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# Hypertension-Related Mortality in California

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**Synopsis**

*Death rates in California for hypertension-related diseases during 1969–71 and 1979–81 are compared. During both periods, age-standardized rates for a composite hypertension-related mortality category are highest for blacks, followed by whites, and lowest for Asians and Pacific Islanders. Filipinos who have high prevalence rates of hypertension record low rates of hypertension-related mortality. After adjusting for the comparability ratio, the age-standardized hypertension-related death rate declined by more than 28 percent between 1969–71 and 1979–81. The decrease was greatest at age 15–44 years. Of all major hypertension-related diseases, cerebrovascular diseases registered consistently large percentage declines in mortality for all age and race groupings examined.*

*Possible reasons for the considerable decline in hypertension-related mortality and low death rates for Asians and Pacific Islanders are discussed. The combined effects of improved population awareness, level of treatment, and control of hypertension; a greater knowledge of cardiovascular risk factors and associated modifications of behavior; and improved medical technology and care may have contributed to the decline.*

NATIONAL SURVEYS CONDUCTED DURING THE 1970s indicate there has been a marked improvement in awareness and treatment of hypertension (*1*). In 1972, the National High Blood Pressure Education Program was initiated by the National Heart, Lung, and Blood Institute (NHLBI) to disseminate knowledge to health professionals and the general public. An intensive campaign was undertaken to increase awareness of hypertension and the need to control it. Survey evidence indicates the program has been successful in increasing public awareness, treatment, control, and understanding about hypertension (*2*).

In 1975, NHLBI assisted the California State Department of Health Services in building an effective statewide hypertension control program. Service projects, task forces, and coordinating councils have been created throughout the State to enhance screening, detection, referral for treatment and followup and to develop a strong professional and public educational component. The statewide network uses an extensive body of public and private volunteers to implement its prevention program. Resource directories have been developed along with professional workshops and media outreach that works through radio, television, newspapers, and newsletters.

As part of an effort to understand current trends in cardiovascular and cerebrovascular disease and to evaluate hypertension control programs, we have analyzed the changes in reported hypertension-related deaths in California between 1969–71 and 1979–81. Death rates were calculated using 3-year periods rather than a single year in order to increase statistical reliability.

Because mortality from hypertension-related disease is relatively easy to define and nearly all deaths in California are registered, mortality data are extremely useful for studying trends. Although death rates provide only a limited assessment of the health status of a population, such data are useful in identifying age, race, and sex subgroups with special needs for obtaining certain types of preventive or curative services.

Diagnostic categories used in this paper are from the International Classification of Disease—Adapted, Eighth Revision (ICDA–8) (*3*) and the International Classification of Disease, Ninth Revision (ICD–9) (*4*). Four of the morbid conditions associated with hypertension are hypertensive disease (ICDA–8 400–404; ICD–9 401–405); ischemic heart disease (ICDA–8 410–413; ICD–9 410–414); heart and ventricular failure (ICDA–8 427.0–427.1; ICD–9 428.0–428.1); and cerebrovascular disease (ICDA–8 and ICD–9 430–438). These four groupings, which are subcategories of diseases of the circulatory system, are aggregated into a collective category called hypertension-related diseases.

## Review of the Literature

A decline in death rates from cardiovascular-renal diseases between 1950 and 1960 was observed in California by Borhani and Hechter (*5*). They discovered that the rate of mortality decline was far greater for women than men. Among three racial groupings, "other nonwhites" recorded the greatest relative decline, followed by whites and negroes. The largest reduction occurred in mortality from hypertensive heart disease, and next, in vascular lesions affecting the central nervous system and in arteriosclerotic heart disease. Borhani and Hechter attributed these declines to lifestyle alterations and improvement in the therapeutic management of hypertension.

Levy noted in 1978 that in the United States cardiovascular mortality decreased by more than 30 percent in the previous 30 years, with 60 percent of the decline between 1965 and 1975 (*2*). He indicated that the NHLBI had launched a three-pronged attack aimed at primary prevention. NHLBI concentrated on research dealing with the etiology and pathophysiology of arteriosclerosis and hypertension, risk factor alterations, and lifestyle changes. Borhani found an 18 percent decline in mortality from acute myocardial infarction with hypertensive disease, and a 27 percent drop in acute myocardial infarction without hypertensive disease in the United States between 1968 and 1976 (*6*). Furthermore, he found that the death rate from hypertensive heart disease declined by 81 percent between 1950 and 1976. Borhani attributed this dramatic

drop to increased public awareness of hypertension, improved physicians' attitudes toward hypertension, and the efficacy of treatment of hypertension.

In 1979, Stern noted a 21 percent decrease in ischemic heart disease mortality in the United States between 1968 and 1976 (*7*). The mortality decline was attributed to improvements in diet accompanied by decreased serum cholesterol, control of hypertension, decreased smoking, and increased exercise.

Levy reviewed in 1981 the many potential explanations suggested for the decline in cardiovascular mortality, and he concluded that risk factor and lifestyle changes accounted for a major portion of the decline (*8*). Stallones concluded a similar review of trends in ischemic heart disease with a more neutral tone—that the evidence is ambiguous whether risk factor change alone accounts for the observed decline (*9*).

## Methods

The unstandardized 3-year death rate we used was defined as the sum of the number of deaths recorded in California for each of two 3-year periods (1969–71 and 1979–81) divided by the estimated California population for the middle year of each period (1970 and 1980). Age-standardized 3-year death rates were adjusted for age to the 1970 California total population using the direct method.

The racial and ethnic groups were whites and others, blacks, and Asians and Pacific Islanders; the final group was broken into Chinese, Filipino, and Japanese subgroups. Special attention was given to the three subgroups because of their numbers in California and because of previous findings that Filipinos have relatively high rates of hypertension (*10*). Hispanics, a major population group in California, were included in the group of whites and others. Hispanics were not tabulated separately because of significant problems in obtaining accurate numerator and denominator data for this group.

California population data used as denominators for calculating death rates for 1970 and 1980 were based on the population enumerated by the U.S. Census Bureau in those years. The 1980 census figures showed that population estimates made between censuses used in earlier studies for the years between 1971 and 1979 were in error, which consequently biased mortality results based on those data. Special care was taken to ensure that denominator data from the 1970 and 1980 censuses were comparable. For example, the category "white and other" was constructed to include all white Hispanics for both time points, even though the actual definition of Hispanic or Spanish surname varied considerably in the two censuses. Numerators were derived from medical certification information on the death certificate. When more than one cause of death is reported, the underlying cause was selected for coding and tabulation.

Analysis of death rates for Asians and Pacific Islanders and the subcategories Chinese, Japanese, and Filipino presented the problem of underestimation of numerators. If race-ethnicity was unknown at the time of death, it was usually coded as "other," which was then combined with white, the largest population group. A downward basis in death rate estimates for these groups might affect 1970 and 1980 rates equally and still enable an assessment of change from 1970 to 1980. Clearly, such estimates should be treated with caution. They are, nevertheless, of interest because they are the most carefully developed estimates available for Asians and Pacific Islanders in California.

Comparability ratios have been developed by the National Center for Health Statistics (*11*) for deaths in the United States in order to adjust for changes in ICD code definitions between ICDA–8 and ICD–9. They facilitated mortality trend analyses by providing measures of similarity for statistical comparison of data gathered before and after 1979. Comparability ratios for the United States were used to adjust California data in this study.

We would have preferred to use comparability ratios specific to California, but were unfortunately not in a position to do so. Such ratios are not available, and the task of creating such ratios solely for this study would have involved resources beyond our budget. Finally, the availability of national ratios, developed following established procedures, was deemed an acceptable alternative, far better than an analysis in the absence of any adjustment factor.

A comparability ratio exceeding unity (perfect correspondence) generally indicates an increase in assignment of deaths to a set of diagnostic conditions in ICD–9 compared with ICDA–8, while a comparability ratio less than unity indicates the opposite. A comparability ratio of unity does not necessarily indicate that designations of deaths to the diagnostic condition were unaffected by changes in classification and coding procedures, since offsetting alterations may have occurred (*11*).

Changes in the procedures for coding death certificates from ICDA–8 to ICD–9 did not greatly affect mortality rates for hypertension-related deaths, which are the focus of this study. We calcu-

lated a comparability ratio of 0.940 for the category of hypertension-related diseases, which is a composite of four circulatory illnesses. The comparability ratio of 0.940 equals the sum of deaths assigned, according to ICD–9, to the sum of deaths assigned, according to ICDA–8, for the four illnesses combined. The comparability ratios for the four component diseases are ischemic heart disease (comparability ratio = 0.878), cerebrovascular disease (1.005), hypertensive disease (2.062), and heart and ventricular failure (1.083). Because of the excessively large comparability ratio for hypertensive disease, no separate analysis was performed for this illness. Following the recommendation of the National Center for Health Statistics, we estimated a comparability ratio of 1.083 for heart and ventricular failure by dividing the number of deaths in the United States in 1979, recorded for categories 428.0 and 428.1, by the number of deaths in 1978 assigned to 427.0 and 427.1.

## Results

Three-year age-specific and age-standardized death rates are presented in tables 1 through 5. The aggregated category of hypertension-related deaths comprises 73.9 percent ischemic heart disease in 1969–71 and 69.1 percent in 1979–81, 23.5 percent cerebrovascular disease in 1969–71 and 24.1 percent in 1979–81, 1.9 percent hypertensive disease in 1969–71 and 5.0 percent in 1979–81, and 0.7 percent heart and ventricular failure in 1969–71 and 1.8 percent in 1979–81.

The age-specific death rates in columns 1 and 2 of tables 1 through 5 are unstandardized. Also, both unstandardized and standardized rates are presented for all groups combined. Column 3 is the unadjusted percent change in death rates from 1969–71 to 1979–81. Column 4 is the percent change after adjusting for comparability ratios. The comparability ratio for hypertension-related diseases is .94. Thus, for the uppermost row in table 1, the adjusted percent change comparing death rates between 1969–71 and 1979–81 of −22.09 percent is computed using

$$[(DR_{1979-81} \div CR) \div DR_{1969-71}] - 1 = [(850.14 \div .94) \div 1{,}160.79] - 1$$

where $DR$ = death rate, $CR$ = comparability ratio.

The footnote in column 4 indicates that the −22.09 percent difference is significant at the .05 level in the 2-tail test using Chiang's equation (No. 16) for standard errors of age-adjusted death rates (*12*).

The age-standardized death rates are based on the age distribution of the 1970 California total population for all races combined. The age composition effect is the percent excess of the unstandardized death rate over the age-standardized rate. For example, in table 1, the unstandardized death rate in 1969–71 for whites and others of 1,208.71 exceeds the standardized rate of 1,161.75 by 4.04 percent, which is the result of whites and others having an older age distribution than the overall California population in 1969–71.

Overall age-standardized and unstandardized rates (in the top two rows of tables 1–5) are weighted averages for the three racial groupings. In 1969–71, the racial group weights that sum to 1.000 are 0.904 for whites and others, 0.070 for blacks, and 0.026 for Asians and Pacific Islanders. The corresponding 1979–81 weights are 0.883, 0.077, and 0.040.

**Data for 1979–81.** We began by examining the 1979–81 mortality rates for all hypertension-related deaths combined. These rates serve as a control against spurious trends resulting from a shift in assignment of cause of death from one hypertension-related mortality category to another. In view of the close relationship between age and risk of death, age may be considered to be the most important factor in the analysis of hypertension-related mortality. For whites and others (88.3 percent of the population), the mortality rate is quite low in children and young adults, rises sharply at ages 45–64, then increases 4-fold for persons aged 65–74 years, and triples for persons aged 75 years and older.

The importance of age-standardization is most evident when comparing race-specific mortality rates of whites and others with those of blacks. The unstandardized death rate for hypertension-related deaths in 1979–81 is 42.5 percent higher for whites and others (892.33) than for blacks (626.07) (table 1). However, the age-standardized black mortality rate of 887.58 per 100,000 exceeds the age-standardized rate of 777.76 for whites and others by 14.1 percent. The age-specific rates for blacks surpass whites and others by a factor of 2 prior to age 45; the rates are more than 50 percent greater for blacks than for whites and others at age 45–64 years and more than 25 percent greater at age 65–74 years. After age 75, the rate for whites and others slightly exceeds the black mortality rate.

The age composition effect in 1979–81 is −29.46 percent for blacks. This means that the relatively young age structure of the black population ac-

counts for a 29.46 percent lower mortality rate than they would have experienced if they had the same age distribution as the total population. It is significant that race-specific hypertension-related death rates are very low for Asians and Pacific Islanders. The age-standardized rate of 421.99 in

Table 1. 3-year age-standardized and age-specific death rates and percent change, 1969–71 to 1979–81, per 100,000 Californians for hypertension-related diseases (race by age)

| Race by age | Age-specific death rate | | Percent change, 1969–71 to 1979–81 | |
|---|---|---|---|---|
| | 1969–71 | 1979–81 | Unadjusted | Adjusted for comparability ratio (0.940) |
| Overall: | | | | |
| Unstandardized rate | 1,160.79 | 850.14 | −26.76 | −22.09[1] |
| Age-standardized rate[2] | 1,156.27 | 771.96 | −33.24 | −28.97[1] |
| White and other | 1,208.71 | 892.33 | −26.18 | −21.46[1] |
| 0–14 years | 2.63 | 3.33 | 26.62 | 34.70 |
| 15–44 years | 53.52 | 26.73 | −50.06 | −46.87[1] |
| 45–64 years | 1,170.29 | 723.58 | −38.17 | −34.22[1] |
| 65–74 years | 5,002.56 | 3,077.51 | −38.48 | −34.55[1] |
| 75 and over | 17,825.93 | 12,810.26 | −28.14 | −23.55[1] |
| Age-standardized rate | 1,161.75 | 777.76 | −33.05 | −28.78[1] |
| Age composition effect, percent | 4.04 | 14.73 | ... | ... |
| Black | 760.41 | 626.07 | −17.67 | −12.41[1] |
| 0–14 years | 4.92 | 6.62 | 34.55 | 43.14 |
| 15–44 years | 122.80 | 63.81 | −48.04 | −44.72[1] |
| 45–64 years | 1,704.39 | 1,145.05 | −32.82 | −28.53[1] |
| 65–74 years | 5,673.69 | 3,934.35 | −30.66 | −26.23[1] |
| 75 and over | 14,427.82 | 11,672.34 | −19.10 | −13.93[1] |
| Age-standardized rate | 1,218.52 | 887.58 | −27.16 | −22.51[1] |
| Age composition effect, percent | −37.60 | −29.46 | ... | ... |
| Asian-Pacific Islander | 572.63 | 350.14 | −38.85 | −34.95[1] |
| 0–14 years | 2.90 | 2.54 | −12.41 | −6.82 |
| 15–44 years | 32.88 | 12.54 | −61.86 | −59.43[1] |
| 45–64 years | 698.83 | 285.73 | −59.11 | −56.50[1] |
| 65–74 years | 3,741.35 | 1,697.19 | −54.64 | −51.74[1] |
| 75 and over | 12,408.01 | 7,542.93 | −39.21 | −35.33[1] |
| Age-standardized rate | 798.05 | 421.99 | −47.12 | −43.75[1] |
| Age composition effect, percent | −28.25 | −17.03 | ... | ... |
| Chinese | 619.81 | 360.83 | −41.78 | −38.07[1] |
| 0–14 years | 4.43 | 0.00 | −100.00 | −100.00 |
| 15–44 years | 36.36 | 8.81 | −75.77 | −74.22 |
| 45–64 years | 884.41 | 286.49 | −67.61 | −65.54[1] |
| 65–74 years | 4,505.83 | 1,859.35 | −58.73 | −56.10[1] |
| 75 and over | 13,958.81 | 7,876.38 | −43.57 | −39.97 |
| Age-standardized rate | 934.19 | 440.51 | −52.85 | −49.84[1] |
| Age composition effect, percent | −33.65 | −18.09 | ... | ... |
| Filipino | 505.75 | 280.29 | −44.58 | −41.04[1] |
| 0–14 years | 2.44 | 4.34 | 77.87 | 89.22 |
| 15–44 years | 12.79 | 12.47 | −2.50 | −3.72 |
| 45–64 years | 853.95 | 316.91 | −62.89 | −60.52[1] |
| 65–74 years | 4,486.25 | 1,684.56 | −62.45 | −60.05[1] |
| 75 and over | 8,303.89 | 5,532.96 | −33.37 | −29.12[1] |
| Age-standardized rate | 718.39 | 357.74 | −50.20 | −47.02[1] |
| Age composition effect, percent | −29.60 | −21.65 | ... | ... |
| Japanese | 577.50 | 432.35 | −25.13 | −20.36[1] |
| 0–14 years | 1.93 | 2.54 | 31.61 | 40.01 |
| 15–44 years | 42.06 | 17.48 | −58.44 | −55.79[1] |
| 45–64 years | 478.18 | 263.13 | −44.97 | −41.46[1] |
| 65–74 years | 2,470.93 | 1,442.31 | −41.63 | −37.90[1] |
| 75 and over | 12,780.19 | 9,136.94 | −28.51 | −23.94[1] |
| Age-standardized rate | 699.63 | 461.18 | −34.08 | −29.87[1] |
| Age composition effect, percent | −17.46 | −6.25 | ... | ... |

[1] Significant at .05 level.

[2] The 1970 California population has the following age-composition proportions: age 0–14, .27725; 15–44, .43007; 45–64, .20220; 65–74, .05550; and 75 and over, .03499. All age-adjusted rates are standardized to this population.

NOTE: Hypertension-related diseases include ICDA–8 400–404, 410–413, 427.0–427.1, and 430–438 and ICD–9 401–404, 410–414, 428.0–428.1, and 430–438.

SOURCE: California Death Records, 1969–71, 1979–81.

Table 2. 3-year age-standardized and age-specific death rates and percent change, 1969–71 to 1979–81, per 100,000 Californians for hypertension-related diseases (sex by age)

| Sex by age | Age-specific death rate | | Percent change, 1969–71 to 1979–81 | |
|---|---|---|---|---|
| | 1969–71 | 1979–81 | Unadjusted | Adjusted for comparability ratio (0.940) |
| Males | 1,261.01 | 862.10 | −31.63 | −27.27[1] |
| 0–14 years | 3.23 | 3.68 | −13.93 | 21.20 |
| 15–44 years | 82.86 | 40.81 | −50.75 | −47.60[1] |
| 45–64 years | 1,781.23 | 1,072.46 | −39.79 | −35.95[1] |
| 65–74 years | 6,920.29 | 4,243.58 | −38.68 | −34.77[1] |
| 75 and over | 19,575.53 | 14,008.12 | −28.44 | −23.87 |
| Age-standardized rate | 1,465.72 | 961.09 | −34.43 | −30.24[1] |
| Age composition effect, percent | −13.97 | −10.30 | ... | ... |
| Females | 1,063.82 | 838.82 | −21.15 | −16.12[1] |
| 0–14 years | 2.43 | 3.53 | 45.27 | 54.54[1] |
| 15–44 years | 32.77 | 17.15 | −47.67 | −44.33[1] |
| 45–64 years | 633.73 | 414.80 | −34.55 | −30.37[1] |
| 65–74 years | 3,527.43 | 2,158.18 | −38.82 | −34.91[1] |
| 75 and over | 16,441.58 | 11,860.98 | −27.86 | −23.26[1] |
| Age-standardized rate | 913.97 | 627.02 | −31.14 | −27.01[1] |
| Age composition effect, percent | 16.40 | 33.78 | ... | ... |

[1] Significant at .05 level.
NOTE: Hypertension-related diseases include ICDA–8 400–404, 410–413, 427.0–427.1, and 430–438 and ICD–9 401–404, 410–414, 428.0–428.1, and 430–438.
SOURCE: California Death Records, 1969–71, 1979–81.

1979–81 is only 54.7 percent of the corresponding rate of 771.96 for the total population.

In table 2, mortality rates for males are compared with rates for females. Age-standardized mortality rates for 1979–81 are 53.3 percent higher for males (961.09) than for females (627.02). Age-specific death rates are higher for males across all ages. The female advantage peaks during the reproductive years between 15 and 44 and beyond to age 64, during which time the male mortality rate surpasses the female rate by a factor of 2.5. The relative male disadvantage is least before age 14 (when rates are quite low) and after age 75.

When cause-specific death rates are examined (tables 3–5), age-standardized mortality rates in 1979–81 for blacks exceed those for whites and others by a factor of 1.30 for cerebrovascular disease and 1.20 for heart and ventricular failure. For ischemic heart disease, the pattern is reversed, with blacks realizing death rates 5.1 percent below whites and others. Asian-Pacific Islander death rates in 1979–81 are only 47.3 percent of that for whites and others for ischemic heart disease, 59.5 percent for heart and ventricular failure, and 71.1 percent for cerebrovascular disease.

**Changes over the 10-year period.** For the total population, there was a remarkable decline in mortality between 1969–71 and 1979–81 (after adjusting for the comparability ratio) due to hypertension-related diseases. The decrease was observed for all age groups above 15 years, both sexes, and for each major racial-ethnic aggregation (table 1). Among races, the differential in mortality experience has widened. The greatest relative decline (from 1969–71 to 1979–81) in hypertension-related deaths is found among Asians and Pacific Islanders, the group which had the lowest rates in the baseline period. The greatest declines in age-standardized mortality are in the Chinese (49.84 percent) and the Filipinos (47.02 percent). The smallest decline over the decade was 22.51 percent registered by blacks, the group with the highest standardized rates in 1969–71.

For whites and others (88.3 percent of the 1980 California population), there is an increase of 34.70 percent for hypertension-related deaths in the group aged 0–14 years, which is not statistically significant because the rate was only 3.33 per 100,000 living persons in this age bracket in 1979–81. Because this rate represents a small percent of the population, the increase in hypertension-related disease for persons under age 15 does not present a major problem in itself unless this age cohort continues to experience a high death rate at an older age. If this age-cohort pattern continues, this would represent a startling reversal in the trend towards the attentuation of hypertension-related deaths. The group aged 15–44 years experienced the greatest proportionate reduction in mortality between 1969–71 and 1979–

Table 3. 3-year age-standardized and age-specific death rates and percent change, 1969–71 to 1979–81, per 100,000 Californians for ischemic heart disease

| Race by age | Age-specific death rate | | Percent change 1969–71 to 1979–81 | |
|---|---|---|---|---|
| | 1969–71 | 1979–81 | Unadjusted | Adjusted for comparability ratio (0.878) |
| Overall: | | | | |
| Unstandardized rate | 857.32 | 587.71 | −31.45 | −21.92[1] |
| Age-standardized rate | 852.68 | 532.93 | −37.50 | −28.81[1] |
| White and other | 896.57 | 624.05 | 30.40 | −20.76[1] |
| 0–14 years | 0.67 | 1.45 | 116.42 | 146.38[1] |
| 15–44 years | 39.85 | 17.30 | −56.59 | −50.58[1] |
| 45–64 years | 990.36 | 569.35 | −42.51 | −34.55[1] |
| 65–74 years | 3,888.28 | 2,301.46 | −40.81 | −32.62[1] |
| 75 and over | 12,270.07 | 8,457.42 | −31.07 | −21.53[1] |
| Age-standardized rate | 862.70 | 546.62 | −36.64 | −27.87[1] |
| Age composition effect, percent | 3.93 | 14.17 | ... | ... |
| Black | 524.50 | 364.48 | −30.51 | −20.89[1] |
| 0–14 years | 1.03 | 1.24 | −20.39 | −37.05 |
| 15–44 years | 70.03 | 30.25 | −56.80 | −50.82[1] |
| 45–64 years | 1,237.93 | 672.09 | −45.71 | −38.19[1] |
| 65–74 years | 3,937.85 | 2,373.58 | −39.72 | −31.38[1] |
| 75 and over | 9,729.56 | 6,788.80 | −30.23 | −20.57[1] |
| Age-standardized rate | 839.70 | 518.52 | −38.25 | −29.70[1] |
| Age composition effect, percent | −37.54 | −29.71 | ... | ... |
| Asian-Pacific Islander | 388.51 | 215.16 | −44.62 | −36.95[1] |
| 0–14 years | 0.00 | 1.02 | ... | ... |
| 15–44 years | 18.62 | 6.58 | −64.66 | −59.77[1] |
| 45–64 years | 494.55 | 172.30 | −65.16 | −60.34[1] |
| 65–74 years | 2,628.95 | 1,152.11 | −56.18 | −50.11[1] |
| 75 and over | 8,150.91 | 4,473.60 | −45.12 | −37.52[1] |
| Filipino | 499.66 | 236.72 | −52.62 | −46.04[1] |
| Age-standardized rate | 539.11 | 258.42 | −52.07 | −45.43[1] |
| Age composition effect, percent | −27.93 | −16.74 | ... | ... |

[1] Significant at .05 level.

NOTE: Ischemic heart disease includes ICDA–8 410–413 and ICD–9 410–414.
SOURCE: California Death Records, 1969–71, 1979–81.

81 (46.87 percent). Above age 45, the mortality decline is 34.22 percent for persons aged 45–64, 34.55 percent for those aged 65–74 and 28.78 percent for those 75 years of age and older.

Hypertension-related mortality is considerably higher among males than females, but the disparity decreased somewhat in California during the 1970s (table 2). Improvements in diagnostic methods in general and change in terminology should affect males and females equally. The age-specific declines in hypertension-related deaths follow a similar pattern for males and females.

There is a general decline in mortality for each category of hypertension-related diseases. This indicates that it is unlikely that a large number of deaths ascribed to one cause in 1969–71 would be ascribed to another cause in 1979–81. The general decline varies considerably among diseases, after age standardization and adjusting for comparability ratios. The decline was 32.50 percent in the incidence of death by cerebrovascular disease and 28.81 percent for ischemic heart disease. For all hypertension-related diseases combined, the decline is 28.97 percent (tables 1, 3, and 5).

There were large declines in ischemic heart disease deaths across all races for persons above age 15 (table 3). The declines are 45.43 percent for Asians and Pacific Islanders, 29.70 percent for blacks, and 27.87 percent for whites and others. The greatest decline for the overall population was in adults 15–44 years of age.

The analysis of heart and ventricular failure presents a unique problem because the National Center for Health Statistics (*11*) has not provided a comparability ratio for heart and ventricular failure (table 4). As stated earlier, a comparability ratio (1.083) was estimated using the ratio of 1979 deaths in the United States ascribed to ICD-9 428.0–428.1 to 1978 deaths assigned to ICDA–8 427.0–427.1. After applying a comparability ratio computed by

Table 4. 3-year age-standardized and age-specific death rates and percent change, 1969–71 to 1979–81, per 100,000 Californians for heart and ventricular failure disease

| Race by age | Age-specific death rate | | Percent change, 1969–71 to 1979–81 | |
|---|---|---|---|---|
| | 1969–71 | 1979–81 | Unadjusted | Adjusted for comparability ratio (1.083)[1] |
| Overall: | | | | |
| Unstandardized rate | 8.09 | 15.03 | 85.78 | 71.55[2] |
| Age-standardized rate | 8.14 | 13.49 | 65.72 | 53.02[2] |
| White and other | 8.28 | 15.77 | 90.46 | 75.86[2] |
| 0–14 years | 0.10 | 0.42 | 320.00 | 287.78[2] |
| 15–44 years | 0.41 | 0.23 | −43.90 | −48.20[2] |
| 45–64 years | 5.68 | 6.51 | 14.61 | 5.83 |
| 65–74 years | 31.22 | 44.60 | 42.86 | 31.91[2] |
| 75 and over | 138.65 | 271.32 | 95.69 | 80.69[2] |
| Age-standardized rate | 7.94 | 13.50 | 70.05 | 56.99[2] |
| Age composition effect, percent | 4.28 | 16.81 | ... | ... |
| Black | 7.09 | 10.99 | 55.01 | 43.13[2] |
| 0–14 years | 0.21 | 0.62 | 195.24 | 172.61 |
| 15–44 years | 0.65 | 0.75 | 15.38 | 6.54 |
| 45–64 years | 15.16 | 14.02 | −7.52 | −14.61 |
| 65–74 years | 57.25 | 58.33 | 1.89 | −5.92 |
| 75 and over | 142.10 | 274.80 | 93.38 | 78.56[2] |
| Age-standardized rate | 11.55 | 16.19 | 40.17 | 29.43[2] |
| Age composition effect, percent | −38.61 | −32.12 | ... | ... |
| Asian-Pacific Islander | 4.05 | 6.48 | 60.00 | 47.73[2] |
| 0–14 years | 0.00 | 0.00 | ... | ... |
| 15–44 years | 0.00 | 0.21 | ... | ... |
| 45–64 years | 4.30 | 2.16 | −49.77 | −53.62 |
| 65–74 years | 25.00 | 28.91 | 15.64 | 6.78 |
| 75 and over | 102.47 | 168.51 | 64.45 | 51.84 |
| Age-standardized rate | 5.84 | 8.03 | 37.50 | 29.96[2] |
| Age composition effect, percent | 30.65 | −19.30 | ... | ... |

[1] Percent changes are highly suspect and should be used with extreme caution.
[2] Significant at 0.5 level.

NOTE: Heart failure disease includes ICDA–8 427.0—427.1 and ICD–9. 428.0–428.1.
SOURCE: California Death Records, 1969–71, 1979–81.

this method, the age-adjusted death rates for heart and ventricular failure increased by 53.02 percent for the total population and 56.99 percent for whites and others over the decade. This increased death rate runs counter to the 1969–71 to 1979–81 pattern of decrease observed for the other four hypertension-related disease categories. The rise in the death rate may be a result of medical care that postpones death from other classifications of heart disease. Alternatively, this anomalous finding may well be a nosological artifact that should be treated with caution until the National Center for Health Statistics publishes a reliable comparability ratio for heart and ventricular failure that can be applied to California mortality data.

Of all major hypertension-related diseases, cerebrovascular disease registered consistently large declines for all age and race groupings (table 5). For whites and others, the declines over the decade exceed 22 percent for every age-specific category. Asians and Pacific Islanders registered declines greater than 33 percent for every age category. For persons aged 65–74 years, there were steep declines for all three racial groups. Blacks have the highest rates, both in 1970 and in 1980, and they exhibit the smallest decline in age-standardized rates.

**Hypertension and health status.** In table 6, the age-standardized hypertension-related death rates in 1979–81 are compared with six measures of health status for six racial-ethnic categories. It is not surprising that blacks who experience high death rates from hypertension-related deaths have the highest rates of uncontrolled hypertension. Using the criteria of 140 mm Hg systolic or 90 mm Hg diastolic or above or both, the black rate is 26.1 percent compared to a corresponding 19.8 percent for the total population. Filipinos experience a high rate of uncontrolled hypertension (24.5 percent), which is 23.7 percent above the rate for the total population. Filipino rates of hypertension are also excessive at the greater than or equal to 160 mm Hg systolic and/or 95 mm Hg and above diastolic cutoff. Surprisingly, the hypertension-related disease death

Table 5. 3-year age-standardized and age-specific death rates and percent change, 1969–71 to 1979–81, per 100,000 Californians for cerebrovascular disease

| Race by age | Age-specific death rate | | Percent change 1969–71 to 1979–81 | |
|---|---|---|---|---|
| | 1969–71 | 1979–81 | Unadjusted | Adjusted for comparability ratio (1.005) |
| Overall: | | | | |
| Unstandardized rate | 273.22 | 205.18 | −24.90 | −25.28[1] |
| Standardized | 272.73 | 185.00 | −32.17 | −32.50[1] |
| White and other | 282.53 | 213.08 | −24.58 | −24.96[1] |
| 0–14 years | 1.83 | 1.43 | −21.86 | −22.24[1] |
| 15–44 years | 12.31 | 7.73 | −37.21 | −37.51[1] |
| 45–64 years | 157.99 | 107.44 | −32.00 | −32.33[1] |
| 65–74 years | 1,004.78 | 590.90 | −41.19 | −41.81[1] |
| 75 and over | 5,062.17 | 3,563.65 | −29.60 | −29.95[1] |
| Age-standardized rate | 270.64 | 182.93 | −32.41 | −32.74[1] |
| Age composition effect, percent | 4.39 | 16.48 | ... | ... |
| Black | 193.75 | 165.45 | −14.61 | −15.02[1] |
| 0–14 years | 3.69 | 3.73 | 1.08 | 0.59 |
| 15–44 years | 36.81 | 19.02 | −48.33 | −48.58[1] |
| 45–64 years | 367.90 | 246.47 | −33.01 | −33.33[1] |
| 65–74 years | 1,449.60 | 995.58 | −31.32 | −31.66[1] |
| 75 and over | 4,125 41 | 3,514.79 | −14.80 | −15.22 |
| Age-standardized rate | 316.04 | 237.29 | −24.92 | −25.66[1] |
| Age composition effect, percent | −38.69 | −30.28 | ... | ... |
| Asian-Pacific Islander | 163.47 | 107.16 | −34.45 | −34.77[1] |
| 0–14 years | 2.90 | 1.52 | −47.59 | −47.48 |
| 15–44 years | 13.47 | 4.52 | −66.44 | −66.61[1] |
| 45–64 years | 186.00 | 91.28 | −50.92 | −51.16[1] |
| 65–74 years | 995.75 | 410.88 | −58.74 | −58.94[1] |
| 75 and over | 3,698.18 | 2,471.51 | −33.17 | −33.50[1] |
| Filipino | 196.09 | 94.39 | −51.86 | −52.10[1] |
| Age-standardized rate | 228.87 | 130.10 | −43.16 | −43.44[1] |
| Age composition effect, percent | −28.58 | −17.63 | ... | ... |

[1] Significant at 0.05 level.

NOTE: Cerebrovascular disease includes ICDA–8 and ICD–9 430–438.
SOURCE: California Death Records, 1969–71, 1979–81.

rate of 357.74 per 100,000 population for Filipinos is 53.7 percent below the rate for all races combined (771.98). Filipino death rates in 1979–81 were low for hypertensive, ischemic heart, and cerebrovascular disease. Another discrepancy is that in California Chinese are significantly more hypertensive than Japanese, yet their age-standardized death rates are lower for hypertension-related diseases.

Among racial-ethnic groups, there is a strong, direct relationship between hypertension-related mortality and use of medical services as measured by visiting a physician or staying in a hospital overnight or longer in the past year. Blacks with the highest levels of mortality are most likely to seek medical care through a physician visit or a hospital stay. Conversely, Asians and Pacific Islanders, whose hypertension-related, age-standardized death rate is only 54.3 percent as high as whites and others, are least likely to visit a physician or stay in a hospital overnight.

Among all Asian-Pacific Islander subgroups surveyed in 1979 (*13*), the percentage of persons who stated they had not been well in the past 2 weeks and who stated they had a physical disability is much lower than the overall population. Igra and coauthors reported other indicators of Asian and Pacific Islander nonuse of health care, including preventive services (*13*). The percentage of Asian-Pacific Islander adult women who take birth control pills, who know what a Pap smear is, or who have breast examinations is far lower than among other racial groups (*13*).

The paucity of physician visits and hospital stays among Asians and Pacific Islanders, in addition to their stated lack of physical disabilities, might be attributed in part to a purposeful lack of contact with the medical system. Some elderly foreign-born Asians and Pacific Islanders take a stoic attitude toward illness and are reluctant to enter hospitals unless it is absolutely necessary. Some elderly

Table 6. Age-standardized death rates and measures of health status for racial-ethnic groups in California

| Grouping | Age-standardized hypertension-related death rate, per 100,000, 1979–81 | Percent uncontrolled hypertensive, 1979 | | Percent in hospital past year, 1979 (13) | Percent not well past 2 weeks, 1979 (13) | Percent saw physician past year, 1979 (13) | Life expectancy at age 35, 1959–61 (14) | Percent with physical disability, 1965 (14) |
|---|---|---|---|---|---|---|---|---|
| | | 140/90 | 160/95+ | | | | | |
| Overall | 771.98 | 19.8 | 6.6 | 12.5 | 15.4 | 78.3 | ... | 15.0 |
| Race-ethnicity: | | | | | | | | |
| White and other | 777.76 | 20.2 | 6.6 | 12.6 | 15.6 | 79.9 | 75.0 | 15.0 |
| Black | 887.58 | 26.1 | 10.2 | 13.1 | 18.3 | 82.9 | 72.5 | 16.0 |
| Asian-Pacific Islander | 421.99 | 18.1 | 7.0 | 9.2 | 8.0 | 69.3 | ... | ... |
| Chinese | 440.51 | 15.7 | 5.8 | 3.9 | 5.4 | 67.4 | 75.5 | 6.0 |
| Filipino | 357.74 | 24.5 | 9.9 | 11.3 | 10.0 | 69.5 | ... | ... |
| Japanese | 461.18 | 12.5 | 4.3 | 11.6 | 5.2 | 73.4 | 80.5 | 1.0 |
| Sex: | | | | | | | | |
| Male | 961.09 | 23.5 | | 10.2 | 11.5 | 71.8 | ... | ... |
| Female | 627.02 | 16.5 | | 14.6 | 18.9 | 84.3 | ... | ... |

Chinese-Americans adhere to ancient folk medicine and the use of herbs for certain ailments. Through the family structure, certain attitudes toward health are passed on to succeeding generations. Japanese-Americans have a concept of "ga-man," which is euphemistically translated as "grin and bear it," denoting the internalization and suppression of pain (*15*).

## Discussion

It is difficult to assess the many factors that may have contributed to the decrease in hypertension-mortality. A major factor is, undoubtedly, the development of effective therapy for hypertension and the subsequent increased professional and public awareness concerning cardiovascular and cerebrovascular risk factors. There have been significant changes in lifestyles over the decade, involving increased exercise levels and reduced cigarette smoking and reduced cholesterol, animal fat, and sodium intake. A second factor is the improved technical management of cardiovascular disease, including intensive care units, coronary bypass surgery, more effective emergency medical services, chemotherapy, and antibiotics (*2*).

Research indicates that health behavior innovations, such as increased physical activity and reduction in smoking are more readily adopted by persons of higher social economic status. Because whites have a higher average level of education and income than blacks, it is possible that they have reduced risk factors to a greater degree over the decade (*7*).

If incidences of heart attacks and strokes are decreasing or their severity is diminishing, then risk-factor reduction is most likely playing a significant role in the hypertension-related mortality decline. Conversely, if incidences of heart attacks and strokes remain constant, it is likely that improved medical care and technology are largely responsible for the decline in deaths (*16*).

The decline in hypertensive-related disease mortality is attributable, in part, to an increased awareness, treatment, and control of hypertension. High blood pressure is the most potent of all risk factors as a contributor to cerebrovascular mortality. More than half of the strokes in the adult population occur in hypertensive patients. Persons with hypertension in the Framingham study had seven times as many brain infarctions as persons with normal blood pressure (*17*). The black population, which has the highest level of hypertension, also exhibits the highest age-adjusted mortality rate from cerebrovascular disease. Although hypertension is also well established as a risk factor for heart disease (*6, 18*), there are other equally well-established factors such as smoking and blood cholesterol levels.

Census under-enumeration is a factor that may bias death rates for blacks. Incomplete census coverage is known to be highest among racial minorities, illegal immigrants, and the poor. The result is a death rate denominator (the population size) that is attenuated and a death rate that is artifically high (*19*).

The low death rates from hypertension-related diseases among Filipinos, a group who exhibit high rates of hypertension, is a puzzle. This may be a function of a poor estimate of rate numerators because of a disproportionate misclassification of Filipinos as Chinese, Japanese, or Hispanics on California death certificates.

Immigration is a major confounding variable when comparing the rate of hypertension-related deaths in 1969–71 with 1979–81. In California, in 1970, 58 percent of the Filipinos, 46 percent of the Chinese, and 21 percent of the Japanese were foreign born (*20*). During the 1970s, the percent of foreign born grew considerably. In California between 1970 and 1980, the Filipino population grew by more than 2.5-fold and the Chinese population by 1.9-fold. Immigration was less important for the Japanese, whose population increased by only 23.4 percent over the decade (California Center for Health Statistics, unpublished tables, 1982). Consequently, Filipinos and Chinese in 1969–71 and 1979–81 represent, to a large extent, a different mix of people.

A major contributing factor to the low rate of hypertension-related mortality among Asians and Pacific Islanders may be that these immigrants represent a select group of people, in good health and well-educated. According to the 1980 census, of those persons 25 years or older, 31.1 percent of Asians and Pacific Islanders had completed 4 or more years of college compared with 20.8 percent of whites, 11.3 percent of blacks, and 6.4 percent of Hispanics.

Also, Asians and Pacific Islanders who migrate to the United States are closer in culture to their country of origin than persons of Asian and Pacific Islander descent born in the United States. In 1976, the unstandardized death rate from heart disease was more than 3 times higher in the United States (338.2 per 100,000) than in Japan (109.1) or the Philippine Islands (72.9) (*21*). The low rate in the Philippines is, in part, due to a younger population. The differential mode of assigning cause of death in each country must also be considered. In addition, the traditional Asian-Pacific Islander diet is low in saturated fats and cholesterol. These societies also have a tendency to place more emphasis on group cohesion, social stability, and social support from the family unit.

These cultural characteristics are in clear contrast to the non-Asian American emphasis on social and geographic mobility and on individual striving ambition associated with type A or coronary-prone behavior (*22*).

In conclusion, mortality data indicate a sharp decline in death rates due to hypertension-related diseases in California during the 1970s. The combined effects of improved awareness, treatment, and control of hypertension; a greater knowledge and associated modifications of cardiovascular risk factors; and improved medical technology and care may have contributed to the decline.

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