

# Increase of Human Longevity: Past, Present and Future

John R. Wilmoth  
Department of Demography  
University of California, Berkeley

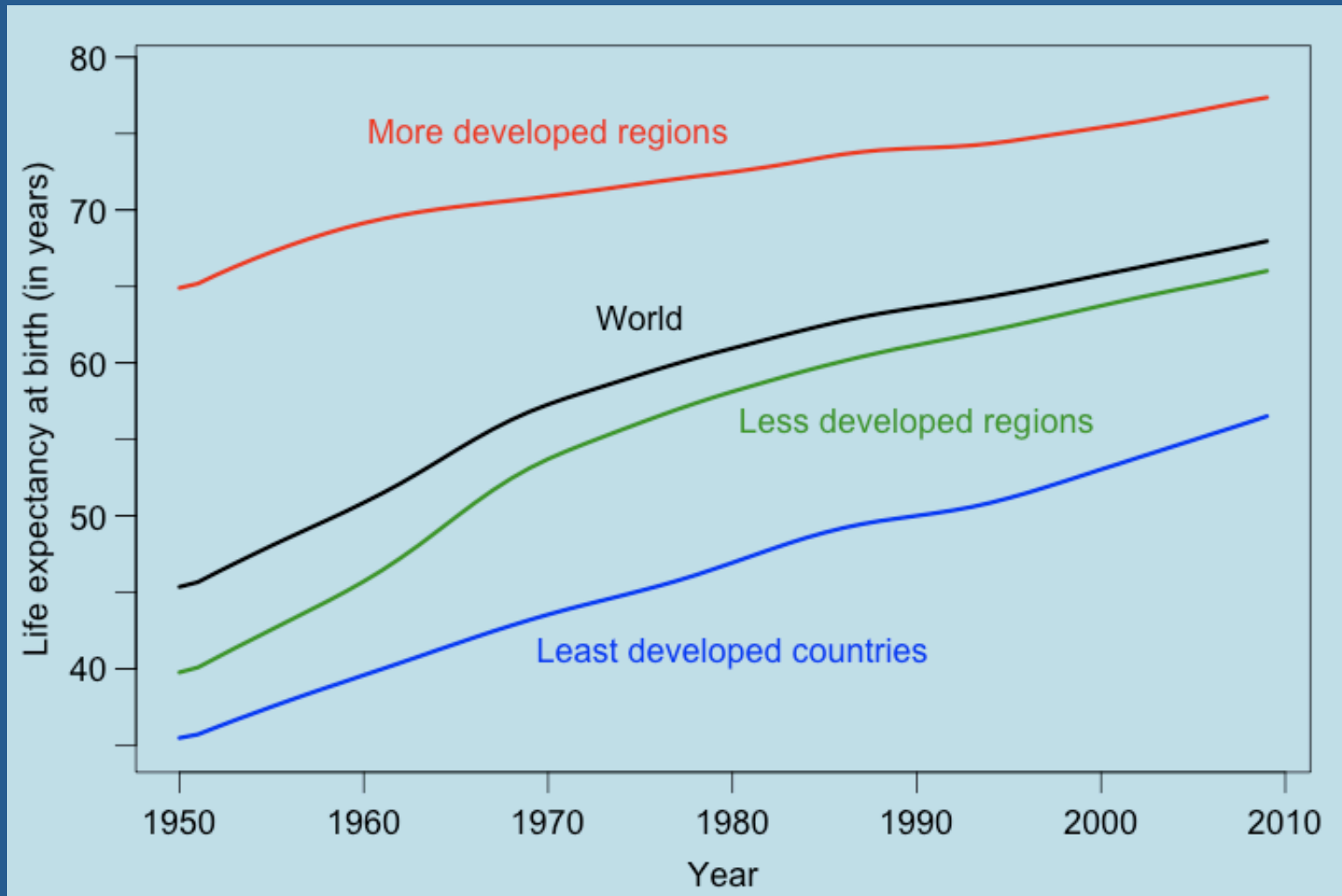
Institute for Population and Social Security Research  
Tokyo, Japan  
22 December 2009

# Topics

- Historical increase of longevity
- Age patterns of mortality
- Medical causes of death
- Social and historical causes
- Limits to the human life span?
- Future prospects

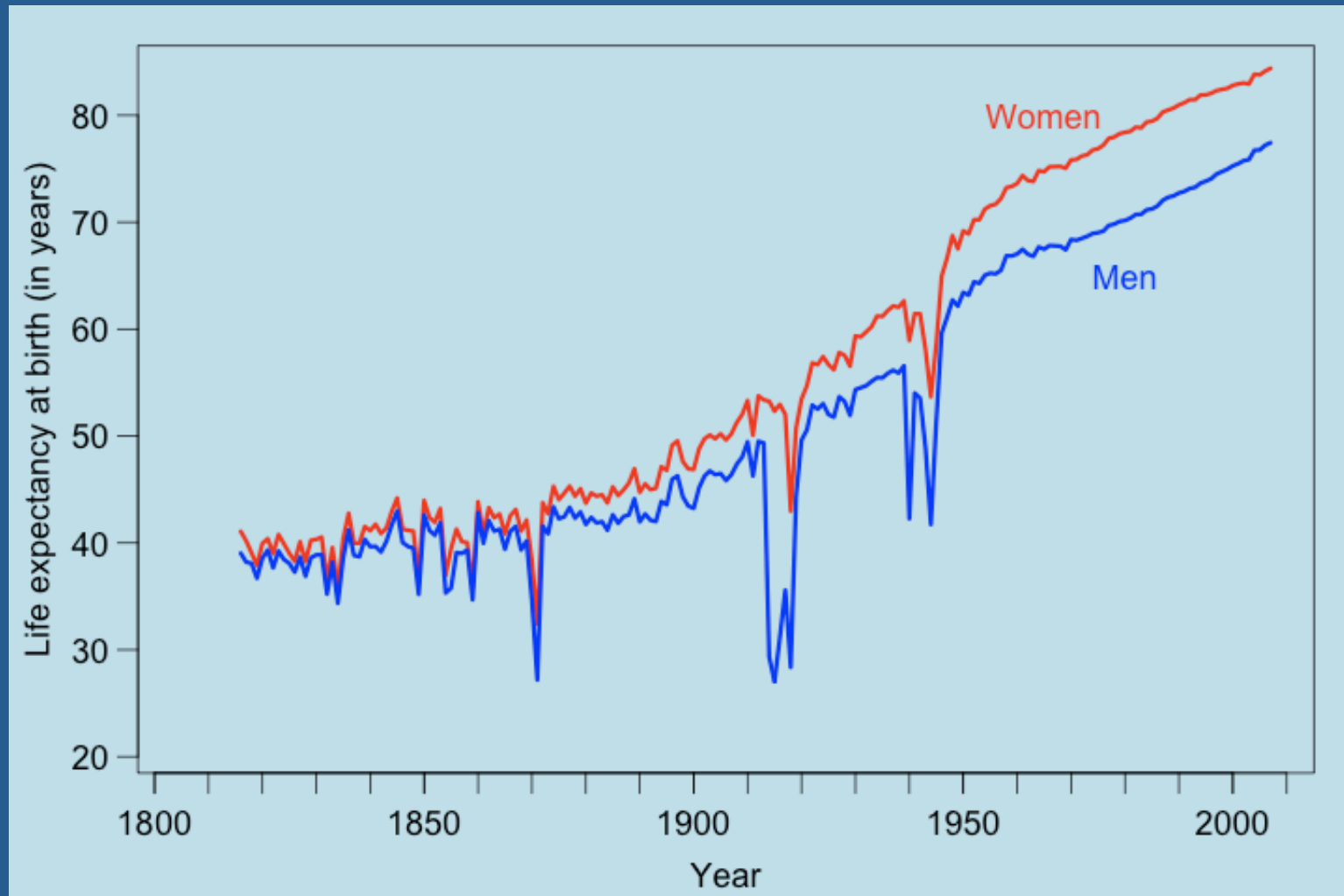
# Historical Increase of Longevity

# Life Expectancy at Birth, 1950-2009



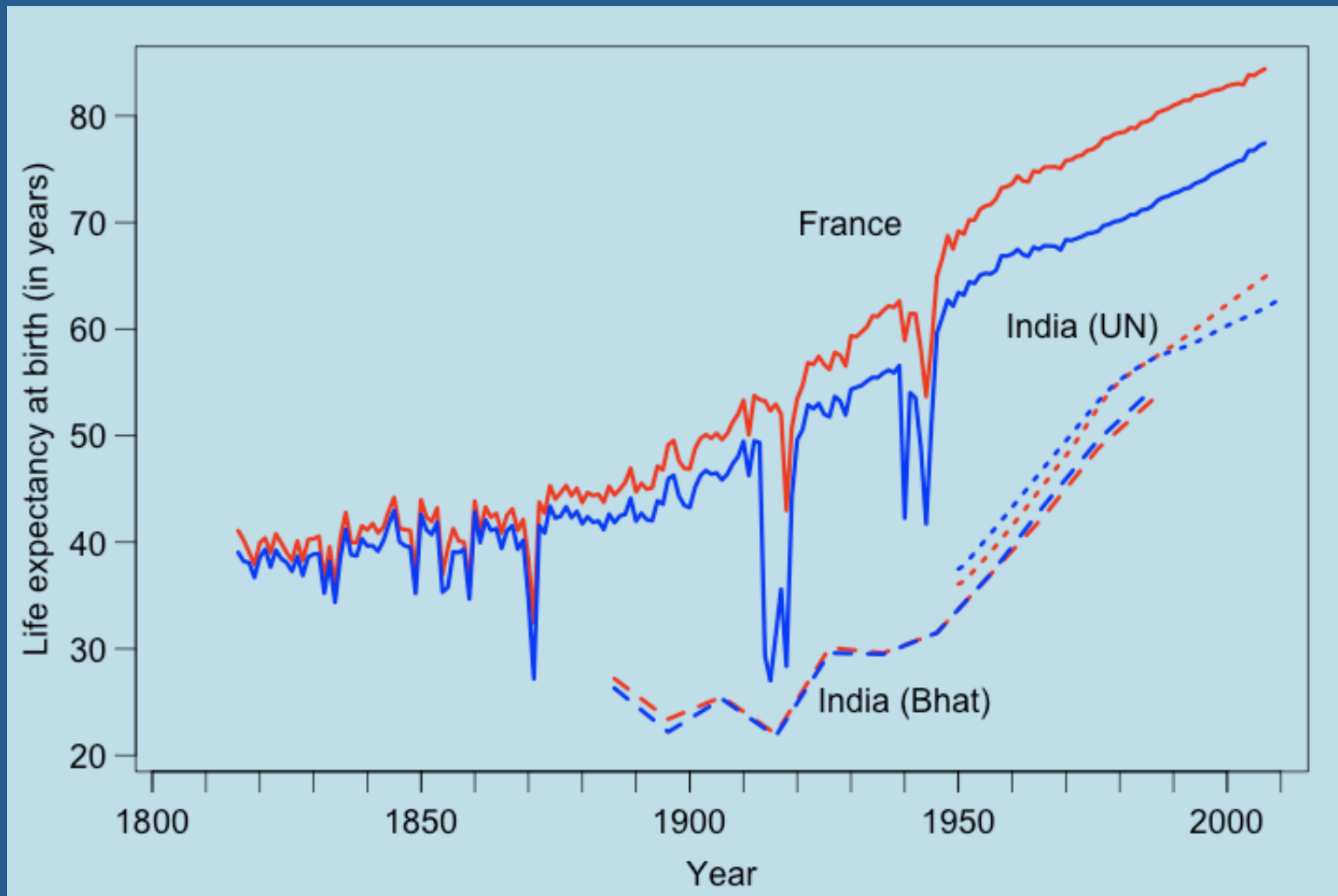
Data source: United Nations, *World Population Prospects: 2008 Revision*, 2009

# Life Expectancy at Birth, France, 1816-2007



Data source: Human Mortality Database, 2009 ([www.mortality.org](http://www.mortality.org))

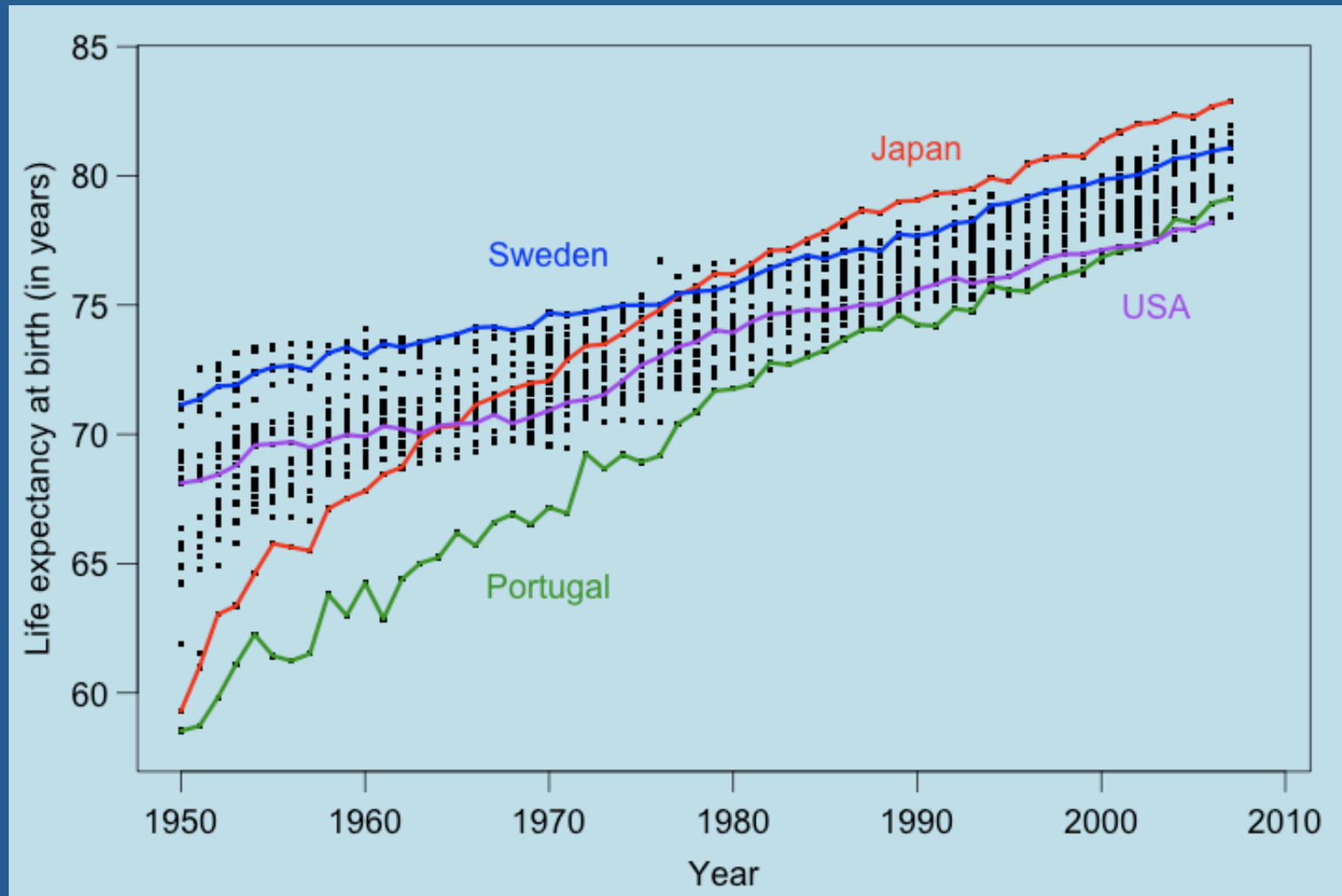
## Life Expectancy at Birth, France and India, 19<sup>th</sup> and 20<sup>th</sup> C.



Data sources: HMD, 2009; M. Bhat, 1989, 1998 & 2001; United Nations, 2009

# Life Expectancy at Birth, 1950-2007

## W. Europe, USA, Canada, Australia, NZ, Japan



Data source: Human Mortality Database, 2009 ([www.mortality.org](http://www.mortality.org))

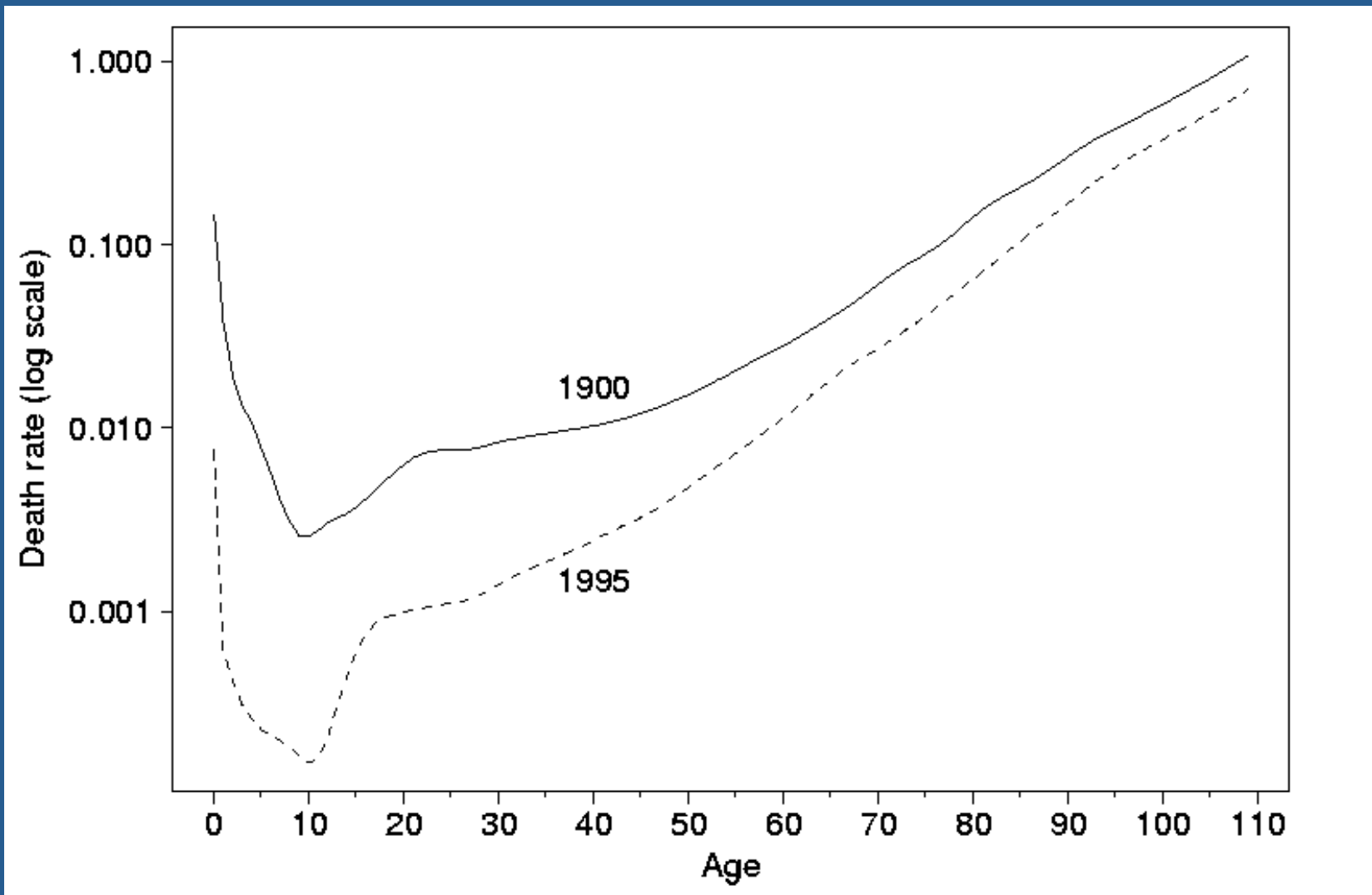
# Historical mortality levels

	Life expectancy at birth (in years)	Infant mortality rate (per 1000 live births)
Prehistoric	20-35	200-300
Sweden, 1750s	36	212
India, 1880s	25	230
U.S.A., 1900	48	133
France, 1950	66	52
Japan, 2007	83	<3

Source: J. Wilmoth, *Encyclopedia of Population*, 2003 (updated)

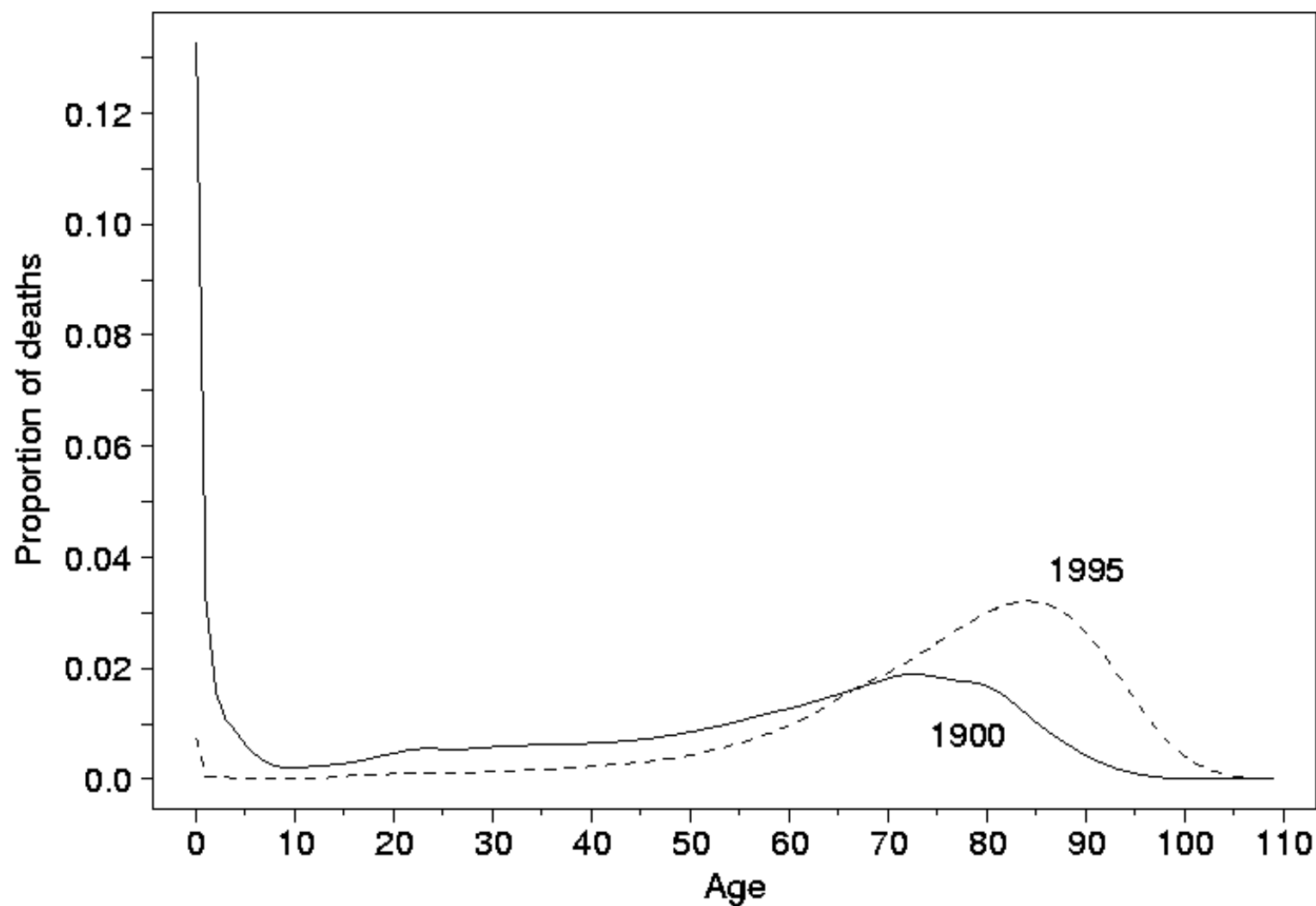
# Age Patterns of Mortality

# Death Rates by Age, U.S., 1900 & 1995



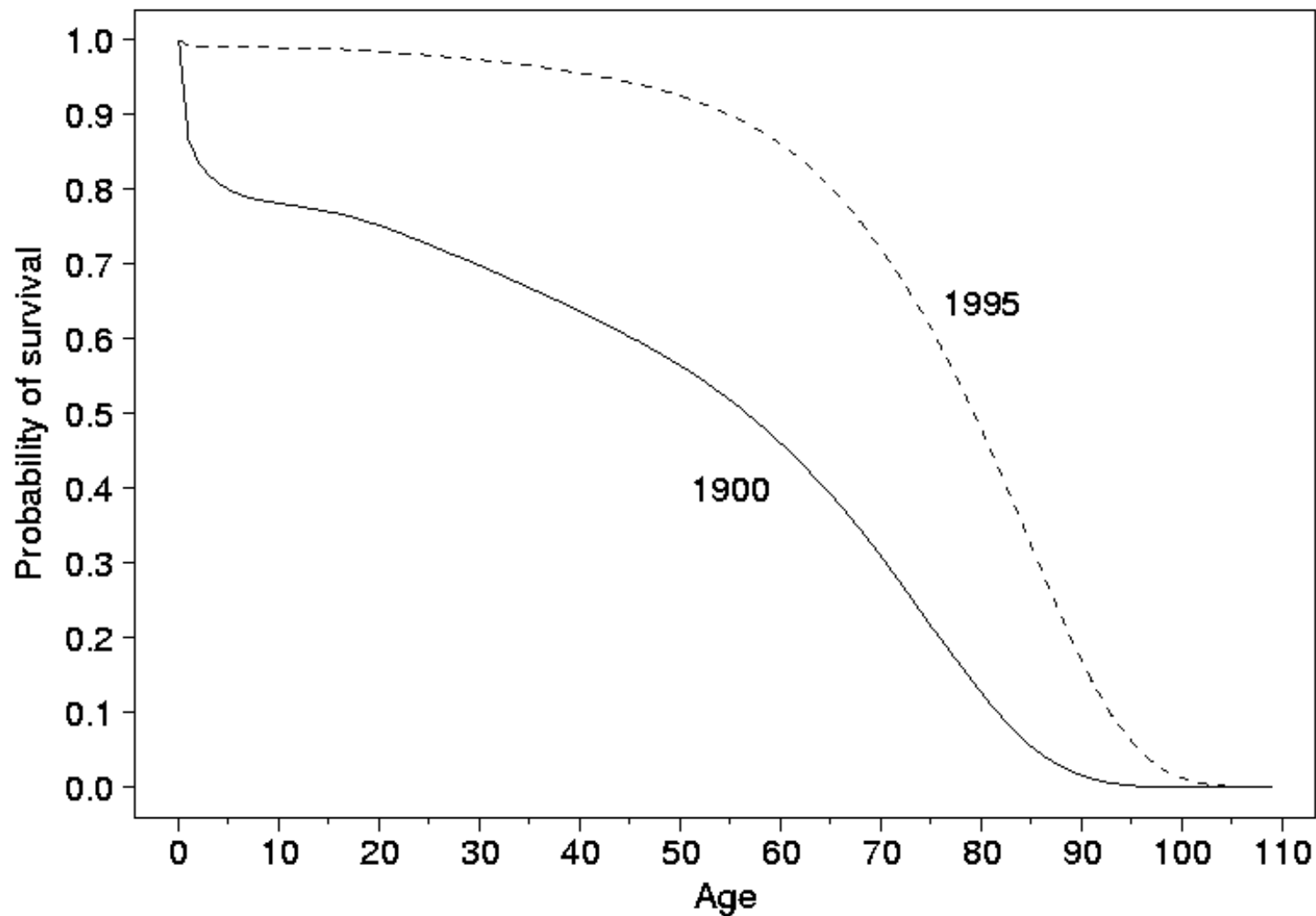
Data source: Social Security Administration, United States

# Distribution of Deaths, U.S., 1900 & 1995



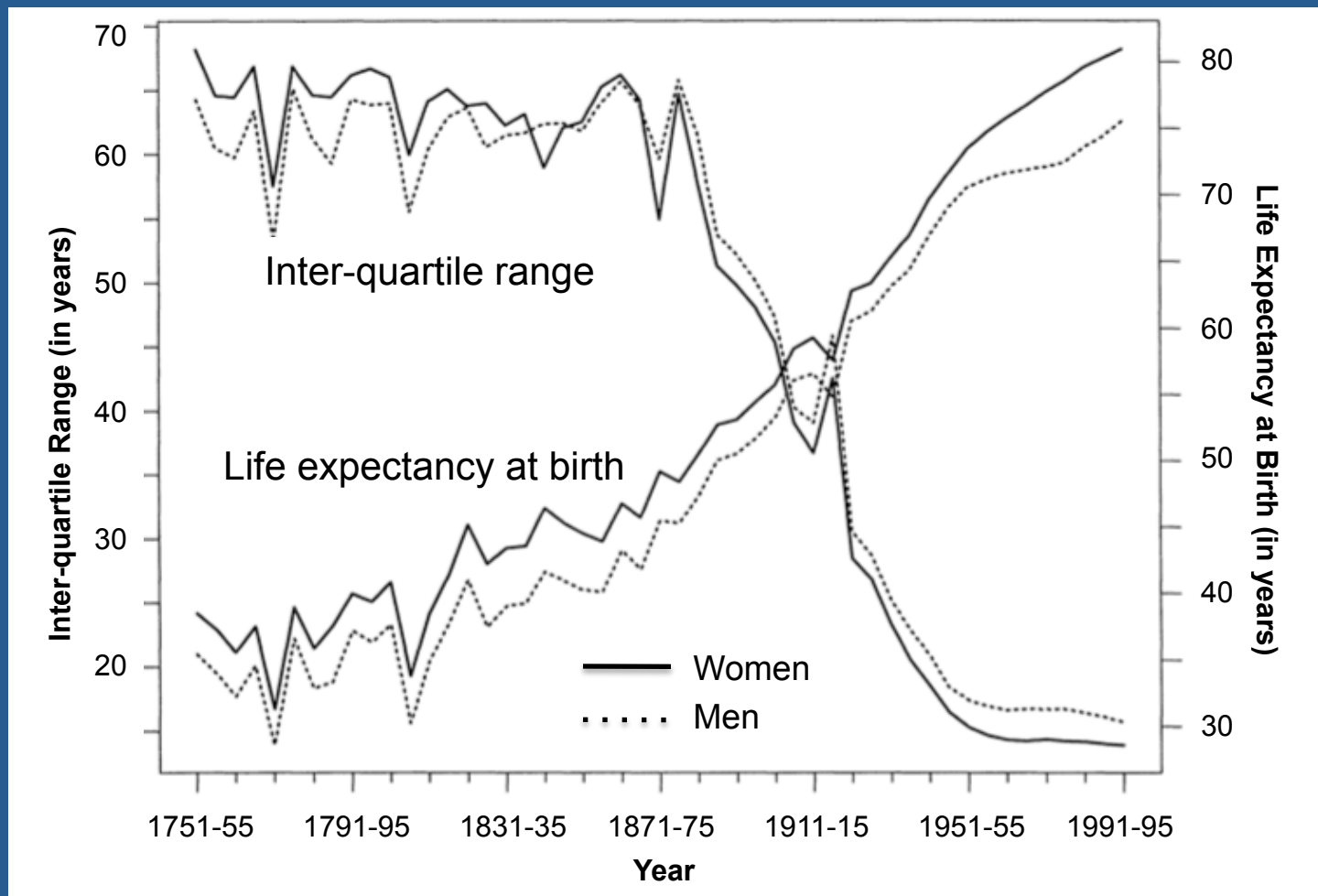
Data source: Social Security Administration, United States

# Probability of Survival, U.S., 1900 & 1995



Data source: Social Security Administration, United States

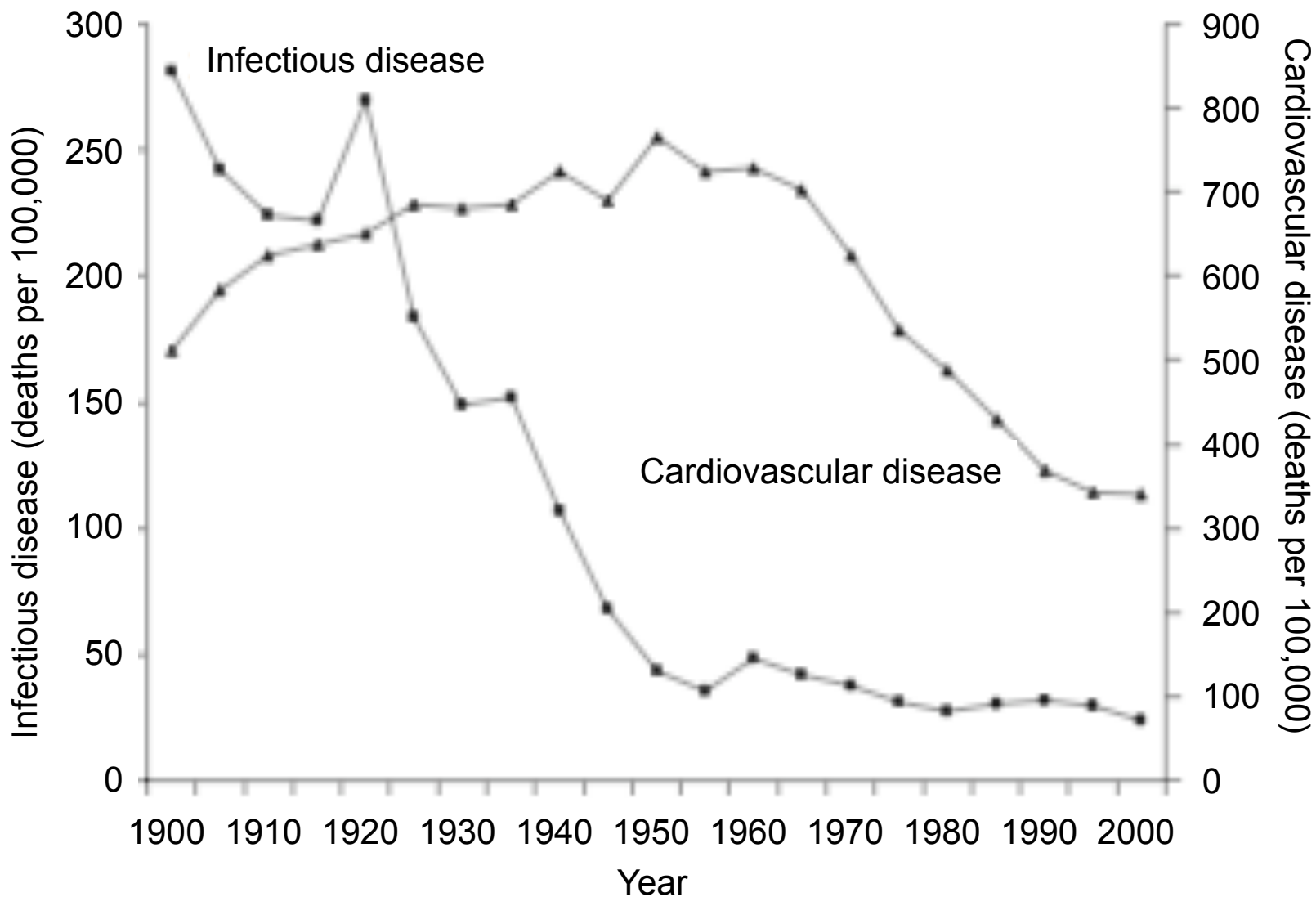
# Dispersion of Ages at Death vs. Life Expectancy at Birth, Sweden 1751-1995



Source: J. Wilmoth and S. Horiuchi, *Demography* 36(4): 475-495, 1999

# Medical Causes of Death

# Death Rates (age-adjusted), United States



Source: D. Cutler *et al.*, *Journal of Economic Perspectives* 20(3): 97-120, 2006

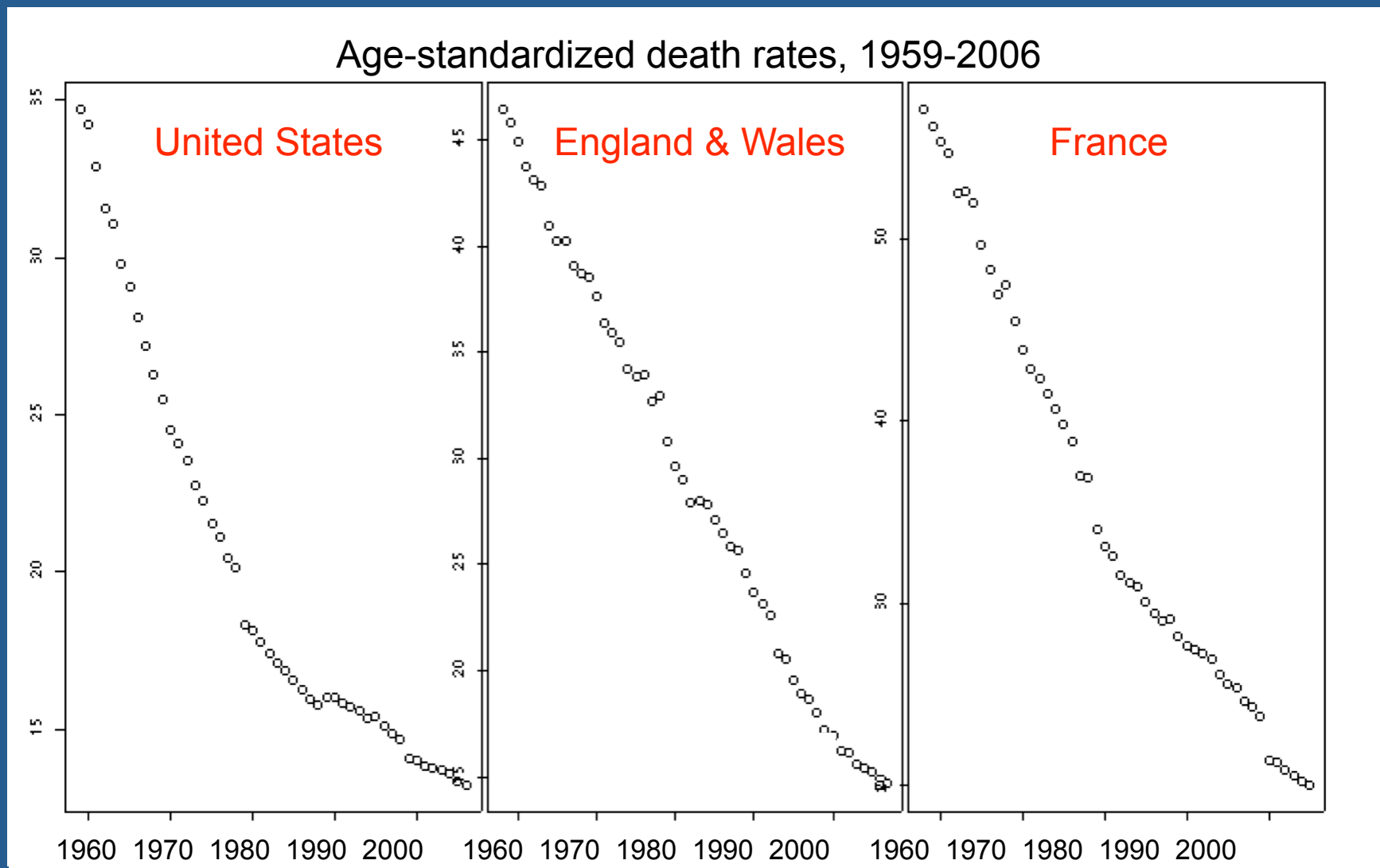
# Medical Causes of Decrease in Infectious Disease Mortality

- Collective efforts to control the spread of infection (sanitation, clean water, quarantine)
- Better personal hygiene (cleanliness, avoiding close contact with sick persons)
- Anti-bacterial drugs (sulfonamides, antibiotics)

# Medical Causes of Decrease in Cardiovascular Disease Mortality

- Decline in cigarette smoking
- Changes in diet, especially a reduction in consumption of saturated fat and cholesterol
- Medical interventions to control high blood pressure and high cholesterol levels
- Better diagnosis and treatment of heart disease and stroke
- More and better coronary-care units and emergency services

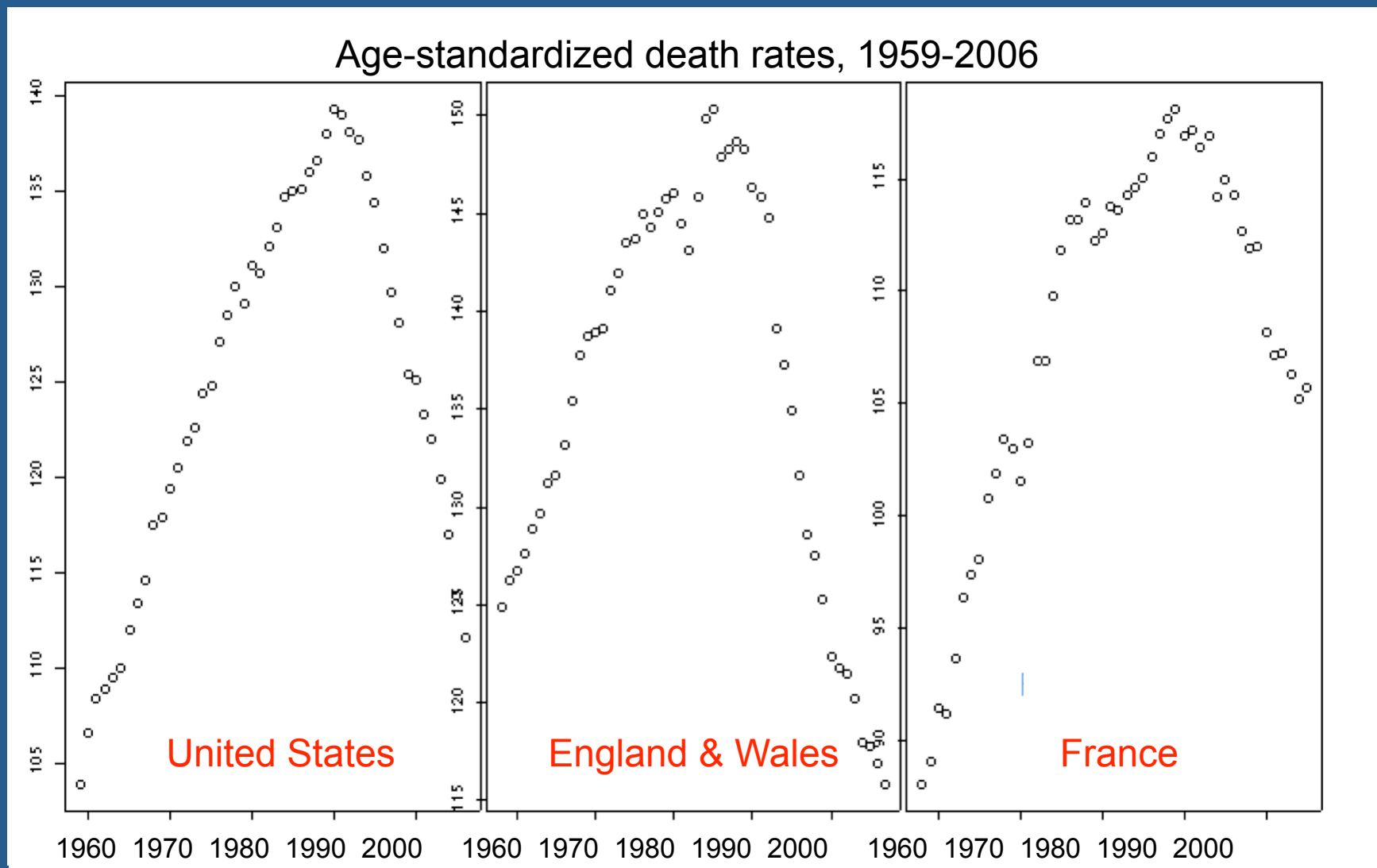
# Cancers with Infectious Causes\*



\* Stomach, uterus, and liver

Source: O. Gersten, M. Barbieri and J. Wilmoth (in preparation)

# Cancers with Non-Infectious Causes\*



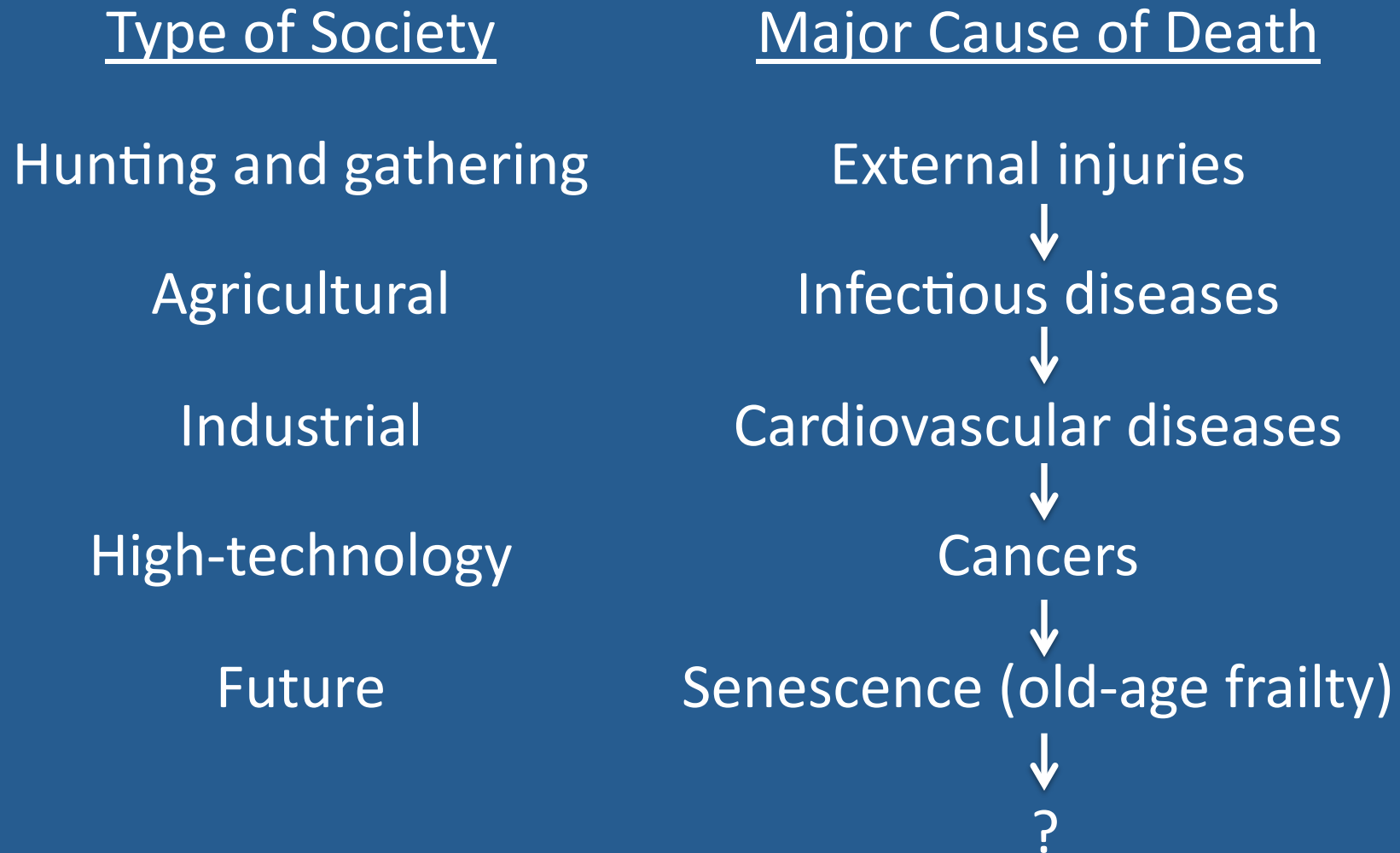
\* Lung, breast, colorectum, pancreas, esophagus, prostate and leukemia

Source: O. Gersten, M. Barbieri and J. Wilmoth (in preparation)

# Medical Causes of Decrease in Cancer Mortality

- Better control of infection (*H. pylori*, human papilloma virus, hepatitis)
- Decline in cigarette smoking
- Improved treatment (surgery, chemotherapy)
- Better screening and earlier treatment

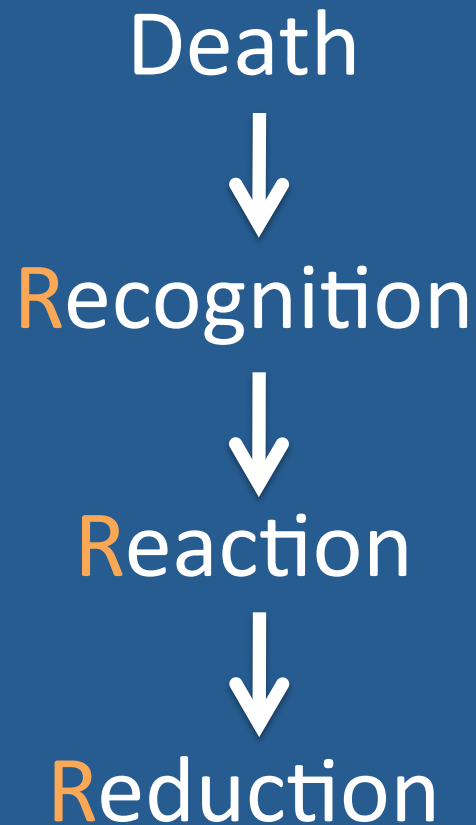
# Epidemiologic Transitions in Human History



Source: S. Horiuchi, in United Nations, *Health and Mortality: Issues of Global Concern*, 1999

# Social and Historical Causes

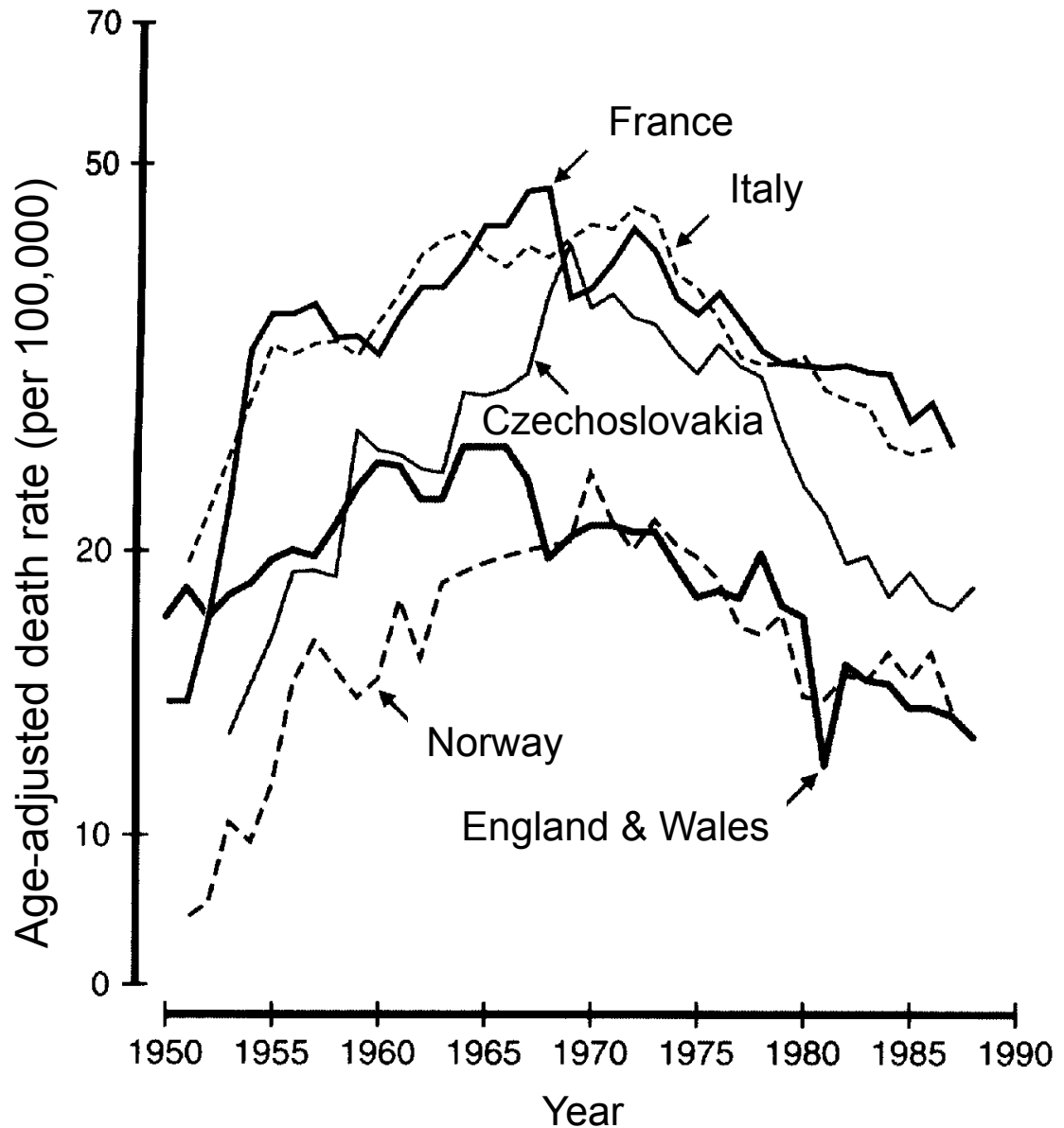
# Why Mortality Falls over Time



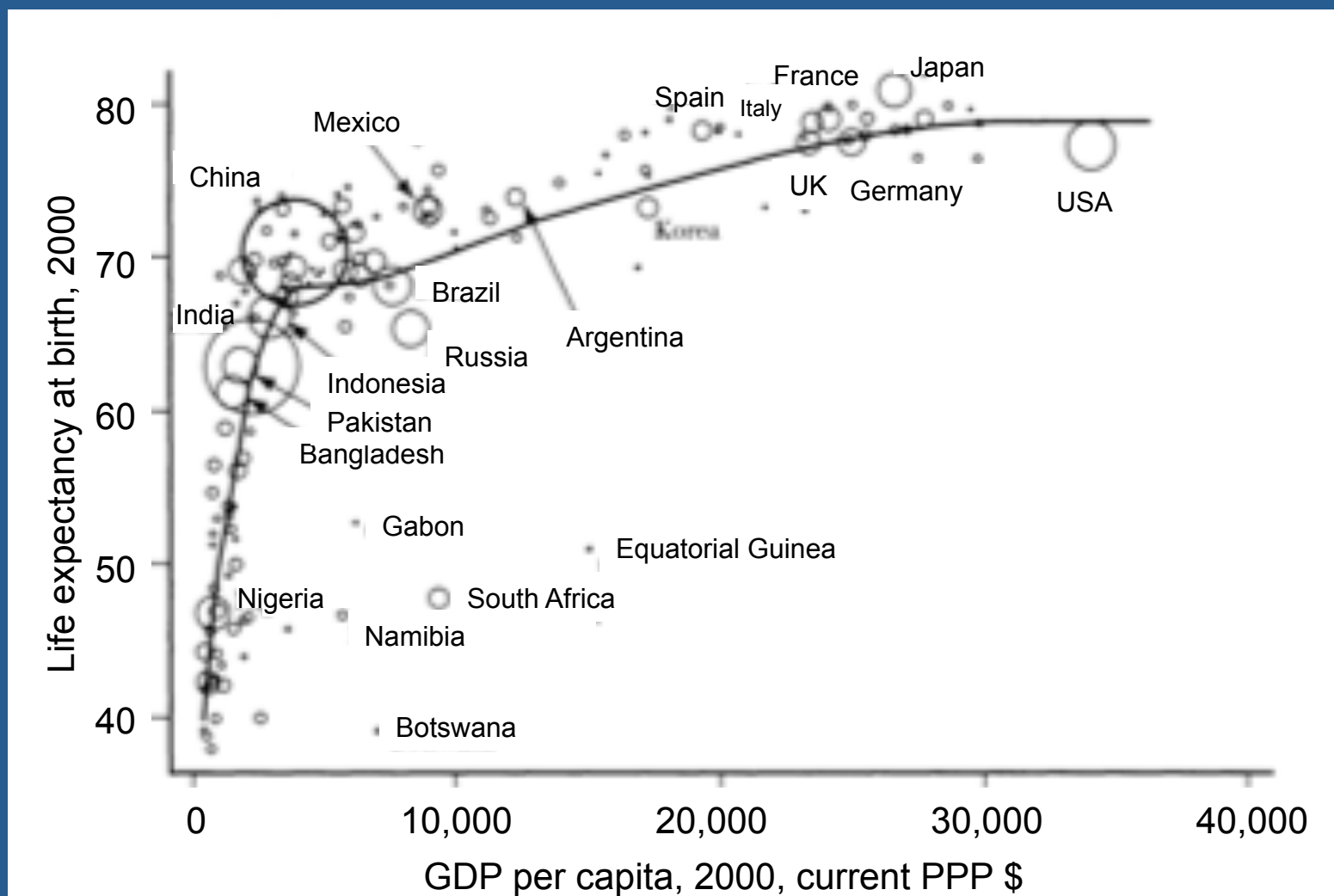
# Road Accident Death Rates

## 5 Countries 1950-1987

Source: F. Meslé,  
*Médecine/Science*  
13: 1008-1017, 1997



# Income and Life Expectancy



Source: A. Deaton, *Journal of Economic Literature* 41: 113-158, 2003

# Major Social and Historical Causes of Longevity Increase

- Increasing income (better nutrition, housing)
- Science and technology
- Application of science and technology

# Major Scientific Breakthroughs

## Scientific Discovery

Confirmation of germ theory of disease, 1880s

Discovery of anti-bacterial drugs, 1930s and 1940s

Development of effective therapies for cardiovascular disease and some cancers, late 1960s to the present

## Impact on Mortality

Helped spawn public health movement of late 19<sup>th</sup> and early 20<sup>th</sup> centuries

Led to effective therapies and improved survival of sick persons (all ages)

Delayed onset of disease and improved survival after diagnosis (older adults )

# Limits to the Human Life Span?

# Possible Limits

- Could there be some biological limit with respect to the **maximum** life span?
  - Logical difficulty of specifying an age that marks the upper limit of the human life span
  - World record life span has been increasing
  - Maximum ages at death for individual countries have been increasing

Jeanne  
Calment

1875-1997



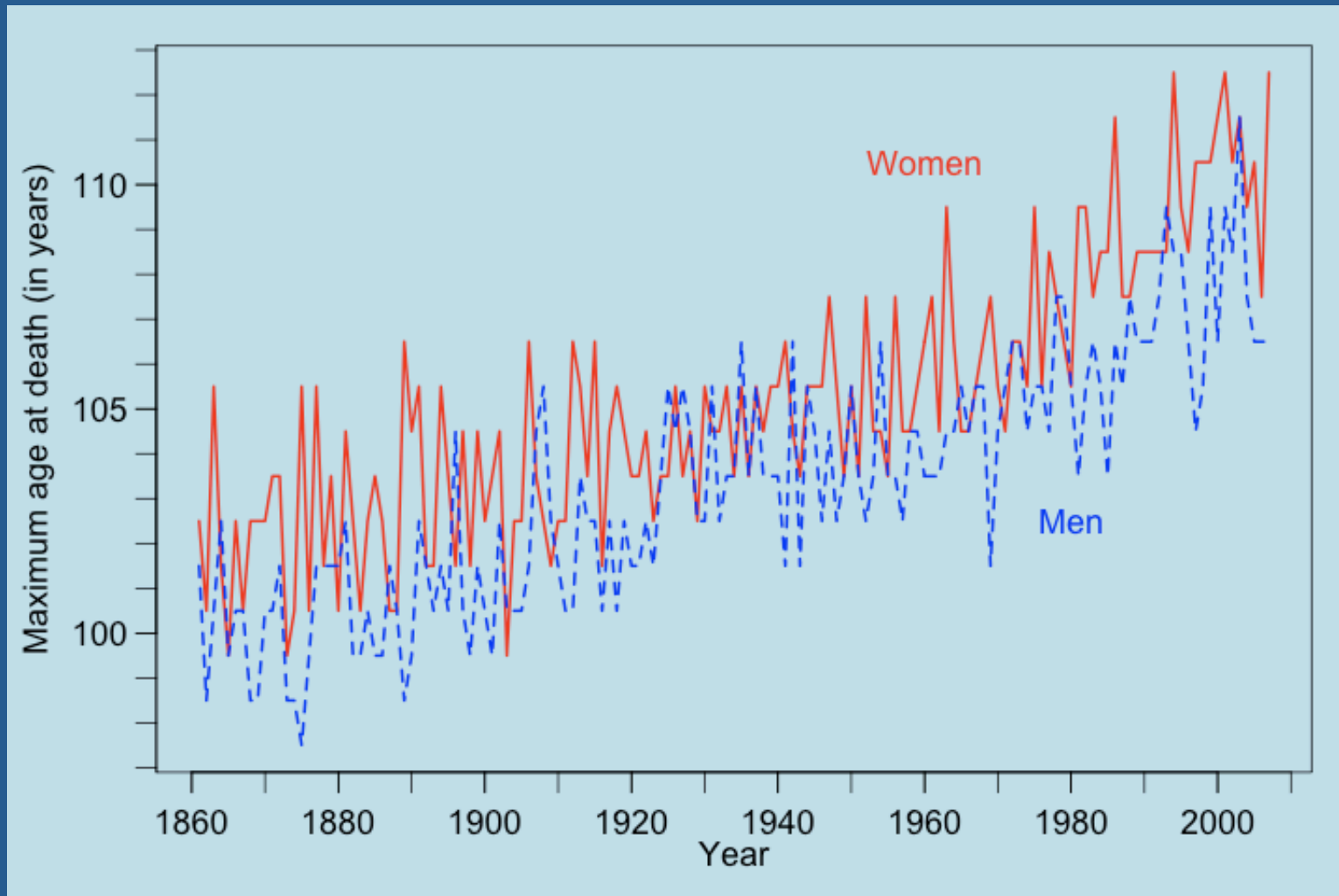
Christian  
Mortensen

1882-1998



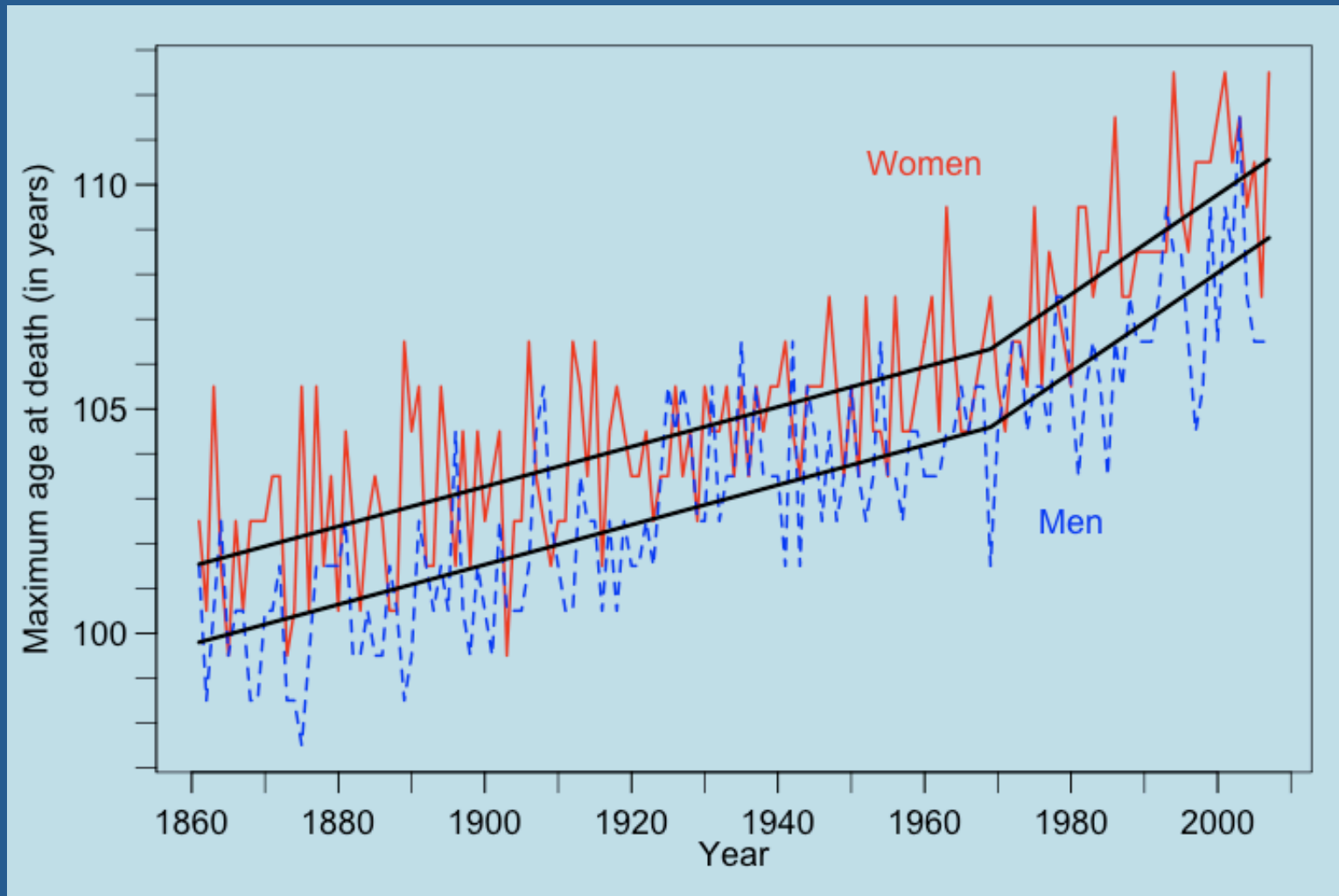
Examiner / Katy Raddatz

# Maximum Age at Death, Sweden, 1861-2007



Source: Wilmoth *et al.*, *Science* 289: 2366-8, 2000 (updated)

# Maximum Age at Death, Sweden, 1861-2007

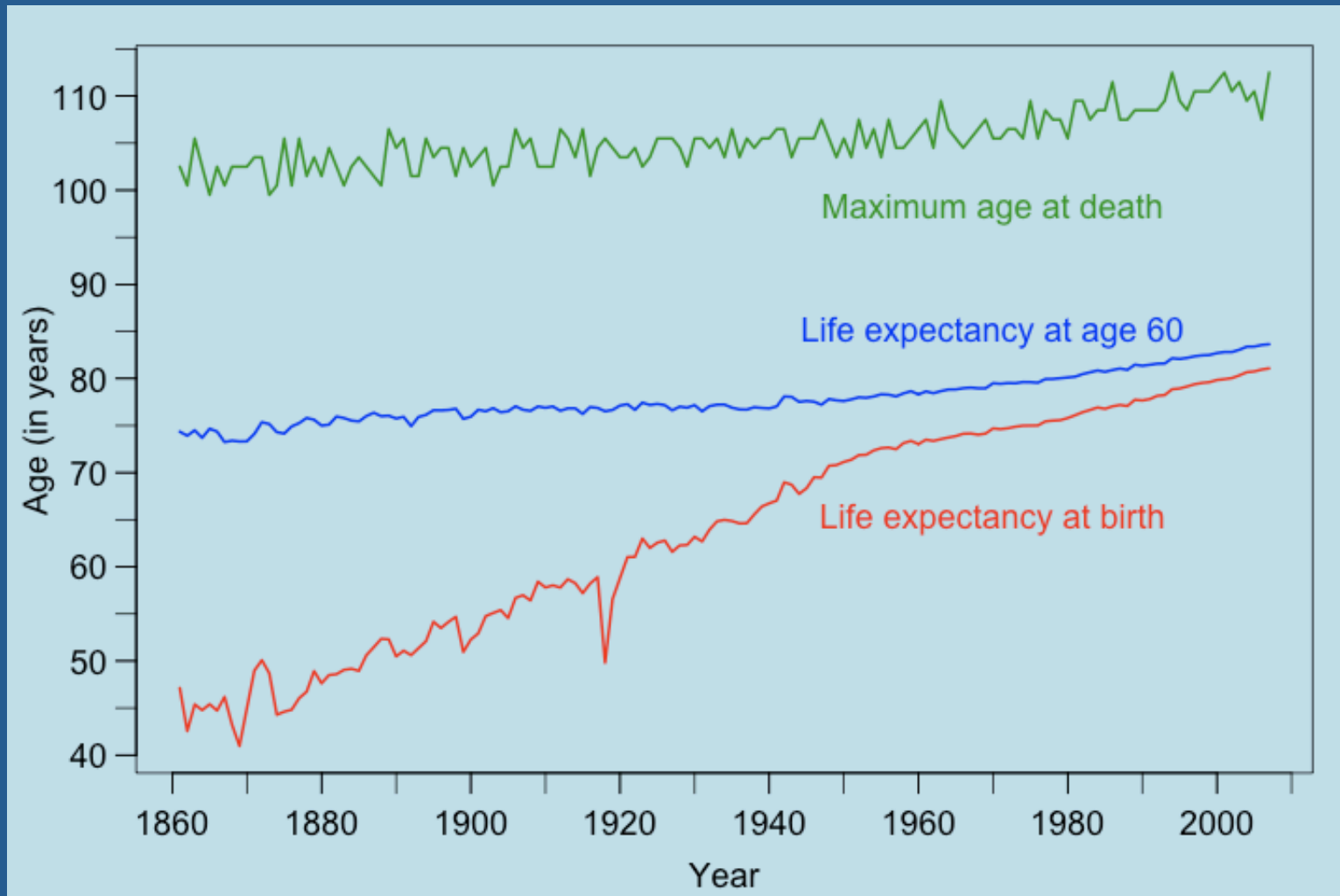


Source: Wilmoth *et al.*, *Science* 289: 2366-8, 2000 (updated)

## Possible Limits (cont.)

- Could there be some biological limit with respect to the **average** life span?
  - Difficult to specify a lower bound (absolute minimum) for age-specific death rates
  - Available data do not provide strong evidence (thus far) for convergence to a limit
  - Some countries with very low mortality (like Japan) continue to make very rapid gains in longevity

# Mean vs. Maximum Age at Death, Sweden



Data source: Human Mortality Database, 2009 ([www.mortality.org](http://www.mortality.org))

# Summary of Longevity Trends

## Summary of major trends in human longevity in industrialized countries

	Before 1960	After 1970
Average life span	Increasing rapidly	Increasing moderately
Maximum life span	Increasing slowly	Increasing moderately
Variability of life span	Decreasing rapidly	Stable

## Change (per decade) in key mortality indicators, Sweden

	1861-1960	1970-1999
Average life span	3.1	1.8
Maximum life span	0.4	1.5
Inter-quartile range	-5.8	-0.3

# Future Prospects

# Expected Trends in Life Expectancy at Birth

	<u>2009</u>	<u>2029</u>	<u>2049</u>
WORLD	68	72	76
More developed regions	77	81	83
Australia	82	84	86
France	81	84	86
Japan	83	85	87
United States	79	82	83
Less developed regions	66	71	75
Brazil	73	77	80
China	73	77	79
India	64	70	74
Nigeria	48	55	63

Source: United Nations, *World Population Prospects: 2008 Revision*, 2009

# Lessons of History

- Mortality decline results from a deep human desire for longer life
- Past increase was due to many causes acting simultaneously or in sequence
- No one factor caused the increase in the past; probably no one factor can stop the increase in the future
- With continuing economic growth and political stability, there are no obvious limits to future gains in human longevity

The End