Center for Health Statistics

Age Standardization of Death Rates in New Jersey
Implications of a Change in the Standard Population

By: Rose Marie Martin, M.P.H.

Abstract
Beginning with data year 1999, the U.S. Department of Health and Human Services is using a new standard population based on the year 2000 population for age standardization (age-adjustment). The year 2000 standard population has replaced the standard population based on the 1940 population, which had been used by the National Center for Health Statistics and state Centers for Health Statistics for more than 50 years. Use of the year 2000 standard will narrow race differentials in age-adjusted rates, will affect rankings of leading causes of death and will have an impact on trends in age-adjusted rates for certain causes of death. This report examines the rationale for the change to a new standard population and the effect of the change on the age-adjusted rates for all causes and selected leading causes of death in New Jersey. Major implications of the change on data users are also explored. One of the major benefits from the change to a uniform standard will be the ability to compare age-adjusted rates from all state and federal agencies. The change to a new standard population will, however, require re-computation of age-adjusted rates for past years using the new standard population, for purposes of examining trends. The need to incorporate an examination of age-specific rates into any analysis of death rates is also addressed.

INTRODUCTION

Beginning with data year 1999, there was a change in the standard population used by federal and many state government and other health agencies for age adjustment of rates. The change in population standard has had an effect on the magnitude of death rates, on the ranking of the leading causes of death and on the relative disparities in these rates by race. In this report, these effects on New Jersey's death rates will be explored by examining relative rankings of leading causes of death, differences in crude and age-adjusted rates, and changes in racial differences in death rates using the two different age standards.

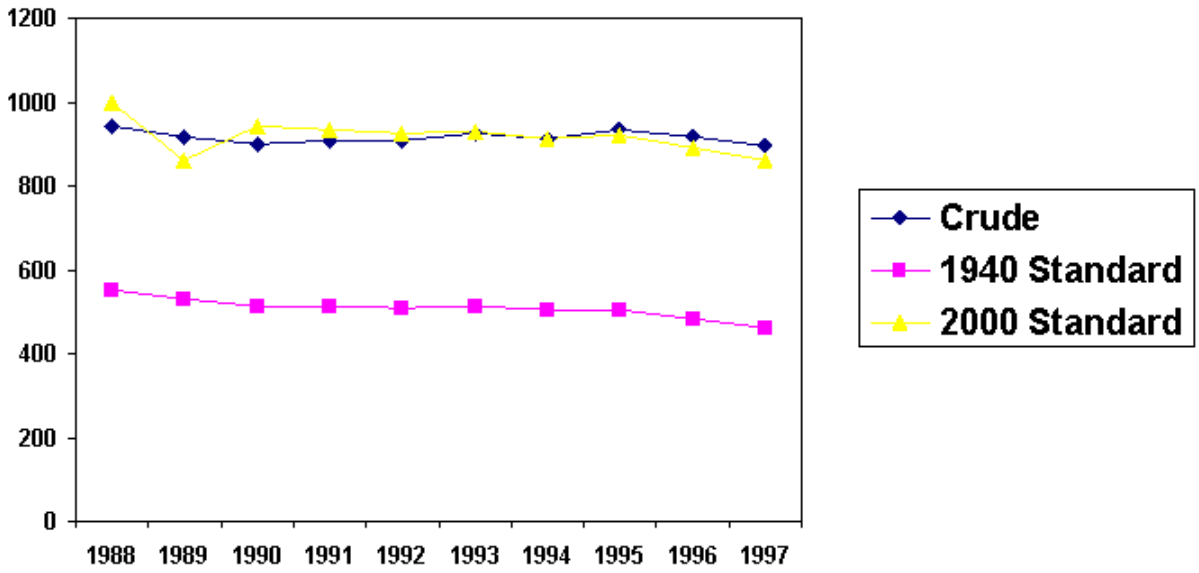
Death rates are greatly affected by the socioeconomic/demographic composition of the population at risk. Specifically, death rates have been shown to vary by age, race, gender, occupation, education and income levels of the population. However, death rates are most greatly impacted by the age distribution of the population.1 The overall death rate and the death rates from most causes will be higher in populations with a greater proportion of persons in the older age groups than in populations with relatively large proportions of younger people. Thus, comparisons of crude or unadjusted death rates among groups or over time may be misleading if the age distributions of the populations at risk are different. For this reason, death rates intended for use as trend data or for comparisons among groups are usually adjusted or standardized, to remove the effect of the differences in age distribution over time or by place.

Age adjustment, using the direct method, requires the selection of a standard population. Since 1943, the National Center for Health Statistics (NCHS) and the state Centers for Health Statistics have used a standard population derived from the 1940 Census count. Population demographics have changed considerably since 1940 in this country. Fertility has declined resulting in a smaller proportion of the population in the youngest age groups at the same time that life expectancy has increased, leading to growth in the number and percentage of persons in the older age groups. This disparity between the actual and standard population distributions has led to a substantial discrepancy between the crude and age-adjusted death rates (Figure 1). Additionally, there is an overall lack of consistency in the use of standard populations. At present, there are at least three other standard populations in use by various governmental and private health agencies.2 For example, the National Cancer Institute (NCI) uses the 1970 U.S. census count as the population standard for age adjustment and the New Jersey cancer registry has followed NCI's lead in using the 1970 population standard for age-adjusted rates.

To examine the major issues related to selection of a standard population, NCHS sponsored two

workshops during the 1990s which included a wide range of governmental and private health professionals as well as academicians as participants. The outcome of the second workshop was a recommendation that a new standard for age adjustment of rates be adopted based on the projected year 2000 U.S. population. The recommendation has been approved by the Secretary of the Department of Health and Human Services and was implemented beginning with data year 1999.3

FIGURE 1. CRUDE AND AGE-ADJUSTED DEATH RATES BASED ON THE 1940 AND 2000 STANDARD POPULATIONS: NEW JERSEY, 1988-1997



Changing to the year 2000 standard population has led to age-adjusted rates that are very close to the crude death rates (Figure 1). This occurs because the population proportions by age group for current years are very similar to those in the year 2000 U.S. population projections. The magnitude of the age-adjusted rates using the year 2000 standard is almost twice the age-adjusted rates computed using the 1940 standard population. For example, in 1997 the age-adjusted death rate for New Jersey using the 1940 standard population was 460.3 per 100,000 and the comparable rate using the year 2000 standard population was 861.4. In the same year, the crude death rate was 894.6 per 100,000 population. Although this report will be limited to a discussion of death rates, the methods of age standardization discussed here are valid for many other types of rate adjustments, including morbidity and birth rates and for adjustment for characteristics other than age, such as gender, income and race.

METHODOLOGY

The crude or unadjusted death rate is calculated by dividing the number of deaths in a population during a defined period of time, usually a year, by the population exposed to the risk of death during the period. The result is multiplied by a constant, usually 1,000 or 100,000, to avoid expressing these rates as numbers less than one. For example, the crude death rate among New Jersey residents in 1997 was 894.6 per 100,000 population, arrived at by dividing 72,039 resident deaths by the estimated mid-year population of the state, 8,052,849, and multiplying the result by 100,000. Crude death rates serve several public health purposes, which include providing an indication of the magnitude of overall and cause-specific mortality in a population.

Although useful for certain purposes, the crude death rate as a comparative measure has a major shortcoming: it is a function of the age distribution of the population at risk. A summary measure that eliminates the effect of the underlying age distribution of the population on the rate is the age-adjusted death rate. The result is a figure that represents the theoretical risk of mortality for a population, if the population had an age distribution identical to that of the standard population. There are two major techniques for computing age-adjusted rates: the direct and the indirect methods. The indirect method, which is not in wide usage in this country, will not be addressed here. The direct method age-adjusted

rate is calculated by applying a series of weights to the age-specific death rates. The weights are the respective proportions of the standard population in each of the relevant age groups. Table 1 provides an example of the calculation of the total age-adjusted death rate for New Jersey residents in 1997 using the 1940 standard population.

In Table 1, the number of deaths in 1997 in each of the age groups is divided by the estimated mid-year 1997 population in the respective age group and the resulting age-specific rate is multiplied by 100,000. Each of these rates is next multiplied by a weight, which is the proportion of the population of the 1940 standard population in each of the age groups. The total of the weights is one, as shown in the table. The resulting weighted rates for the age groups are then summed to form the age-adjusted rate for the total population, 460.3 deaths per 100,000 standard population.

**TABLE 1. AGE ADJUSTMENT:
NEW JERSEY DEATH RATE, 1997
USING THE 1940 STANDARD POPULATION**

Age Group	Deaths	Population	Rate *100,000	Standard Million Weight	Weighted Rate
Under 5	870	556867	156.231	0.080	12.508
5-14	194	1118060	17.351	0.170	2.956
15-24	666	979280	68.009	0.182	12.356
25-34	1331	1169765	113.784	0.162	18.440
35-44	2837	1385043	204.831	0.139	28.520
45-54	4358	1055453	412.903	0.118	48.645
55-64	6865	682693	1005.576	0.080	80.742
65-74	14414	596403	2416.822	0.048	117.037
75-84	21604	385512	5603.976	0.017	96.966
85+	18807	123773	15194.752	0.003	42.089
Unknown	93				
Total	72039	8052849	894.578	1	460.259

The age-adjusted rate derived in this manner can then be compared with other similarly age-adjusted rates to assess the relative risks of mortality from populations or over time, when the effect of the differences in age distribution of the population has been removed. Several important points apply:

- The age-adjusted or age-standardized rate is an index number and is not an actual death rate. It is a hypothetical figure designed for the purpose of facilitating comparisons among populations or within the same population over time.
- The age-adjusted rate can only be compared to other rates generated through use of the same method of adjustment and using the same standard population.
- The use of a summary statistic, such as the age-adjusted death rate, may not accurately reflect important trends and differences in age-specific death rates.

EFFECTS OF CHANGING TO THE YEAR 2000 POPULATION STANDARD

The choice of a standard population does not effect the trends in age-adjusted rates, unless trends in these death rates vary by age groups. However, the relative ranking of causes of death may differ, depending on the standard used. As shown in Table 2, New Jersey's total age-adjusted rate for 1997 will

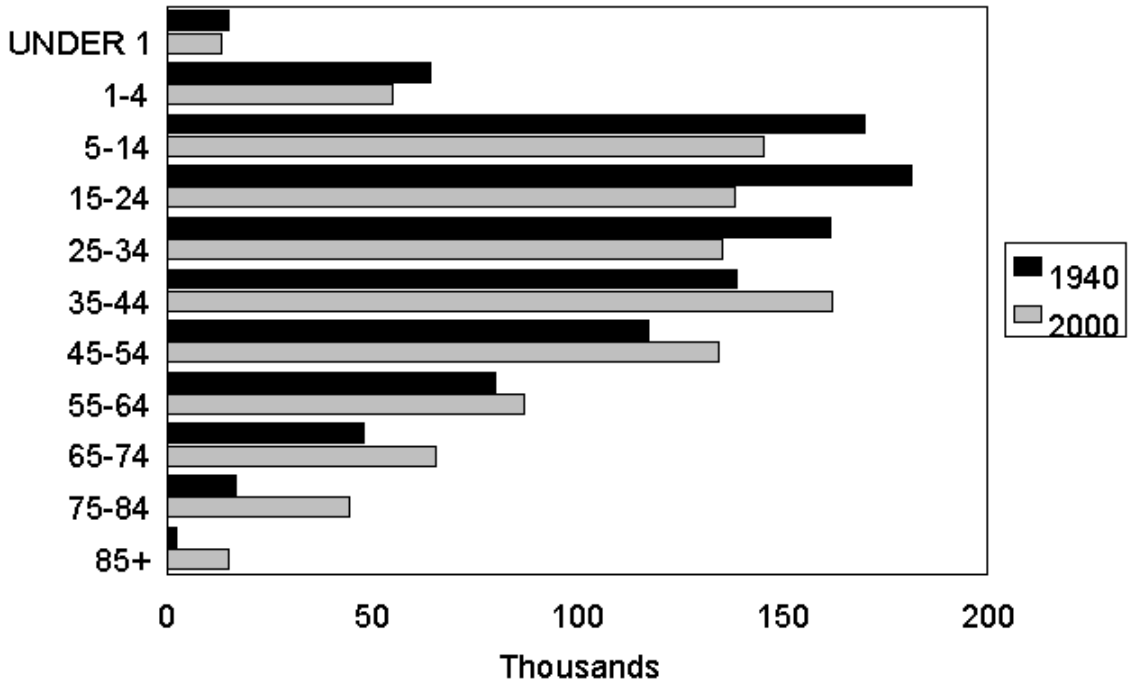
increase from 460.3 per 100,000 standard population using the 1940 standard to 861.4 per 100,000 when using the 2000 standard. The leading causes of death which are most prevalent in the older age groups (e.g., diseases of the heart, stroke, chronic obstructive heart disease, pneumonia and influenza and diabetes) will tend to have adjusted rates that are considerably higher using the 2000 standard, compared to using the 1940 standard. Causes of death that are more prevalent among young and middle-aged populations, i.e., unintentional injuries, HIV infection, homicide and suicide, will have similar adjusted rates using either standard population. The rankings of the age-adjusted rates for leading causes of death differ depending on the standard population used. The differential changes in magnitude of age-adjusted rates by cause depend on the age groups with the highest risks of death and the most heavily weighted age groups in the standard population. (Table 2).

TABLE 2
AGE-ADJUSTED DEATH RATES, LEADING CAUSES AND TOTAL DEATHS
USING 1940 AND 2000 STANDARD POPULATIONS
NEW JERSEY, 1997

Cause of Death	1940 Standard		2000 Standard	
	RATE	RANK	RATE	RANK
Diseases of the Heart (390-398, 402, 404-429)	123.0	2	277.5	1
Malignant Neoplasms (140-208)	127.9	1	212.5	2
Cerebrovascular Diseases (430-438)	21.5	4	50.5	3
Chronic Obstructive Pulmonary Diseases (490-496)	16.0	6	32.8	4
Pneumonia/Influenza (480-487)	11.3	8	29.5	5
Diabetes Mellitus (250)	16.1	5	28.5	6
Unintentional Injuries (E800-E949)	23.4	3	26.4	7
Septicemia (038)	7.2	9	15.7	8
Nephritis/Nephrosis (580-589)	6.0	10	13.1	9
HIV Infection (042-044)	11.6	7	12.3	10
Total, All Causes	460.3		861.4	

Table 2 illustrates the effect of the choice of a standard population overall and on the leading causes of death in 1997. For each of the causes which affected primarily the elderly population (all of the ten leading causes except unintentional injury and HIV infection), the age-adjusted rate using the 2000 standard population was two or more times the age-adjusted rate using the 1940 standard population. The death rates resulting from using the two different standards were very similar for HIV infection and unintentional injury deaths. This effect is due to the higher population weights in older age groups in the year 2000 standard (Figure 2). Larger population weights are applied to the highest age-specific rates when calculating age-adjusted rates for heart disease, stroke, pneumonia and influenza, and other causes effecting primarily the oldest population.

FIGURE 2. POPULATION DISTRIBUTION BY AGE GROUP UNITED STATES, 1940 AND 2000 STANDARD POPULATIONS



SOURCE: U.S. BUREAU OF THE CENSUS

Changing to the 2000 standard population will effect the differences in age-adjusted rates by race. Age-specific rates differ substantially between white and black races. In New Jersey in 1997, for example, the black death rate for the population under 25 was 2.5 times the white rate, yet for persons aged 65 and over, the death rates were virtually identical (Table 3). Although black age-adjusted rates are higher than white rates using either standard population and the gap between the age-adjusted rates persists, the ratio of black/white rates is smaller using the year 2000 standard population: a black/white ratio of 1.6 using the 1940 standard population and a ratio of 1.3 using the year 2000 population. The higher relative death rate in blacks under the age of 25 receives a lower weight using the 2000 population standard, as the younger population is relatively smaller using this standard than in the 1940 standard. Because of the lack of consistency in the relative rates by race among age groups, it is important that the presentation of age-adjusted rates by race be supplemented by analysis of age-specific rates.

TABLE 3. CRUDE AND AGE-ADJUSTED DEATH RATES FOR BLACK AND WHITE RACES USING 1940 AND 2000 STANDARD POPULATIONS NEW JERSEY, 1997

DEATH RATE	WHITE	BLACK	RATIO
CRUDE	955.4	769.7	
AGE-ADJUSTED			
1940 STANDARD	429.4	674.3	1.6
2000 STANDARD	831.3	1099.7	1.3

AGE-SPECIFIC			
UNDER 25	49.9	126.0	2.5
25-64 YEARS	318.5	638.2	2.0
65 AND OVER	5015.7	4914.5	1.0

TIME TRENDS IN MAJOR CAUSES OF DEATH BY AGE

An age-adjusted rate as a summary measure serves a critical function in allowing comparison of mortality risks over time, eliminating the effect of the changes in age distribution of the population. If the death rates from a specific cause are either consistently increasing or decreasing in all age groups over a time period, the age-adjusted rate may adequately summarize the trends in mortality risks attributable to the cause excluding differences in age as a factor. However, Choi et al warn data users to "be particularly wary in time trend analysis for, if the age-specific rate trends vary across age groups, an age and calendar time interaction may exist, and thus summary statistics such as the age-standardized rate may actually conceal more than they reveal"4. As an illustration, death rates from diseases of the heart have declined among New Jersey residents over the past ten years and the decreases have been fairly uniform over all age groups. Thus, the age-adjusted death rate is an adequate summary measure for the trend in heart disease during the past decade. During the same time period, however, the overall crude and age-adjusted death rates from unintentional injury have changed very little, but the rates by age show different trends. Death rates from unintentional injuries have declined among the young and the elderly, but have increased among persons 25 through 64 years. This increase in deaths among young and middle aged adults would not be apparent from an examination of the age-adjusted rates from this cause. Among the leading causes of death, stroke, diabetes and cancer deaths have also exhibited different patterns by age.

DISCUSSION

A change from use of a 1940 standard population to the projected 2000 population as a standard for age-adjustment will have both positive and negative effects for users of health data. All programs of the federal Department of Health and Human Services have been directed by the Secretary to use the new standard beginning with data year 1999. Although not legally required of state Departments of Health, the programmatic and financial ties between state and federal agencies and the need to coordinate and compare health data will no doubt lead to a high degree of compliance with the use of the new standard among states. Use of a uniform standard will simplify and ease the burden of comparison of data from different sources, using different standard populations. In particular, baseline data for selected health objectives for the year 2010 will be recomputed and, in many of these cases, new targets will be developed.

Death rates age-adjusted to the new standard population will differ in magnitude from those previously used, most notably those developed using the 1940 standard population. The rates standardized to the 2000 standard will be similar to current crude death rates. These changes must be explained to users of the data and careful note of the population standard used must be included in any data presentation. Race differentials will narrow with introduction of the new population standard to age-adjusted rates and this must be explained as a result of differing age-specific rates by race and the differences in age distribution of the two standard populations.

Thorough analysis of health data will incorporate examination of differences in trends in rates by age group, as use of age-standardization alone may mask important information. Calculation of age-specific rates is needed to establish whether age-adjustment is the proper means of analysis in a given situation. Although the age-adjusted rate is an important technique in comparative data analysis, health data analysis should routinely include an examination of age-specific rates.

References:

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