BRIEF
HEALTH STATISTICS SECTION

Colorado Department
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Age-Adjusted Death Rates in Colorado Vital Statistics: Implementation of the Year 2000 Standard

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Age standardization, often referred to as "age-adjustment," has been used for over half a century as a way for official United States mortality statistics to eliminate the confounding effects of differences in the age composition among different populations or across time. The 1940 U.S. population has been used as the standard population in reporting Colorado vital statistics. A new population standard, the projected year 2000 U.S. population, has been approved for use by the U.S. Department of Health and Human Services (DHHS) and has been implemented by the National Center for Health Statistics (NCHS) in all states for deaths occurring in 1999.[1]

Changing from the 1940 standard population to the year 2000 standard will affect the magnitude of age-adjusted death rates, and in some cases, trends in mortality. This special report will briefly describe the rationale for and the implications of implementing the new 2000 population standard for age-adjusting death rates. It will evaluate the impact of the new standard on Colorado age-adjusted death rates using Colorado 1990-1998 death data.

Background

The burden of disease in a population can be denoted by the total number of people who contract or die from a particular illness. However, it is widely accepted that the absolute number of events is seldom useful for making comparisons between groups or examining changes over time because the numbers depend largely on population size. The number of events must be related to the size of the "population at risk" experiencing the event.

The crude death rate is one summary measure used to assess the burden of disease in a community. It is defined as the total number of deaths divided by the total midyear population and is often expressed as deaths per 1,000 or 100,000 population. Although it is the simplest way to express relative mortality risk, the crude death rate is also inadequate for comparing the burden of deaths between groups or time periods because many health outcomes such as death vary substantially by age. Because the risk of dying is much greater at older ages, populations with older age distributions tend to have higher crude death rates than do younger populations.

In order to overcome the effect of population age distribution on comparison of crude death rates, the age-adjusted death rate was first introduced in 1841 for the analysis of mortality data.[2] The age-adjusted death rate is defined as the death rate that would occur if the observed age-specific death rates were present in a population with an age distribution equal to a standard population. The age-adjusted death rate is calculated by multiplying each age-specific rate by the standard population weight and summing the weighted age-specific death rates.[1] Because each population or time period shares a common age distribution represented by the age-specific standard population weights, the effects of variation in age distribution are eliminated.

Since 1943, the National Center for Health Statistics and many states have used the 1940 United States population as the standard population for age-adjusting death rates. In 1991 and 1997, NCHS sponsored workshops to consider implementing a more up-to-date standard to reflect the aging of the U.S. population since 1940.[3] The result was a recommendation, approved by the U.S. Department of Health and Human Services and the National Center for Health Statistics, to use the projected year 2000 population proportions as the standard for calculating age-adjusted deaths rates, effective with 1999 death data. The projected population age distribution for the year 2000 standard was then prepared by the U.S. Bureau of the Census and converted by NCHS to a standard million population by dividing the age-specific populations by the total population and multiplying by one million.[1]

Table 1 shows the 1940 and year 2000 standard populations with their corresponding age-specific weights. Between1940 and 2000, the U.S. population aged substantially. The year 2000 population shows a higher concentration of population in the middle and older age groups, such as between 35 to 45 years of age and 65 and over. The population age 65 years and over almost doubled during this period. Because the standard populations serve as the weights for calculating age-adjusted rates, it is to be expected that the change to the year 2000 standard will affect the magnitude of age-adjusted death rates and trends in mortality, since more weight is given to older age groups.

Table 1 Years 1940 and 2000 U.S. standard populations

	1940		2000	
Age	Number	Weight	Number	Weight
All ages	1,000,000	1.000000	1,000,000	1.000000
Under 1 year	15,343	0.015343	13,818	0.013818
1-4 years	64,718	0.064718	55,317	0.055317
5-14 years	170,355	0.170355	145,565	0.145565
15-24 years	181,677	0.181677	138,646	0.138646
25-34 years	162,066	0.162066	135,573	0.135573
35-44 years	139,237	0.139237	162,613	0.162613
45-54 years	117,811	0.117811	134,834	0.134834
55-64 years	80,294	0.080294	87,247	0.087247
65-74 years	48,426	0.048426	66,037	0.066037
75-84 years	17,303	0.017303	44,842	0.044842
85+ years	2,770	0.002770	15,508	0.015508

Magnitude of age-adjusted death rates in Colorado

The change in the population standard from 1940 to the year 2000 will affect the magnitude of age-adjusted death rates for Colorado. The rate based on the year 2000 standard will be much larger than that based on the 1940 standard. In comparing the deaths which occurred in Colorado from 1990 to 1998 using both standards, the overall age-adjusted death rates using the 2000 standard (848.4 per 100,000 population

in 1998) were almost twice as high as the rates using the 1940 standard (426.7 per 100,000 population in 1998).

The magnitude of the effect of switching to the new standard will vary greatly by causes of death. Table 2 demonstrates that causes of death such as heart disease and COPD, which occur at higher rates among older population groups, show the greatest increase from the 1940 standard to the 2000 standard because of the increased weight given to those age groups. However, rates for other causes, such as suicide, homicide and injury, are virtually unchanged.

Although the change in the standard affects the magnitude of the age-adjusted death rate, the trend upward or downward over time is preserved (Figure 1).

Figure 1 Crude and age-adjusted death rates based on the 1940 and 2000 standard populations:Colorado, 1990-1998
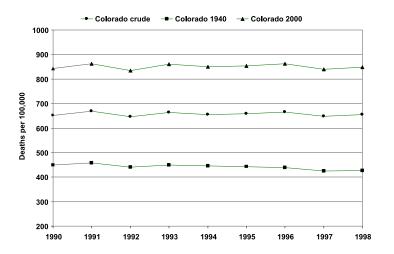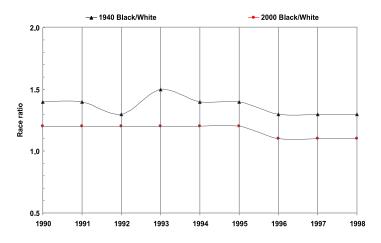
Table 2 Age-adjusted death rates and percent change based on years 1940 and 2000 U.S. standard populations for 17 leading causes of death

Cause of death and ICD-9 classification	Standard Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1990-98 % change
All Causes	N	21,514	22,534	22,426	23,740	24,188	24,898	25,716	25,606	26,582	
	1940	449.7	457.1	439.8	450.0	445.0	442.7	438.6	424.9	426.7	-5.1
	2000	843.3	862.2	834.0	860.2	850.4	853.7	862.6	839.3	848.4	0.6
Diseases of the heart	N	6,123	6,122	6,161	6,124	6,321	6,420	6,595	6,519	6,614	
(390-398, 402, 404-429)	1940	115.9	111.2	108.5	104.2	104.4	102.4	100.6	97.6	95.7	-17.4
	2000	251.9	246.8	241.6	233.5	233.4	231.3	231.9	222.8	220.1	-12.6
Malignant neoplasms	N	4,930	5,197	4,947	5,333	5,419	5,454	5,656	5,638	5,798	
(140-208)	1940	114.5	116.0	107.0	112.0	110.7	107.1	107.9	103.7	104.0	-9.2
	2000	189.1	194.5	179.7	187.8	185.0	181.8	183.1	178.9	178.6	-5.5
Cerebrovascular disease	N	1,319	1,359	1,427	1,614	1,539	1,600	1,678	1,712	1,736	
(430-438)	1940	22.3	22.0	22.2	24.2	22.2	22.6	22.7	23.2	22.6	1.2
	2000	55.8	56.3	57.9	63.8	59.1	59.8	61.1	60.2	59.5	6.6
COPD	N	1,300	1,507	1,407	1,519	1,517	1,583	1,653	1,659	1,834	
(490-496)	1940	26.2	29.9	27.4	28.6	27.1	27.2	27.4	26.8	29.1	10.9
	2000	52.1	58.7	53.0	56.0	54.7	55.8	56.7	55.7	59.8	14.7
Unintentional injuries	N	1,109	1,176	1,137	1,211	1,334	1,437	1,427	1,468	1,509	
(E800-E949)	1940	29.6	31.3	29.5	30.1	31.8	33.2	32.0	32.0	31.7	6.9
	2000	36.5	38.0	35.4	36.6	39.8	41.8	40.8	41.1	41.4	13.7
Pneumonia & influenza	N	933	944	940	972	882	948	980	853	1,032	
(480-487)	1940	14.2	14.4	13.8	13.9	12.1	13.2	12.9	10.6	12.5	-11.8
	2000	40.5	39.7	38.3	38.8	34.2	35.3	35.8	30.6	36.0	-11.1
Suicide	N	548	562	595	606	601	646	692	627	600	
(E950-E959)	1940	15.7	15.7	16.3	15.9	15.3	16.0	16.6	15.0	13.6	-13.3
	2000	17.2	17.1	17.5	17.4	16.8	17.4	18.4	16.1	15.3	-11.0
Diabetes Mellitus	N	404	476	436	459	457	533	552	527	567	
(250)	1940	8.6	10.0	8.5	9.1	9.0	10.0	9.8	9.1	9.7	12.5
	2000	16.0	18.1	16.2	16.5	15.8	18.1	18.3	17.1	17.7	10.8
Atherosclerosis	N	274	314	387	394	398	371	380	391	414	
(440)	1940	3.5	3.8	4.9	4.7	4.7	4.2	4.0	4.1	4.3	21.5
	2000	12.3	13.9	16.4	16.5	16.0	14.6	14.7	14.7	15.0	21.6
Chronic liver disease and cirrhosis	N	293	319	310	315	329	318	341	346	350	
(571)	1940	7.9	8.5	7.8	7.8	8.0	7.2	7.5	7.5	7.3	-8.0
	2000	10.4	11.0	10.3	9.9	10.1	9.4	9.8	9.6	9.5	-9.0
Alzheimer's Disease	N	175	205	193	273	270	279	295	355	376	
(331.0)	1940	2.5	3.0	2.5	3.4	3.4	3.3	3.3	3.8	3.8	52.0
	2000	7.8	8.8	8.2	11.3	10.7	10.9	11.3	13.2	13.7	75.6
Nephritis, nephrosis, nephrotic syndrome	N	122	120	134	233	242	250	254	250	273	
(580-589)	1940	2.2	2.1	2.2	3.9	4.1	4.1	3.8	3.5	3.7	71.3
	2000	5.0	4.8	5.3	8.9	8.8	8.9	9.0	8.8	9.2	82.9
HIV	N	314	350	374	384	381	406	244	126	84	
(042-044)	1940	8.7	9.5	9.6	9.6	9.4	9.8	5.7	2.9	1.9	-78.6
	2000	9.0	9.7	9.9	10.1	9.8	10.1	5.9	3.1	2.0	-77.9
Septicemia	N	151	192	178	193	195	190	234	198	233	
(038)	1940	2.8	3.5	3.2	3.3	3.4	3.3	3.9	3.1	3.5	26.4
	2000	6.2	7.7	6.9	7.3	7.0	6.7	8.0	6.6	7.6	22.9
Homicide & legal intervention	N	152	204	217	206	205	209	213	192	184	
(E960-E978)	1940	4.7	6.3	6.4	6.0	5.7	5.6	5.7	5.0	4.8	2.3
	2000	4.3	5.9	6.0	5.6	5.3	5.4	5.3	4.8	4.4	0.7
Congenital anomalies	N	170	157	142	153	150	142	158	161	182	
(740-759)	1940	4.9	4.4	3.9	4.1	4.0	3.7	4.0	4.0	4.4	-10.1
	2000	4.8	4.4	3.9	4.1	4.0	3.8	4.2	4.2	4.6	-4.4
Perinatal period conditions	N	185	154	149	159	153	131	148	170	164	
(760-779)	1940	5.4	4.4	4.2	4.4	4.3	3.7	4.1	4.6	4.3	-20.7
	2000	4.9	3.9	3.8	4.0	3.9	3.3	3.7	4.2	3.9	-20.5
Injury by firearms	N	413	428	497	542	502	497	534	463	447	
(E922, E955.0-E955.4, E965.0-E965.4,	1940	12.1	12.5	14.2	14.8	13.3	12.7	13.2	11.3	10.5	-13.3
E970, E985.0-E985.4)	2000	12.8	13.1	14.4	15.5	13.7	13.3	14.1	11.8	11.4	-11.5
Drug-induced death	N	140	170	167	182	211	273	234	250	266	
(292, 304, 305.2-305.9, E850-E858,	1940	3.8	4.6	4.3	4.7	5.2	6.5	5.5	5.9	6.0	57.6
E962.0, E950.0-E950.5, E980.0-E980.5)	2000	4.3	5.0	4.7	4.9	5.6	7.1	5.9	6.2	6.4	49.8
Alcohol-induced death	N	347	385	388	367	387	392	370	377	367	
(291, 303, 305.0, 357.5, 425.5, 535.3,	1940	9.7	10.7	10.1	9.2	9.7	9.4	8.5	8.4	7.9	-19.1
E860, 790.3, 571.0-571.3)	2000	12.0	12.9	12.5	11.1	11.4	11.1	10.1	10.1	9.4	-21.6

Race differences in mortality using new standard

The year 2000 standard will affect the race and ethnic differentials in mortality, particularly the difference between black and white populations.[1] One way of showing the differentials in mortality between population groups is the "mortality race ratio," which is the ratio of the age-adjusted death rate for one group (e.g., the black population) to that of another group (the white population). Results from 1990-1998 data in Colorado indicate that the mortality race ratio for the black and white population is reduced from 1.3 using the 1940 standard to 1.1 using the year 2000 standard (see Figure 2).

Figure 2 Mortality race ratio based on the 1940 and 2000 standard populations: Colorado residents, 1990-1998

*White refers to White/Non-Hispanic.

Using the 1940 standard, the black population has an age-adjusted death rate that is 30 percent higher than that of the white population. In contrast, the year 2000 standard results in a rate for the black population that is only 10 percent higher. The reason for the narrowing of the differential lies in the age-specific death rates and the population structure of the two race groups. The reduction in the overall (all ages combined) mortality ratio from the 1940 to the year 2000 standard reflects the greater weight that the year 2000 standard gives to the older population, where race differentials in mortality are smaller. In this case, the single ratio of age-adjusted rates masks the important age-specific differences in the mortality race ratio, which is one of the limitations of age-adjusted rates.

Limitations of age-adjusting death rates

Researchers and program managers should be mindful of these changes as they evaluate the age-adjusted rates in vital statistics and consider the disadvantages of using age-adjusted deaths rates. First, considered alone, the age-adjusted death rate does not reflect the mortality risk of a "real" population. The average risk of mortality of a real population is represented by the crude death rate. Age-adjusted death rates are appropriate only when comparing groups or examining trends across multiple time periods.[1] Second, age standardization may mask important information if the age-specific rates in the populations being compared do not have a consistent relationship. For example, if age-specific death rates increase in younger populations while declining in older populations (or vice versa), the age-adjusted death rate may remain relative unchanged, thereby masking the underlying trends in mortality. Finally, because age-adjusted death rates are weighted averages, they represent merely the beginning analysis strategy that should proceed to age-specific analyses and then to examination of additional sociodemographic variables.

References

[1] Anderson RN, and Rosenberg HM. Age standardization of death rates: implementation of the year 2000 standard. National Center for Health Statistics. National Vital Statistics Report 3 (47). 1998.

[2] Neison FGP. On the method recently proposed for conducting inquiries into the comparative sanatory condition of various districts. Journal of the Royal Statistical Society of London 7: 40-68, 1844.

[3] Anderson RN, and Rosenberg HM. Report of the second workshop on age adjustment. National Center for Health Statistics. Vital Health Statistics Report 4 (30). 1998.