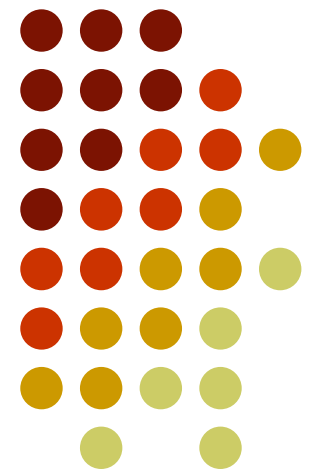


Mortality: Measures & Trends

URBPL 5/6010: Urban Research
University of Utah
Pam Perlich
Rev. 09/05/2006



Vital Records



- Late 19th early 20th century
- Data collection to support public health movement
- To measure and combat problems of overcrowding, poor sanitation, and the resulting diseases
- National registry of state data - 1915
- Utah Office of Vital Records, Dept. of Health

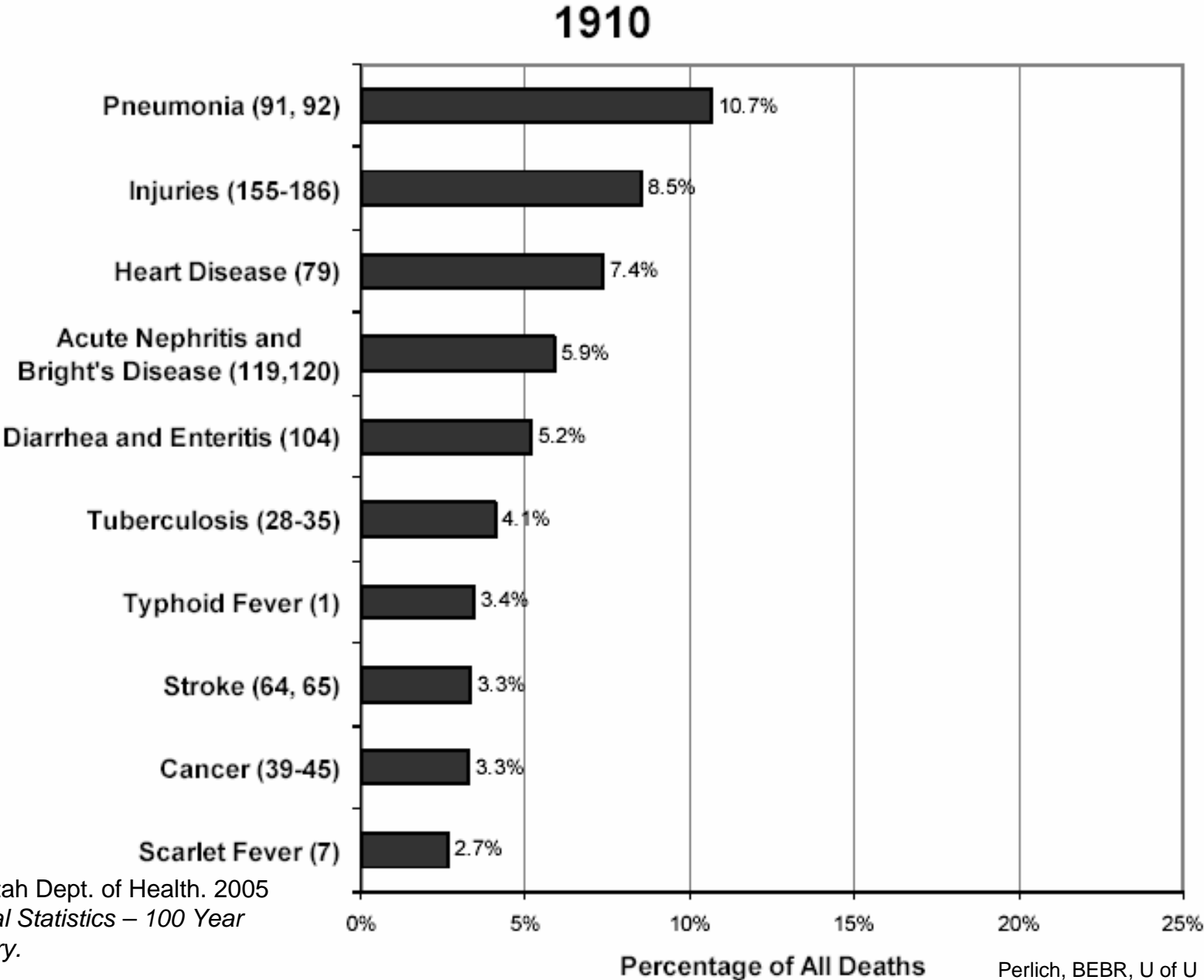


Planning / Policy

- Vital records account for location, age, sex, race, location of death, and cause of death.
- Measures of infant mortality, public health status, “hot spots” for various causes of death.
- Policies to address public health concerns that are identified.
- Example: National Cancer Institute – Cancer Mortality Maps / Graphs

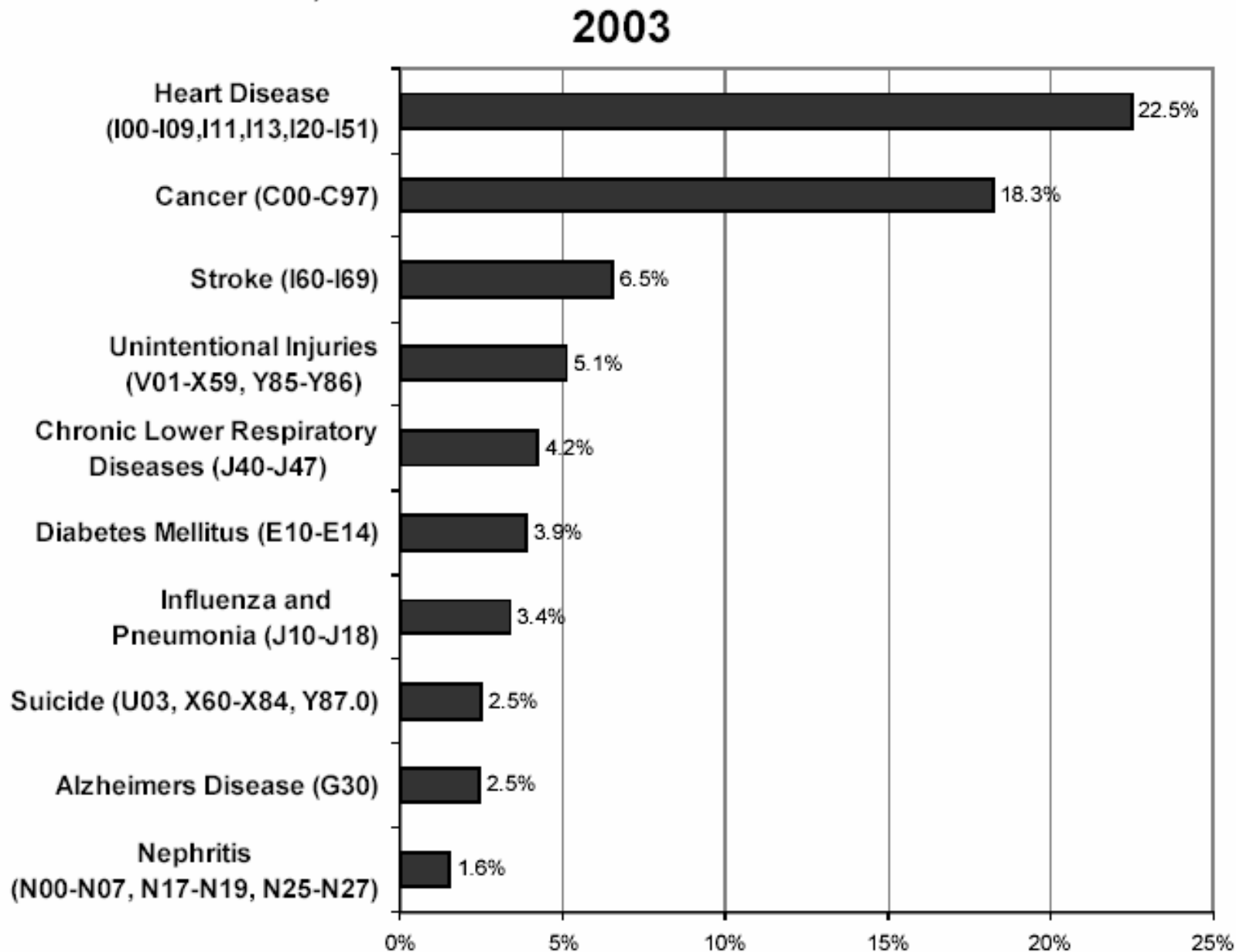
<http://www3.cancer.gov/atlasplus/>

Figure 1. Top 10 leading causes of death as a percentage of all deaths—Utah, 1910 and 2003



Source: Utah Dept. of Health. 2005
Utah's Vital Statistics – 100 Year Anniversary.

Figure 1. Top 10 leading causes of death as a percentage of all deaths—Utah, 1910 and 2003



Source: Utah Dept. of Health. 2005 *Utah's Vital Statistics – 100 Year Anniversary*.

Percentage of All Deaths

Perlich, BEBR, U of U

Crude Death Rate



$$\text{(Number of Deaths)}/\text{(Population)}$$

Flow Data

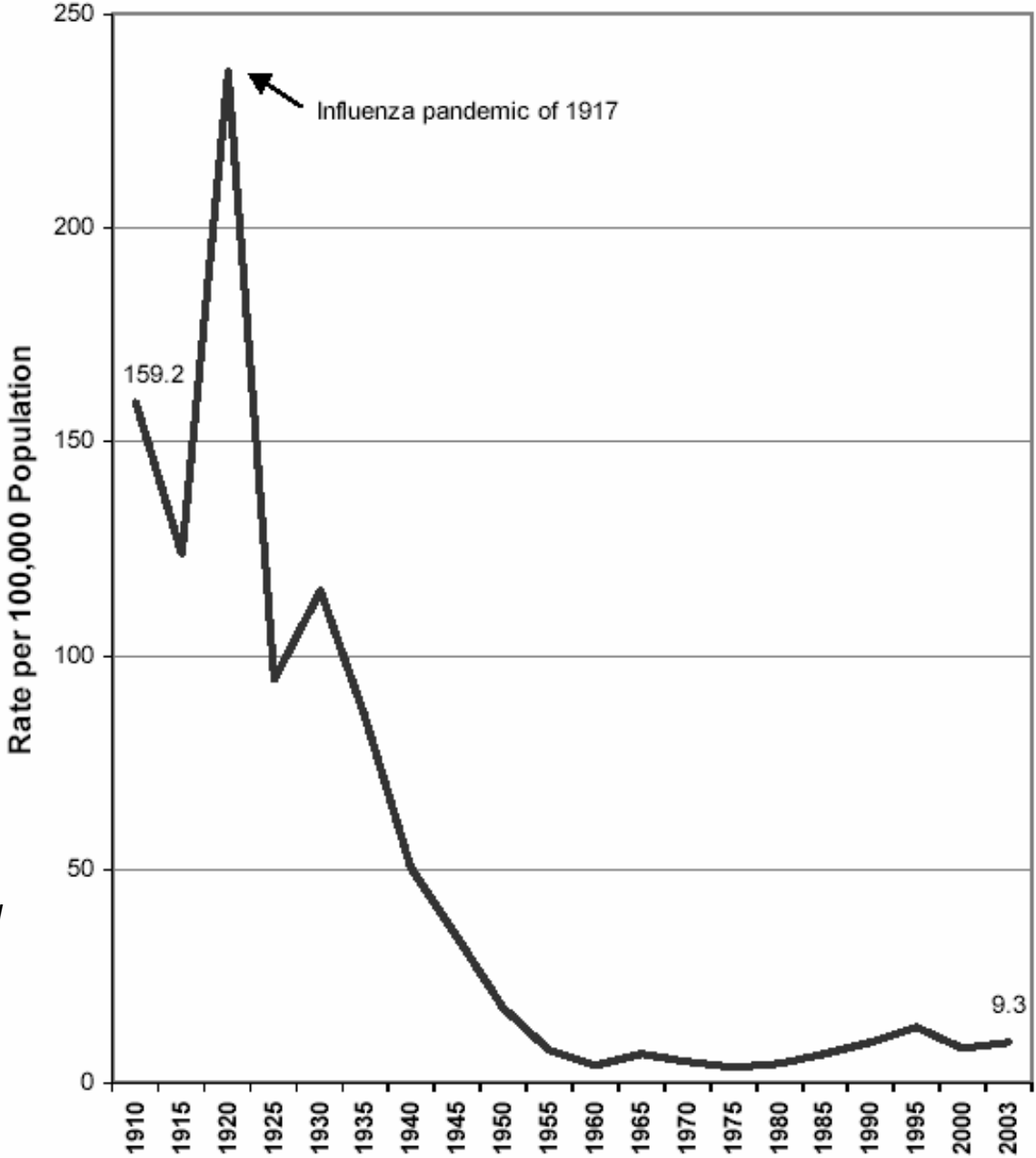
Over a period of time

Stock Data

Point in time

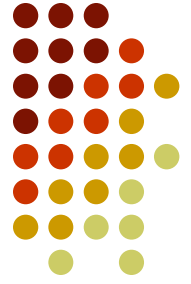
(Centered on birth data)

Figure 2. Crude death rates per 100,000 population for infectious diseases—Utah, 1910-2003



Source: Utah Dept. of Health. 2005 *Utah's Vital Statistics – 100 Year Anniversary*.





Age Specific Death Rate

$$\frac{\text{(Deaths Ages 55-60)}}{\text{(Population Ages 55-60)}}$$

Flow Data

Over a period of time

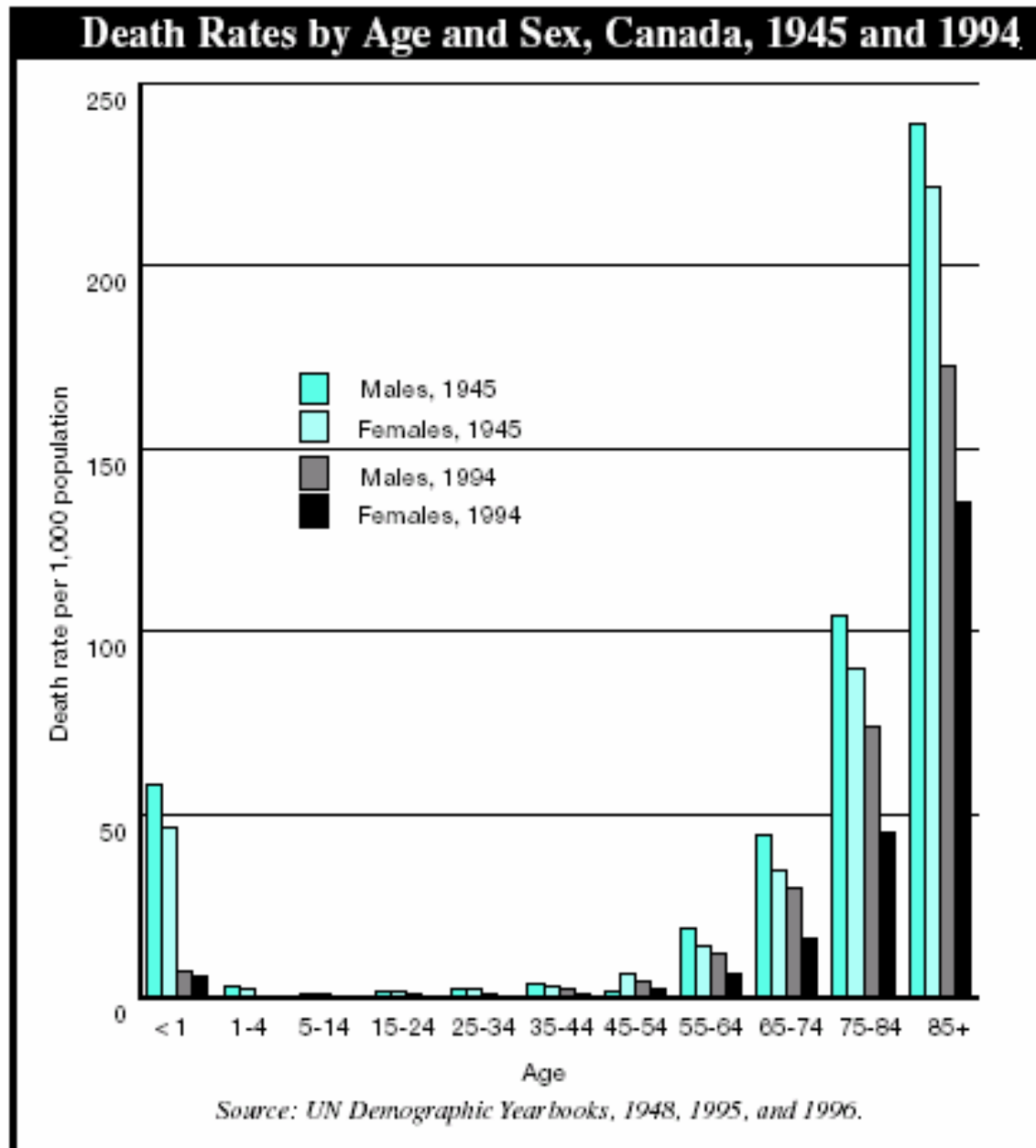
Stock Data

Point in time

(Centered on birth data)

Age-Specific Death Rates

Source: PRB,
Population Handbook, 4th Edition, 2000.



Cause Specific Death Rate



$$\text{(Cancer Deaths)}/\text{(Population)}$$

Flow Data

Over a period of time

Stock Data

Point in time

(Centered on birth data)

Proportion Dying From a Specific Cause

(Cancer Deaths)/(Deaths)

Sources: PRB,
Population Handbook,
4th Edition, 2000;
Deseret News, Salt Lake
City, 3/10/2004

Premature deaths

The number of deaths in the United States due to poor diet and physical inactivity rose between 1990 and 2000.

Actual causes of death,
by percentage of total deaths

■ 1990 ■ 2000



SOURCE: Journal of the American Medical Association



Infant Mortality Rate



$$\text{(Deaths of person < 1 year)}/\text{(Births)}$$

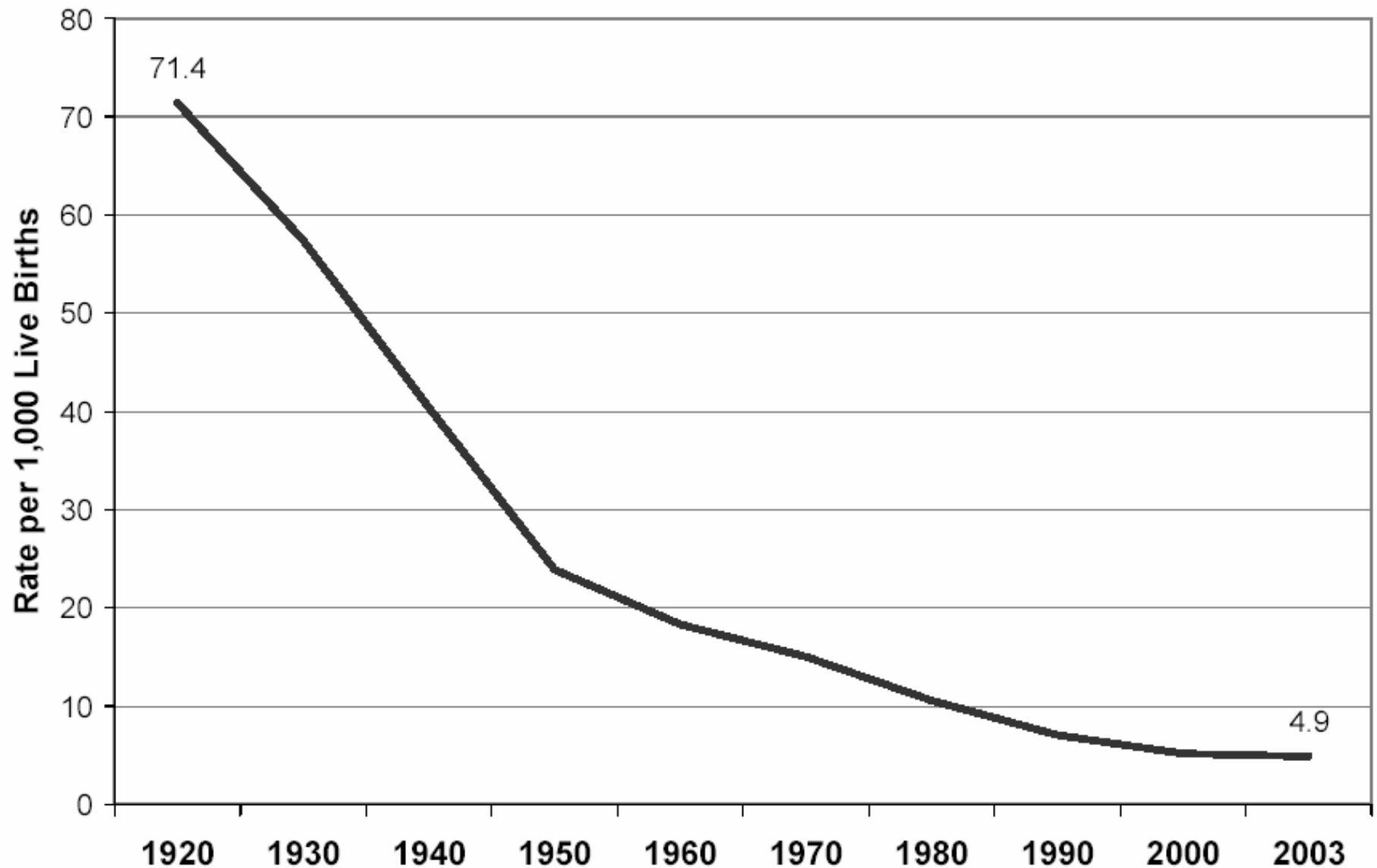
Flow Data

Over a period of time

Flow Data

Over the same period of time

Figure 3. Infant mortality: number of infant deaths per 1,000 live births—Utah, 1920-2003



Source: Utah Dept. of Health. 2005 *Utah's Vital Statistics – 100 Year Anniversary*.

Perlich, BEBR, U of U

Maternal Mortality Rate



$$\frac{\text{(Maternal Deaths)}}{\text{(Live Births)}}$$

Flow Data
Over a period of time

Flow Data
Over the same period of time



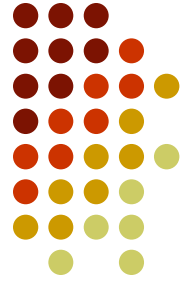
Life Expectancy

- Average number of years a person could expect to live given:
 - Age
 - Sex
 - Race
- Apply current age-specific death rates
- Does not account for generational effects



Decennial Mortality Rates

- Population by age, sex, race, geography
 - e.g., 2000 Census
 - point in time cross section
- Deaths by age, sex, race, geography
 - e.g., FY 1999, 2000, and 2001
 - Average of these
 - Flow data – cumulate to create annual data



Life Table

- Hypothetical population of 100,000 born in the same year
- Applies mortality rates to each year and survives the population
- The table terminates – all are “killed off” by the last entry

Age Interval	Proportion Dying	Of 100,000 Born Alive		Stationary Population		Average Remaining Years
		Number Living at Beginning of Age Interval	Number Dying During Age Interval	In the Age Interval	In This and All Subsequent Intervals	Average Number of Years of Life Remaining at Beginning of Interval
Period of Life Between Two Ages	Proportion of persons alive at beginning of interval dying during interval	l_x	d_x	L_x	T_x	$o e_x$
0-1	0.00653	100,000	653	99,512	8,037,620	80.38
1-2	0.00069	99,347	68	99,313	7,938,108	79.9

"Column 1 of the Life Table—Age interval (x to x+1)—The age interval shown in column 1 is the interval of 1 year between the two exact ages indicated. For instance, '21–22' indicates the interval between the 21st birthday and the 22d, in other words, the 22d year of life." Source: National Center for Health Statistics, US Decennial Life Tables for 1989-91, Volume 2, Number 45, Utah, 1998, pages 3 and 4. Data for the illustration is from table 3, pages 10 and 11 of this publication (life table for Utah females).

Age Interval	Proportion Dying	Of 100,000 Born Alive		Stationary Population		Average Remaining Years
Period of Life Between Two Ages	Proportion of persons alive at beginning of interval dying during interval	Number Living at Beginning of Age Interval	Number Dying During Age Interval	In the Age Interval	In This and All Subsequent Intervals	Average Number of Years of Life Remaining at Beginning of Interval
	q_x	l_x	d_x	L_x	T_x	$o e_x$
0-1	0.00653	100,000	653	99,512	8,037,620	80.38
1-2	0.00069	99,347	68	99,313	7,938,108	79.9

"Column 2 of the Life Table —Proportion dying (q_x)—This column shows the proportion of the members of the life-table cohort alive at the beginning of the indicated year of age who will die before reaching the next birthday on the basis of the mortality rates of 1989–91 in Utah. For example, for females who reach age 21, the proportion dying before reaching their 22d birthday is 0.00045—out of every 1,000 female babies surviving to age 21, 0.45 will die before reaching their 22d birthday." Source: National Center for Health Statistics, US Decennial Life Tables for 1989-91, Volume 2, Number 45, Utah, 1998, pages 3 and 4. Data for the illustration is from table 3, pages 10 and 11 of this publication (life table for Utah females).

Age Interval	Proportion Dying	Of 100,000 Born Alive		Stationary Population		Average Remaining Years
Period of Life Between Two Ages	Proportion of persons alive at beginning of interval dying during interval	Number Living at Beginning of Age Interval	Number Dying During Age Interval	In the Age Interval	In This and All Subsequent Intervals	Average Number of Years of Life Remaining at Beginning of Interval
	q_x	l_x	d_x	L_x	T_x	e_x
0-1	0.00653	100,000	653	99,512	8,037,620	80.38
1-2	0.00069	99,347	68	99,313	7,938,108	79.9

"Column 3 of the Life Table —Number surviving (l_x)—This column shows the number of persons, starting with a cohort of 100,000 live births, who will survive to the birthday marking the beginning of the indicated year of age. Thus out of 100,000 female babies born alive in the cohort of table 3, 99,347 will complete the first year of life and enter the second, 98,778 will reach age 21, and 73,968 will live to age 75." Source: National Center for Health Statistics, US Decennial Life Tables for 1989-91, Volume 2, Number 45, Utah, 1998, pages 3 and 4. Data for the illustration is from table 3, pages 10 and 11 of this publication (life table for Utah females).

Column 2 times Column 3 = Column 4

Age Interval	Proportion Dying	Of 100,000 Born Alive		Stationary Population		Average Remaining Years
Period of Life Between Two Ages	Proportion of persons alive at beginning of interval dying during interval	Number Living at Beginning of Age Interval	Number Dying During Age Interval	In the Age Interval	In This and All Subsequent Intervals	Average Number of Years of Life Remaining at Beginning of Interval
	q_x	l_x	d_x	L_x	T_x	e_x
0-1	0.00653	100,000	653	99,512	8,037,620	80.38
1-2	0.00069	99,347	68	99,313	7,938,108	79.9

"Column 4 of the Life Table —Number dying (d_x)—This column shows the number dying in each successive age interval out of 100,000 live births. Thus out of 100,000 females born alive, 653 will die in the first year of life, 44 in the 22d year, and 2,084 in the 76th year. Each figure in column 4 is the difference between two successive figures in column 3." Source: National Center for Health Statistics, US Decennial Life Tables for 1989-91, Volume 2, Number 45, Utah, 1998, pages 3 and 4. Data for the illustration is from table 3, pages 10 and 11 of this publication (life table for Utah females).

Age Interval	Proportion Dying	Of 100,000 Born Alive		Stationary Population		Average Remaining Years
				In the Age Interval	In This and All Subsequent Intervals	Average Number of Years of Life Remaining at Beginning of Interval
Period of Life Between Two Ages	Proportion of persons alive at beginning of interval dying during interval	Number Living at Beginning of Age Interval	Number Dying During Age Interval	L_x	T_x	$o e_x$
	q_x	l_x	d_x			

"Columns 5 and 6 of the Life Table —Stationary population (L_x and T_x)— Suppose that a group of 100,000 persons like that assumed in columns 3 and 4 is born every year, and that the proportion dying in each such group in each age interval throughout the lives of the members is exactly that shown in column 2. If there were no migration and if the births were evenly distributed over the year, the survivors of these births would constitute what is called a stationary population, because **in such a population the number of persons living in any given age interval would never change.** When an individual left an age interval, whether by death or growing older and entering the next higher age interval, his place would immediately be taken by someone entering from the next lower age interval. Thus a census taken at any time in such a stationary community would always show the same total population and the same numerical distribution of that population among the various age intervals. In such a stationary population supported by 100,000 annual births, column 3 shows the number of persons who, each year, will reach the exact age that marks the beginning of the age interval indicated in column 1, and column 4 shows the number of persons who will die each year in that year of age interval." Source: National Center for Health Statistics, US Decennial Life Tables for 1989-91, Volume 2, Number 45, Utah, 1998, pages 3 and 4. Data for the illustration is from table 3, pages 10 and 11 of this publication (life table for Utah females).

Age Interval	Proportion Dying	Of 100,000 Born Alive		Stationary Population		Average Remaining Years
		Number Living at Beginning of Age Interval	Number Dying During Age Interval	In the Age Interval	In This and All Subsequent Intervals	Average Number of Years of Life Remaining at Beginning of Interval
Period of Life Between Two Ages	Proportion of persons alive at beginning of interval dying during interval	l_x	d_x	L_x	T_x	e_x
0-1	0.00653	100,000	653	99,512	8,037,620	80.38
1-2	0.00069	99,347	68	99,313	7,938,108	79.9

"Column 5 of the Life Table, L_x , shows the number of females in the stationary population in the indicated year of age. For example, the figure shown in table 3 for the year of age 21–22 is 98,757. This means that in a stationary population supported by 100,000 annual births, and with proportions dying in each age interval always in accordance with column 2, a census taken on any date would show 98,757 persons at age 21 (that is, between exact ages 21 and 22 years)."

Source: National Center for Health Statistics, US Decennial Life Tables for 1989-91, Volume 2, Number 45, Utah, 1998, pages 3 and 4. Data for the illustration is from table 3, pages 10 and 11 of this publication (life table for Utah females).

Age Interval	Proportion Dying	Of 100,000 Born Alive		Stationary Population		Average Remaining Years
Period of Life Between Two Ages	Proportion of persons alive at beginning of interval dying during interval	Number Living at Beginning of Age Interval	Number Dying During Age Interval	In the Age Interval	In This and All Subsequent Intervals	Average Number of Years of Life Remaining at Beginning of Interval
	q_x	l_x	d_x	L_x	T_x	$o e_x$
0-1	0.00653	100,000	653	99,512	8,037,620	80.38
1-2	0.00069	99,347	68	99,313	7,938,108	79.9

"Column 6— T_x - Total stationary population in the indicated age interval and all subsequent age intervals.

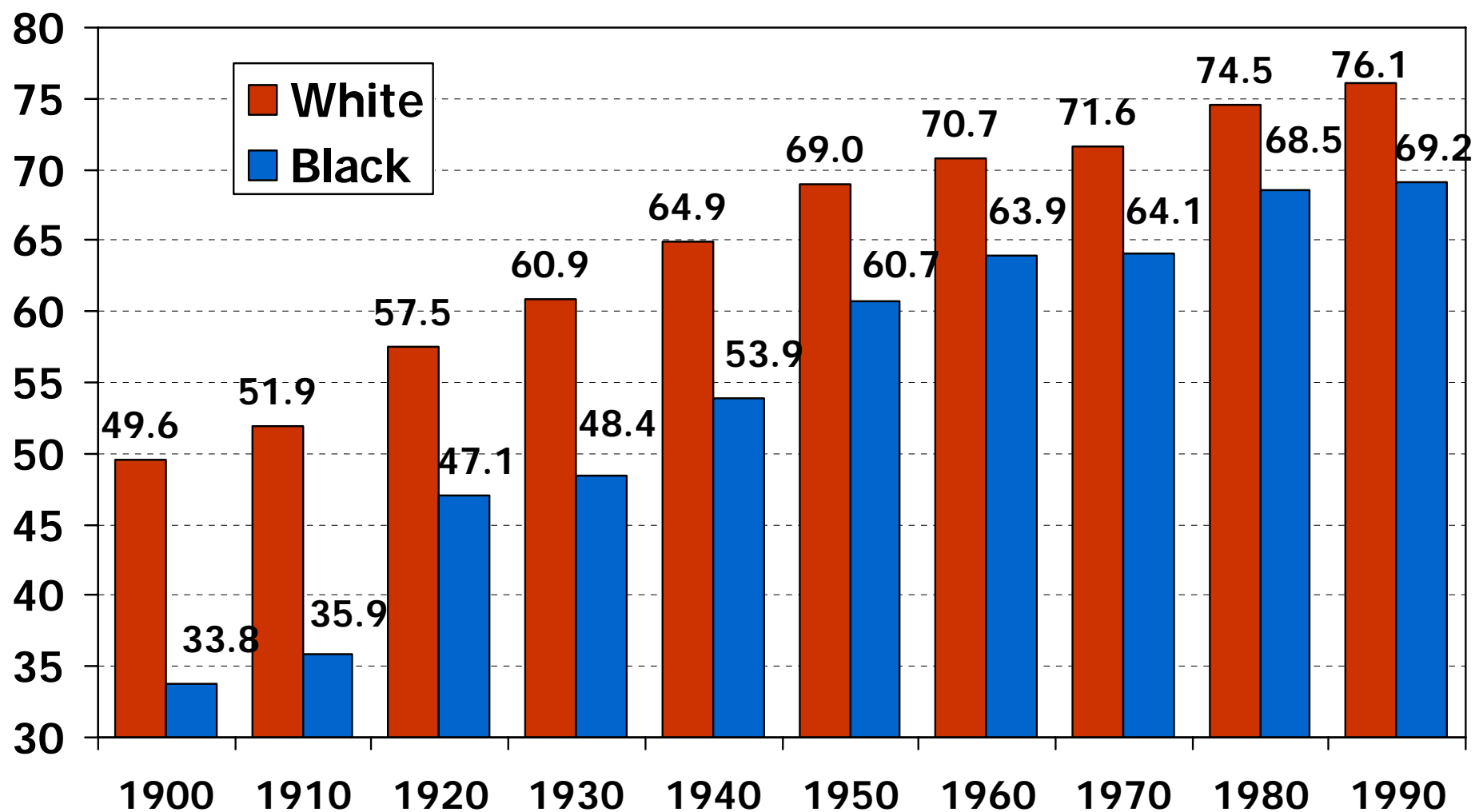
Age Interval	Proportion Dying	Of 100,000 Born Alive		Stationary Population		Average Remaining Years
		Number Living at Beginning of Age Interval	Number Dying During Age Interval	In the Age Interval	In This and All Subsequent Intervals	Average Number of Years of Life Remaining at Beginning of Interval
Period of Life Between Two Ages	Proportion of persons alive at beginning of interval dying during interval	l_x	d_x	L_x	T_x	$o e_x$
0-1	0.00653	100,000	653	99,512	8,037,620	80.38
1-2	0.00069	99,347	68	99,313	7,938,108	79.9

"Column 7—Average remaining lifetime ($o e_x$)—The average remaining lifetime (also called expectation of life) at any given age is the average number of years remaining to be lived by those surviving to that age, on the basis of a given set of age-specific rates of dying. "

Column 5 / Column 3 = Column 7

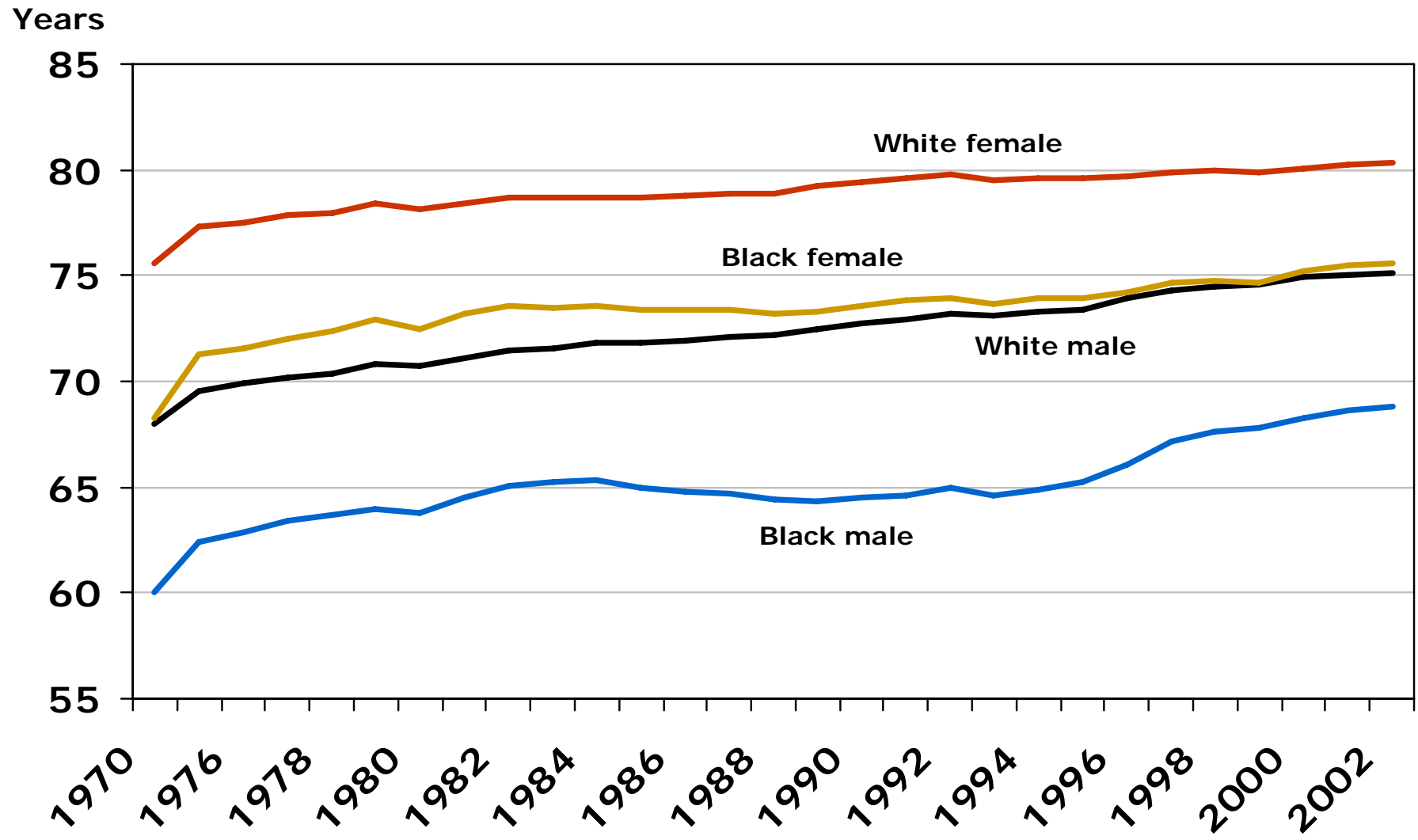
Source: National Center for Health Statistics, US Decennial Life Tables for 1989-91, Volume 2, Number 45, Utah, 1998, pages 3 and 4. Data for the illustration is from table 3, pages 10 and 11 of this publication (life table for Utah females).

US Life Expectancy at Birth by Race



Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

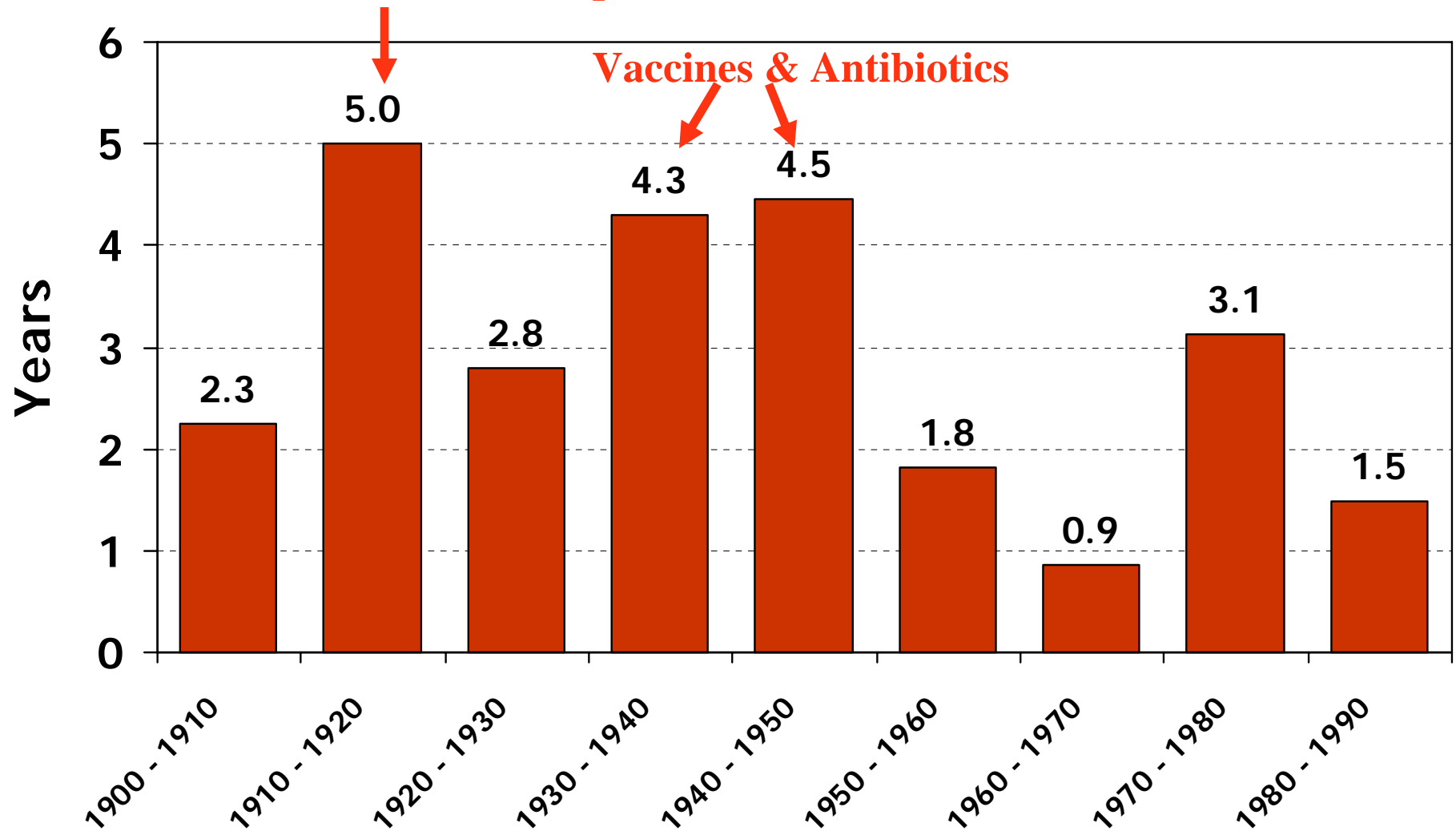
US Life Expectancy by Sex and Race



Source: National Center for Health Statistics. This slide downloaded from www.PRB.org on 9/3/2005.

Change in US Life Expectancy at Birth

Survivors of 1918 flu epidemic



Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Table A. Life expectancy at birth in years and change from previous period, by race and sex: Death-registration States, 1900–1902 to 1919–21, and United States, 1929–31 to 1989–91

Period	Total			White			Black		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
Life expectancy at birth									
1989–91	75.37	71.83	78.81	76.13	72.72	79.45	69.16	64.47	73.73
1979–81	73.88	70.11	77.62	74.53	70.82	78.22	68.52	64.10	72.88
1969–71	70.75	67.04	74.64	71.62	67.94	75.49	64.11	60.00	68.32
1959–61	69.89	66.80	73.24	70.73	67.55	74.19	¹ 63.91	¹ 61.48	¹ 66.47
1949–51	68.07	65.47	70.96	69.02	66.31	72.03	¹ 60.73	¹ 58.91	¹ 62.70
1939–41	63.62	61.60	65.89	64.92	62.81	67.29	53.85	52.26	55.56
1929–31	² 59.3	² 57.8	² 61.1	² 60.9	59.12	62.67	^{1,2} 48.4	47.55	49.51
1919–21	² 56.5	² 55.7	² 57.5	² 57.5	56.34	58.53	^{1,2} 47.1	47.14	46.92
1909–11	51.49	49.86	53.24	² 51.9	50.23	53.62	^{1,2} 35.9	34.05	37.67
1900–1902	49.24	47.88	50.70	² 49.6	48.23	51.08	^{1,2} 33.8	32.54	35.04
Change in life expectancy									
1900–1902 to 1989–91	26.13	23.95	28.11	26.53	24.49	28.37	35.36	31.93	38.69
1979–81 to 1989–91	1.49	1.72	1.19	1.60	1.90	1.23	0.64	0.37	0.85
1969–71 to 1979–81	3.13	3.07	2.98	2.91	2.88	2.73	4.41	4.10	4.56
1959–61 to 1969–71	0.86	0.24	1.40	0.89	0.39	1.30	³ 0.20	– ³ 1.48	³ 1.85
1949–51 to 1959–61	1.82	1.33	2.28	1.71	1.24	2.16	³ 3.18	³ 2.57	³ 3.77
1939–41 to 1949–51	4.45	3.87	5.07	4.10	3.50	4.74	³ 6.88	³ 6.65	³ 7.14
1929–31 to 1939–41	³ 4.3	³ 3.8	³ 4.8	³ 4.0	3.69	4.62	³ 5.5	4.71	6.05
1919–21 to 1929–31	³ 2.8	³ 2.1	³ 3.6	³ 3.4	2.78	4.14	³ 1.3	0.41	2.59
1909–11 to 1919–21	5.0	³ 5.8	³ 4.3	³ 5.6	6.11	4.91	³ 11.2	13.09	9.25
1900–1902 to 1909–11	2.25	1.98	2.54	³ 2.3	2.00	2.54	³ 2.1	1.51	2.63

Vaccines and antibiotics

Survivors of 1918 flu epidemic

Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health

Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

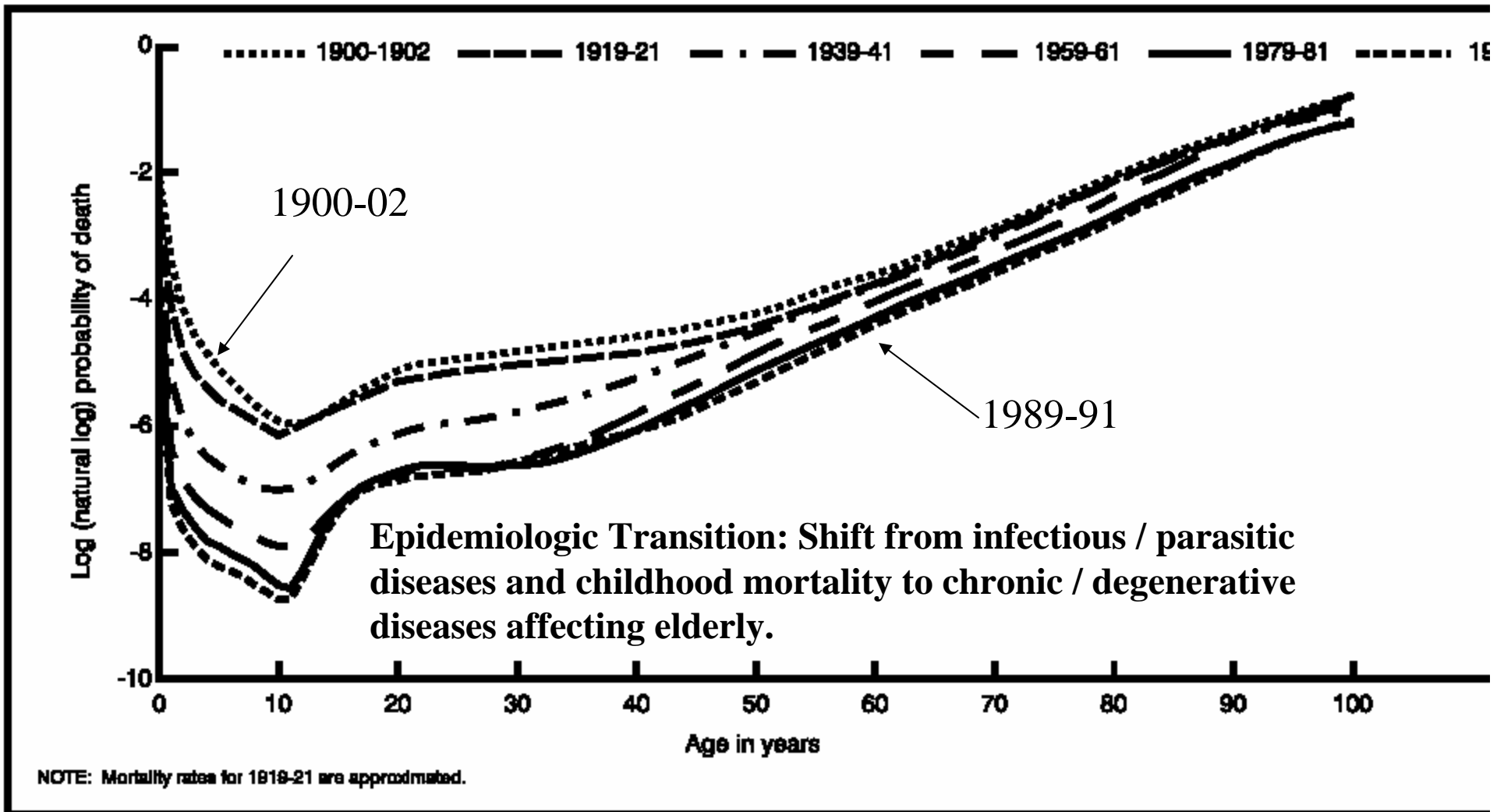
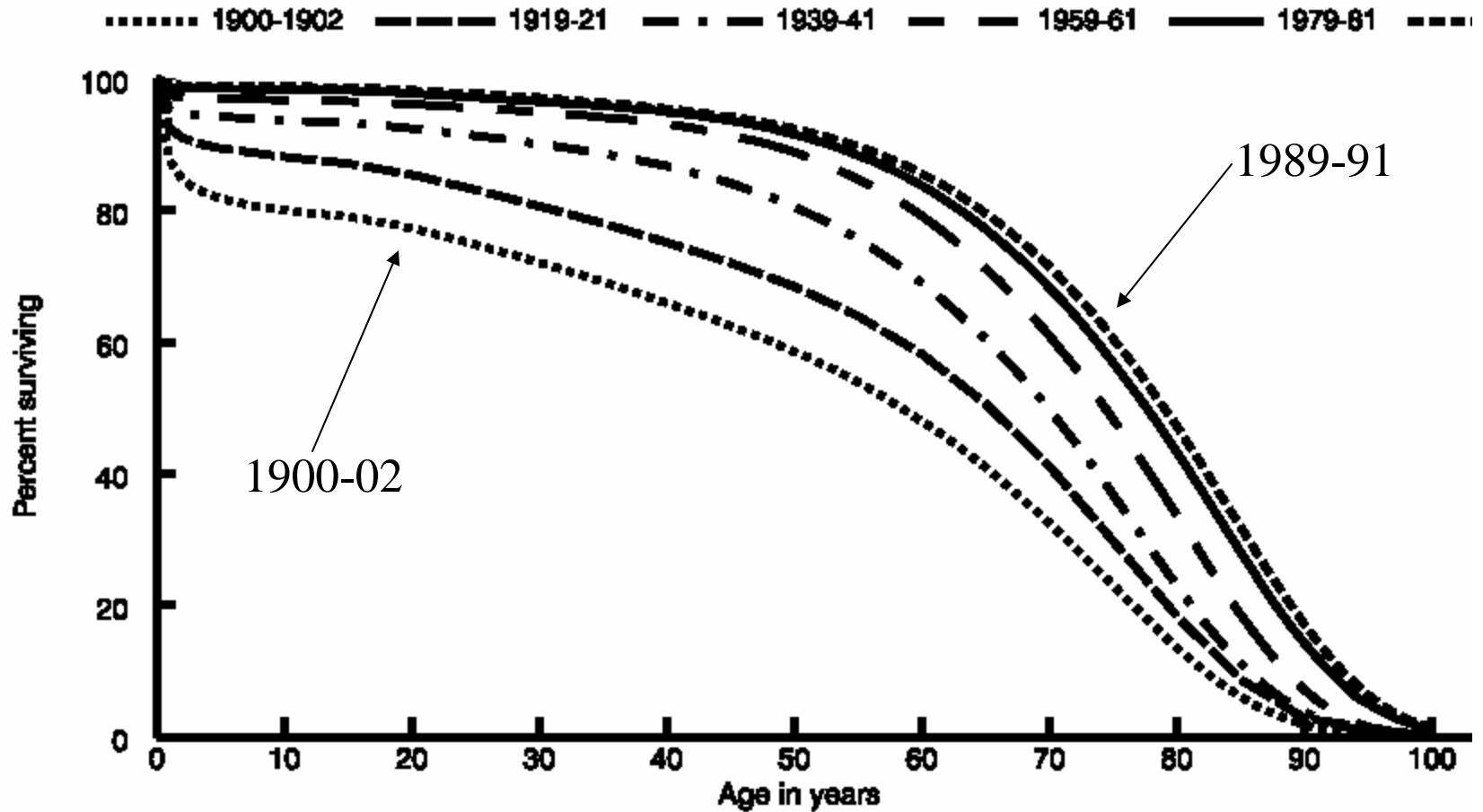


Figure 1. Log of the probability of dying (q) by age: Death-registration States, 1900–1902 to 1919–21, and United States, 1939–1989–91

Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Percent Surviving by Age



Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Percent Surviving by Age

Age	Percent survivorship					
	1900–1902	1919–21 ¹	1939–41	1959–61	1979–81	1989–91
0	100.0	100.0	100.0	100.0	100.0	100.0
10	80.1	88.1	93.7	96.8	98.3	98.8
20	77.2	85.4	92.4	96.1	97.7	98.2
30	72.0	80.6	90.1	94.9	96.5	97.1
40	65.9	75.1	86.7	93.1	94.9	95.4
50	58.5	68.4	80.5	88.8	91.5	92.4
60	47.9	58.1	68.9	79.1	83.7	85.5
70	32.4	41.1	49.7	60.9	68.2	71.4
80	13.5	18.3	22.9	33.6	43.2	47.1
90	1.9	2.8	3.8	7.1	14.2	17.0
100	0.03	0.04	0.1	0.2	1.2	1.4
Median age at death . .	58	66	70	74	78	79

Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Change in Survival (Years)

Age	Change in survival				
	1900–1902 to 1919–21 ¹	1919–21 ¹ to 1939–41	1939–41 to 1959–61	1959–61 to 1979–81	1979–81 to 1989–91
0	0.0	0.0	0.0	0.0	0.0
10	8.0	5.6	3.1	1.5	0.5
20	8.2	7.0	3.7	1.6	0.5
30	8.6	9.5	4.8	1.6	0.6
40	9.2	11.6	6.4	1.8	0.5
50	9.9	12.1	8.3	2.7	0.9
60	10.2	10.8	10.2	4.6	1.8
70	8.7	8.6	11.2	7.3	3.2
80	4.8	4.6	10.7	9.6	3.9
90	0.9	1.0	3.3	7.1	2.8
100	0.0	0.1	0.1	1.0	0.2
Change in median age at death	8	4	4	4	1

Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Percent Surviving by Age & Sex

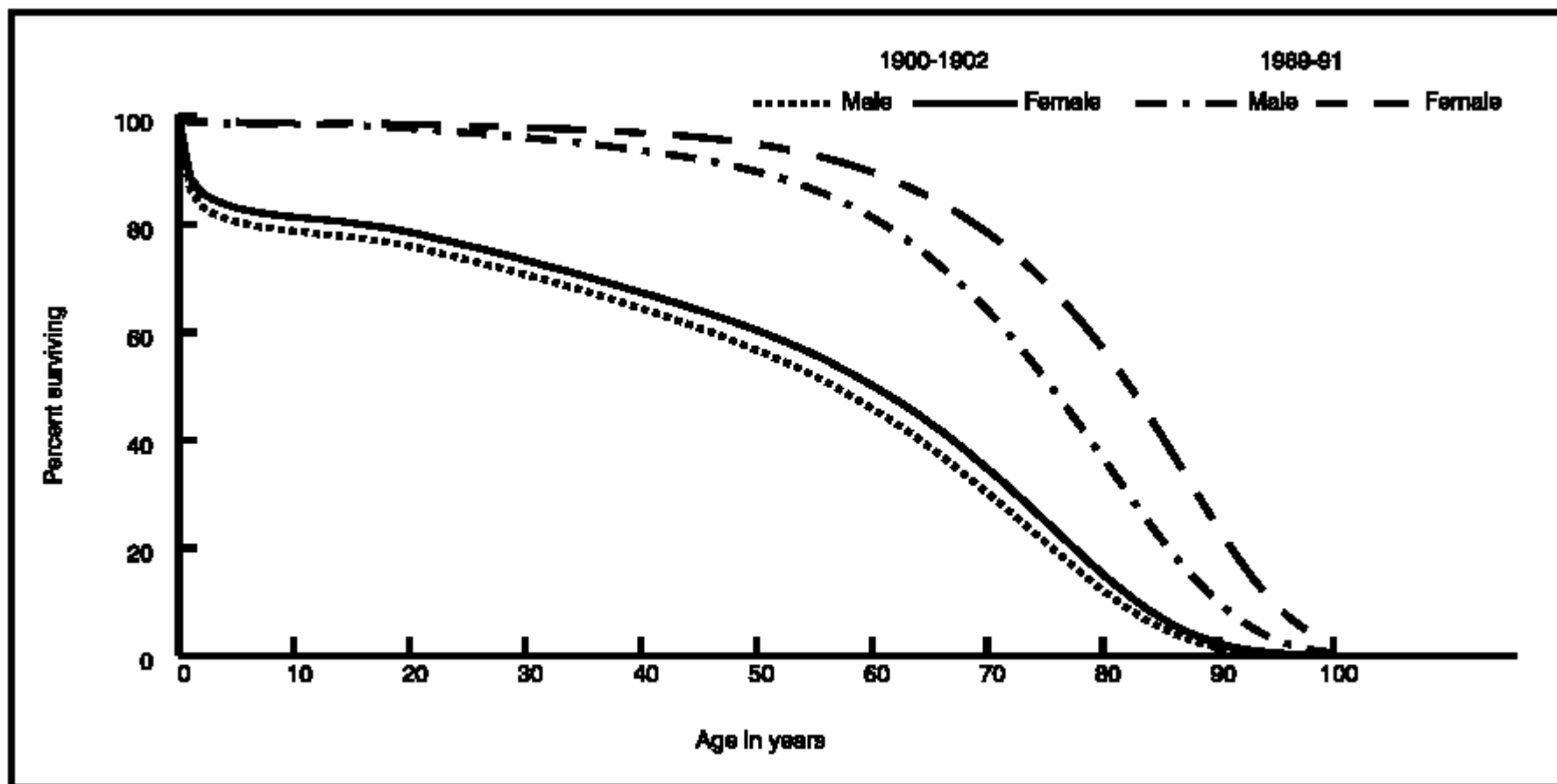


Figure 3. Percent surviving by age and sex: Death-registration States, 1900-1902, and United States, 1989-91

Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Life Expectancy Differences

Years	Difference between female and male life expectancy			Difference between white and black life expectancy		
	All races	White	Black	Both sexes	Male	Female
1989-91	6.98	6.73	9.26	6.97	8.25	5.72
1979-81	7.51	7.40	8.78	6.01	6.72	5.34
1969-71	7.60	7.55	8.32	7.51	7.94	7.17
1959-61	6.44	6.64	¹ 4.99	¹ 6.82	¹ 6.07	¹ 7.72
1949-51	5.49	5.72	¹ 3.79	¹ 8.29	¹ 7.40	¹ 9.33
1939-41	4.29	4.48	3.30	11.07	10.55	11.73
1929-31	² 3.3	3.55	1.96	² 12.5	11.57	13.16
1919-21	² 1.8	2.19	-0.22	² 10.4	9.20	11.61
1909-11	3.38	3.39	3.62	² 16.0	16.18	15.95
1900-1902	2.82	2.85	2.50	² 15.8	15.69	16.04

Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Percent Surviving by Age, Race, and Sex: 1900-02

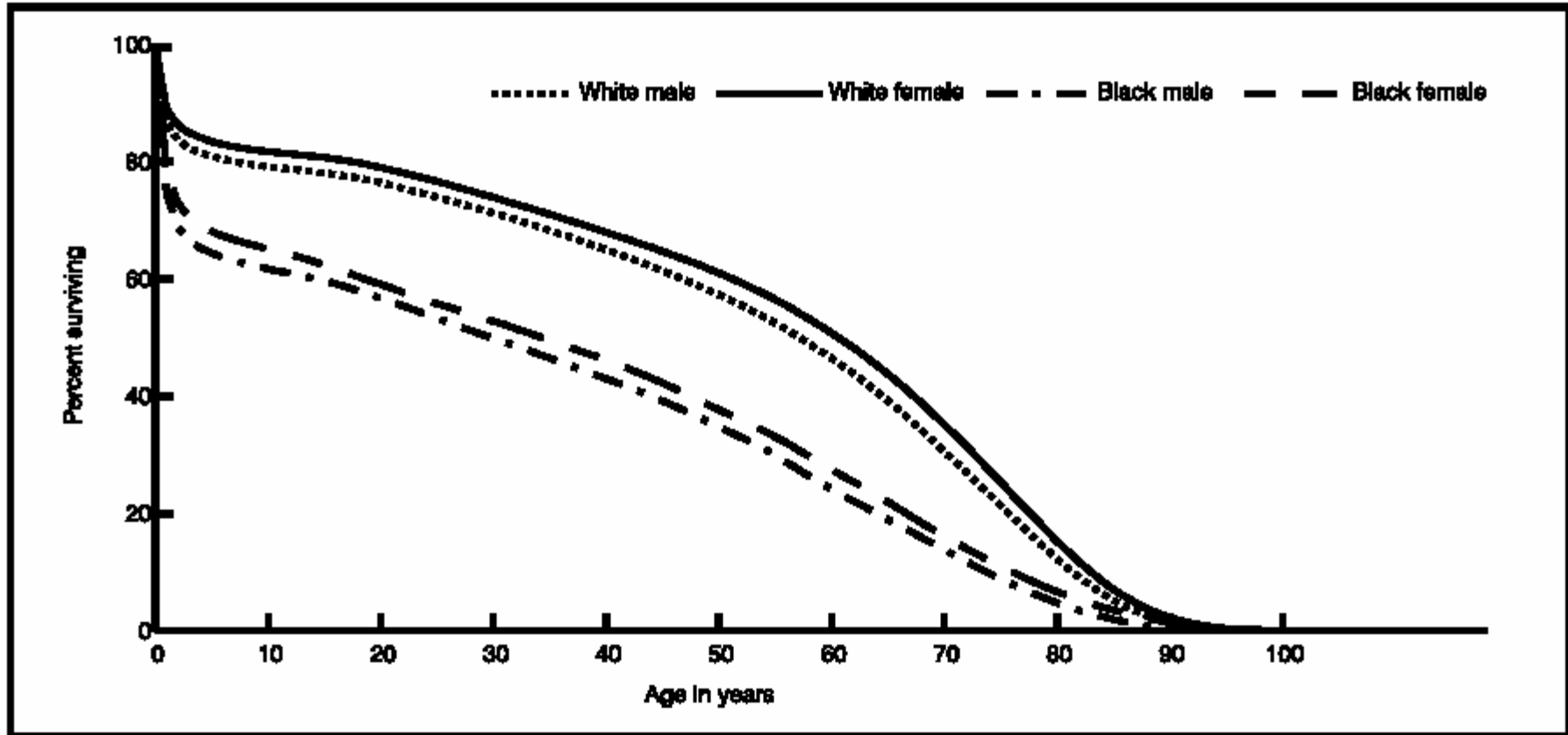


Figure 4. Percent surviving by age, race, and sex: Death-registration States, 1900-1902

Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Percent Surviving by Age, Race, and Sex: 1989-91

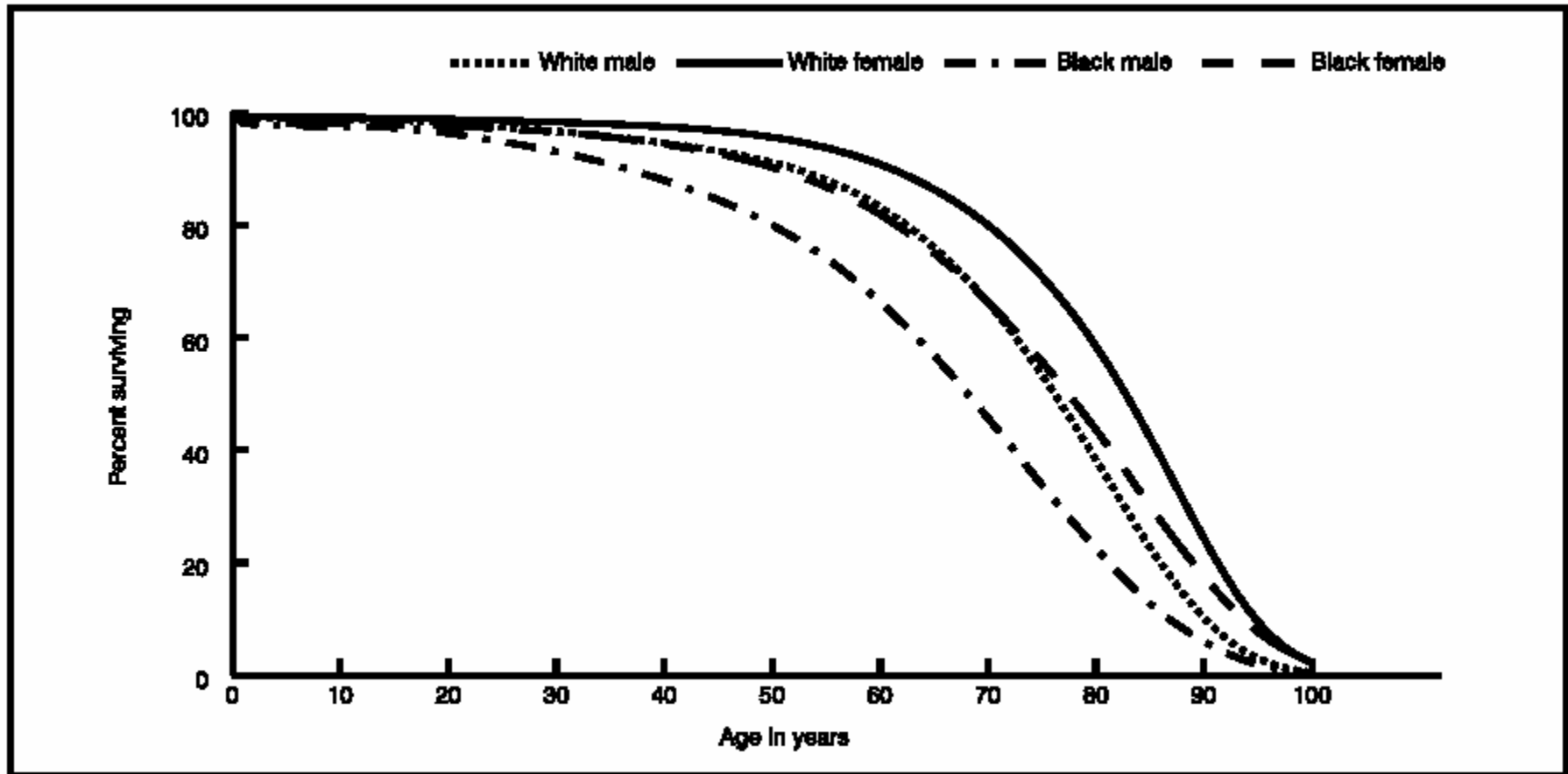


Figure 5. Percent surviving by age, race, and sex: United States, 1989-91

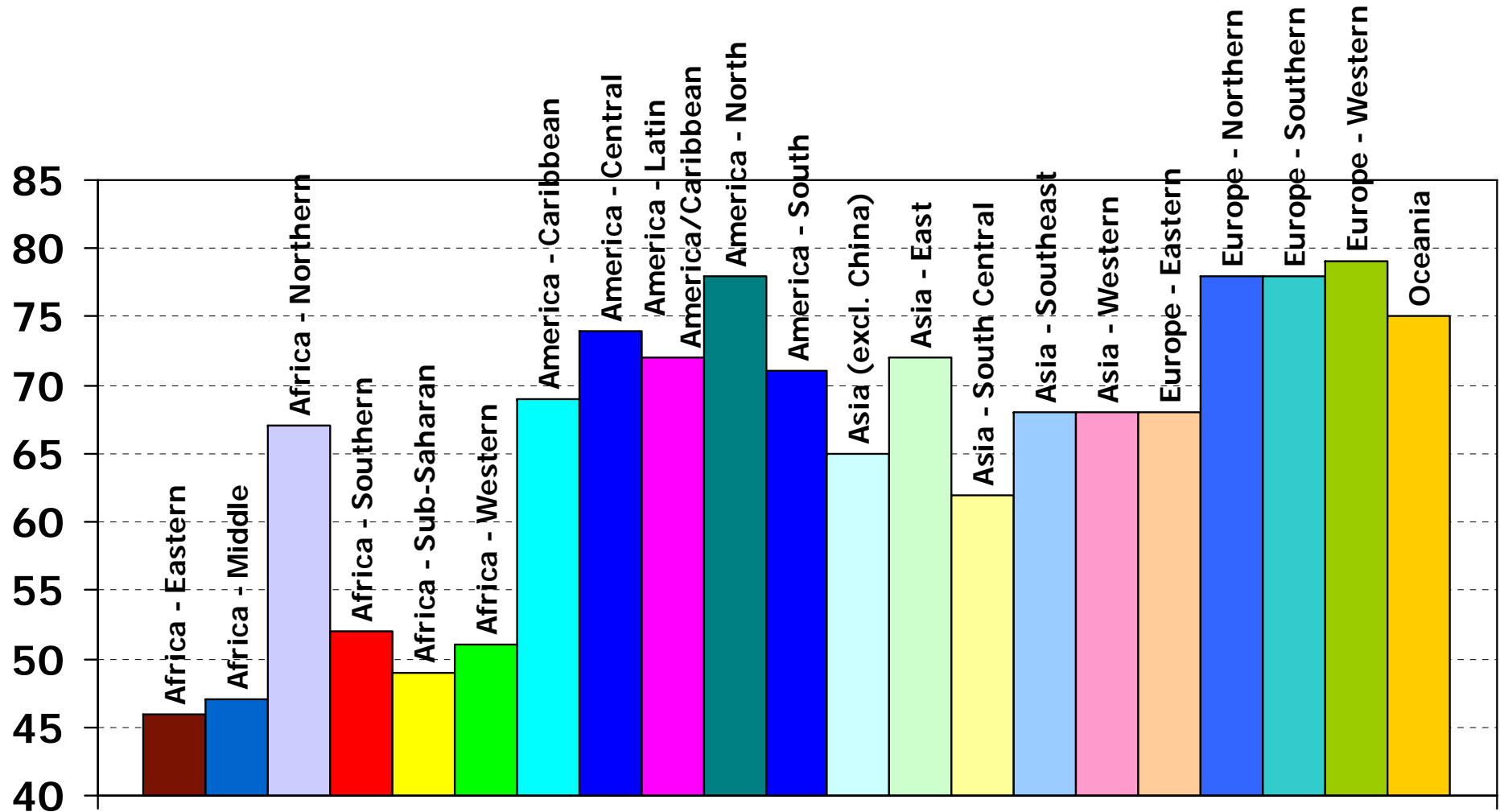
Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Life Expectancy at Birth

Area	1989–91		
Alabama	73.64	Missouri	75.25
Alaska	74.83	Montana	76.23
Arizona	76.10	Nebraska	76.92
Arkansas	74.33	Nevada	74.18
California	75.86	New Hampshire	76.72
Colorado	76.96	New Jersey	75.42
Connecticut	76.91	New Mexico	75.74
Delaware	74.76	New York	74.68
District of Columbia	67.99	North Carolina	74.48
Florida	75.84	North Dakota	77.62
Georgia	73.61	Ohio	75.32
Hawaii	78.21	Oklahoma	75.10
Idaho	76.88	Oregon	76.44
Illinois	74.90	Pennsylvania	75.38
Indiana	75.39	Rhode Island	76.54
Iowa	77.29	South Carolina	73.51
Kansas	76.76	South Dakota	76.91
Kentucky	74.37	Tennessee	74.32
Louisiana	73.05	Texas	75.14
Maine	76.35	Utah	77.70
Maryland	74.79	Vermont	76.54
Massachusetts	76.72	Virginia	75.22
Michigan	75.04	Washington	76.82
Minnesota	77.76	West Virginia	74.26
Mississippi	73.03	Wisconsin	76.87
		Wyoming	76.21

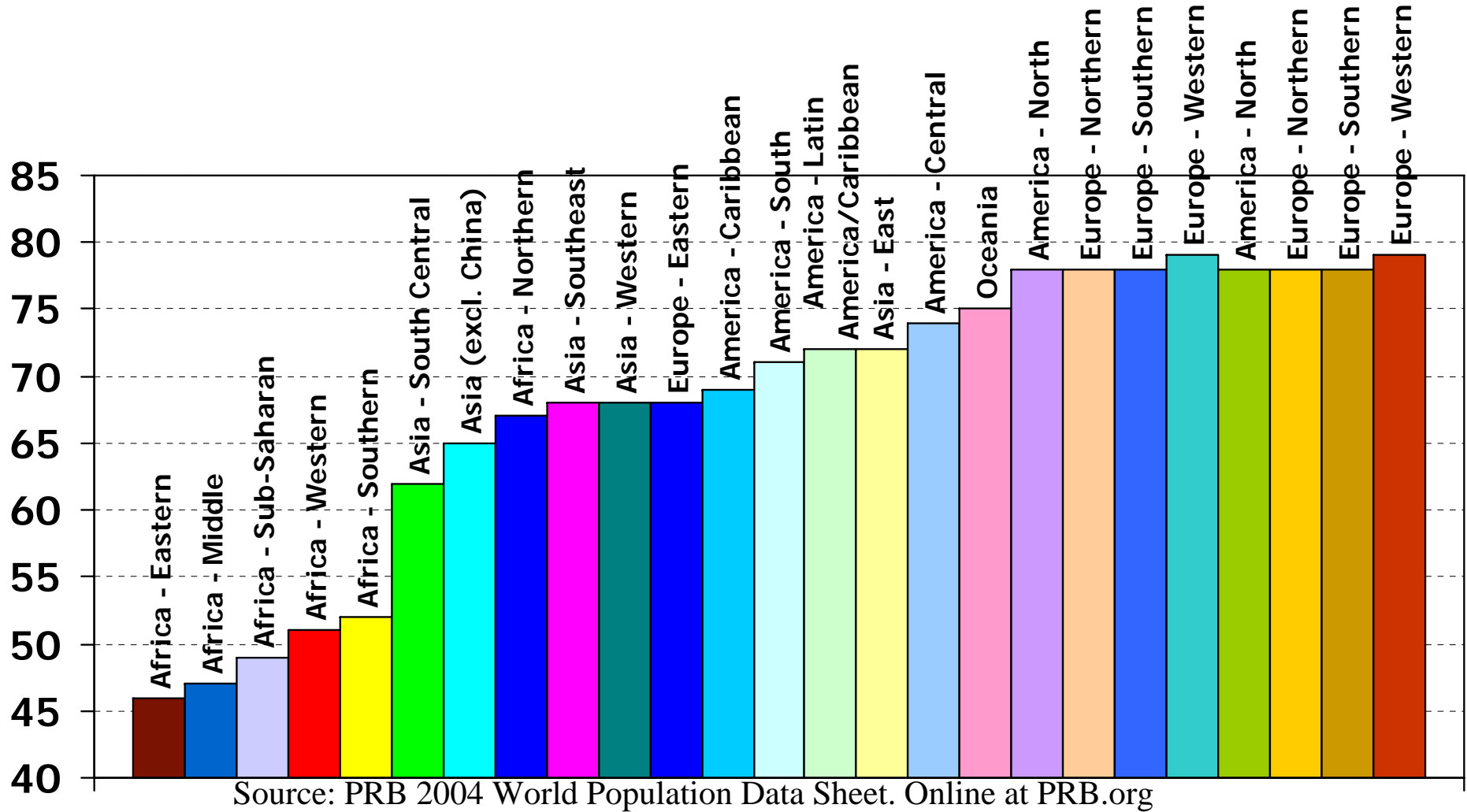
Some Trends and Comparisons of United States Life Table Data: 1900-1991, National Center for Health Statistics, 1999, online at http://www.cdc.gov/nchs/data/lifetables/life89_1_3.pdf

Life Expectancy: Global Comparisons

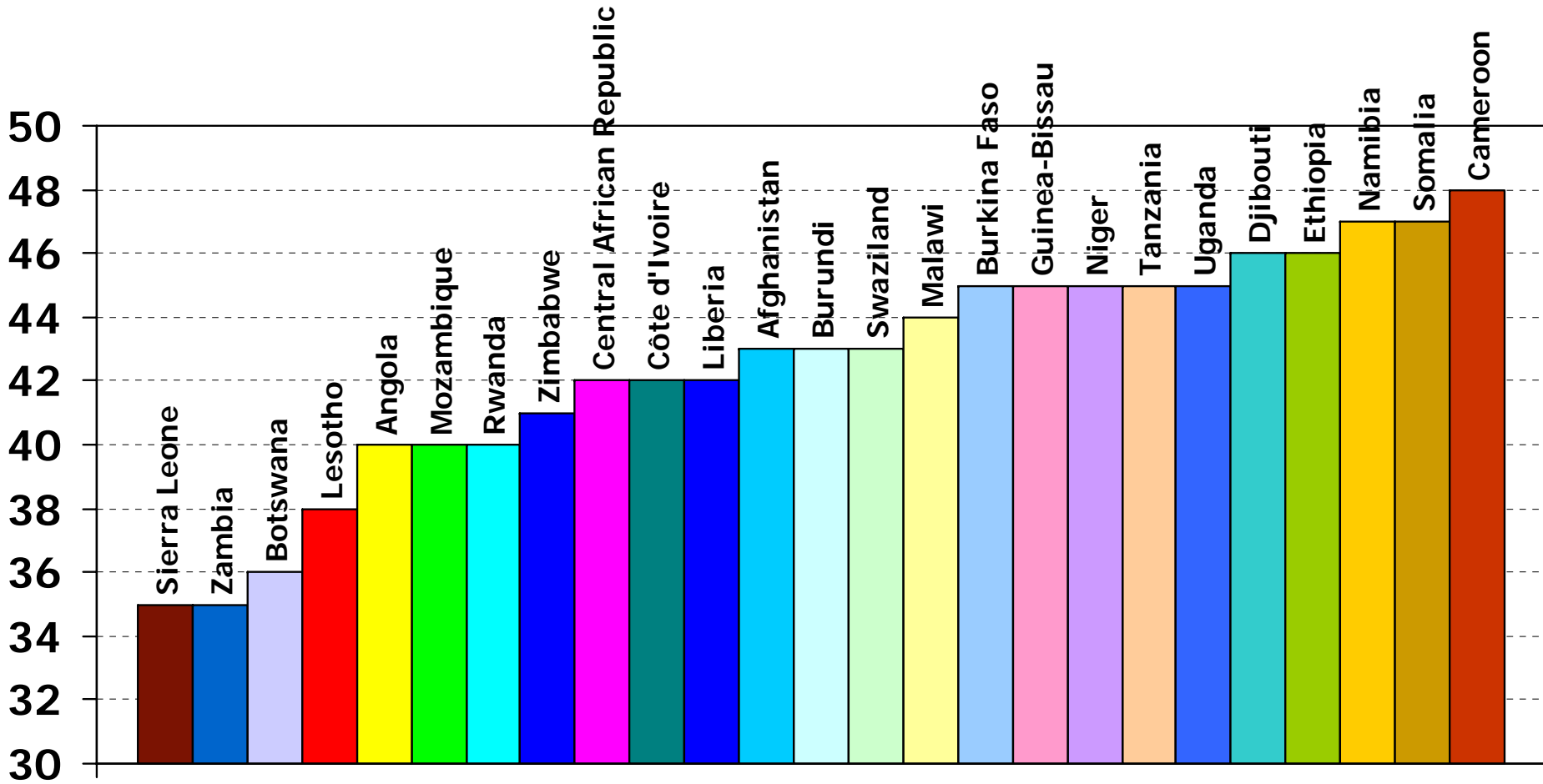


Source: PRB 2004 World Population Data Sheet. Online at PRB.org

Life Expectancy: Ranked in Ascending Order

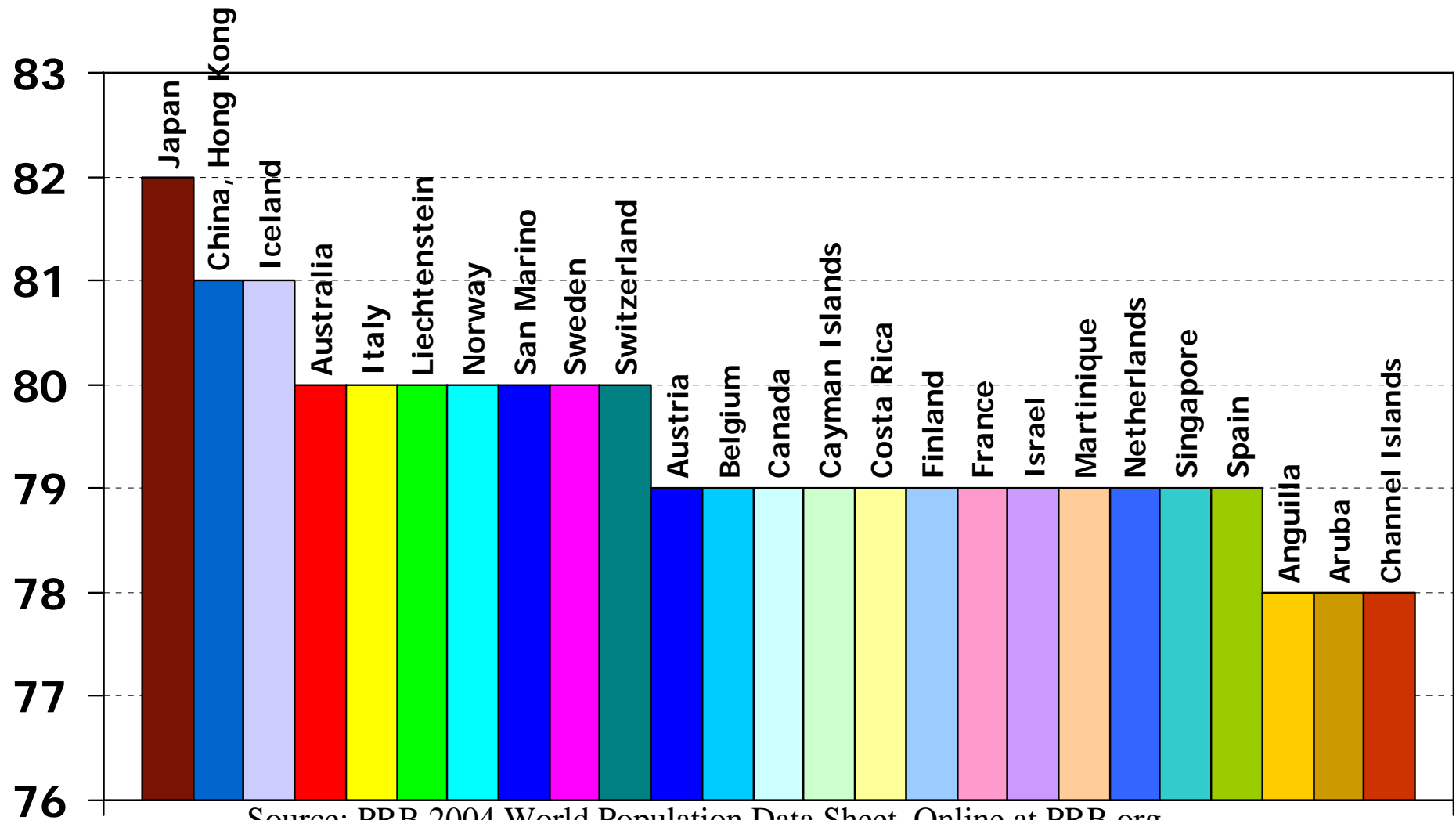


Life Expectancy: Bottom 25 Nations



Source: PRB 2004 World Population Data Sheet. Online at PRB.org

Life Expectancy: Top 25 Nations (US is ranked 46 at 77.3)



Mortality Research Resources



- National Center for Health Statistics
 - <http://www.cdc.gov/nchs/fastats/deaths.htm>
- Utah Population Database
 - <http://www.hci.utah.edu/groups/ppr/>
- Utah Office of Vital Records
 - <http://health.utah.gov/vitalrecords/>
- Berkeley Mortality Database
 - <http://www.mortality.org/>