# Articles

## Ischemic Heart Disease and Stroke Mortality in African-American, Hispanic, and Non-Hispanic White Men and Women, 1985 to 1991

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We compare recent trends in ischemic heart disease (IHD) and stroke mortality in California among the 6 major sex-racial or -ethnic groups. Rates of age-specific and -adjusted mortality were calculated for persons aged 35 and older during the years 1985 to 1991. Log-linear regression modeling was performed to estimate the average annual percentage change in mortality. During 1985 through 1991, the mortality for IHD and stroke was generally highest for African Americans, intermediate for non-Hispanic whites, and lowest for Hispanics. Age-adjusted mortality for IHD declined significantly in all sex-racial or -ethnic groups except African-American women, and stroke rates declined significantly in all groups except African-American and Hispanic men. African Americans had excess IHD mortality relative to non-Hispanic whites until late in life, after which mortality of non-Hispanic whites was higher. Similarly, African Americans and Hispanics had excess stroke mortality relative to non-Hispanic whites early in life, whereas stroke mortality in non-Hispanic whites was higher at older ages. The lower IHD and stroke mortality among Hispanics was paradoxical, given the generally adverse risk profile and socioeconomic status observed among Hispanics. An alarmingly high prevalence of self-reported cardiovascular disease risk factors in 1994 to 1996, particularly hypertension, leisure-time sedentary lifestyle, and obesity, is a serious public health concern, with implications for future trends in cardiovascular disease mortality. Of particular concern was the growing disparities in stroke and IHD mortality among younger-aged African Americans relative to Hispanics and non-Hispanic whites.

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In the United States, mortality attributable to the two major forms of cardiovascular disease (CVD), ischemic heart disease (IHD) and stroke, has varied considerably among the three major racial or ethnic groups, African Americans, non-Hispanic whites, and Hispanics.[1] Overall, CVD mortality has dropped considerably since 1970, although the rate of the decline appears to be slowing.[2,3] Trends in minority populations have not been as favorable, resulting in a widening racial or ethnic disparity.[4-6] Consequently, the identification and continued monitoring of high-risk subgroups are important components of CVD-prevention efforts.

Although trends in CVD mortality in African Americans and non-Hispanic whites have been well docu-

mented, recent published information for this country's fasting growing minority, Hispanics, is relatively scarce, especially with regard to stroke.[7,8] Documenting trends in Hispanics is of particular interest because of their paradoxically low CVD mortality despite unfavorable cardiovascular risk profiles.[9,10] Historically, less than half of the states have collected Hispanic race or ethnicity on death records, and in most cases, the practice began within the past decade. The distribution of CVD risk factors varies among the three major Hispanic subgroups—Mexican Americans, Cuban Americans, and Puerto Ricans[11]—and, in turn, the distributions of these subgroups vary widely from state to state, making the pooling of data problematic. California has reliably

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ABBREVIATIONS USED IN TEXT
BRFSS = Behavioral Risk Factor Surveillance System
CVD = cardiovascular disease
ICD-9 = International Classification of Diseases, 9th Revision
IHD = ischemic heart disease
MI = myocardial infarction
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recorded Hispanic origin on death certificates since 1985. The Hispanic population in California is overwhelmingly Mexican American and represents about 35% of Hispanics in the US population. In addition, California has a large African-American population, providing adequate statistical power for racial-ethnic comparisons. In this article, we examine the trends in IHD and stroke mortality among these three major racial-ethnic groups in California during the years 1985 to 1991 and recent results from the California Behavioral Risk Factor Surveillance System (BRFSS).

## Methods

Mortality data for California residents were obtained from the death certificate computer files of the California Department of Health Services, Health Data and Statistics Branch, Health Demographics Section for 1985 to 1991. The computer files were searched for underlying-cause-of-death codes 410 to 414 (IHD) and 430 to 438 (stroke) according to the International Classification of Diseases, 9th Revision (ICD-9).[12] Race- or ethnicity-specific population estimates for California residents were obtained from the California Department of Finance.

Race- or ethnicity-specific, age-adjusted mortality rates for ages 35 and older were calculated using the 1980 US census as the standard for direct adjustment.[13] Numerators of the age-specific rates were based on IHD and stroke deaths in ten-year age intervals to increase the stability of each age-sex-racial or -ethnic stratum. The relative change (average annual percentage change in the rate) in IHD mortality was estimated using a log-linear model that assumes a constant proportional change.[14] Statistical interactions between the relative change and race or ethnicity were assessed as a test of statistical differences in the trends. Age-specific rate ratios were calculated using non–Hispanic-white age-specific rates as the referent group. Results from the California BRFSS for the years 1994 to 1996 were used to estimate the prevalence of selected cardiovascular risk factors, after age-adjusting to the 1990 California population. The BRFSS sample sizes for men and women, respectively, were as follows: African American, 274 and 406; Hispanic, 1,217 and 1,559; and non-Hispanic white, 3,413 and 4,296. In this article, the term "race or ethnicity" is meant to reflect the combination of defining human physical-biologic variations and adaptations, as well as the social context, including historical conditions, economic and social factors, and political and cultural forces.[15]

## Results

### Ischemic Heart Disease

For men, between 1985 and 1991, the age-adjusted rates of IHD mortality in California were consistently lowest for Hispanics, whereas those in African-American and non–Hispanic-white men were similar. For women, the age-adjusted rates of IHD mortality were consistently lowest for Hispanics and highest for African Americans. The racial or ethnic differences were substantial, with about a twofold higher age-adjusted IHD mortality in African-American and non–Hispanic-white men than in Hispanic men and in African-American women than in Hispanic women.

During this period, the age-adjusted IHD mortality declined more for men than for women in each of the three racial or ethnic groups (Table 1). For men, non-Hispanic whites had the largest, Hispanics intermediate, and African Americans the smallest decline in rates. For women, Hispanics again had the largest and non-Hispanic whites had slightly lesser declines, whereas African Americans showed no significant decline (95% confidence interval includes zero). Among African-American women, there was a slight increase in IHD mortality during the early years; however, by 1991 the rate had dropped back to the level observed in 1985. Racial-ethnic differences in these trends were not statistically significant for men ($P = .15$), but approached significance in women ($P = .08$).

During 1985 to 1991, the age-specific rates (Table 2) were consistently lowest for Hispanics among both men and women. Among men, the age-specific IHD mortality was lower for non-Hispanic whites than for African Americans until midlife, after which a "crossover" occurred, and African Americans had lower rates during the older ages. The age of mortality crossover for African-American and non-Hispanic whites changed over time as well, ranging from the 60s during 1985 to the 80s in 1991. A similar pattern was observed between non–Hispanic-white and African-American women, although the age at mortality crossover was later. In general, the age-specific IHD rates for those younger than 65 years have dropped between 1985 and 1991 (Table 2). The age-specific rate ratios suggest, however, that, except for men aged 35 to 44 years, the gap between the rates for African-American and non–Hispanic-white men and women has widened whereas that between Hispanic and non–Hispanic-white men and women has narrowed.

### Stroke

For both men and women, the mortality for stroke was consistently highest for African Americans, lowest for Hispanics, and intermediate for non-Hispanic whites (Table 1). Substantial racial-ethnic variation occurred, with about a twofold higher age-adjusted rate in African Americans relative to Hispanic men and women during the entire period.

During 1985 through 1991, the age-adjusted stroke mortality declined slightly more for women than for men

TABLE 1.—*Average Annual Percentage Change\* in Age-adjusted Mortality† of Ischemic Heart Disease and Stroke by Race or Ethnicity and Sex, Ages ≥35 Years, California, 1985 to 1991*

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | Mortality Rate, /100,000 | | Avg Annual % Change | Mortality Rate, /100,000 | | Avg Annual % Change |
| | 1985 | 1991 | (95% CI) | 1985 | 1991 | (95% CI) |
| Ischemic heart disease | | | | | | |
| African American . . . . . . . . . . . . . . . .618 | 560 | −2.1 (−2.9 to −1.3) | 416 | 405 | −0.3 (−1.8 to +1.3) |
| Hispanic . . . . . . . . . . . . . . . . . . . . .352 | 290 | −2.8 (−4.1 to −1.5) | 232 | 192 | −2.4 (−4.1 to −0.8) |
| Non-Hispanic white . . . . . . . . . . . . .648 | 517 | −3.5 (−3.8 to −3.1) | 351 | 301 | −2.3 (−3.2 to −1.5) |
| Stroke | | | | | | |
| African American . . . . . . . . . . . . . . . .178 | 197 | +1.4 (−0.7 to +3.5) | 193 | 176 | −1.2 (−2.6 to +0.2) |
| Hispanic . . . . . . . . . . . . . . . . . . . . . .99 | 96 | −1.8 (−4.0 to +0.6) | 89 | 76 | −2.4 (−4.1 to −0.7) |
| Non-Hispanic white . . . . . . . . . . . . .140 | 124 | −1.5 (−2.3 to −0.7) | 135 | 115 | −2.2 (−3.2 to −1.2) |

Avg = average, CI = confidence interval

\*Calculated using a log-linear regression model.
†Age-adjusted rate per 100,000 person-years, adjusted to the 1980 US population.

in each of the three racial-ethnic groups (Table 1). The rates showed no significant changes in African-American and Hispanic men or African-American women, but declines occurred in the remaining sex-racial or -ethnic groups. Racial or ethnic differences in these trends were not significant in women ($P = .58$), but approached significance in men ($P = .06$).

During 1985 to 1991, non-Hispanic whites had the lowest stroke mortality in the youngest age groups; however, their rates crossed over the Hispanic rates in the 65- to 74-year-old group and the African-American rates in the oldest age group (≥85 years). The 1985 to 1991 trends in age-specific stroke rates for those younger than 65 years have been mixed and have not shown as much improvement as in IHD (Table 2). As was the case with IHD, the age-specific rate ratios suggest that the gap between stroke rates for African-American and non–Hispanic-white men and women has widened. The gap between Hispanic and non–Hispanic-white men and women was also widening, however, while Hispanic age-specific strokes rates have exceeded those of non-Hispanic whites at the younger ages.

*Cardiovascular Risk Factors*

Table 3 details the age-adjusted prevalence estimates by race or ethnicity and sex for five major, self-reported, CVD behavioral risk factors: cigarette smoking, obesity, hypertension, diabetes mellitus, and leisure-time sedentary lifestyle. In general, the prevalence of current smoking was similar among sex-racial or -ethnic groups, except for Hispanic women, who reported a statistically lower prevalence. African-American men and women had the highest prevalence of hypertension. For African-American men, it was statistically higher than among Hispanic or non–Hispanic-white men, and for African-American women, it was statistically higher than among non–Hispanic-white women. The prevalences of obesity, diabetes mellitus, and leisure-time sedentary lifestyle

were statistically lower among non-Hispanic whites than among the two minority populations. At nearly 70%, the prevalence of a sedentary lifestyle was statistically higher among Hispanic men than among African-American men or women.

## Discussion

During 1985 to 1991, the age-adjusted mortality for IHD declined statistically in all sex-racial or -ethnic groups except African-American women. Stroke rates declined statistically in non–Hispanic-white men and women and Hispanic women whereas African-American men had an increase in rates, albeit nonsignificant. For each racial-ethnic group and across the time period, men had higher age-adjusted IHD mortality than women, but stroke mortality was similar among men and women. The racial-ethnic patterns for both CVDs were consistent with the general patterns observed at the national level; Hispanics had the lowest age-adjusted rates, non-Hispanic whites had intermediate rates, and African-Americans had the highest rates.[1] The relatively greater effects of CVD for African-American men and women were clearly evident; on average, African Americans were dying at the fastest rate and at the youngest age relative to Hispanics and non-Hispanic whites and had the least favorable trends between 1985 and 1991.

Although observing patterns in an age-adjusted rate over time is the simplest way to evaluate trends in CVD mortality, such a population-weighted average masks the important age-specific racial-ethnic differences in the groups that we observed. In addition, identifying excess mortality, in particular race- or ethnicity-age strata, will facilitate appropriate tailoring of CVD-prevention efforts. Non–Hispanic-white IHD rates increased more rapidly with age than those for African Americans or Hispanics. Subsequently, African-American men and women had an excess IHD mortality relative to non-His-

TABLE 2.—*Age-Specific Mortality (/100,000) and Rate Ratios\* for Ischemic Heart Disease and Stroke Mortality by Race or Ethnicity*

| Disease Mortality | Ages, yr | | | | | |
|---|---|---|---|---|---|---|
| | *35 to 44* | *45 to 54* | *55 to 64* | *65 to 74* | *75 to 84* | *≥85* |
| **Ischemic heart disease [†]** | | | | | | |
| Men 1985 | | | | | | |
| African American | 57 (1.73) | 191 (1.20) | 510 (1.14) | 999 (0.93) | 2,327 (0.88) | 3,836 (0.82) |
| Hispanic | 17 (0.51) | 63 (0.39) | 203 (0.46) | 542 (0.50) | 1,563 (0.59) | 3,014 (0.64) |
| Non-Hispanic white | 33 (1.00) | 160 (1.00) | 445 (1.00) | 1,075 (1.00) | 2,651 (1.00) | 4,686 (1.00) |
| Men 1991 | | | | | | |
| African American | 36 (1.62) | 133 (1.40) | 385 (1.28) | 888 (1.14) | 2,135 (1.05) | 4,811 (0.89) |
| Hispanic | 9 (0.42) | 50 (0.53) | 167 (0.56) | 500 (0.64) | 1059 (0.52) | 2,952 (0.54) |
| Non-Hispanic white | 22 (1.00) | 95 (1.00) | 302 (1.00) | 780 (1.00) | 2,033 (1.00) | 5,423 (1.00) |
| Women 1985 | | | | | | |
| African American | 19 (2.37) | 69 (2.04) | 256 (1.90) | 726 (1.55) | 1,678 (1.06) | 3,459 (0.77) |
| Hispanic | 2 (0.23) | 16 (0.46) | 100 (0.74) | 336 (0.72) | 966 (0.61) | 3,048 (0.68) |
| Non-Hispanic white | 8 (1.00) | 34 (1.00) | 135 (1.00) | 468 (1.00) | 1,581 (1.00) | 4,474 (1.00) |
| Women 1991 | | | | | | |
| African American | 17 (3.23) | 57 (2.29) | 202 (1.89) | 596 (1.72) | 1,612 (1.29) | 4,785 (1.01) |
| Hispanic | 2 (0.45) | 21 (0.85) | 83 (0.78) | 264 (0.76) | 790 (0.64) | 2,531 (0.54) |
| Non-Hispanic white | 5 (1.00) | 25 (1.00) | 107 (1.00) | 346 (1.00) | 1,246 (1.00) | 4,731 (1.00) |
| **Stroke [†]** | | | | | | |
| Men 1985 | | | | | | |
| African American | 12 (2.02) | 53 (3.36) | 115 (2.08) | 275 (1.49) | 808 (1.15) | 1,077 (0.72) |
| Hispanic | 8 (1.36) | 19 (1.19) | 48 (0.87) | 150 (0.81) | 414 (0.59) | 996 (0.67) |
| Non-Hispanic white | 6 (1.00) | 16 (1.00) | 55 (1.00) | 185 (1.00) | 701 (1.00) | 1,488 (1.00) |
| Men 1991 | | | | | | |
| African American | 23 (3.88) | 58 (4.25) | 120 (2.70) | 326 (2.17) | 749 (1.37) | 1,515 (0.88) |
| Hispanic | 7 (1.21) | 23 (1.72) | 54 (1.22) | 143 (0.95) | 385 (0.70) | 940 (0.55) |
| Non-Hispanic white | 6 (1.00) | 14 (1.00) | 44 (1.00) | 151 (1.00) | 547 (1.00) | 1,722 (1.00) |
| Women 1985 | | | | | | |
| African American | 20 (3.56) | 40 (2.64) | 124 (3.03) | 261 (1.74) | 839 (1.35) | 1,685 (0.87) |
| Hispanic | 6 (1.12) | 11 (0.73) | 38 (0.94) | 114 (0.76) | 347 (0.56) | 1,229 (0.63) |
| Non-Hispanic white | 6 (1.00) | 15 (1.00) | 41 (1.00) | 150 (1.00) | 622 (1.00) | 1,944 (1.00) |
| Women 1991 | | | | | | |
| African American | 19 (4.11) | 49 (3.88) | 107 (3.09) | 216 (1.84) | 701 (1.42) | 1,830 (0.98) |
| Hispanic | 6 (1.37) | 17 (1.33) | 39 (1.12) | 97 (0.83) | 300 (0.61) | 921 (0.49) |
| Non-Hispanic white | 5 (1.00) | 13 (1.00) | 35 (1.00) | 117 (1.00) | 493 (1.00) | 1,871 (1.00) |

\*Due to rounding of the age-specific rates, rate ratios may be slightly different from the race-ethnic age-specific rates divided by non-Hispanic white age-specific rates.
[†]Rate ratio relative to non-Hispanic whites.

panic whites until late in life, after which non–Hispanic-white mortality was higher. During 1985 to 1991, despite a slight drop in the age-specific rates, growing racial-ethnicity disparities in IHD were observed among the youngest ages. In particular, the youngest African-American women had high rate ratios of 3.23 in 1991 compared with 2.37 in 1985. Hispanics consistently had the lowest age-specific IHD rates, with age-specific rate ratios (relative to non-Hispanic whites) often below 0.75, although the gap narrowed during the observation period.

Stroke rates also increased most rapidly with age for non-Hispanic whites. Consequently, African-American and Hispanic men and women had an excess stroke mortality relative to non-Hispanic whites early in life, whereas non–Hispanic-white mortality was higher after

a varying mortality crossover point in the age groups 55 to 64 years and 65 to 74 years. This mortality crossover has also been noted in other vital-statistics studies of stroke in Hispanics and non-Hispanic whites.[7,8] Despite a slight drop in the age-specific rates during 1985 to 1991, the excess stroke mortality relative to non-Hispanic whites increased; for example, in 1991, African-American men and women in the youngest age group had about a fourfold higher stroke mortality than did non-Hispanic whites. In addition, young Hispanics had, in general, higher age-specific stroke rates than non-Hispanic whites in 1991.

The substantially lower mortality of IHD in Hispanics relative to non-Hispanic whites among women, in addition to men, make our findings different from those

TABLE 3.—*Cardiovascular Disease Risk Factor Profiles Among California Residents Aged ≥18 Years, by Sex and Race or Ethnicity, 1994 to 1996*

| Risk Factor | Men, 1994 to 1996 | | Women, 1994 to 1996 | |
|---|---|---|---|---|
| | Prevalence | 95% CI | Prevalence | 95% CI |
| Current smoking, % | | | | |
| African American | 21.1 | (15.8–26.4) | 19.8 | (15.5–24.2) |
| Hispanic | 17.7 | (15.3–20.2) | 9.8 | (8.1–11.4) |
| Non-Hispanic white | 20.4 | (18.8–22.0) | 17.8 | (16.4–19.1) |
| Hypertension, % | | | | |
| African American | 32.2 | (25.9–38.5) | 29.8 | (24.8–34.9) |
| Hispanic | 19.2 | (16.2–22.3) | 22.8 | (20.1–25.5) |
| Non-Hispanic white | 20.3 | (18.8–21.7) | 19.6 | (18.3–20.9) |
| Obesity, % | | | | |
| African American | 35.4 | (29.0–41.7) | 40.6 | (35.1–46.1) |
| Hispanic | 38.7 | (35.3–42.2) | 35.4 | (32.4–38.4) |
| Non-Hispanic white | 25.0 | (23.4–26.6) | 22.1 | (20.6–23.5) |
| Diabetes, % | | | | |
| African American | 9.0 | (4.7–13.3) | 9.1 | (6.0–12.3) |
| Hispanic | 8.4 | (6.0–10.9) | 7.6 | (5.9–9.3) |
| Non-Hispanic white | 3.5 | (2.8–4.1) | 3.1 | (2.6–3.6) |
| Leisure time sedentary lifestyle, % | | | | |
| African American | 58.9 | (52.4–65.5) | 59.5 | (54.1–64.9) |
| Hispanic | 69.5 | (66.4–72.6) | 67.4 | (64.7–70.1) |
| Non-Hispanic white | 48.8 | (46.9–50.8) | 48.9 | (47.2–50.7) |

CI = confidence interval

of recent reports[16–20] (although not others[21]). Inconsistencies may be due to the inclusion of differing ICD-9 codes or temporal or geographic variations between studies. Hispanics also had the most favorable secular trends, with the steepest declines in rates of IHD in women and of stroke in men and women.

The Hispanic results are paradoxical considering the relatively low socioeconomic status of this racial-ethnic group and the well-established association between socioeconomic status and CVD mortality.[22–24] Hispanics have advantageous rates of other key health indicators, such as infant mortality, life expectancy, and measures of functional health, while having a greater proportion of persons living in poverty, without health insurance, and with reduced access to health care than non-Hispanic whites.[9,25,26] With 22% of Hispanics falling below the federally established poverty threshold, Hispanics have higher rates of poverty than African Americans (21%) or non-Hispanic whites (9%) in California.[27] A national study has suggested a "healthy migrant effect," with foreign-born Hispanics having lower mortality than native-born persons.[21] In that study, however, the Hispanic advantage remained even after adjusting for nativity.

The paradoxically low rates in Hispanics are made even more perplexing by the generally adverse cardiovascular risk profile in this racial-ethnic group.[28] On average, Hispanics have higher triglyceride levels, lower high-density-lipoprotein–cholesterol levels, higher systolic blood pressures, higher body mass index and central obesity, and a greater incidence and prevalence of non–insulin-dependent diabetes mellitus.[27,29–39] Among the racial-ethnic groups participating in the first National Health and Nutrition Examination Survey (NHANES-1) (1976–1980) and the Hispanic Health and Nutrition Examination Survey (HHANES) (1982–1984), Hispanics aged 45 to 74 years had the highest prevalence of diabetes mellitus (diagnosed plus undiagnosed): 12% in non-Hispanic whites, 19% in African Americans, and 24% in Mexican Americans.[40] Whereas the overall prevalence of hypertension is lower among Hispanics than among African Americans and similar to that of non-Hispanic whites,[27,32,41–43] the proportion of hypertensive persons with poor blood pressure control is high in both Hispanics and African American.[32,33,44] These adverse risk factors may be partially offset by a lower rate of smoking; in one study, California Hispanics were statistically less likely than non-Hispanic whites to be current smokers and, among smokers, smoked fewer cigarettes.[45] The recent BRFSS results also support a lower prevalence of current smoking in Hispanics, although significant only in women.

Vital-statistics studies and surveillance studies of incident and prevalent CVD have presented inconsistent findings with regard to the Hispanic paradox, especially for IHD. The Corpus Christi (Texas) Heart Project has shown a greater incidence of hospitalized myocardial infarction (MI) among Hispanics than among non-Hispanic whites.[28] This study, however, lacks data on silent MIs and fatal, out-of-hospital coronary events, which comprise a third to half of the fatal coronary events.[46]

The same study group also observed higher case-fatality rates after MI in Hispanics than in non-Hispanic whites.[10,47] In the San Luis Valley (Colorado). Diabetes Study, the prevalence of coronary heart disease in men with diabetes was 50% lower among Hispanics than non-Hispanic whites, but little difference was evident among those without diabetes.[48] In contrast to the San Luis study, the San Antonio (Texas) Heart Study showed a lower prevalence of MI in Hispanics than in non–Hispanic-white men in those without diabetes.[18] The higher case-fatality rate in Hispanics may explain the higher incidence of MI observed in one study and the lower prevalence observed in the other.[28,48] The lower IHD mortality observed in Hispanics in this and other vital-statistics studies, however, is not consistent with a concomitant high case-fatality and high incidence rate of MI previously reported for this racial-ethnic group.

Vital-statistics data have limitations that may explain these inconsistencies. We have not validated death certificate coding, and thus, coding artifacts could account for a portion of the observed racial-ethnic differences, especially for Hispanics. Substantial underreporting for Hispanic race or ethnicity has been noted in death certificates by some.[48,49] The National Longitudinal Mortality Study, however, observed that 94% of self-reported Hispanics were classified as Hispanic on the death certificate (98.7% overall agreement for Hispanic origin).[50] Inflating Hispanic rate numerators by an additional 6%, however, would not account for the sizable CVD rate discrepancies observed between Hispanics and African Americans or non-Hispanic whites. Previous studies have discounted coding artifacts because of the consistency in results across state borders.[33] Additional missed deaths could have resulted if Hispanics chose to return to Mexico or other countries of origin to die after severe CVD events and thus not be reported,[8] although this probably represents a small fraction of the total.

Alarmingly higher IHD and stroke mortality in African Americans than in non-Hispanic whites has resulted in a targeting of preventive efforts. Public health efforts to reduce the disparity in CVD outcomes require a continued identification and characterization of racial-ethnic and age-specific risks. It is important to evaluate not only group differences in mortality when considering possible target groups, but also current differences and secular trends in CVD risk factor profiles that affect future mortality. In recent years, the prevalences of cigarette smoking and obesity showed competing trends; the favorable decline in the prevalence of cigarette smoking in all sex-racial or -ethnic groups among California's adult population (27.5% decrease since 1984–1987) was offset by a dramatic rise in the prevalence of obesity (52.1% increase since 1984–1987). Between 1984 to 1987 and 1994 to 1996, the prevalence of a sedentary lifestyle was relatively stable at 55% for all Californians. Combined with the greater prevalence of diabetes in the minority populations, these are serious public health concerns with implications for future trends in CVD mortality. The

effect of increasing levels of these risk factors on mortality trends may be somewhat offset by recent improvements in the management of patients at risk.

Clearly the forces behind the recent declines in CVD mortality have not benefited all demographic groups equally. The benefits of improved secondary prevention especially will likely lag for more economically disadvantaged groups. For African Americans, particularly early in life, the highest IHD and stroke mortality, lack of a comparable decline in age-adjusted IHD and stroke rates, and unfavorable trends in CVD risk factors suggest that increased primary and secondary prevention efforts should be focused on this race or ethnicity currently at greatest risk. Although comparing different populations requires caution, national data on IHD mortality from 1968 through 1985 indicate that the average annual percentage decline may be slowing dramatically for African-American women (−3.9% in 1968 to 1978, −2.0% in 1979 to 1985 in the national data,[4] and −0.3% in 1985 to 1991 in California data). A similar but more gradual decelerating decline occurred in African-American men and non-Hispanic white women, whereas an acceleration in the declines occurred in non-Hispanic white men. Despite the lower and declining age-adjusted IHD mortality, Hispanics had higher stroke mortality than non-Hispanic whites early in life. Taken together with Hispanics' less favorable CVD risk profile and the large number of Hispanics entering the ages of greater risk for IHD and stroke over the next several decades,[28] this minority population also deserves careful monitoring efforts. The interplay between race or ethnicity, risk factor profile, and the trends in CVD mortality and, in particular, the paradoxical finding of unexpectedly low CVD rates in Hispanics despite an adverse cardiovascular risk profile, lower socioeconomic status, and inconsistent epidemiologic findings need further investigation.

## Acknowledgment

### REFERENCES

1. Cardiovascular disease surveillance, ischemic heart disease, 1980-1989. Atlanta (Ga): Centers for Disease Control and Prevention; 1993

2. Centers for Disease Control and Prevention. Trends in ischemic heart disease deaths—United States, 1990-1994. MMWR Morb Mortal Wkly Rep 1997; 46:146–150

3. Gillum RF, Sempos CT. The end of the long-term decline in stroke mortality in the United States? Stroke 1997; 28:1527–1529

4. Sempos C, Cooper R, Kovar MG, McMillen M. Divergence of recent trends in coronary mortality for the four major race-sex groups in the US. Am J Public Health 1988; 78:1422–1427

5. Williams DR, Collins C. US socioeconomic and racial differences in health: patterns and explanations. Annu Rev Sociol 1995; 21:349–386

6. Liao Y, Cooper RS. Continued adverse trends in CHD mortality among blacks, 1980-1991. Public Health Rep 1995; 110:572–579

7. Howard G, Anderson R, Sorlie P, Andrews V, Backlund E, Burke GL. Ethnic differences in stroke mortality between non-Hispanic whites, Hispanic whites, and blacks—the National Longitudinal Mortality Study. Stroke 1994; 25:2120–2125

8. Morgenstern LB, Spears WD, Goff DC Jr, Grotta JC, Nichaman MZ. African Americans and women have the highest stroke mortality in Texas. Stroke 1997; 28:15–18

9. Markides KS, Coreil J. The health of Hispanics in the southwestern United States: an epidemiologic paradox. Public Health Rep 1986; 101:253–265

10. Goff DC, Varas C, Ramsey DJ, Wear ML, Labarthe DR, Nichaman MZ. Mortality after hospitalization for myocardial infarction among Mexican Americans and non-Hispanic whites: the Corpus Christi Heart Project. Ethnicity Dis 1993; 3:55–63

11. Flegal KM, Ezzati TM, Harris MI, Haynes SG, Juarez RZ, Knowler WC, et al. Prevalence of diabetes in Mexican Americans, Cubans, and Puerto Ricans from the Hispanic Health and Nutrition Examination Survey, 1982–1984. Diabetes Care 1991; 14(suppl 3):628–638

12. International classification of diseases, 9th revision, clinical modification. Washington (DC): Public Health Service, US Dept of Health and Human Services; 1988

13. Fleiss JL. Statistical methods for rates and proportions, 2nd ed. New York (NY): John Wiley & Sons; 1981

14. Kleinman JC. State trends in infant mortality, 1968–83. Am J Public Health 1986; 76:681–687

15. Williams DR. Race and health: basic questions, emerging directions. Ann Epidemiol 1997; 7:322–333

16. Schoen R, Nelson VE. Mortality by cause among Spanish-surnamed Californians, 1969–71. Soc Sci Q 1981; 62:259–274

17. Goff DC, Ramsey DJ, Labarthe DR, Nichaman MZ. Acute myocardial infarction and coronary heart disease mortality among Mexican Americans and non-Hispanic whites in Texas, 1980 through 1989. Ethnicity Dis 1993; 3:64–69

18. Mitchell BD, Hazuda HP, Haffner SM, Patterson JK, Stern MP. Myocardial infarction in Mexican Americans and non-Hispanic whites: the San Antonio Heart Study. Circulation 1991; 83:45–51

19. Stern MP, Gaskill SP. Secular trends in ischemic heart disease and stroke mortality from 1970 to 1976 in Spanish-surnamed and other white individuals in Bexar County, Texas. Circulation 1978; 58:537–543

20. Stern MP, Bradshaw BS, Eifler CW, Fong DS, Hazuda HP, Rosenthal M. Secular decline in death rates due to ischemic heart disease in Mexican Americans and non-Hispanic whites in Texas, 1970–1980. Circulation 1987; 76:1245–1250

21. Sorlie PD, Backlund E, Johnson NJ, Rogot E. Mortality by Hispanic status in the United States. JAMA 1993; 270:2464–2468

22. Wing S. Social inequalities in the decline of coronary mortality. Am J Public Health 1988; 78:1415–1416

23. Wing S, Casper M, Riggan W, Hayes C, Tyroler HA. Socioenvironmental characteristics associated with the onset of decline of ischemic heart disease mortality in the United States. Am J Public Health 1988; 78:923–926

24. Kaplan GA, Keil JE. Socioeconomic factors and cardiovascular disease: a review of the literature. Circulation 1993; 88(pt 1):1973–1998

25. Council on Scientific Affairs, American Medical Association. Hispanic health in the United States. JAMA 1991; 265:248–252

26. Ginzburg E. Access to health care for Hispanics. JAMA 1991; 265:238–241

27. Health data summaries for California counties. Sacramento (Calif): Dept of Health Services, Planning and Data Analysis Section; 1994

28. Goff DC, Nichaman MZ, Chan W, Ramsey DJ, Labarthe DR, Ortiz C. Greater incidence of hospitalized myocardial infarction among Mexican Americans than non-Hispanic whites: the Corpus Christi Heart Project, 1988–1992. Circulation 1997; 95:1433–1440

29. Haffner SM, Stern MP, Hazuda HP, Pugh JA, Patterson JK. Hyperinsulinemia in a population at high risk for non-insulin dependent diabetes mellitus. N Engl J Med 1986; 315:220–224

30. Hamman RF, Marshall JA, Baxter J, Kahn LB, Mayer E, Orleans M, et al. Methods and prevalence of non-insulin dependent diabetes mellitus in a biethnic population: the San Luis Valley Diabetes Study. Am J Epidemiol 1989; 129:294–311

31. Haffner SM, Hazuda HP, Mitchell BD, Patterson JK. Increased incidence of type II diabetes mellitus in Mexican Americans. Diabetes Care 19091; 14:102–108

32. Haffner SM, Morales PA, Hazuda HP, Stern MP. Level of control of hypertension in Mexican Americans and non-Hispanic whites. Hypertension 1993; 21:83–88

33. Mitchell BD, Stern MP, Haffner SM, Hazuda HP, Patterson JK. Risk factors for cardiovascular disease mortality in Mexican Americans and non-Hispanic whites: the San Antonio Heart Study. Am J Epidemiol 1990; 131:423–433

34. Burchfield CM, Hamman RF, Marshall JA, Baxter J, Kahn LB, Amirani JJ. Cardiovascular risk factors and impaired glucose tolerance: the San Luis Valley Diabetes Study. Am J Epidemiol 1990; 131:57–70

35. Stern MP, Rosenthal M, Haffner SM, Hazuda HP, Franco LJ. Sex difference in the effects of sociocultural status on diabetes and cardiovascular risk factors in Mexican Americans: the San Antonio Heart Study. Am J Epidemiol 1984; 120:834–851

36. Diehl AK, Stern MP. Special health problems of Mexican Americans: obesity, gallbladder disease, diabetes mellitus, and cardiovascular disease. Adv Intern Med 1989; 34:79–96

37. Stern MP, Gaskill SP, Allen CR Jr, Garza V, Gonsales JL, Waldrop RH. Cardiovascular risk factors in Mexican Americans in Laredo, Texas: 1. Prevalence of overweight and diabetes and distributions of serum lipids. Am J Epidemiol 1981; 113:546–555

38. Stern MP, Haskell WL, Wood PD, Osann KE, King AB, Farquhar JW. Affluence and cardiovascular risk factors in Mexican-Americans and other whites in three northern California communities. J Chronic Dis 1975; 28:623–636

39. Stern MP, Gaskill SP, Hazuda HP, Gardner LI, Haffner SM. Does obesity explain excess prevalence of diabetes among Mexican Americans? results of the San Antonio Heart Study. Diabetologia 1983; 24:272–277

40. Kenny SJ, Aubert RE, Geiss LS. Prevalence and incidence of non-insulin-dependent diabetes. In: Diabetes in America. 2nd ed. Rockville (Md): National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health; 1995, NIH publication No. 95-1468

41. Franco LJ, Stern MP, Rosenthal M, Haffner SM, Hazuda HP, Comeaux PJ. Prevalence, detection, and control of hypertension in a biethnic community: the San Antonio Heart Study. Am J Epidemiol 1985; 121:684–696

42. Haffner SM, Mitchell BD, Stern MP, Hazuda HP, Patterson JK. Decreased prevalence of hypertension in Mexican Americans. Hypertension 1990; 16:225–232

43. Haffner SM, Mitchell BD, Valdez RA, Hazuda HP, Morales PA, Stern MP. Eight-year incidence of hypertension in Mexican Americans and non-Hispanic whites: the San Antonio Heart Study. Am J Hypertens 1992; 5:147–153

44. 1988 Joint National Committee. The 1988 report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. Arch Intern Med 1988; 148:1023–1028

45. Winkleby MA, Schooler C, Kraemer HC, Lin J, Fortman SP. Hispanic versus white smoking patterns by sex and level of education. Am J Epidemiol 1995; 142:410–418

46. Escobedo LG, Caspersen CJ. Risk factors for sudden coronary death in the United States. Epidemiology 1997; 8:175–180

47. Goff DC, Ramsey DJ, Labarthe DR, Nichaman MZ. Greater case-fatality after myocardial infarction among Mexican Americans and women than among non-Hispanic whites and men: the Corpus Christi Heart Project. Am J Epidemiol 1994; 139:474–483

48. Rewers M, Shetterly SMN, Hoag S, Baxter J, Marshall J, Hamman RF. Is the risk of coronary heart disease lower in Hispanics than in non-Hispanic whites? the San Luis Valley Diabetes Study. Ethnicity Dis 1993; 3:44–54

49. Poe GS, Powell-Griner E, McLaughlin JK, Placek PJ, Thompson GB, Robinson K. Comparability of the death certificate and the 1986 National Mortality Followback Survey. Vital Health Stat 2 1993; 118:1–53

50. Sorlie PD, Rogot E, Johnson NJ. Validity of demographic characteristics on the death certificate. Epidemiology 1992; 3:181–184