Ethnic Differences in Stroke Mortality Between Non-Hispanic Whites, Hispanic Whites, and Blacks

The National Longitudinal Mortality Study

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Background and Purpose Although US blacks are known to have an excess stroke mortality compared with US whites, little is known about the stroke burden of the Hispanic white population. This report will provide estimates of the relative burden of stroke mortality in the US black and Hispanic population relative to the white population and examine the consistency of this relation across age.

Methods Data were from participants aged >45 years from the National Longitudinal Mortality Study. There were 1844 stroke deaths among 239 734 non-Hispanic whites, 46 deaths among 12,527 Hispanic whites, and 234 deaths among 23 468 black participants. Standard statistical methods were used to examine the ethnic differences in stroke mortality.

Results The hazard ratios for black men and women (relative to non-Hispanic whites) were nearly identical, at >4.0 at age 45 but marginally <1.0 by age 85. For both Hispanic men and women, the hazard ratios (relative to non-Hispanic whites) were approximately 1.0 at age 45 but were marginally significantly <1.0 at older ages. The ethnic differences in stroke death rates reveal differences in age distributions of age at fatal stroke between these groups. Approximately 6% of fatal strokes for non-Hispanic whites occurred before age 60, whereas >15% occurred in both Hispanic whites and blacks.

Conclusions These results suggest that (1) for Hispanics, stroke risk is similar to that for non-Hispanic whites at young ages but is marginally lower at older ages, (2) the excess stroke mortality in blacks mainly occurs at younger ages (between 45 and 55 years), and (3) the relation between stroke risk for blacks and Hispanics relative to whites is similar by sex. The impact of age on relative stroke mortality would argue against simple age adjustment for describing ethnic differences in stroke mortality. Finally, proportionally, more strokes occur at older ages in non-Hispanic whites than in either US blacks or Hispanic whites. (Stroke. 1994;25:2120-2125.)

Key Words • cerebrovascular disorders • mortality • racial differences

Despite the widespread knowledge of excess stroke mortality in the US black population, basic shortcomings exist in the description of mortality from this third leading cause of death among adults. Most race comparisons have been between white and nonwhite groups; hence, the relative burden of stroke mortality in the second largest and fastest growing minority group, the Hispanic population, is relatively undocumented. Data from the National Longitudinal Mortality Study (NLMS) has already shown a lower general mortality for Hispanic whites relative to their non-Hispanic white counterparts. This same study has also shown a larger excess all-cause mortality for blacks at younger ages than at older ages. That the excess stroke mortality in blacks may fall disproportionately on specific age strata plays a major role in the development of hypotheses that may underlie the racial differences and may be important in developing appropriate primary and secondary prevention efforts.

Subjects and Methods

The NLMS linked 10 Current Population Surveys (CPSs) with the National Death Index (NDI) and coded the causes of the deaths that occurred during a 5-year follow-up period. The CPS is an ongoing probability sample of noninstitutionalized households, primarily conducted to provide unemployment and labor force statistics. The response rate to the survey is generally >96%. The survey contains information (including Social Security number) that allows reliable linking to the NDI. The surveys selected for matching were performed from January 1979 to March 1985 and contain 1 281 475 persons. Each of these cohorts was linked to the NDI, and 44 828 death certificates were retrieved from the states. Loss to follow-up is not an issue in the NDI because the follow-up is via death certificate reporting. The death certificates were reviewed, and causes of death were coded by the International Classification of Diseases, version 9 (ICD-9) system.

Analysis was restricted to persons aged >45 years since there were relatively few stroke deaths before that age. Subjects were categorized as black or white by response to the CPS question, “What is the race of each person in this household?” Subjects that were neither white nor black were excluded from the analysis. The white study population was separated into Hispanic and non-Hispanic white on the basis of the CPS question, “What is the origin or descent of each...
person in the household?" The Hispanic white population includes persons of Mexican, Puerto Rican, Cuban, and other Hispanic (Central or South American or other Spanish) descent. The Hispanic black (very small sample) and non-Hispanic black populations were pooled for analysis purposes. The black, Hispanic white, and non-Hispanic white populations are reported. Age was taken as the attained age reported in the CPS survey, noting that during the 5-year follow-up the age of survivors increased.

Deaths with ICD-9 codes of 430 to 438 (cerebrovascular disease) were considered stroke deaths, and deaths from other causes were considered censored. There were 1844 stroke deaths in the 5-year follow-up among 239 734 non-Hispanic whites, 46 deaths among 12 527 Hispanic whites, and 234 deaths among 23 468 black participants.

Standard survival analyses were used to estimate stroke mortality and the impact of age on this mortality. The three ethnic cohorts were separated by sex and age strata. Age strata were arbitrarily chosen based on the distribution of stroke deaths in each stratum. Survival estimates were made by means of Kaplan-Meier techniques. A proportional hazards (Cox regression) model was fit to the data, and the hazard ratio was estimated for the Hispanic white and black populations relative to the non-Hispanic white population for each sex as a function of increasing years of age. This proportional hazards model was used as the primary analysis technique for this report to test for the consistency of ethnic differences across age, to test if the relation was consistent for the two sexes, and to test for "significant" hazard ratios at arbitrarily chosen ages of 45, 55, 65, 75, and 85 years. PROC LIFETEST (SAS Inc) was used for the Kaplan-Meier analysis, and PROC PHREG software was used for the proportional hazards modeling.

To assess the expected proportion of stroke deaths in each age stratum for each of the ethnic groups, the sex- and ethnic-specific stroke mortality rates were weighted by the proportion of the 1992 population (chosen to project the impact of ethnic differences in survival to the current population distribution) in each of the age strata, which would provide the expected proportion of strokes in each stratum.

Results

The Table provides a description by age, sex, and ethnic group of the number of subjects, stroke deaths, Kaplan-Meier estimates of 5-year stroke mortality, and relative risk of stroke death for the Hispanic white and black populations relative to the non-Hispanic white population. For all sex and ethnic groups there was a clear increase in the estimated 5-year stroke mortality with increasing age. Mortality estimates for subjects aged 45 to 59 years ranged from 0.12% (white women) to 0.55% (black men); for subjects aged ≥75 years the estimated mortality ranged from 1.85% (Hispanic women) to 4.60% (white men). The stroke mortality rate increased faster with age for the non-Hispanic white population than for either the Hispanic white or black population. While non-Hispanic whites aged 45 to 59 years had the lowest rates of the ethnic groups, at ages ≥75 years they attained the highest mortality rates.

The results of proportional hazards (Cox regression) analysis with age as continuous covariate are provided in Fig 1. There proved to be a highly significant (P≤.0001) interaction of age by ethnic group, in which the hazard ratios for stroke mortality between the ethnic groups differed greatly by age (primarily black/non-Hispanic white differences). For black participants, there was clear evidence of a decrease in the hazard ratio relative to non-Hispanic whites for both men and women with age (P≤.0001). The hazard ratio for both black men and women was approximately 4.5 times that of non-Hispanic whites at age 45 but decreased dramatically with age to a level marginally below the hazard of non-Hispanic whites by age 85. The hazard ratios for black males and females were above those for non-Hispanic whites at ages 45, 55, 65, and 75 (P≤.05); however, the differences proved nonsignificant (P>.05) for age 85. There was no evidence of a sex difference in the relation of black and non-Hispanic white hazard ratios (P>.05).

For Hispanic white subjects, there was not clear evidence of decreasing hazard ratio with age for men or women (P>.1) relative to their non-Hispanic white counterparts. However, while there was no evidence of

<table>
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<th>Age, y/Ethnic Group</th>
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<th>RR</th>
<th>Women Stroke Deaths</th>
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RR indicates relative risk.

*Because of the relatively small number of deaths in the Hispanic population, the estimates of the death rate in this population should be viewed with caution. A more detailed discussion of concerns related to these estimates is provided in the third from final paragraph of the "Discussion."
dramatic in blacks, remarkably little effort has been made to describe the relative stroke risk in Hispanic white or black counterparts.

For both men and women, the Hispanic white population is notably younger than the white population, followed by the black population. The age-, sex-, and ethnic-specific stroke death rates can be applied to the proportion of the population aged >45 years in each of the three ethnic populations (Fig 2, bottom panel). For non-Hispanic whites, 7% of fatal strokes for men and 5% for women occurred in subjects aged <60 years compared with 61% and 74%, respectively, occurring in subjects aged ≥75 years. This is in stark contrast to Hispanic white and black populations, in which between 15% and 22% (depending on ethnic/sex strata) of strokes occurred in those aged <60 years, and between 37% and 54% occurred in those aged ≥75 years. For either sex, the age of fatal stroke was much older for non-Hispanic whites than for their Hispanic white or black counterparts.

**Discussion**

Despite considerable attention to excess stroke mortality in blacks, remarkably little effort has been made to describe the relative stroke risk in Hispanic white populations. While there are dramatic increases in the risk of stroke death with increasing age in all race/ethnic groups, the rate increases faster with age among non-Hispanic whites compared with Hispanic whites and produces a slight trend for decreasing relative risk of stroke mortality for both Hispanic white men and women (compared with US whites) with increasing age. The proportional hazards analysis showed that although Hispanic white stroke mortality was approximately equal to non-Hispanic white stroke mortality at age 45, there was marginally significantly lower relative mortality at older ages.

In both this report and data from the National Center for Health Statistics (NCHS), the mortality rates of non-Hispanic whites and Hispanic whites are approximately equal at young ages (45 to 60/64), and the mortality rates of both of these ethnic groups are substantially lower than the mortality rate for blacks. Both of these data sources also show that at older ages (≥75 years) mortality is highest for non-Hispanic whites, followed by blacks, and it is lowest for Hispanic whites. This pattern is consistent for both men and women. The estimates from the NCHS have the notable advantage of being based on data with a substantially larger number of deaths; therefore, they provide much more stable estimates. Although both the NCHS and the NLMS rely on death certificate data, the NLMS used central coding and may have avoided biases introduced by the nonstandard coding used by the NCHS (but may be equally susceptible to biases introduced in recording the information on the death certificate). The consistency of these two sources of data suggests that the estimates of both are valid.

The decreasing Hispanic to non-Hispanic white relative mortality is consistent with hospital incidence data from northern Manhattan reported by Sacco et al, in which a higher stroke incidence was observed for Hispanic white than for non-Hispanic white men in age strata 40 to 49 and 50 to 59 years, nearly identical incidence for Hispanic white and non-Hispanic white men aged 60 to 69 years, and higher incidence for non-Hispanic white men aged 70 to 79 and ≥80 years. For women the pattern was not consistent: Sacco et al reported a lower stroke incidence for non-Hispanic white than for Hispanic white women aged 50 to 59, 60 to 69, and 70 to 79 years but a higher incidence for non-Hispanic white women aged 40 to 49 and >80 years.

Like our data showing small differences in non-Hispanic/Hispanic white stroke mortality, small differences were also reported by Kattapong and Becker for the adjusted stroke mortality of New Mexico Hispanics and non-Hispanic whites. Their analysis offers the opportunity to address temporal changes in the relative mortality of the Hispanic and non-Hispanic populations. The ratio of Hispanic to non-Hispanic white mortality across the six 5-year periods ranged from 85% to 127% for men and from 91% to 110% for women, without an apparent temporal consistency. In this study age-specific rates were not reported, and a more detailed comparison of Hispanic/non-Hispanic stroke mortality was not possible.

Because of similar risk factors, similar ethnic patterns would be expected for stroke and ischemic heart disease. Both Rewers et al and Stern et al reported lower coronary heart disease rates for Hispanic men.
for action" by Dr Edward Cooper, the past President of the American Heart Association. This concern is based primarily on numerous reports of excess stroke mortality in blacks, including our own, contrast the age-adjusted stroke mortality of black men and women with that of their white counterparts and find an approximately 1.5- to 2.0-fold excess of black to white stroke mortality, a surplus clearly warranting national attention. While a few reports have also described declining excess stroke mortality with increasing age, the description of this trend has not been the focus of the majority of the previous reports. Our data support the previous findings that the estimated excess stroke mortality in blacks is due to high stroke mortality in younger persons, whereas older blacks have little excess risk.

Presentation of only age-adjusted mortality data may mask true age-specific racial/ethnic differences as were observed in our data. Direct age adjustment of mortality rates is a common approach for examination of differences in the risk of multiple populations. In this method, age adjustment of stroke rates creates a weighted average stroke mortality rate, in which the weights are assigned proportional to the reference population used in the adjustment. If the same standard or reference population is used across groups, all rates are directly comparable. However, implicit in the assumption of the use of population-weighted average mortality to represent data is the fact that the average is representative of the data it is describing across age groups. That the stroke rate for blacks greatly exceeds that for non-Hispanic whites at young ages and is approximately equal to that for non-Hispanic whites at older ages would make studies that use age adjustment likely to obscure differences in black/non-Hispanic white stroke mortality. In this case, the large excess mortality in blacks at younger ages would be averaged with the approximately equal stroke mortality at older ages. Hence, age adjustment in the previous reports has tended to “hide” an even more extreme problem in the younger subgroup of the black population. While a risk of 1.5 to 2.0 overall is a matter of concern, the estimated excess of approximately 4.0 in our report for the relatively young black population is of extreme interest not only because of the magnitude of the excess risk but also because the age of the group at risk implies a greater morbidity and loss of productivity. The mechanisms possibly underlying the excess risk at younger ages are likely to be different and can assist in directing future research to fruitful areas to address excess stroke mortality in blacks compared with non-Hispanic whites.

A number of studies focusing on stroke incidence reflect the decreasing relative risk of the black population with increasing age. Heyman et al reported a higher incidence of stroke in black men aged 35 to 44, 45 to 54, and 55 to 64 years than in their white counterparts but a higher incidence in the white male population aged >65 years. Gross et al reported that the ratio of black to white stroke incidence rates in southern Alabama was 2.5 for subjects aged 55 to 64, 2.4 for those aged 65 to 74, and only 1.3 for those aged >75 years. Sacco et al reported a decreasing ratio of stroke incidence in blacks (relative to whites) in men with increasing age and a decreasing ratio for women aged >50 years with age.
Finally, Kittner et al\textsuperscript{28} reported a strictly decreasing ratio of stroke incidence for blacks versus whites for women in the National Health and Nutrition Examination Survey, in which the relative risk for blacks aged 35 to 44 years was 5.8 times that of their white counterparts, decreasing to 3.3 for those aged 45 to 54, 3.0 for those aged 55 to 64, and 1.3 for those aged 65 to 74 years. Kittner et al also reported that the ratio of black to white incidence rates among men was lower at ages 65 to 74 (ratio=1.2) than among the immediately younger cohort aged 55 to 64 years (ratio=2.2). It appears likely that the decrease in relative black mortality (compared with whites) is at least partially attributable to a decreasing relative incidence of stroke. Kittner et al\textsuperscript{29} have also reported higher black hemorrhage and infarction incidence rates among Baltimore City/County residents aged <45 years than in their white counterparts; however, these subjects are below the age discussed in this report.

Klatsky et al\textsuperscript{29} reported a 2.35-fold higher relative risk of hospitalization for hemorrhagic stroke among black compared to white adults of a large health maintenance organization compared with their white counterparts. The risk of black participants in the organization was 1.64-fold greater than that of their white counterparts in regard to being admitted for a nonspecific stroke. A similar risk (relative risk of 1.01) was reported regarding admission for occlusive diseases. This suggests not only a higher incidence rate for blacks but, more importantly, a higher incidence rate for hemorrhagic disease. Since hemorrhages constitute a larger proportion of stroke at young ages and result in a higher mortality rate than occlusive diseases,\textsuperscript{31} it follows that case-fatality rate may also be contributing to the elevated (but declining with age) black stroke mortality rate at young ages. Sacco et al\textsuperscript{29} have reported 1-year fatality rates after stroke. In a relatively old stroke cohort (mean ages: white, 69; black, 67; and Hispanic, 63 years), white participants were observed to have the highest stroke recurrence and mortality rates, followed by blacks; Hispanics had the lowest rates. That this ordering is the same as the mortality rates for older NLMS participants also suggests that case-fatality rates may be playing a role in the ethnic differences in stroke mortality rates.

Finally, ethnic differences in stroke mortality rates contribute to large differences in the expected age distribution of fatal strokes. Young blacks (both male and female) represent a larger proportion of the black population than do young non-Hispanic whites in their population and experience a larger excess stroke mortality relative to non-Hispanic whites. In contrast, the younger age at which fatal strokes occur among Hispanic whites is driven by (1) the smaller proportion of older Hispanic whites relative to older non-Hispanic whites in their respective populations and (2) a marginally lower stroke mortality risk. Hence, while blacks have a lower mean age for fatal strokes because of the large number of strokes observed at younger ages, Hispanics have a lower mean age because of the lower number of strokes observed at older ages.

It should be noted that the relatively small number of stroke deaths in both male and female Hispanic populations limits the marginal findings for the comparisons between Hispanics and non-Hispanic whites. This small number of stroke deaths is a product of both the smaller sample size for Hispanics and their lower stroke risk (at older ages). Because the standard error of the estimate becomes large (\(>23\%\)) relative to the estimate of the mortality, the NCHS does not report mortality estimates in cases with fewer than 20 deaths.\textsuperscript{33} This is the case for all Hispanic estimates of mortality in the Table. For example, the estimated 95% confidence limits for male Hispanics are approximately \(\pm 0.12\%\) for the estimated 0.15% mortality for Hispanics aged 45 to 59 years. While this estimation error may be relatively large in terms of the magnitude of the estimate, it is relatively small in comparison to differences between the ethnic groups. Nevertheless, the estimates of specific mortality rates based on a small number of deaths should be viewed with caution. For this reason, we consider the proportional hazards analysis in Fig 1 (which incorporates deaths across all ages) to be the primary analysis for this report. The information in the Table is provided (1) to describe the sample size and number of deaths for each ethnic group in broad age strata, (2) to provide crude estimates of mortality to show contrasts between ethnic groups, and (3) to serve as the foundation for the hazard ratios presented in the Table. The mortality rates on the expected ethnic differences in the age at stroke onset. While comparisons between ethnic groups are reasonable in the Table, "improved" estimates are available from the proportional hazards analysis. In this analysis, even with the relatively small number of events (deaths), the difference between the Hispanic and non-Hispanic white populations reached statistical significance at older ages. The study could clearly be strengthened by a larger sample of Hispanics; however, the current report represents the survival estimated in a Hispanic sample aged >45 years with approximately 62,000 person-years of exposure. If the reader is seeking ethnic age-specific estimates of mortality rates, the reader is encouraged to also consider data available from other sources.\textsuperscript{30,33}

The major strengths of this study are the representative nature of the study population and the central coding of the death certificates. Although the 4% nonresponse of the CPS may introduce some bias, use of the CPS should provide a representative sample of the general population. There are a number of shortcomings. First, the statistical power to detect differences between the Hispanic and black/non-Hispanic populations was less than that between the black and non-Hispanic populations. However (as discussed above), the study still reports the survival experience of a sizable Hispanic cohort. Second, it would have been of great interest to subdivide the Hispanic population and provide estimates for subethnic groups (Puerto Rican, Mexican, etc), but the sample size of Hispanics was not sufficient. Finally, the group of black Hispanics was too small to provide meaningful results, and this group was pooled with the non-Hispanic black population. The central coding of the death certificates and the longitudinal nature of the follow-up present an opportunity for analysis of the impact of risk factors (such as socioeconomic status) on stroke mortality rates in an environment in which sources of potential biases are reduced.

In conclusion, these data suggest that the stroke risk for Hispanics is lower than that of non-Hispanics at young ages (approximately age 45), but by age 85 the Hispanic population may have a marginally lower risk of stroke. The excess risk of stroke...
mortality among the US black population is much higher at younger than older ages, and the previously reported excess stroke mortality in blacks appears mainly attributable to stroke onset at younger ages. The relation between stroke risk for blacks and Hispanics relative to whites is similar by sex. For blacks, the relative risk of stroke mortality was dramatically affected by age; as such, these data point to the need to present age-adjusted and age-specific data when making comparisons of ethnic differences in stroke mortality.

References
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