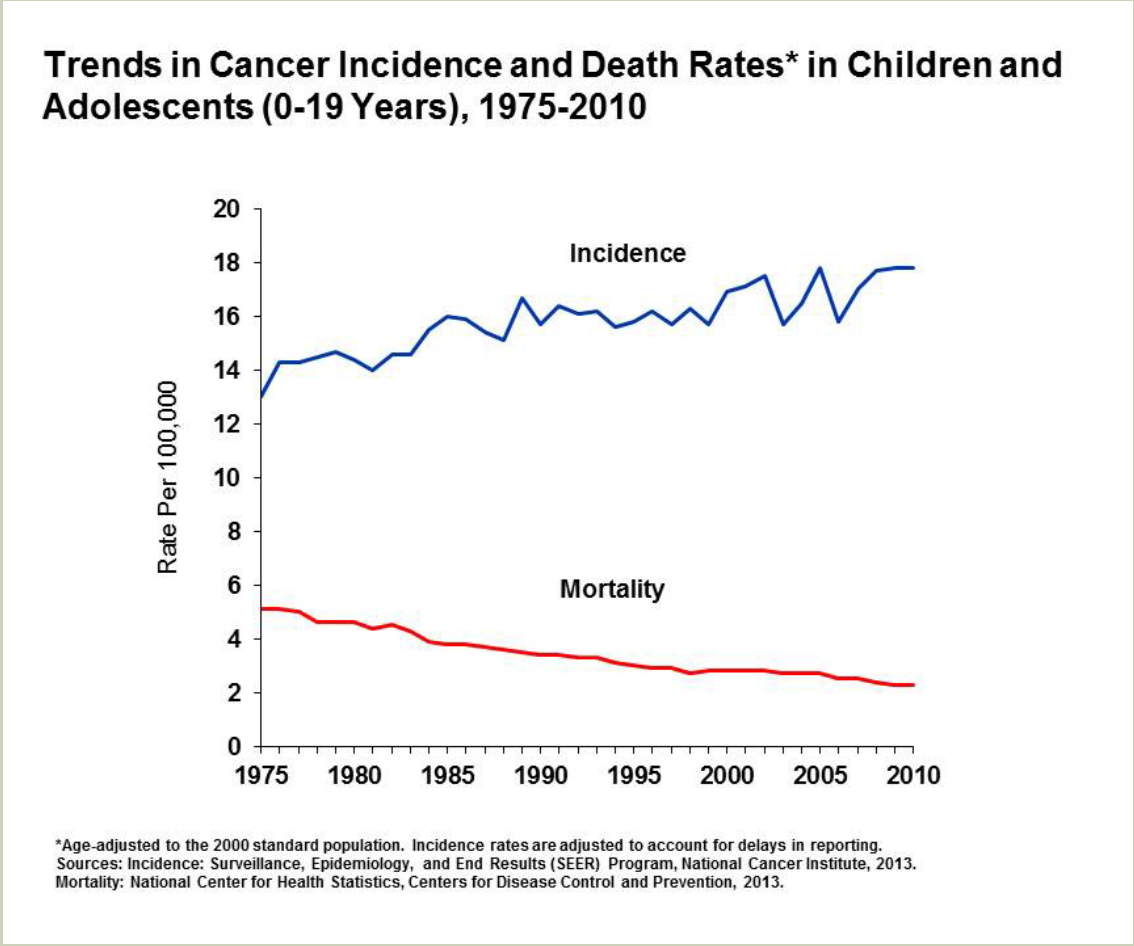
ESTIMATED CASES FOR CHILDHOOD AND ADOLESCENT CANCERS, US, 2014

Estimated Cases* for Childhood and Adolescent Cancers, US, 2014

Children (0-14 Years)		Adolescents (15-19 Years)	
Acute lymphocytic leukemia	26%	Hodgkin lymphoma	15%
Brain & CNS	21%	Thyroid carcinoma	11%
Neuroblastoma†	7%	Brain & CNS	10%
Non-Hodgkin lymphoma	6%	Testicular germ cell tumors	8%
Wilms tumor	5%	Non-Hodgkin lymphoma	8%
Acute myeloid leukemia	5%	Acute lymphocytic leukemia	8%
Bone tumors‡	4%	Bone tumors‡	7%
Hodgkin lymphoma	4%	Melanoma of skin	6%
Rhabdomyosarcoma	3%	Acute myeloid leukemia	4%
Retinoblastoma	3%	Ovarian germ cell tumors	2%
All other sites	16%	All other sites	21%

CNS=Central nervous system.
* Estimates are for malignant cancers only and are rounded to the nearest 10.
† Includes ganglioneuroblastoma.
‡ Bone tumors include osteosarcoma and Ewing sarcoma.

TRENDS IN CANCER INCIDENCE AND DEATH RATES IN CHILDREN AND ADOLESCENTS, 1975-2010

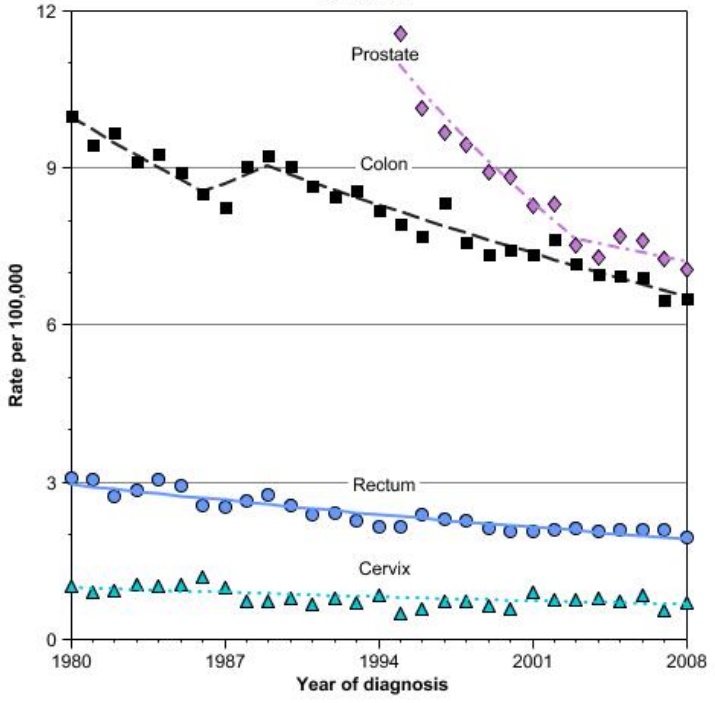


LATE-STAGE DIAGNOSIS OF CANCER

- Cancers can be diagnosed at different stages in their development. Stage of cancer diagnosis may be expressed as numbers (I, II, III, or IV, for example) or by terms such as "localized," "regional," and "distant.".
- The lower the number or the more localized the cancer, the better a person's chances of benefiting from treatment and being cured.
- Tracking the rates of late-stage (distant) cancers is a good way to monitor the impact of cancer screening. When more cancers are detected in early stages, fewer should be detected in late stages.
- A lower rate of diagnosis at late stages is an early sign of the effectiveness of cancer screening efforts. These lower rates can be expected to occur before decreases in death rates are seen.

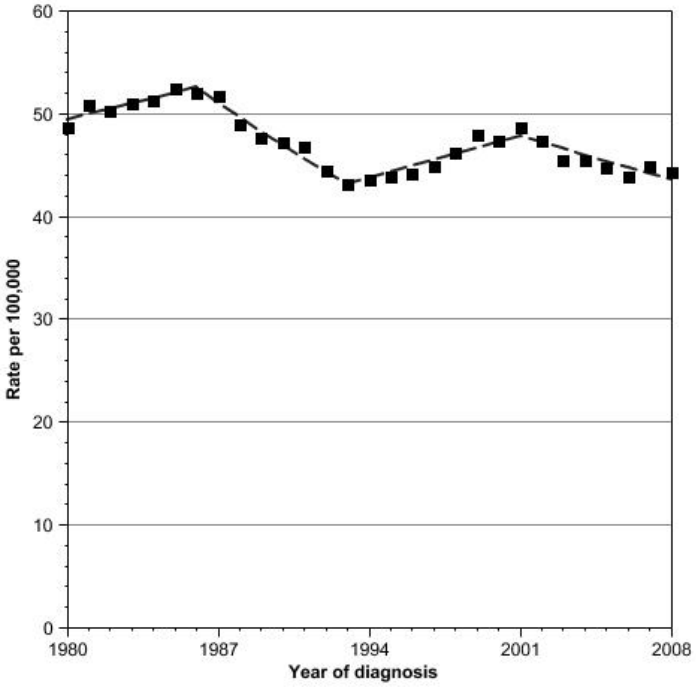
RATES OF NEW CANCERS OF DISTANT STAGE DISEASES BY CANCER SITE: 1980-2008

Figure DST1: Rates of new cancers of distant stage diseases by cancer site: 1980-2008



Source: SEER Program, National Cancer Institute. Incidence data are from the SEER 9 areas (http://seer.cancer.gov/registries/terms.html).
Data are age-adjusted to the 2000 standard using age groups:<1, 1-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85+. Analysis uses the 2000 Standard Population (Census P25-1130) as defined by NCI(http://seer.cancer.gov/stdpopulations/).

Figure DST2: Rates of new late stage breast cancer: 1980-2008



Source: SEER Program, National Cancer Institute. Incidence data are from the SEER 9 areas (http://seer.cancer.gov/registries/terms.html).
Late stage breast cancer includes cases diagnosed at regional and distant stages.
Data are age-adjusted to the 2000 standard using age groups:<1, 1-4, 5-9, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80-84, 85+. Analysis uses the 2000 Standard Population (Census P25-1130) as defined by NCI(http://seer.cancer.gov/stdpopulations/).

TRENDS IN FIVE-YEAR RELATIVE SURVIVAL (%)* RATES, US, 1975-2010

Trends in Five-year Relative Cancer Survival Rates (%), 1975-2010

Site	1975-1977	1987-1989	2004-2010
All sites	49	55	68
Breast (female)	75	84	91
Colon	51	60	65
Leukemia	34	43	60
Lung & bronchus	12	13	18
Melanoma of the skin	82	88	93
Non-Hodgkin lymphoma	47	51	71
Ovary	36	38	45
Pancreas	3	4	7
Prostate	68	83	100*
Rectum	48	58	68
Urinary bladder	72	79	79

5-year relative survival rates based on patients diagnosed in the SEER 9 areas from 1975-1977, 1987-1989, and 2004-2010, all followed through 2011.
*99.6%
Source: Surveillance, Epidemiology, and End Results (SEER) Program, National Cancer Institute, 2014.

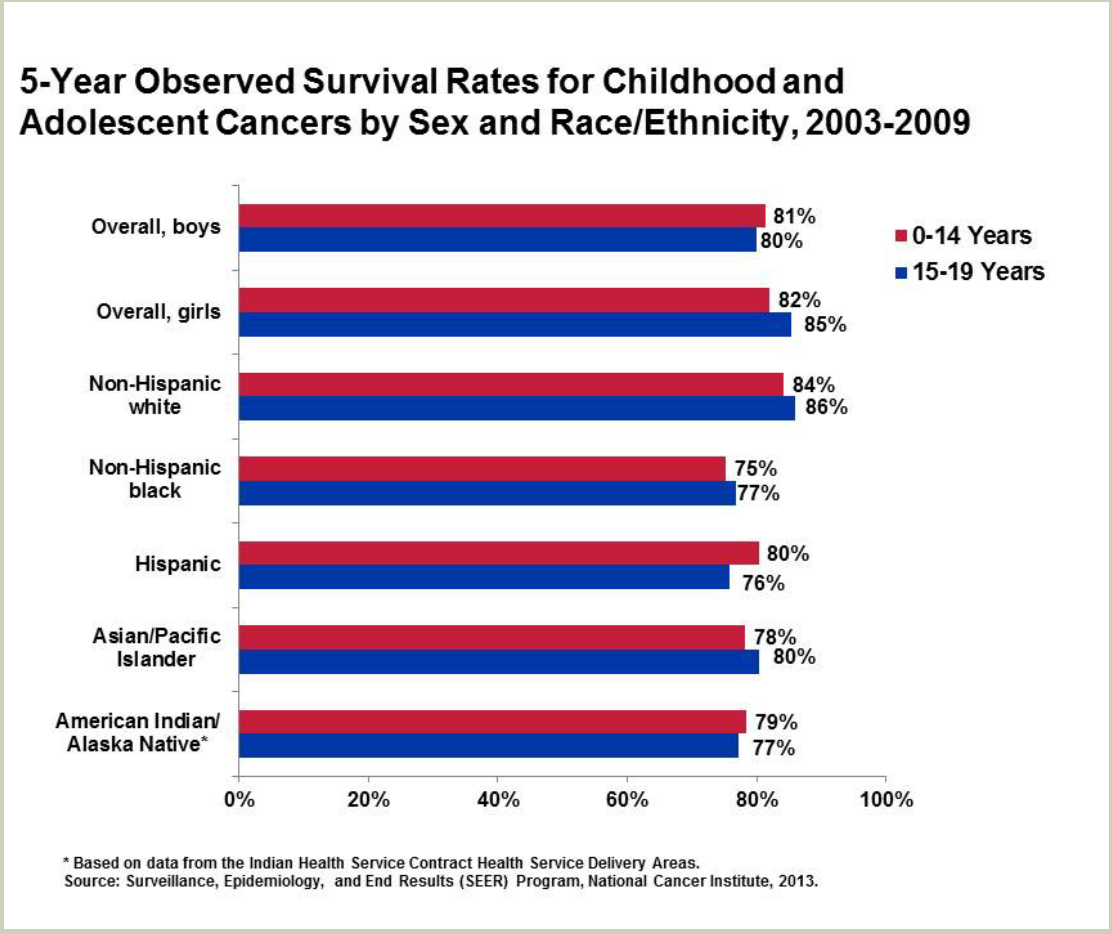
5 YEAR CANCER SURVIVAL*(%) BY RACE,2004-2010

Five-year Relative Cancer Survival Rates (%) by Race, 2004-2010

Site	White	Black	Absolute Difference
All Sites	69	62	7
Breast (female)	92	80	12
Colon	67	56	11
Esophagus	21	13	7
Leukemia	61	54	7
Non-Hodgkin lymphoma	73	63	10
Oral cavity & pharynx	67	45	22
Prostate	100*	98	2
Rectum	68	63	5
Urinary bladder	80	64	16
Uterine cervix	71	62	9
Uterine corpus	85	65	20

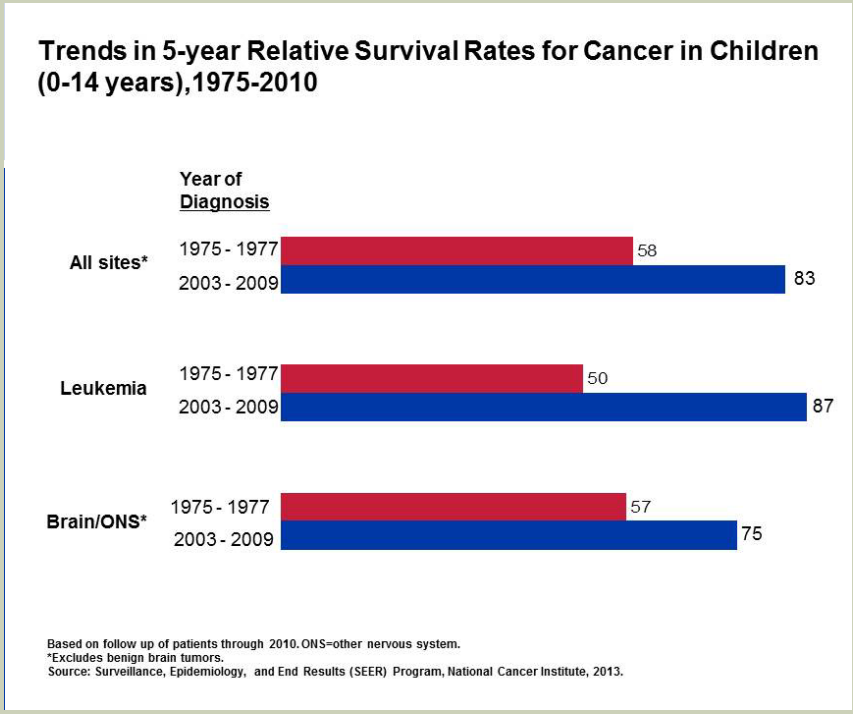
5-year relative survival rates based on patients diagnosed in the SEER 9 areas from 2004 to 2010, all followed through 2011.
*99.8%
Source: Surveillance, Epidemiology, and End Results (SEER) Program, National Cancer Institute, 2014.

5 YEAR CANCER SURVIVAL FOR CHILDHOOD AND ADOLESCENT CANCERS BY SEX AND RACE/ETHNICITY,2003-2009

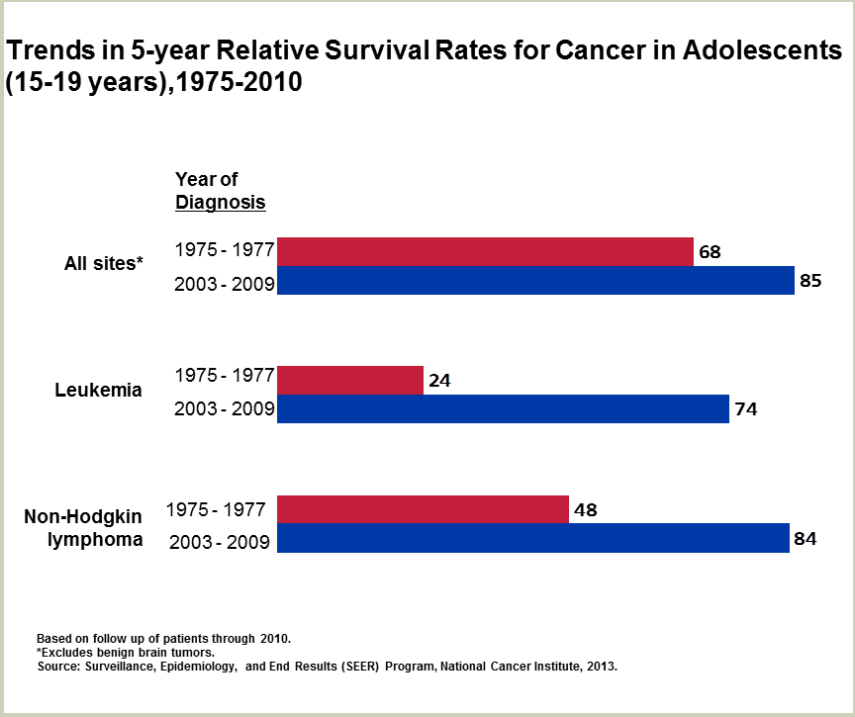


TRENDS IN 5 YEAR RELATIVE SURVIVAL FOR CANCER IN CHILDREN,1975-2010

0-14 years



15-19 years



END OF LIFE

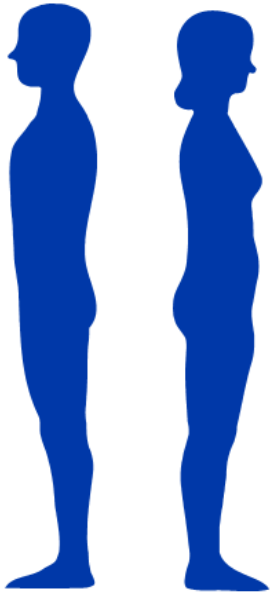
- **Mortality.** The ultimate measure of success against cancer is how quickly and how far we can lower death rates.

- The number of cancer deaths per 100,000 people per year, age-adjusted to a U.S. 2000 standard population.

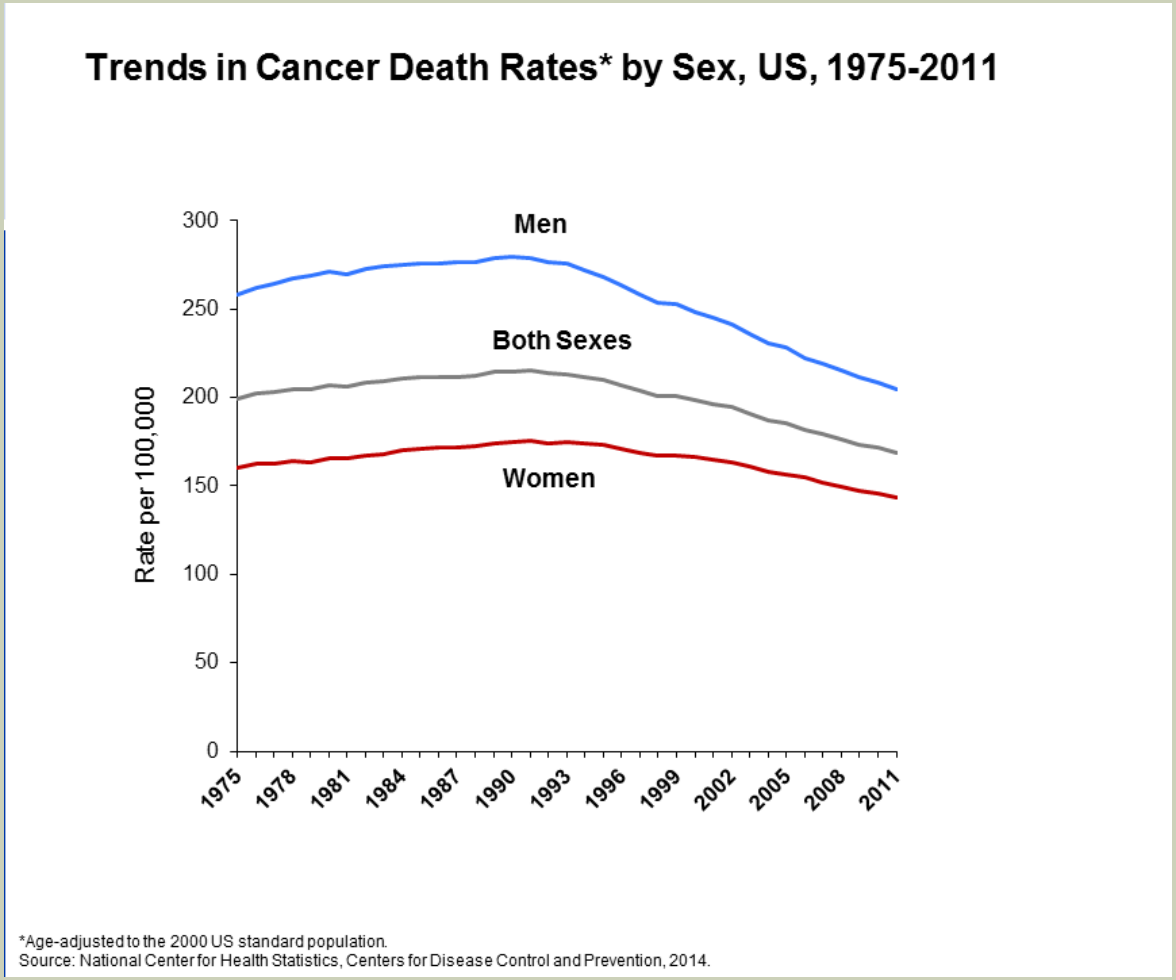
- **Person-years of life lost (PYLL).** The years of life lost due to early death from a particular cause or disease. PYLL due to cancer helps to describe the extent to which life is cut short by cancer. On average, each person who dies from cancer loses an estimated 15.5 years of life.

2015 ESTIMATED US CANCER DEATHS

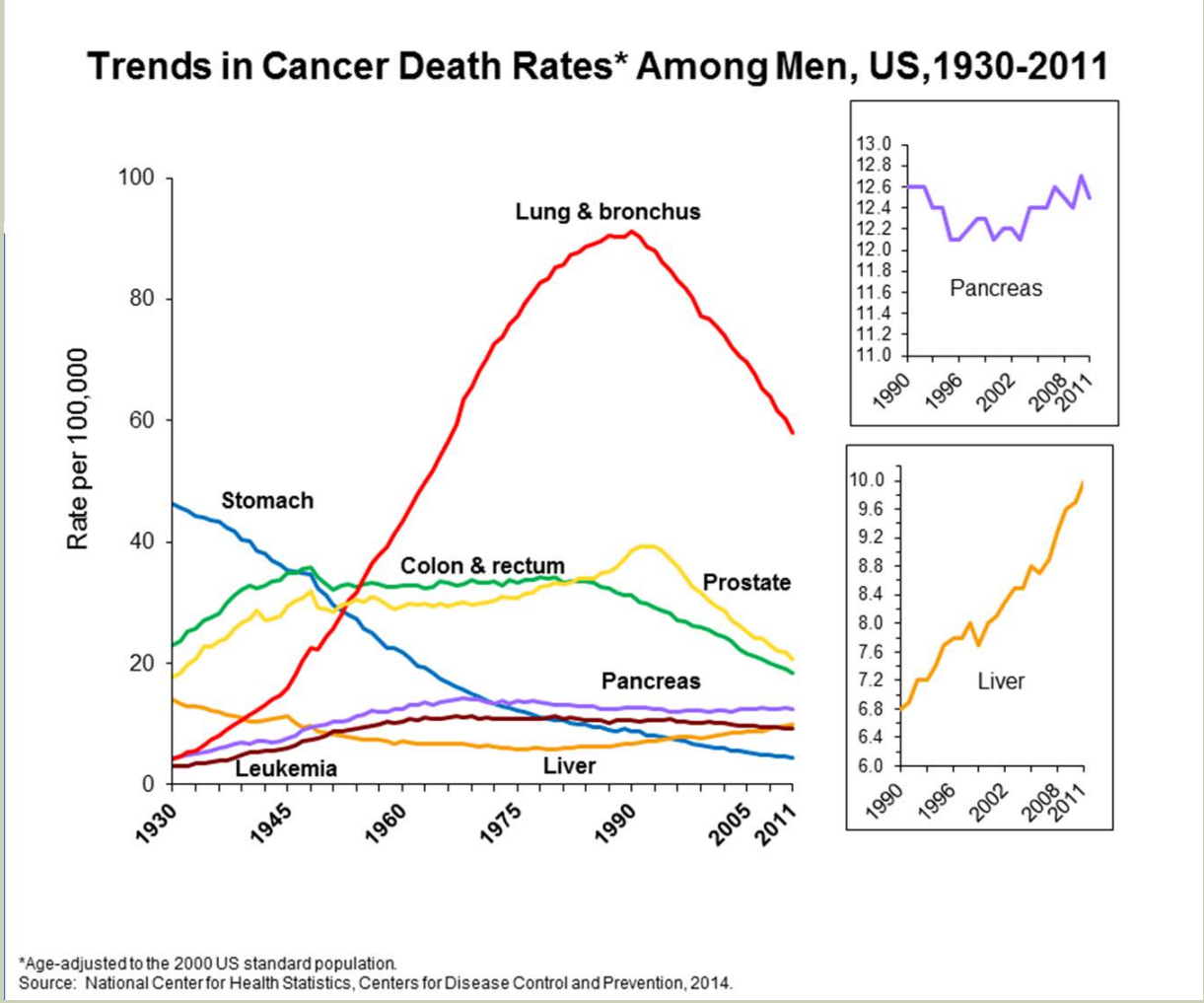
Estimated Cancer Deaths in the US in 2015

		Men 312,150	Women 277,280		
Lung & bronchus	28%			26%	Lung & bronchus
Prostate	9%			15%	Breast
Colon & rectum	8%			9%	Colon & rectum
Pancreas	7%			7%	Pancreas
Liver & intrahepatic bile duct	5%			5%	Ovary
Leukemia	5%			4%	Leukemia
Esophagus	4%			4%	Uterine corpus
Urinary bladder	4%			3%	Non-Hodgkin lymphoma
Non-Hodgkin lymphoma	4%			3%	Liver & intrahepatic bile duct
Kidney & renal pelvis	3%			2%	Brain & other nervous system
All other sites	24%			23%	All other sites

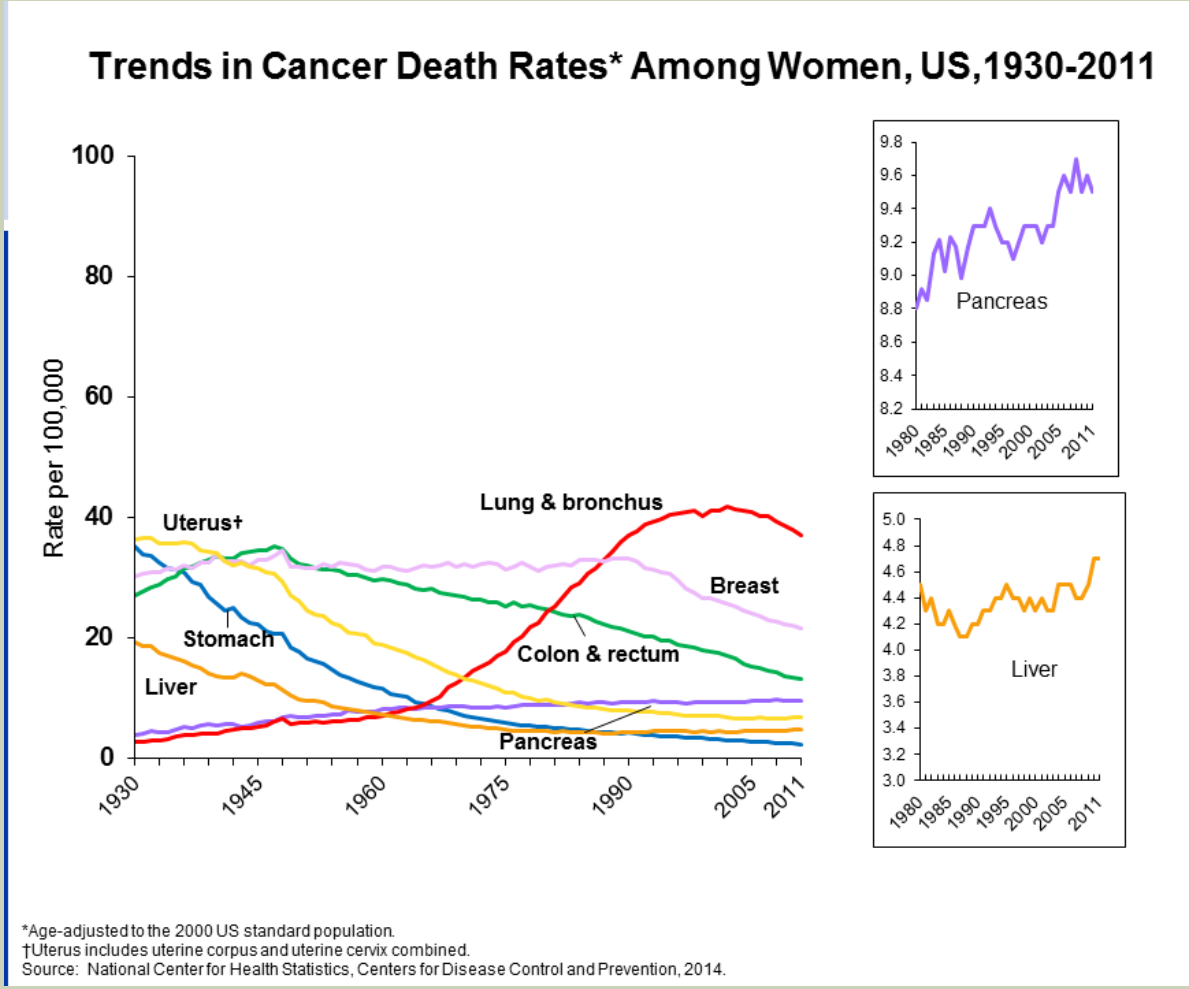
CANCER DEATH RATES* BY SEX, US, 1975-2011



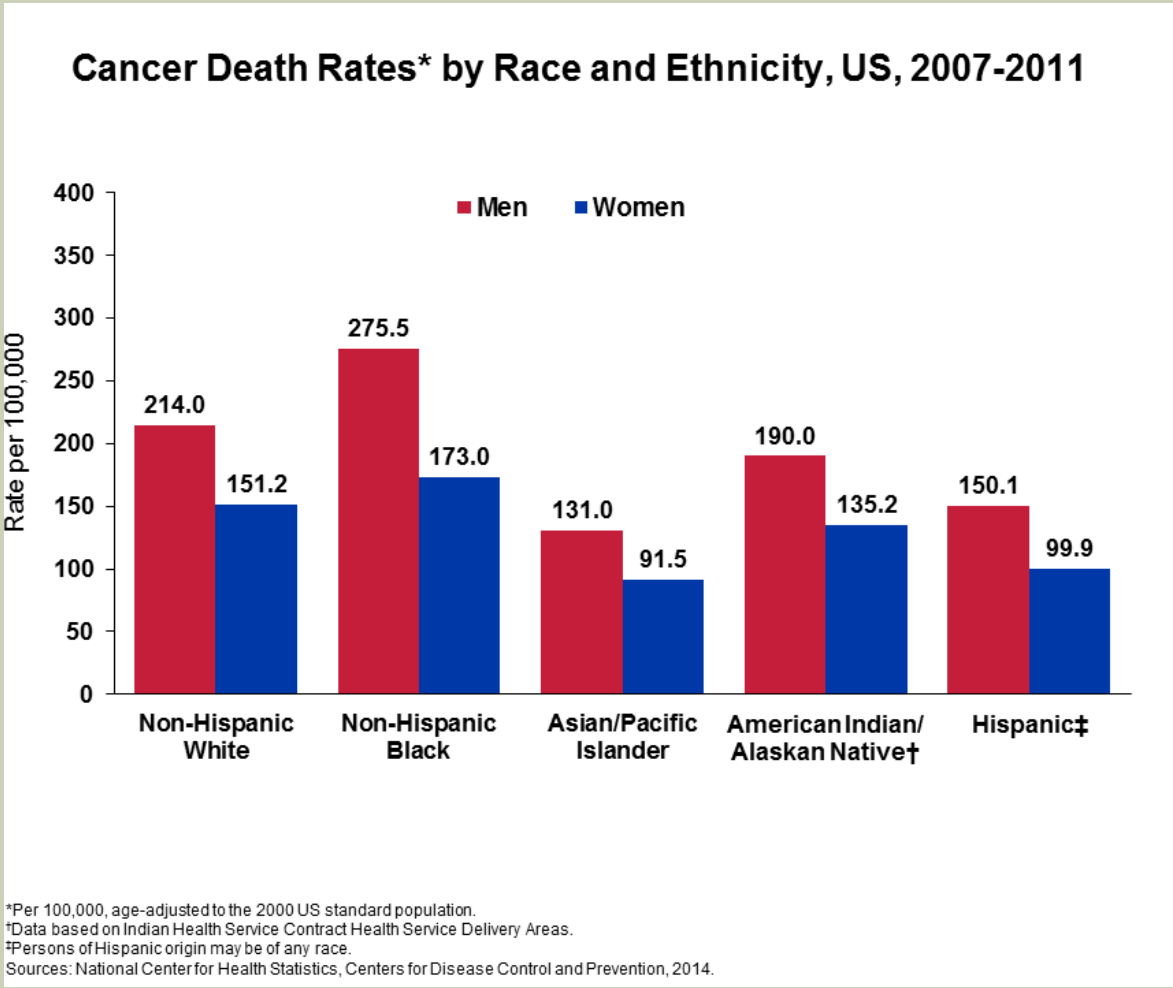
CANCER DEATH RATES* AMONG MEN, US,1930-2011



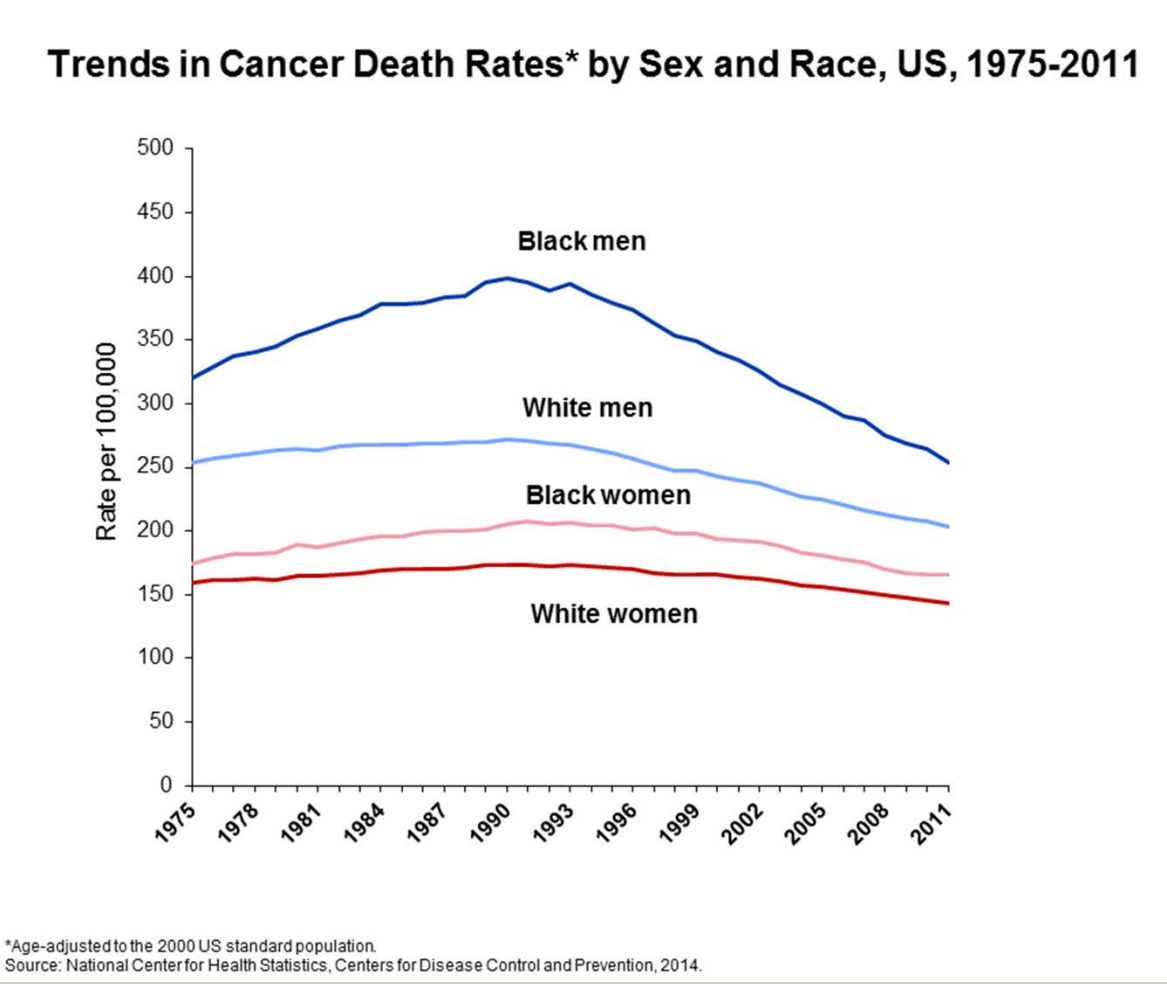
CANCER DEATH RATES* AMONG WOMEN, US,1930-2011



CANCER DEATH RATES* BY RACE AND ETHNICITY, US, 2007-2011

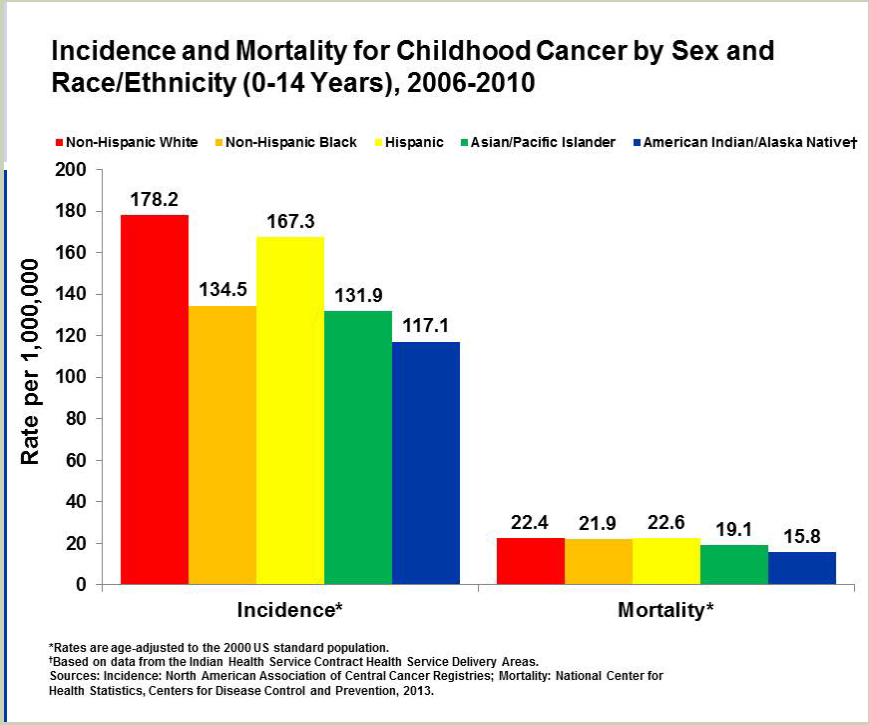


CANCER DEATH RATES* BY SEX AND RACE, US, 1975-2011

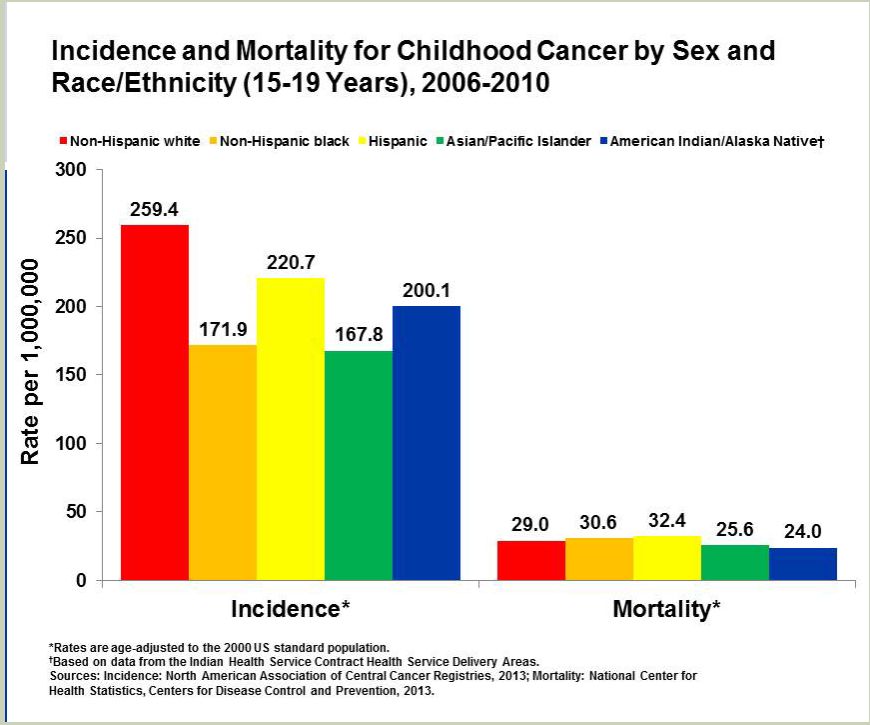


INCIDENCE AND MORTALITY FOR CHILDHOOD CANCER BY SEX AND RACE, 2006-2010

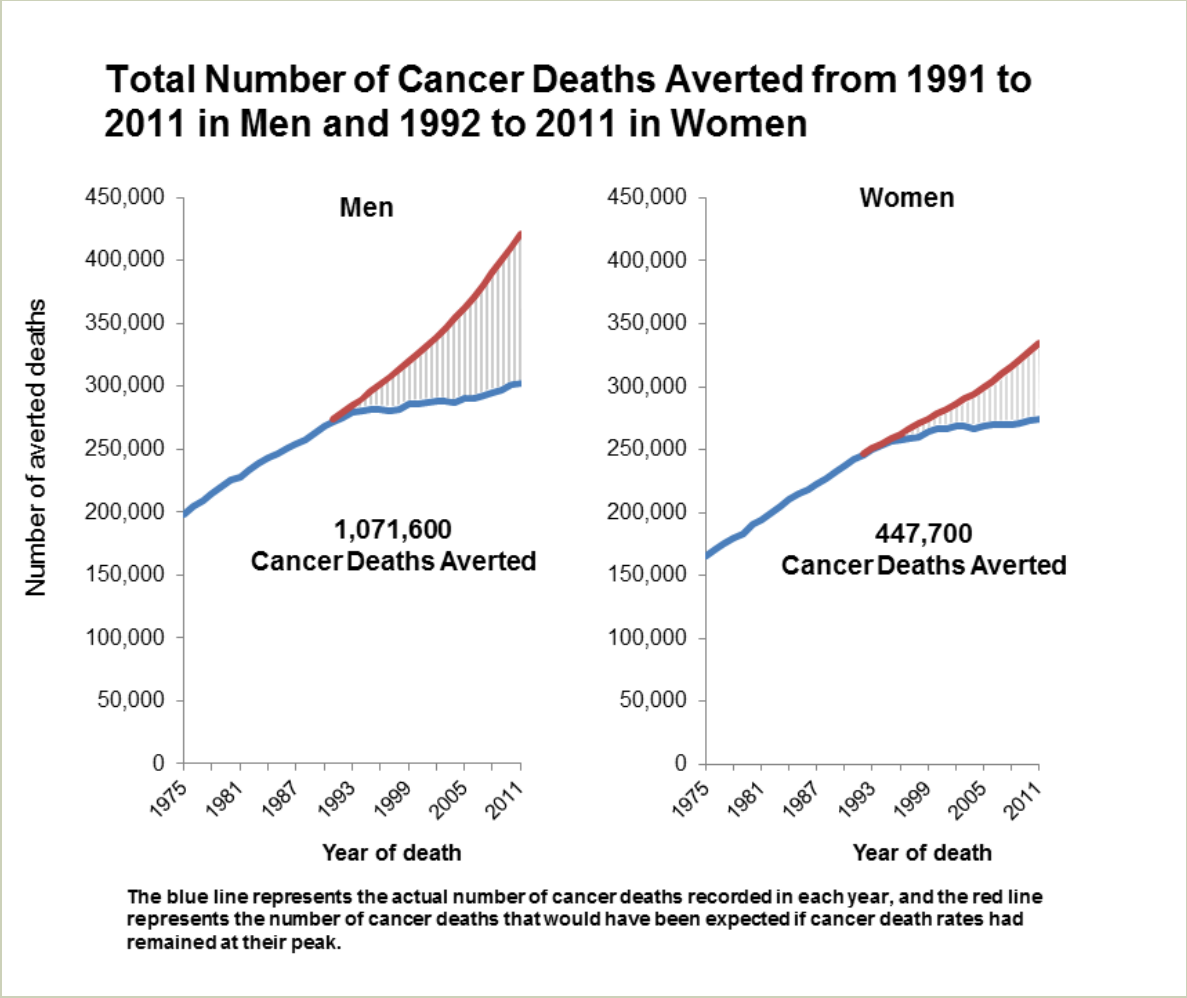
0-14 yrs



15-19 yrs



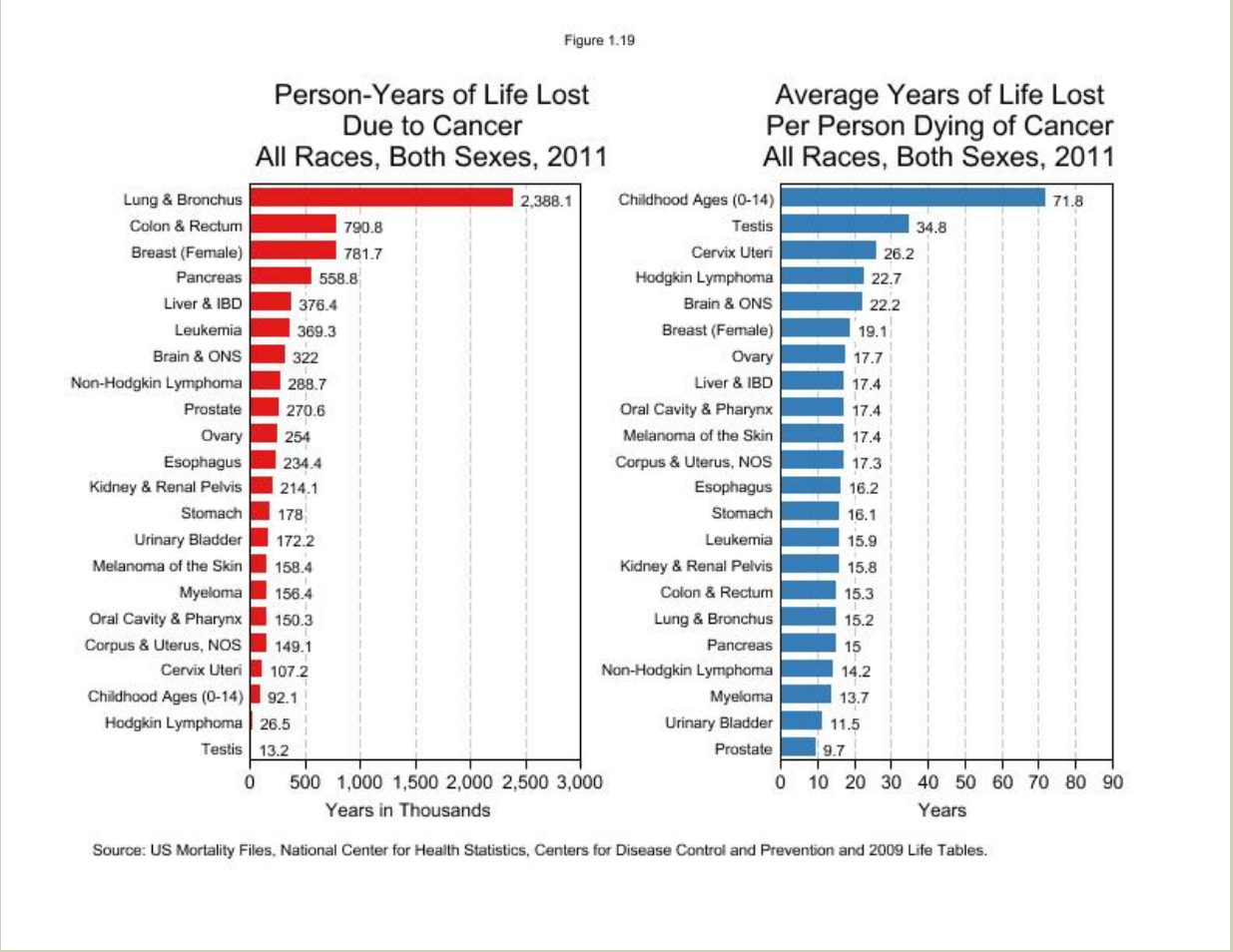
TOTAL NUMBER OF CANCER DEATHS AVOIDED FROM 1991 TO 2011 IN MEN AND 1992 TO 2011 IN WOMEN



PERSON-YEARS OF LIFE LOST

- The difference between the actual age of death due to the disease/cause and the expected age of death.
- Specifically, this measure is estimated by linking life table data to each death of a person of given age and sex.
- The life table permits a determination of the number of additional years an average person of that age, race, and sex would have been expected to live.

PERSON-YEARS OF LIFE LOST IN THE US DUE TO CANCER, ALL RACES, BOTH SEXES: 2011



LIFE AFTER CANCER

- Advances in the ways that cancer is diagnosed and treated have increased the number of people who live disease-free for long periods of time.
- More and more people are benefiting from the early detection of cancer and its successful treatment. These medical advances are improving both quality of life and length of survival.
- National data regarding life after cancer are limited and include survival rates by each stage at diagnosis, economic impact of cancer, cancer survivor’s smoking status.

WHO ARE CANCER SURVIVORS?

- Any person who has been diagnosed with cancer, from the time of diagnosis through the balance of life.
- In practice, concept of survivorship often associated with period after active treatment ends.

3 Distinct Phases of Cancer Survival

Diagnosis to end of initial treatment

Transition from treatment to extended survival

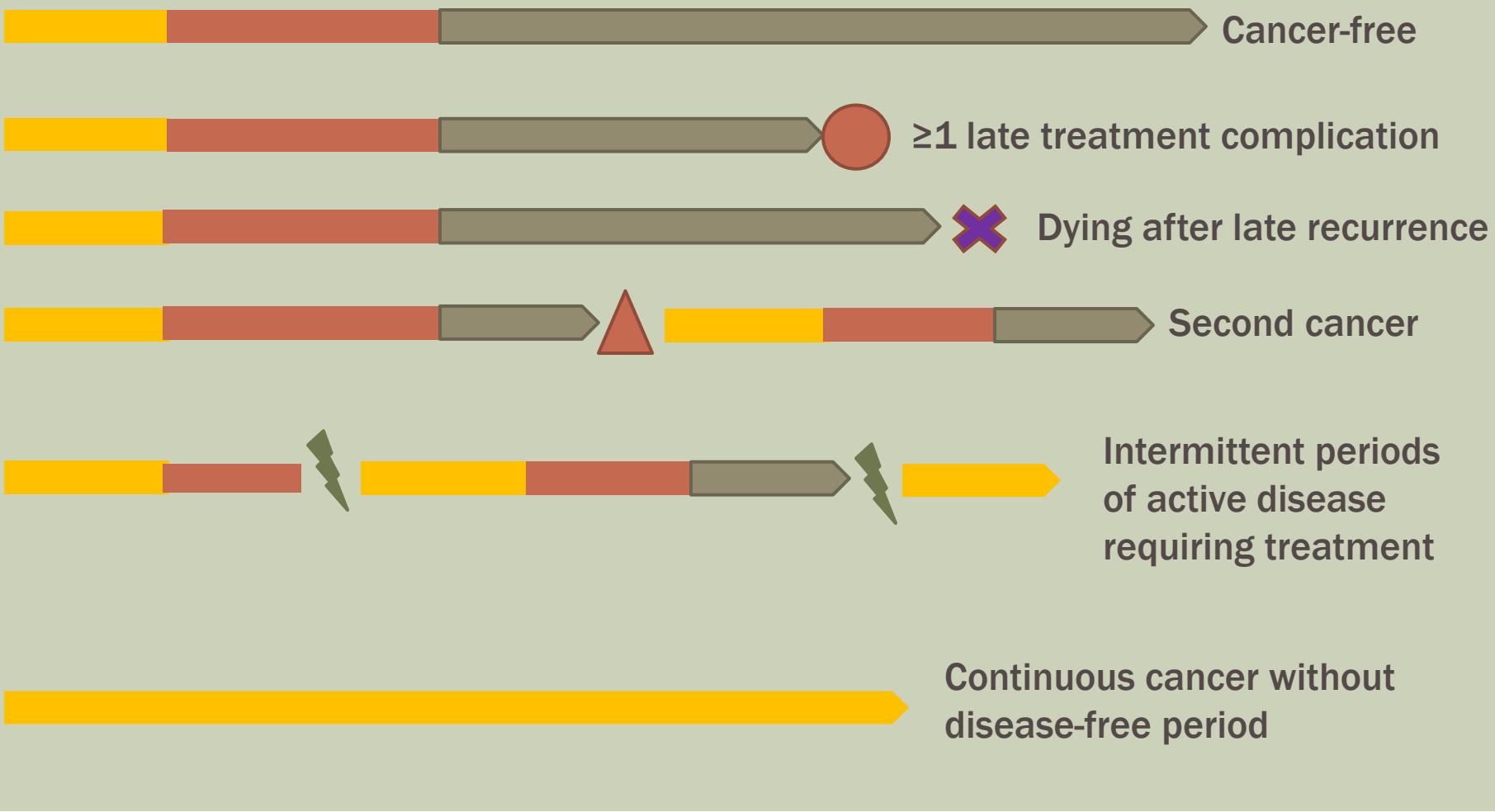
Long-term survival

NCI OFFICE OF CANCER SURVIVORSHIP

Dr Rowland talks to ecancertv at the European Breast Cancer Conference, Vienna, March 2012, about the developing field of cancer survivorship.

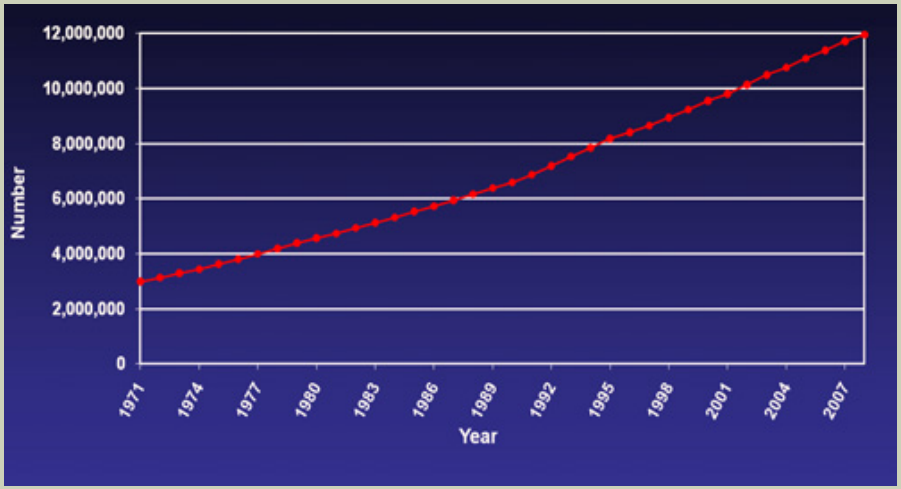
http://ecancer.org/tv/conference/140/1333

RANGE OF CANCER EXPERIENCES AMONG SURVIVORS



HOW MANY CANCER SURVIVORS ARE ALIVE IN THE US?

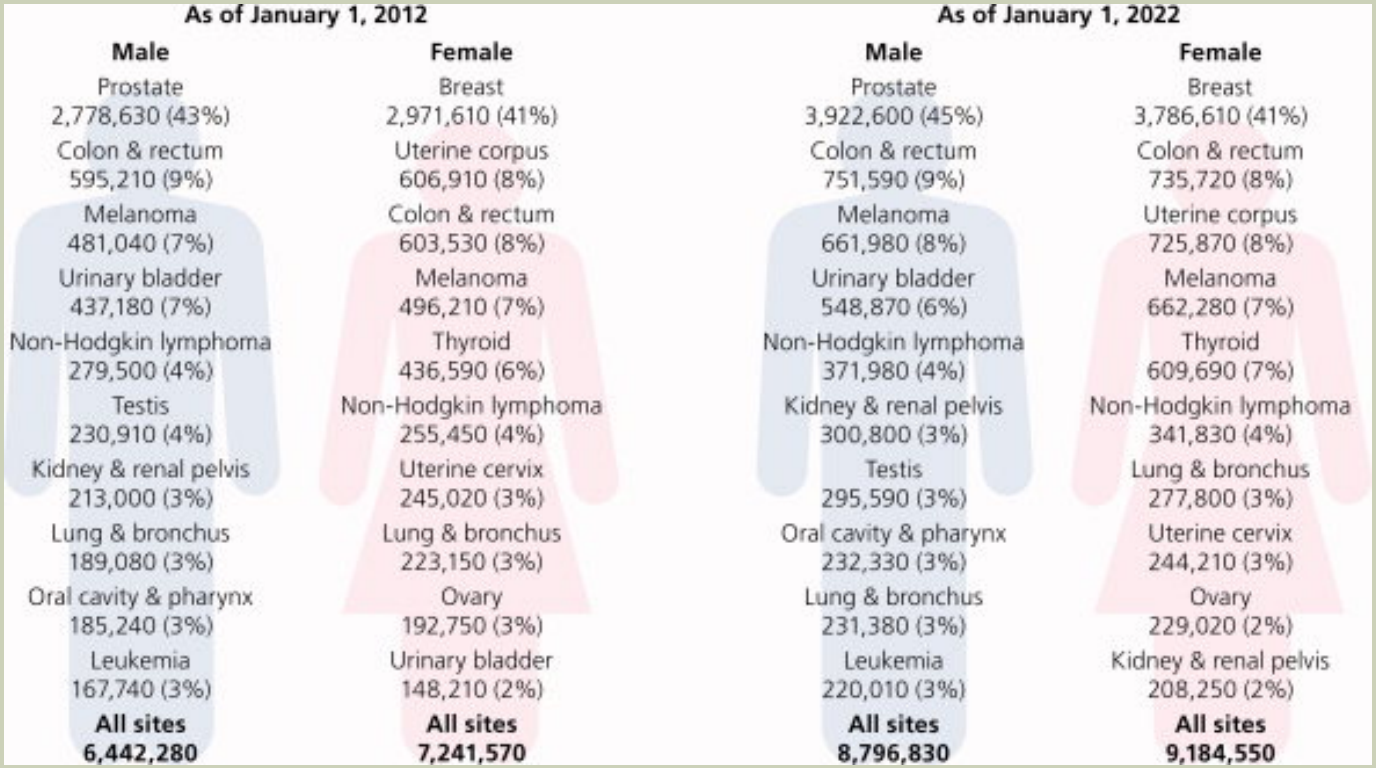
- As of January 1, 2012, it is estimated that there are 13.7 million cancer survivors (~4% of the population)
- Increased from 3 million (1.5%) in 1971



Invasive/1st Primary Cases Only

- Increasing number of survivors due to:
  - Aging and growth of population
  - Improved survival rates

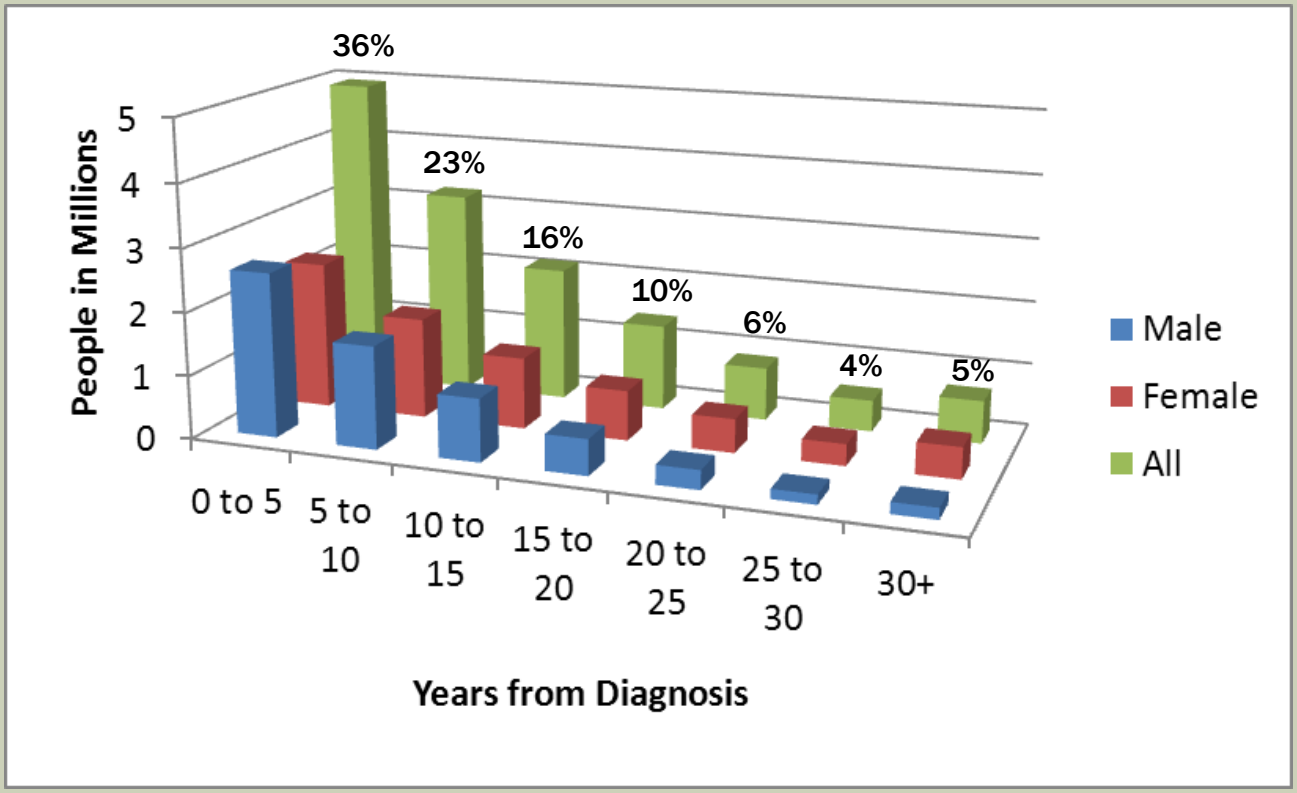
ESTIMATED NUMBER OF US CANCER SURVIVORS BY SITE IN 2012 AND 2022



CA: A Cancer Journal for Clinicians 62: 220-241, 2012

ESTIMATED US CANCER PREVALENCE COUNTS: WHO ARE OUR CANCER SURVIVORS IN THE U.S.?

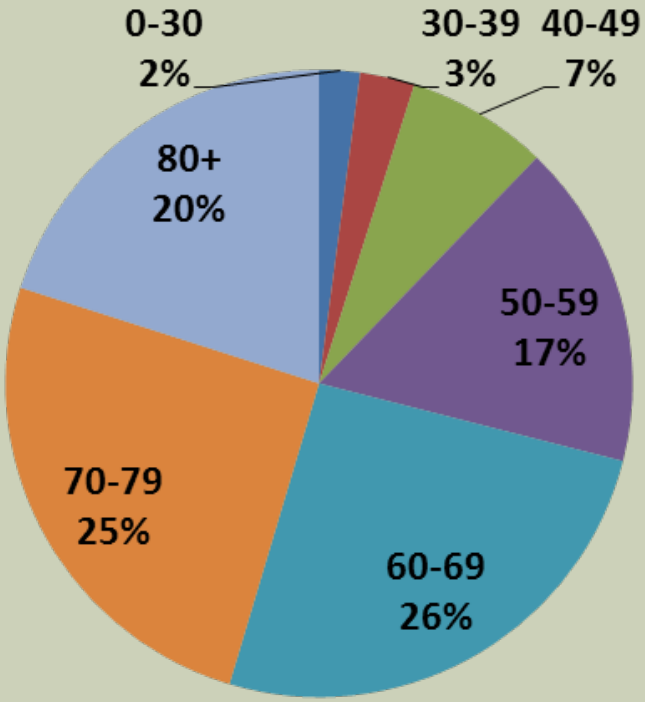
- Majority of cancer (64%) diagnosed 5 or more years ago.
- 15% diagnosed 20 or more years ago.



CA: A Cancer Journal for Clinicians 62: 220-241, 2012

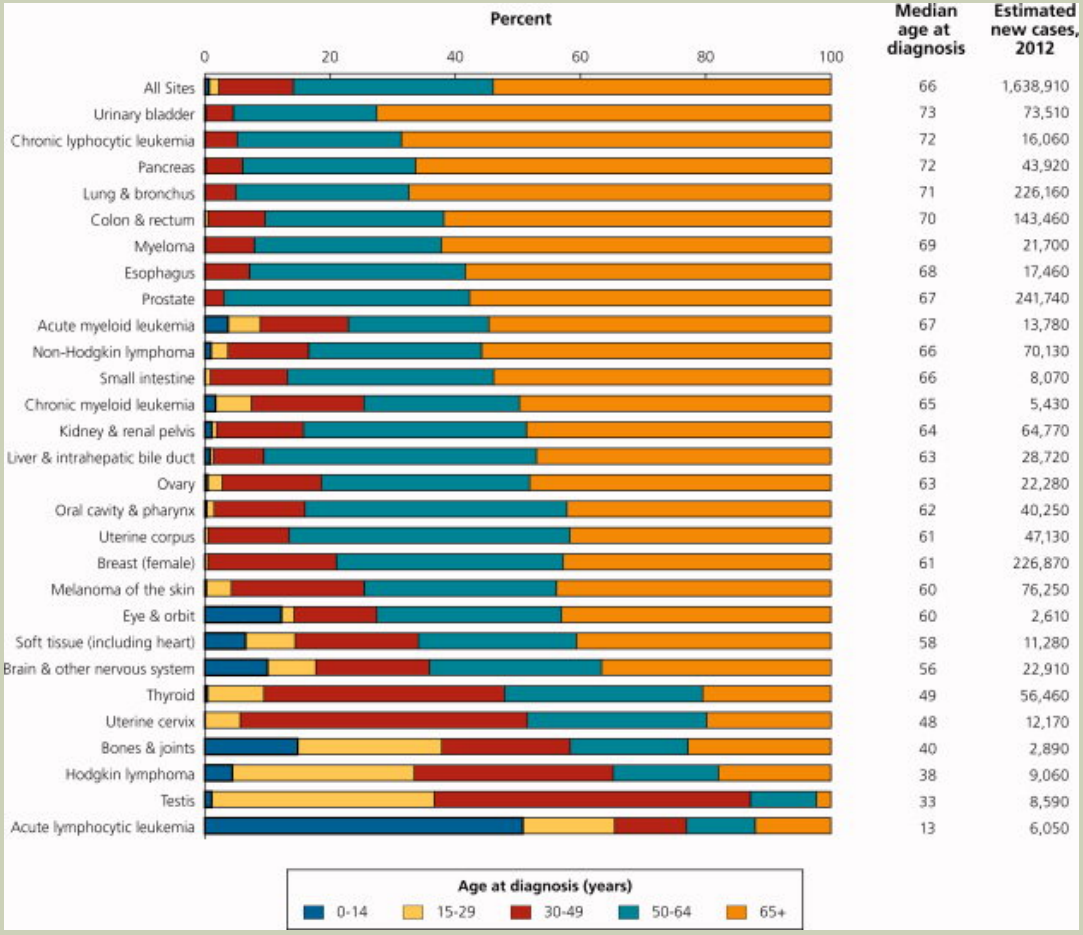
ESTIMATED US CANCER PREVALENCE COUNTS: WHO ARE OUR CANCER SURVIVORS IN THE U.S.?

- 71% of survivors are currently 60 years of age and older.
- Almost half (45%) are age 70 years of age or older.
- Only 5% are younger than 40 years of age



CA: A Cancer Journal for Clinicians 62: 220-241, 2012

AGE DISTRIBUTION AND MEDIAN AGE AT DIAGNOSIS BY TUMOR SITE

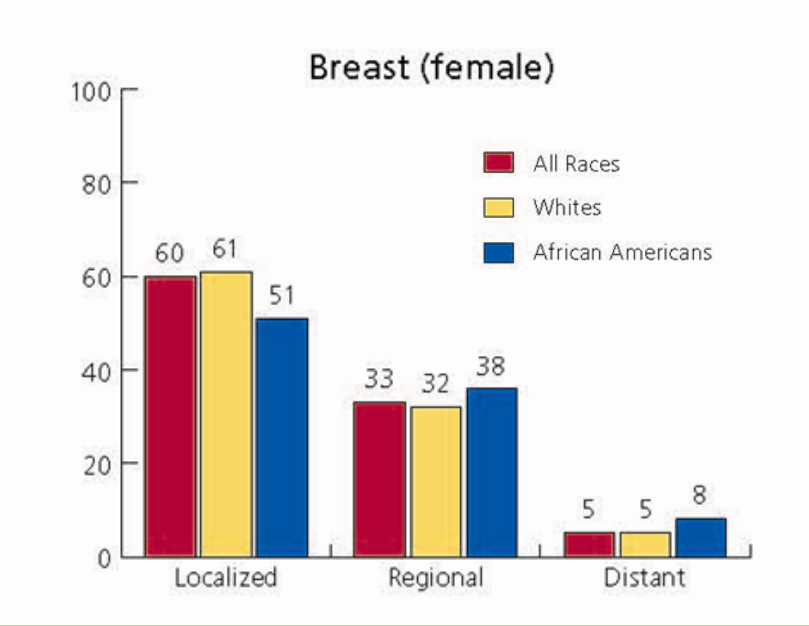


Seer 17 registries

CA: A Cancer Journal for Clinicians 62: 220-241, 2012

BREAST CANCER

- In 2012, estimated 2.9 million women living in US with history of invasive BrCa
- Median age at Dx is 61
- 20% of BrCa occurs in women ≤50 yrs; 40% in women ≥ 65 yrs
- 60% of BrCa diagnosed at localized stage, 2001-07



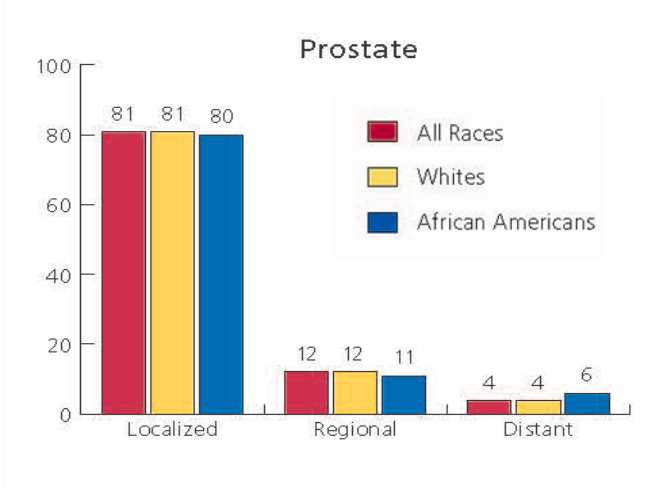
CA: A Cancer Journal for Clinicians 62: 220-241, 2012

SPECIAL CONCERNS AMONG BREAST CANCER SURVIVORS

- 10 to 50% of patients develop lymphedema of the arm as a side effect of surgery and radiation
  - Use of sentinel lymph node biopsy, rather than axillary lymph node dissection reduces risk.
  - Some evidence that upper body exercise and physical activity may reduce risk.
- Numbness or tightness, pulling, stretching in the chest wall, arms, or shoulders
- Premature menopause, impaired fertility among younger patients
- Increased risk of osteoporosis
- Treatment with aromatase inhibitors can cause muscle pain, joint stiffness and/or pain, osteoporosis.

PROSTATE CANCER

- 2.8 M men living with a history of prostate cancer in US
- Additional 241,740 estimated cases in 2012.
- Median age at Dx is 67
- Most men diagnosed by PSA screening, although expert groups conclude data is insufficient to recommend routine use of PSA.
- >90% of all prostate cancers are discovered in the local or regional stages for which the 5-yr mortality rate is 100%.
- 10 and 15 yr survival rate is 97.8% and 91.4%, respectively.

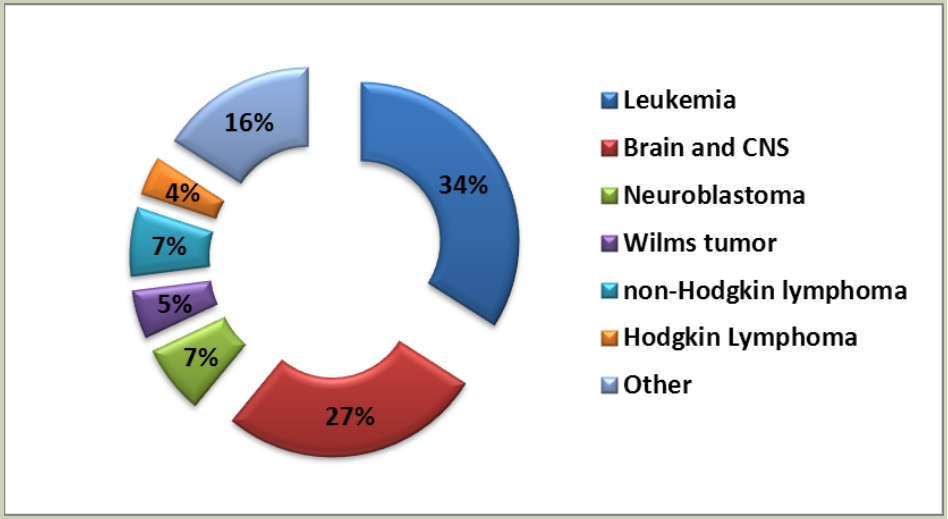


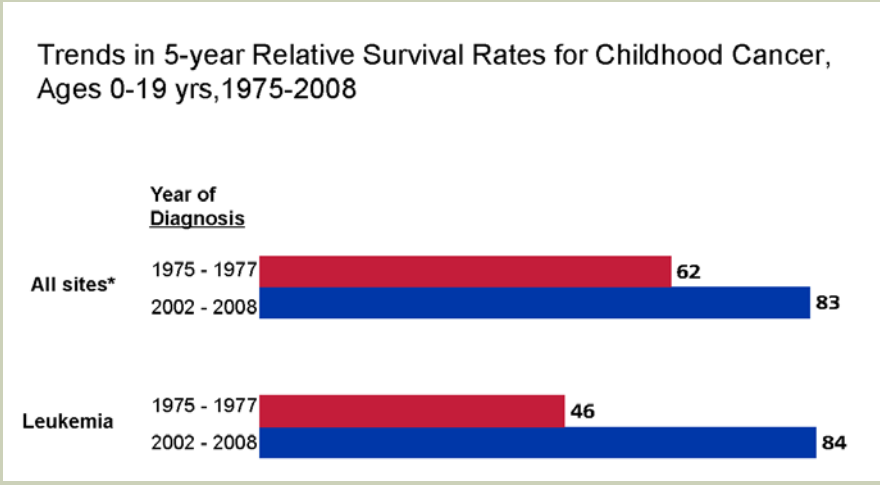
SPECIAL CONCERNS OF PROSTATE CANCER SURVIVORS

- Survivors treated with surgery or radiation therapy experience incontinence, erectile dysfunction, bowel complications.
- Patients receiving hormonal treatment may experience loss of libido, menopausal-like symptoms including hot flashes, night sweats, irritability, and osteoporosis.
- Over long-term, hormone therapy increases risk of diabetes, cardiovascular disease, obesity.

CANCERS IN CHILDREN

- 1% of all new cancers (birth to age 14)
- 2nd leading cause of death in children (accidents is 1st)
- 58,510 childhood cancer survivors in US
- ~12,060 will be diagnosed in 2012.
- 5-year survival rate has improved over past 30 yrs due to new and improved treatments,





SPECIAL CONCERNS OF CHILDHOOD CANCER SURVIVORS

- Children may experience treatment-related side effects many years after diagnosis.
- Aggressive treatments used during 1970s and 80s, and even some newer treatments, result in a number of late effects, including risk of second cancers, organ dysfunction, reduced growth and development, decreased fertility, cognitive impairments, early death.
- Most common second cancers are breast, brain/CNS, bone, thyroid soft tissue, melanoma, acute myeloid leukemia.

SPECIAL CONCERNS OF CHILDHOOD CANCER SURVIVORS

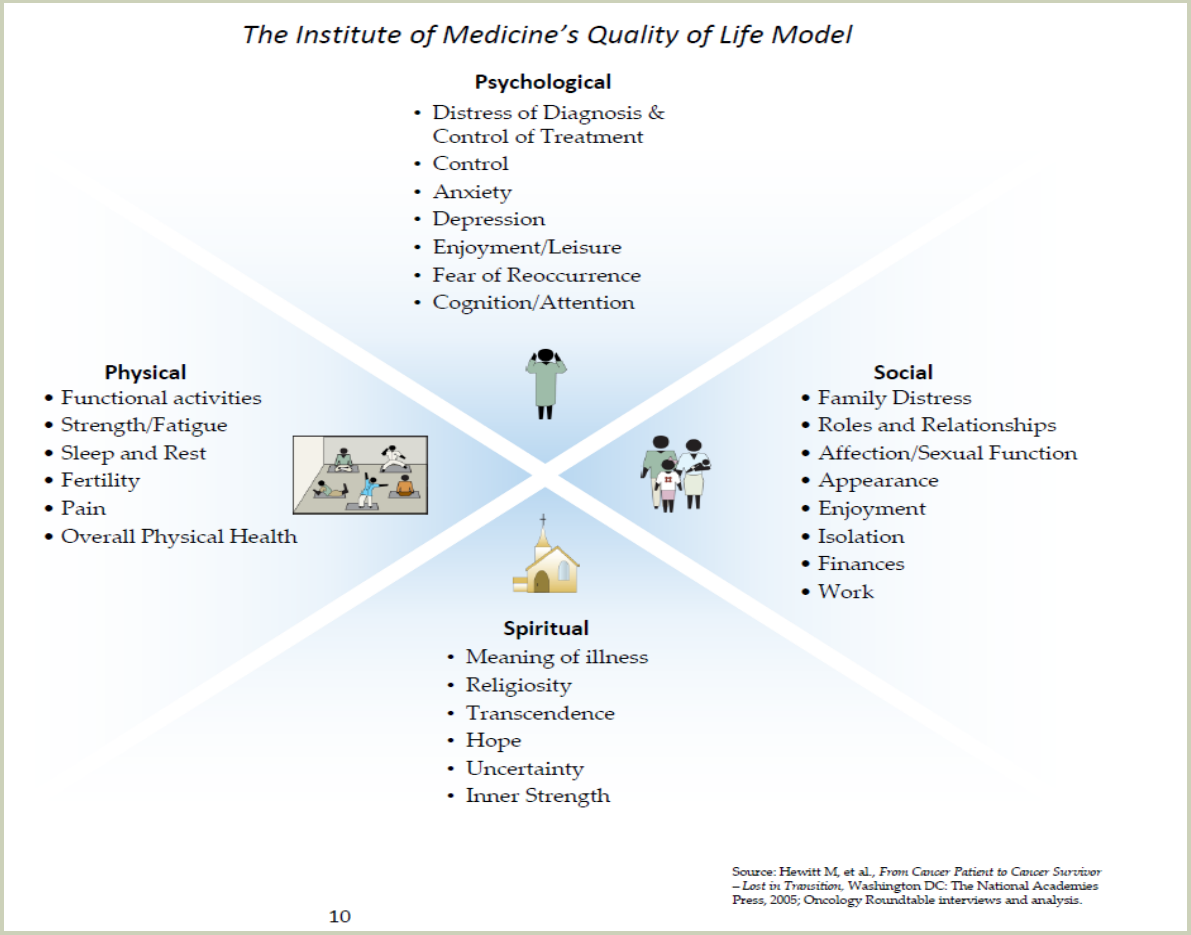
- Radiation to brain or spine can slow growth. If “at risk” for being short, healthcare provider can recommend tests and treatments.
- Survivors treated with chest radiation or anthracyclines might have heart problems. More likely at higher doses and if treatment occurred before heart finished growing.
- Radiation and some anticancer drugs affect sexual development and reproduction. Risk of delayed puberty, infertility, early menopause.
- Adolescents and young adults face additional challenges related to insurance coverage.
- Medicaid covers cancer treatment for pediatric cancer patients meeting income criteria, but more general coverage lapses at age 18 or 21 depending on state of residence.

COMMON EFFECTS OF CANCER AND ITS TREATMENT

- Management of cancer and treatment-related symptoms is an important aspect of cancer care, affecting QOL, functional status, and completion of treatment.

- Most common side-effects:
  - Pain
  - Fatigue
  - Emotional distress
  - Bone density
  - Cardiotoxicity
  - Cognitive Deficits

IOM'S QUALITY OF LIFE MODEL



Slide from Jennifer Hydeman

PAIN

Pain (ACS Cancer Facts & Figures 2007)

- One of most common symptoms associated with cancer and one of most important factors reducing QOL
- Associated with depression and poor functioning.
- Can interfere with normal activities, diminish enjoyment of everyday pleasures, prevent relaxation and sleep, increase anxiety, stress, and fatigue.
- Can cause people to withdraw and reduce contact with friends and family.
- Recent meta-analysis estimated prevalence of pain to be:
  - 59% undergoing active treatment
  - 33% after treatment
  - 64% with advanced/metastatic/terminal disease

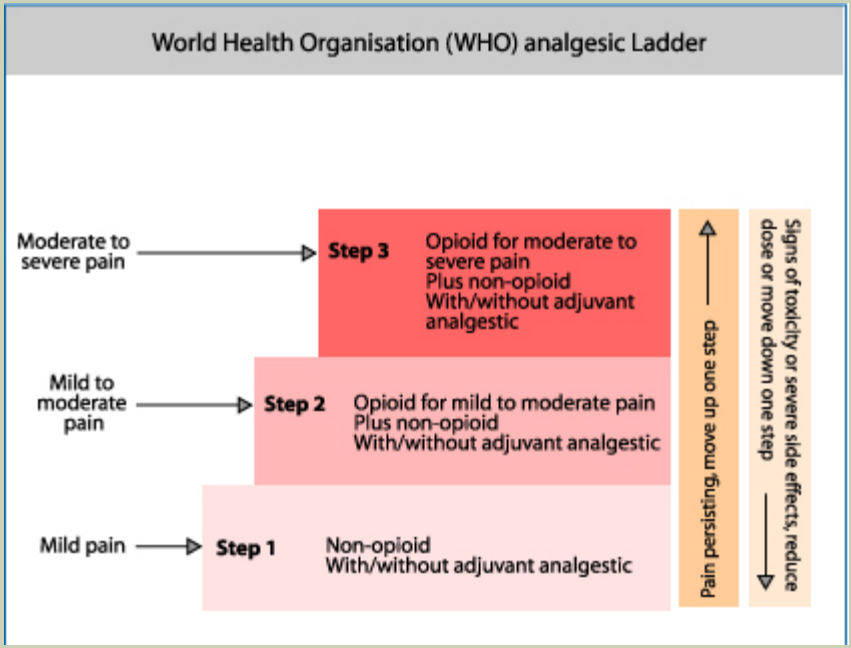
PAIN

- Both surgery and radiation can cause nerve damage, resulting in chronic pain.
- Chemotherapy drugs, especially vincristine and taxanes, can damage sensory nerve cells, causing peripheral neuropathy. Extent of damage is dose-dependent and may take months or years to resolve.
- Regardless of stage of disease or recovery, ~ 80% of cancer-associated pain can be relieved by proper treatment.
- Often undertreated (minorities, age 70 or older, female). Serious problem in developed countries. Even more serious in developing countries.

PAIN

- Clinical guidelines from WHO and NCCN recommend that doctors ask about pain and other symptoms throughout course of treatment and continuing care (eg. Wong-Baker FACES Pain Rating Scale)

- Pharmacologic treatment of cancer pain provided by WHO's Three-Step Analgesic Ladder



PAIN

Use of Complementary Methods to help Control Pain

- Cognitive and behavioral techniques to divert attention from pain, improve pain tolerance.
- Acupuncture
- Mind-body imaging techniques (hypnosis, progressive muscle relaxation)
- Therapeutic massage

Issues with Reimbursement

- Lack of health insurance plays significant role in which pain is treated (47 million Americans have no health insurance).
- Depending on health insurance, some have full access to adequate pain management while others do not.
- Problems are worse for the most vulnerable populations – low SES, and racial and ethnic minorities, who have been shown to have a greater degree of pain and suffering from cancer than other Americans.

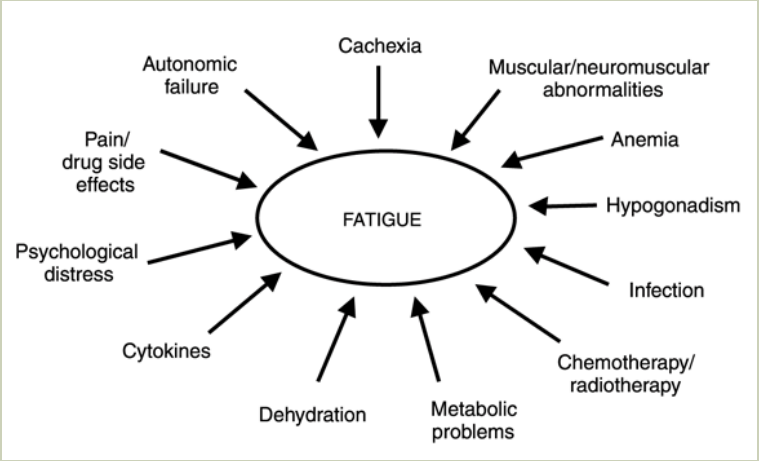
FATIGUE

- One of the most common side-effect of cancer treatment; reported in 28% to 90% of cancer patients.
- Reported by 80-90% of those receiving chemotherapy or radiation.
- Different from feeling tired after a long day and does not get better with rest or sleep.

- For many patients, chronic fatigue persists long after treatment has ended. At least 3 studies suggest that persistent fatigue is present in 17 to 26% of cancer survivors.
- Fatigue in cancer patients is underdiagnosed, underreported, and undertreated.
- Seldom occurs by itself. Commonly associated with sleep disturbance, emotional distress (depression, anxiety), or pain.

FATIGUE

- Cause is multifactorial.
  - Anemia
  - Depression
  - Chronic inflammatory processes with elevated cytokines
  - Alterations in muscular energy systems



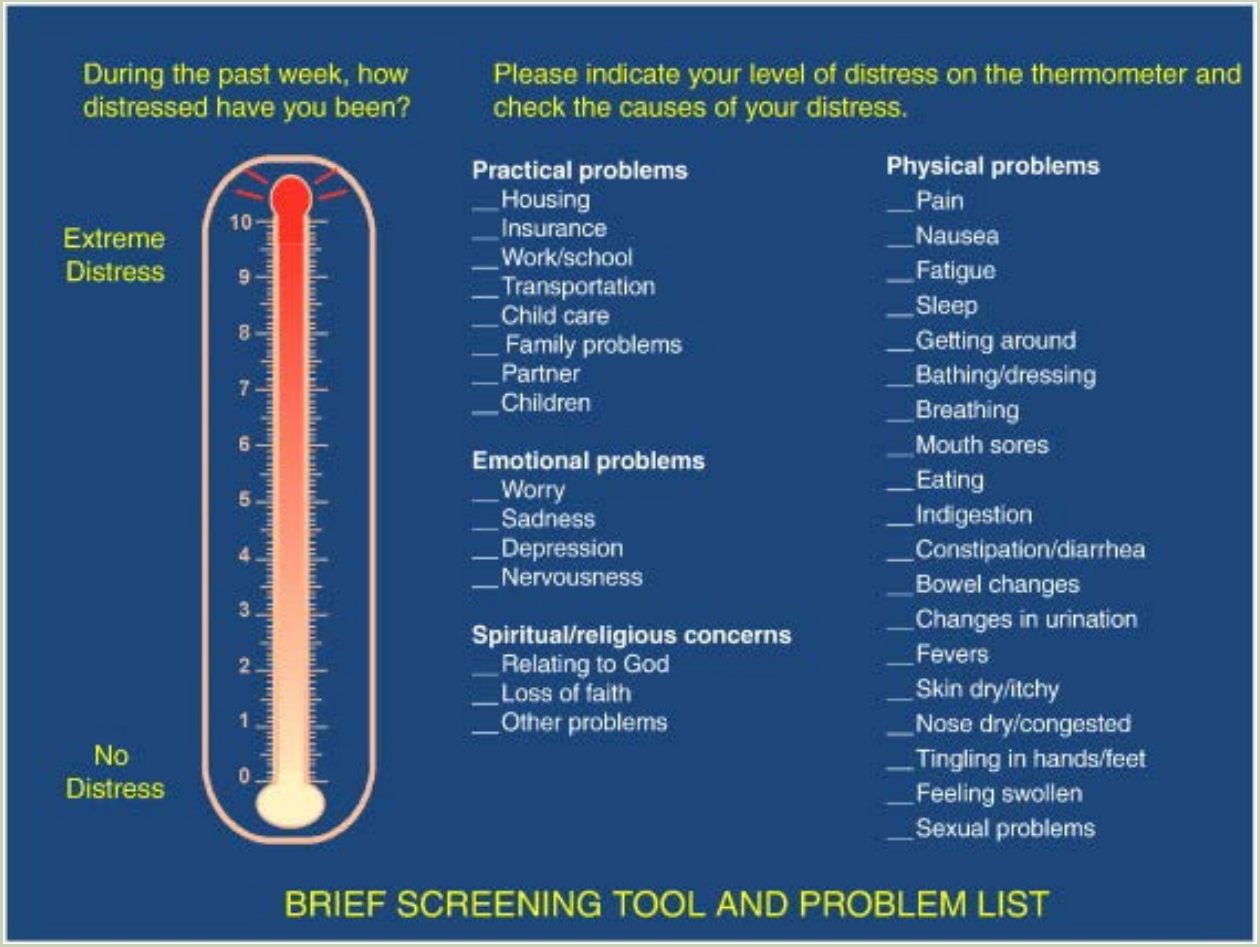
- Meta-analyses show that exercise, especially moderate-intensity resistance exercise, reduces cancer-related fatigue.
- Some evidence for the efficacy of psychological interventions or psychostimulants.

CANCER-RELATED DISTRESS

- Defined as a multifactorial unpleasant emotional experience of a psychosocial nature that may interfere with the ability to cope effectively with cancer and its treatment.
- Complex response to effects of pain, fatigue, and/or other stressors associated with cancer diagnosis and treatment.
- Difficult to identify because of overlap with other symptoms (eg. Fatigue, changes in appetite, sleep disruption).
- Recent meta-analysis found 30 to 40% of cancer patients with diagnosable mood disorder, though this is thought to be an underestimate.
- Early detection and treatment of distress can improve treatment adherence and patient-provider communication and decrease the risk of severe depression or anxiety.

CANCER-RELATED DISTRESS

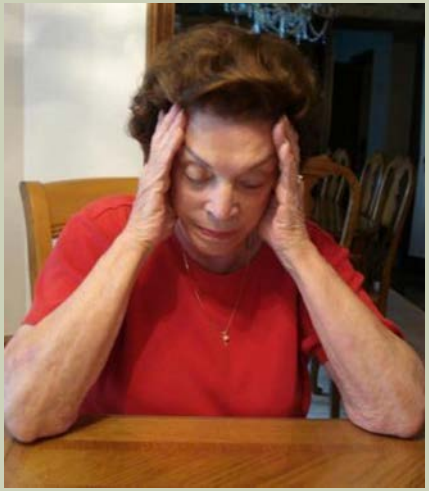
- 2008 IOM report supported work of the National Comprehensive Cancer Network (NCCN) guidelines for Distress Management.
- Recommends routine screening for distress and has developed a measurement tool called the Distress Thermometer.
- Those with moderate to severe distress often referred to supportive services (mental health, social work, counseling).



COGNITIVE DEFICITS

Memory and Thinking Problems

- Chemobrain
- Can negatively impact cognitive function, including problems with attention, concentration, memory, comprehension, mental speed processing, and reasoning.
- Can be debilitating
- Long-term survivors of breast, lung, and ovarian cancers and lymphoma may have cognitive and neurological complications caused by systemic therapy.
- Study of brain dysfunction is complicated by chemo-related fatigue, depression, and anxiety which also contributes to poor cognitive performance.
- Risk of cognitive impairment from chemo increases with advanced age, lower pretreatment IQ, and the apolipoprotein E genotype, which is associated with Alzheimer disease.

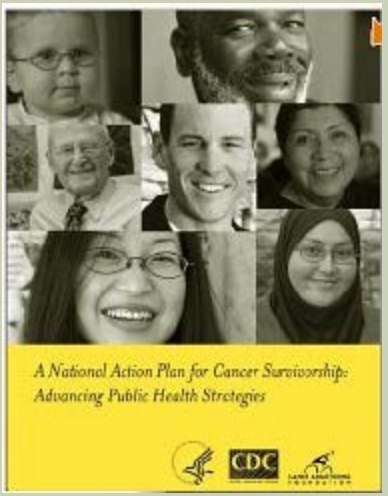


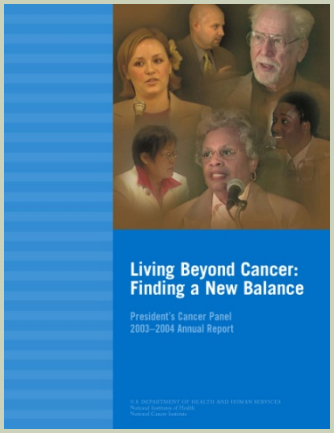
FEAR OF CANCER RECURRENCE

- Among chief concerns of post-treatment cancer survivors and may persist long after treatment ends, even among survivors who are considered to be cancer free or in remission.
- ACS Studies of Cancer Survivors indicate that ~60% of 1-year cancer survivors reported moderate to severe concerns about disease recurrence.
- Fear of recurrence is elevated among survivors and caregivers who find less meaning in the cancer experience and who experience more concomitant family stressors.

REPORTS RECOMMENDING CANCER SURVIVORSHIP DATA COLLECTION/SURVEILLANCE

- **National Action Plan for Cancer Survivorship (2004)**
  - Identified surveillance and applied research as major areas of public health focus for cancer survivorship.
  - Recommended development of infrastructure for comprehensive database on cancer survivorship
  - Recommended improved coordination among administrators of existing databases and the addition of variables of indicators to collect supplementary information on cancer survivors.





- **Presidents Cancer Panel Report (2004)**
- **Institute of Medicine Report (2006)**
  - Emphasized the importance of surveillance in monitoring cancer treatment and factors associated with the ongoing health concerns of cancer survivors

CDC BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives. Protecting People.™

- Established in 1984
- Largest continuously conducted telephone health survey in the world
- >355,710 interviews annually
- 50 states, District of Columbia, Puerto Rico, Virgin Islands, Guam

HEALTH RISKS IN THE UNITED STATES
BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM

BRFSS CORE TOPICS (2007)

- Demographics
- Health Status
- Health Care Access
- Healthy Days
- Life Satisfaction
- Emotional Support
- Disability
- Tobacco Use
- Oral Health
- Alcohol Consumption
- Exercise
- Immunization
- HIV/AIDS
- Diabetes
- Asthma
- Cardiovascular Disease
- Emerging Issues
- Veteran's Status
- Hypertension Awareness
- Cholesterol Awareness
- Arthritis Burden
- Physical Activity
- Fruits and Vegetables

CDC BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM 2009 AND 2010 CANCER PREVALENCE QUESTIONNAIRE

Centers for Disease Control and Prevention
CDC 24/7: Saving Lives. Protecting People.™

Core Questions

1. Have you ever been told by a doctor, nurse, or other health care professional that you had cancer?
2. *[If yes]* At what age were you told that you had cancer?
3. How many different types of cancer have you had?
4. *[If one]* What type of cancer was it?
   [Or if more than one] With your most recent diagnosis of cancer, what type of cancer was it?

HEALTH RISKS IN THE UNITED STATES
BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM

2009 & 2010 BRFSS QUESTIONNAIRE OPTIONAL SURVIVORSHIP MODULE

- **States may choose to ask 10 questions added as an optional module**
- **Source of questions**
  - 1992 National Health Interview Survey Cancer Survivorship Supplement
  - State CCC programs, CDC staff
- **Allowed state-level assessment of survivorship issues related to cancer treatment, pain, and access to care**
  - 2009: 4 states participated (Connecticut, North Carolina, Vermont, Virginia)
  - 2010: 10 states participated (Alaska, Connecticut, Guam, Indiana, Massachusetts, Missouri, New Mexico, Ohio, South Dakota, Wisconsin)

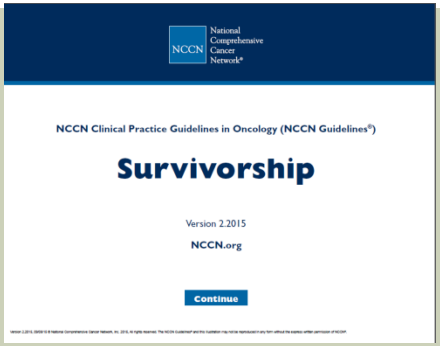
2009 & 2010 BRFSS QUESTIONNAIRE OPTIONAL SURVIVORSHIP MODULE

1. Previously you said that you had been told by your doctor that you had cancer. I will now ask you about your experiences with cancer. Are you currently receiving treatment for cancer? By treatment, we mean surgery, radiation therapy, chemotherapy, or chemotherapy pills.
2. What type of doctor provides the majority of your health care? (cancer surgeon, family practitioner, etc)
3. Did any doctor, nurse, or other health professional EVER give you a written summary of all the cancer treatments that you received?
4. Have you EVER received instructions from a doctor, nurse, or other health professional about where you should return or who you should see for routine cancer check-ups after completing treatment for cancer?

2009 & 2010 BRFSS QUESTIONNAIRE
OPTIONAL SURVIVORSHIP MODULE

5. Were these instructions written down or printed on paper for you?
6. With your most recent diagnosis of cancer, did you have health insurance that paid for all or part of your cancer treatment? (Note: "Health insurance" also includes Medicare, Medicaid, or other types of state health programs.)
7. Were you EVER denied health insurance or life insurance coverage because of your cancer?
8. Did you participate in a clinical trial as part of your cancer treatment?
9. Do you currently have physical pain caused by your cancer or cancer treatment?
10. Is your pain currently under control?

NCCN SURVIVORSHIP GUIDELINES 2015



General Survivorship Principles

Definition of Survivorship & Standards for Survivorship Care
Screening for Second Cancers
Assessment by Health Care Provider at Regular Intervals
Survivorship Baseline Assessment
Survivorship Resources for Health Care Professional and Patients

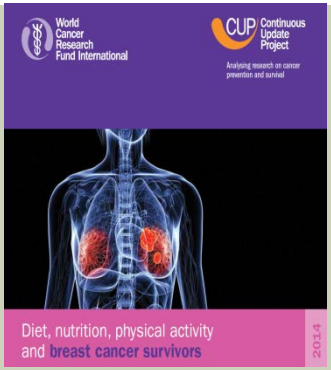
Late Effects/Long-term Psychosocial and Physical Problems

Anthracycline-Induced Cardiac Toxicity
Anxiety and Depression
Cognitive Function
Fatigue
Pain
Sexual Function
Sleep Disorders

Preventive Health

Exercise (and avoid inactivity)
Diet
Alcohol intake
Smoking Cessation
Sun Safety
Immunizations
Anthropometrics (weight, height, body composition)
Followup with primary care physician regularly

GUIDELINES ON LIFESTYLE FACTORS FOR CANCER SURVIVORS



American Cancer Society®

- **Cancer recurrence**
- **Developing new cancer**
- **Heart disease**

1. GET TO AND STAY AT A HEALTHY WEIGHT

- Increased risk of postmenopausal breast, colon, endometrium, esophageal, kidney, and pancreatic cancer.
- Obesity increases risk of cancer recurrence
- Decreased survival rates among breast, prostate, and colon cancer survivors.
- Risk factor for developing other cancers, heart disease, osteoporosis.

2. BE ACTIVE!!

- Reduce risk of breast, colon, endometrial, and prostate cancer.
- >20 studies show lower risk of cancer recurrence and improved overall survivor.
- Many studies show that being physically active improves quality of life among cancer survivors.
- Lower risk of other health problems such as heart disease, high blood pressure, diabetes, and osteoporosis

Breast Cancer

- Lower risk of recurrence
- Lower risk of breast cancer deaths
- Lower risk of dying from all causes

Colon Cancer

- Lower risk of recurrence
- Lower risk of colon cancer deaths

BENEFITS TO CANCER SURVIVOR

- Helps prevent treatment-related weight gain
- Keep and improve physical abilities
- Improve balance and reduce risk of falls
- Reduces risk of osteoporosis
- Keep muscles from wasting away
- Reduces fatigue (tiredness), depression, anxiety
- Improves quality of life
- Improving cancer-specific survival and all cause survival
- Lowers risk of heart disease

WHY IS IT SO IMPORTANT TO KEEP MOVING?

- Increasingly clear that sedentary time is associated with increased risk of dying after considering the benefits of moderate-vigorous exercise.

- Among breast cancer survivors, those in the top tertile of television time have a ~2-fold increased risk of dying compared to those in the bottom third.
- After adjusting for time exercising their risk of death was still 70% higher.

Using 2007-2010 NHANES data, cancer survivors exercised more than those without cancer BUT are more likely to be sedentary!

3. EAT A VARIETY OF HEALTHY FOODS, WITH MORE FOODS FROM PLANT SOURCES

- Higher vegetable and fruit intake associated with reduced cancer risk
- Food choices may affect risk of recurrence and survival among survivors.
- Most studies in breast cancer, some for colon and prostate cancer survivors.

- Like cancer prevention, looks like it's the overall dietary pattern that is important for cancer survivorship.
- It's not one food, or even a whole group of foods that makes a difference.

It's the combination of many different nutrients – working together- that offers the best protection

Best Protection Comes From a Diet that is:

- "High in fruits, vegetables and whole grains.
- Includes more fish and poultry instead of red and processed meats.
- Includes non-fat and low-fat instead of full-fat dairy products.
- Includes nuts and olive oils instead of less healthy sources of fat, such as butter or saturated fats found in many processed snack foods.

- **Prudent diet:** high in fruit and vegetables, poultry and fish.
- **Western diet:** high in meat, fat, refined grains, dessert.
- ***Higher intake of western dietary pattern associated with almost 3 time greater risk of colon cancer recurrence.***

LIMIT ALCOHOL

- Alcohol consumption increases risk of breast, head and neck, esophageal, breast, colorectal, and liver cancer.
- Even small amounts of drinking increases the risk of developing cancer, and increases with the amount of alcohol consumed.
- Men ≤ 2 drinks per day; women ≤ 1 drink per day

Alcohol and Breast Cancer Survival

- A few studies to date
- Half link alcohol to worse outcomes
- Half show no harm or benefit.

ONCOLOGY FOR SCIENTISTS

Contact Information

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