Lecture 02

Measuring Risk and Life Statistics

Acknowledgement

Most of the materials in this class have been
originally created and collected
by Prof. Jery Stedinger of Cornell University, USA.
We appreciate him for sharing his course materials.

Dimensions of Risk

Potency: How much needed to kill me?

Rate of Action: How fast does it kill you?

Exposure: How many people are exposed?
How much reaches me?

Total Social Impact: Total Deaths

Relative Social Impact: % deaths

Descriptions of Risk

- Additional cancer deaths/million exposed individuals/ lifetime
- Additional cancer deaths/year in US
- Expert rankings
- Fatalities per year (from different causes)
- Cigarettes needed to increase chance of death by 10^{-6} yr
- Expected change in days of life expectancy
- (from different activities and causes of death)
- Deaths/year with different travel modes
- Deaths per billion passenger miles for different modes
- Death rates (deaths/100,000 population)
- Odds of death (1 in 2,000 etc.)
- Infant death rate (deaths/ 1,000 births)
- % US total deaths from different causes

Increased Chance of Death by 10^{-6}/year

- Smoking 1.4 cigarettes (cancer, heart disease)
- Drinking 0.5 liter of wine (cirrhosis of the liver)
- Spending 1 hour in a coal mine (black lung)
- Traveling 6 minutes by canoe (accident)
- Eating 40 tablespoons of peanut butter (aflatoxin B)
- Drinking Miami water for a year (chloroform)
- Eating 100 char-broiled steaks (cancer)
- Living within 5 miles of a nuclear reactor for 50 years
- (accidental release of radiation)

- See Wilson article in *Readings in Risk*, p. 57:
- 0.00 00 01 = 10^{-6}= 1 in a million

Annual Risks of Death

Annual risks of death associated with some activities and exposures as compiled by E. Crouch and R. Wilson

Activity Exposure	Annual Risk (Deaths per 100,000 persons at risk)
Motorcycling	2000
All causes, all ages	1000
Smoking (all causes)	300
Smoking (cancer)	120
Fire fighting	80
Hand gliding	80
Coal Mining	63
Farming	36
Motor vehicles	24

Annual Risks of Death (con't)

• Rodeo performer	3
• Fires	2.8
• Chlorinated drinking water	0.8* (chemical by-products)
• 4 tbsp peanut butter per/day (aflatoxin)	0.8**
• 3 oz charcoal broiled steak/ day	0.5 (PAHs, Chapter 7)
• Floods	0.06
• Lightning	0.05
• Hit by meteorite	0.000006

- * Assumes water contains maximum level of by-product permitted by EPA; most
- water supplies contain less.

- ** Assumes aflatoxin present at maximum FDA-permitted level; most commercial brands
- contain much lower levels

- Source: Crouch and Wilson as cited by Slovic, P., 1986. Informing and educating the public about risk. Risk Analysis 6:403-15. Note: Risks from activities are actuarial and much more certain than those associated with chemical exposures, which are estimated using regulatory models. Risks of cancer are assumed to equate with risks of death. Lifetime risk will be about 70 times higher if risks do?

TOP 10 most dangerous jobs

RANK	OCCUPATION	FATALITY RATE*
1	Timber Cutters	117.8
2	Fishers	71.1
3	Pilots & Navigators	69.8
4	Structural Metal Workers	58.2
5	Driver-Sales Workers	37.9
6	Roofers	37.0
7	Electrical Power Installers	32.5
8	Farm Occupations	28.0
9	Construction Laborers	27.7
10	Truck Drivers	25.0

*Selected occupations had a minimum of 30 fatalities in 2002 and 45,000 employed.

Source: Bureau of Labor Statistics

Risks for lethal unintentional home hazards

Hazard	Deaths/ year in USA	Death Rate per 100, 000	Knowledge
1. Radon Gas	15,000	5.8	S
2. Falls	8,200	3.1	D
3. Poisoning	8,200	3.1	D
4. Fires and Burns	2,900	1.1	D
5. Suffocation	2,100	0.8	D
6. Firearm accidents	800	0.3	D
7. Env. Tobacco Smke	900	2.4	S
8. Formaldehyde Gas	400	1.3	P
9. Insulation Fibers	200	0.01	P

Knowledge S = suggestive D = Definite P = Plausible

Source J.L. DeAscentis, and J.D. Graham, Ranking Risks in the Home, *Risk in Perspective,* Harvard Center for Risk Analysis, April 1998

Measurements of Radiation Doses in Various Exams Offered at Gannett Health Center

Exam	mr/Exposure for average person at skin entrance
Hand/finger/wrist	2 - 6.25 mr
Elbow/forearm/heel/foot/ankle	19.93 mr
Chest	9.16 mr
Shoulder/Humerus/Femur	39.94 mr
Pelvis/Ribs/Abdomen/Spine	184.88 mr
Skull/Sinuses	39.90 mr

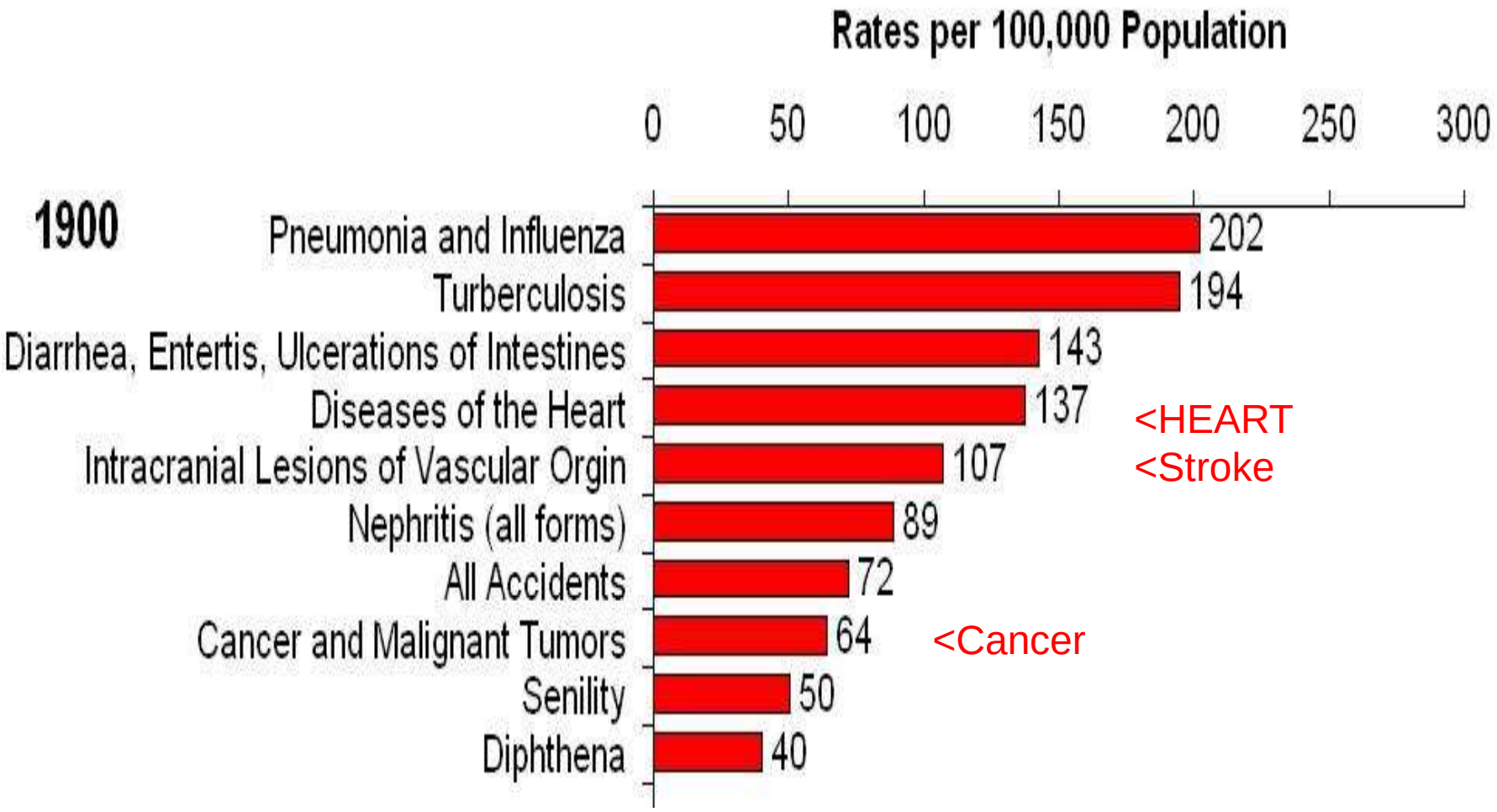
* Usually two or more exposures are necessary for each exposure

Risk Comparison

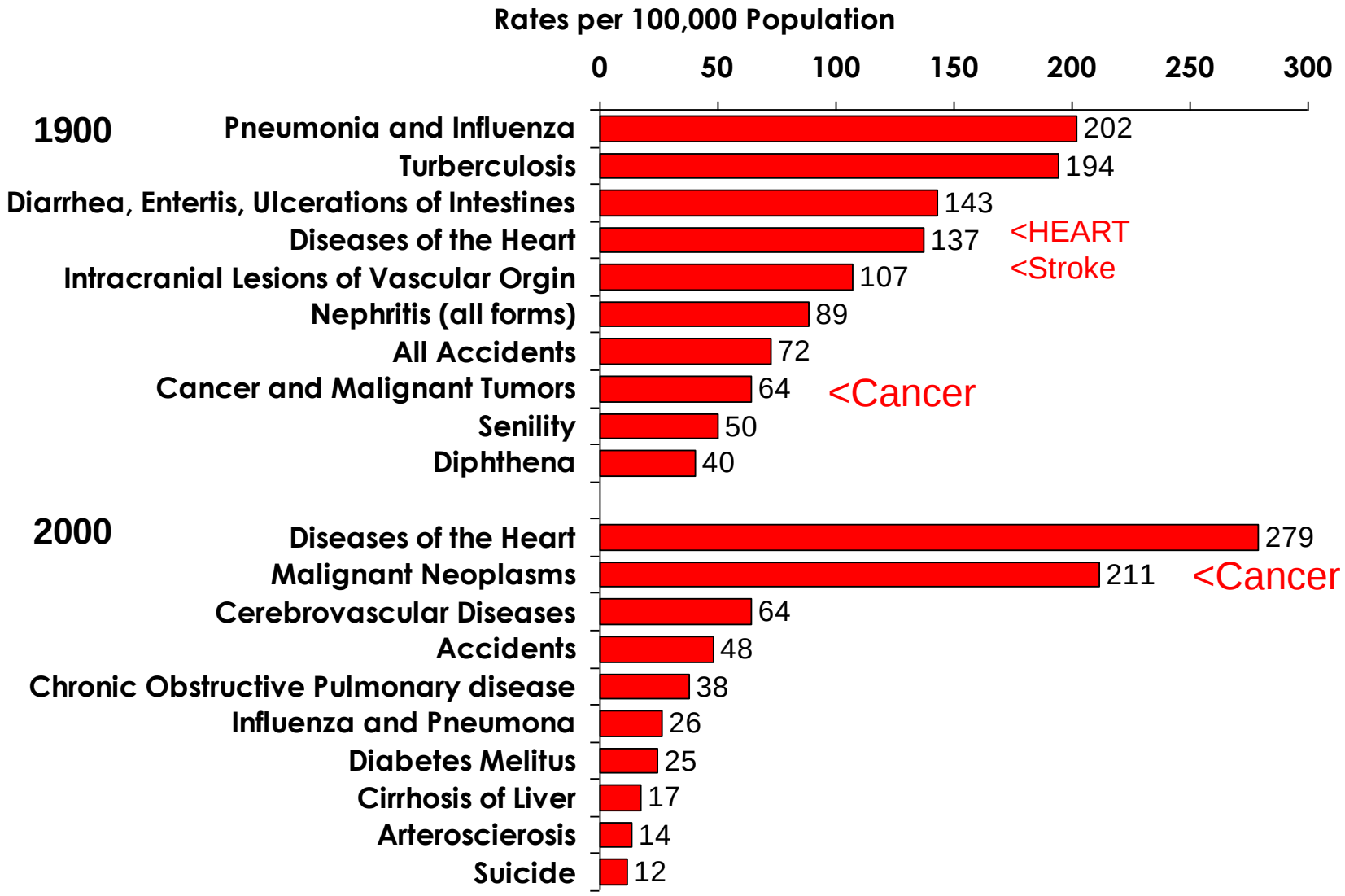
Risks	Loss in Life Expectancy
Smoking a cigarette	10 min.
Home accidents	95 days
Radiation, (1 mr)	1.5 min
Occupational exposure	1 day

* Taken from "Radiation Risks Associated with Diagnostic Radiology", by Joseph Whalen, M.D. and Stephen Balter, PhD.

Leading causes of death: 1900



Leading causes of death: 1900 & 2000



Risk Watch

Some Specific, Major Technological Advances of the 20th Century which contributed to Risk Reduction for the Cohort of 1907

Year of discovery, recognition or first use	Technological advance
1901*	X-rays for diagnosis
1910*	Salvarsan: beginning of modern drug therapy
1911*	Recognition of vitamins
1921*	Discovery of Insulin
1936*	Liver extract for pernicious anemia
1937*	1st Sulfa drug
1944*	Introduction of DDT
1945*	Penicillin, the 1st antibiotic
1945	1st Renal dialysis
1948*	Streptomycin, the 1st anti-TB drug
1949	Tetracycline, the 1st broad spectrum antibiotic
1952	1st practical antihypertensive drug
1953**	1st cardicac surgery for rheumatic heart disease
1955*	1st kidney transplant
1960	1st cardiac pacemaker implanted
1962	1st beta blocker drug for circulatory diseases
1970**	Coronary artery bypass surgery made practical
1975	Parenteral nutrition
1976*	Computer assisted tomography

* Nobel Prize for discovery

** Nobel Prize for critical background work

Cancer Now Top Killer of Americans Under 85

2005 Prediction: 1,500 Cancer Deaths Every Day

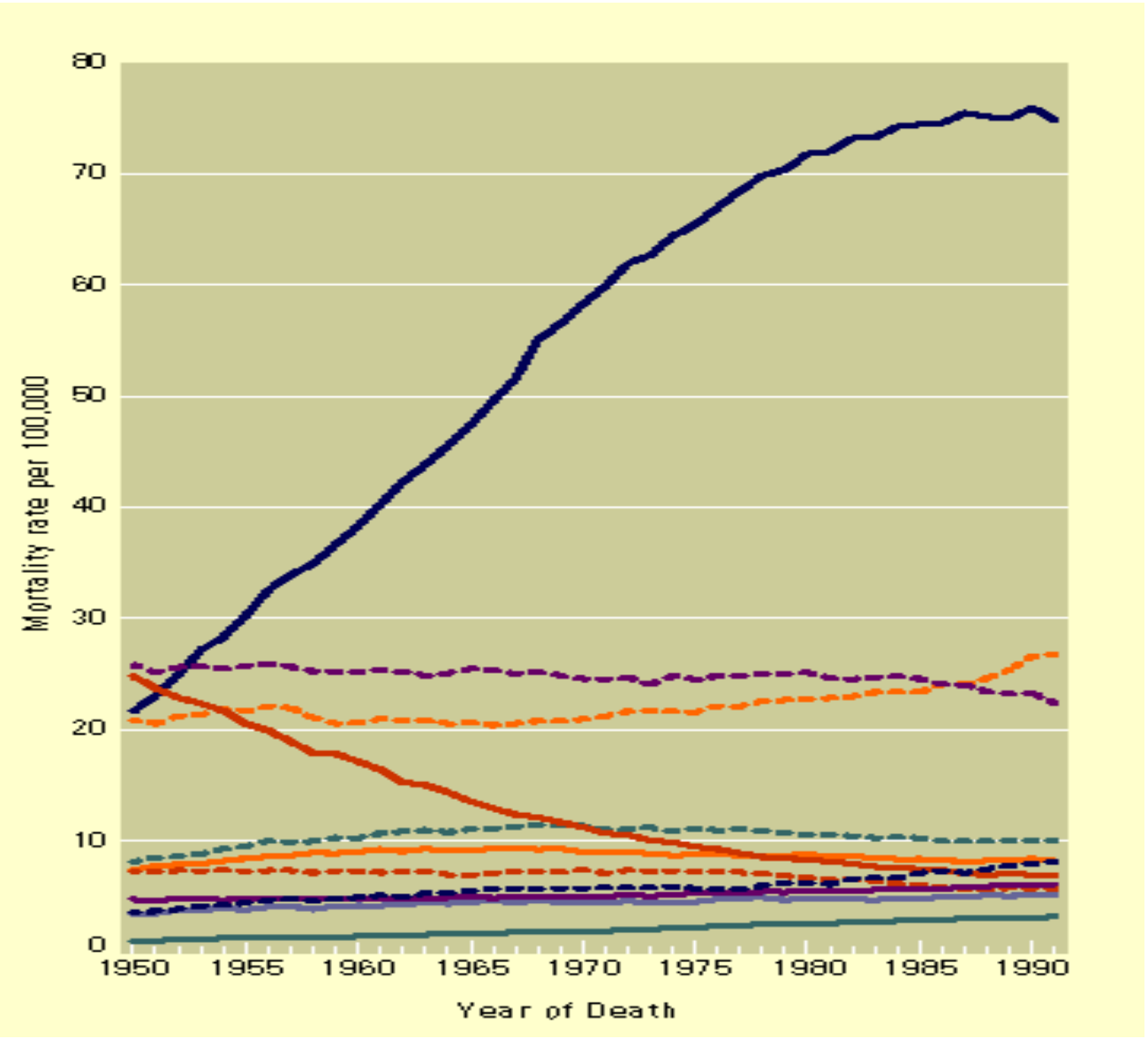
Jan. 19, 2005 -- Cancer has surpassed heart disease to become the leading cause of death in the U.S. in people under 85, according to new statistics released today by the American Cancer Society.

Despite cancer's spot as America's No. 1 cause of death among people under age 85, the overall U.S. cancer death rate actually has been going down. Why? More widespread cancer screening and better cancer treatment, says Elizabeth Ward, PhD, director of surveillance research for the American Cancer Society.

Heart disease is still the No. 1 killer of people 85 and over.

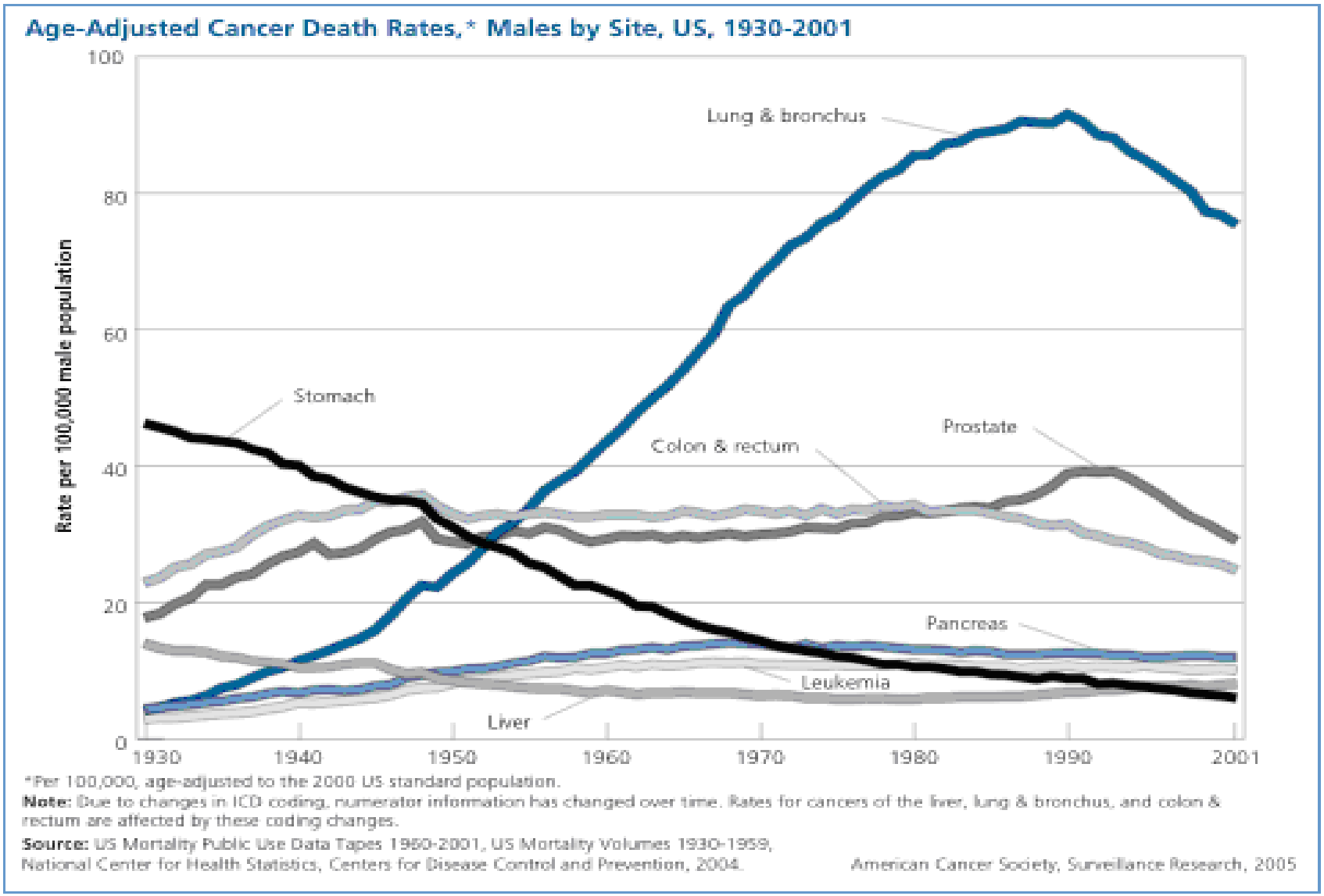
http://www.webmd.com/content/article/99/105264.htm

Cancer Death rates for males per 100, 000 1950 – 91, Age-adjusted to 1970

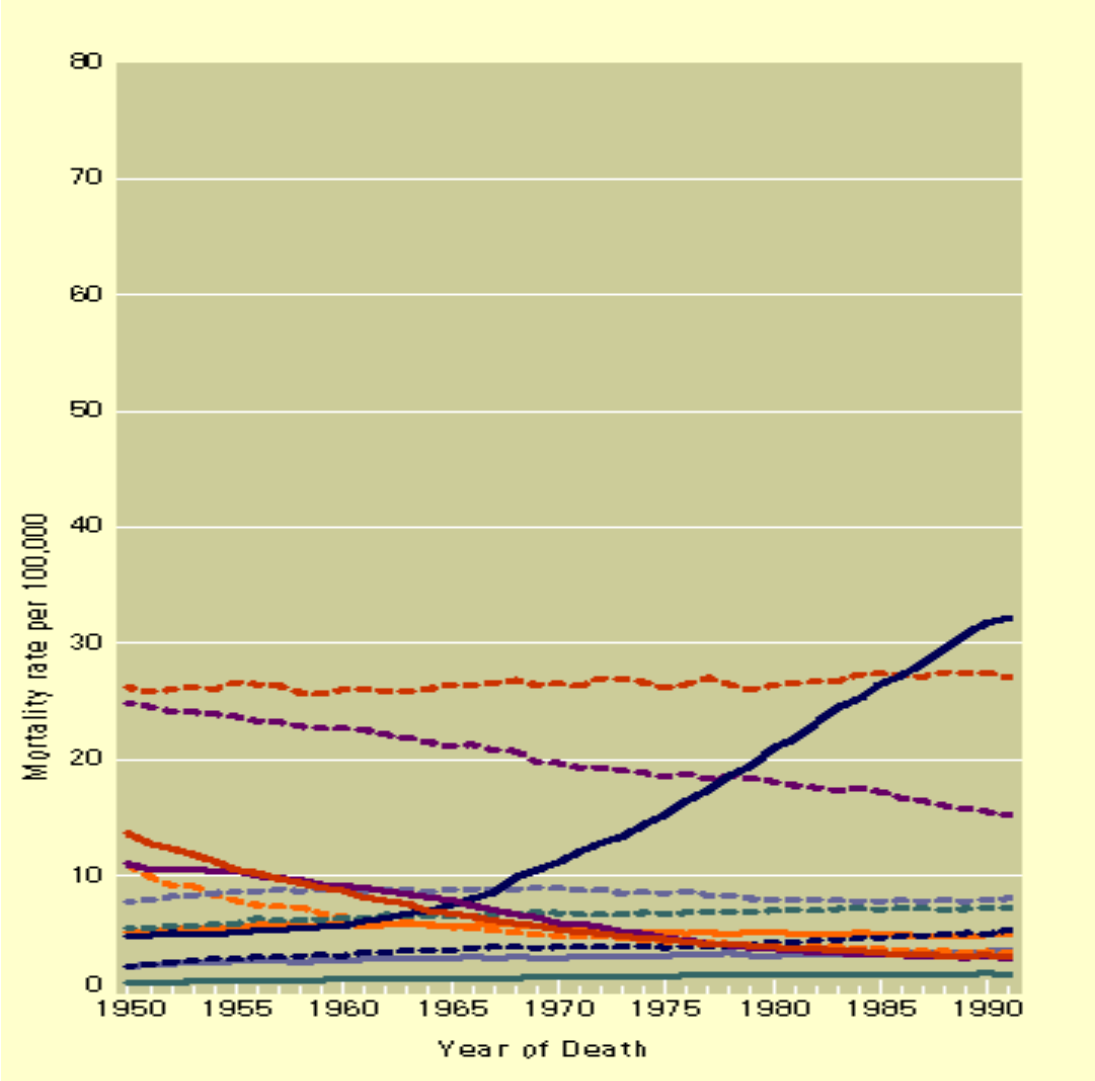


Lung Cancer is UP
Stomach cancer is DOWN.

Age Adjusted cancer death rates Males by Site, 1930 - 2001

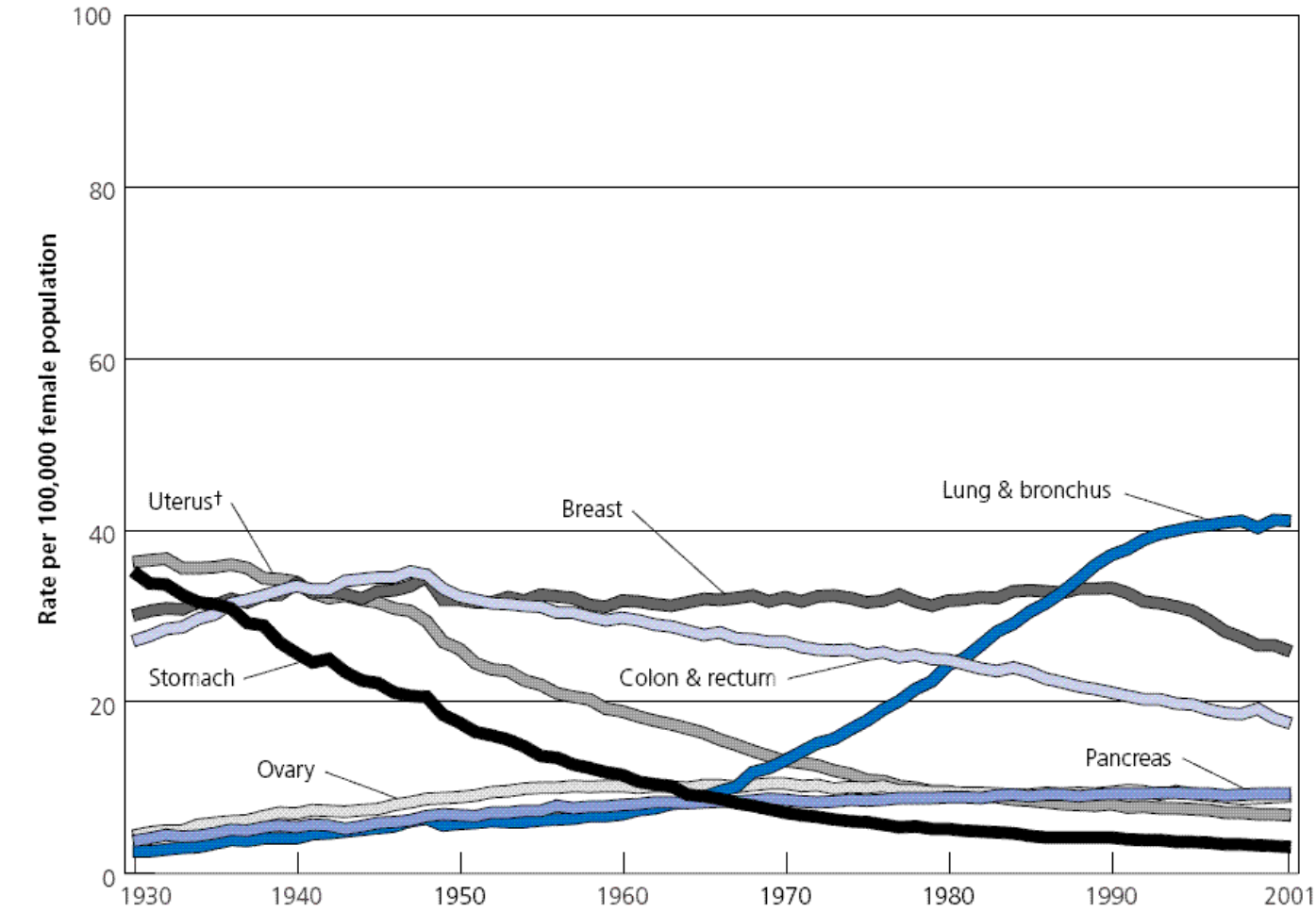


Cancer death rates for Females per 100, 000 for 1950 – 91, Age-adjusted to 1970



Lung Cancer going UP. Stomach, uterus, colon cancers are DOWN.

Age Adjusted cancer death rates* for selected sites females, united states, 1930 –



*Per 100,000, age-adjusted to the 2000 US standard population. †Uterus cancer death rates are for uterine cervix and uterine corpus combined.
Note: Due to changes in ICD coding, numerator information has changed over time. Rates for cancers of the lung & bronchus, colon & rectum, and ovary are affected by these coding changes.

Source: US Mortality Public Use Data Tapes 1960-2001, US Mortality Volumes 1930-1959, National Center for Health Statistics, Centers for Disease Control and Prevention, 2004.

American Cancer Society, Surveillance Research, 2005

Now lets look at the

current leading causes of death

in the United States.

Ten leading causes by race

Table E. Deaths and percentage of total deaths for the 10 leading causes of death, by race: United States, 2001

[Data for races other than white and black should be interpreted with caution because of misreporting of race on death certificates; see "Technical Notes." For explanation of asterisks preceding cause-of-death categories, see "Classification of terrorism-related deaths" in this report]

Cause of death (Based on the *International Classification of Diseases, Tenth Revision*, 1992)	White			Black			American Indian			Asian or Pacific Islander		
	Rank[1]	Deaths	Percent of total deaths	Rank[1]	Deaths	Percent of total deaths	Rank[1]	Deaths	Percent of total deaths	Rank[1]	Deaths	Percent of total deaths
All causes	...	2,079,691	100.0	...	287,709	100.0	...	11,977	100.0	...	37,048	100.0
Diseases of heart (I00–I09,I11,I13,I20–I51)	1	610,638	29.4	1	77,674	27.0	1	2,402	20.1	2	9,428	25.4
Malignant neoplasms (C00–C97)	2	479,651	23.1	2	62,170	21.6	2	2,155	18.0	1	9,792	26.4
Cerebrovascular diseases (I60–I69)	3	140,465	6.8	3	19,002	6.6	5	574	4.8	3	3,497	9.4
Chronic lower respiratory diseases (J40–J47)	4	113,819	5.5	8	7,589	2.6	7	427	3.6	6	1,178	3.2
Accidents (unintentional injuries) (V01–X59,Y85–Y86)	5	85,964	4.1	4	12,462	4.3	3	1,361	11.4	4	1,750	4.7
Diabetes mellitus (E10–E14)	6	57,180	2.7	5	12,305	4.3	4	644	5.4	5	1,243	3.4
Influenza and pneumonia (J10–J18)	7	54,774	2.6	11	5,771	2.0	9	318	2.7	7	1,171	3.2
Alzheimer's disease (G30)	8	50,348	2.4	14	3,114	1.1	15	93	0.8	15	297	0.8
Nephritis, nephrotic syndrome and nephrosis (N00–N07,N17–N19,N25–N27)	9	31,345	1.5	9	7,274	2.5	10	236	2.0	9	625	1.7
Intentional self-harm (suicide) (*U03,X60–X84,Y87.0)	10	27,710	1.3	16	1,957	0.7	8	321	2.7	8	634	1.7
Septicemia (A40–A41)	11	25,806	1.2	10	5,880	2.0	12	155	1.3	11	397	1.1
Chronic liver disease and cirrhosis (K70,K73–K74)	12	23,408	1.1	15	2,775	1.0	6	533	4.5	14	319	0.9
Assault (homicide) (*U01–*U02,X85–Y09,Y87.1)	19	11,328	0.5	6	8,226	2.9	11	211	1.8	10	543	1.5
Human immunodeficiency virus (HIV) disease (B20–B24)	22	6,171	0.3	7	7,844	2.7	16	74	0.6	24	86	0.2

... Category not applicable.

[1]Rank based on number of deaths.

Numbers of Deaths in US by sex (in thousands; Year 2000)

	Total	Male	Female
Diseases of the Heart	710	345	366
Malignant Neoplasms (cancer	553	286	267
Cerebrovascular Disease (Strol	167	65	102
Other heart disease and hyper	183	79	104
Chronic lower respiratory disec	122	60	62
Accidents, all types	98	64	34
Motor Vehicle	43	29	14
Other	55	35	20
Diabetes mellitus	69	32	38
Pneumonia and Influenza	65	27	37
Alzheimer's disease	50	14	35
Suicide	29	24	6
Chronic Liver disease, cirrhosis	27	17	9
Homocide and legal interventi	17	13	4
Nephritis, Nephrosis, Septicemi	68	31	37
Other	246	121	125
Total	2,403	1,178	1,226

Death Rate in US by sex and total (per 100,000 population; Year 2000)

	Total		Male	Female
Diseases of the Heart	258		256	260
Malignant Neoplasms (cancer)	201		213	190
Cerebrovascular Disease (Stroke)	61		48	72
Other heart disease and hypertension	66		59	74
Chronic lower respiratory diseases	44		45	44
Accidents, all types	36		48	24
Motor Vehicle		16	22	10
Other		20	26	14
Diabetes mellitus	25		24	27
Pneumonia and Influenza	24		20	26
Alzheimer's disease	18		10	25
Suicide	11		18	4
Chronic Liver disease, cirrhosis	10		13	7
Homocide and legal intervention	6		10	3
Nephritis, Nephrosis, Septicemia	25		23	26
Other	89		90	89
Total	873		875	871

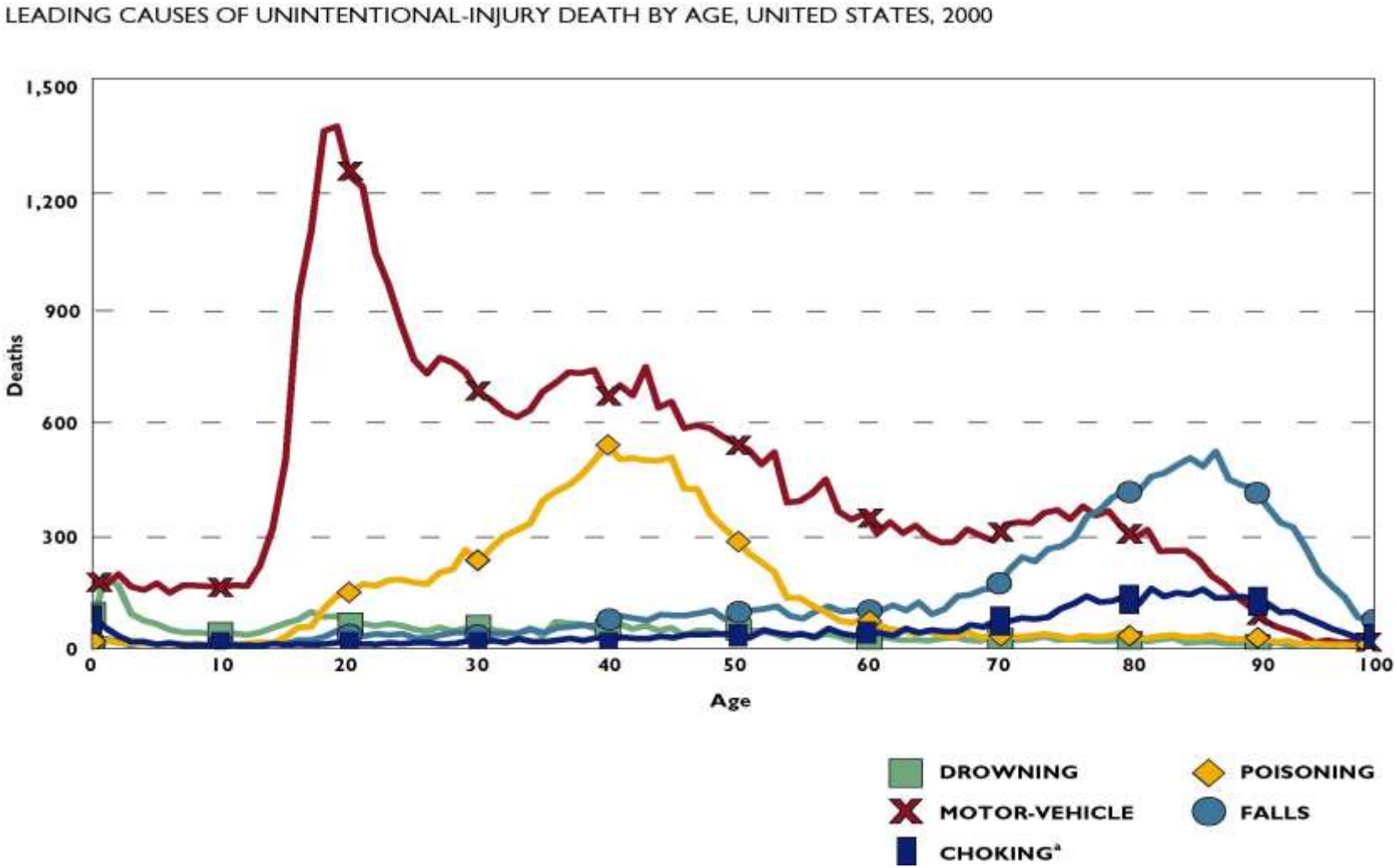
US Deaths as a percentage by sex and total (Year 2000)

	Total	Male	Female
Diseases of the Heart	30	29	30
Malignant Neoplasms (cancer)	23	24	22
Cerebrovascular Disease (Stroke)	7	6	8
Other heart disease and hypertension	8	7	8
Chronic lower respiratory diseases	5	5	5
Accidents, all types	4	5	3
Motor Vehicle	2	2	1
Other	2	3	2
Diabetes mellitus	3	3	3
Pneumonia and Influenza	3	2	3
Alzheimer's disease	2	1	3
Suicide	1	2	0
Chronic Liver disease, cirrhosis	1	1	1
Homocide and legal intervention	1	1	0
Nephritis, Nephrosis, Septicemia	3	3	3
Other	10	10	10
Total	100	100	100

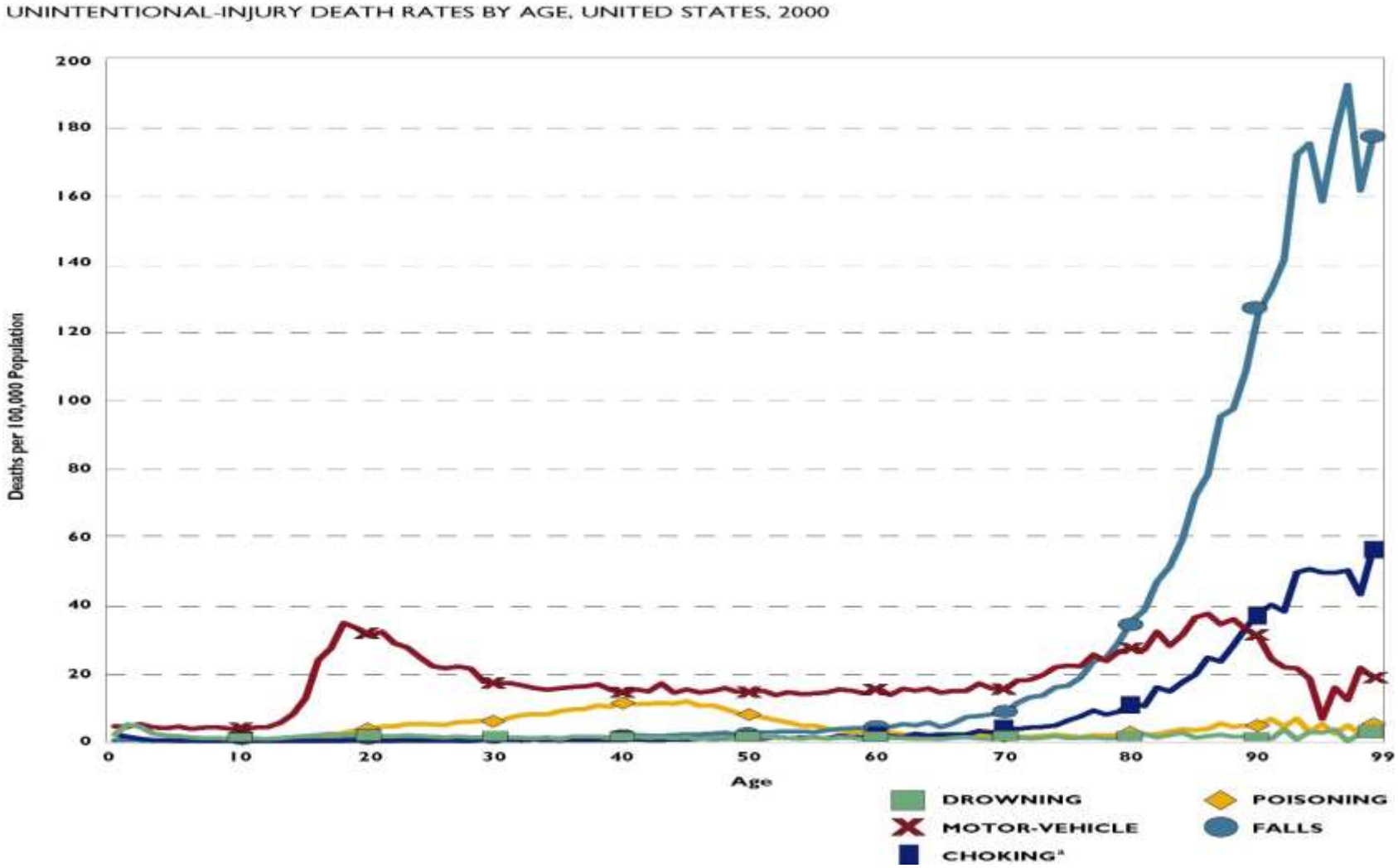
US Death statistics: total, rate, percent
(Year 2000)

	Total Deaths (Thousands)	Rate (per 100,000)	Percent of Total
Diseases of the Heart	710	258	30
Malignant Neoplasms (cancer)	553	201	23
Cerebrovascular Disease (Stroke)	167	61	7
Other heart disease and hypertension	183	79	104
Chronic lower respiratory diseases	122	44	5
Accidents, all types	98	36	4
Motor Vehicle	43	16	2
Other	55	20	2
Diabetes mellitus	69	25	3
Pneumonia and Influenza	65	24	3
Alzheimer's disease	50	18	2
Suicide	29	11	1
Chronic Liver disease, cirrhosis	27	10	1
Homocide and legal intervention	17	6	1
Nephritis, Nephrosis, Septicemia	68	25	3
Other	246	89	10
Total	2,403	873	100

Leading causes of Unintentional Injury Death by Age, United States, 2000



Unintentional Injury Death Rates by Age United States 2000



How should risk be described?

Which statistic
best describes the true risk?

Alternative Measures of Risk

Criterion	Points Out	Ignores
Total US deaths/year	total social impact	exposure
% US deaths/year	relative social impact importance relative to what else is happening	exposure
Deaths/100,000	potency: death rate absolute rate: can compare across time and cultures	exposure; other risks
Δ life expectancy	impact on expected life = potency * rate of action	total social impact

Alternative Measures of Risk - 2

Criterion	Points out	Ignores
minutes-of-life-loss	impact on expected life	total social impact
.	= potency*RateOfAction	.
deaths per mile	potency	exposure, Total Social Impact
.	.	
amount to increase	potency rate of action	total social impact
.	.	.
LD50	potency	exposure
(dose kills 50% animals)	.	.
Cigarettes smoked / wk	exposure	everything else
Life expectency after HIV infection	rate of action	social impact

Lessons …

There are many ways to present death risks.
Some are clearer. They emphasize different things.

Results can be presented so they are meaningless and misleading, or they are useful.

Coronary Heart Disease
National Mortality Rates (Deaths/ 1000)

FIGURE 2

RELATIONSHIP BETWEEN I.H.D. MORTALITY RATE IN MEN AGED 55–64 AND WINE CONSUMPTION.

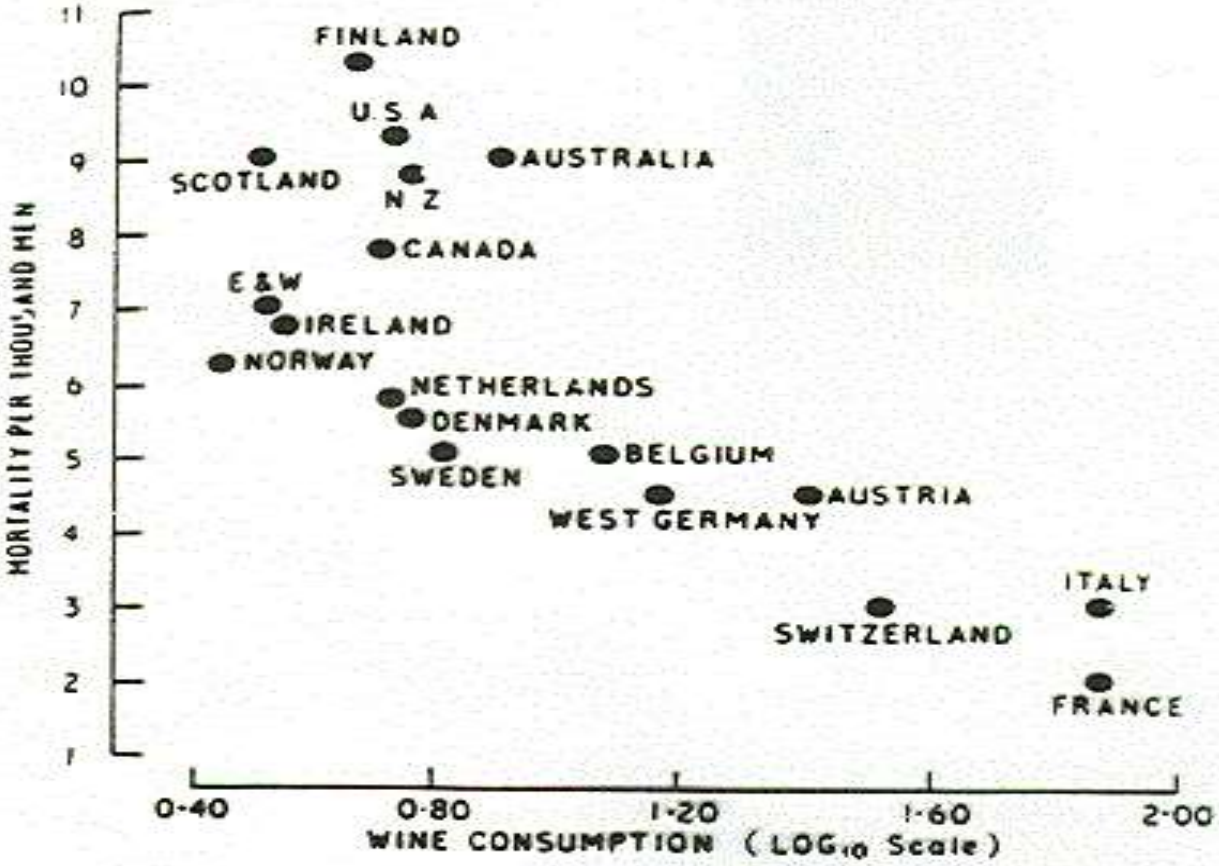


Figure 2. Inverse correlation between per capita wine consumption and the rate of deaths due to coronary heart disease. (Source: Note 8. Reproduced with permission.)