Basic Public Health and Epidemiology

Objectives:

1. **Learn basic concepts of public health / epidemiology**
2. **Begin to think quantitatively**
3. **Understand how causes of disease are identified**
4. **Learn examples of how prevention works**
5. **Consider the application of prevention science to Africa**

Key Concepts in Public Health

1. **Natural populations are the target.**
2. **Surveillance systems provide information.**
3. **Public health infrastructure links institutions that gather, disseminate and act on surveillance information.**
4. **Communities are mobilized.**
5. **Health and disease are the result of *social processes*.**

Rudolf Virchow said . . . . . (1845)

Mass disease means society is out of joint.

Ottawa Charter
WHO

The fundamental conditions and resources for health are:

Peace
Shelter
Education
Food
Income
A stable eco-system
Sustainable resources
Social justice
Equity

Public health is the science of protecting and improving the health of communities through education, promotion of healthy lifestyles, and research for disease and injury prevention.

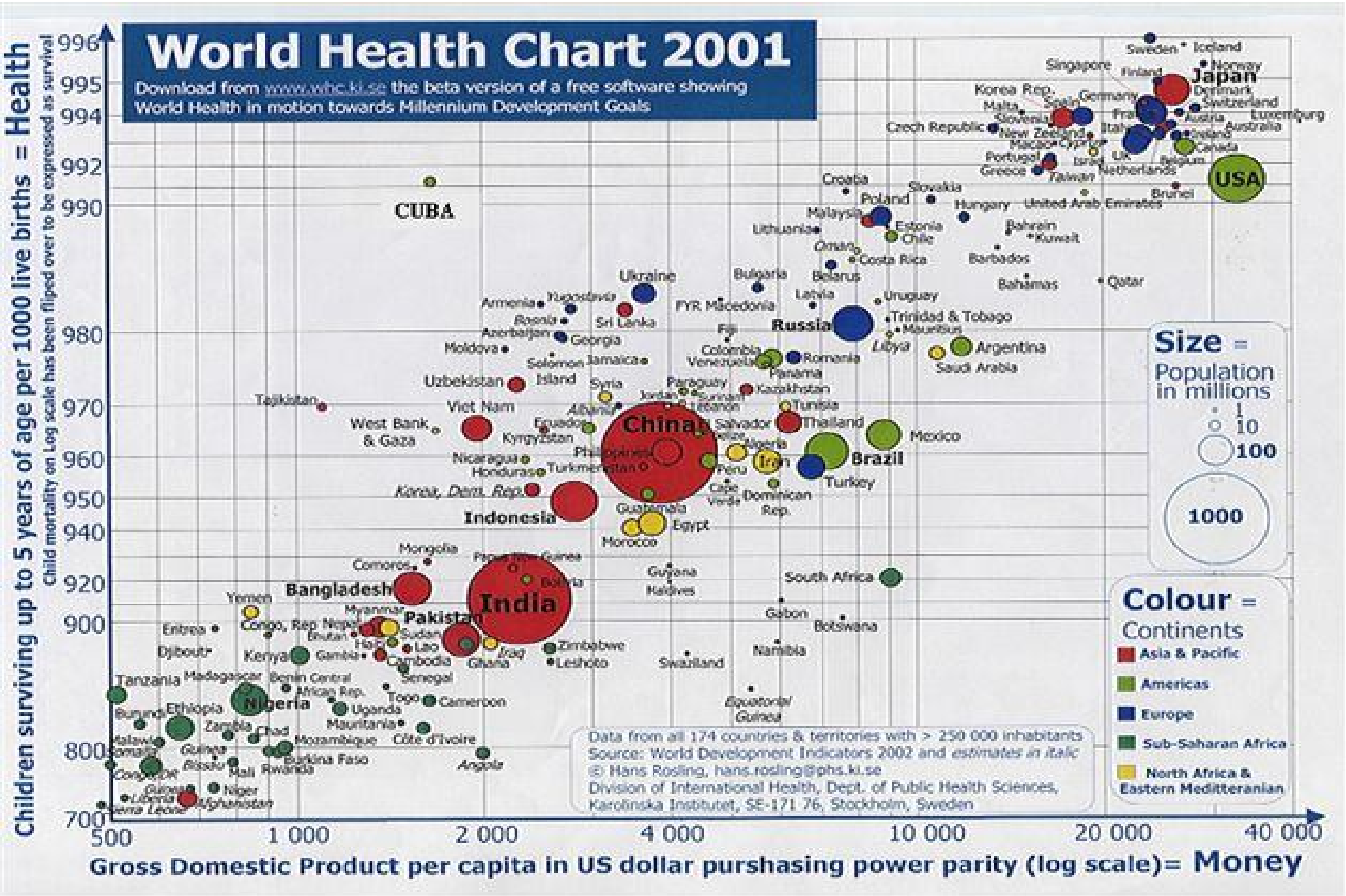
Public health involves the application of many different disciplines including:

- biology sociology mathematics anthropology public policy medicine education psychology computer science business engineering and much, much more . . . .

- Public health is concerned with protecting the health of entire populations.

- These populations can be as small as a local neighborhood, or as big as an entire country.

- Public health professionals try to prevent problems from happening or re-occurring through **implementing educational programs, developing policies, administering services, and conducting research**, in contrast to clinical professional, such as doctors and nurses, who focus primarily on treating individuals after they become sick or injured.


World Health Chart 2001
Download from www.whc.ki.se the beta version of a free software showing World Health in motion towards Millennium Development Goals
Children surviving up to 5 years of age per 1000 live births = Health
Child mortality on Log scale has been fliped over to be expressed as survival
996
995
994
992
990
980
970
960
950
940
920
900
800
700
500
1 000
2 000
4 000
10 000
20 000
40 000
Gross Domestic Product per capita in US dollar purshasing power parity (log scale)= Money
CUBA
China
India
Indonesia
Bangladesh
Pakistan
Nigeria
Russia
Japan
USA
Brazil
Mexico
Thailand
Argentina
Size = Population in millions
1
10
100
1000
Colour = Continents
Asia & Pacific
Americas
Europe
Sub-Saharan Africa
North Africa & Eastern Mediterranean
Data from all 174 countries & territories with > 250 000 inhabitants
Source: World Development Indicators 2002 and estimates in italic
© Hans Rosling, hans.rosling@phs.ki.se
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What is Epidemiology?

Classic definition: Study of the distribution and determinants of disease in populations.

Also: Study of outcomes and effectiveness of medical interventions. In its technical application epidemiology relies heavily on statistics.

"Science and medicine have different ends. The intellectual foundation for medicine lies not in basic science but in epidemiology. The epidemiological setting provides the proper ground on which debates about the applicability of research evidence to practice should take place."

Lancet, 1995

Key Concepts in Epidemiology

Epidemiology has Two Branches:

1. Observational Studies-

   Including - cross-sectional, case series, case-control, prospective (cohort) studies

2. Interventional Studies-

   Randomized controlled trials; individuals or communities

Some Basic Vocabulary :

Measures of occurrence: Prevalence Incidence

Measures of risk: Relative risk Odds Ratio Attributable Risk

Age adjustment

Learning to think quantitatively . . . . .

Mathematics is the language of science.

John Snow's Investigation of Cholera Deaths, London, 1854

Water Supply	Number of Houses	Deaths	Deaths per 10,000 Houses
Southwark & Vauxhall Co.	40,046	1,263	315
Lambeth Co.	26,107	98	37
Rest of London	256,423	1,422	59

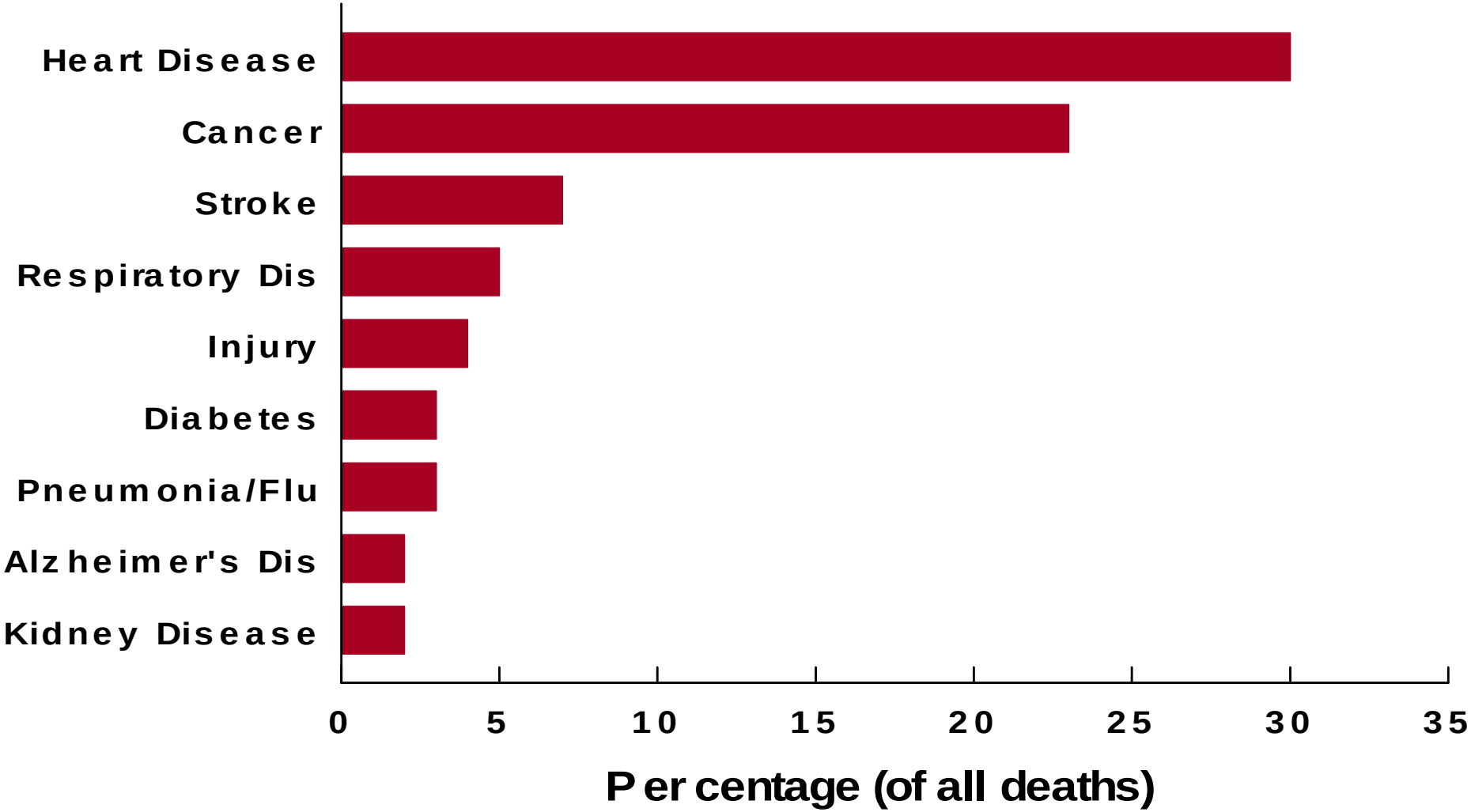
John Snow’s Cholera Map, London, 1854

Vital Statistics Measures

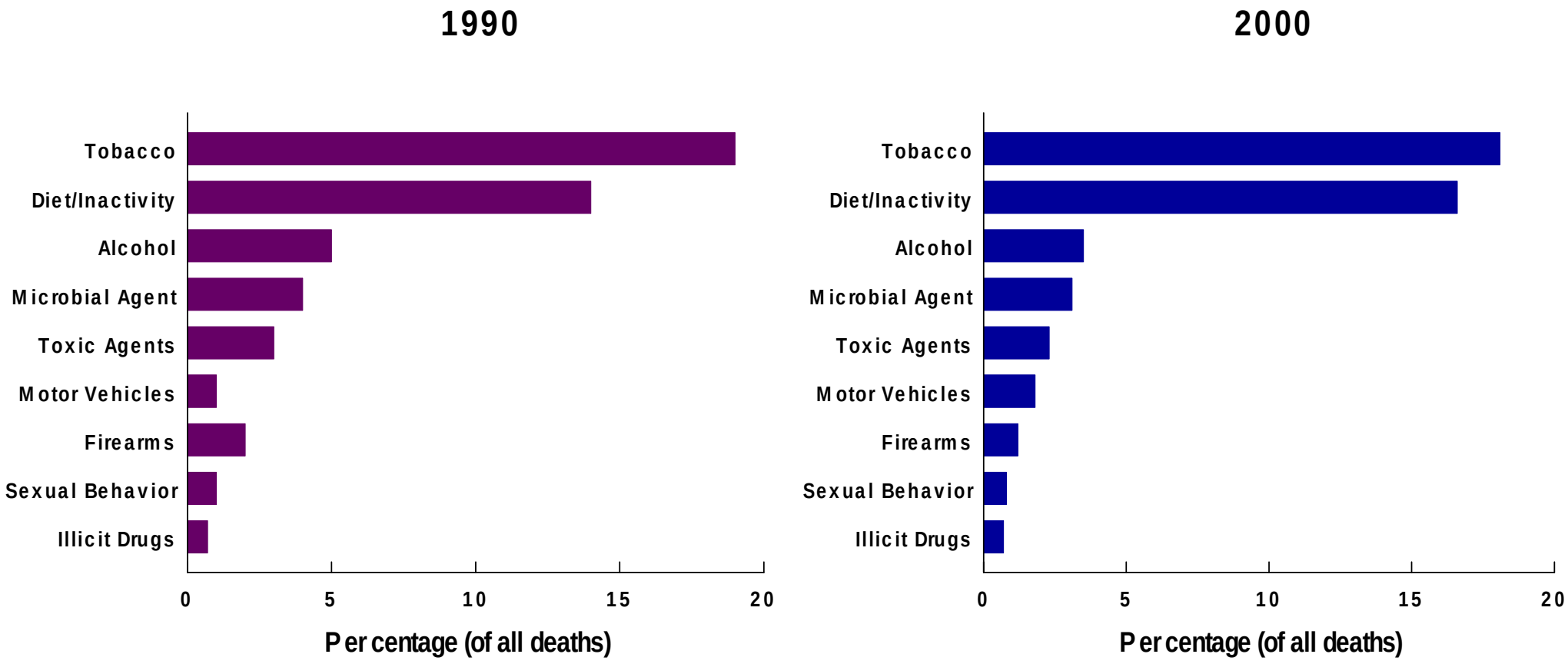
	Numerator (Events)	Denominator (Pop. at risk)
Birth rate	Live Births	Midyear pop.
Crude death rate	Deaths	Midyear pop.
Infant mortality rate	Deaths before age 1	Live Births in the year
Age-specific mortality	Deaths for a specific age group	Pop. in age group
Age-adjusted mortality		Crude rate adjusted to a standard pop.

Leading Causes of Death in US, 2000

Centers for Disease Control & Prevention

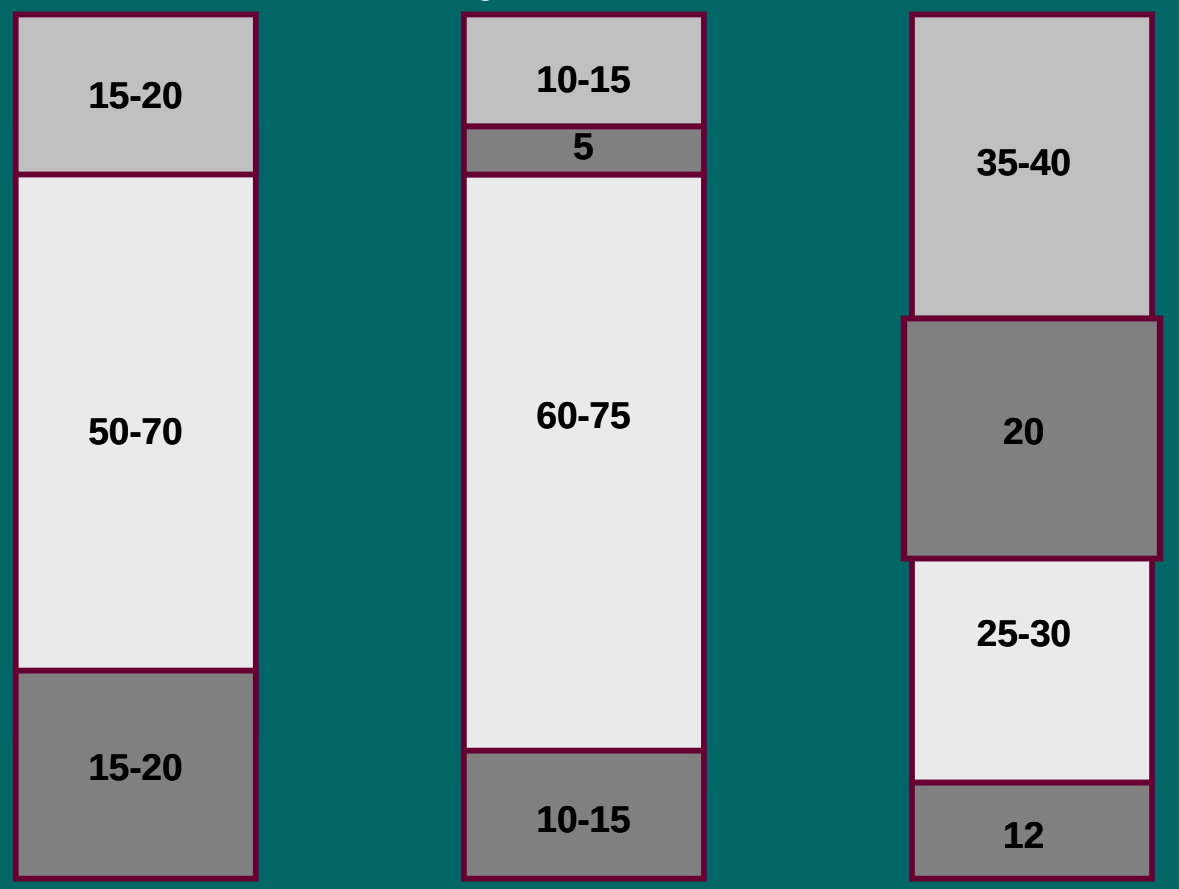


Actual Causes of Death in the US, 1990 & 2000



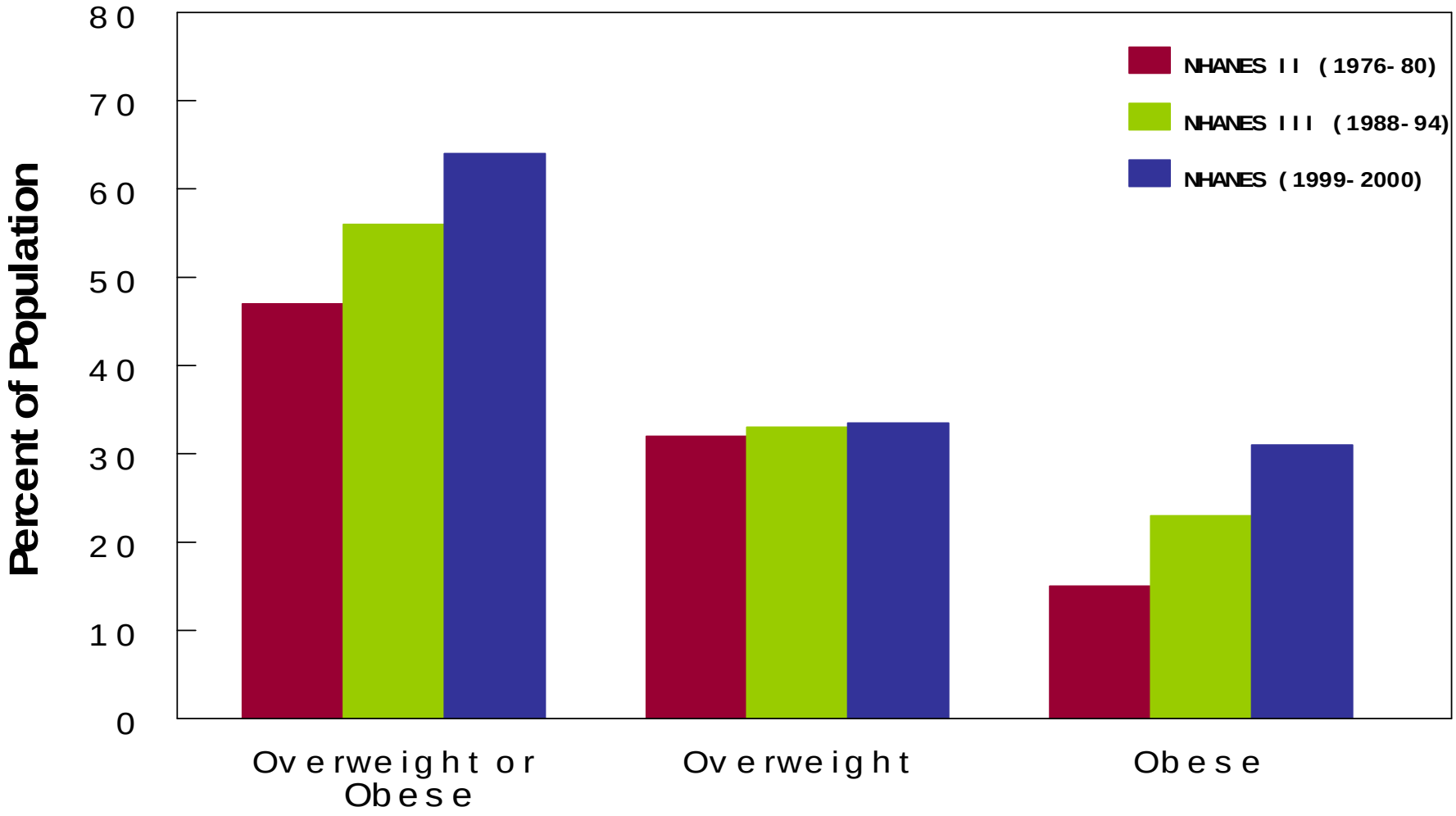
www.cdc.gov, 2004

Percent of Energy from Different Food Components



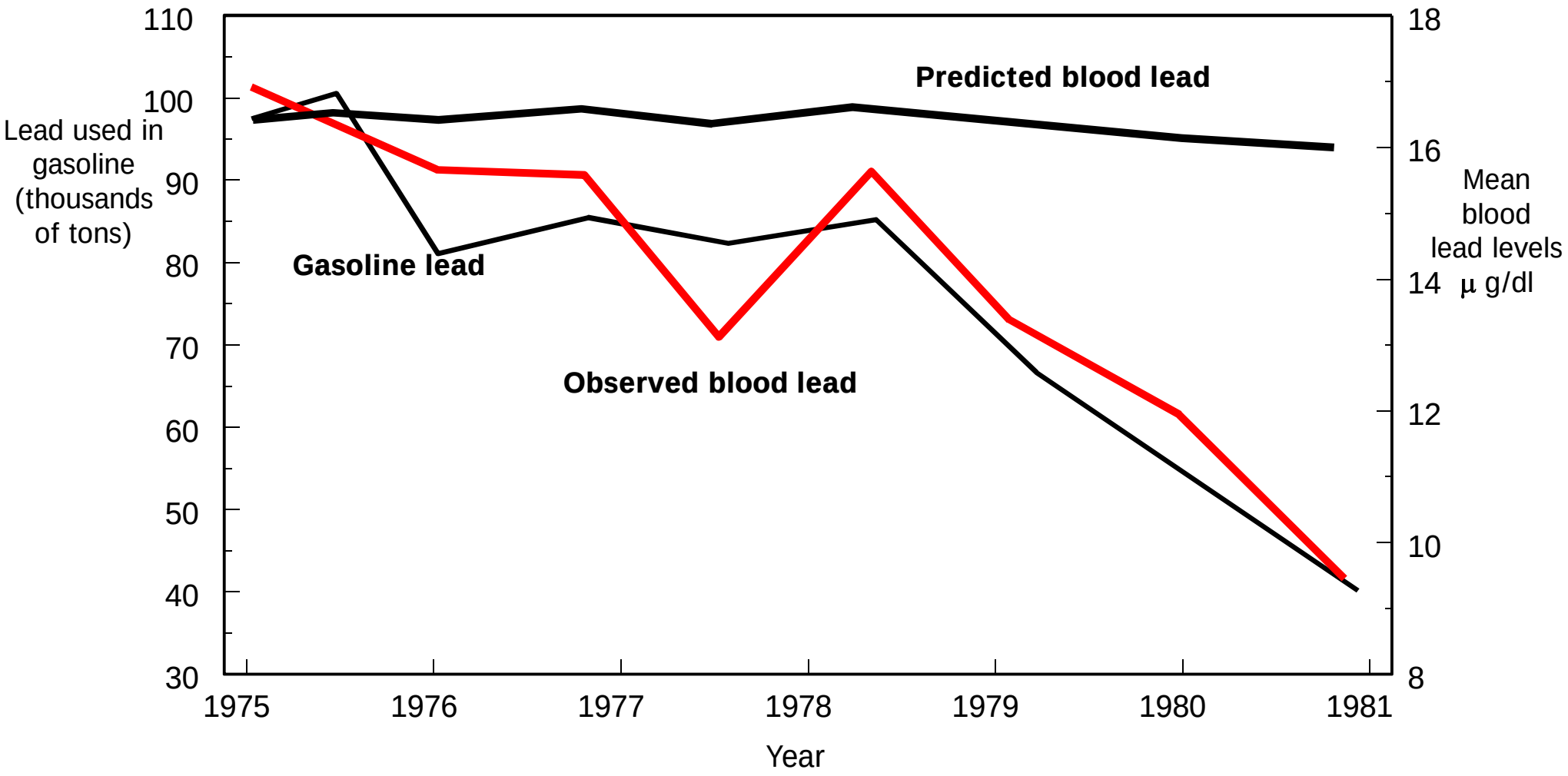
	Hunter-Gatherers	Peasant Agriculturalists	Modern Affluent Societies
Salt (g/d)	1	5-15	10
Fiber (g/d)	40	60-120	20

Age-Adjusted Prevalence of Overweight or Obesity in US Adults



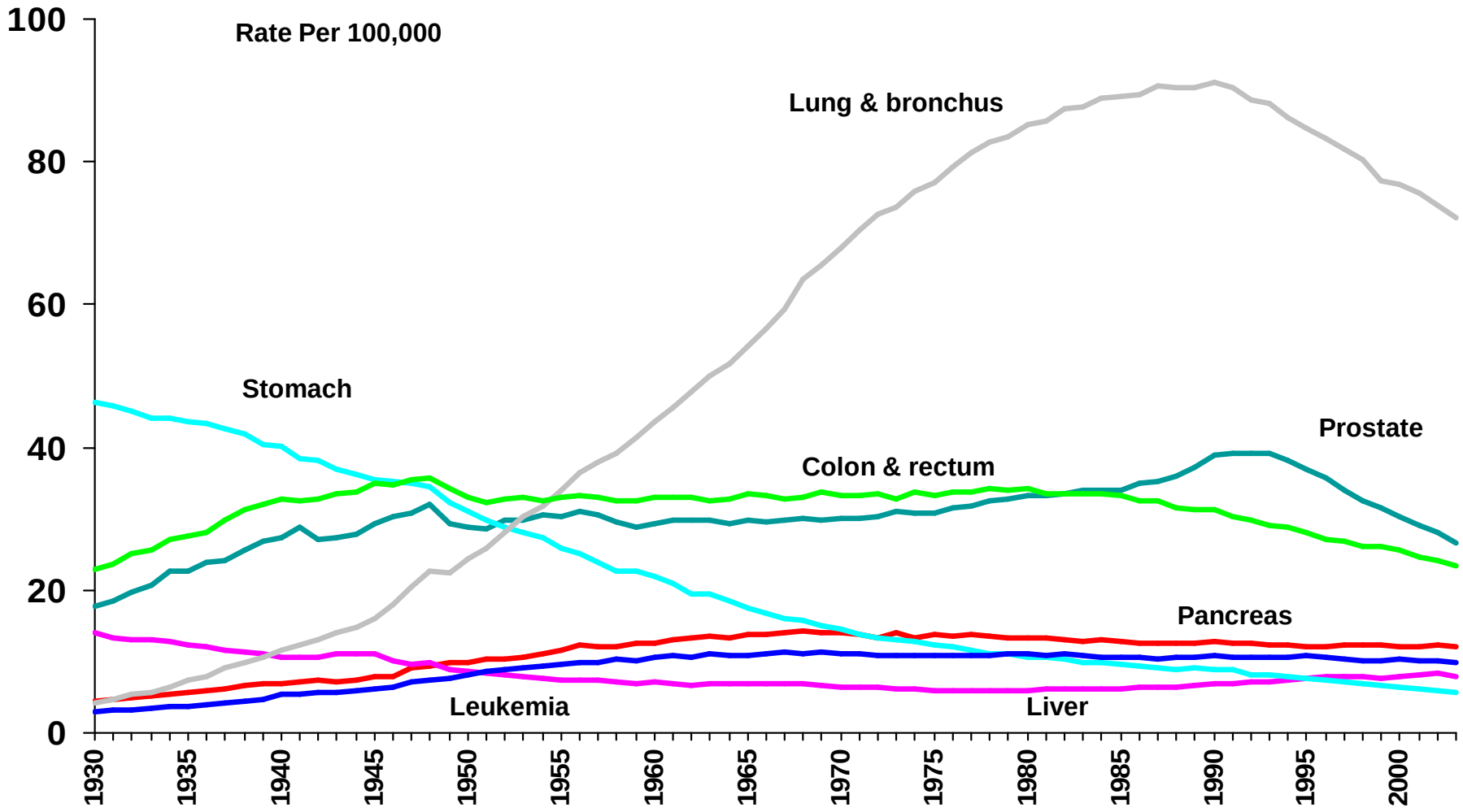
from National Center for Health Statistics website
www.cdc.gov/nchs

Blood Lead Measurements 1975-1981

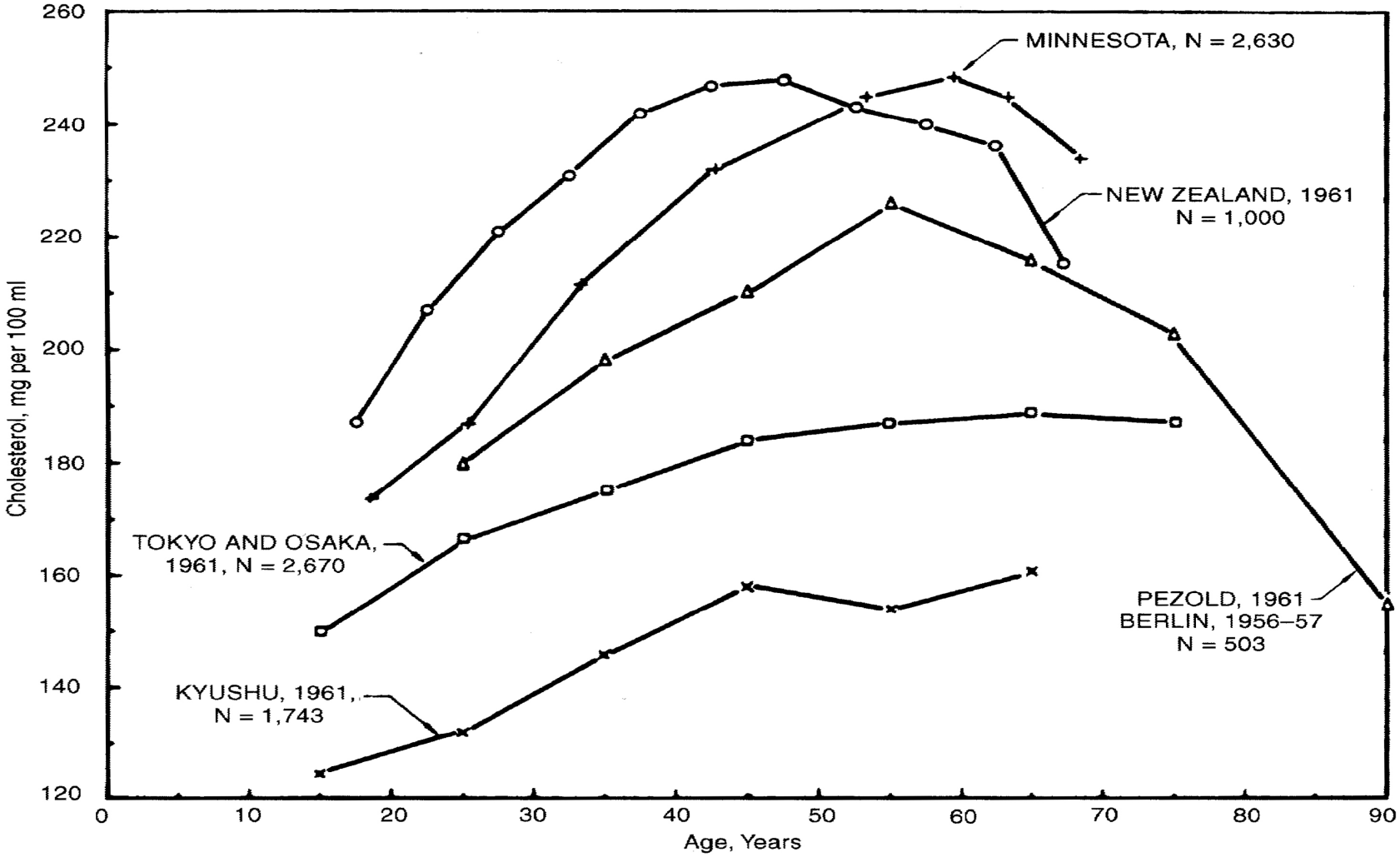


Source: Pirkle et al JAMA 272:284-91, 1994

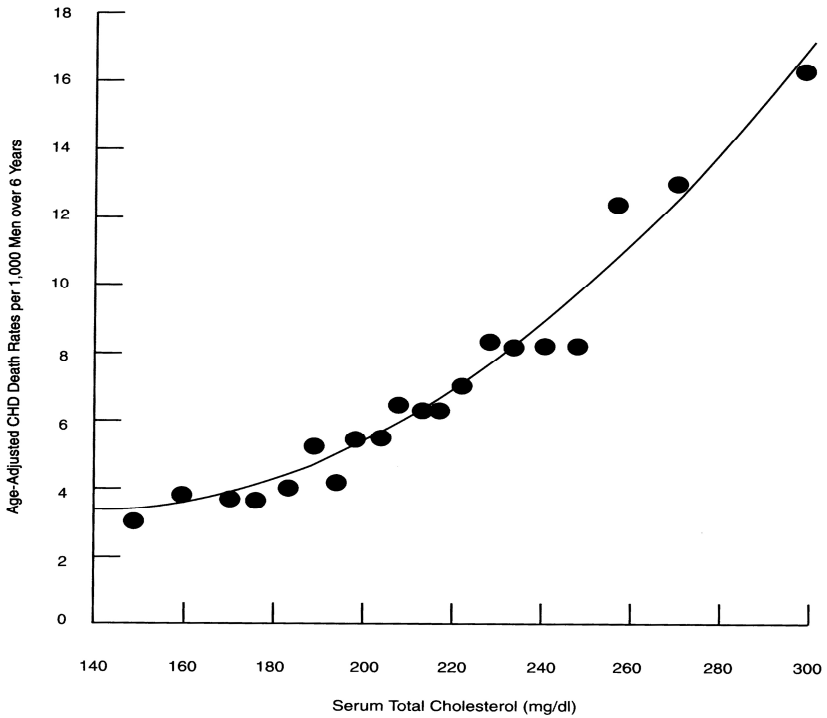
Cancer Death Rates, Men, US, 1930-2003



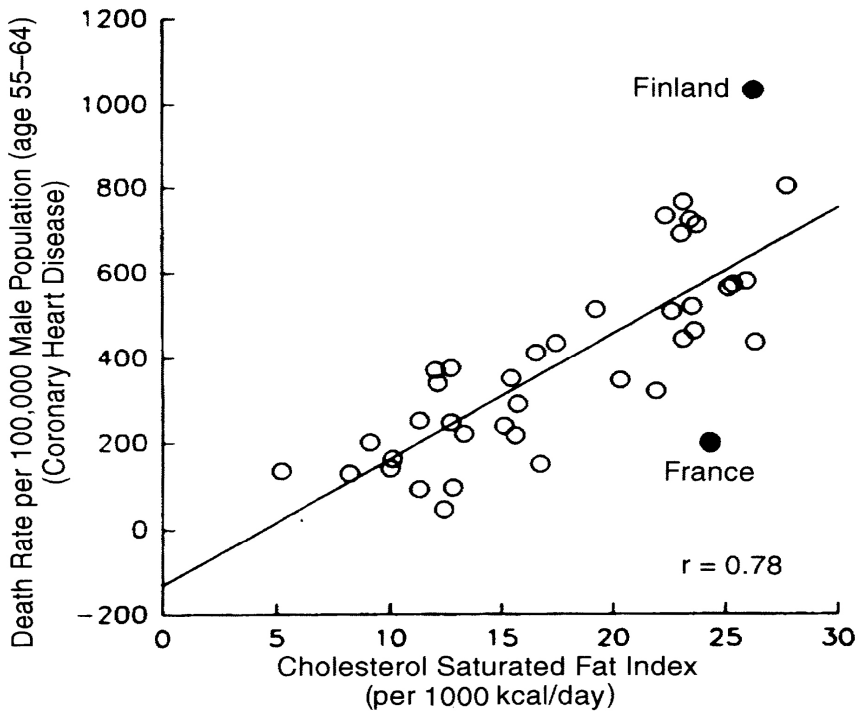
Trends in Serum Cholesterol, Men, Selected Countries



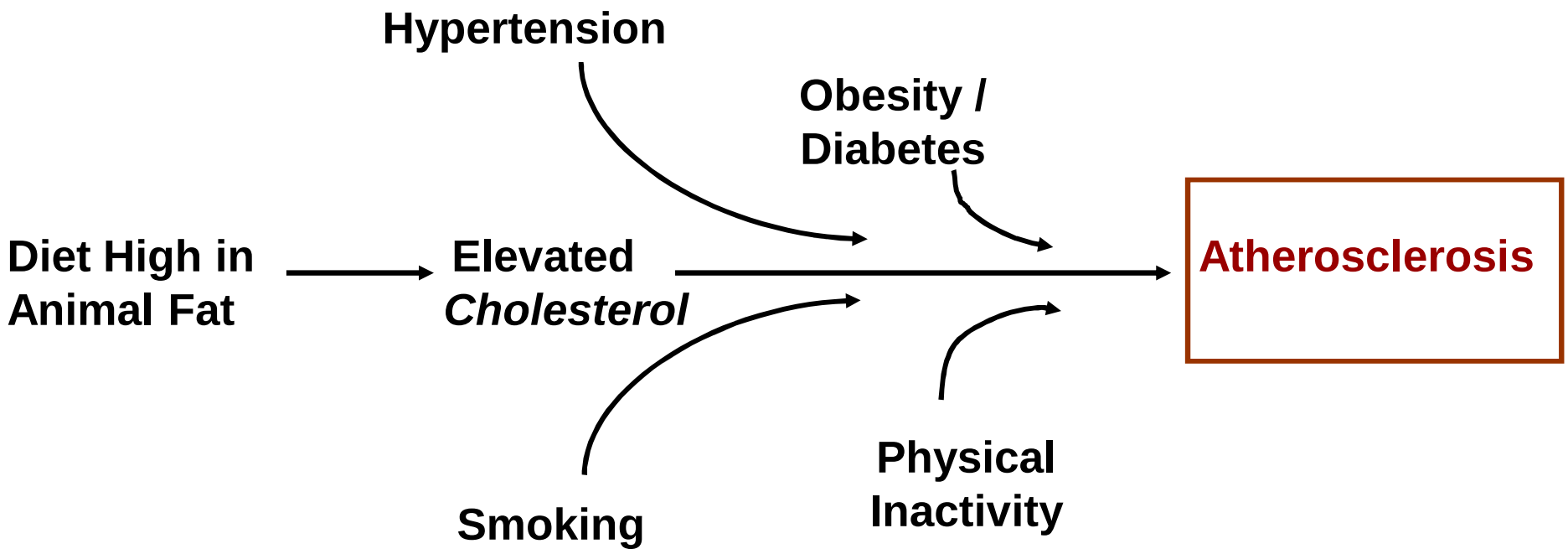
Serum Cholesterol and Risk of CHD, MRFIT



CHD and Saturated Fat Intake in 40 Countries



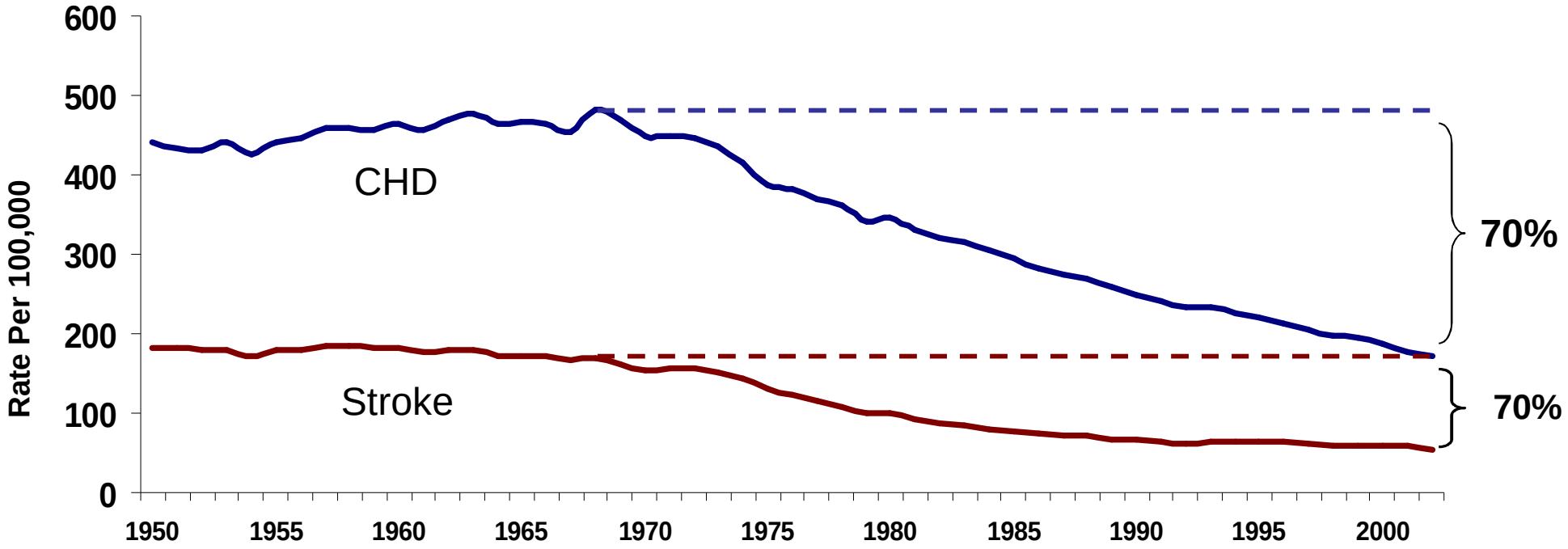
Causal Process in Atherosclerosis



The Development Process of CVD

Pathway					
Social and Environmental Conditions →	Adverse Behavioral Patterns →	Major Risk Factors →	First Event/ Sudden Death →	Disability/ Risk of Recurrence →	Late Death
Target Population					
Whole Population	Whole Population	Persons with Risk Factors	Cases with First Fatal or Non-Fatal Events	Survivors	Late Deaths
Interventions					
Policy and Environmental Change	Behavior Change	Risk Factor Detection and Control	Emergency Care/Acute Case Management	Rehabilitation /Long-Term Care	End-Of-Life Care

Death Rates from CHD and Stroke, US, 1950-2002



Trends in Stroke, 1967-97, Men

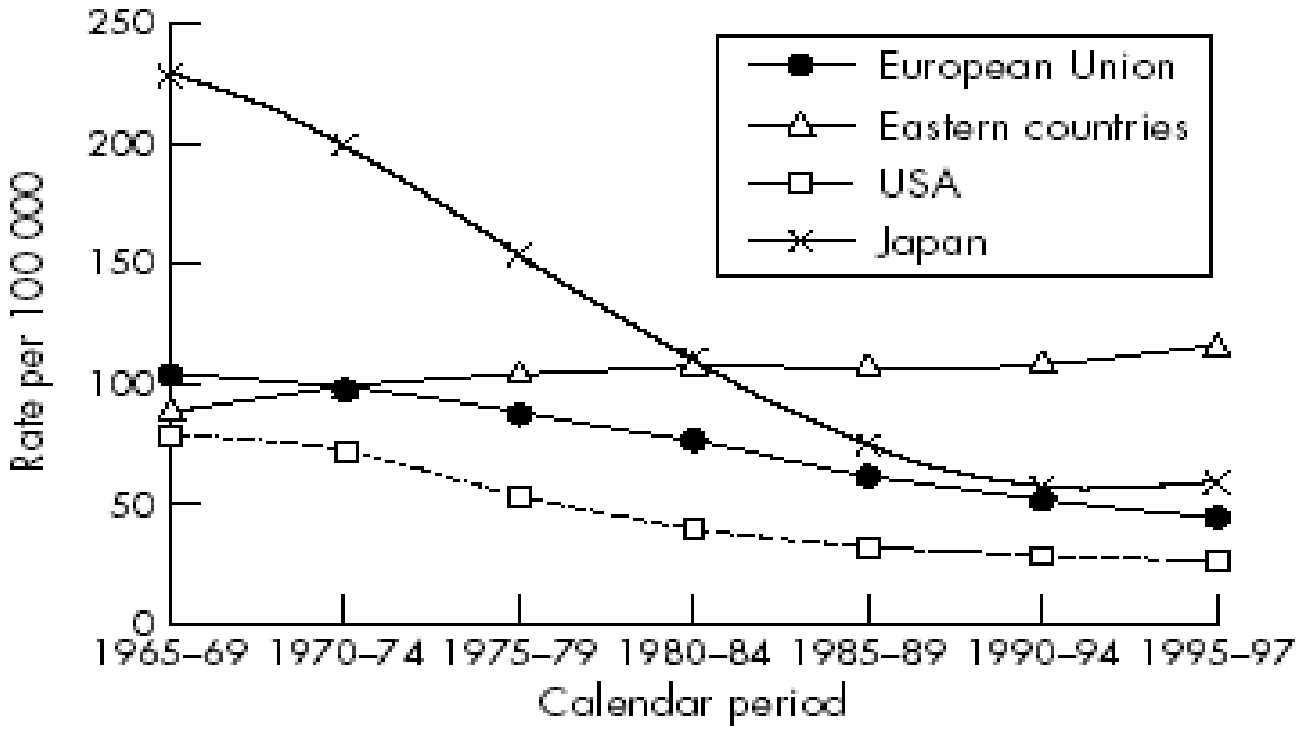


Figure 3 Trends in age standardised (world population) death certification rates from cerebrovascular diseases in men in all age groups from the European Union, eastern European countries (Bulgaria, Czech Republic, Hungary, Poland, Romania, and Slovakia), the USA, and Japan, 1965 to 1997.

Goal of adjustment

- Age Adjustment
  - Age influences rate of most disease
  - Comparison of rates must account for age differences in populations
- To reduce distortions and incomparability of rates when making comparison over time and among populations
- So we are not comparing apples to oranges

Crude Mortality Rates in Florida & Alaska 1988

	Florida	Alaska
Number of Deaths	131,044	2,064
Total Pop.	12,335,000	524,000
Rate (/100,000)	1,062	394

Age-Adjusted Mortality for Florida & Alaska, 1988

Age Group	Age - Specific Death Rate Florida	Age - Specific Death Rate Alaska	U. S. Pop. Structure (%)	Standardized Rate Florida	Standardized Rate Alaska
<5	284	274	7.4	21.0	20.3
5-19	57	65	21.5	12.3	14.0
20-44	198	188	39.9	79.0	75.0
45-64	815	629	18.7	152.4	117.6
>65	4425	4350	12.5	553.1	543.8
			100%		
			Age - adjusted rate =	817.8	808.5
			[Crude rate =	1,062	394]

Cross-Sectional Community Survey

- Population based
- Requires sampling frame to be representative
- Provides prevalence estimates
- Can be a baseline for a Prospective Study

Prevalence and Incidence

$$\text{Prevalence} = \frac{\text{Number of Cases in Population}}{\text{Population}}$$

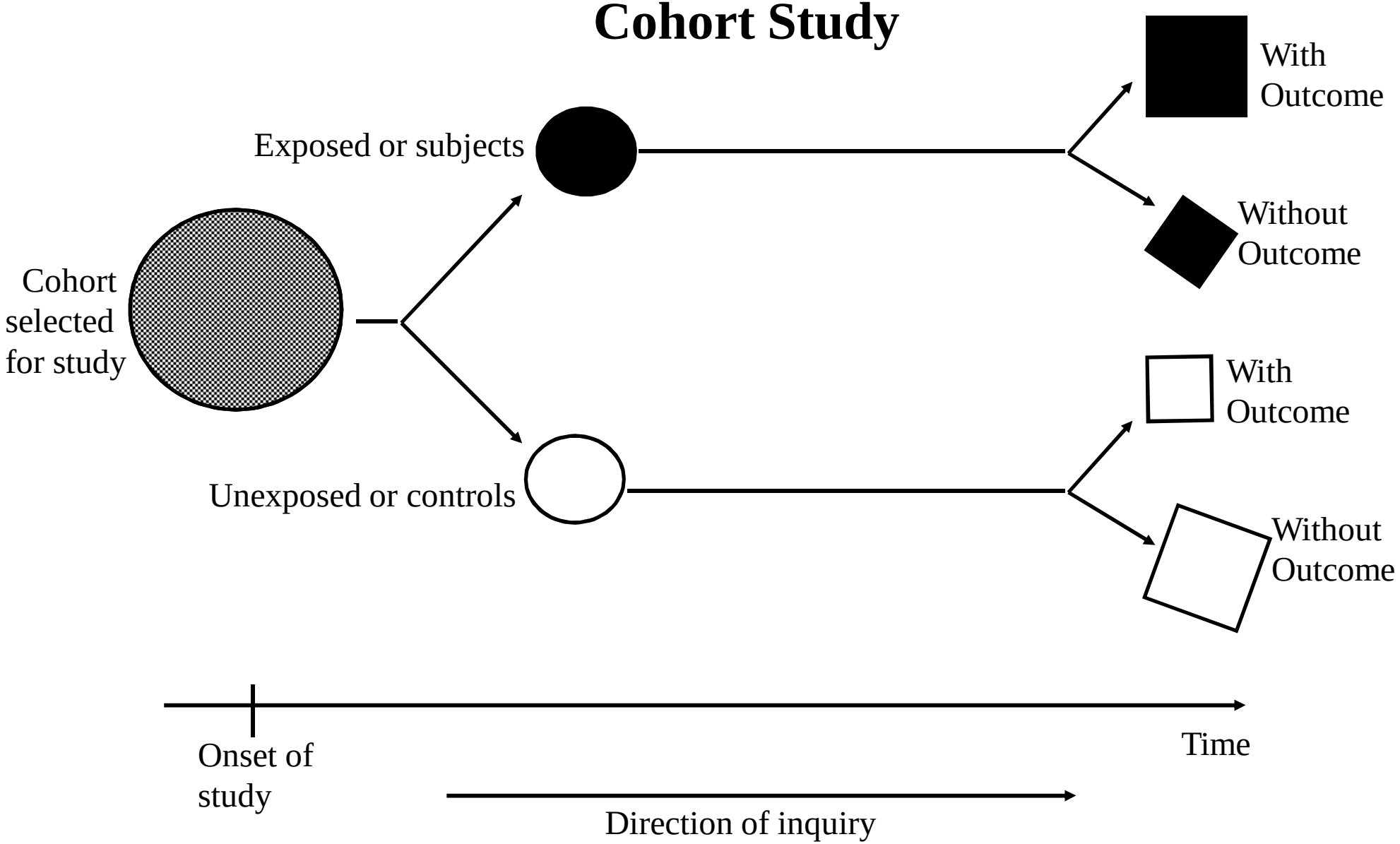
$$\text{Incidence} = \frac{\text{Number of New Cases}}{\text{Total Number at Risk}}$$

Prospective or Cohort Study

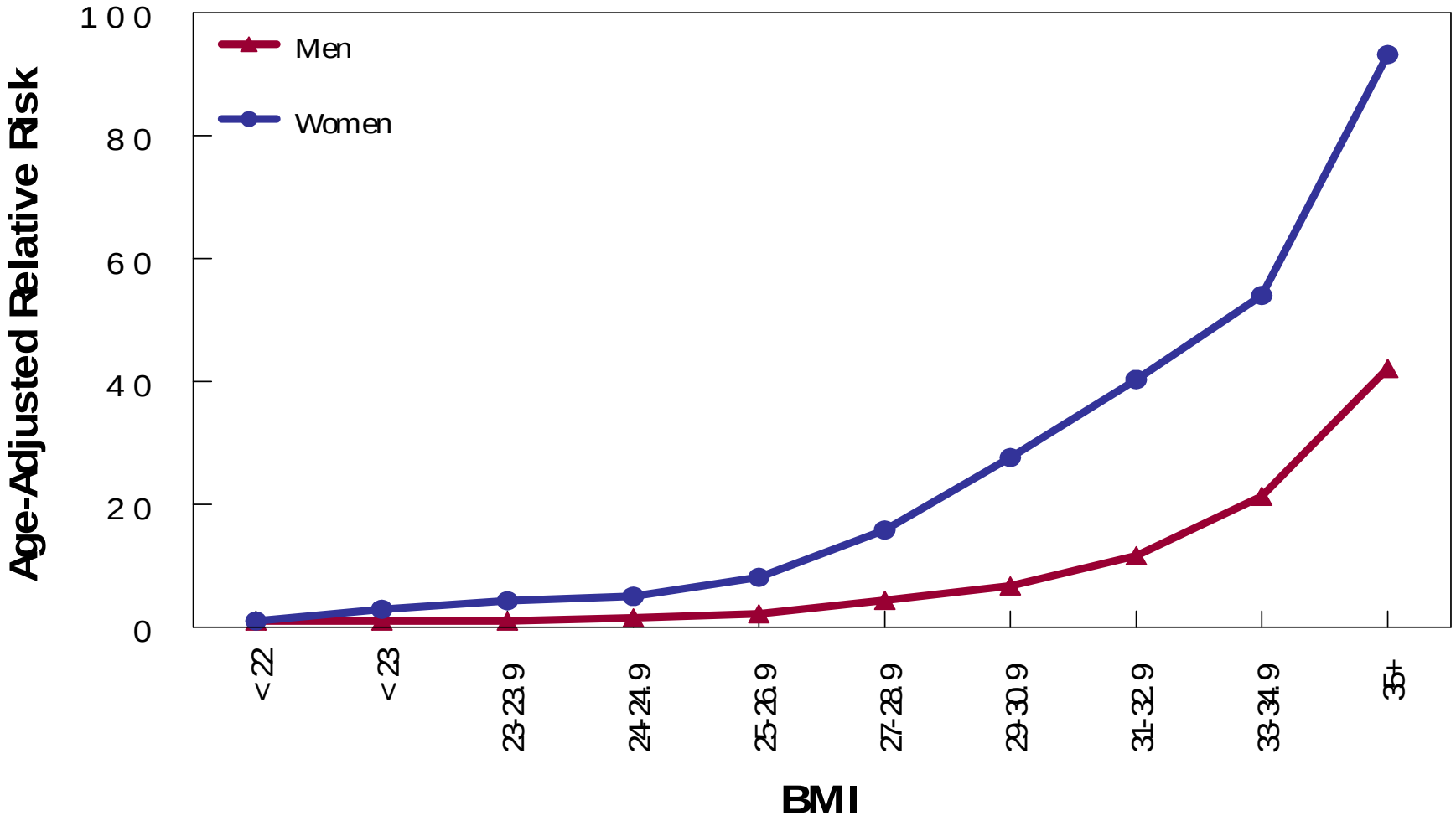
Time →

Past	Present	Future
	Determine Exposure	Determine Outcome

Cohort Study



Relationship between BMI and Risk of Type 2 Diabetes Mellitus



Chan JM Diabetes Care 1994;17:961-69.

Prospective Study

Hepatitis B Antibody Status and Liver Cancer

Hep B Ab Status	Number of People at Baseline, 1975	Number of Cases 1975 - 1986	Incidence Rate, per 100,000
Pos.	3, 454	152	495
Neg.	19, 253	9	5

Relative Risk = 495/5 = 99

Prospective or Cohort Study

Study Design

Exposure:	Number with Disease	Number without Disease
Yes	A	B
No	C	D

Statistic of Interest: Relative Risk = $$\frac{\frac{A}{A+B}}{\frac{C}{C+D}}$$

Prospective or Cohort Study

Smoking and Mortality

Vital Status at 20 Years

Exposure:	Dead	Alive	Total
Smokers	333	1336	1498
Non-Smokers	132	486	819

Prospective or Cohort Study

Smoking and Mortality

Vital Status at 20 Years

$$\text{Incidence in Exposed} = \frac{A}{A+B} = \frac{333}{1498} = 22.2 \text{ per } 100$$

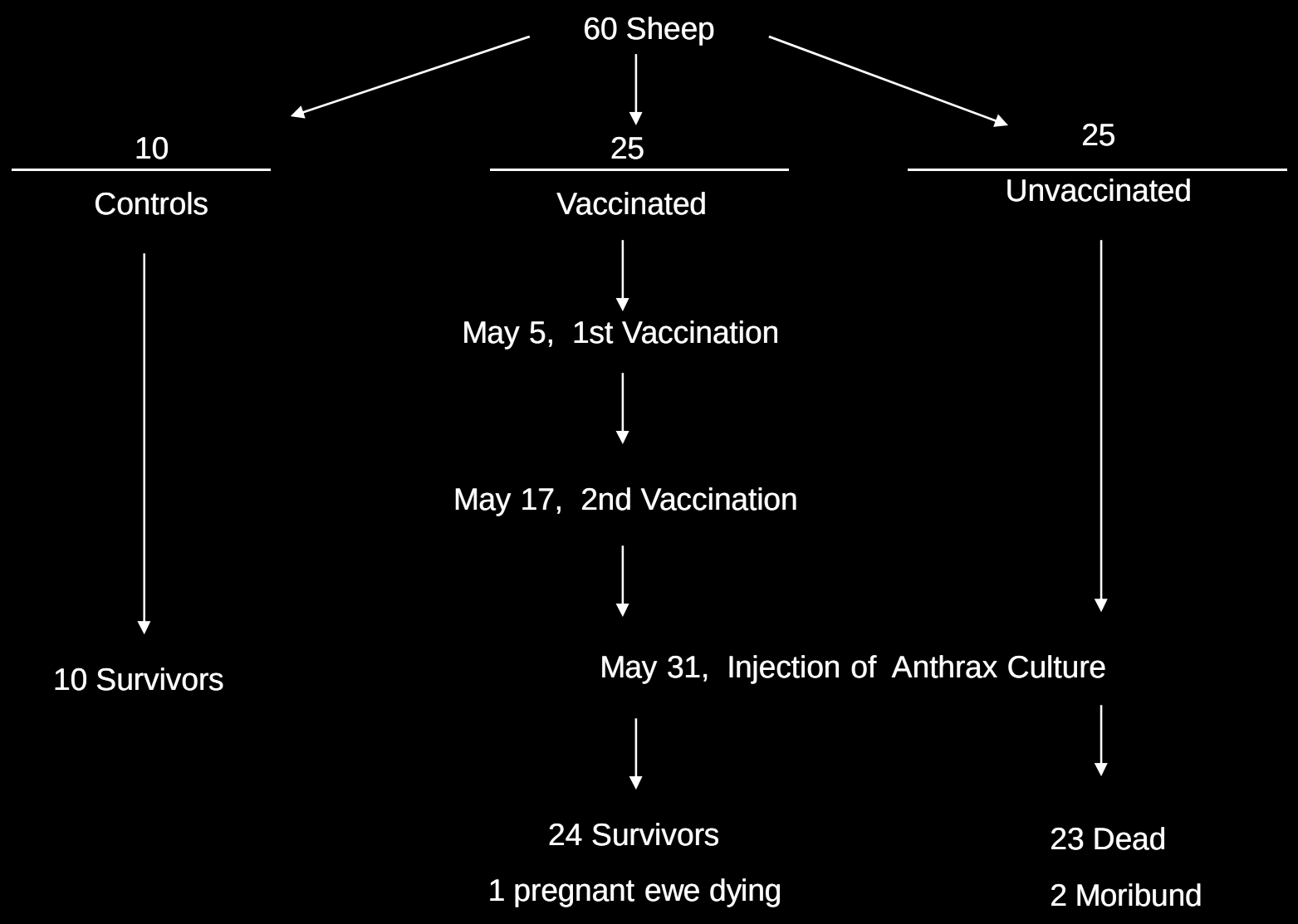
$$\text{Incidence in Unexposed} = \frac{C}{C+D} = \frac{132}{819} = 16.1 \text{ per } 100$$

$$\text{Relative Risk} = \frac{22.2}{16.1} = 1.4$$

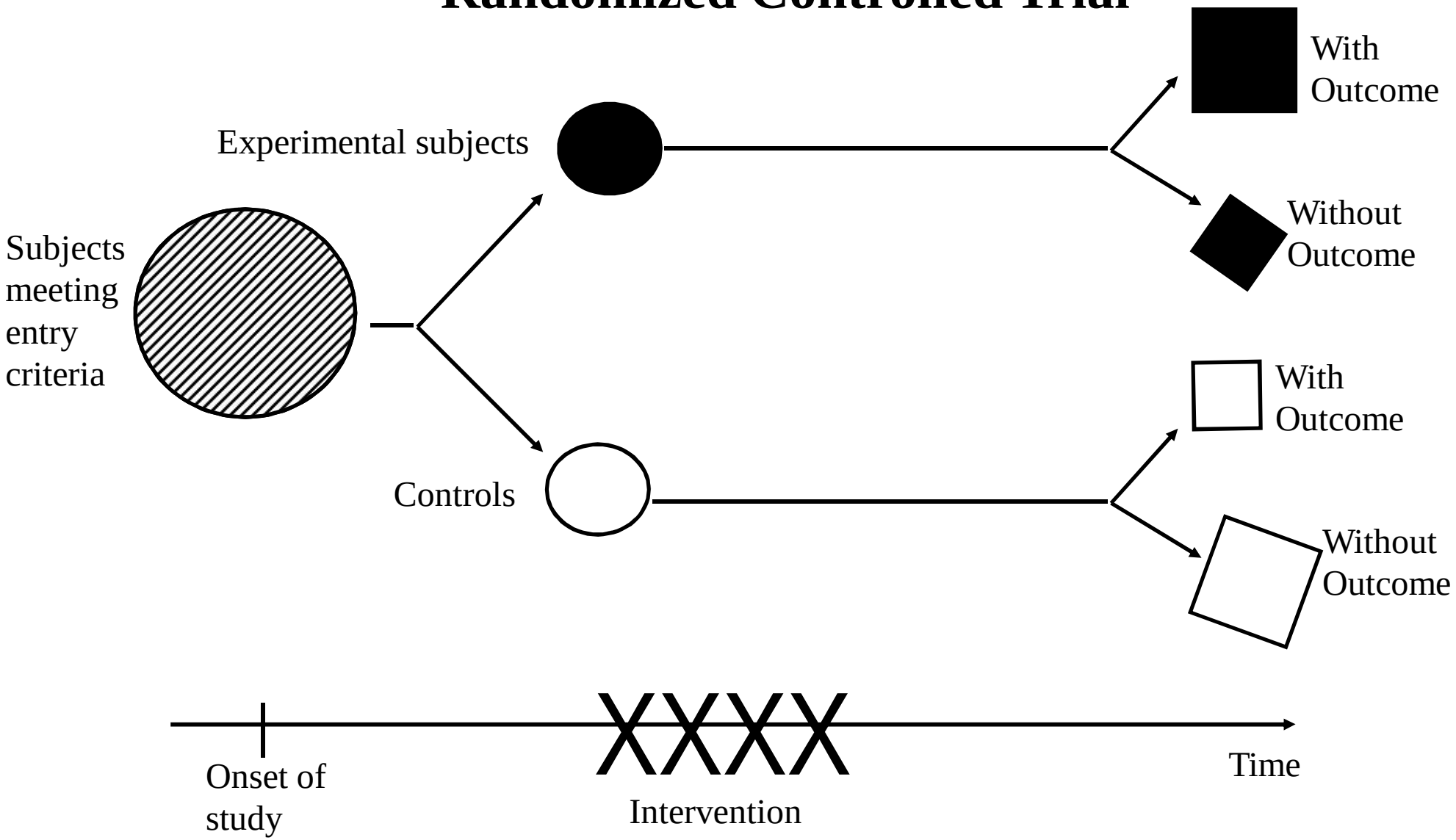
Randomized Controlled Trial

Study Design

Demonstration by Pasteur of Anthrax Vaccination, 1881



Randomized Controlled Trial



Randomized Controlled Trial

Study Design

	Disease Outcome	
'Exposure - ie, treatment-Status'	Yes	No
Yes	A	B
No	C	C

Statistic of Interest: Relative Risk $= \dfrac{\frac{A}{A+B}}{\frac{C}{C+D}}$

Streptomycin in the Treatment of Tuberculosis

	Appearance of chest x-ray at six months	
X-ray Appearance	Streptomycin	Control
Considerable Improvement	28	4
Moderate Improvement	10	13
No Change	2	3
Moderate Deterioration	5	12
Considerable Deterioration	6	6
Death	4	14
	55	52

Brit Med J, 1948

Randomized Controlled Trial

Lipid Research Clinics CHD Primary Prevention Trial

Disease Outcome

Treatment:	CHD	Non-CHD	Total
Yes	155	1751	1906
No	187	1713	1900

Randomized Controlled Trial

Lipid Research Clinics CHD Primary Prevention Trial

Disease Outcome

Incidence in ‘exposed’ - ie, treated $= \frac{155}{1906} = 8.1$ per 100

Incidence in ‘unexposed’ - ie, untreated $= \frac{187}{1900} = 9.8$ per 100

Relative Risk $= \frac{8.1}{9.8} = 0.83$

TABLE 1
Descriptive summary of sodium-reduction trials in hypertensive subjects[1]

Author and year	Duration	Blinding	Urinary Na change	(No) Changes in confounders	Blood pressure change	
					Systolic	Diastolic
	mo		*mmol/24 h*		*mm Hg*	
Crossover trials						
Parijs et al 1973 (8), (n = 15)	1	NR	−98	(Wt)	−6.7	3.2
MacGregor et al 1982 (9), (n = 19)	1	DB	−76	Wt, (K)	−10.0[2]	−5.0[2]
Watt et al 1983 (10), (n = 18)	1	DB	−56	(Wt), (K)	−0.5	−0.3
Richards et al 1984 (11), (n = 12)	1–1.5	NR	−105	(Wt), K	−5.2	−1.8
Grobbee et al 1987 (12), (n = 40)	1.5	DB	−72	(Wt), (K)	−0.8	−0.8
MacGregor et al 1989 (13), (n = 20)	1	DB	−82	(Wt), (K)	−8.0[2]	−5.0[2]
Dodson et al 1989 (14), (n = 9)	1	DB	−76	(Wt), (K)	−9.7[2]	−5.1
ANHMRC 1989 (15), (n = 88)	2	DB	−67	(K)	−2.6[2]	−2.1[2]
Benetos et al 1992 (16), (n = 20)	1	DB	−78	(Wt), (K), (Ca)	−6.5[2]	−3.7[2]
Parallel trials[3]						
Morgan et al 1978 (17), (n = 31, 31)	24	BP obs	−27	NR	−1.5[2]	−6.9[2]
Morgan and Myers 1981 (18), (n = 6, 6)	2	BP obs	−98	K	NR	−6.0[2]
Morgan and Myers 1981 (18), (n = 6, 6)	2	BP obs	−78	K	NR	−4.0
Costa et al 1981 (19), (n = 20, 21)	12	NR	NR[4]	NR	−18.3[2]	−5.9[2]
Silman et al 1983 (20), (n = 10, 15)	12	BP obs (RZ)	−53	(Wt), (K)	−8.7	−6.3
Puska et al 1983 (21), (n = 15, 19)	1.5	BP obs	−117	Wt, K, Alc, (P:S)	1.8	0.5
Fagerberg et al 1984 (22), (n = 15, 15)	2.3	NR	−89	(Wt), (K), (Alc)	−13.3[2]	−6.7[2]
Maxwell et al 1984 (23), (n = 18, 17)	3	NR	−171	Wt	−2.0	2.0
Erwteman et al 1984 (24), (n = 44, 50)	6	BP obs (RZ)	58	NR	2.7	3.4[2]
Chalmers et al 1986 (25), (n = 48, 52)	3	NR	−54	(K)	−5.1[2]	−4.2[2]
Logan 1986 (26), (n = 37, 38)	6	BP obs	−32	Wt, (K)	−1.1	−0.2
Dodson et al 1989 (14), (n = 17, 17)	3	BP obs	−59	(Wt), (K)	−13.0[2]	−1.8
ANHMRC 1989 (27), (n = 50, 53)	2	DB	−71	(Alc)	−5.5[2]	−2.8[2]
Sciarrone et al 1992 (28), (n = 46, 45)	2	DB	−84	(Wt), (K)	−6.0[2]	−1.0
Parker et al (29) (low Alc), (n = 16, 15)	1	DB	−80	(Wt), (Alc), (K), (Ca), (Mg)	2.2	0.5
Parker et al (29) (norm Alc), (n = 15, 13)	1	DB	−52	(Wt), (Alc), (K), (Ca), (Mg)	−0.1	0.8

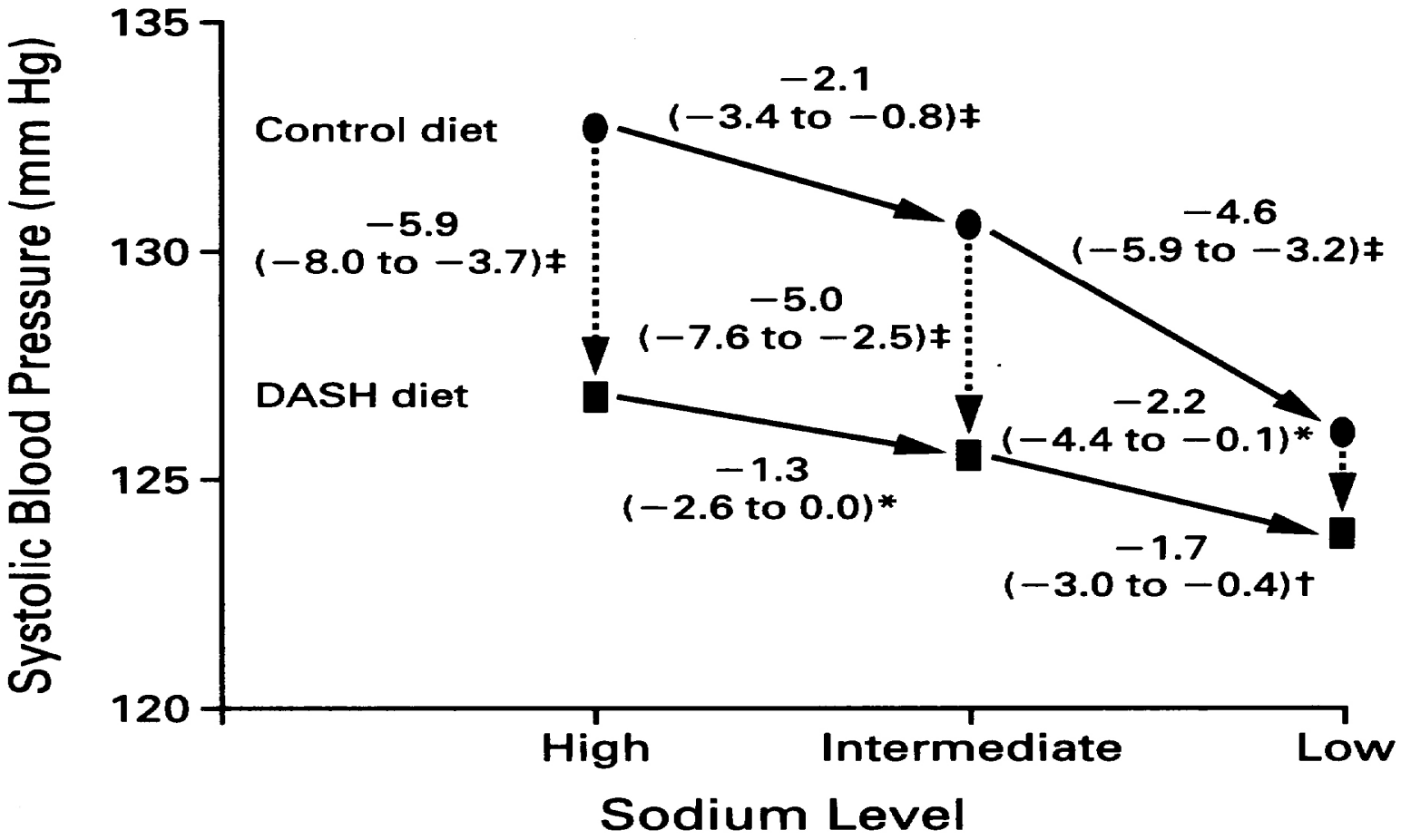
[1] NR, not reported; Wt, body weight; DB, double blind; K, potassium intake/excretion; ANHMRC, Australian National Health and Medical Research Council; Ca, calcium intake/excretion; BP obs, observers blinded; RZ, random zero manometer; Alc, alcohol intake; P:S, ratio of polyunsaturated to saturated fatty acid; Mg, magnesium excretion.

[2] $P < 0.05$.

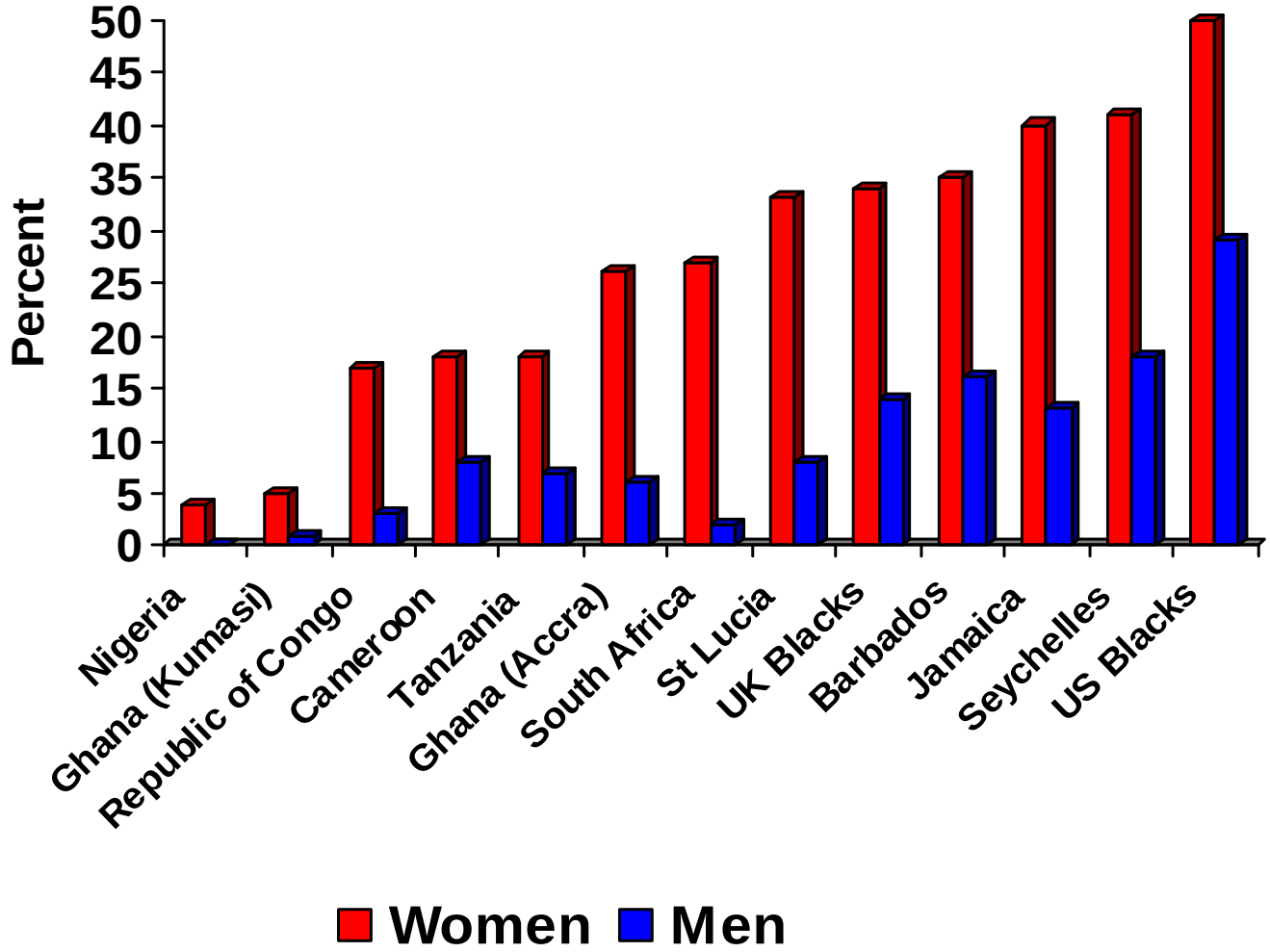
[3] n values given for each study are the number of subjects in the sodium-reduction treatment and control groups, respectively.

[4] −23% intracellular Na.

Systolic BP Change in the DASH Trial

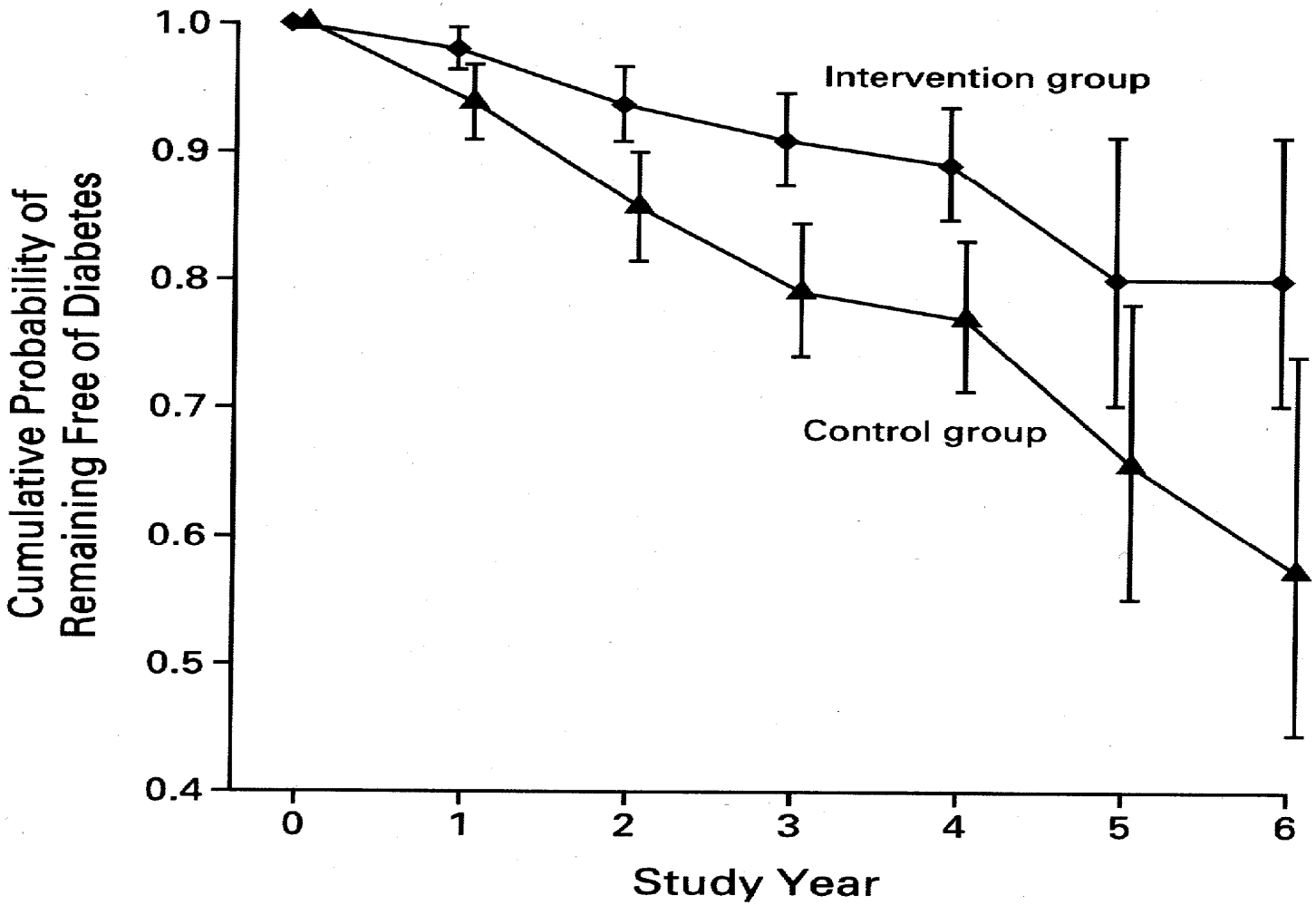


Prevalence of Obesity in Populations of African Origin



Cappuccio et al, in press

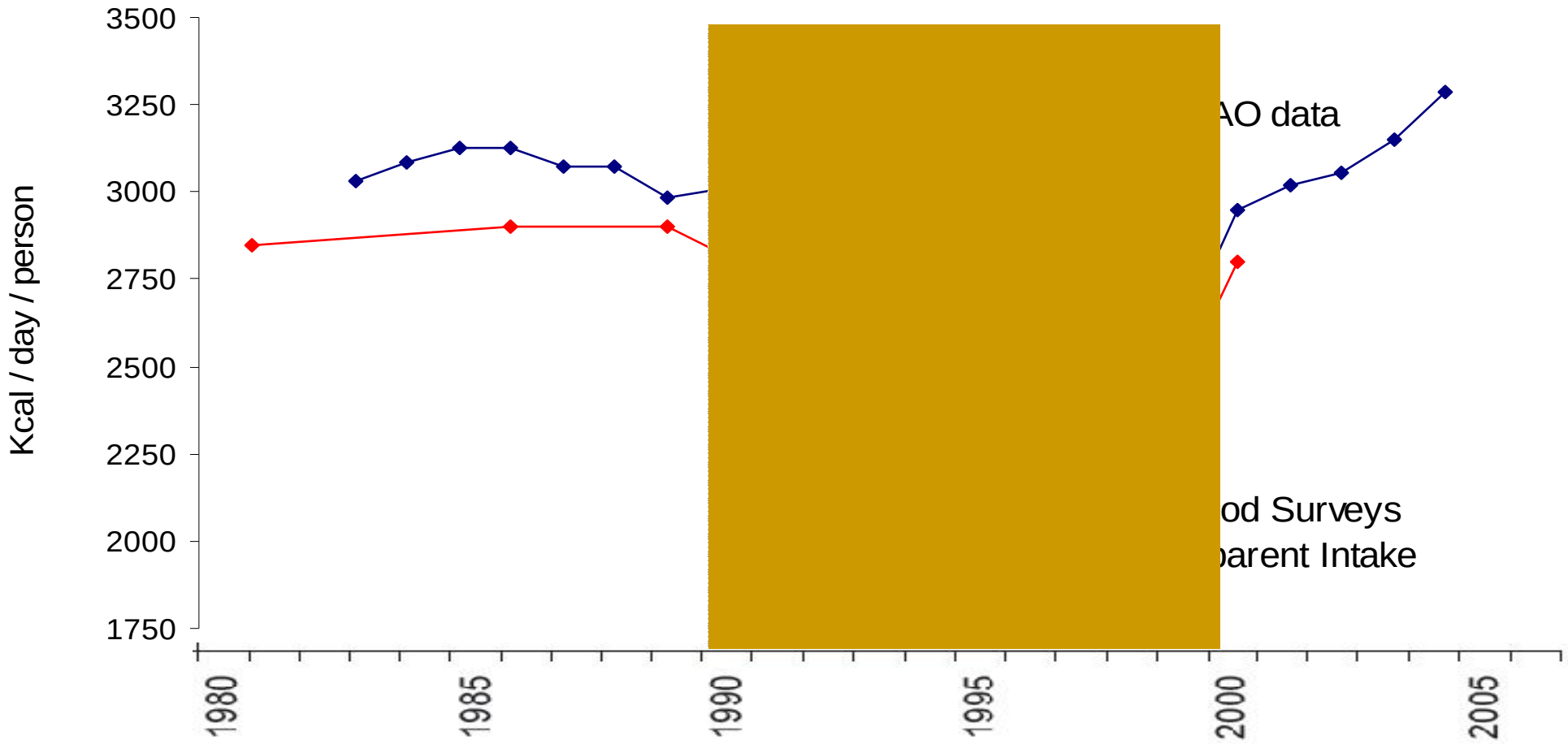
Prevention of Type 2 Diabetes, Finnish Lifestyle Prevention Study



NEJM, 2001

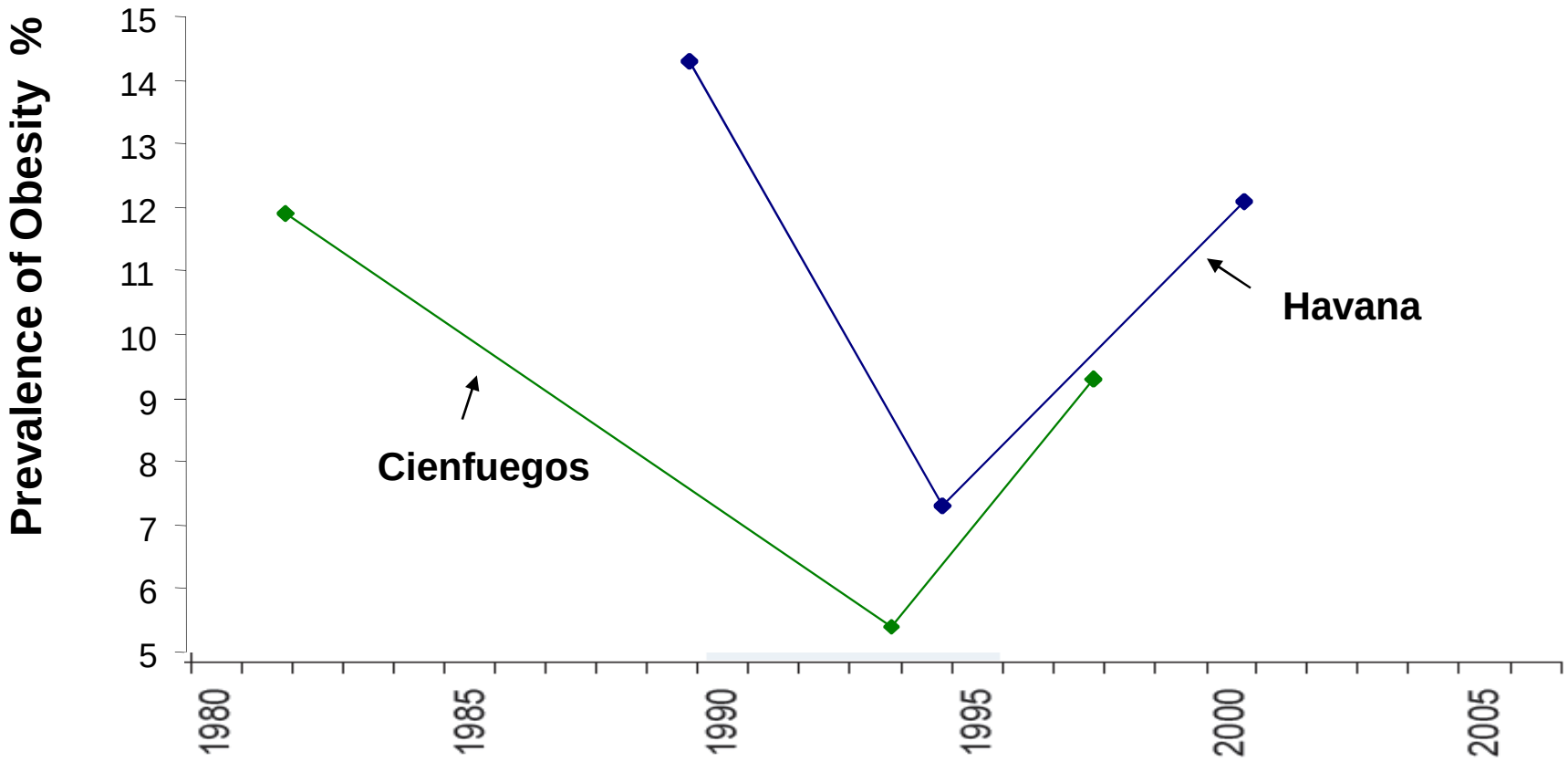
The Potential of Population-wide Prevention of Diabetes . . .

Per capita Daily Energy Intake in Cuba, 1980-2005

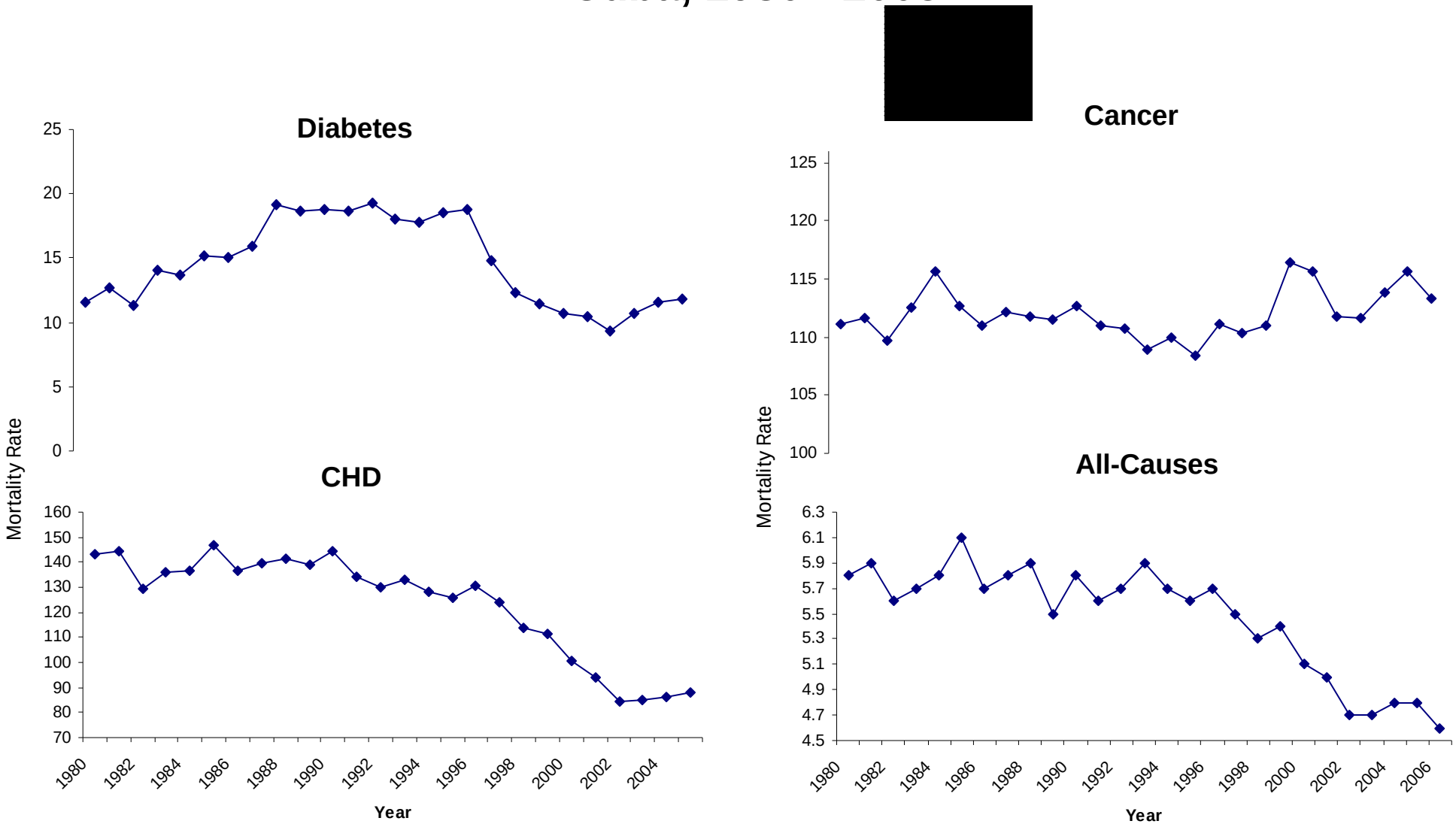


Franco, Cooper et al Am J Epidemiology, 2007

Prevalence of Obesity in Cienfuegos and Havana, Cuba, 1990-2000



Trends in Mortality from Diabetes, CHD, Cancer and All-Causes, Cuba, 1980 - 2005



Per 100,000

Measures to improve public health, relating as they do to such obvious and mundane matters as housing, smoking, and food, may lack the glamour of high-technology medicine, but what they lack in excitement they gain in their potential impact on health, precisely because they deal with the major causes of common disease and disabilities.

Geoffrey Rose, ***The Strategy of Preventive Medicine***. Oxford University Press, 1992