APPENDIX IV. Mortality Measures

IV-A. The Age-Adjusted Mortality Rate

The mortality rate for a given population in a given time period is defined as the number of deaths occurring within that population divided by the size of the population in that time period. For example, the 1996-1998 Connecticut black resident mortality rate is

$$\frac{5,898}{900,408} \times 100,000 = 655.0 \text{ deaths per } 100,000$$

where 5,898 is the number of deaths of Connecticut black residents occurring in 1996-1998, and 900,408 is the Connecticut black population of the same time period. It is also noted that the mortality rates are presented in deaths per 100,000 in many occasions. Mortality rates so obtained are also referred to as "crude mortality rates."

A population's mortality rate is meaningful only when it is compared with another population's mortality rate in the same time period. For comparison purposes, the crude mortality rate for white residents in Connecticut between 1996-98 was also calculated and the following result was obtained:

$$\frac{81,970}{8,657,782} \times 100,000 = 946.8 \text{ deaths per } 100,000$$

We observe that the crude mortality rate for white residents is much higher than that for the black residents and might conclude that in Connecticut, whites were more likely to die than blacks during the years 1996-1998.

This observation is misleading because the demographic composition of the two populations is different. One problem with comparing the crude mortality rate of one population with that of another population is that the crude rates are heavily influenced by the age composition of the populations. According to the 1990 Census, whites had a higher percentage of residents 65 years or older (14.4%) compared to blacks (6.3%).

It is well established that age is one of the major determinants of death. The number of deaths naturally increases with the increasing age in almost any population. Although it would be preferable to compare the age-specific mortality rate of one population to another, e.g., Connecticut white resident death rate of the 70-74 age group vs. Connecticut black resident death rate of the 70-74 age group, this is not usually practical.

Therefore, it is often useful to have a summary mortality rate that will take into consideration the differences in the age distribution of the population. This is accomplished by the method of "age adjustment" or "age standardization." One such method, the *Direct Method* of age adjustment is used in this report. Following is the formula used in the calculation:

$$\text{AAMR} = \sum_{i=\text{all age groups}} \frac{d_i}{n_i} sp_i$$

where AAMR is the abbreviation for "Age Adjusted Mortality Rate"; *i* ("Index") ranges from 1 to 18 and represents age groups from 0 to 85 & older in five-year increments ranging from 1 to 18; d_i is the number of deaths in age group *i*; n_i is the population for age group *i*; and sp_i is the standard population for age group *i*.

The choice of standard population in this work is the US standard population. In practice, the US standard population is enumerated according to a specific year (e.g., 1940, 2000, etc), expressed on a per million basis, and the numbers are distributed across the age groups according to the year standardized (e.g., 2000 Standard Million).

NOTE:

Age-adjusted mortality rates using the 2000 Standard Million (SM) should always be compared with the same. For example, the AAMR (2000 SM) for Connecticut white residents (1996-98) should never be compared with the AAMR (1940 SM) for Connecticut black residents even for the same time period. The age structure of the US population in 1940 was very different from its age structure in 2000.

Table 1 shows an example of calculating the age-adjusted mortality rates for the Connecticut black and white residents using the 2000 U.S. standard population. It demonstrates that, in actuality, black Connecticut residents had 1.3 times the all-cause age-adjusted mortality compared to white residents in the period 1996-98.

Table 1. Connecticut black and white resident deaths, 1996-1998

		White				Black			
Age Groups	2000 US Std Pop sp_i	# of Deaths d_i	Population n_i	Crude Rates	Expected Deaths	# of Deaths d_i	Population n_i	Crude Rates	Expected Deaths
0-4	69,136	731	550,134	0.001329	91.9	286	75,061	0.003810	263.4
5-9	72,533	74	590,462	0.000125	9.1	19	85,802	0.000221	16.1
10-14	73,032	91	557,435	0.000163	11.9	29	80,271	0.000361	26.4
15-19	72,169	234	509,878	0.000459	33.1	82	73,803	0.001111	80.2
20-24	66,477	326	463,066	0.000704	46.8	108	63,275	0.001707	113.5
25-29	64,529	409	557,500	0.000734	47.3	131	74,553	0.001757	113.4
30-34	71,044	704	699,024	0.001007	71.5	149	84,423	0.001765	125.4
35-39	80,762	1,019	775,423	0.001314	106.1	254	79,575	0.003192	257.8
40-44	81,851	1,365	723,834	0.001886	154.4	311	65,745	0.004730	387.2
45-49	72,118	1,741	623,881	0.002791	201.3	335	52,783	0.006347	457.7
50-54	62,716	2,291	535,766	0.004276	268.2	366	42,421	0.008628	541.1
55-59	48,454	2,800	403,143	0.006945	336.5	466	34,258	0.013603	659.1
60-64	38,793	3,836	334,980	0.011451	444.2	528	25,977	0.020326	788.5
65-69	34,264	6,146	349,063	0.017607	603.3	499	22,557	0.022122	758.0
70-74	31,773	8,965	329,273	0.027227	865.1	603	16,210	0.037199	1,181.9
75-79	26,999	12,170	287,700	0.042301	1,142.1	567	11,509	0.049266	1,330.1
80-84	17,842	13,976	196,444	0.071145	1,269.4	466	6,355	0.073328	1,308.3
85+	15,508	25,092	170,776	0.146929	2,278.6	699	5,830	0.119897	1,859.4
					7,980.8				10,267.4

Direct Age-Adjusted Mortality Rate for black residents:

$$\frac{(0.00381\times 69{,}136)+(0.000221\times 72{,}533)+\ldots+(0.119897\times 15{,}508)}{10} = 1026.7 \text{ deaths per } 100{,}000$$

Direct Age-Adjusted Mortality Rate for white residents:

$$\frac{(0.001329\times 69{,}136)+(0.000125\times 72{,}533)+\ldots+(0.146929\times 15{,}508)}{10} = 798.1 \text{ deaths per } 100{,}000$$

IV-B. Measuring Years of Potential Life Lost as an Age-Adjusted Rate

The Years of Potential Life Lost (YPLL) is another widely used mortality measure. It differs from AAMR in that it emphasizes mortality in the younger age groups. It assumes that if a normal person in a given community lives to a certain age, say, 75 years old, then there are years of potential life lost due to any deaths that occur before that age. By applying the direct method of age adjustment to the YPLL, the effect of age structure of the population is removed. Thus, comparisons of YPLL among different populations can be made. In this work, age-adjusted YPLL at 75 was calculated and discussed.

The years of potential life lost at age 75 is calculated by summing up the difference in years between age at death and 75 years of age over all the dead. For data that are aggregated into age groups, this is done to each and every age group. For a given age group, the midpoint is used to represent the age of the whole age group. For example, the midpoint age of age group 15–19 is 17.5, and so on. The only exception is the 0–4 age group, where 0.5 is used instead of 2.5. This is to acknowledge the fact that most deaths in this age group are <1 year of age. Next, the number of deaths for each age group is multiplied by a "number of years life lost measure" defined as the difference between the endpoint, which is 75 years of age in this report, and the midpoint of the age group. Within each of the age group, the "number of years life lost measure" is then weighted by the age specific death rates applied to the standard population. The age adjusted YPLL is the sum of all the YPLLs in each age group. An illustration for this computation is shown in Table 2.

Following is the formula used in this work to calculate the age-adjusted YPLL:

$$\text{AAYPLL} = \frac{\sum_{i<75} \frac{d_i}{n_i} (75\text{-age}_i) \cdot sp_i}{\sum_{i<75} sp_i}$$

where AAYPLL is the abbreviation for Age-Adjusted Years of Potential Life Lost; age_i is the midpoint age for age group i; other symbols are the same as mentioned in the AAMR formula. The denominator is to acknowledge the fact there is no years of potential life lost for the 75 and older age groups.

Table 2. Connecticut Resident Deaths, 1996-1998
Years of Potential Life Lost at 75 for All Causes

Age Groups	# of Deaths d_i	Population n_i	75-age$_i$	2000 US Std Pop sp_i	Crude Rate[1] d_i/n_i	YPLL$_i$
0-4	1,058	647,891	74.5	69,136	163.3	841,093,433.3
5-9	96	696,340	67.5	72,533	13.8	67,497,751.1
10-14	123	657,096	62.5	73,032	18.7	85,441,625.0
15-19	325	602,347	57.5	72,169	54.0	223,900,540.3
20-24	452	547,044	52.5	66,477	82.6	288,367,884.5
25-29	563	656,496	47.5	64,529	85.8	262,860,212.8
30-34	882	809,432	42.5	71,044	109.0	329,006,555.2
35-39	1,295	879,886	37.5	80,762	147.2	445,740,087.4
40-44	1,709	810,637	32.5	81,851	210.8	560,819,351.6
45-49	2,111	693,199	27.5	72,118	304.5	603,957,910.4
50-54	2,704	589,664	22.5	62,716	458.6	647,087,398.9
55-59	3,312	446,156	17.5	48,454	742.3	629,464,546.0
60-64	4,421	367,254	12.5	38,793	1,203.8	583,737,185.3
65-69	6,706	376,044	7.5	34,264	1,783.3	458,272,936.1
70-74	9,642	348,737	2.5	31,773	2,764.8	219,617,696.1
				939,651		6,246,865,114.0

$$\text{Age-Adj. YPLL} = \frac{\text{Age-Adj.YPL(Total)}}{\text{2000 Std.Pop.(age<75)}} = \frac{6,246,865,114.0}{939,651}$$

= 6648.1 years of potential life lost to age 75 per 100,000

IV-C. Impact of Changing the Standard Reference Population from 1940 to 2000

The year 2000 age distribution has more elderly than the former 1940 population standard used by NCHS, consequently this shift will give more emphasis to diseases common among the elderly

Figure-1 displays the 1940 and 2000 standard million populations in each 5-year interval. The difference in the counts is most noticeable in the first five intervals (ages 0-24). For most causes of death, changes in the weights under age 25 will have little impact because deaths are more common at older ages. For deaths due to unintentional injuries (a cause that affects more young people) the lower weights in the 2000 standard will tend to diminish the the overall AAMR or YPLL figure. At age 60 and above, the 2000 counts exceed the 1940 counts. Since deaths are more common among the elderly for many causes, most AAMRs will be greater due to the use of the 2000 standard.

Figure 1

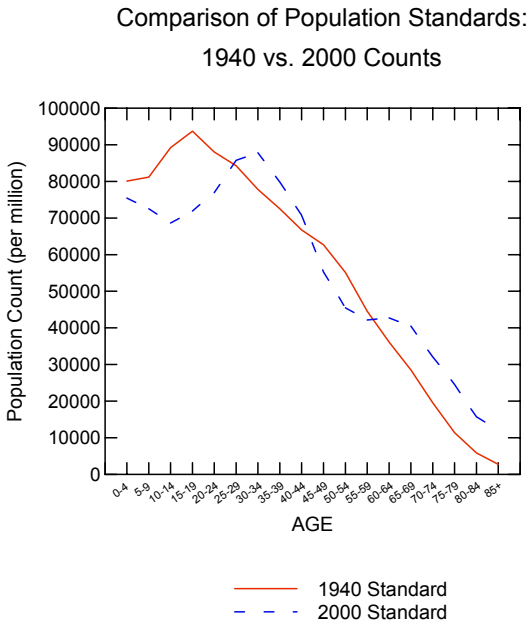

Figure 2 displays the change between 1940 and 2000 as a percentage of the 1940 count within each age group. Under age 25 the difference is large in absolute terms (see Figure 1) but small in relative terms (see Figure 2). The impact of this shift on specific causes of death is summarized in table 1. AAMRs based on the 1940 and 2000 standard populations are compared. These rates are for 1996-1998, both sexes, unless the condition is sex-specific.

Figure-2

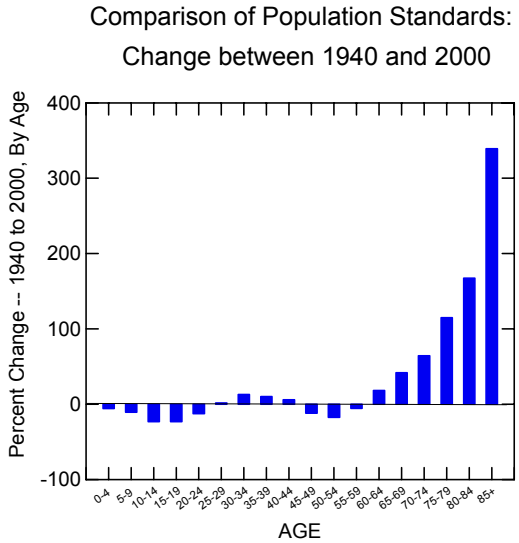

Table 1

Comparison of AAMRs based on the 1940 and 2000 standard populations
Rates are for 1996-1998, both sexes (unless the condition is sex-specific)

Causes of Death	1940 AAMR	2000 AAMR	Ratio	
			" 2000/1940	Increase?
All causes	425.0	815.1	1.9	Yes
Infectious diseases and parasitic disease (1-139)	16.8	24.6	1.5	Yes
Septicemia (038)	4.8	10.4	2.2	Yes
Septicemia-related (038)	19.5	38.8	2.0	Yes
HIV infection (042-044)	6.9	7.4	1.1	Yes
All cancer (140-208)	118.4	199.0	1.7	Yes
Oral cavity or pharynx (140.0-149.9)	1.8	2.7	1.5	Yes
Colorectal cancer (153.0-154.3,154.8,159.0)	11.1	20.6	1.9	Yes
Colon cancer (153)	9.1	16.9	1.9	Yes
Rectal cancer (154)	1.9	3.4	1.8	Yes
Pancreatic cancer (157)	6.7	11.5	1.7	Yes
Lung and other respiratory cancer (160-165)	34.4	54.4	1.6	Yes
Lung cancer (162.2-.9)	33.3	52.7	1.6	Yes
Malignant melanoma of skin (172)	1.7	2.7	1.5	Yes
Female breast cancer (174)	20.0	30.0	1.5	Yes
Cervical cancer (180)	1.7	2.2	1.3	Yes
Endometrial cancer (182)	1.2	2.1	1.8	Yes
Ovarian cancer (183)	5.5	8.6	1.5	Yes
Prostate cancer (185)	12.3	31.0	2.5	Yes
Bladder cancer (188)	2.4	5.0	2.1	Yes
Brain & other CNS cancer (191-192)	3.1	4.4	1.4	Yes
Leukemia (204-208)	4.6	7.5	1.6	Yes
Diabetes mellitus (250)	10.0	18.4	1.8	Yes
Diabetes-related (250)	36.2	69.8	1.9	Yes
Diabetic ketoacidosis (DKA) (250.1)	0.3	0.4	1.5	Yes
Alzheimer's diseases (331.0)	2.0	6.7	3.3	Yes
Cardiovascular disease (390-459)	147.3	338.1	2.3	Yes
Diseases of the heart (390-398,402,404-429)	117.9	265.4	2.3	Yes
Heart disease-related (390-398,402,404-429)	204.0	446.2	2.2	Yes
Coronary heart disease (CHD) (402,410-414,429.2)	84.5	189.7	2.2	Yes
Congestive heart failure (CHF) (428.0)	4.9	15.0	3.1	Yes
Hypertension without renal disease (401,403)	1.8	4.2	2.3	Yes
Hypertension-related (401,403)	26.1	57.4	2.2	Yes
Cerebrovascular disease (430-438)	20.4	51.9	2.5	Yes
Atherosclerosis (440)	1.6	4.9	3.1	Yes
Atherosclerosis-related (440)	7.4	20.9	2.8	Yes
Aortic aneurysm (441)	2.9	6.1	2.1	Yes
Pneumonia & influenza (480-487)	11.5	32.2	2.8	Yes
Chronic obstructive pulmonary disease (COPD) (490-496)	15.9	33.5	2.1	Yes
COPD-related (490-496)	36.5	77.4	2.1	Yes
Asthma (493)	1.1	1.6	1.4	Yes

Table 1 (continued)

Comparison of AAMRs based on the 1940 and 2000 standard populations
Rates are for 1996-1998, both sexes (unless the condition is sex-specific)

Causes of Death	1940 AAMR	2000 AAMR	Ratio	
			" 2000/1940	Increase?
Chronic liver disease and cirrhosis (571)	6.4	8.6	1.3	Yes
Nephritis, nephrotic syndrome/nephrosis (580-589)	4.4	9.6	2.2	Yes
Nephritis-related (580-589)	21.2	43.1	2.0	Yes
End stage renal disease (ESRD) (581-588,591,593.8,593.9)	5.4	11.5	2.1	Yes
Unintentional injuries (E800-E949)	24.6	30.7	1.2	Yes
Motor vehicle accidents (E810-E825)	10.2	10.3	1.0	Yes
Falls and fall related injuries (E880-E888)	2.5	5.6	2.2	Yes
Drowning (E830,E832,E910)	0.9	0.9	1.0	Yes
Residential fires (E890-E899)	0.8	1.0	1.1	Yes
Suicide (E950-E959)	7.8	8.3	1.1	Yes
Homicide and legal intervention (E960-E978)	5.4	4.8	0.9	**No**
Homicide (E960-E969)	5.3	4.7	0.9	**No**
All injury (E800-E999)	38.9	44.9	1.2	Yes
All motor vehicle accidents (E810-E819,E958.5,E988.5)	9.9	10.1	1.0	Yes
All falls (E880-E886,E888,E957,E968.1,E987)	2.2	4.2	1.9	Yes
All firearms (E922.0-.3,E922.8-.9,E955.0-.4,E965.0-.4,E970,E985.0-.4)	6.9	6.5	0.9	**No**
Firearm Suicide (E955.0-.4)	2.9	3.1	1.1	Yes
Firearm Homicide (E965.0-.4)	3.7	3.1	0.8	**No**
All poisoning (E850-E869,E950-E952,E962,E972,E980-E982)	8.2	8.7	1.1	Yes
Alcohol-induced (291,303,305.0,357.5,425.5,535.3,571.0-.3,790.3,E860)	3.9	4.7	1.2	Yes
Drug-induced (292,304,305.2-.9,E850-E858,E950.0-.5,E962.0,E980.0-.5)	7.2	7.5	1.0	Yes