Joint Colloquium of the IACA, PBSS and IAAHS Sections of the International Actuarial Association

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U.S. Mortality

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IACA

SECTION SUR LES PENSIONS, AVANTAGES SOCIAUX ET SÉCURITÉ SOCIALE DE L'AAI
IAA PENSIONS, BENEFITS AND SOCIAL SECURITY SECTION
PBSS

SECTION SANTÉ DE L'AAI
IAA HEALTH SECTION
IAAHS

Agenda

- Introduction
- Historical experience
- Issues moving forward

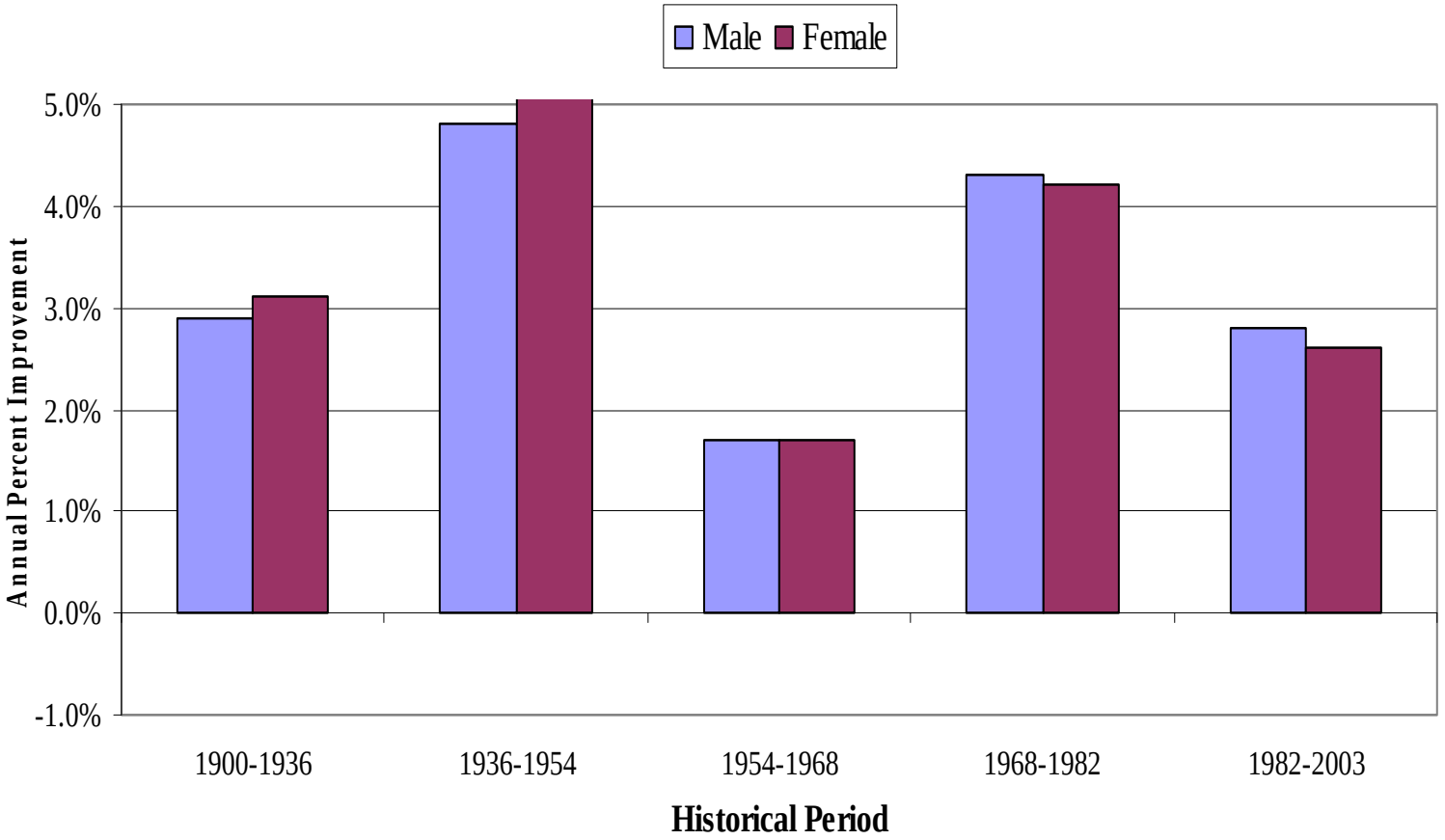
Introduction

- U.S. mortality has experienced a century-long period of mortality improvement
- Different drivers of change have affected mortality in different historical periods
- Will we continue to benefit from recent sources of improvement?
  - Where might future sources of improvements come from?
  - Or will we stagnate or fall back?

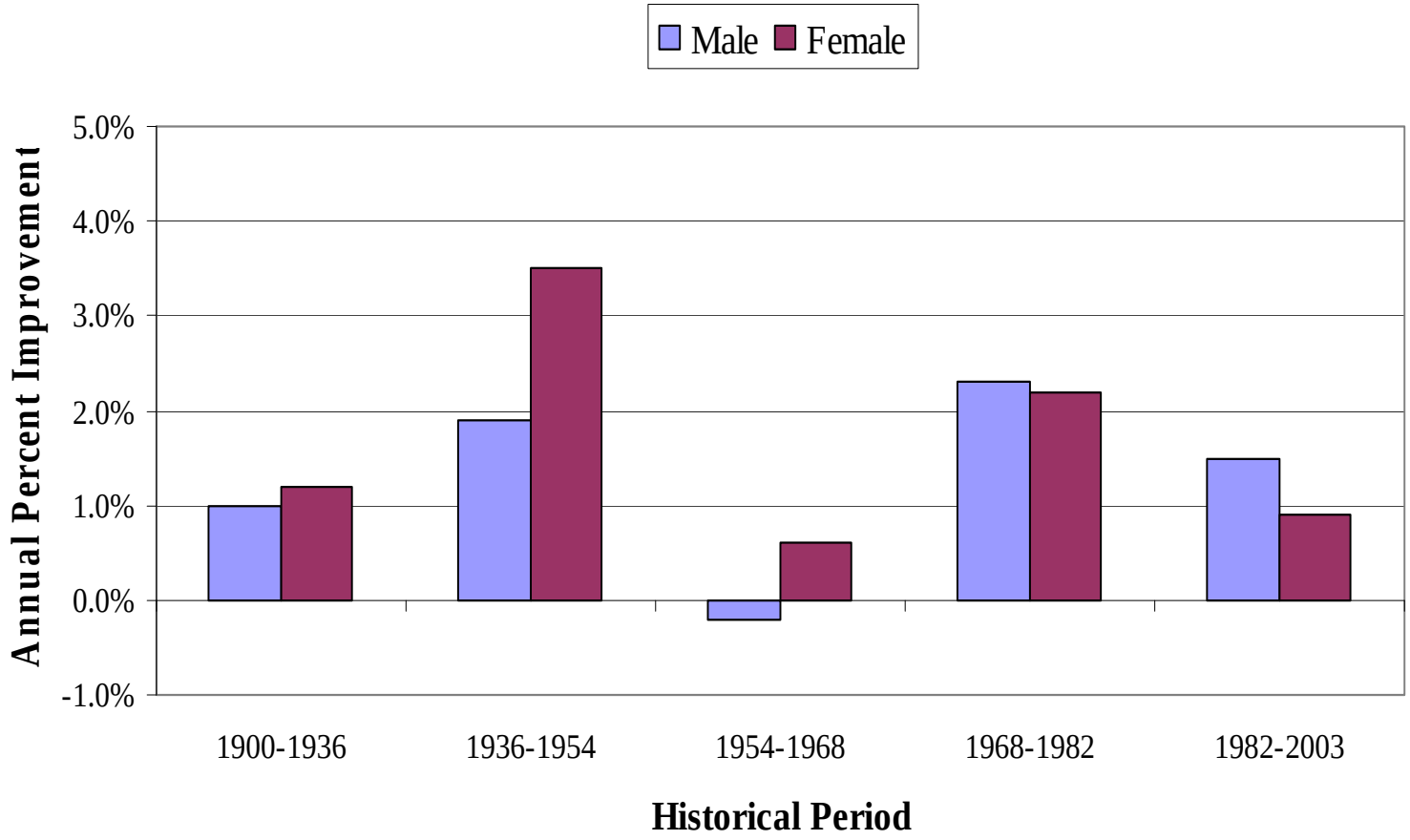
Introduction (2)

- The effect of U.S. historical trends have varied by age group and period
- First half of 1900s
  - Public sanitation
  - Communicable diseases
- Mid 1900s
  - Antibiotics
  - Treatment of cardiovascular risk factors and disease
- End of 1900s
  - Treatment of cardiovascular risk factors and disease
  - Reduction in smoking (males so far)
  - Introduction of Medicare and Medicaid
- 2000s
  - More elderly taking medication?

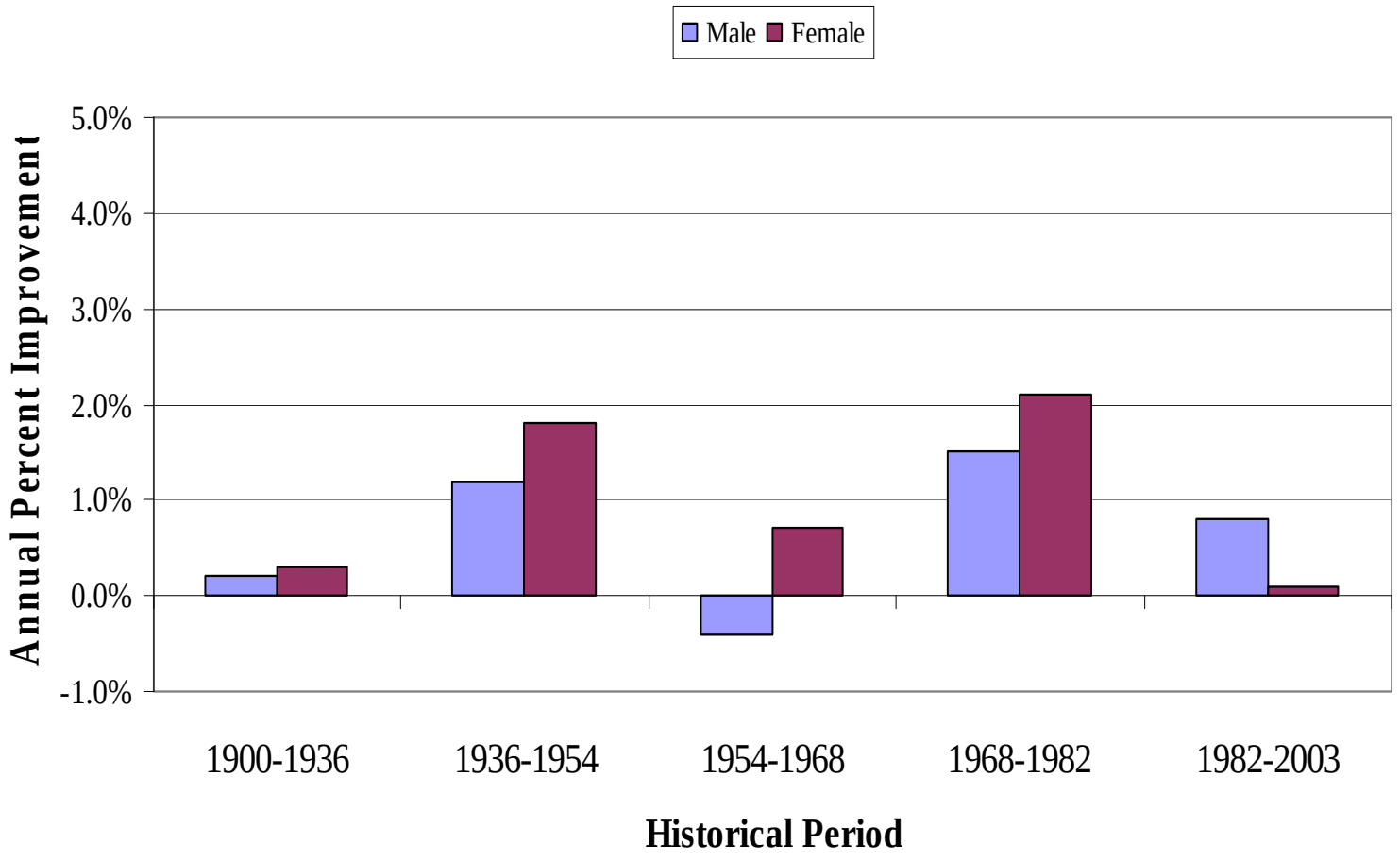
Rates of Mortality Improvement for Ages 0-14



Rates of Mortality Improvement for Ages 15 - 64



Rates of Mortality Improvement for Ages 65 +



Historical Trends

- A lull in the 1950s and 1960s – due to smoking?
- Significant spurt in the 1970s and 1980s
  - Most significant were significant annual mortality improvements in cardiovascular diseases
- Apparent slow down in the 1990s
  - Reduction in coronary heart disease improvements
  - Among young adults, deterioration in several CHD risk factors
- Between 1980 and 2002
  - Overall mortality decrease of 52%
- Improvement in the last five years for those over age 85

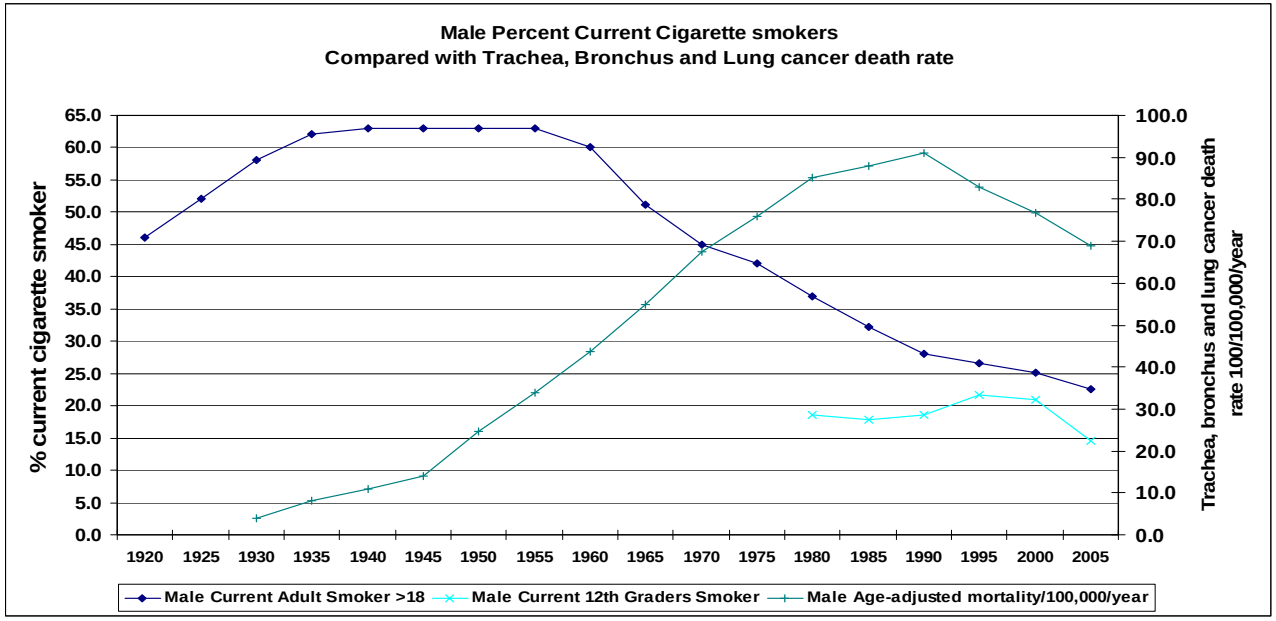
Sources of improvements in mortality between 1980 and 2000

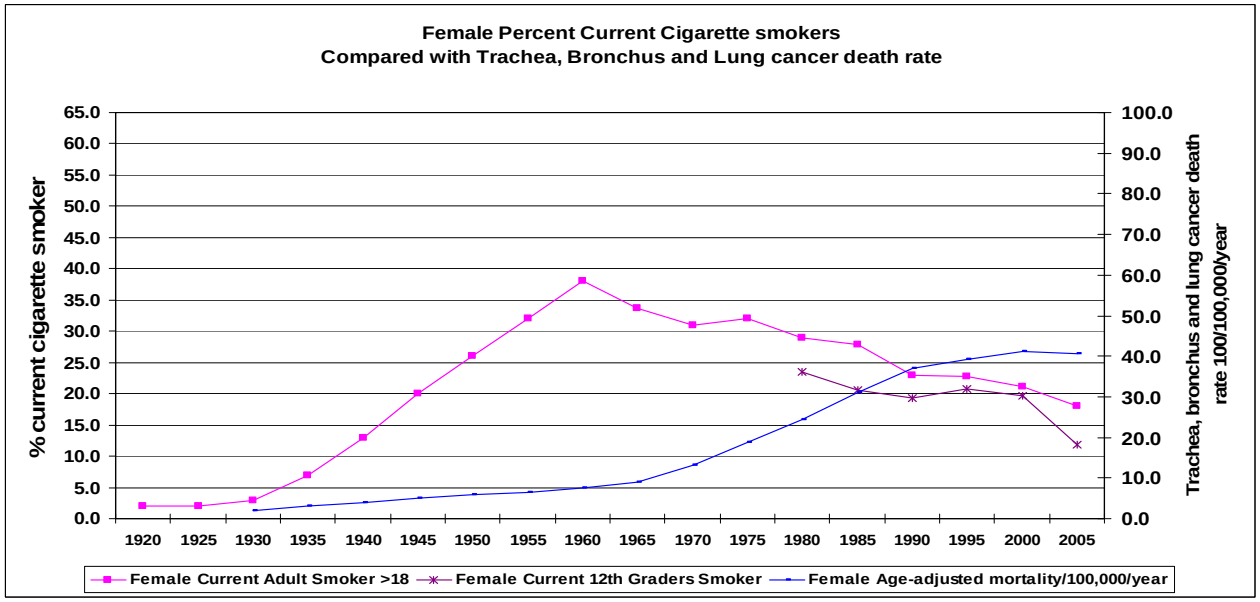
- 40% reduction in cardiovascular heart disease
- Unlike the U.K., no cohort pattern evident
- Attribution by source (Ford et al., 2007)

Source	Contribution
Medical treatments	47%
Reduced total cholesterol levels	24
Reduced blood pressure levels	20
Reduced smoking prevalence	12
Increased physical activity	5
Increased wieght	- 8
Increased diabetes prevalence	- 10

Potential future trends affecting mortality

- Long-term effects of smoking
  - Mortality decline already started for males
  - Will start soon for females
  - Still 20% of adults are smokers, mostly lower income
- Cardiovascular diseases
  - Have seen spectacular reductions
  - Reductions diminishing lately
- Obesity and diabetes
  - Significant increases in the last 30 years
  - A surprise and future risk
- Possible long-range effects
  - Genetics applications
  - Aging research possible


Male Percent Current Cigarette smokers
Compared with Trachea, Bronchus and Lung cancer death rate
% current cigarette smoker
Trachea, bronchus and lung cancer death rate 100/100,000/year
65.0
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005
Male Current Adult Smoker >18
Male Current 12th Graders Smoker
Male Age-adjusted mortality/100,000/year


Female Percent Current Cigarette smokers
Compared with Trachea, Bronchus and Lung cancer death rate
% current cigarette smoker
Trachea, bronchus and lung cancer death rate 100/100,000/year
65.0
60.0
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40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005
Female Current Adult Smoker >18
Female Current 12th Graders Smoker
Female Age-adjusted mortality/100,000/year

U.S. obesity trends

	Males			Females		
Age	**1988-94**	**2001-04**	**2005-06**	**1988-94**	**2001-04**	**2005-06**
20-34	14.1%	23.2%		18.5%	28.6%	
35-44	21.5	33.8		25.5	33.3	
45-54	23.2	31.8		32.4	38.0	
55-64	27.2	36.0		33.7	39.0	
65-74	24.1	32.1		26.9	37.9	
75+	13.2	19.9		19.2	23.2	
Total (age-adjusted)	20.2	29.5	33.3%	25.5	33.2	35.3%
Ethnic Group - adults						
Non-Hispanic white	20.3%	30.2%		22.9%	30.7%	
Non-Hispanic black	20.9	30.8		38.3	51.1	
Mexican	23.8	29.1		35.2	39.4	

Income - adults	**Males and females**	
	1988-94	**2001-04**
< poverty line	28.1%	33.7%
1-2x poverty line	26.1	33.6
> 2x poverty line	21.1	30.0
Total	22.9	31.4

Age - Children	**1971-74**	**1988-94**	**2001-04**
2-5	5.0%	7.2%	12.2%
6-11	4.0	11.3	17.5
12-19	6.1	10.5	17.0

International obesity trends

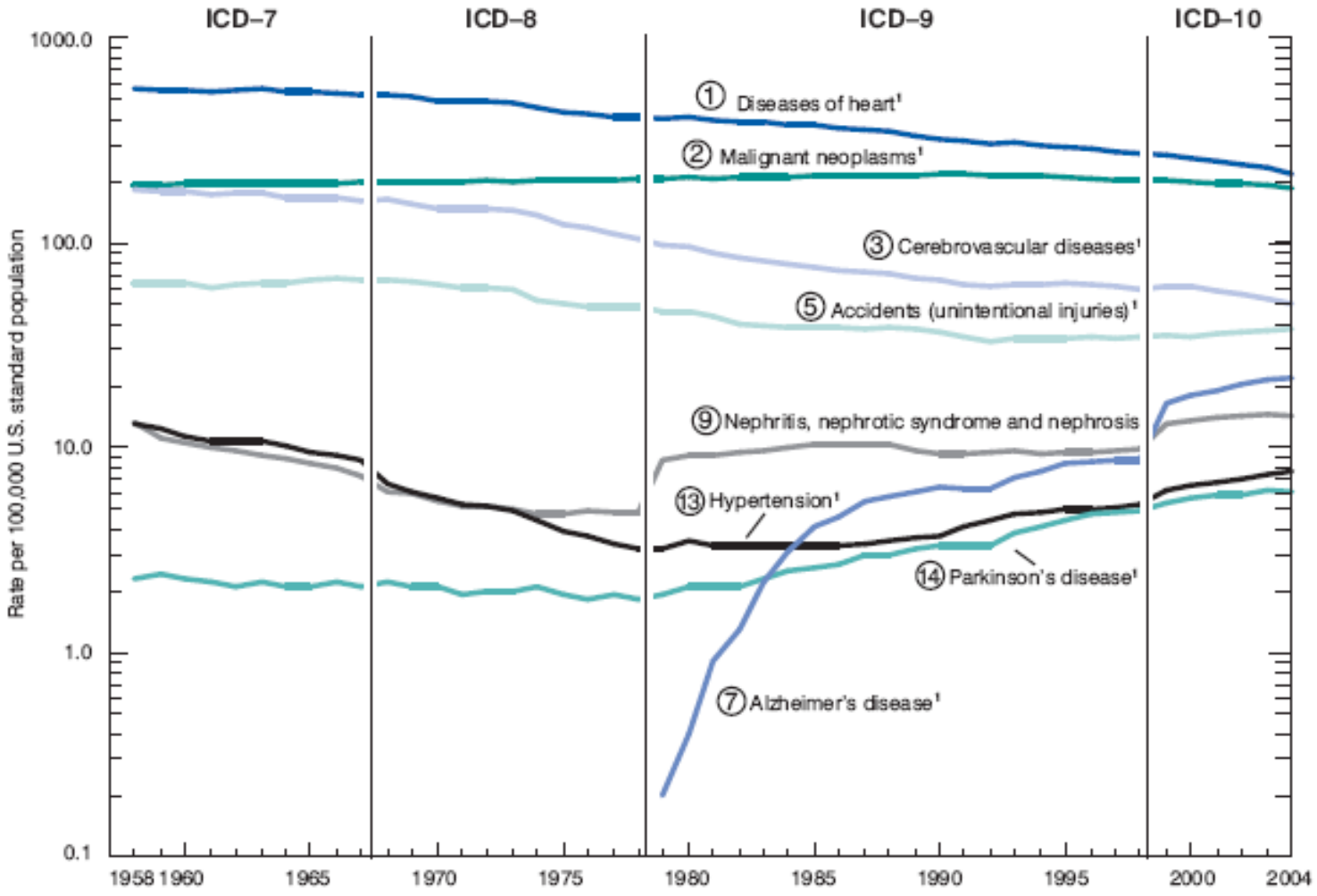
Both in developing and developed countries

Primarily due to increase in ‘western’ food, as well as less physical work, more motorized transport and more sedentary lifestyle

Some OECD countries

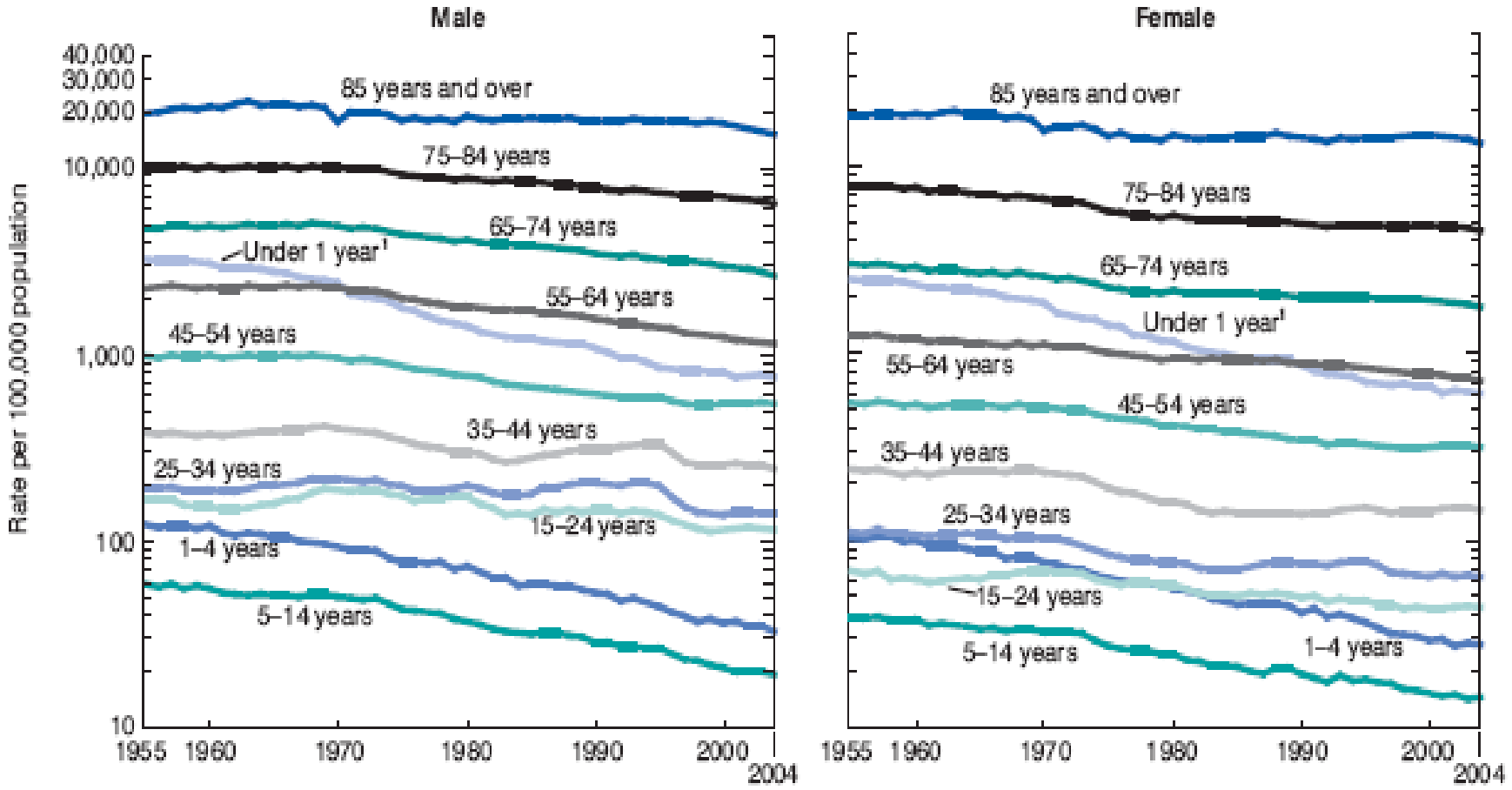
	Obesity levels	
	2005	**1995**
Australia	21.7% (1999)	19.8%
Canada	18.0	12.1
Finland	14.1	10.4
France	9.5	7.0
Japan	3.0	2.6
Mexico	30.2	24.2(2000)
Netherlands	10.7	6.9
New Zealand	20.9	17.0
Spain	13.1	10.3
Sweden	10.7	7.9
Switzerland	7.7	6.8
United Kingdom	23.0	16.0
United States	32.2	22.9(1991)

U.S. Causes of Death (1955-60)



¹Circled numbers indicate ranking of conditions as leading causes of death in 2004.
NOTE: Age-adjusted rates per 100,000 U.S. standard population, see "Technical Notes."
SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

U.S. Mortality Trend by Age (1955-2004)

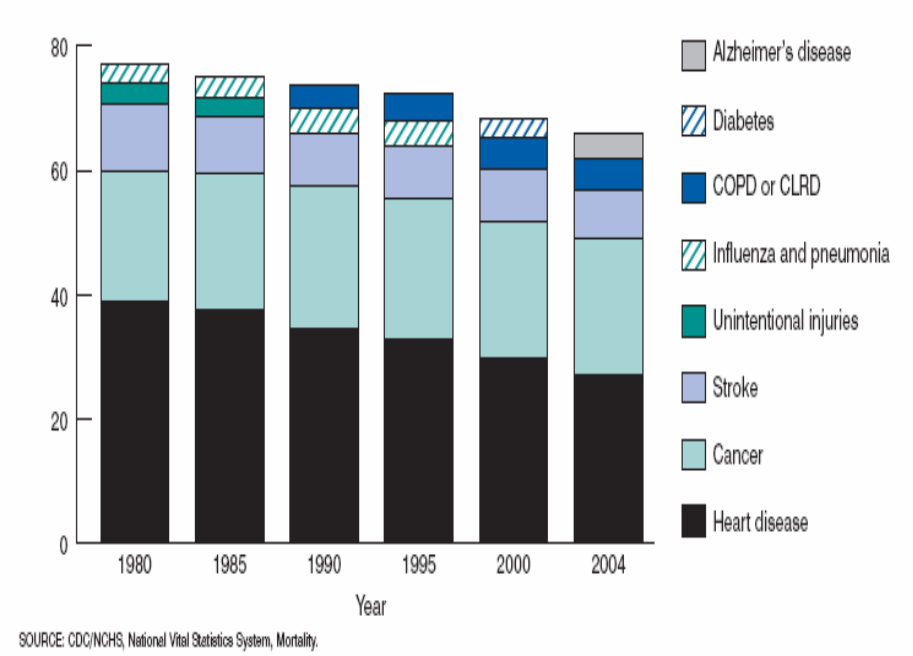


[1]Death rates for "under 1 year" (based on population estimates) differ from infant mortality rates (based on live births); see Figure 6 for infant mortality rates and "Technical Notes" for further discussion of the difference.

SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

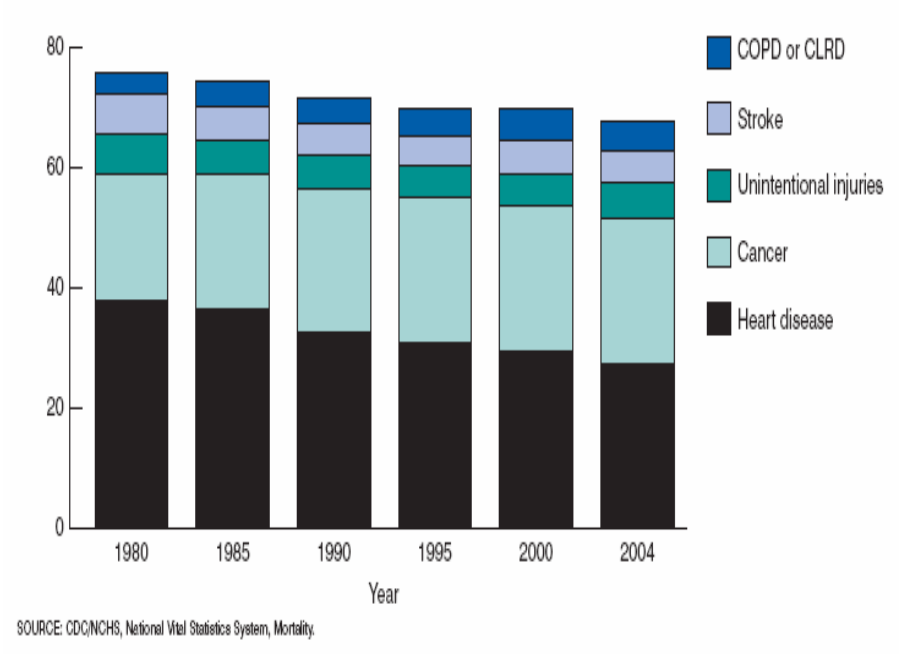
5 Leading U.S. Causes of Death (1980-2004)

Females



SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

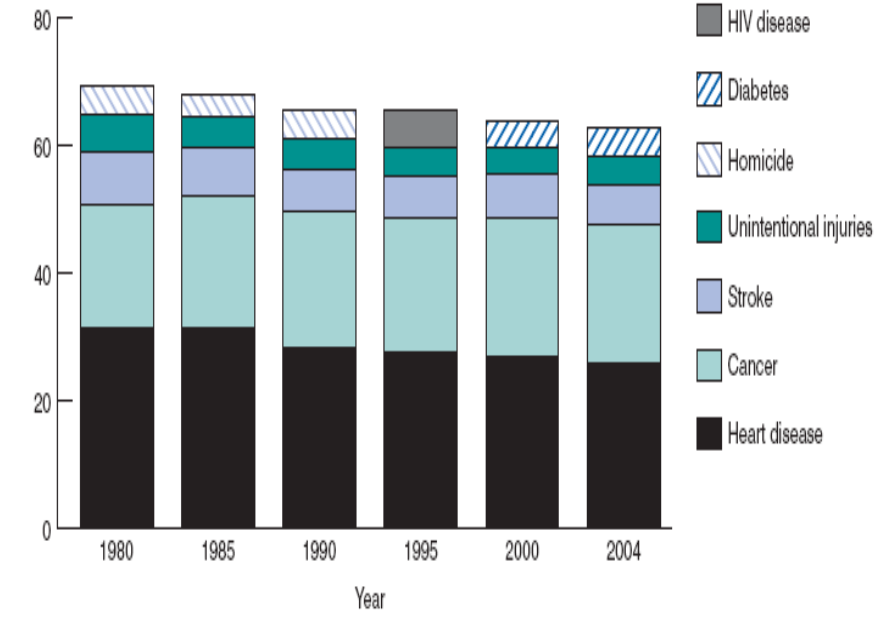
Males



SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

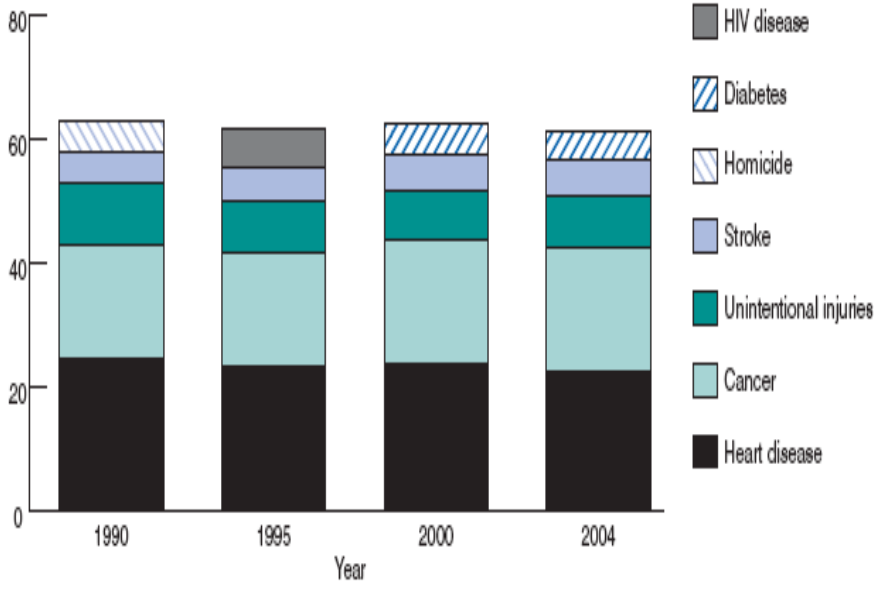
5 Leading U.S. Causes of Death (1980-2004)

Blacks



SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

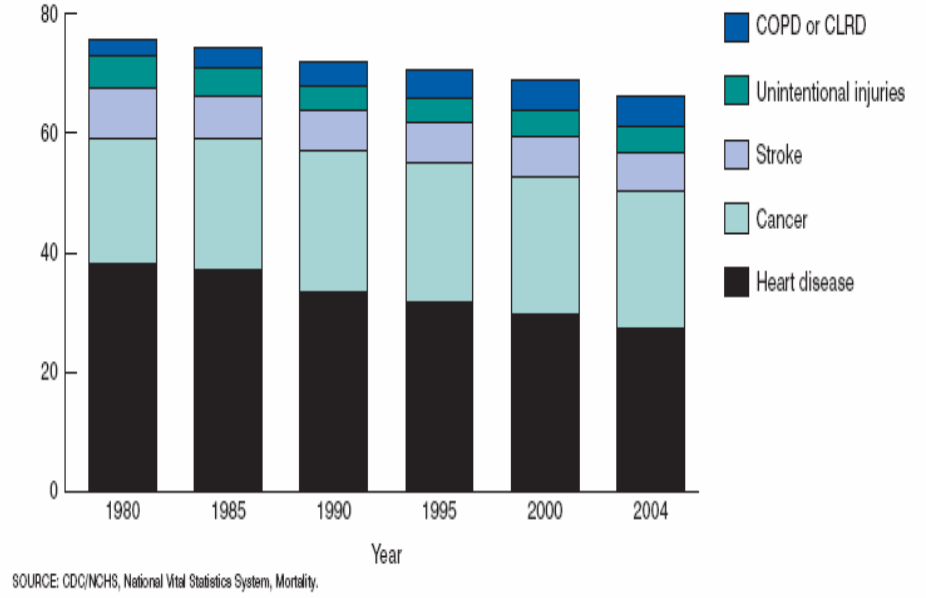
Hispanics



SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.
NOTE: Data for Hispanic persons were first collected in 1984. However, trend data for the Hispanic population are presented only from 1990 because the 1990 data covered 89% of this population compared with 77% or less in earlier years (17,21).

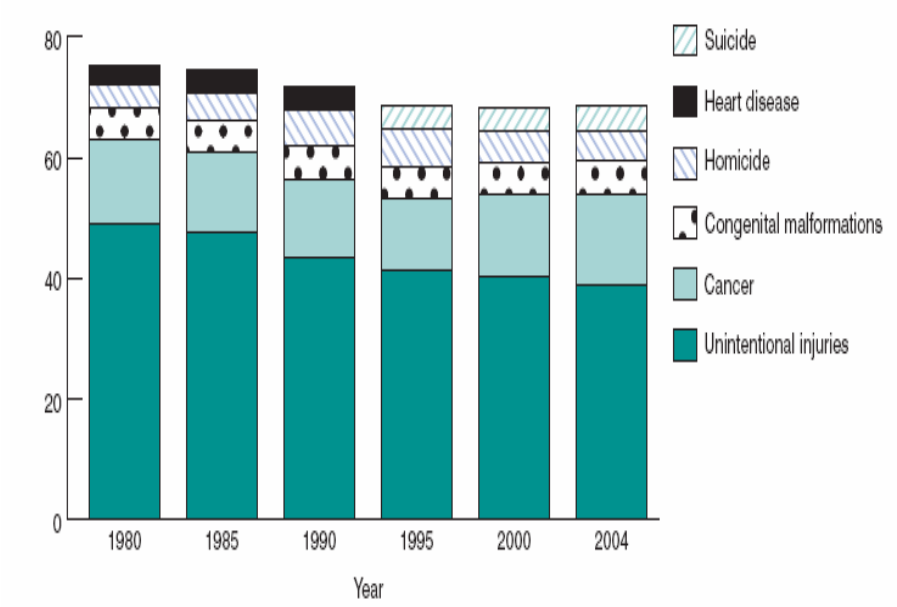
5 Leading U.S. Causes of Death (1980-2004)

All Ages



SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

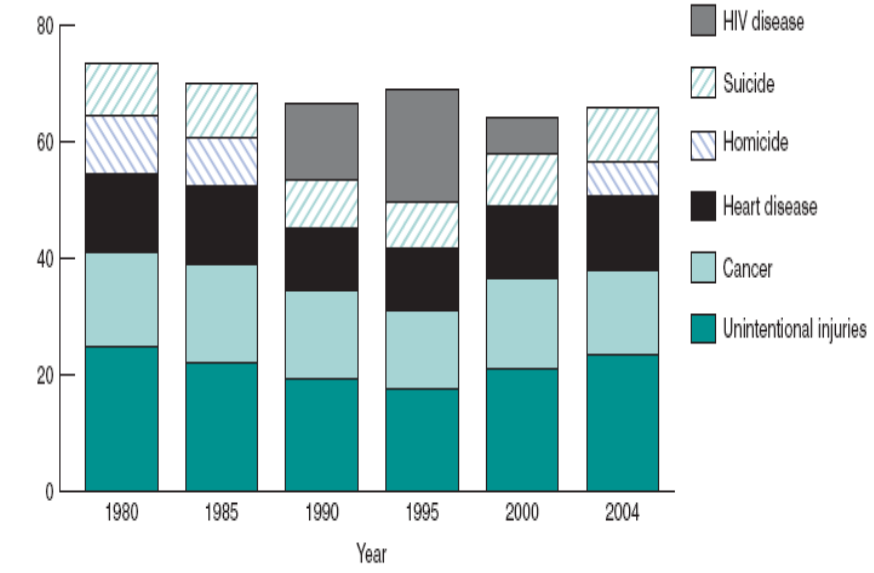
Ages 0-15



SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

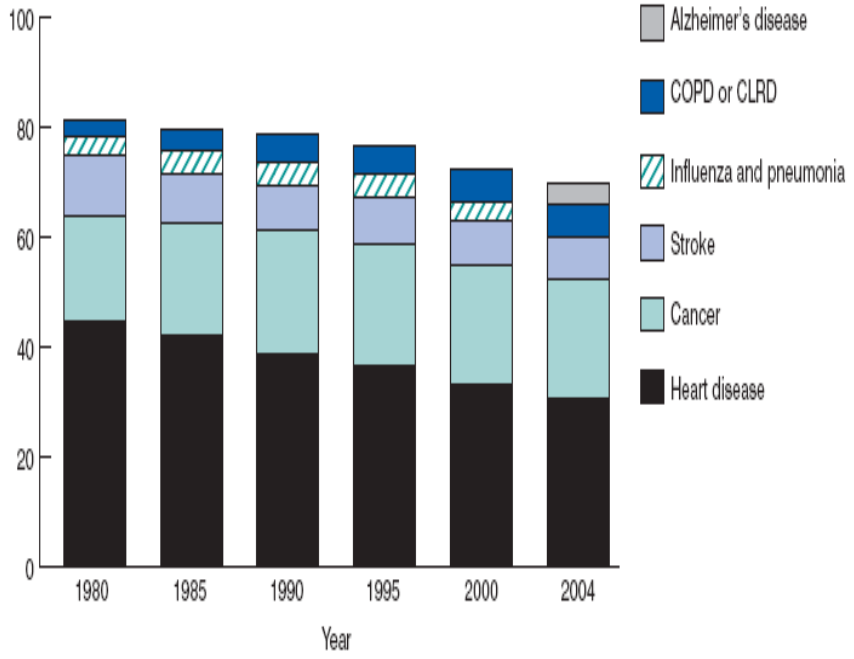
5 Leading U.S. Causes of Death (1980-2004)

Ages 25-44



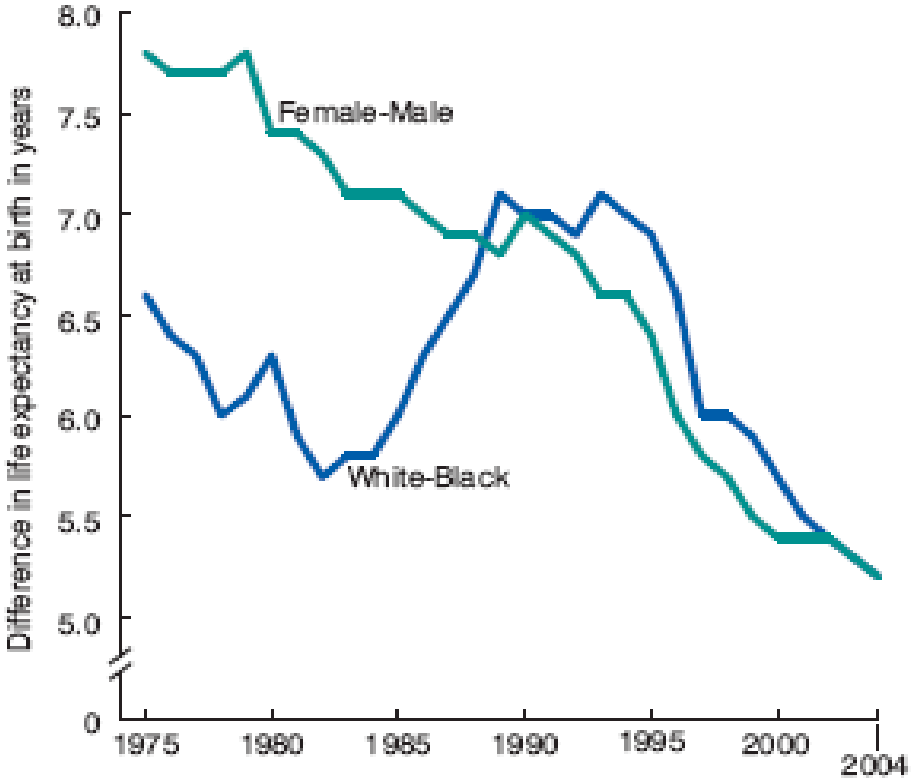
SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

Ages 65+



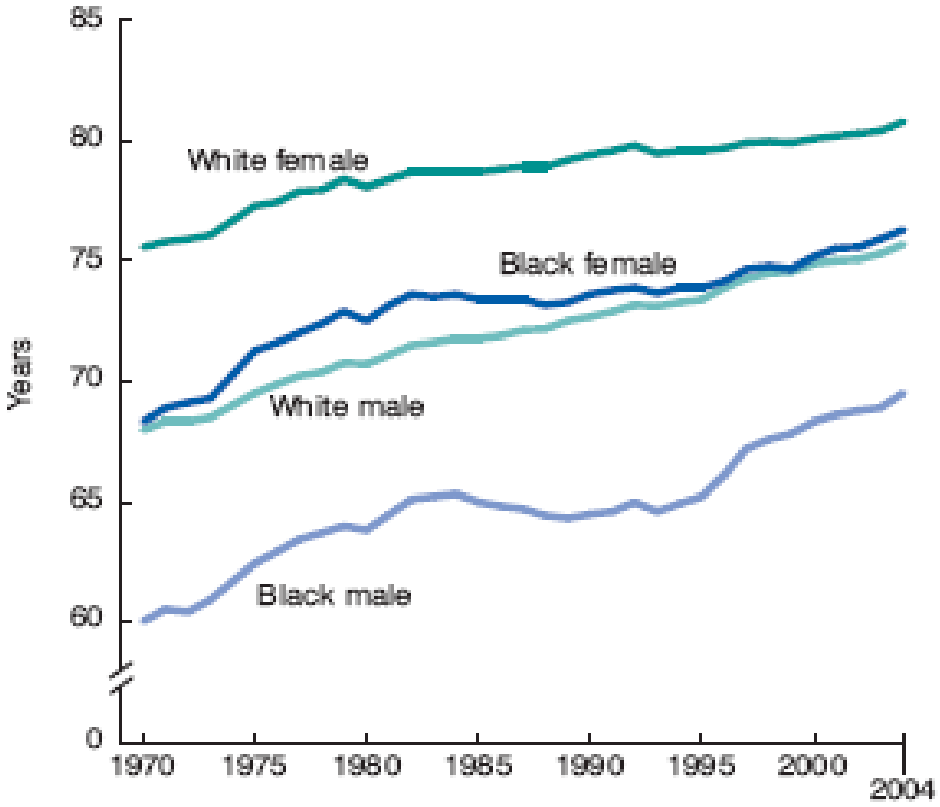
SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

U.S. Life Expectancy Differences Gender and Race



SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

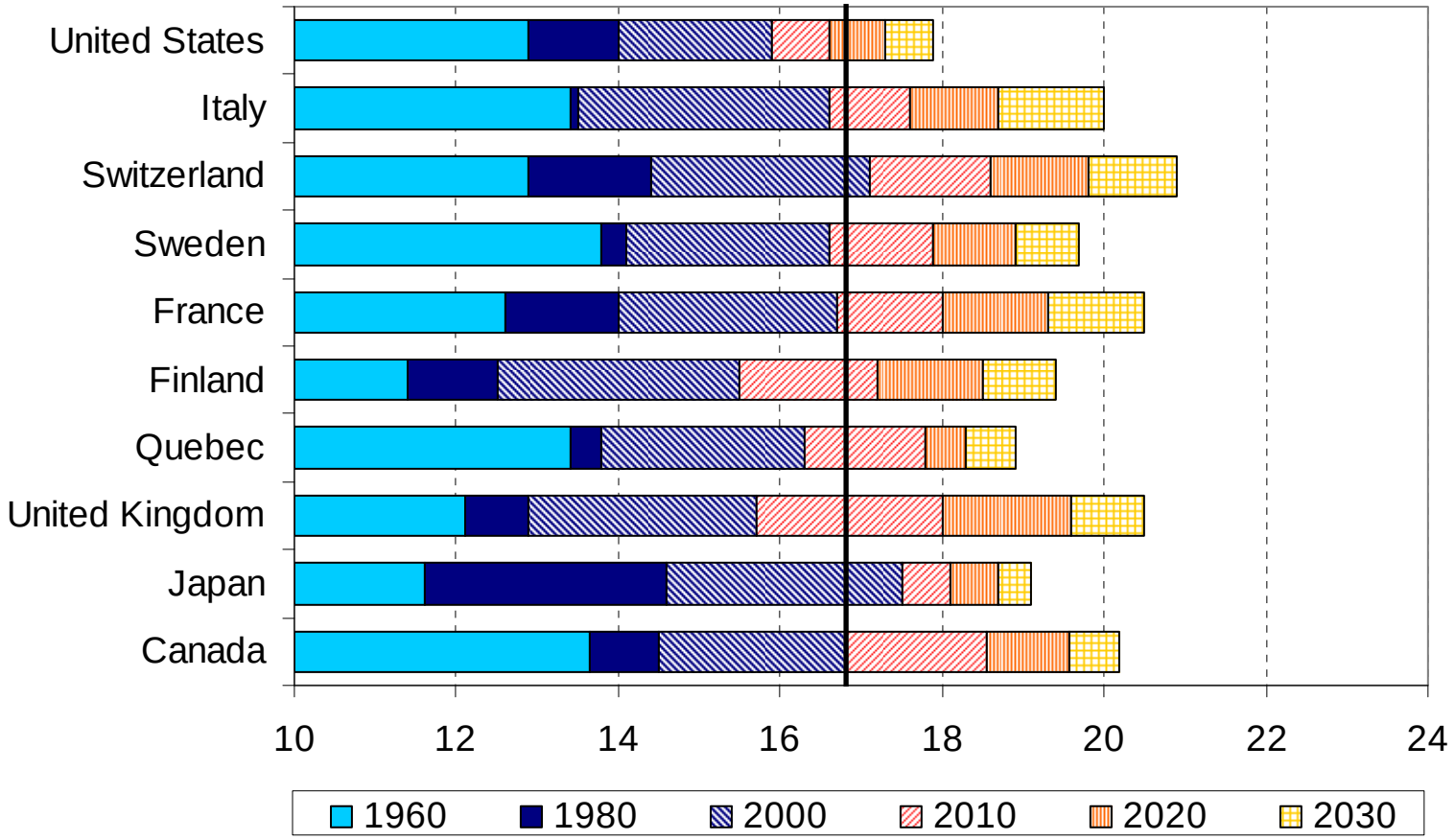
U.S. Life Expectancies Gender and Race



SOURCE: CDC/NCHS, National Vital Statistics System, Mortality.

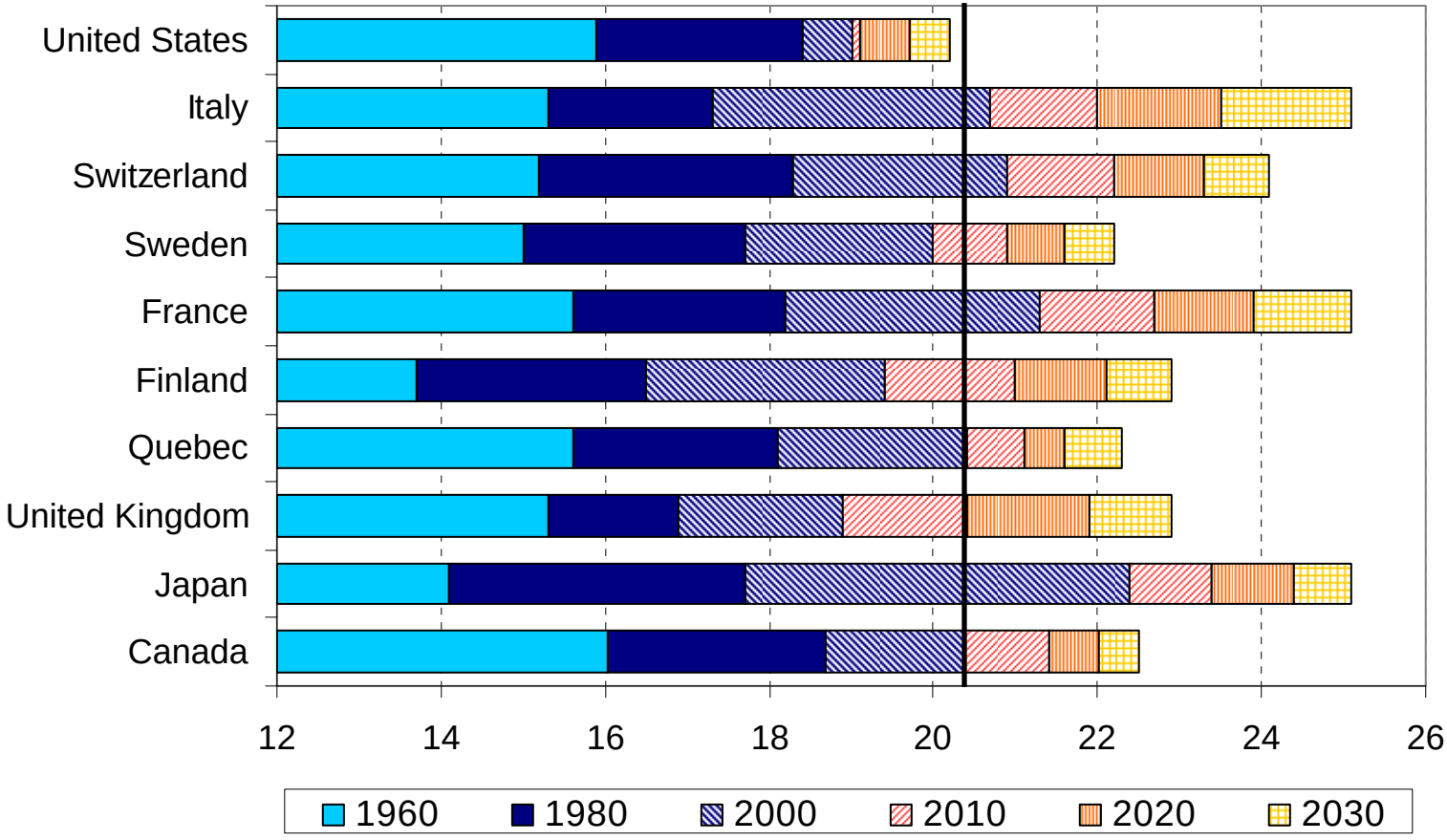
Life expectancy at age 65 for men, 2000-2030

(with no future improvements after year shown)

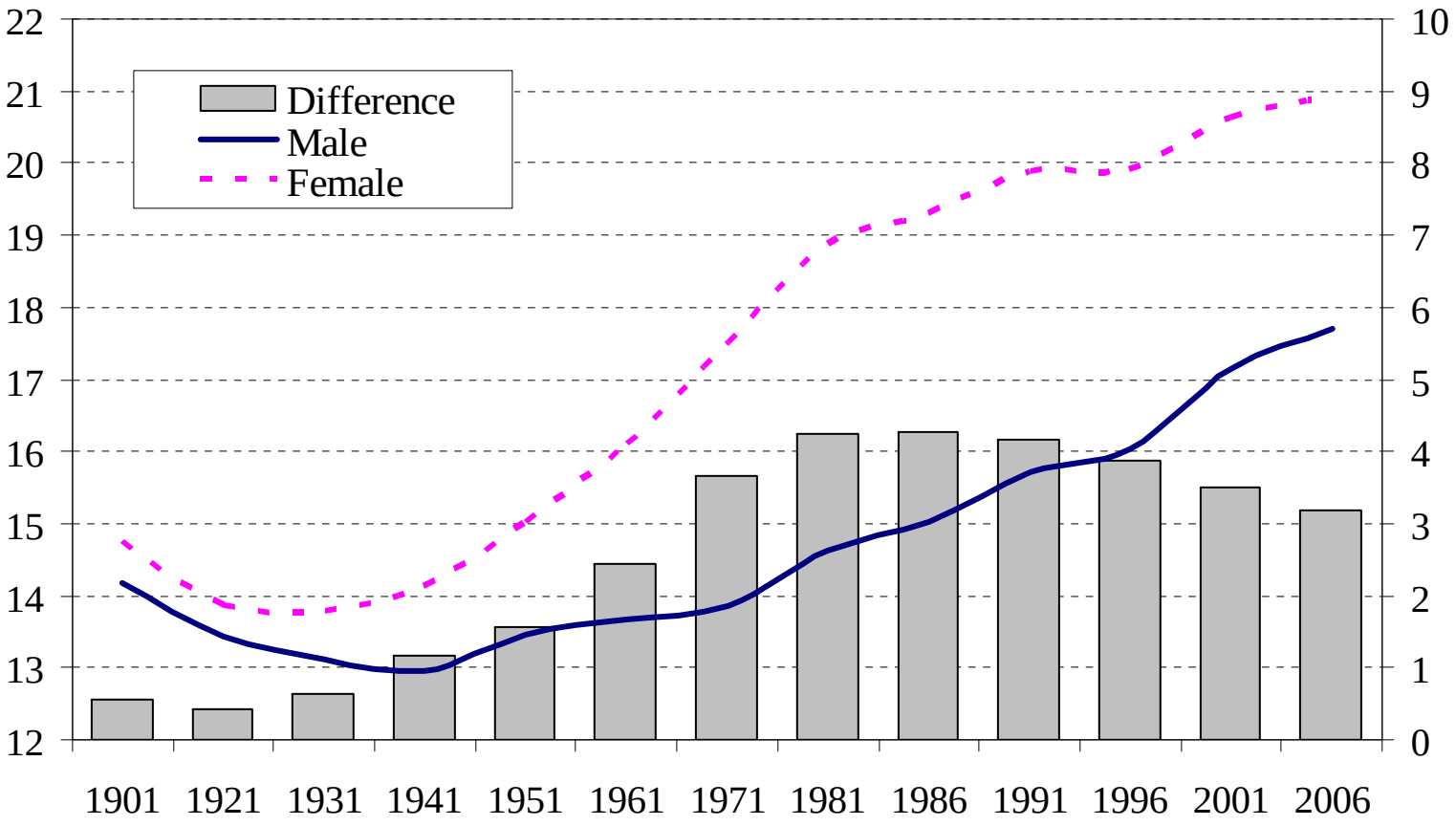


Life expectancy at age 65 for women, 2000-2030

(with no future improvements after year shown)



Life Expectancy at Age 65 (Canada)



Mortality projections

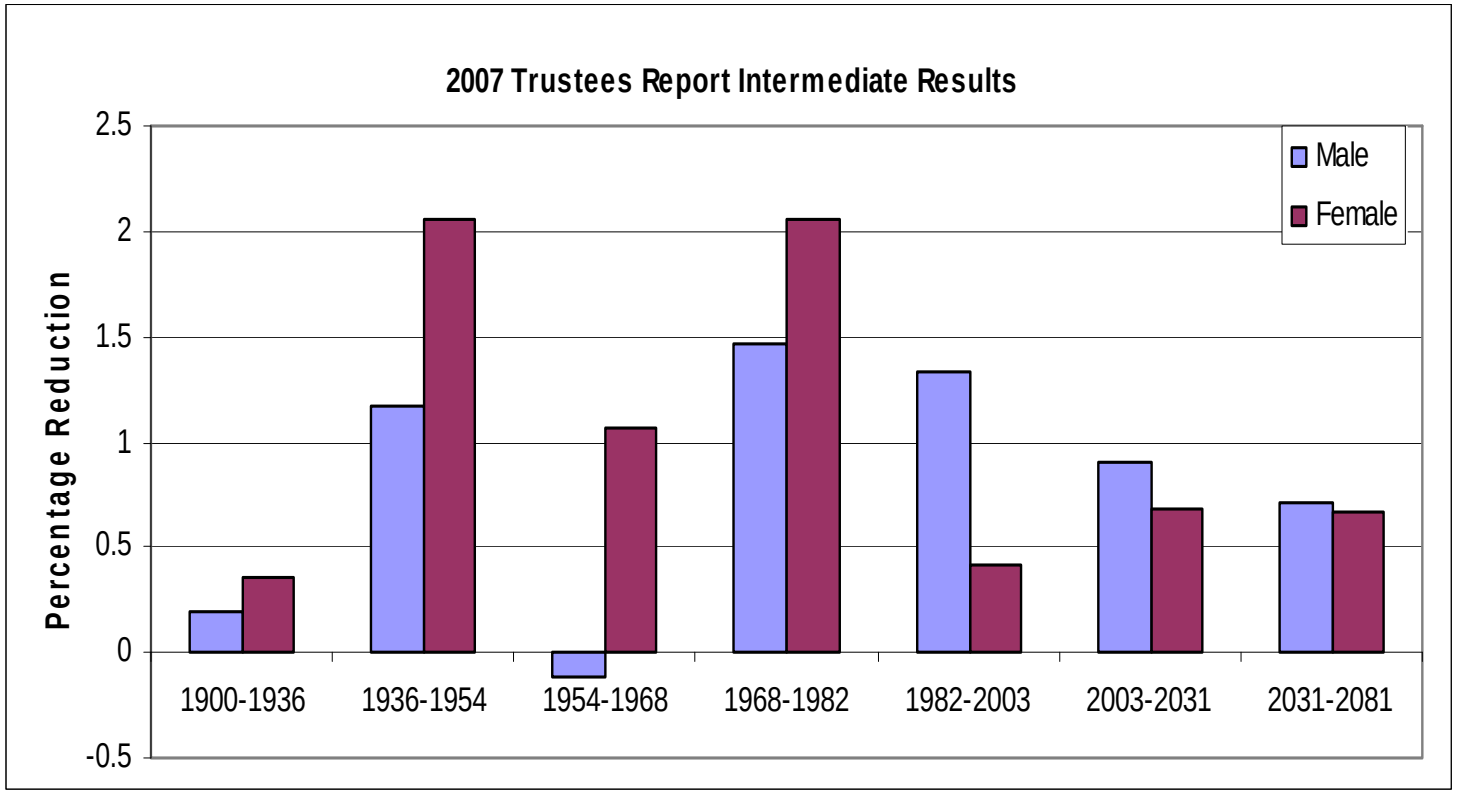
Two basic approaches

- Statistical
  - Project mortality from past trends
  - Current favored example – Lee-Carter
- Structural
  - Explore causes of death data
  - Reflect recent and expected trends – smoking, obesity
  - But can future changes are unknown and likely to be a dynamic response to adverse trends
- Both have strong advocates
  - Optimistic
    - Vaupel – best nation experience
    - Lee-Carter -- extrapolation of past experience
    - Biologists
  - Pessimistic
    - Behaviorists

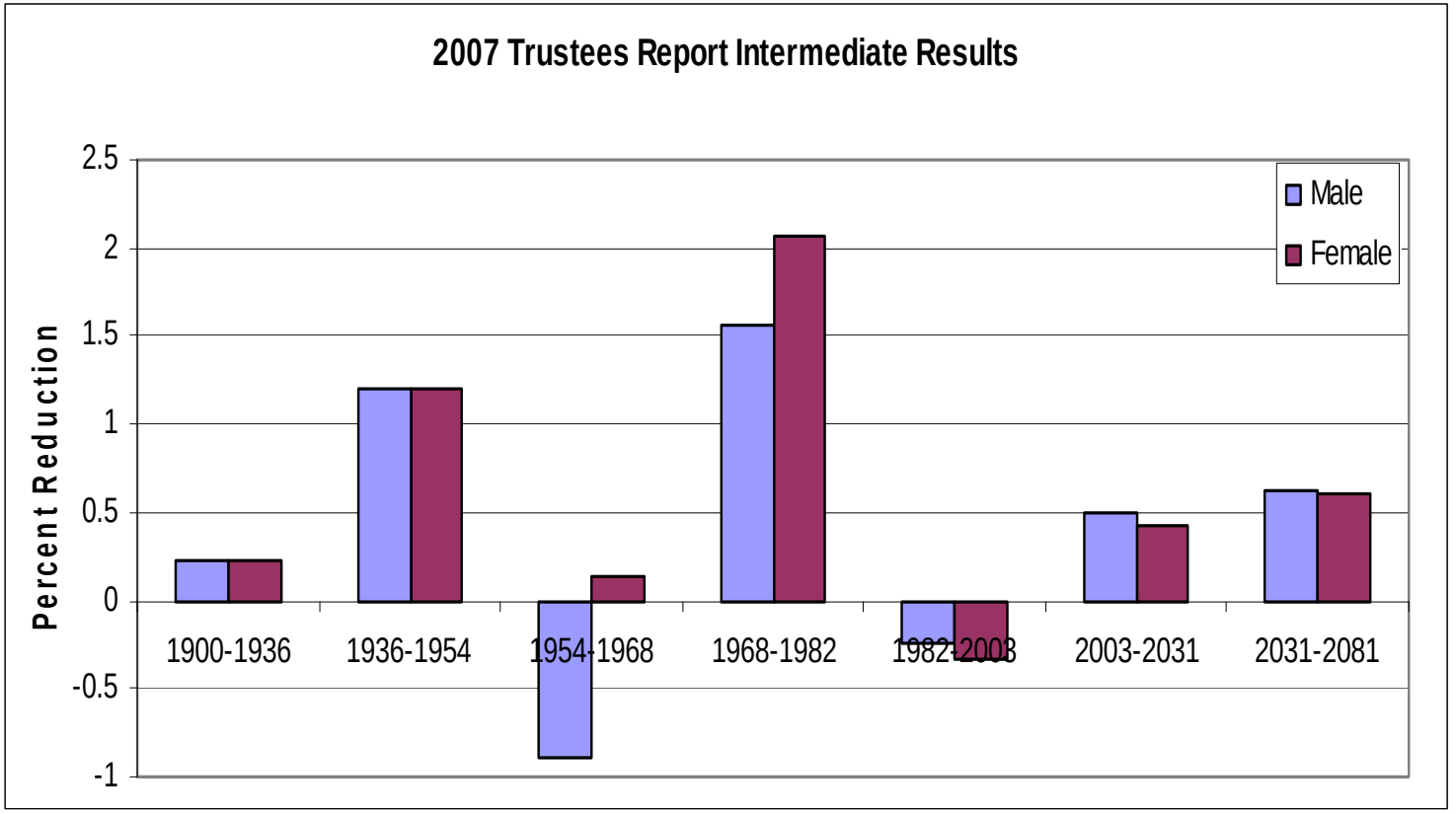
Mortality projections

- Need to understand the purpose of the projection and its use and users
- Gather relevant experience
  - General population, specific group
  - Confirm current practice
- Understand consequences of uncertainty
  - Margins needed
  - Usually better to be explicit
- Clearly communicate results and risks

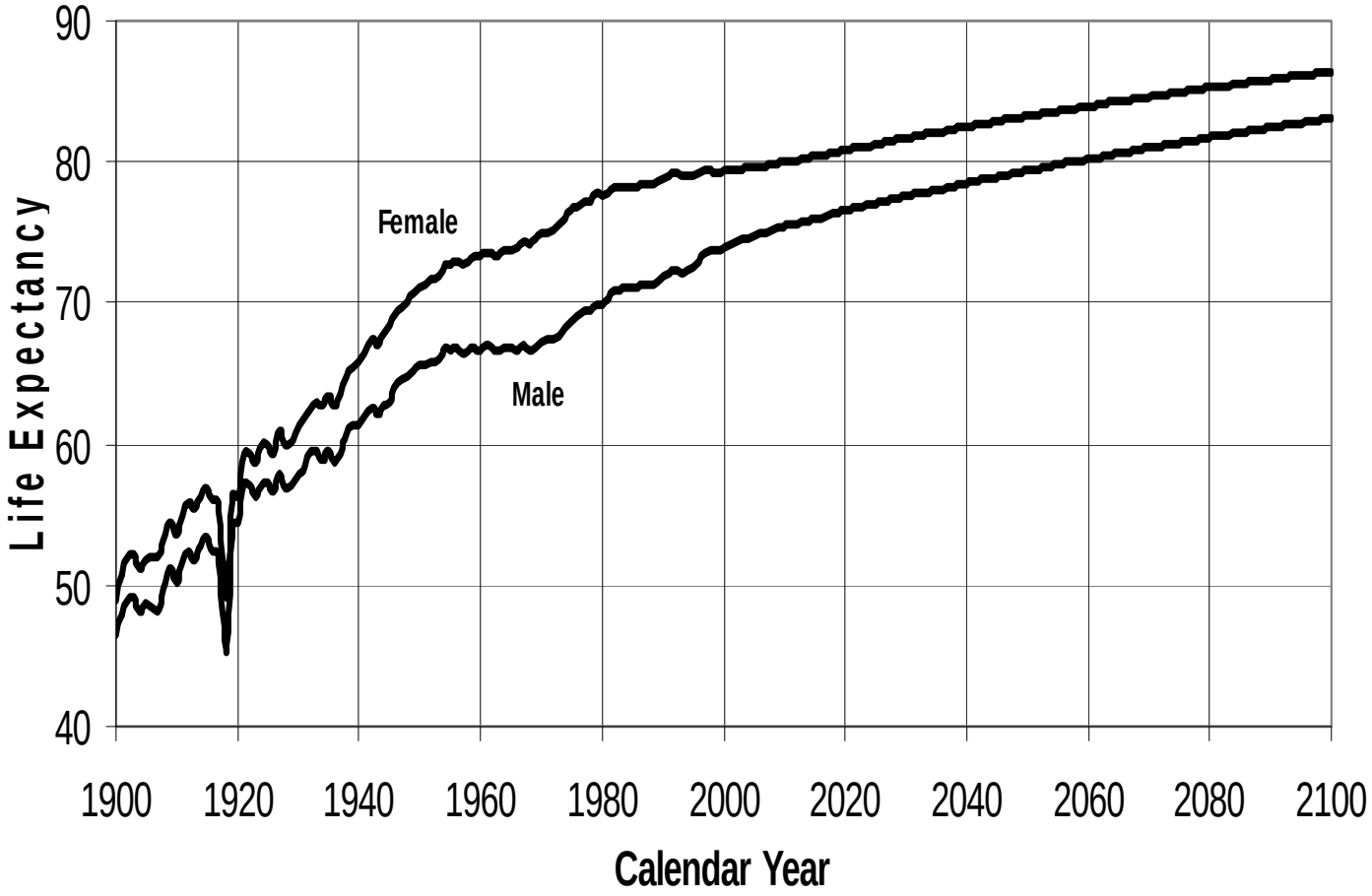
Historical and Projected Annual Percentage Reductions in Central Death Rates: Age 65-84 (projected by U.S. Social Security actuaries)



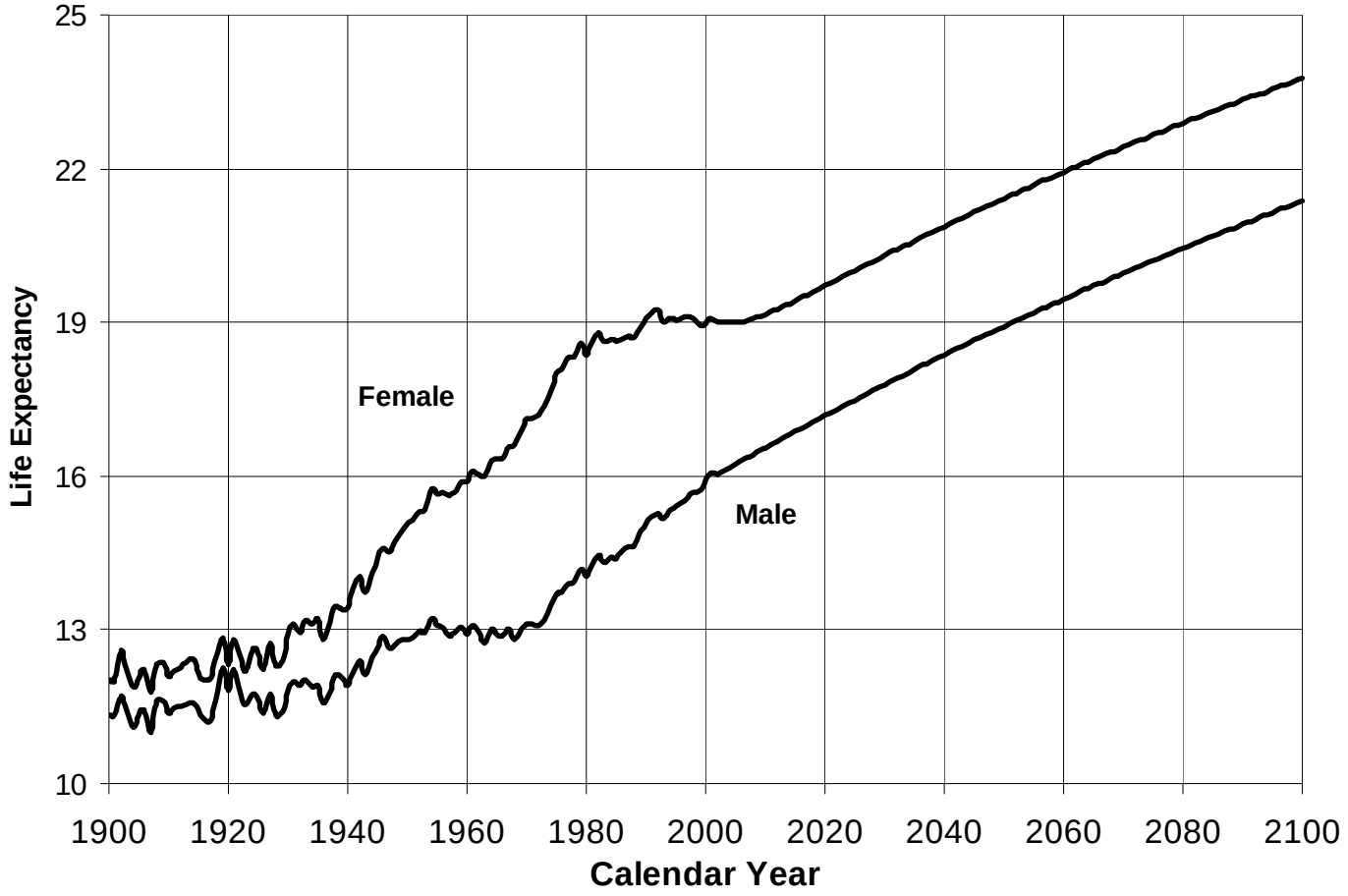
Historical and Projected Annual Percentage Reductions in Central Death Rates: Age 85+ (projected by U.S. Social Security actuaries)



U.S. Life Expectancy at Age 0
by Sex and Calendar Year (based on period tables)
(projected by U.S. Social Security actuaries)



U.S. Life Expectancy at Age 65
by Sex and Calendar Year (based on Period Tables)
(projected by U.S. Social Security actuaries)



Cost of living

- Don’t forget disability and health care services
  - Although overall health of the population has improved, there are longer term health risks
    - Better diagnostics and treatments
    - Earlier age at onset of chronic disease due to adverse risk factor trends
    - Enhanced and more expensive medical equipment and pharmaceuticals
    - Complexity and cost of health management increases with age
- How much can health of the population improve?
  - Current early warning signs of change

One comparison of health by period

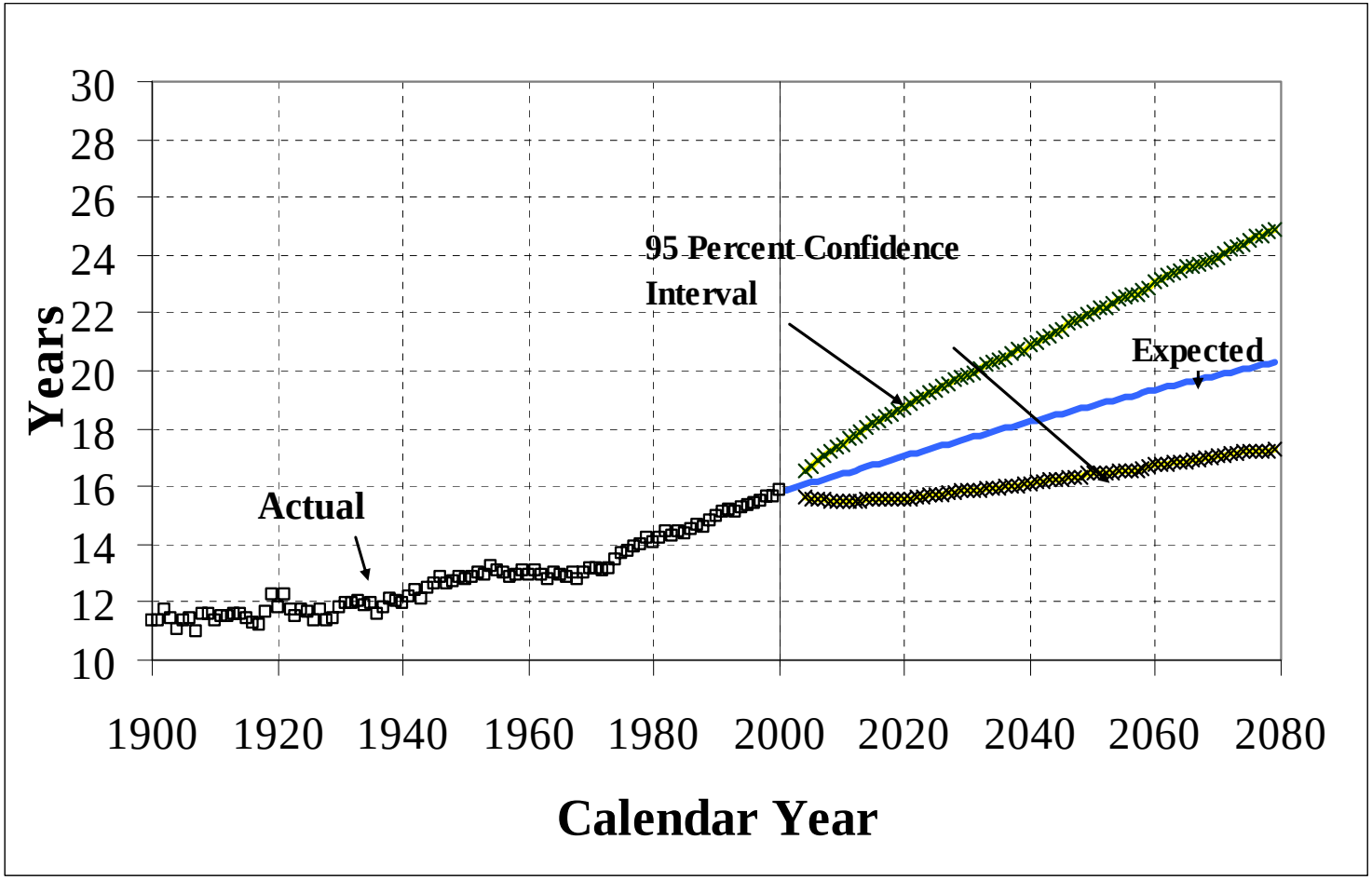
A 65-year-old woman in 1870

A 65-year-old woman in 2005

Uncertainty in Mortality Projections

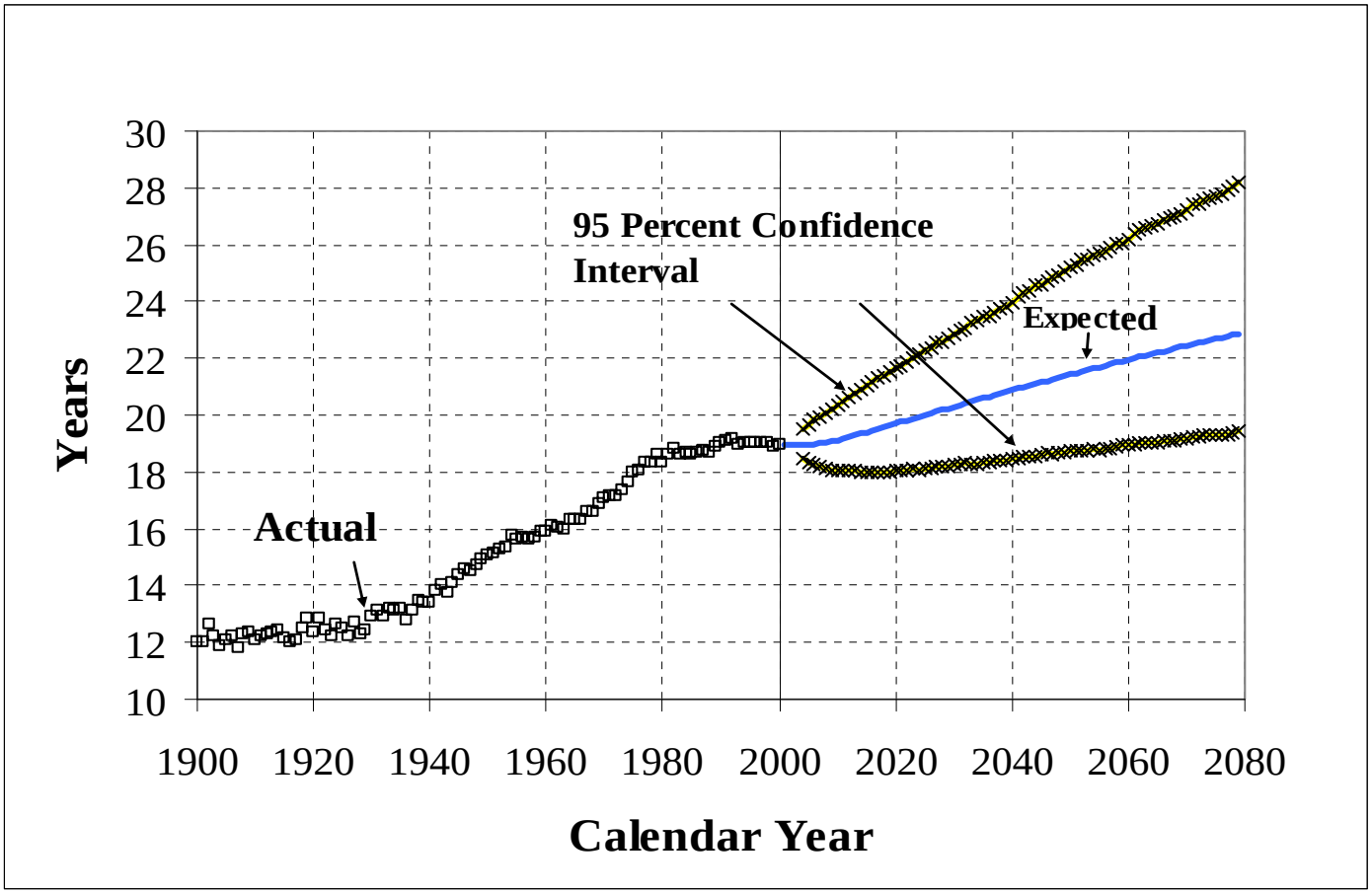
- Methods to incorporate and communicate uncertainty
  - Alternative scenarios, with high and low set
  - Stochastic calculations, with challenges of
    - Development of applicable distributions
    - Reflection of all risk factors
    - Determining inter-relations of underlying drivers
- Provide information so that users of projections can form their own judgment

U.S. Male Life Expectancy at Age 65
(projected by U.S. Social Security actuaries)



U.S. Female Life Expectancy at Age 65

(projected by U.S. Social Security actuaries)



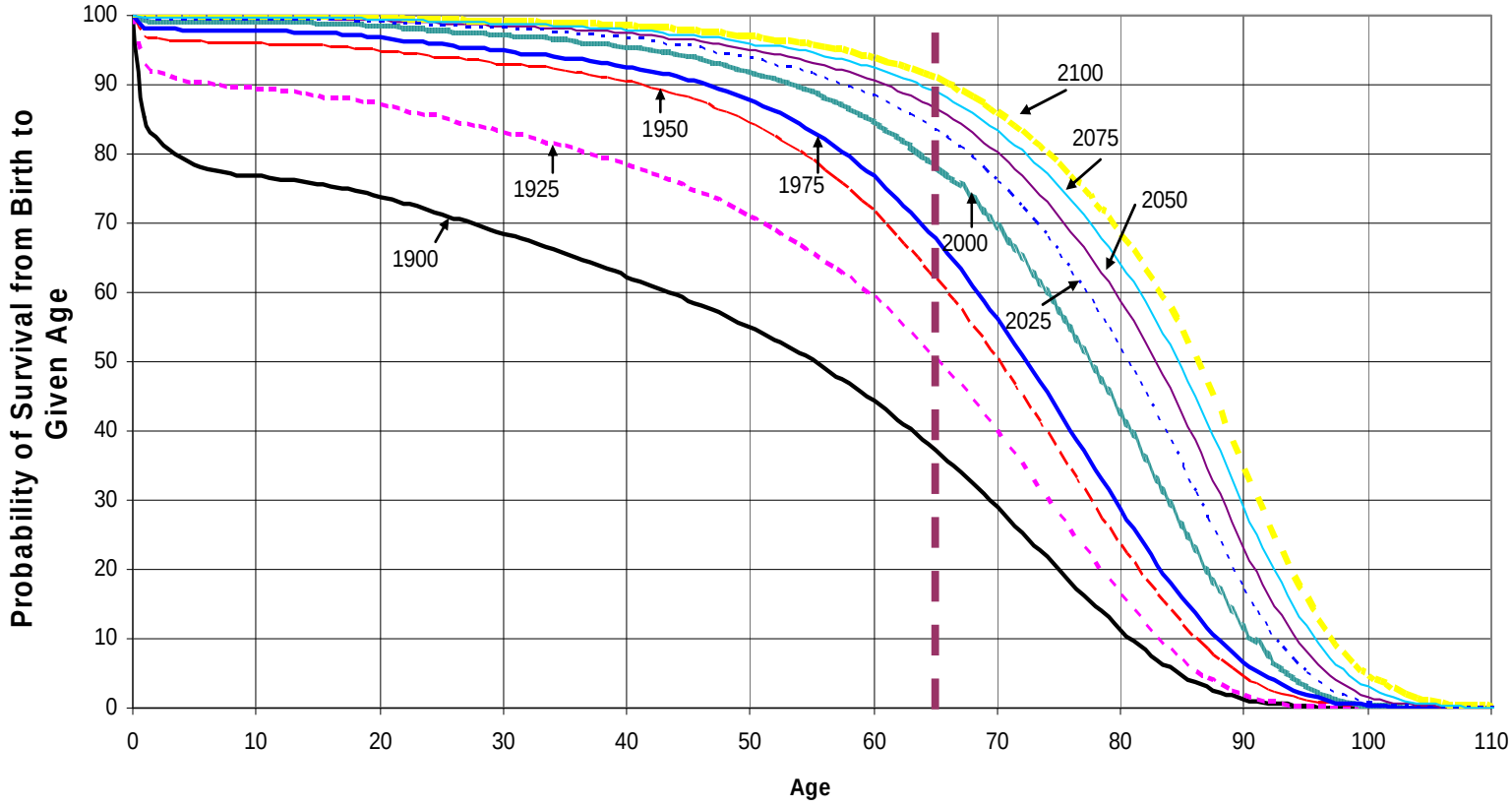
Squaring the mortality curve

- Population in developed countries have moved a long way in the last century to square the mortality curve
  - How much further can we go?
  - Is there an ultimate length of life?
- Population in developing countries are almost all moving in that direction

U.S. Population Survival Curves to 2100

Males

for Selected Calendar Years (based on Period Tables)

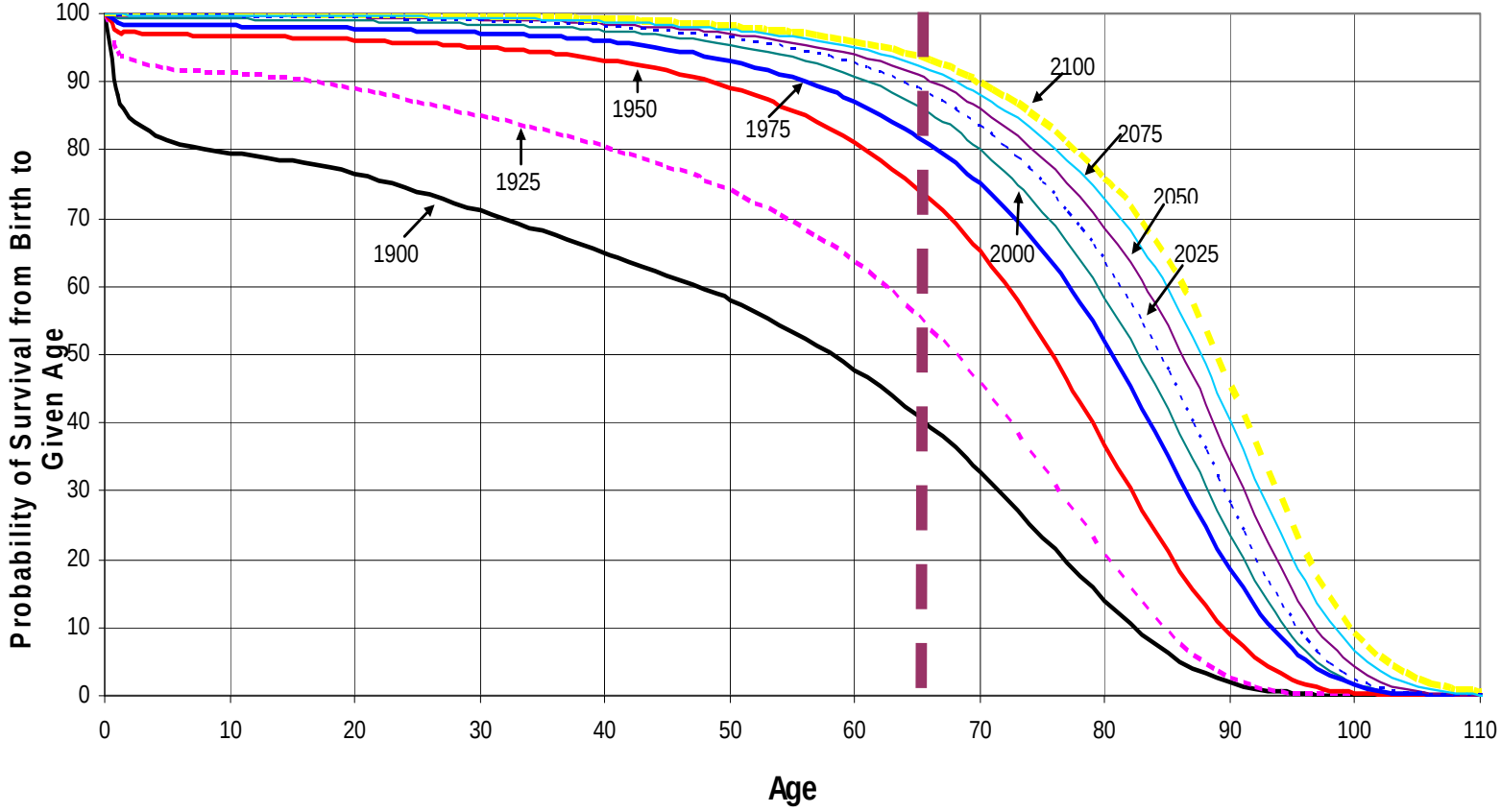


U.S. Population Survival Curves to 2100

Females

for Selected Calendar Years

(based on Period Tables)



Issues Moving Forward

- Possible research breakthroughs
- Continuing effect of human behavior
  - Reduction in smoking
  - Increase in weight
    - Consequential increase in diabetes
    - Possible reversal in cardiovascular disease trend
  - Not everyone takes advice of health care professionals
- Mitigating factors
- Continuing technological and pharmaceutical improvements (and cost)

Possible Black Swan Events

- Will future mortality follow a nice smooth pattern or is it subject to big future discontinuities?
- Bad ones
  - Pandemic
  - Cumulative effect of obesity stronger than many expect
- Good ones
  - People valuing their health more and take preventive or corrective actions
  - Genetic breakthrough
  - Successful aging research

Conclusion

- Future mortality
  - Understanding the past and figuring out the future will remain difficult and complex
  - Future trends are uncertain
  - Important to the individual, society and its institutions
- Many are optimistic
  - But warning signals exist
- Actuaries need to continue to sharpen their skills, experience and attention