Cancer

A Superficial Introduction

Gabor Fichtinger, Queen's University

Cancer – some definitions

Medical term: malignant neoplasm
Class of diseases in which a group of cells display:

- ***uncontrolled growth*** (division beyond the normal limits)
- ***invasion*** (intrusion on and destruction of adjacent tissues)
- **sometimes *metastasis*** (spread to other locations in the body via lymph or blood)

- The above differentiate cancer from non-malignant (benign) growth
- Most cancers are solid and form a tumor.
- Some, like leukemia, do not.
- This course deals mostly solid cancer i.e. tumor.

Cancer – known causes

- Mutation: chemical carcinogens
  - tobacco smoke, some artificial sweeteners, some food preservatives…
- Mutation: ionizing radiation
- Viral or bacterial infection
- Hormonal imbalances
- Immune system dysfunction
- Heredity
- Other causes

Cancers – in this course

- **Prostate**
- Breast
- Gynecological
- Liver
- Bone / spine
- Head and Neck
- Brain
- Kidney
- Leukemia
- Lymph nodes

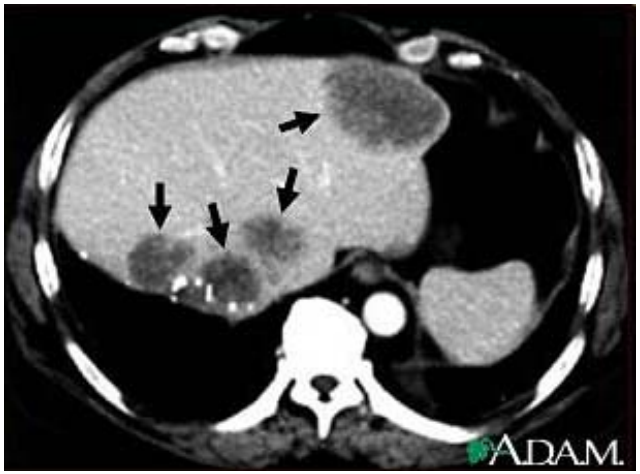
Cancer – known causes

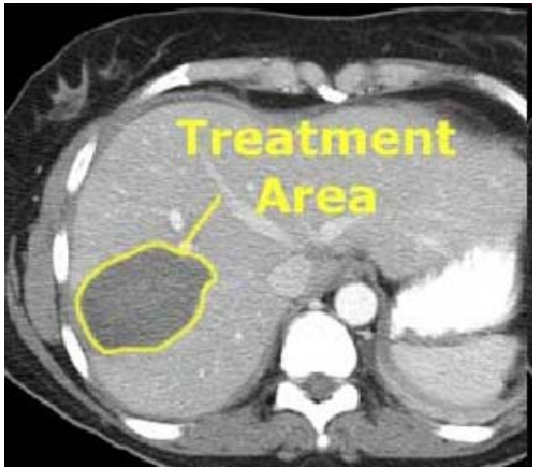
- Mutation: chemical carcinogens
  - tobacco smoke, some artificial sweeteners, some food preservatives…
- Mutation: ionizing radiation
- Viral or bacterial infection
- Hormonal imbalances
- Immune system dysfunction
- Heredity
- Other causes

Cancer – diagnosis

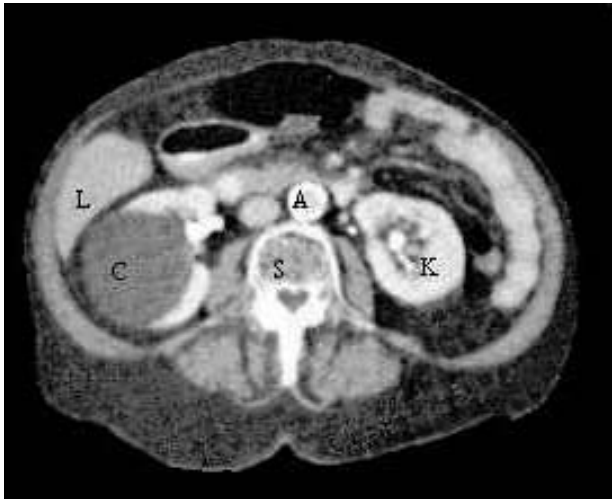
- Non-invasive:
  - Blood serum
  - Palpation (i.e. feel a lump under your finger)
  - Imaging (CT, MRI, Ultrasound, PET, SPECT)
- Tissue biopsy
  - Pathologist – the doctor who examines it
  - Histology or histopathology – the process
  - “Pattern classification” problem
- Diagnosis
- Staging of the disease
- Treatment options…

Cancer imaging – CT

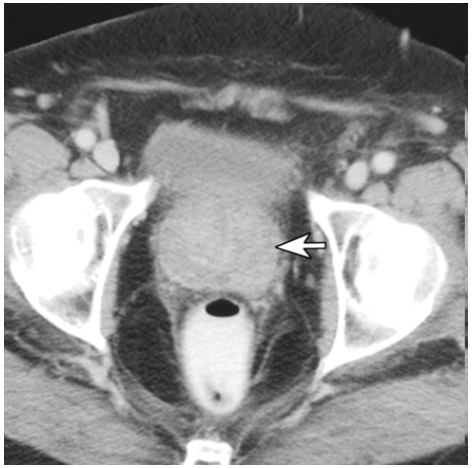




Liver cancer



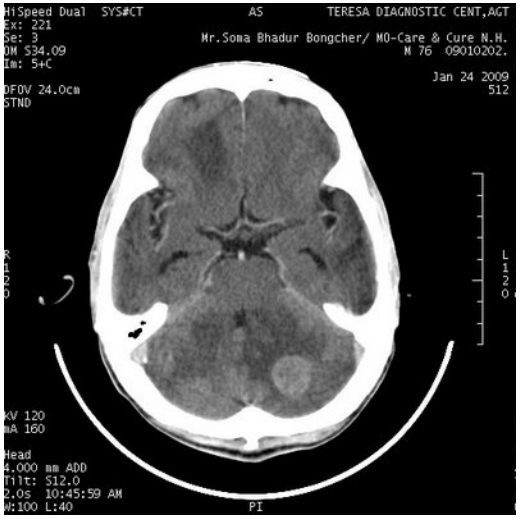
Kidney cancer



Prostate cancer

Cancer imaging – CT

Glioblastoma multiform



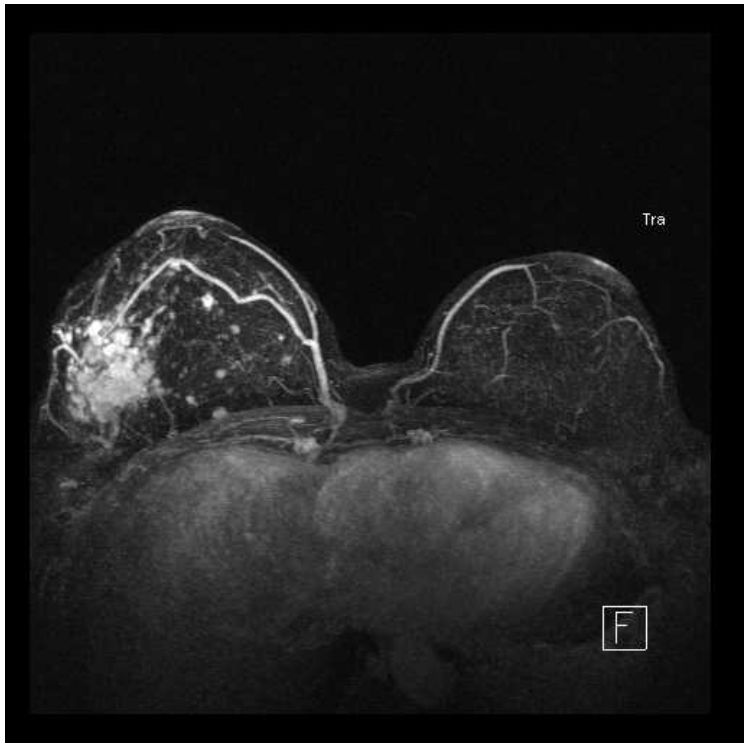
Metastatic brain lesions

Metastatic spine cancer

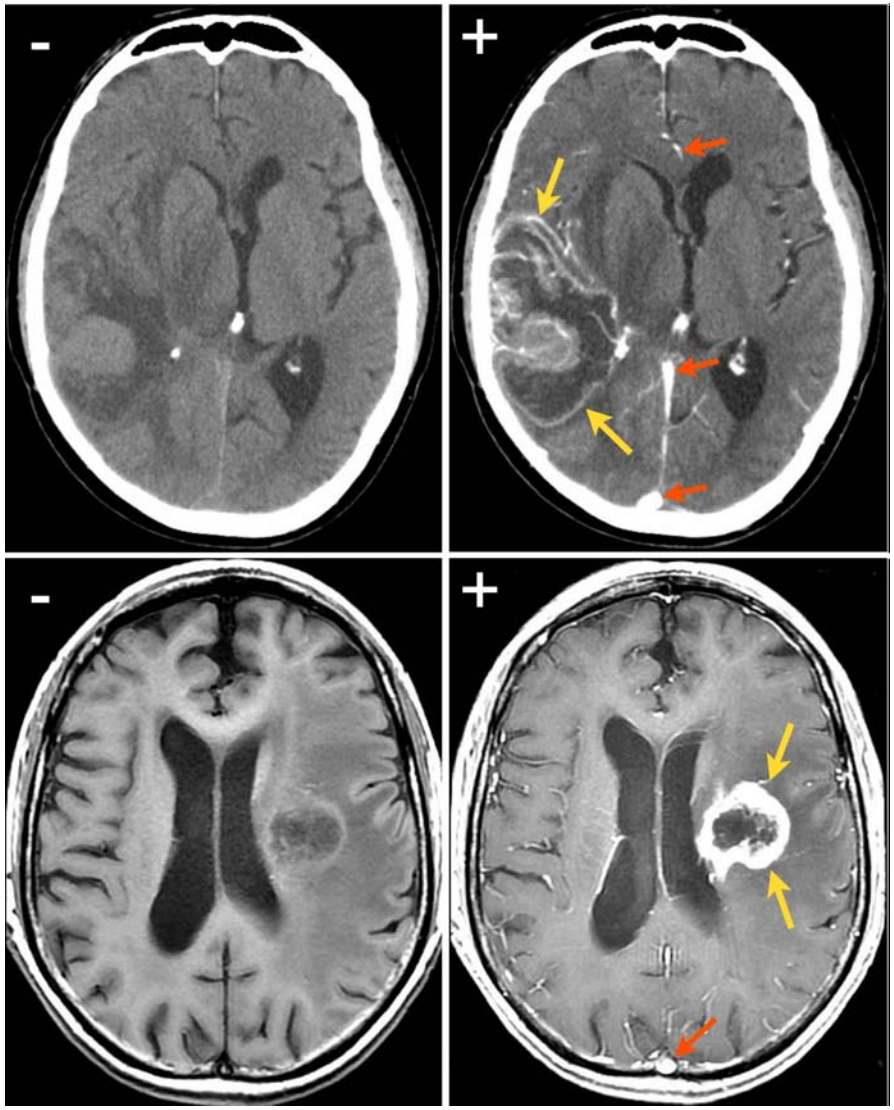
Cancer imaging – MRI

prostate

breast



Cancer imaging – contrast imaging



Issues:

- Toxicity
- Uptake
- Washout

Cancer imaging – ultrasound

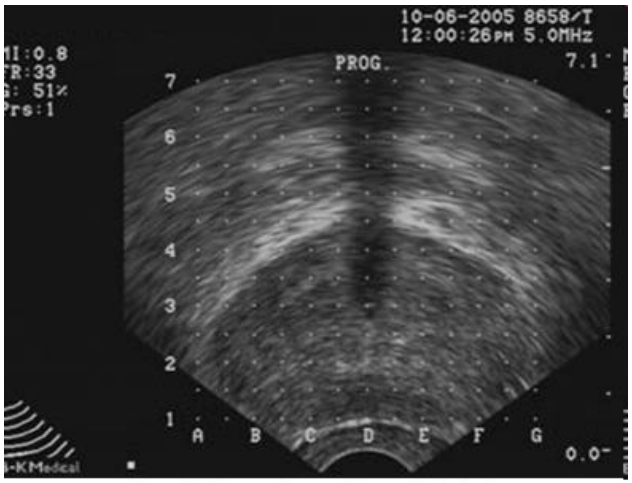
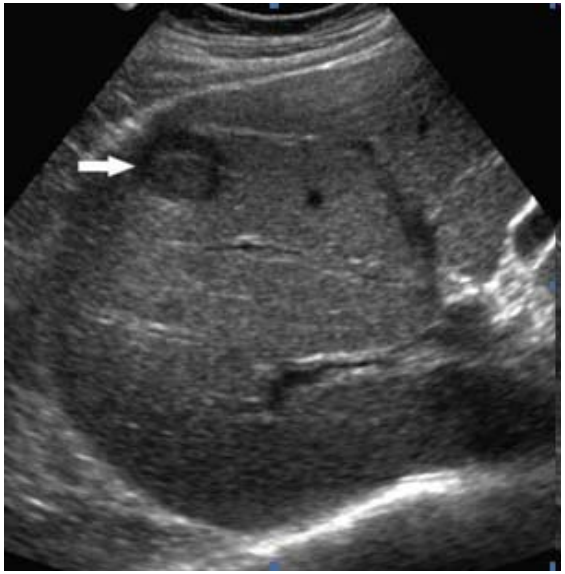


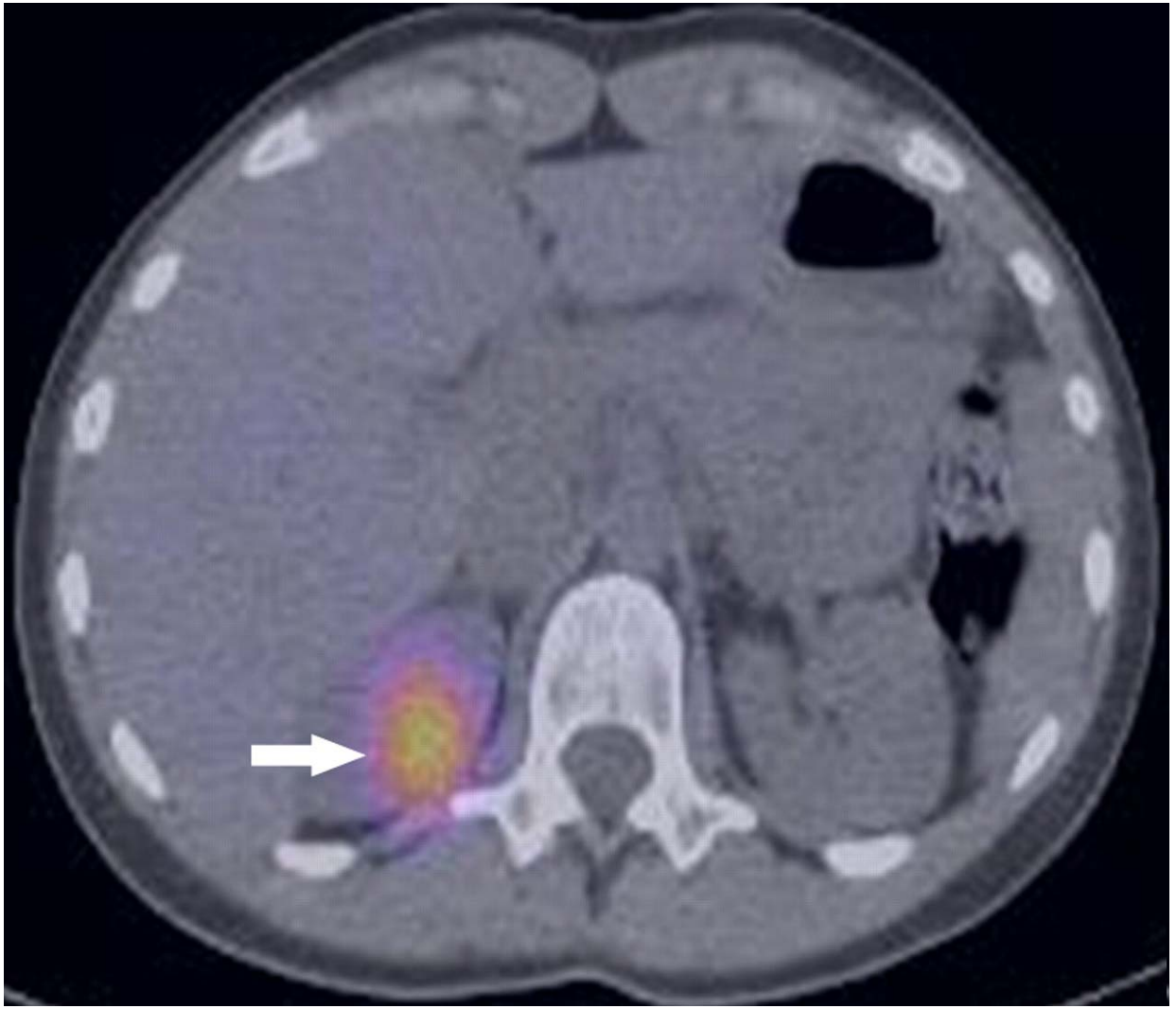
Figure 7: Ultrasound scan of the prostate gland

Prostate - Transrectal Ultrasound (TRUS)

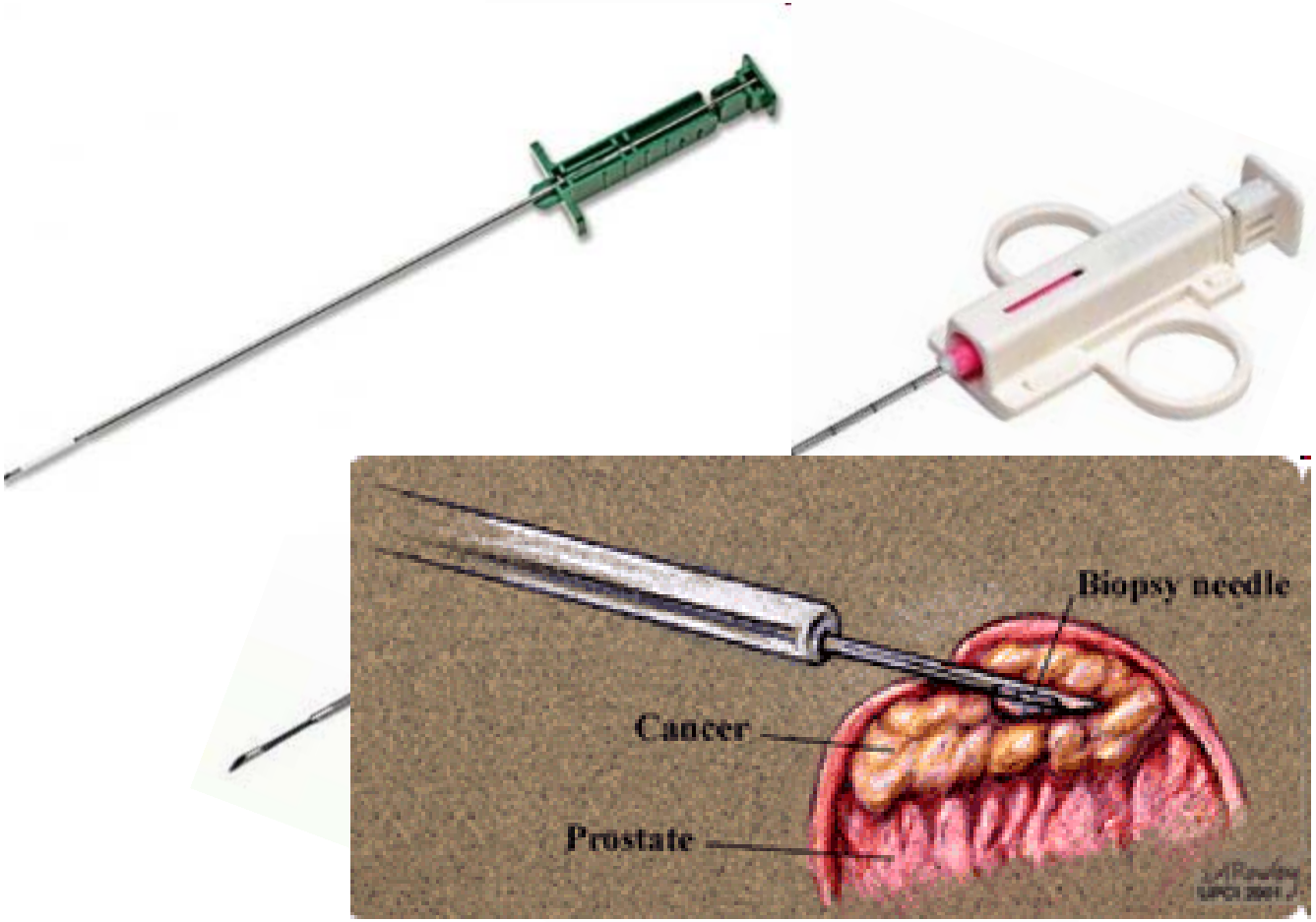


Liver - Transcutaneous Ultrasound

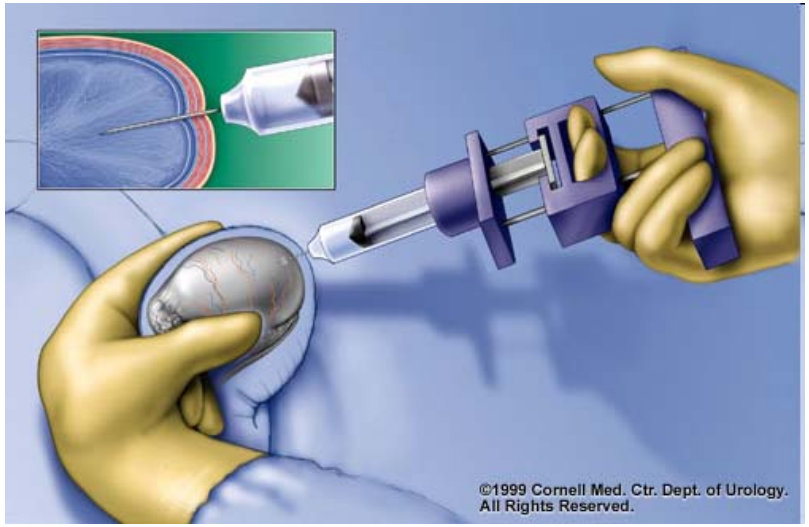
Cancer imaging – SPECT



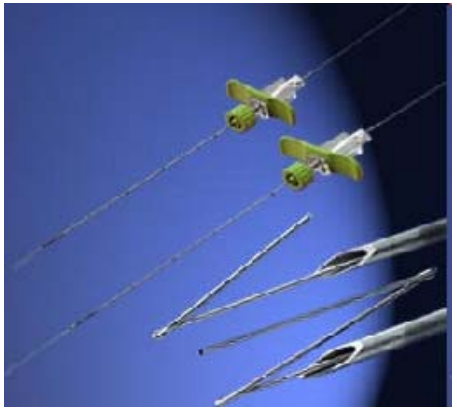
Biopsy - the tools - 'cutting'

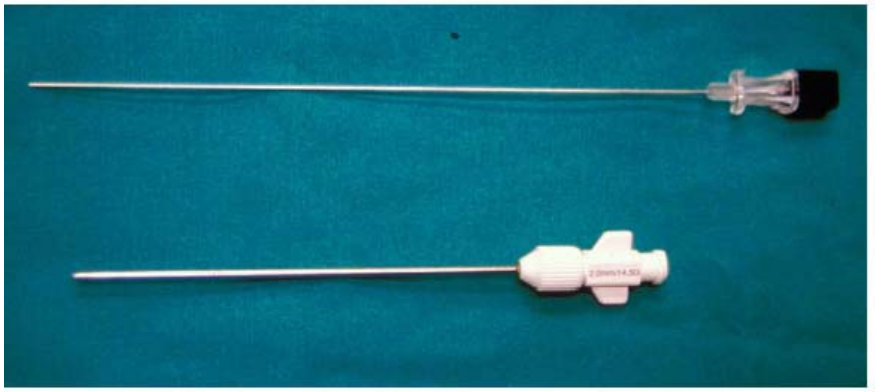


Biopsy - the tools - ‘suction’



Aspiration for serial semen analyses

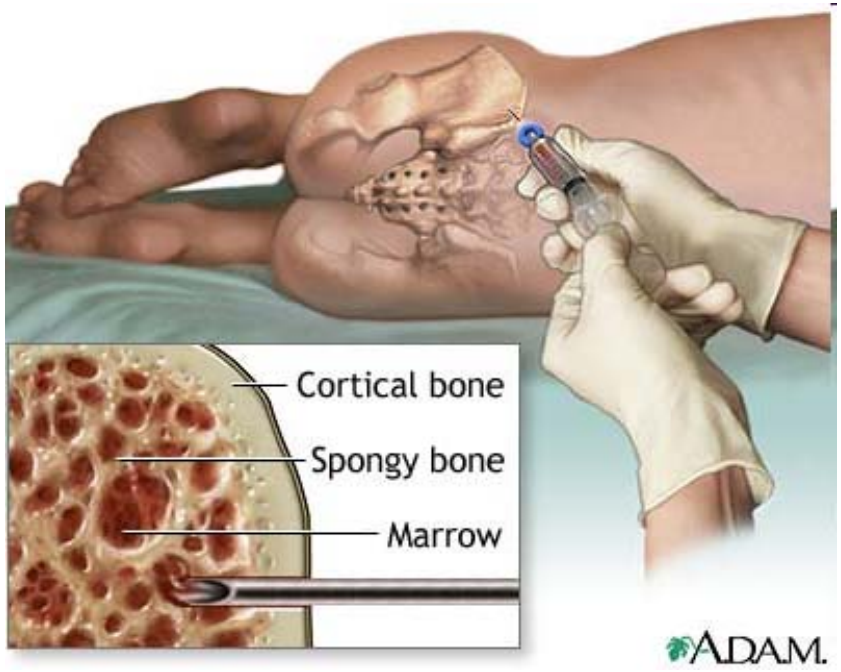




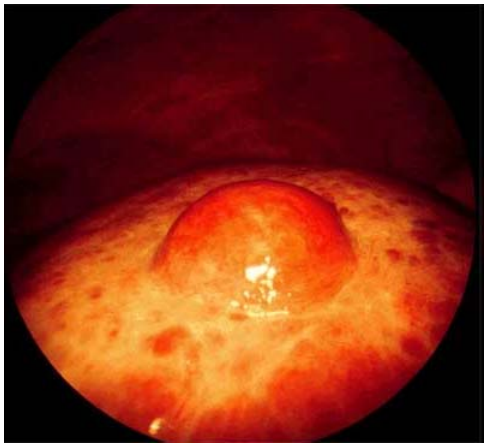
Biopsy - ‘drilling & suction’

Bone biopsy needle

Bone marrow biopsy needle



Biopsy - the tissue (examples)



Primary liver cancer in laparoscopy camera and pathology

Liver mets from testicular (left) and breast cancer (right)

Cancer – Diagnosis
specificity and sensitivity

sensitivity

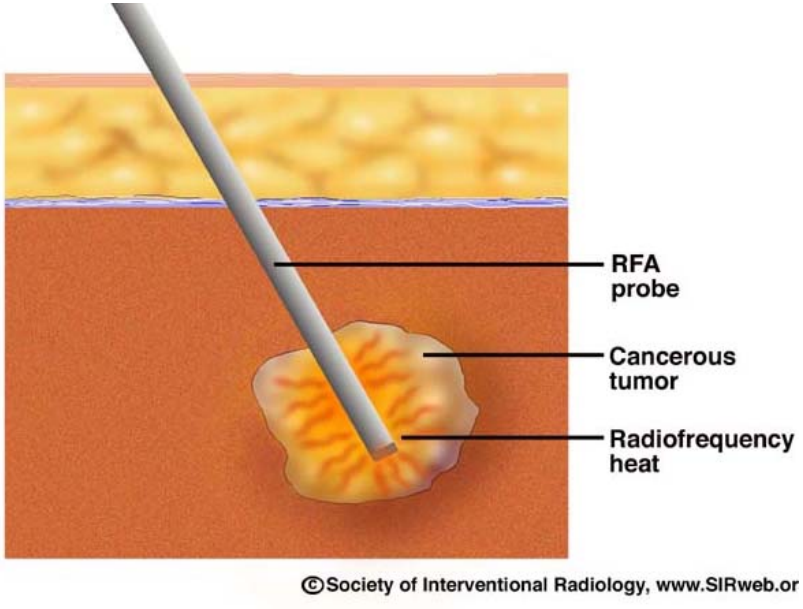
specificity	no	yes
no	**BAD**	**?**
yes	**?**	**IDEAL**

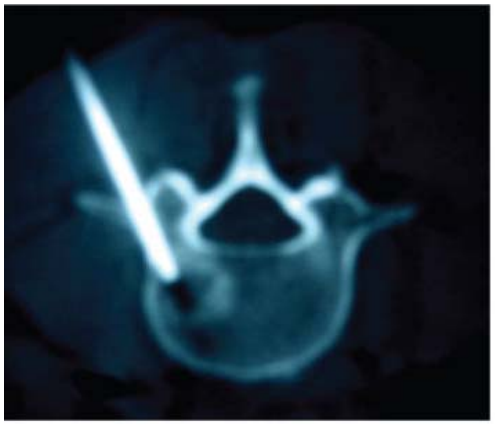
Sensitivity = can I see it if it is there?
Specificity = can I recognize it if I see it?

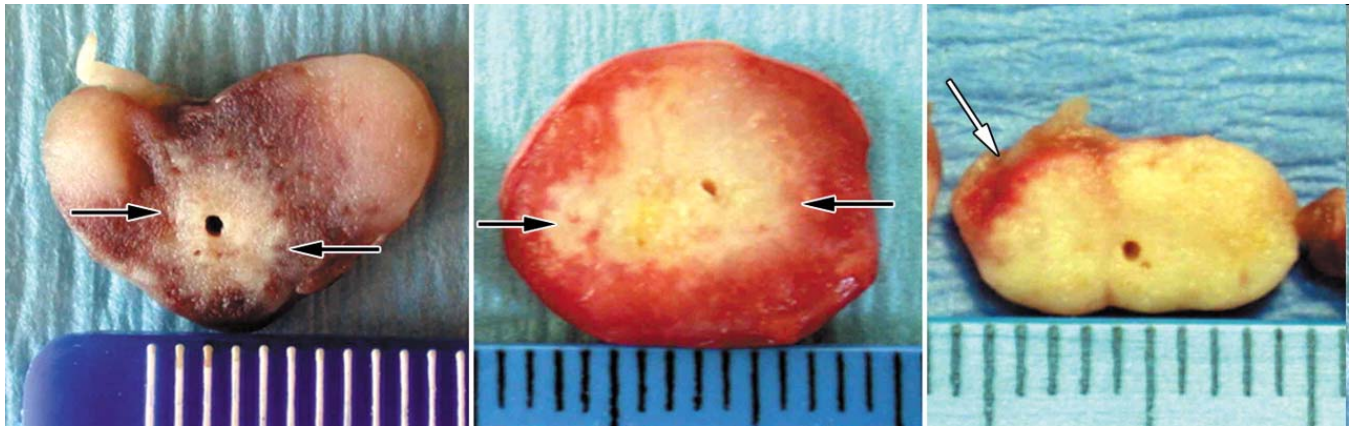
Cancer – treatment

- Chemotherapy (realm of medical oncology)
- Surgery
  - Resection
  - Growth inhibition
    - Thermal Ablation
    - Cryotherapy (freezing)
    - Injection
    - Embolization
- Radiation therapy
  - External beam (EBRT)
  - Implanted sources (brachytherapy)

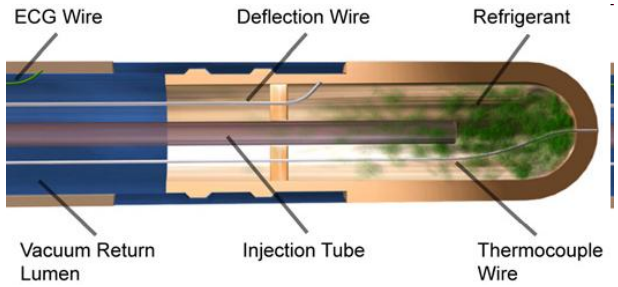
Cancer – MIS tools - RFA

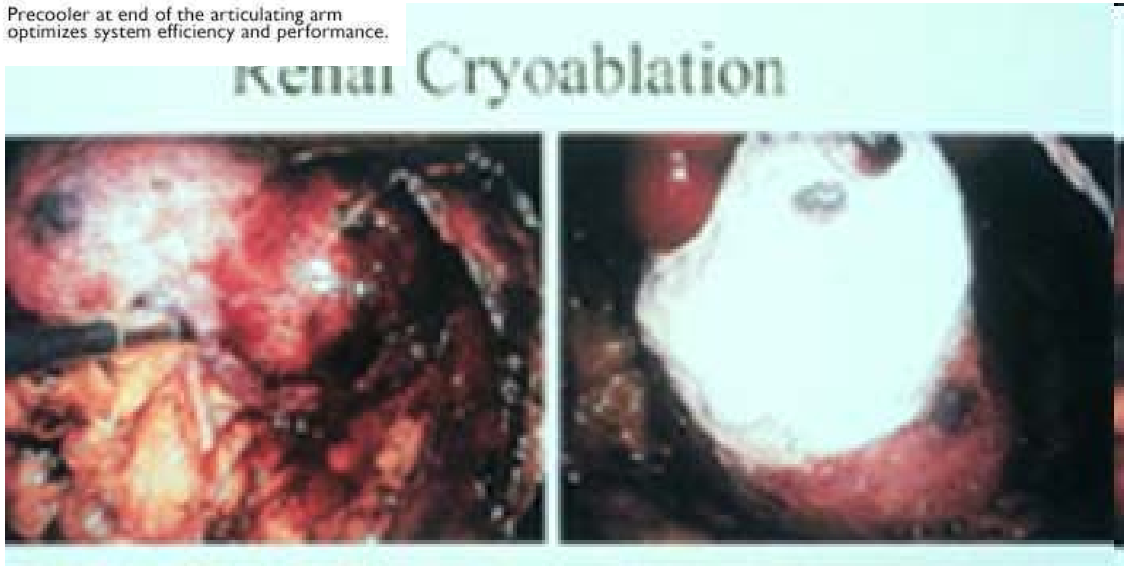






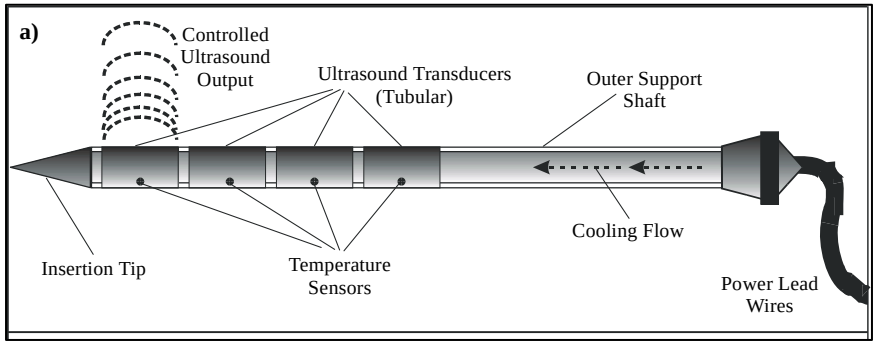
Cancer – MIS tools - cryo

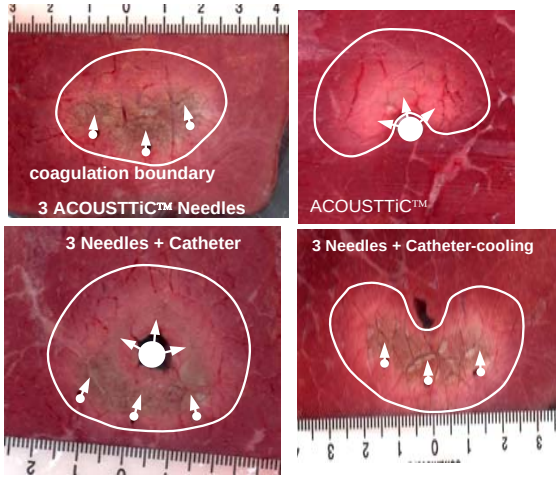


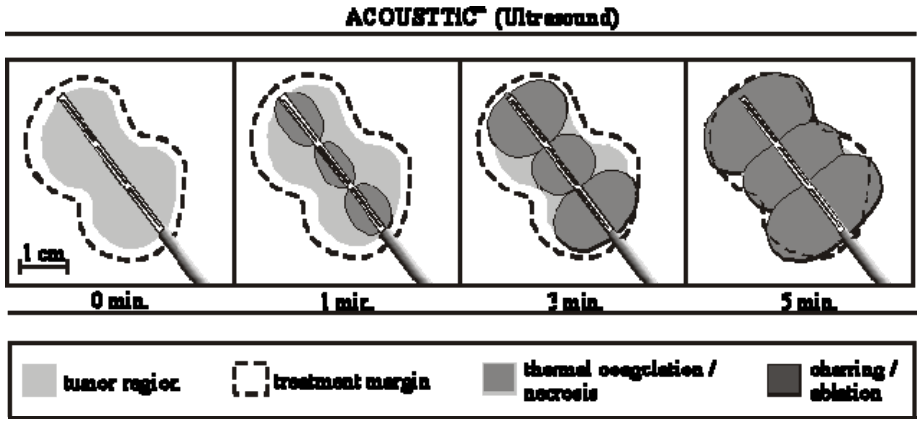


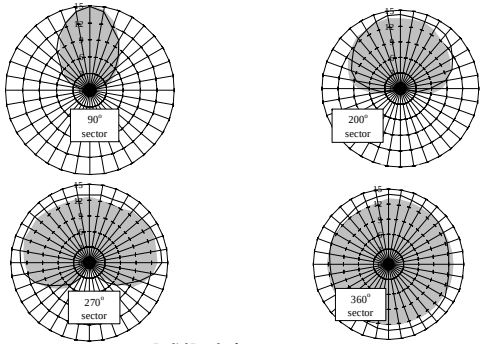
Cancer – MIS tools - microwave

Cancer – MIS tools – HIFU needle









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Cancer – HDR brachytherapy

Cancer Statistics 2007

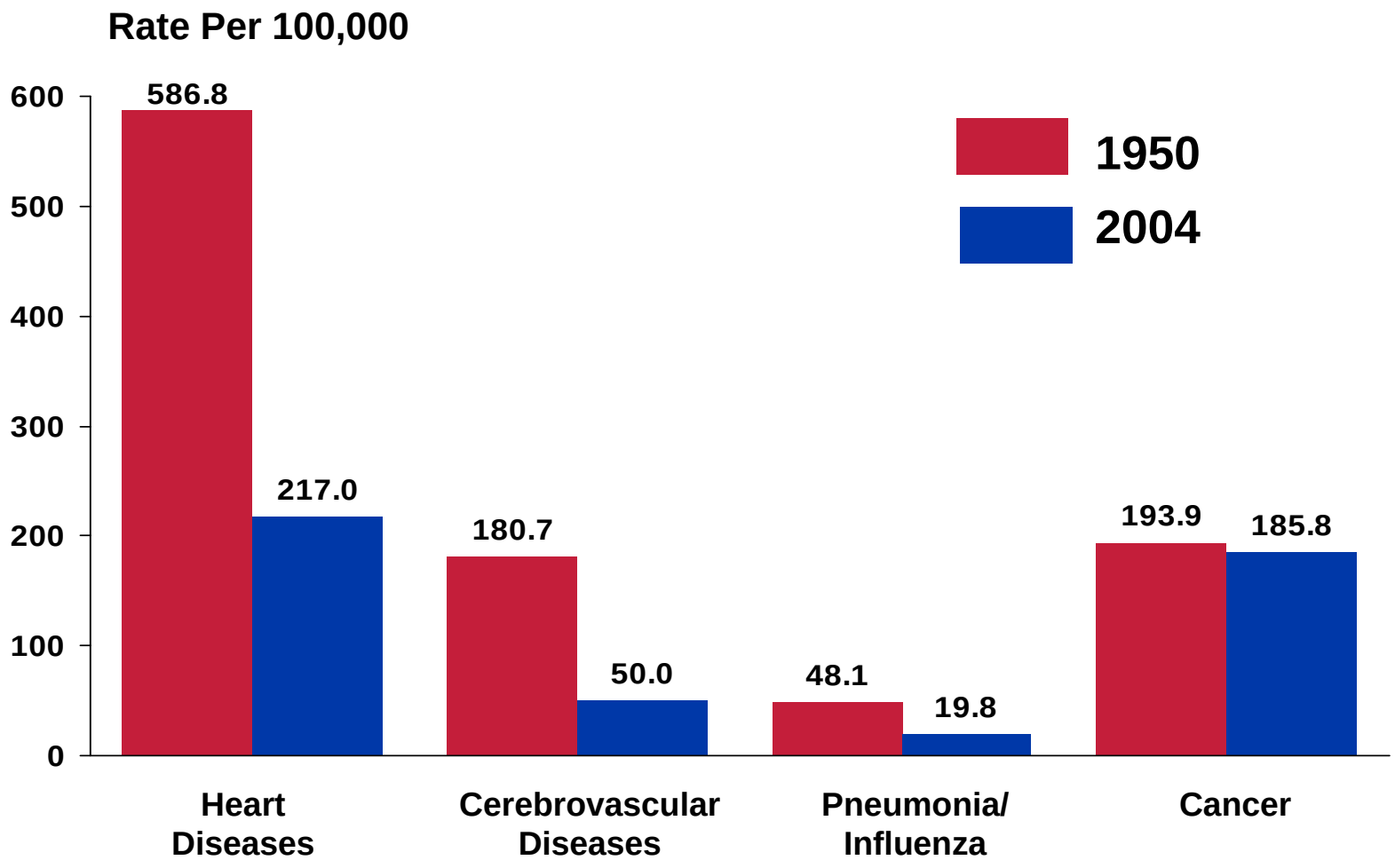
A Presentation From the American Cancer Society

US Mortality, 2004

Rank	Cause of Death	No. of deaths	% of all deaths
1.	Heart Diseases	652,486	27.2
2.	**Cancer**	**553,888**	**23.1**
3.	Cerebrovascular diseases	150,074	6.3
4.	Chronic lower respiratory diseases	121,987	5.1
5.	Accidents (Unintentional injuries)	112,012	4.7
6.	Diabetes mellitus	73,138	3.1
7.	Alzheimer disease	65,965	2.8
8.	Influenza & pneumonia	59,664	2.5
9.	Nephritis	42,480	1.8
10.	Septicemia	33,373	1.4

Source: US Mortality Public Use Data Tape 2004, National Center for Health Statistics, Centers for Disease Control and Prevention, 2006.

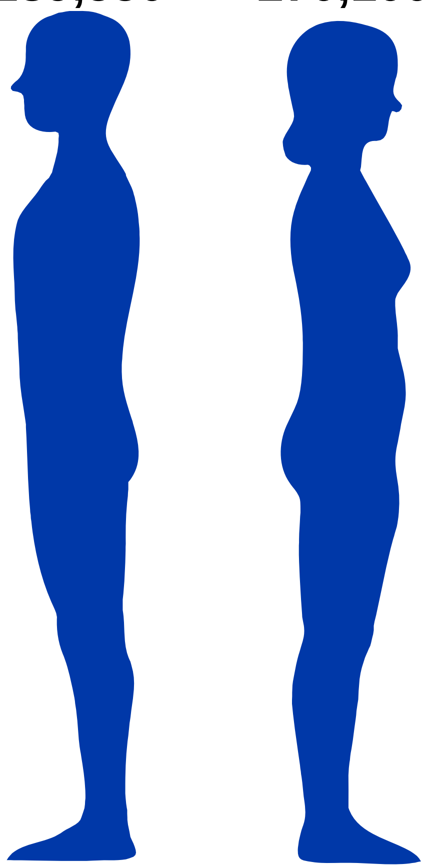
Change in the US Death Rates* by Cause, 1950 & 2004



*** Age-adjusted to 2000 US standard population.**
Sources: 1950 Mortality Data - CDC/NCHS, NVSS, Mortality Revised.
2004 Mortality Data: US Mortality Public Use Data Tape, 2004, NCHS, Centers for Disease Control and Prevention, 2006

2007 Estimated US Cancer Deaths*

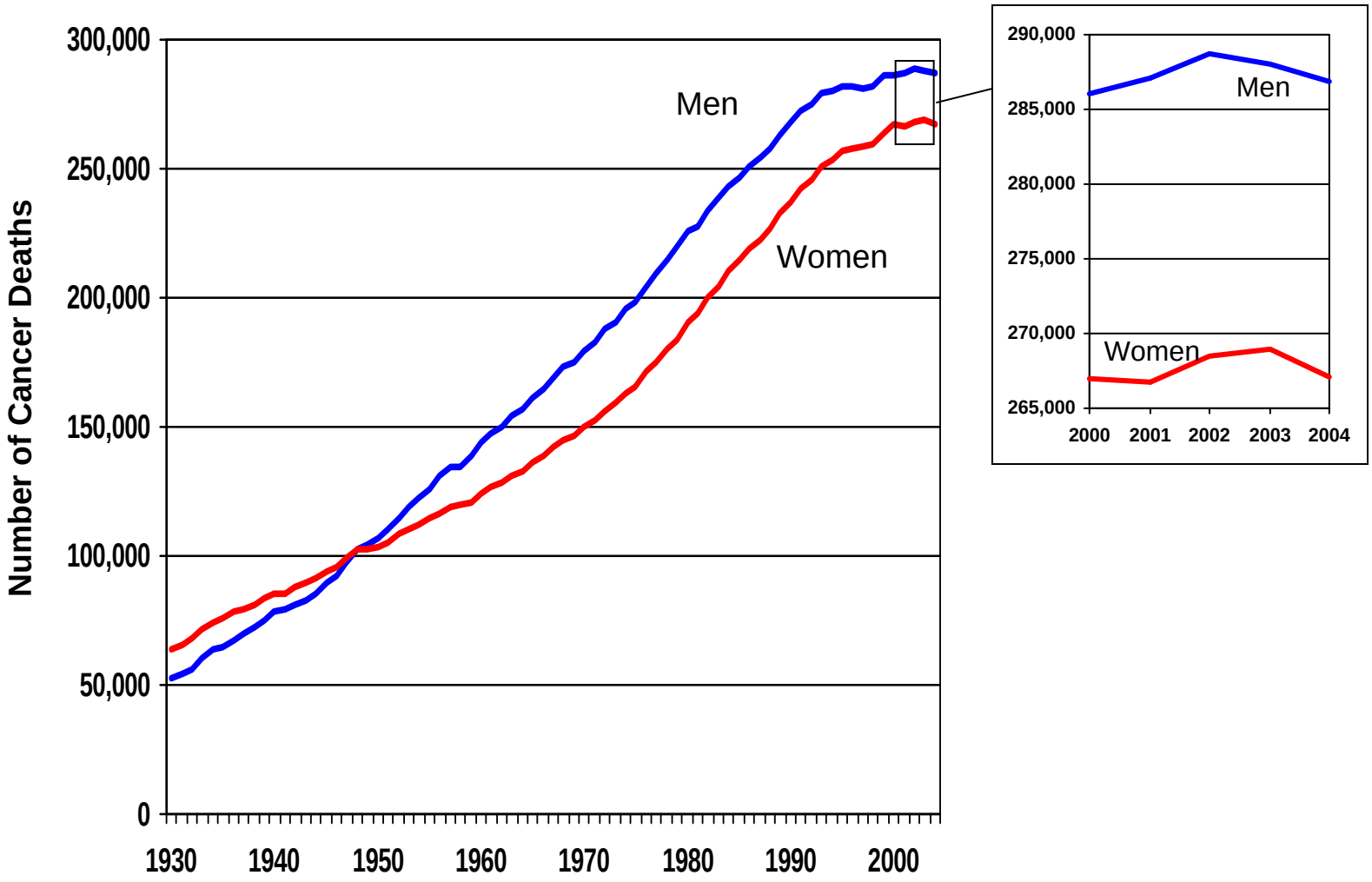
Men 289,550	
Lung & bronchus	31%
Prostate	9%
Colon & rectum	9%
Pancreas	6%
Leukemia	4%
Liver & intrahepatic bile duct	4%
Esophagus	4%
Urinary bladder	3%
Non-Hodgkin lymphoma	3%
Kidney	3%
All other sites	24%



Women 270,100	
26%	Lung & bronchus
15%	Breast
10%	Colon & rectum
6%	Pancreas
6%	Ovary
4%	Leukemia
3%	Non-Hodgkin lymphoma
3%	Uterine corpus
2%	Brain/ONS
2%	Liver & intrahepatic bile duct
23%	All other sites

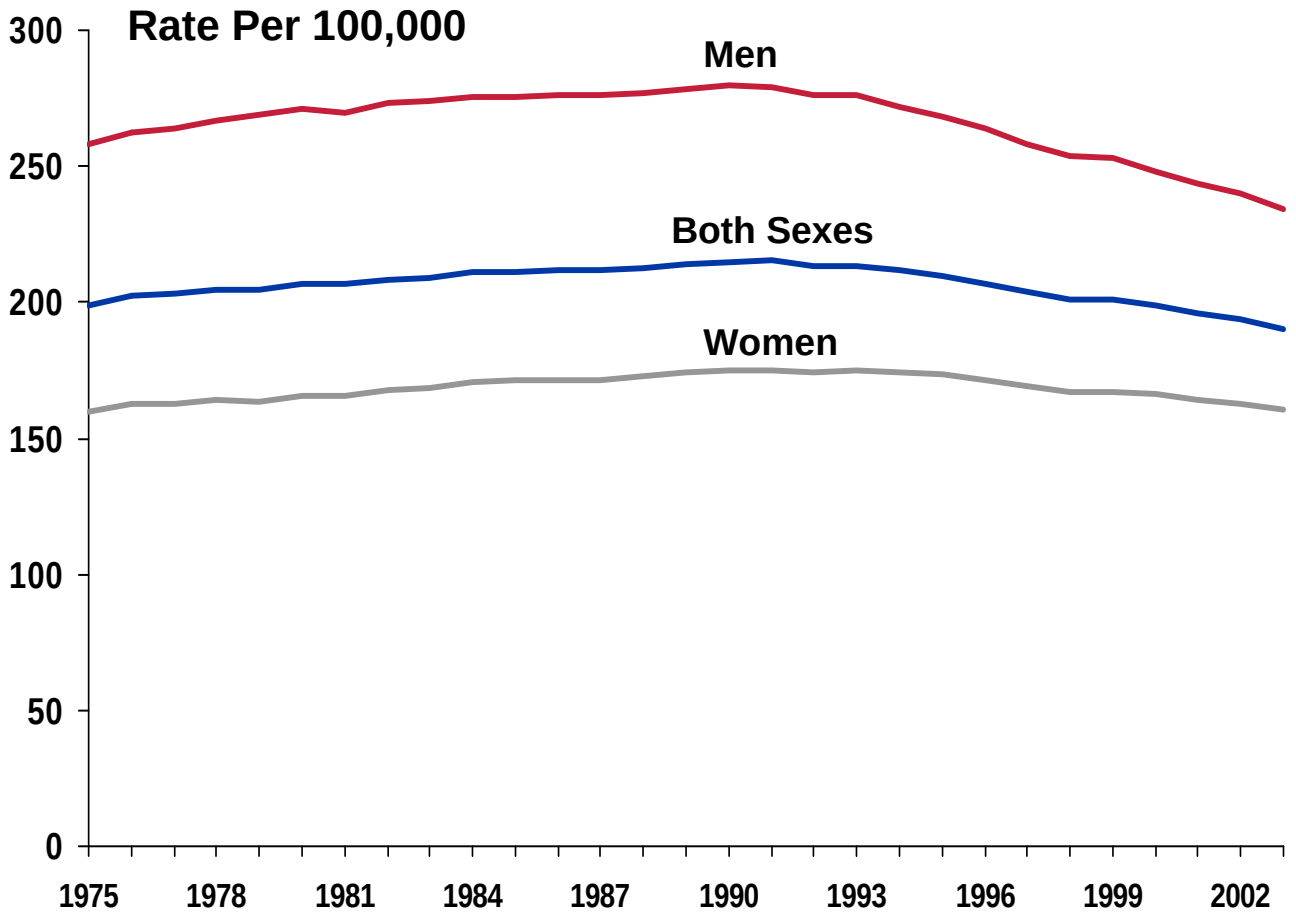
ONS=Other nervous system.
Source: American Cancer Society, 2007.

Trends in the Number of Cancer Deaths Among Men and Women, US, 1930-2004



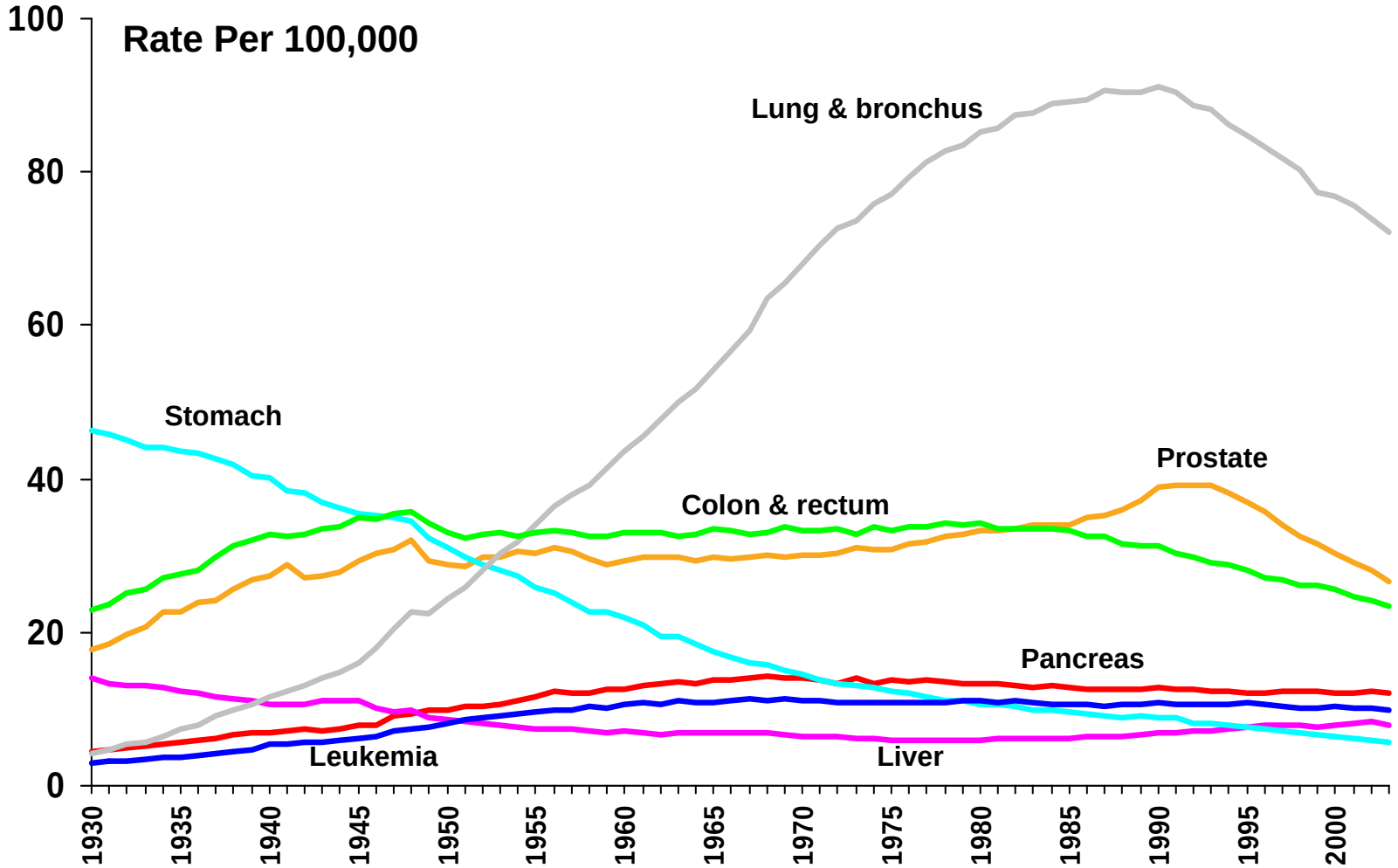
Source: US Mortality Public Use Data Tape, 2004, National Center for Health Statistics, Centers for Disease Control and Prevention, 2006.

Cancer Death Rates*, All Sites Combined, All Races, US, 1975-2003



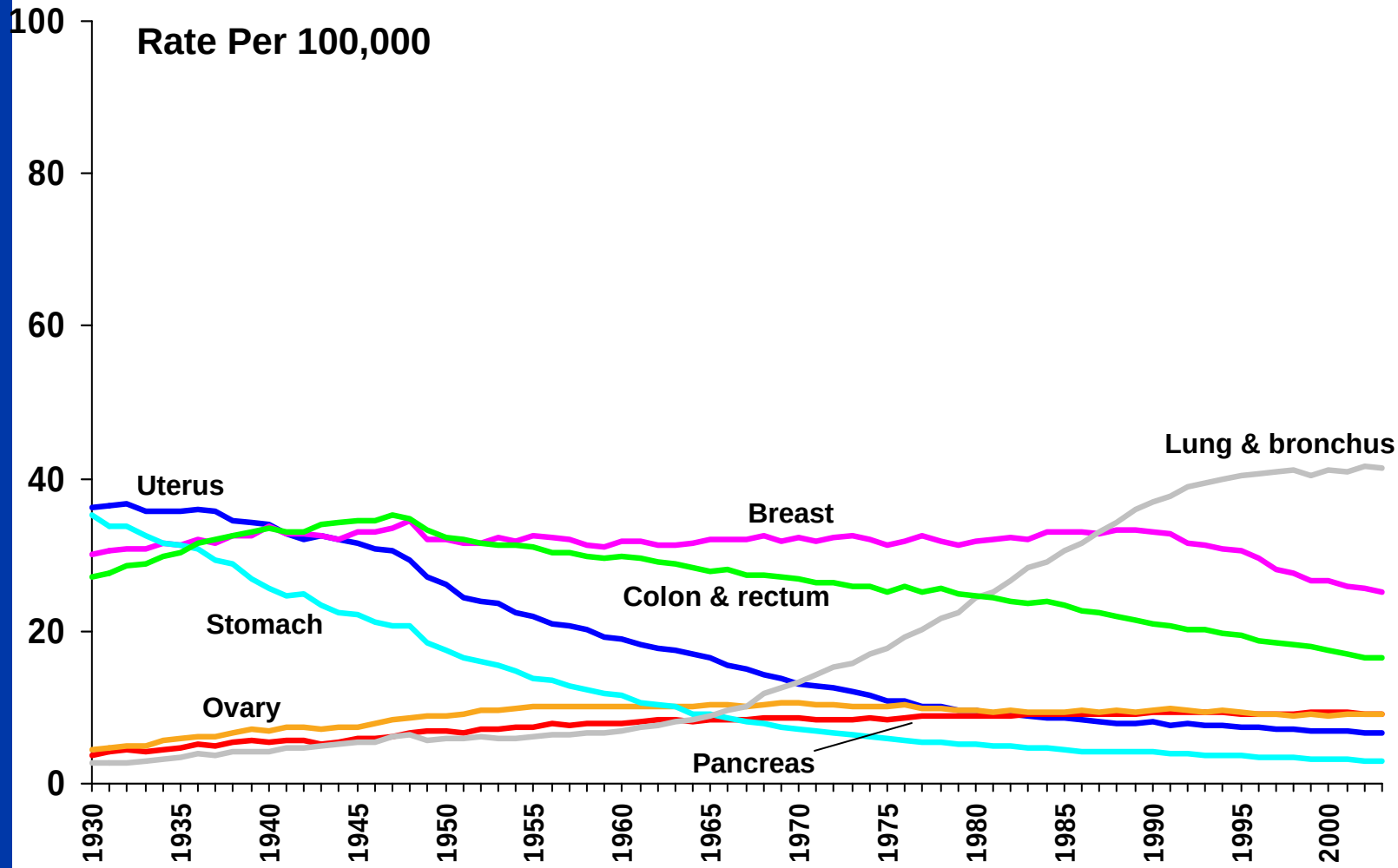
***Age-adjusted to the 2000 US standard population.**
Source: Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Mortality - All COD, Public-Use With State, Total U.S. (1969-2003), National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released April 2006. Underlying mortality data provided by NCHS (www.cdc.gov/nchs).

Cancer Death Rates*, for Men, US,1930-2003



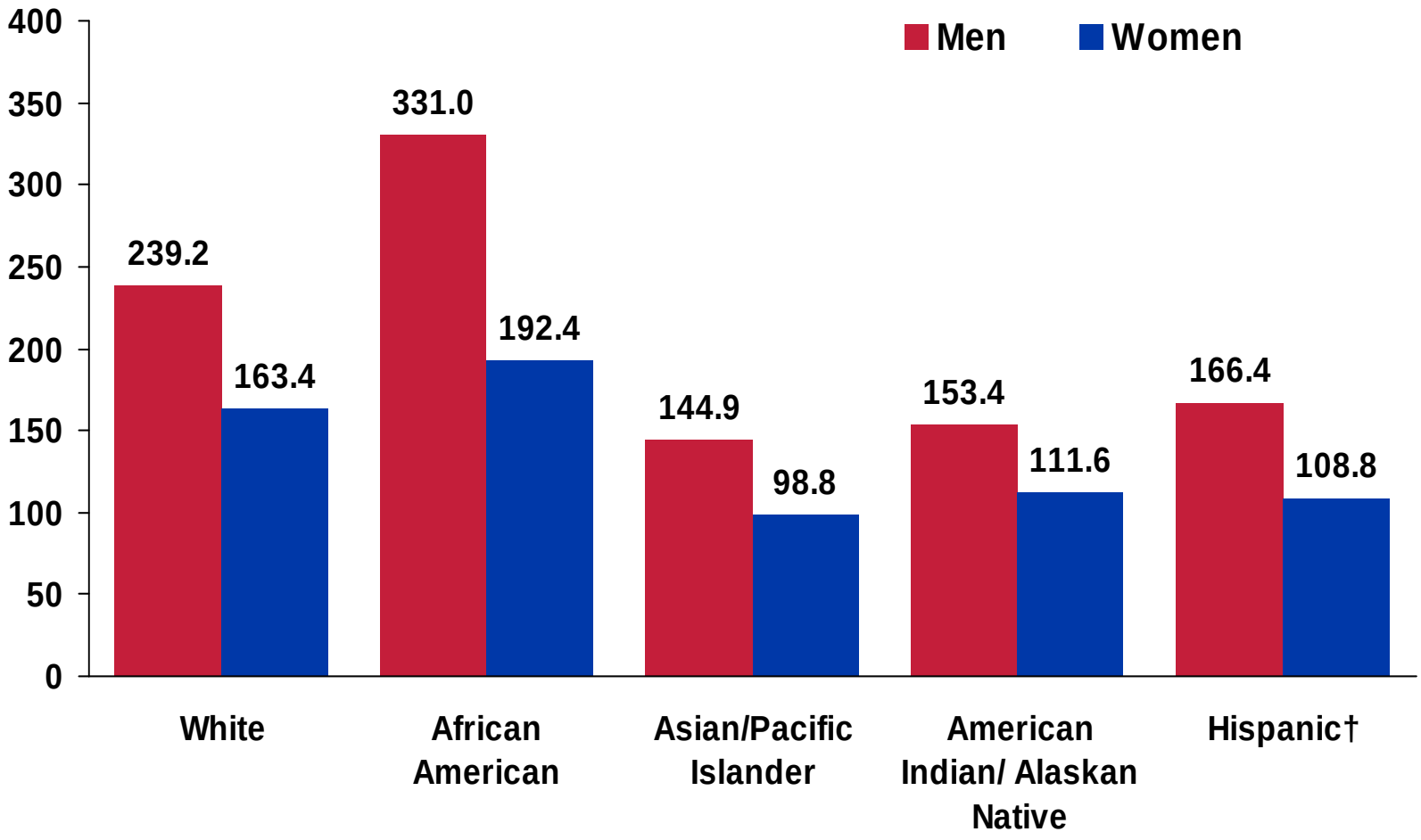
*Age-adjusted to the 2000 US standard population.
Source: US Mortality Public Use Data Tapes 1960-2003, US Mortality Volumes 1930-1959, National Center for Health Statistics, Centers for Disease Control and Prevention, 2006.

Cancer Death Rates*, for Women, US,1930-2003



*Age-adjusted to the 2000 US standard population.
Source: US Mortality Public Use Data Tapes 1960-2003, US Mortality Volumes 1930-1959, National Center for Health Statistics, Centers for Disease Control and Prevention, 2006.

Cancer Death Rates*, by Race and Ethnicity, US,1999-2003



***Per 100,000, age-adjusted to the 2000 US standard population.**
† Persons of Hispanic origin may be of any race.
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Cancer Sites in Which African American Death Rates* Exceed White Death Rates* for Men, US, 1999-2003

Site	African American	White	Ratio of African American/White
All sites	331.0	239.2	1.4
Prostate	65.1	26.7	2.4
Larynx	5.1	2.2	2.3
Stomach	12.4	5.4	2.3
Myeloma	8.6	4.4	2.0
Oral cavity and pharynx	6.9	3.8	1.8
Esophagus	10.7	7.6	1.4
Liver and intrahepatic bile duct	9.6	6.3	1.5
Small intestine	0.7	0.4	1.8
Colon and rectum	33.6	23.7	1.4
Lung and bronchus	98.4	73.8	1.3
Pancreas	15.7	12.0	1.3

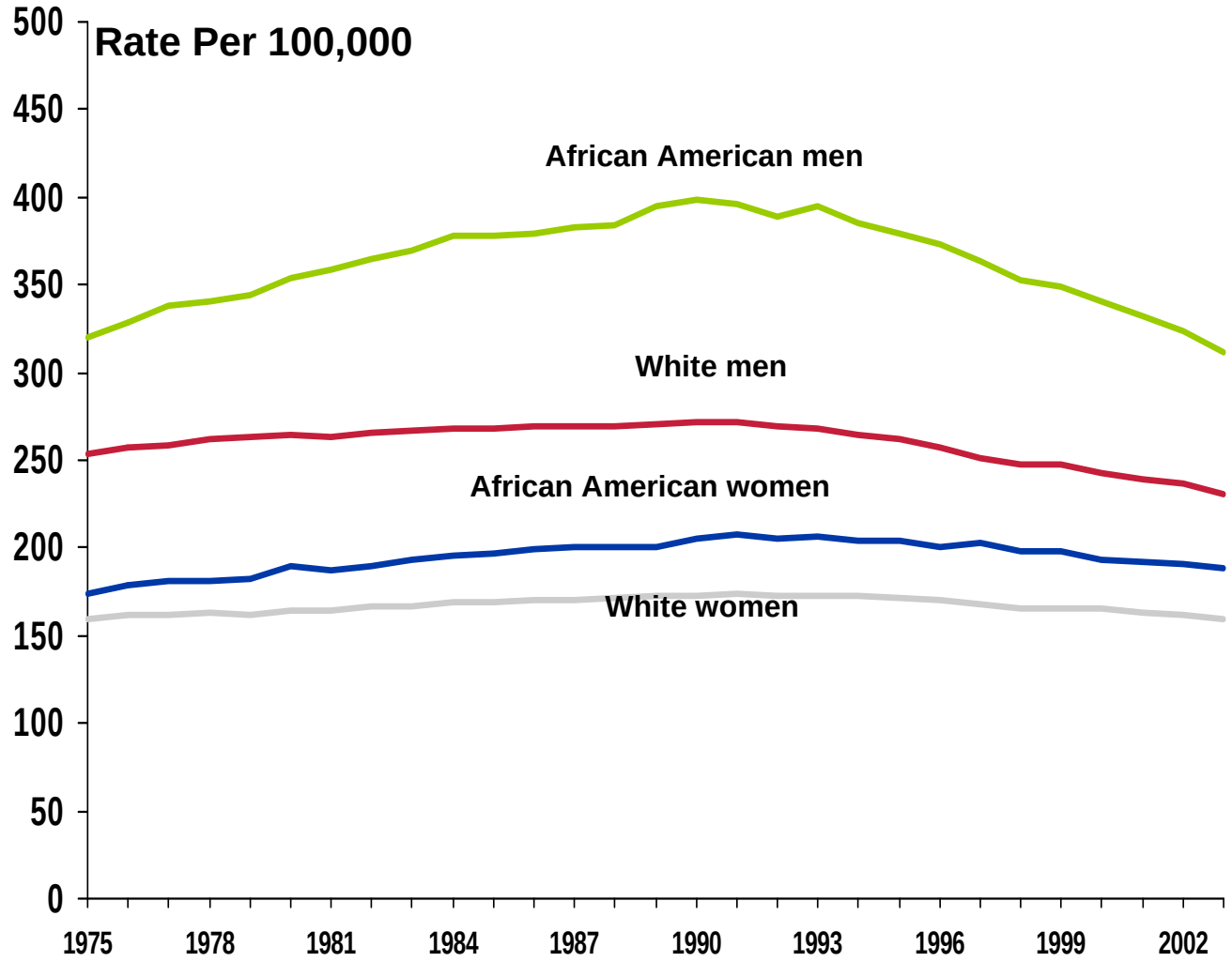
***Per 100,000, age-adjusted to the 2000 US standard population.**
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Cancer Sites in Which African American Death Rates* Exceed White Death Rates* for Women, US, 1999-2003

Site	African American	White	Ratio of African American/White
All sites	192.4	163.4	1.2
Stomach	6.0	2.7	2.2
Myeloma	6.4	2.9	2.2
Uterine cervix	5.1	2.4	2.1
Esophagus	3.0	1.7	1.8
Larynx	0.9	0.5	1.8
Uterine corpus	7.1	3.9	1.8
Small intestine	0.5	0.3	1.7
Pancreas	12.5	9.0	1.4
Colon and rectum	23.7	16.4	1.4
Liver and intrahepatic bile duct	3.8	2.8	1.4
Breast	34.4	25.4	1.4
Urinary bladder	2.9	2.3	1.3
Gallbladder	1.0	0.8	1.3
Oral cavity and pharynx	1.8	1.5	1.2

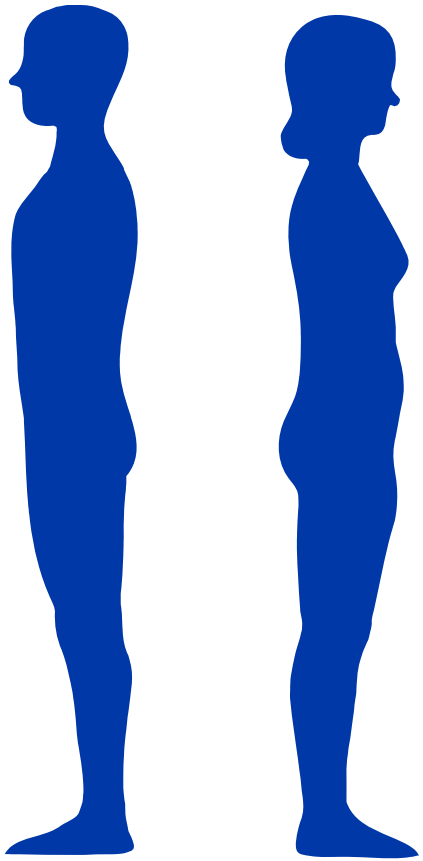
***Per 100,000, age-adjusted to the 2000 US standard population.**
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Cancer Death Rates* by Sex and Race, US, 1975-2003



***Age-adjusted to the 2000 US standard population.**
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

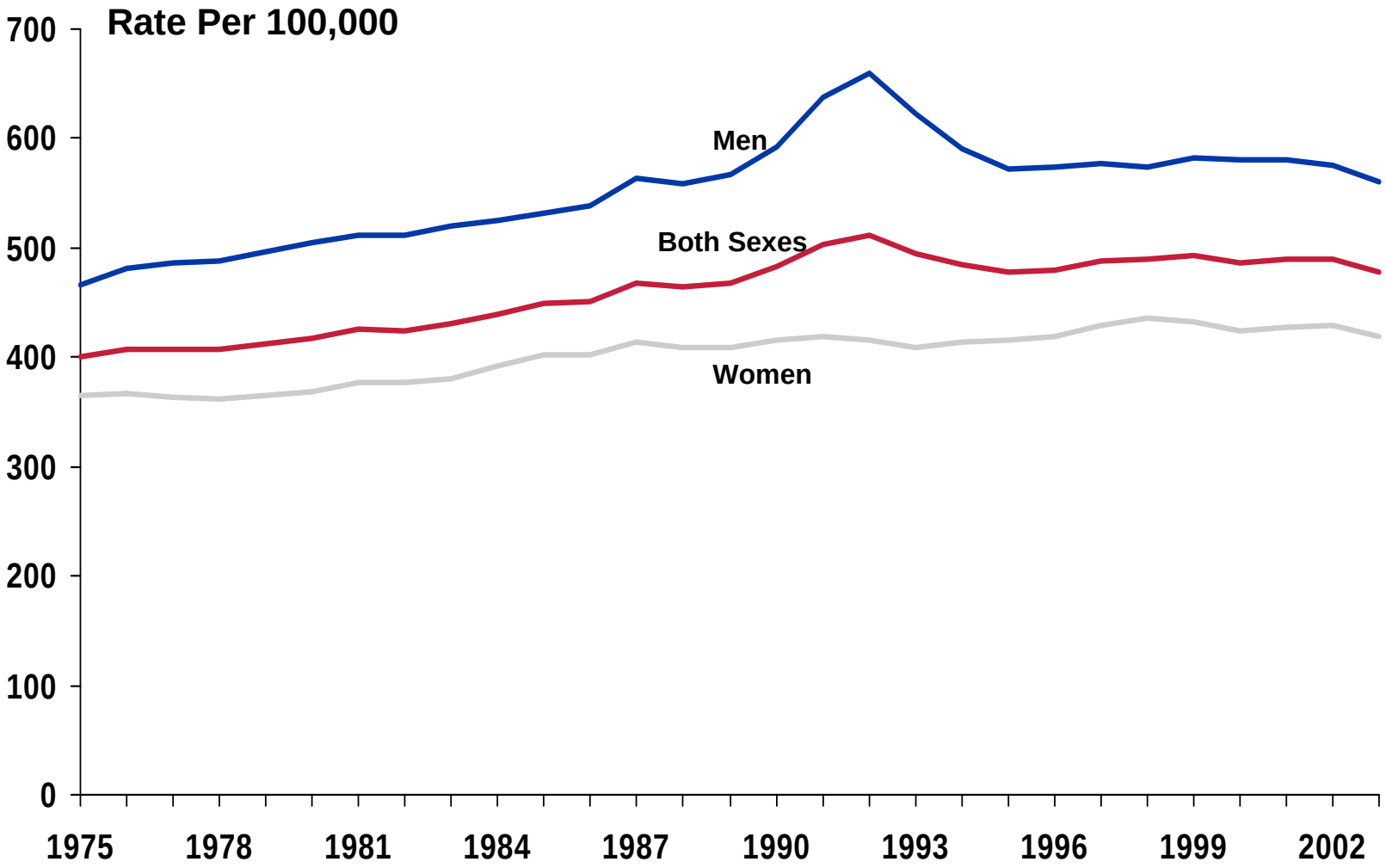
2007 Estimated US Cancer Cases*

		Men 766,860	Women 678,060		
Prostate	29%			26%	Breast
Lung & bronchus	15%			15%	Lung & bronchus
Colon & rectum	10%			11%	Colon & rectum
Urinary bladder	7%			6%	Uterine corpus
Non-Hodgkin lymphoma	4%			4%	Non-Hodgkin lymphoma
Melanoma of skin	4%			4%	Melanoma of skin
Kidney	4%			4%	Thyroid
Leukemia	3%			3%	Ovary
Oral cavity	3%			3%	Kidney
Pancreas	2%			3%	Leukemia
All Other Sites	19%			21%	All Other Sites

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

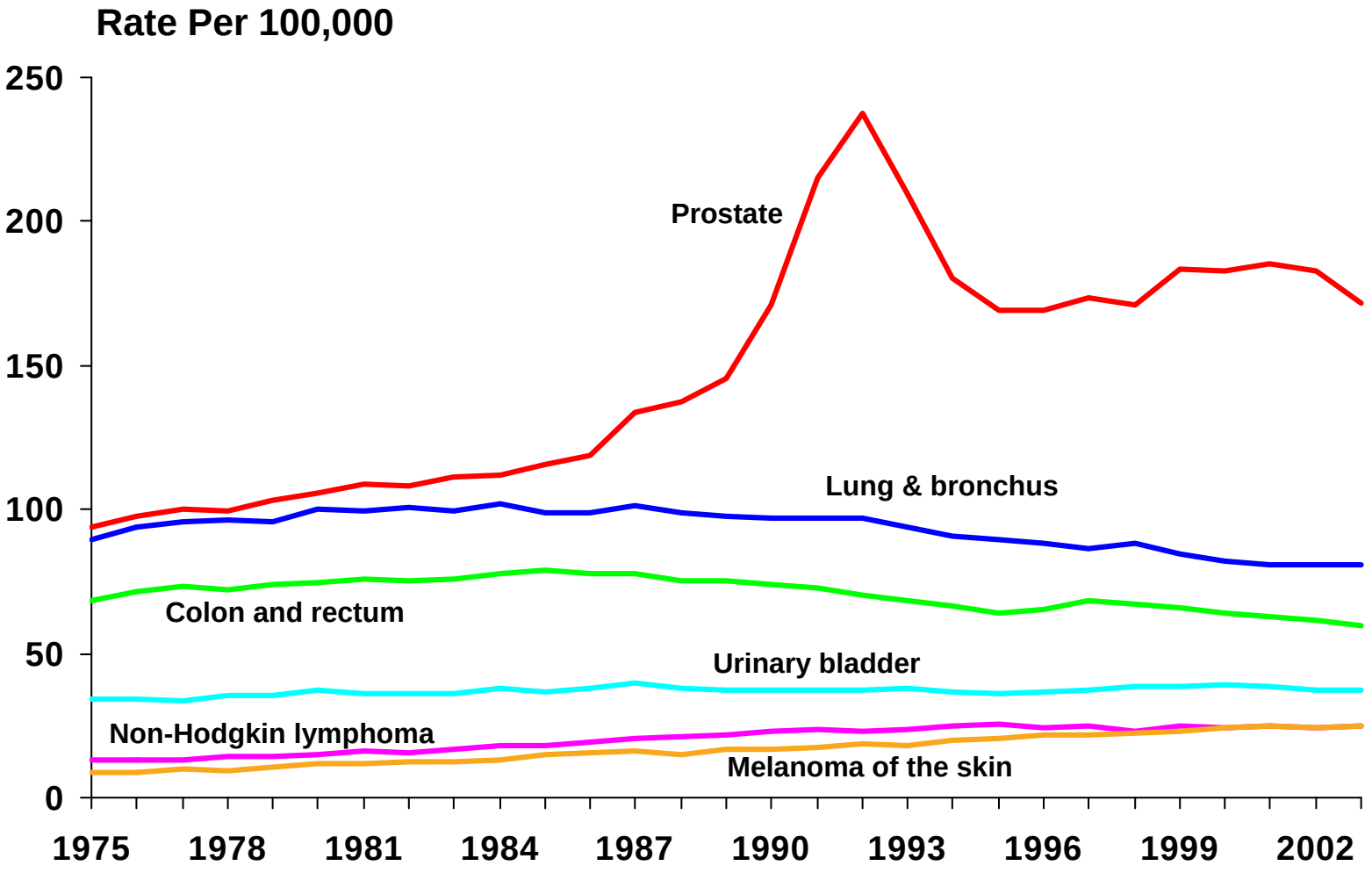
Source: American Cancer Society, 2007

Cancer Incidence Rates*, All Sites Combined, All Races, 1975-2003



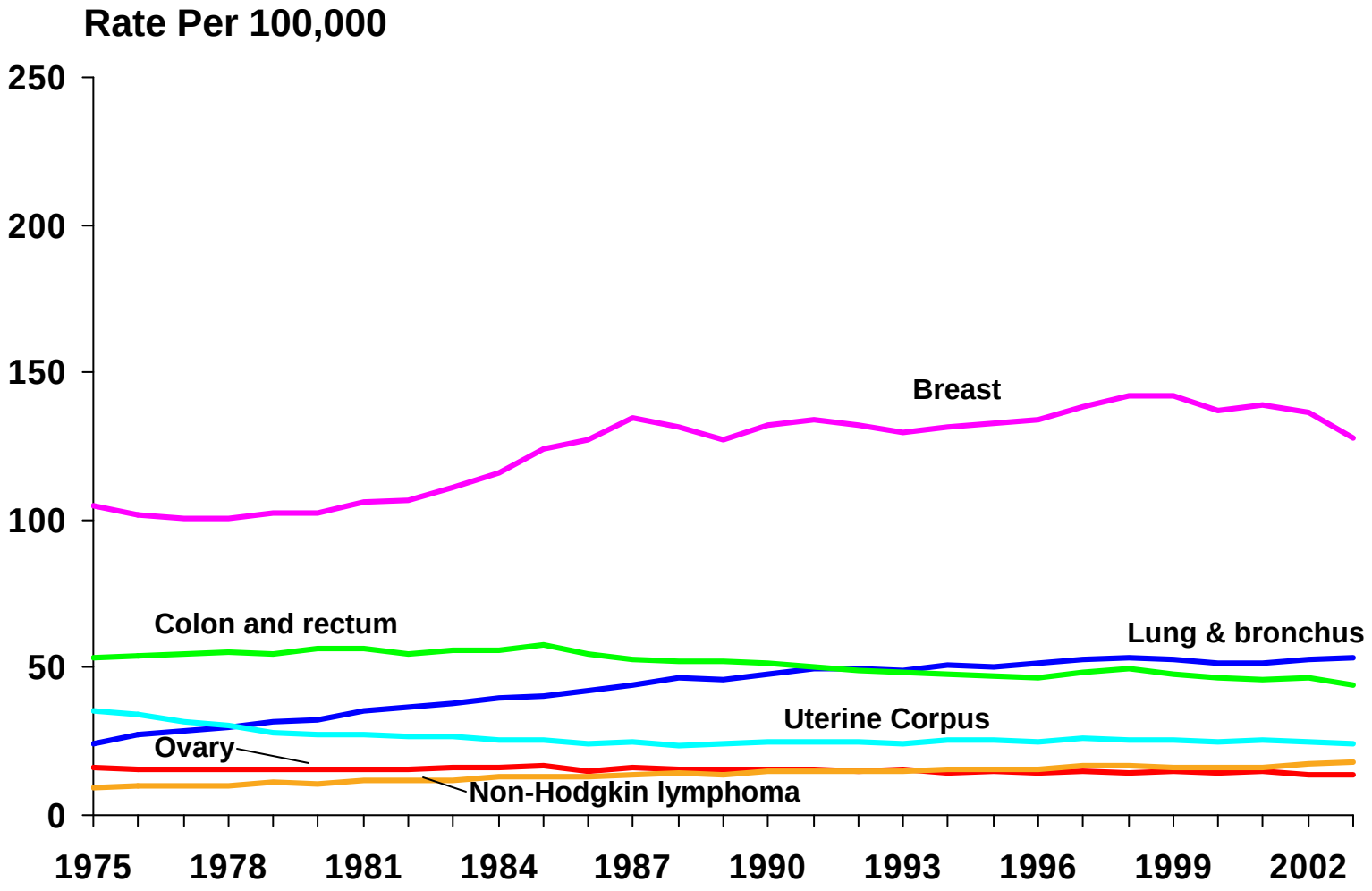
***Age-adjusted to the 2000 US standard population and adjusted for delay in reporting.**
Source: Surveillance, Epidemiology, and End Results Program, 1973-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Cancer Incidence Rates* for Men, 1975-2003



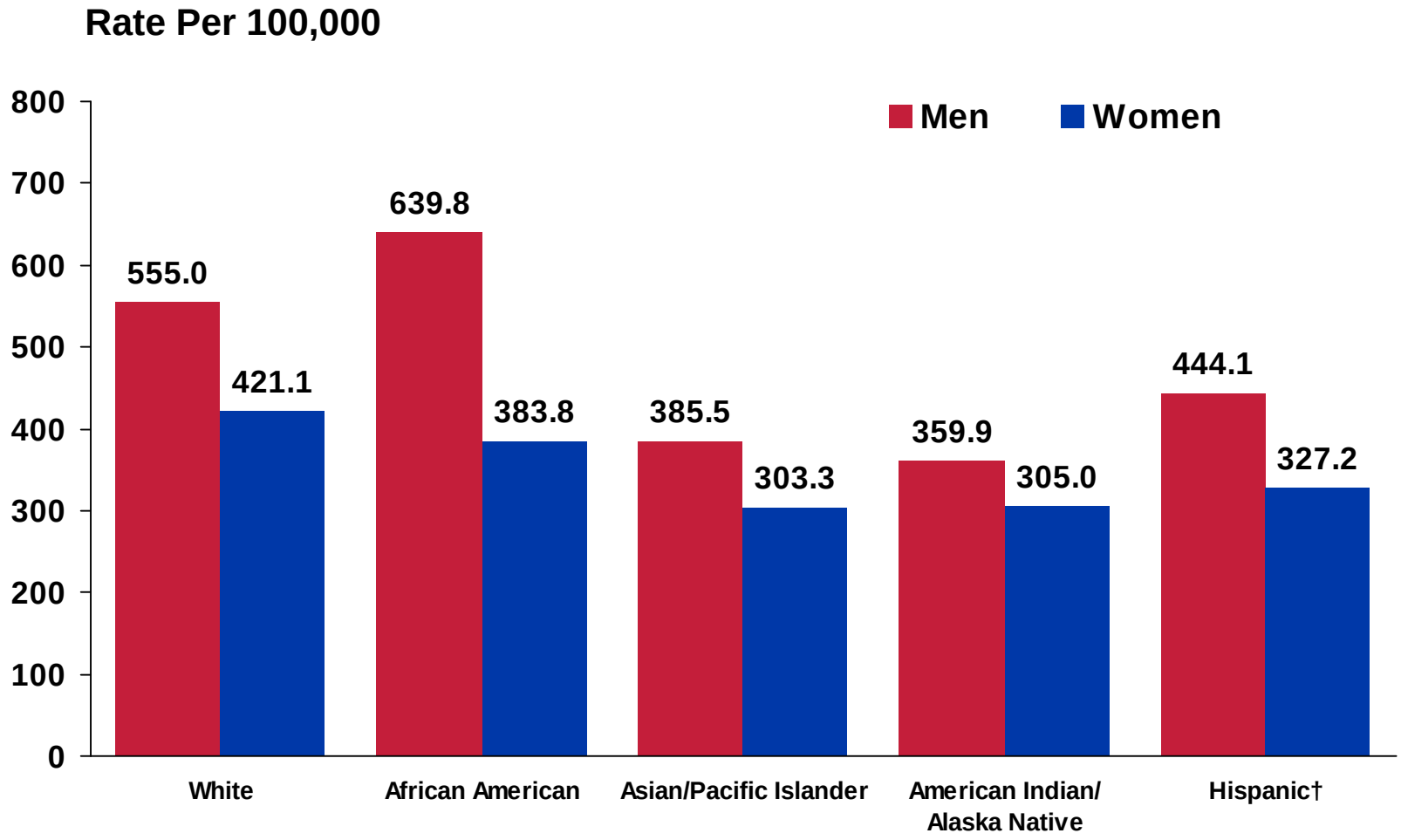
*Age-adjusted to the 2000 US standard population and adjusted for delays in reporting.
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Cancer Incidence Rates* for Women, 1975-2003



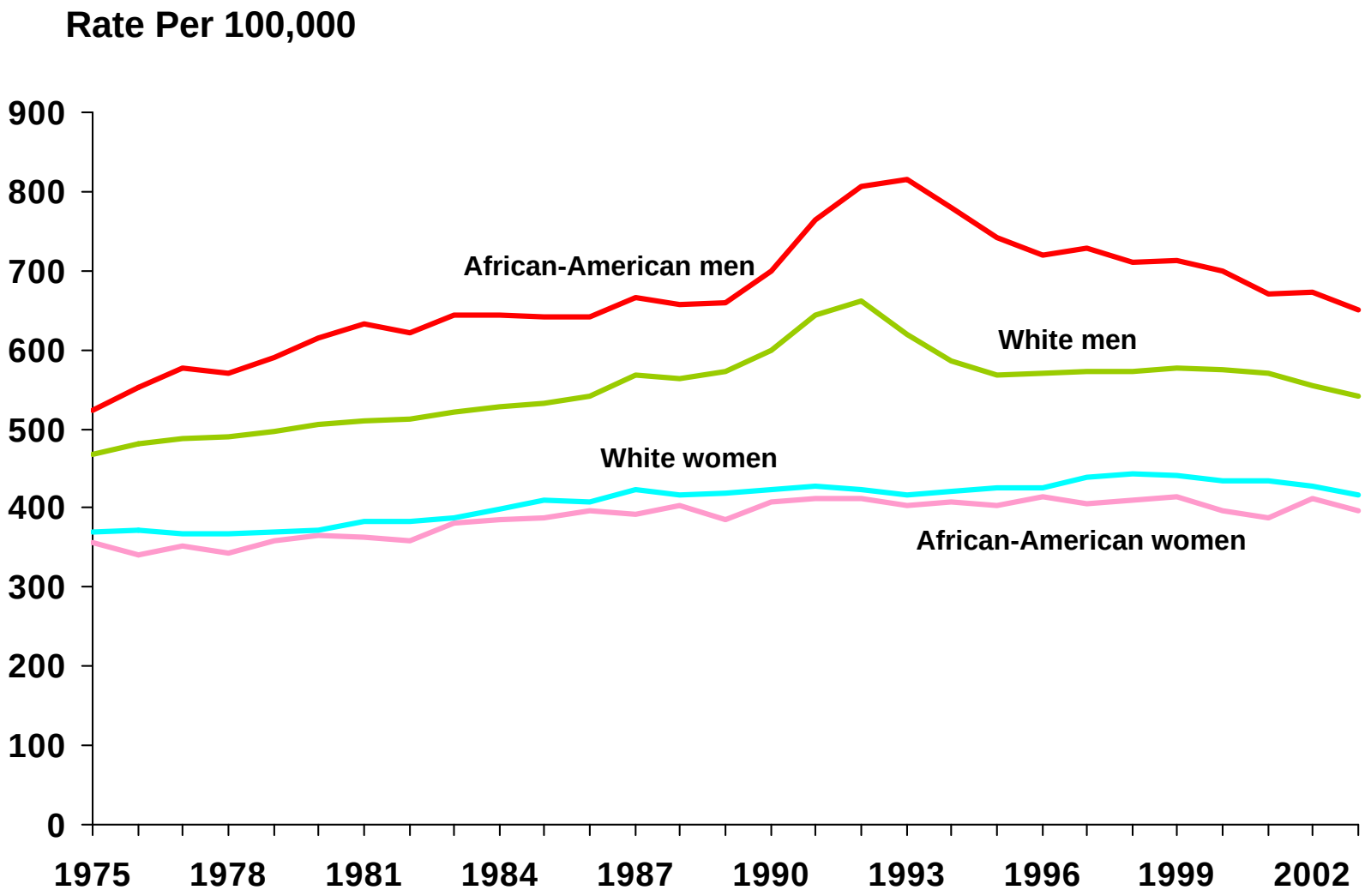
*Age-adjusted to the 2000 US standard population and adjusted for delays in reporting.
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Cancer Incidence Rates* by Race and Ethnicity, 1999-2003



*Age-adjusted to the 2000 US standard population.
†Person of Hispanic origin may be of any race.
Sources: Howe HL, et al. Annual report to the nation on the status of cancer 1975-2003; SEER, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Cancer Incidence Rates* by Sex and Race, All Sites, 1975-2003



*Age-adjusted to the 2000 US standard population.
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Lifetime Probability of Developing Cancer, by Site, Men, 2001-2003*

Site	Risk
All sites†	1 in 2
Prostate	1 in 6
Lung and bronchus	1 in 12
Colon and rectum	1 in 17
Urinary bladder‡	1 in 28
Non-Hodgkin lymphoma	1 in 47
Melanoma	1 in 49
Kidney	1 in 61
Leukemia	1 in 67
Oral Cavity	1 in 72
Stomach	1 in 89

*** For those free of cancer at beginning of age interval. Based on cancer cases diagnosed during 2001 to 2003.**
† All Sites exclude basal and squamous cell skin cancers and in situ cancers except urinary bladder.
‡ Includes invasive and in situ cancer cases
Source: DevCan: Probability of Developing or Dying of Cancer Software, Version 6.1.1 Statistical Research and Applications Branch, NCI, 2006. http://srab.cancer.gov/devcan

Lifetime Probability of Developing Cancer, by Site, Women, US, 2001-2003*

Site	Risk
All sites†	1 in 3
Breast	1 in 8
Lung & bronchus	1 in 16
Colon & rectum	1 in 19
Uterine corpus	1 in 40
Non-Hodgkin lymphoma	1 in 55
Ovary	1 in 69
Melanoma	1 in 73
Pancreas	1 in 79
Urinary bladder‡	1 in 87
Uterine cervix	1 in 138

*** For those free of cancer at beginning of age interval. Based on cancer cases diagnosed during 2001 to 2003.**
† All Sites exclude basal and squamous cell skin cancers and in situ cancers except urinary bladder.
‡ Includes invasive and in situ cancer cases
Source: DevCan: Probability of Developing or Dying of Cancer Software, Version 6.1.1 Statistical Research and Applications Branch, NCI, 2006. http://srab.cancer.gov/devcan

Cancer Survival*(%) by Site and Race,1996-2002

Site	White	African American	% Difference
All Sites	68	57	11
Breast (female)	90	77	13
Colon	66	54	12
Esophagus	17	12	5
Leukemia	50	39	11
Non-Hodgkin lymphoma	64	56	8
Oral cavity	62	40	22
Prostate	100	98	2
Rectum	66	59	7
Urinary bladder	83	65	18
Uterine cervix	75	66	9
Uterine corpus	86	61	25

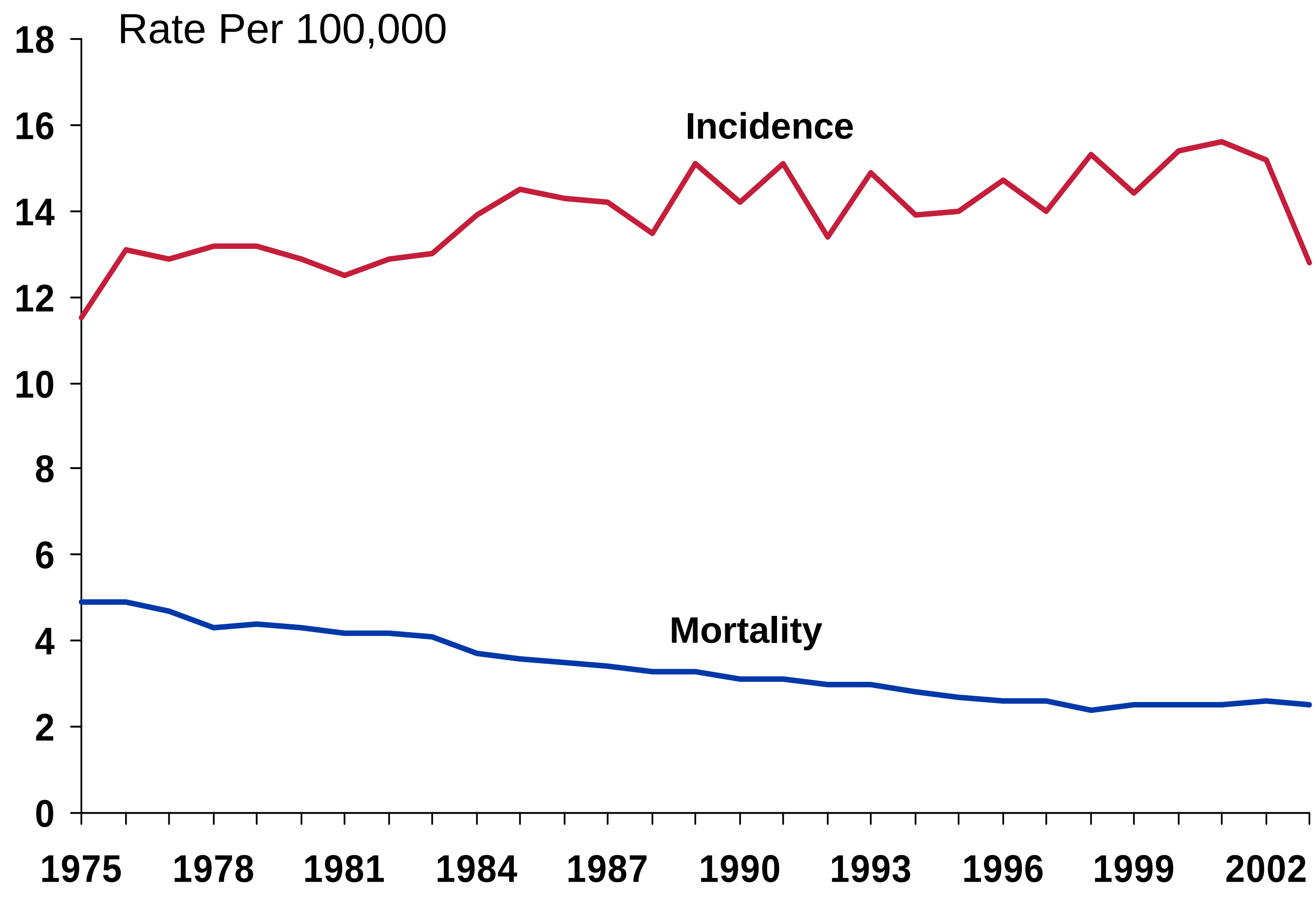
***5-year relative survival rates based on cancer patients diagnosed from 1996 to 2002 and followed through 2003. Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.**

Five-year Relative Survival (%)* during Three Time Periods By Cancer Site

Site	1975-1977	1984-1986	1996-2002
All sites	50	53	66
Breast (female)	75	79	89
Colon	51	59	65
Leukemia	35	42	49
Lung and bronchus	13	13	16
Melanoma	82	86	92
Non-Hodgkin lymphoma	48	53	63
Ovary	37	40	45 †
Pancreas	2	3	5
Prostate	69	76	100
Rectum	49	57	66
Urinary bladder	73	78	82

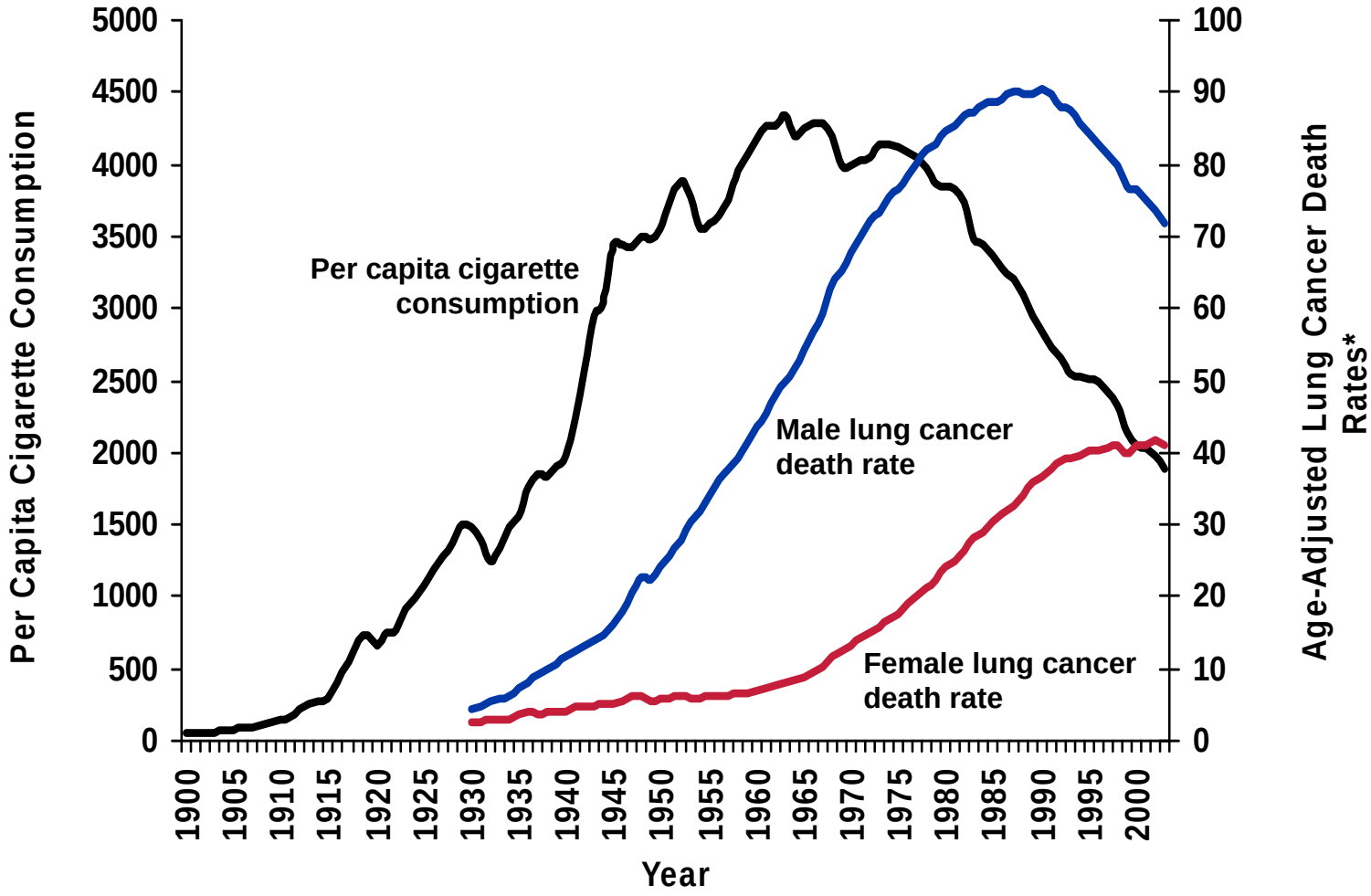
***5-year relative survival rates based on follow up of patients through 2003.**
†Recent changes in classification of ovarian cancer have affected 1996-2002 survival rates.
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Cancer Incidence & Death Rates* in Children 0-14 Years, 1975-2003



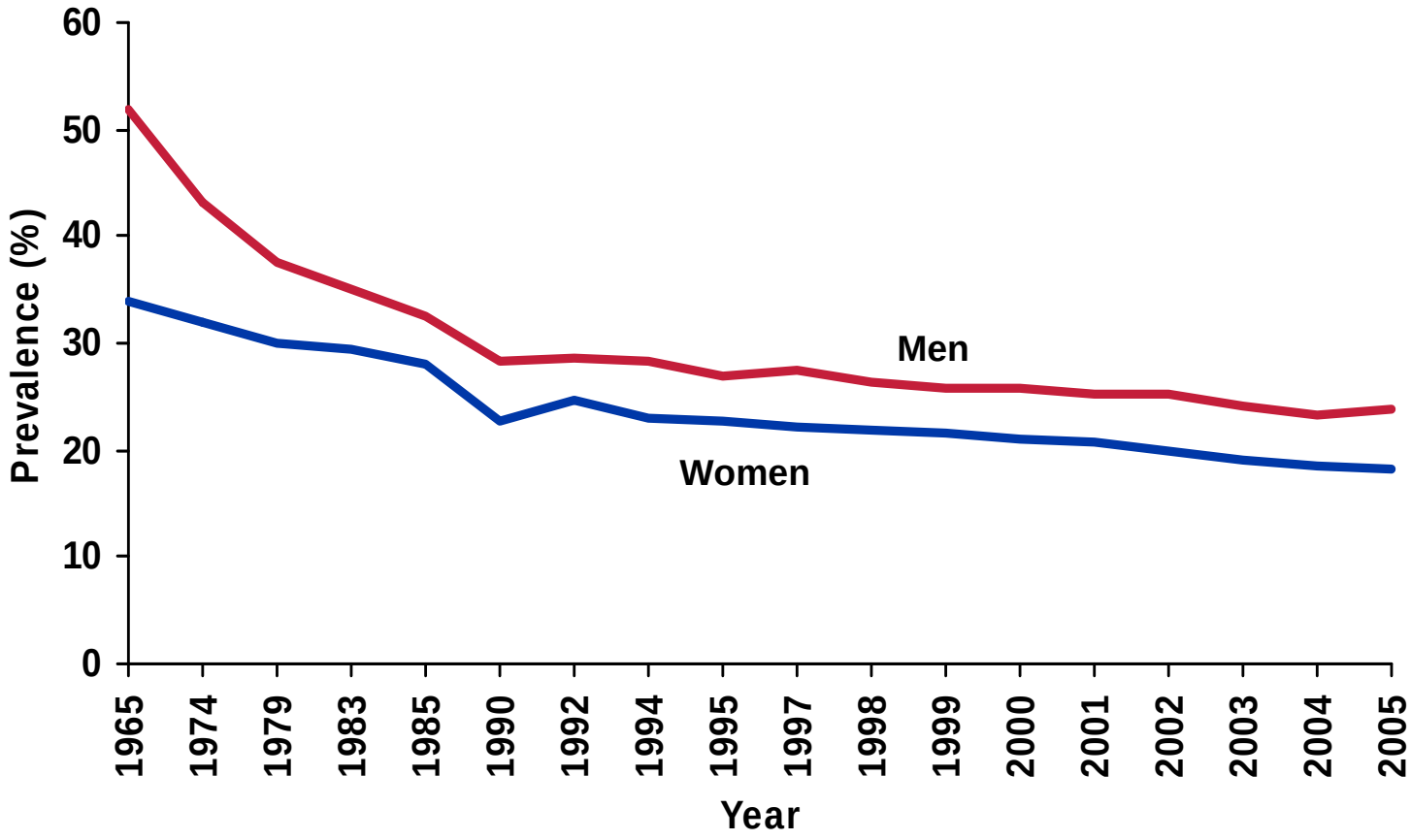
***Age-adjusted to the 2000 Standard population.**
Source: Surveillance, Epidemiology, and End Results Program, 1975-2003, Division of Cancer Control and Population Sciences, National Cancer Institute, 2006.

Tobacco Use in the US, 1900-2003



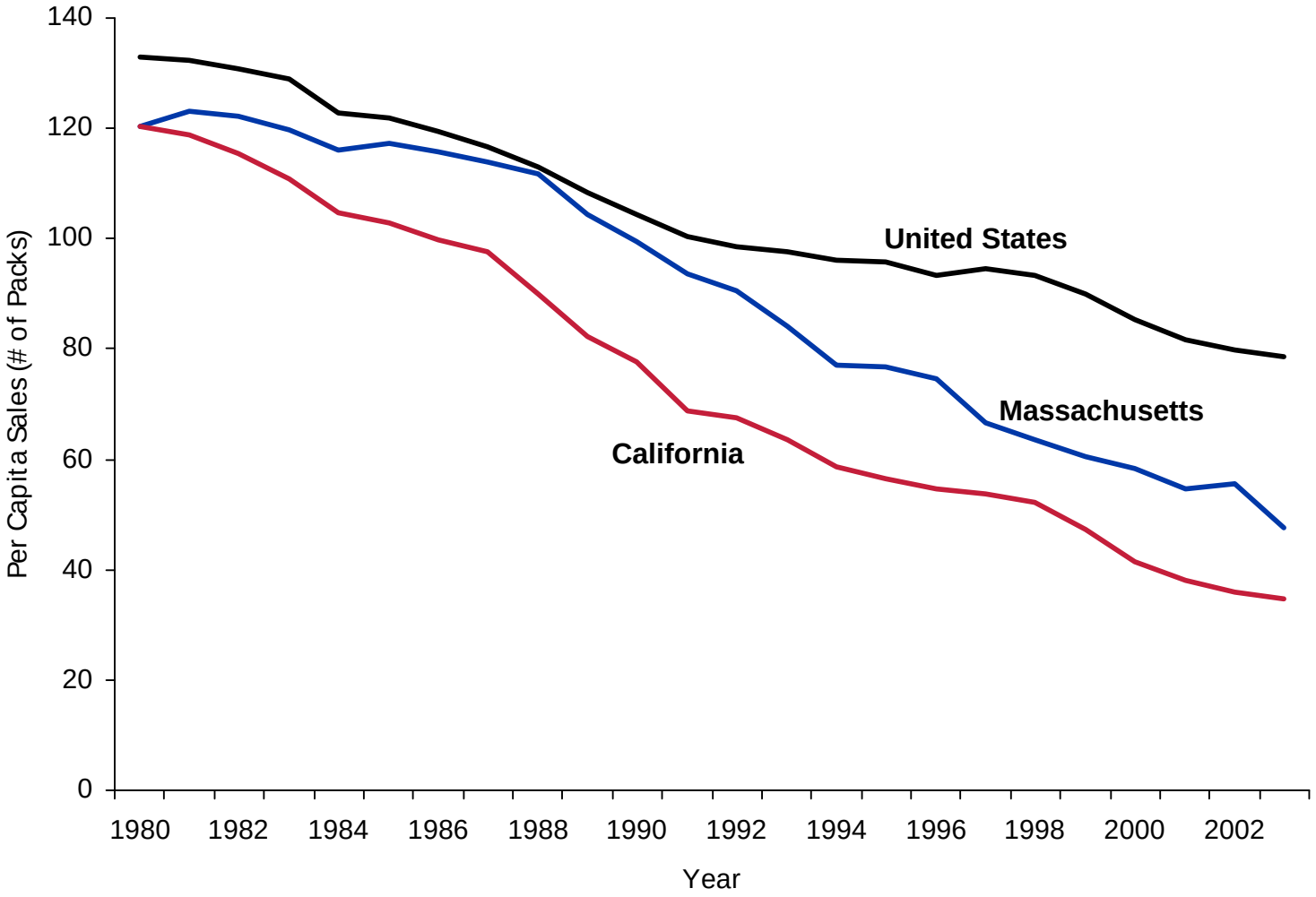
***Age-adjusted to 2000 US standard population.**
Source: Death rates: US Mortality Public Use Tapes, 1960-2003, US Mortality Volumes, 1930-1959, National Center for Health Statistics, Centers for Disease Control and Prevention, 2005. Cigarette consumption: US Department of Agriculture, 1900-2003.

Trends in Cigarette Smoking Prevalence* (%), by Gender, Adults 18 and Older, US, 1965-2005



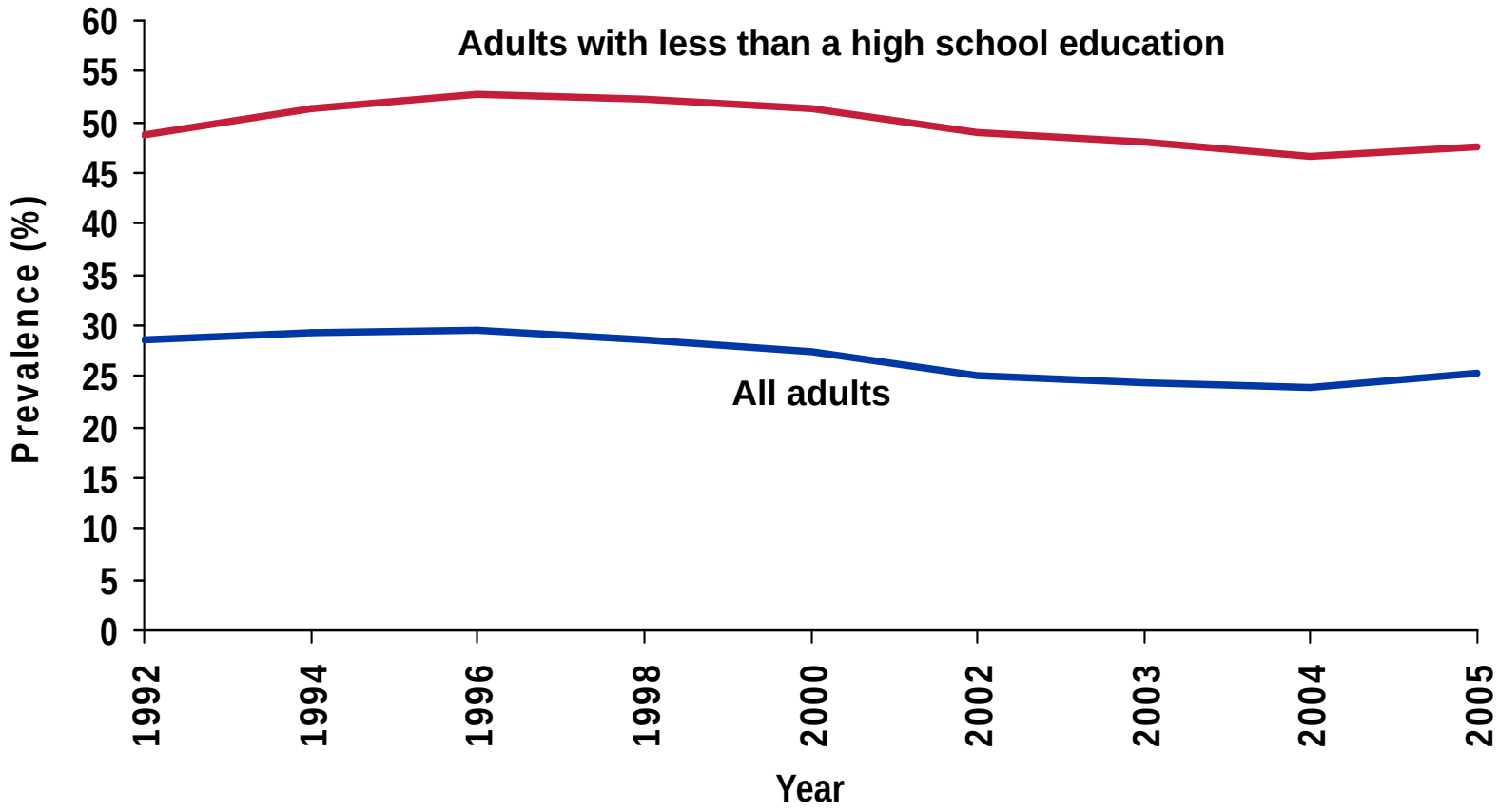
***Redesign of survey in 1997 may affect trends.**
Source: National Health Interview Survey, 1965-2005, National Center for Health Statistics, Centers for Disease Control and Prevention, 2006.

Trends in per capita cigarette consumption for selected states and the average consumption across all states, 1980-2003



Data from: Orzechowski W, Walker RC. The tax burden on tobacco: historical compilation 2003: Volume 36. Arlington (VA): Orzechowski and Walker; 2003.

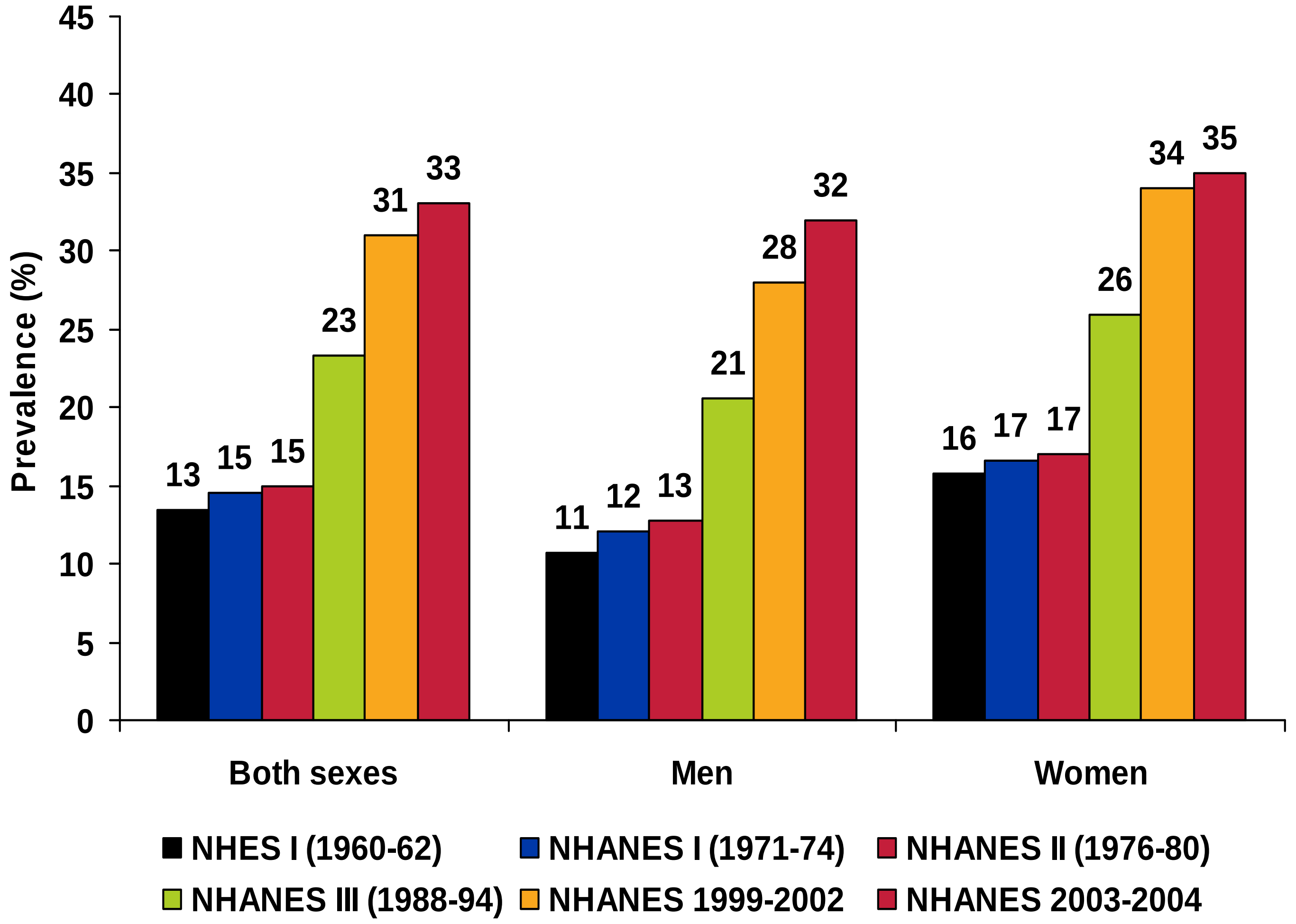
Trends in Prevalence (%) of No Leisure-Time Physical Activity, by Educational Attainment, Adults 18 and Older, US, 1992-2005



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.

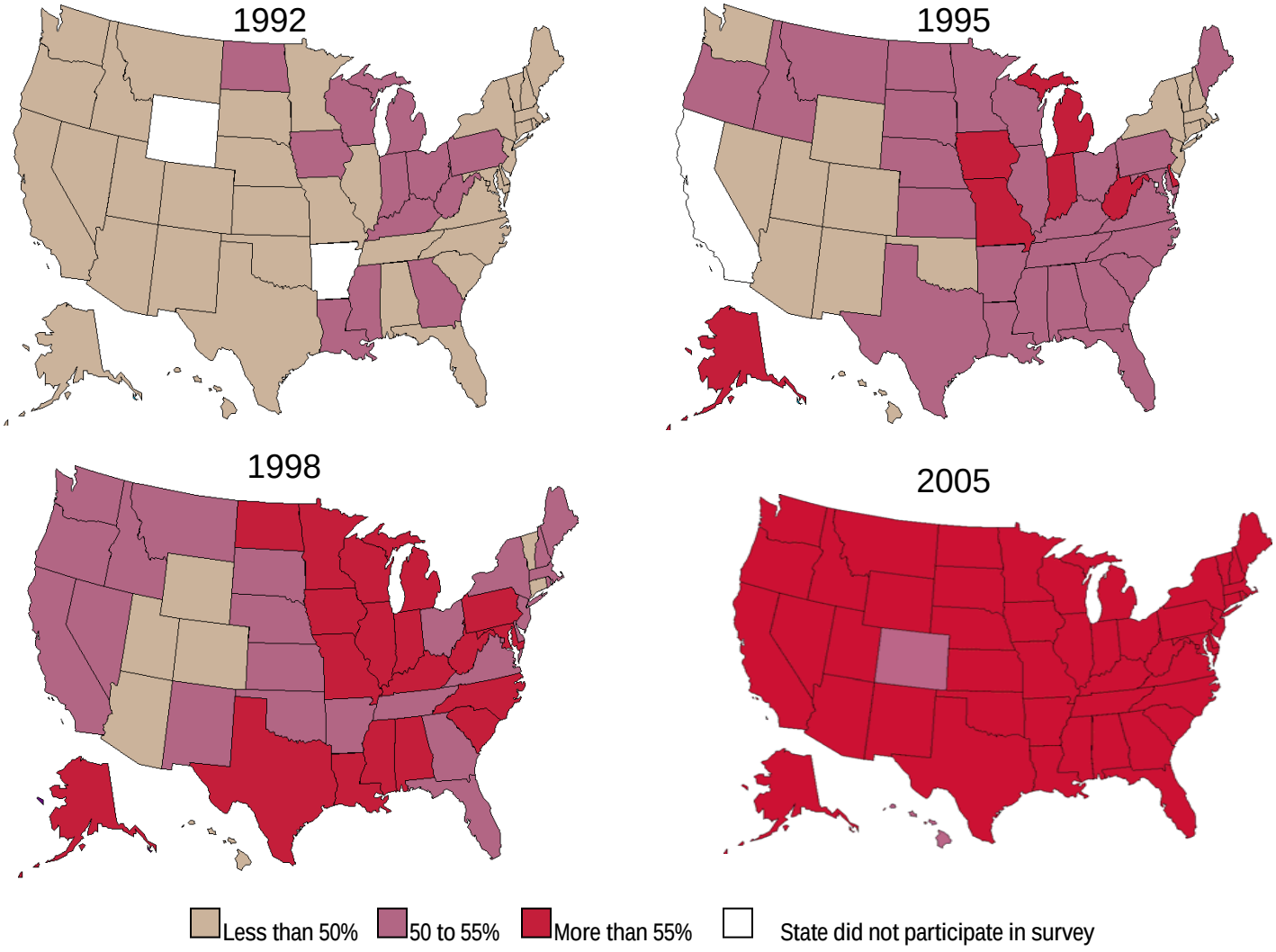
Source: Behavioral Risk Factor Surveillance System CD-ROM (1984-1995, 1996, 1998) and Public Use Data Tape (2000, 2002, 2004, 2005), National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 1997, 1999, 2000, 2001, 2003, 2005, 2006.

Trends in Obesity* Prevalence (%), By Gender, Adults Aged 20 to 74, US, 1960-2004†



***Obesity is defined as a body mass index of 30 kg/m^2 or greater. † Age adjusted to the 2000 US standard population. Source: National Health Examination Survey 1960-1962, 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, 2002, 2004. 2003-2004: National Health and Nutrition Examination Survey Public Use Data Files, 2003-2004, National Center for Health Statistics, Centers for Disease Control and Prevention, 2006.**

Trends in Overweight* Prevalence (%), Adults 18 and Older, US, 1992-2005



***Body mass index of 25.0 kg/m^{2}or greater. Source: Behavioral Risk Factor Surveillance System, CD-ROM (1984-1995, 1998) and Public Use Data Tape (2004, 2005), National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 1997, 2000, 2005, 2006.**