Neurological, Functional, and Cognitive Stroke Outcomes in Mexican Americans

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Background and Purpose—Our objective was to compare neurological, functional, and cognitive stroke outcomes in Mexican Americans (MAs) and non-Hispanic whites using data from a population-based study.

Methods—Ischemic strokes (2008–2012) were identified from the Brain Attack Surveillance in Corpus Christi (BASIC) Project. Data were collected from patient or proxy interviews (conducted at baseline and 90 days poststroke) and medical records. Ethnic differences in neurological (National Institutes of Health Stroke Scale: range, 0–44; higher scores worse), functional (activities of daily living/instrumental activities of daily living score: range, 1–4; higher scores worse), and cognitive (Modified Mini-Mental State Examination: range, 0–100; lower scores worse) outcomes were assessed with Tobit or linear regression adjusted for demographics and clinical factors.

Results—A total of 513, 510, and 415 subjects had complete data for neurological, functional, and cognitive outcomes and covariates, respectively. Median age was 66 (interquartile range, 57–78); 64% were MAs. In MAs, median National Institutes of Health Stroke Scale, activities of daily living/instrumental activities of daily living, and Modified Mini-Mental State Examination score were 3 (interquartile range, 1–6), 2.5 (interquartile range, 1.6–3.5), and 88 (interquartile range, 76–94), respectively. MAs scored 48% worse (95% CI, 23%–78%) on National Institutes of Health Stroke Scale, 0.36 points worse (95% CI, 0.16–0.57) on activities of daily living/instrumental activities of daily living score, and 3.39 points worse (95% CI, 0.35–6.43) on Modified Mini-Mental State Examination than non-Hispanic whites after multivariable adjustment.

Conclusions—MAs scored worse than non-Hispanic whites on all outcomes after adjustment for confounding factors; differences were only partially explained by ethnic differences in survival. These findings in combination with the increased stroke risk in MAs suggest that the public health burden of stroke in this growing population is substantial.

Key Words: ethnicity ■ patient outcome assessment ■ stroke

M exican Americans (MAs), the largest subgroup of Hispanic Americans, have an increased stroke risk compared with non-Hispanic whites (NHWs) but experience less case fatality and longer poststroke survival.1–3 The finding of improved survival in MAs may give the false sense that MA stroke is less burdensome than stroke in NHWs, but it is possible that the tradeoff for decreased poststroke mortality is increased poststroke disability. Limited data support the hypothesis that Hispanics have poorer stroke outcomes than NHWs,4-10 but these studies were either not focused on MAs specifically,3,9 were limited to specialized populations,4,6,7,9 or did not include younger ages where the greatest ethnic difference in stroke incidence for MAs occurs.10 The objective of this study was to test whether MAs have poorer stroke outcomes than NHWs after adjustment for confounding factors in a population-based study. Secondarily, we sought to understand the extent to which any observed ethnic differences in stroke outcomes are attributed to ethnic differences in mortality.

Methods

Data are from the Brain Attack Surveillance in Corpus Christi (BASIC) Project, November 2008 through June 2012, for which methods have been published.11-13 Briefly, the BASIC Project is a population-based stroke surveillance study in a biethnic community in south Texas (Nueces County). The population of the County was 340,223 in 2010, with 61% of residents being MAs.14 This is a nonimmigrant population with most MAs being second- and third-generation US-born citizens limiting loss to follow-up because of return migration to Mexico.

Case ascertainment includes active and passive surveillance. Active surveillance involves identification of cases through daily screening of hospital admission logs, medical wards, and intensive care units. Passive surveillance involves identifying cases by searching hospital

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and emergency department discharge diagnoses, using *International Classification of Diseases, Ninth Revision* codes (430–438). All possible strokes underwent validation by a stroke neurologist blinded to race–ethnicity and age using source documentation. Only ischemic stroke cases were included using a standard clinical definition.

### Interview and Data Collection Procedures

Patients with stroke were invited to participate in a structured, in-person baseline interview and outcome interview conducted ≥90 days after stroke. If the patient was unable to complete an interview, a proxy interview was completed. Interviews were conducted in English or Spanish depending on patient preference. Patients who died before the outcome interview were excluded from the primary analysis but included in the secondary analysis which investigated the influence of mortality on ethnic differences in outcome. If an individual had ≥1 event, only the first was included. Patients with race–ethnicity other than MA or NHW were excluded because of small numbers (n=75).

### Ninety-Day Outcome Measures

Neurological deficits were measured by the National Institutes of Health Stroke Scale (NIHSS) administered by a certified study coordinator. Functional outcome was assessed using scales that measure activities of daily living (ADLs) and instrumental activities of daily living (IADLs). The ADL scale measures 7 basic functional abilities (walking, bathing, grooming, eating, dressing, moving, toileting), and the IADL scale includes 15 questions related to daily functioning. Respondents self-reported level of difficulty performing each ADL/IADL task by themselves with responses including 1 (no difficulty), 2 (some difficulty), 3 (a lot of difficulty), and 4 (can only do with help). Responses were summed for each of the 22 ADL/IADL items and divided by the number of items resulting in an average score ranging from 1 to 4, in keeping with the original Likert scale for ease of interpretation. Global cognitive function was assessed using the Modified Mini-mental State Examination (3MSE), with a cut point of 80 used to classify individuals as having dementia. To determine ability to participate in cognitive testing, we administered a series of questions to assess language dysfunction. Patients who failed this screening were excluded from cognitive testing. Mortality was ascertained from the social security death index, Texas Department of Health, and next of kin reports.

### Variables

Confounding factors were ascertained from baseline interviews and medical records. Baseline interview data included race–ethnicity using Census-defined categories, marital status, educational attainment, prestroke function, and prestroke cognitive status. Prestroke function was measured by the modified Rankin scale ascertained by asking a series of structured questions in reference to the prestroke period and categorized as 0 to 1, 2 to 3, and ≥4 (higher scores represent worse function). Prestroke cognitive status was measured using the validated 16-item Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) completed by an informant who knew the patient well and scored as the average of the individual questions resulting in a scale ranging from 1 to 5 (higher scores represent worse cognitive function). Medical record data included age, sex, insurance (yes/no), risk factors (history of stroke/transient ischemic attack [TIA], hypertension, diabetes mellitus, coronary artery disease, atrial fibrillation, high cholesterol, smoking, excessive alcohol), comorbidities (myocardial infarction, cancer, chronic obstructive pulmonary disease, dementia, Alzheimer disease, epilepsy, congestive heart failure, Parkinson disease, end-stage renal disease), body mass index (BMI), initial stroke severity, treatment with tissue-type plasminogen activator (tPA), nursing home residence before stroke, prestroke modified Rankin scale, prestroke IQCODE, initial NIHSS, risk factors, BMI, and the comorbidity index. Functional forms of continuous covariates were checked by testing whether higher order polynomial terms (eg, quadratic) were significant. It was determined that age, IQCODE, and BMI were appropriately modeled using a linear term and that initial NIHSS required a quadratic term.

To investigate the impact of differential mortality on the associations between ethnicity and the outcomes, we re-estimated outcome models using weights such that patients who completed the 90-day interview but had a low probability of being alive at 90 days received higher weight. Weights were constructed as the ratio of the model-predicted probability of remaining alive at 90 days as predicted by the variables included in the fully adjusted outcome models (see list above) divided by the model-predicted probability of remaining alive at 90 days as predicted by these same factors in addition to do not resuscitate status. Weights ranged from 0.27 to 7.1. We constructed 95% bootstrap confidence intervals (CIs) for all regression coefficients.

When the likelihood of missing outcomes depends on the outcome itself (eg, patients with lower cognitive scores could be less likely to complete the outcome interview), using data from only complete cases may produce biased results. We conducted sensitivity analyses by modeling the probability of missing outcome values as dependent on the outcome itself. We assumed that those missing functional outcome data would have 0, 0.14, 0.43, or 0.75 points higher ADL/IADL scores (higher disability) after adjusting for covariates. Similarly, we assumed that those missing cognitive outcome would have 0, 2.6, 7.8, or 15.1 points lower 3MSE scores and that those missing NIHSS would have 0%, 11%, 37%, or 146% higher NIHSS. Zero difference is equivalent to data missing at random. We used multiple imputation to fill in missing values of covariates under the assumption that covariates were missing at random.

All patients provided written informed consent, and the study was approved by the institutional review boards at the University of Michigan and the local hospitals.

### Results

There were 1198 MA and NHW patients with ischemic stroke during the study period, with 842 (70.3%) agreeing to be interviewed. Mortality at 90 days was 14.5% (n=122), resulting in 720 patients eligible for the outcome interview. Of the 720 (461 MAs, 259 NHWs), 57 patients (7.9%) refused participation in the outcome interview and 69 (9/6%) patients (or their proxies) could not be located for the outcome interview (note 3 of the 69 patients completed the NIHSS but then requested a proxy to complete the interview but a proxy could not be located). Twenty-four (3.3%), 25 (3.5%), and 123 (17.1%) patients had missing or incomplete outcome data.

### Statistical Analysis

Descriptive statistics were calculated for all variables by ethnicity, and differences were assessed using χ² and Kruskal–Wallis tests. Linear regression was used to obtain age-adjusted ethnic differences for ADL and IADL subscores and for individual ADLs/IADLs and items of the NIHSS. Tobit regression was used to assess associations between ethnicity and 90-day outcomes using data from participants with complete data. Tobit regression was used to minimize bias that might result because the primary outcomes are constrained by lower and upper bounds. Because of skewness, NIHSS was modeled as natural logarithm of NIHSS plus 1. Because of the lack of normality of the residuals for the NIHSS model (violation of assumptions for Tobit model), we used ordinary linear regression with robust standard errors for this outcome only. Parameter estimates were back transformed to represent the percent difference in NIHSS between ethnic groups. Models were run unadjusted including only ethnicity and then adjusted for prespecified potential confounders including age, sex, education, insurance status, marital status, nursing home residence before stroke, prestroke modified Rankin scale, prestroke IQCODE, initial NIHSS, risk factors, BMI, and the comorbidity index. Functional forms of continuous covariates were checked by testing whether higher order polynomial terms (eg, quadratic) were significant. It was determined that age, IQCODE, and BMI were appropriately modeled using a linear term and that initial NIHSS required a quadratic term.
for neurological, functional, and cognitive outcomes, respectively. Thus, of the 720 eligible, 573 (79.6%), 569 (79.0%), and 471 (65.4%), had data for neurological, functional, and cognitive outcomes, respectively. Because of missing data on covariates, models with complete cases were estimated with sample sizes of 513 (89.5% of 573), 510 (89.6% of 569), and 415 (88.1% of 471) for neurological, functional, and cognitive outcomes, respectively. Twenty percent of baseline and 21% of outcome interviews were collected from a proxy.

Table 1 displays baseline characteristics by ethnicity for patients with neurological outcome data (n=573). MAs were younger, had lower educational attainment, were less likely to be treated with tPA, to be a former/current smoker, and to have atrial fibrillation than NHWs. MAs were more likely to have diabetes mellitus, hypertension, and higher BMI than NHWs. Patients with neurological outcome data were more likely to be MA, younger, have a higher BMI, and have a lower initial NIHSS, and less likely to have a history of stroke/TIA than patients who survived to 90 days but were not included in this analysis (Table I in the online-only Data Supplement).

Neurological Outcome
Twenty percent of eligible MAs (n=416) and 21% of eligible NHWs (n=259) did not have an NIHSS at 90 days. Median NIHSS was 3 (interquartile range [IQR], 1–6) in MAs and 2 (IQR, 0–4) in NHWs. MAs on average scored higher (worse) on all NIHSS elements with the exception of extinction/inattention (Table II in the online-only Data Supplement). A significant age-adjusted ethnic difference was noted for level of consciousness items, visual, motor, language, and dysarthria.

Among those with complete data (n=513), in unadjusted analysis MAs had a 42% (CI, 18%–71%) higher NIHSS than NHWs. The ethnic difference persisted and became stronger after multivariable adjustment (48%; CI, 23%–78%; Table 2). Prestroke cognitive status, initial NIHSS, and history of stroke/TIA were associated with worse NIHSS at 90 days, whereas tPA treatment was associated with lower NIHSS at 90 days. Prestroke cognitive status (IQCODE) demonstrated a borderline significant association with NIHSS at 90 days.

Table 1. Baseline Characteristics by Ethnicity (n=573)

<table>
<thead>
<tr>
<th></th>
<th>White (n=204)</th>
<th>MA (n=369)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>71.5 (60–80.5)</td>
<td>65 (56–77)</td>
</tr>
<tr>
<td>Female</td>
<td>107 (52.5)</td>
<td>195 (52.8)</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married/living together</td>
<td>107 (52.5)</td>
<td>185 (50.1)</td>
</tr>
<tr>
<td>Single</td>
<td>9 (4.4)</td>
<td>27 (7.3)</td>
</tr>
<tr>
<td>Widow</td>
<td>49 (24.0)</td>
<td>91 (24.7)</td>
</tr>
<tr>
<td>Divorced/separated</td>
<td>39 (19.1)</td>
<td>66 (17.9)</td>
</tr>
<tr>
<td>Education*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than high school</td>
<td>26 (12.7)</td>
<td>184 (50.0)</td>
</tr>
<tr>
<td>High school</td>
<td>65 (31.9)</td>
<td>99 (26.9)</td>
</tr>
<tr>
<td>Vocational/some college</td>
<td>61 (29.9)</td>
<td>50 (13.6)</td>
</tr>
<tr>
<td>College or more</td>
<td>52 (25.5)</td>
<td>35 (9.5)</td>
</tr>
<tr>
<td>Insured</td>
<td>189 (92.6)</td>
<td>323 (87.5)</td>
</tr>
<tr>
<td>Nursing home residence</td>
<td>6 (4)</td>
<td>2.0 (15)</td>
</tr>
<tr>
<td>BMI*</td>
<td>26.6 (24.2–31.6)</td>
<td>29.2 (25.8–33.8)</td>
</tr>
</tbody>
</table>

Cognitive Outcome
Of the subjects eligible for the cognitive testing (n=575), 104 subjects failed the language screening (MAs, n=78; NHWs, n=26). In total, 37% of eligible MAs (n=461) and 31% of eligible NHWs (n=259) did not have cognitive outcome data at 90 days. Among those without significant language dysfunction, median 3MSE score was 88 (IQR, 76–94) in MAs and 92 (IQR, 79–96) in NHWs. Thirty-one percent of MAs had poststroke dementia compared with 25% of NHWs. Among those with complete data (n=415), MAs had on average 1.9 (CI, −1.05 to 4.98) points lower (worse) 3MSE scores compared with NHWs in the unadjusted analysis. After multivariable adjustment
The Brain Attack Surveillance in Corpus Christi (BASIC) Project (November 2008–June 2012). Estimates given were derived as the regression coefficients from the models (3MSE and activities of daily living/instrumental activities of daily living score) and back transformed coefficient for NIHSS. For continuous predictors, estimated association represents difference in outcome associated with 1 interquartile range (IQR) change in predictor (1 IQR: 0.44 for IQCODE, 3 for comorbidity index, 6 for initial NIHSS, 8.1 for BMI, 21 for age). BMI indicates body mass index; CI, confidence interval; IQCODE, Informant Questionnaire for Cognitive Decline in the Elderly; MA, Mexican American; mRS, modified Rankin scale; NHW, non-Hispanic white; NIHSS, National Institute for Health Stroke Scale; TIA, transient ischemic attack; and tPA, tissue-type plasminogen activator.

Table 2. Results of Multivariable Models of the Association of Ethnicity and 90-Day Poststroke Neurological, Functional, and Cognitive Outcomes

<table>
<thead>
<tr>
<th></th>
<th>NIHSS (n=513)</th>
<th>Functional Outcome (n=510)</th>
<th>Cognitive Outcome (n=415)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate (95% CI)</td>
<td>Estimate (95% CI)</td>
<td>Estimate (95% CI)</td>
</tr>
<tr>
<td>MA (vs NHW)</td>
<td>48% (23% to 78%)</td>
<td>0.36 (0.16 to 0.57)</td>
<td>−3.39 (−6.43 to −0.35)</td>
</tr>
<tr>
<td>Age, y</td>
<td>14% (−4% to 35%)</td>
<td>0.37 (0.19 to 0.56)</td>
<td>−7.29 (−10.07 to −4.50)</td>
</tr>
<tr>
<td>Female (vs male)</td>
<td>0% (−15% to 18%)</td>
<td>0.27 (0.09 to 0.45)</td>
<td>0.88 (−1.75 to 3.51)</td>
</tr>
<tr>
<td>Single (vs married)</td>
<td>22% (−13% to 71%)</td>
<td>0.30 (−0.09 to 0.69)</td>
<td>−1.38 (−7.09 to 4.33)</td>
</tr>
<tr>
<td>Widowed (vs married)</td>
<td>−6% (−23% to 15%)</td>
<td>−0.08 (−0.30 to 0.15)</td>
<td>1.00 (−2.49 to 4.49)</td>
</tr>
<tr>
<td>Divorced/separated (vs married)</td>
<td>6% (−14% to 31%)</td>
<td>−0.06 (−0.30 to 0.17)</td>
<td>−0.10 (−3.45 to 3.25)</td>
</tr>
<tr>
<td>High school education (vs no high school)</td>
<td>−1% (−18% to 21%)</td>
<td>−0.15 (−0.36 to 0.07)</td>
<td>8.33 (5.13 to 11.53)</td>
</tr>
<tr>
<td>Vocational/some college (vs no high school)</td>
<td>−9% (−27% to 14%)</td>
<td>0.00 (−0.25 to 0.25)</td>
<td>7.49 (3.86 to 11.12)</td>
</tr>
<tr>
<td>College or more (vs no high school)</td>
<td>−14% (−32% to 9%)</td>
<td>−0.40 (−0.67 to −0.14)</td>
<td>12.36 (8.41 to 16.30)</td>
</tr>
<tr>
<td>Insured</td>
<td>13% (−14% to 48%)</td>
<td>−0.02 (−0.31 to 0.28)</td>
<td>−0.76 (−4.90 to 3.39)</td>
</tr>
<tr>
<td>Nursing home residence</td>
<td>26% (−19% to 95%)</td>
<td>0.43 (−0.10 to 0.95)</td>
<td>−16.67 (−29.27 to −4.07)</td>
</tr>
<tr>
<td>mRS 2–3 (vs 0–1)</td>
<td>7% (−9% to 25%)</td>
<td>0.18 (0.00 to 0.36)</td>
<td>−1.51 (−4.07 to 1.05)</td>
</tr>
<tr>
<td>mRS 4–5 (vs 0–1)</td>
<td>73% (29% to 134%)</td>
<td>0.63 (0.30 to 0.96)</td>
<td>−2.69 (−9.13 to 3.75)</td>
</tr>
<tr>
<td>IQCODE</td>
<td>7% (0% to 15%)</td>
<td>0.09 (0.01 to 0.17)</td>
<td>−2.68 (−4.02 to −1.35)</td>
</tr>
<tr>
<td>Comorbidity index</td>
<td>13% (−11% to 44%)</td>
<td>0.41 (0.14 to 0.67)</td>
<td>−4.60 (−8.55 to −0.65)</td>
</tr>
<tr>
<td>NIHSS</td>
<td>67% (46% to 92%)</td>
<td>0.57 (0.42 to 0.72)</td>
<td>−5.28 (−7.66 to −2.91)</td>
</tr>
<tr>
<td>NIHSS squared</td>
<td>−1% (−2% to 0%)</td>
<td>−0.01 (−0.02 to 0.00)</td>
<td>0.07 (−0.04 to 0.19)</td>
</tr>
<tr>
<td>BMI</td>
<td>−9% (−17% to 1%)</td>
<td>−0.01 (−0.11 to 0.10)</td>
<td>0.39 (−1.18 to 1.97)</td>
</tr>
<tr>
<td>History of stroke/TIA</td>
<td>20% (0% to 45%)</td>
<td>0.23 (0.02 to 0.43)</td>
<td>−1.15 (−4.25 to 1.95)</td>
</tr>
<tr>
<td>Treated with tPA</td>
<td>−25% (−43% to −3%)</td>
<td>−0.40 (−0.69 to −0.11)</td>
<td>5.67 (1.12 to 10.23)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>−9% (−24% to 10%)</td>
<td>−0.04 (−0.25 to 0.17)</td>
<td>1.97 (−1.10 to 5.05)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>6% (−16% to 34%)</td>
<td>−0.08 (−0.33 to 0.18)</td>
<td>0.67 (−3.04 to 4.38)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>−1% (−19% to 21%)</td>
<td>−0.09 (−0.31 to 0.13)</td>
<td>4.33 (0.94 to 7.72)</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>1% (−21% to 23%)</td>
<td>0.04 (−0.24 to 0.31)</td>
<td>1.79 (−2.47 to 6.05)</td>
</tr>
<tr>
<td>Current/former smoker</td>
<td>−1% (−18% to 20%)</td>
<td>−0.05 (−0.26 to 0.16)</td>
<td>0.39 (−2.72 to 3.50)</td>
</tr>
</tbody>
</table>

Discussion

MA stroke survivors may experience mild neurological and cognitive impairment, but one third of MA stroke survivors were classified as having dementia, and MAs experienced more aphasia than NHWs. Levels of functional impairment were more substantial. MAs had increased stroke risk but lower case fatality and longer poststroke survival compared with NHWs. Our current results suggest that prolonged survival is at the expense of poor outcomes because MA stroke survivors experienced poorer neurological and cognitive outcomes than NHWs even after adjustment for a comprehensive list of factors. Differential mortality by ethnicity explained some but not all of the observed ethnic differences in outcomes, suggesting that research on the causes of poorer outcomes in MAs compared with that of NHWs is warranted.

The results of this study provide information on the prognosis of MA stroke survivors. On average at 90 days poststroke, MAs experience mild neurological and cognitive impairment, but one third of MA stroke survivors were classified as having dementia, and MAs experienced more aphasia than NHWs. Levels of functional impairment were more substantial. MAs reported greater difficulty than NHWs with all ADLs and IADLs. Averages for several IADL items were close to or

(Table 2), the ethnic association became stronger and was statistically significant with MAs having on average 3.39 points lower 3MSE scores (CI, 0.35–6.43). Age, nursing home residence before stroke, prestroke cognitive status (IQCODE), comorbidity index, and initial NIHSS scores were associated with worse 3MSE scores, whereas increasing education, tPA treatment, and coronary artery disease were associated with better 3MSE scores.

After re-estimating the outcome models using weights to account for differential poststroke mortality by ethnicity, ethnic differences in all outcomes were attenuated but statistically significant. MAs had a 39% (CI, 30%–48%) higher NIHSS, 0.22 (CI, 0.15–0.30) higher ADL/IADL score, and 2.61 (CI, 1.44–3.44) points lower 3MSE scores compared with NHWs after accounting for mortality differences.

Ethnic differences were slightly attenuated after accounting for the possibility of bias because of missing data, but remained statistically significant across various assumed strengths of the association between the missing values for the outcomes and the likelihood of missing values (Figure).
Our results build on these studies by providing data 
poorer functional and cognitive outcomes than NHWs after 
limited number of studies have reported that Hispanics have 
several years younger on average. Comparability of our results 
from Framingham, potentially caused by our NHWs being 
lower (ie, better function) than those reported in stroke survi-
ors from Framingham, possibly caused by our NHWs being 
dependence in specific ADLs for NHWs are similar but slightly 
lower (ie, better function) than those reported in elderly MAs with self-reported 
stroke in the Hispanic Established Populations for the 
Epidemiologic Study of the Elderly (EPESE), possibly attrib-
utable to the younger average age of our MA population. 
A limited number of studies have reported that Hispanics have 
poorer functional and cognitive outcomes than NHWs after 
stroke. Our results build on these studies by providing data 
on outcomes from a population-based stroke study specifically 
focused on MAs, the largest and fastest growing subgroup of 
Hispanic Americans in the United States.

Although many studies have measured stroke outcomes in 
NHWs, comparisons with our results are challenging attribut-
able to the differing study populations, time frames for out-
come assessments, and measures used. Our results regarding 
dependence in specific ADLs for NHWs are similar but slightly 
lower (ie, better function) than those reported in stroke survi-
ors from Framingham, potentially caused by our NHWs being 
several years younger on average. Comparability of our results 
for NHWs to those in Framingham suggests that our findings 
regarding ethnic differences are not likely attributable to more 
favorable outcomes in our particular population of NHWs.

Given the rapidly growing MA population, increased stroke 
risk in this population in combination with prolonged survival 
and increased disability will result in an escalating number of 
MA stroke survivors requiring assistance. Studies have shown 
that MAs are less likely to be admitted to a nursing home, sug-
gest that informal care may be particularly important in this 
group; however, there are virtually no data available on the 
informal stroke caregiving experience of MAs. This topic 
should be a target of future research to understand the impact 
of informal stroke caregiving on both caregivers and patients.

Strengths of this study include the population-based design, 
the nonimmigrant population limiting return migration, 
comprehensive outcome ascertainment, thorough adjustment 
for confounding factors, and sensitivity analysis to understand 
the impact of potential selection bias. There are some limi-
tations that warrant discussion. We did not have data on the 
psychosocial impacts of stroke, such as depression, or on post-
stroke rehabilitation, both of which may impact outcomes and 
differ by ethnicity. These factors are important targets for 
future research. We did not have data on ischemic stroke 
subtype, although we have previously demonstrated no eth-
nic differences in stroke subtype in this community suggest-
ging this factor does not explain ethnic differences. As in any 
prospective observational study, there was some loss to follow-
up and there were differences noted between patients included 
in our primary analysis and those who were not included with 
respect to age, ethnicity, history of stroke/TIA, initial stroke 
severity, and BMI. Importantly, we included these factors in 
our multivariable models, and our sensitivity analysis demon-
strated that our results regarding ethnic differences were robust 
to missing data. Our outcome measures were broad measures 
of neurological, functional, and cognitive outcomes chosen 
for their validity and previous use in MAs or Hispanics. Given 
our findings of ethnic differences in these broad measures, 
future research should aim to unravel the more subtle differ-
ences that might be behind these disparities. Our measure of 
functional outcome was self-reported, and thus measurement 
error is possible. It is possible that our observed ethnic dif-
fERENCE in cognitive outcome was attributable to potential 
cultural bias in the test or noncognitive factors. Educational 
attainment is a potent cognitive confounder but was included 
in our multivariable model. Our data on risk factors were col-
lected from medical records only versus objective measure-
ments which may have resulted in residual confounding by 
these factors. However, we have previously demonstrated that 
access to medical care in this community is high in both ethnic 
groups, suggesting that there are not large differences in the 
likelihood of diagnosis, although there may be differences in 
risk factor control that we did not account for in our analysis. 
Finally, the study is focused on 1 community in south Texas 
where the majority of MAs are second- and third-generation 

---

**Figure.** Ethnic differences (Mexican American vs non-Hispanic White) in (A) National Institute for Health Stroke Scale, (B) activities of daily living/instrumental activities of daily living score, and (C) Modified Mini-Mental State Examination score across a range of assumed missing data mechanisms (x axis: complete case [CC], missing at random [MAR], and 3 assumed values of the difference in scores that those missing would have after adjusting for covariates).

>3 indicating many MAs have difficulty doing these tasks on 
their own. These findings are of particular importance given 
that increasing ADL/IADL scores are highly predictive of 
nursing home admission and the need for informal care.

Our findings for MAs regarding dependence in specific 
ADLs/IADLs are similar but somewhat lower (ie, better func-
tion) than those reported for elderly MAs with self-reported 
stroke in the Hispanic Established Populations for the 
Epidemiologic Study of the Elderly (EPESE), possibly attrib-
utable to the younger average age of our MA population. 
A limited number of studies have reported that Hispanics have 
poorer functional and cognitive outcomes than NHWs after 
stroke. Our results build on these studies by providing data 
on outcomes from a population-based stroke study specifically 
focused on MAs, the largest and fastest growing subgroup of 
Hispanic Americans in the United States.

Although many studies have measured stroke outcomes in 
NHWs, comparisons with our results are challenging attribut-
able to the differing study populations, time frames for out-
come assessments, and measures used. Our results regarding 
dependence in specific ADLs for NHWs are similar but slightly 
lower (ie, better function) than those reported in stroke survi-
ors from Framingham, potentially caused by our NHWs being 
several years younger on average. Comparability of our results 
for NHWs to those in Framingham suggests that our findings 
regarding ethnic differences are not likely attributable to more 
favorable outcomes in our particular population of NHWs.

Given the rapidly growing MA population, increased stroke 
risk in this population in combination with prolonged survival 
and increased disability will result in an escalating number of 
MA stroke survivors requiring assistance. Studies have shown 
that MAs are less likely to be admitted to a nursing home, sug-
gest that informal care may be particularly important in this 
group; however, there are virtually no data available on the 
informal stroke caregiving experience of MAs. This topic 
should be a target of future research to understand the impact 
of informal stroke caregiving on both caregivers and patients.

Strengths of this study include the population-based design, 
the nonimmigrant population limiting return migration, 
comprehensive outcome ascertainment, thorough adjustment 
for confounding factors, and sensitivity analysis to understand 
the impact of potential selection bias. There are some limi-
tations that warrant discussion. We did not have data on the 
psychosocial impacts of stroke, such as depression, or on post-
stroke rehabilitation, both of which may impact outcomes and 
differ by ethnicity. These factors are important targets for 
future research. We did not have data on ischemic stroke 
subtype, although we have previously demonstrated no eth-
nic differences in stroke subtype in this community suggest-
ging this factor does not explain ethnic differences. As in any 
prospective observational study, there was some loss to follow-
up and there were differences noted between patients included 
in our primary analysis and those who were not included with 
respect to age, ethnicity, history of stroke/TIA, initial stroke 
severity, and BMI. Importantly, we included these factors in 
our multivariable models, and our sensitivity analysis demon-
strated that our results regarding ethnic differences were robust 
to missing data. Our outcome measures were broad measures 
of neurological, functional, and cognitive outcomes chosen 
for their validity and previous use in MAs or Hispanics. Given 
our findings of ethnic differences in these broad measures, 
future research should aim to unravel the more subtle differ-
ences that might be behind these disparities. Our measure of 
functional outcome was self-reported, and thus measurement 
error is possible. It is possible that our observed ethnic dif-
fERENCE in cognitive outcome was attributable to potential 
cultural bias in the test or noncognitive factors. Educational 
attainment is a potent cognitive confounder but was included 
in our multivariable model. Our data on risk factors were col-
lected from medical records only versus objective measure-
ments which may have resulted in residual confounding by 
these factors. However, we have previously demonstrated that 
access to medical care in this community is high in both ethnic 
groups, suggesting that there are not large differences in the 
likelihood of diagnosis, although there may be differences in 
risk factor control that we did not account for in our analysis. 
Finally, the study is focused on 1 community in south Texas 
where the majority of MAs are second- and third-generation 

---

**Figure.** Ethnic differences (Mexican American vs non-Hispanic White) in (A) National Institute for Health Stroke Scale, (B) activities of daily living/instrumental activities of daily living score, and (C) Modified Mini-Mental State Examination score across a range of assumed missing data mechanisms (x axis: complete case [CC], missing at random [MAR], and 3 assumed values of the difference in scores that those missing would have after adjusting for covariates).

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should be a target of future research to understand the impact 
of informal stroke caregiving on both caregivers and patients.

Strengths of this study include the population-based design, 
the nonimmigrant population limiting return migration,
citizens, and therefore, results may not be generalizable to other populations or to immigrant MAs.

Conclusions
MA patients with stroke experienced moderate functional disability and nearly one third had poststroke dementia. In addition, MA patients with stroke experienced worse neurological, functional, and cognitive outcomes at 90 days than NHWs. Increased stroke risk, prolonged poststroke survival, and increased poststroke disability suggest that the future public health burden of stroke in the growing and aging MA population will be staggering.

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Disclosures
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References
Neurological, Functional, and Cognitive Stroke Outcomes in Mexican Americans
Lynda D. Lisabeth, Brisa N. Sánchez, Jonggyu Baek, Lesli E. Skolarus, Melinda A. Smith, Nelda Garcia, Devin L. Brown and Lewis B. Morgenstern

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Supplemental Table I. Baseline Characteristics Comparing Those with Neurologic Outcome Data to Ninety-day Survivors Not Included in the Primary Analysis.

<table>
<thead>
<tr>
<th></th>
<th>Observed* (N=573)</th>
<th></th>
<th>Missing** (N=455)</th>
<th></th>
<th>p-value†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N or Median</td>
<td>% or (%Q1, Q3)</td>
<td>N or Median</td>
<td>% or (%Q1, Q3)</td>
<td></td>
</tr>
<tr>
<td>MA</td>
<td>369</td>
<td>64.4</td>
<td>250</td>
<td>54.9</td>
<td>0.002</td>
</tr>
<tr>
<td>Age</td>
<td>67</td>
<td>(57, 78)</td>
<td>70</td>
<td>(59, 81)</td>
<td>0.003</td>
</tr>
<tr>
<td>Female</td>
<td>302</td>
<td>52.7</td>
<td>227</td>
<td>49.9</td>
<td>0.370</td>
</tr>
<tr>
<td>Insured</td>
<td>512</td>
<td>89.4</td>
<td>400</td>
<td>87.9</td>
<td>0.468</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>79</td>
<td>13.8</td>
<td>70</td>
<td>15.4</td>
<td>0.461</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>172</td>
<td>30.0</td>
<td>137</td>
<td>30.2</td>
<td>0.956</td>
</tr>
<tr>
<td>Diabetes</td>
<td>264</td>
<td>46.1</td>
<td>214</td>
<td>47.2</td>
<td>0.710</td>
</tr>
<tr>
<td>Hypertension</td>
<td>466</td>
<td>81.3</td>
<td>376</td>
<td>82.8</td>
<td>0.536</td>
</tr>
<tr>
<td>History of stroke or TIA</td>
<td>171</td>
<td>29.8</td>
<td>174</td>
<td>38.2</td>
<td>0.005</td>
</tr>
<tr>
<td>Current/former smoker</td>
<td>202</td>
<td>35.3</td>
<td>174</td>
<td>38.4</td>
<td>0.297</td>
</tr>
<tr>
<td>Initial NIHSS‡</td>
<td>4</td>
<td>(2, 8)</td>
<td>4</td>
<td>(2, 8)</td>
<td>0.047</td>
</tr>
<tr>
<td>Comorbidity index</td>
<td>3</td>
<td>(2, 5)</td>
<td>4</td>
<td>(2, 5)</td>
<td>0.075</td>
</tr>
<tr>
<td>BMI</td>
<td>28.4</td>
<td>(24.9, 33.2)</td>
<td>26.6</td>
<td>(23.1, 31.9)</td>
<td>0.000</td>
</tr>
</tbody>
</table>

MA = Mexican American, TI = transient ischemic attack, NIHSS = National Institutes of Health Stroke Scale, BMI = body mass index

* Includes patients with baseline interviews and with observed neurological outcome.
** Includes patients with baseline interviews but missing neurologic outcome and patients who were never interviewed.
† Chi-square test for categorical variable and Kruskal-wallis non-parametric test for continuous variables.
‡ Mean(SD) = 5.9(6.29) for Observed and 6.8(7.1) for Missing.
Supplemental Table II. Ninety-day Post-stroke Neurologic Outcomes by Ethnicity.

<table>
<thead>
<tr>
<th>NIHSS items(range)</th>
<th>MA (N=369)</th>
<th>NHW (N=204)</th>
<th>B* (SE)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level Of Consciousness (0-3)</td>
<td>0.06 (0.33)</td>
<td>0.01 (0.10)</td>
<td>0.05 (0.02)</td>
<td>0.0228</td>
</tr>
<tr>
<td>LOC Questions (0-2)</td>
<td>0.41 (0.74)</td>
<td>0.30 (0.64)</td>
<td>0.19 (0.06)</td>
<td>0.0013</td>
</tr>
<tr>
<td>LOC Commands (0-2)</td>
<td>0.12 (0.45)</td>
<td>0.02 (0.21)</td>
<td>0.12 (0.03)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Best Gaze (0-2)</td>
<td>0.06 (0.30)</td>
<td>0.04 (0.27)</td>
<td>0.03 (0.03)</td>
<td>0.2961</td>
</tr>
<tr>
<td>Visual (0-3)</td>
<td>0.38 (0.75)</td>
<td>0.23 (0.57)</td>
<td>0.16 (0.06)</td>
<td>0.0091</td>
</tr>
<tr>
<td>Facial Palsy (0-3)</td>
<td>0.47 (0.66)</td>
<td>0.39 (0.59)</td>
<td>0.10 (0.06)</td>
<td>0.0910</td>
</tr>
<tr>
<td>Motor items (0-16)</td>
<td>1.88 (3.25)</td>
<td>1.19 (2.43)</td>
<td>0.87 (0.26)</td>
<td>0.0008</td>
</tr>
<tr>
<td>Limb Ataxia (0-2)</td>
<td>0.10 (0.34)</td>
<td>0.05 (0.27)</td>
<td>0.04 (0.03)</td>
<td>0.1096</td>
</tr>
<tr>
<td>Sensory(0-2)</td>
<td>0.43 (0.68)</td>
<td>0.31 (0.60)</td>
<td>0.11 (0.06)</td>
<td>0.0615</td>
</tr>
<tr>
<td>Best Language (0-3)</td>
<td>0.44 (0.90)</td>
<td>0.25 (0.63)</td>
<td>0.26 (0.07)</td>
<td>0.0002</td>
</tr>
<tr>
<td>Dysarthria (0-2)</td>
<td>0.55 (0.72)</td>
<td>0.39 (0.62)</td>
<td>0.21 (0.06)</td>
<td>0.0003</td>
</tr>
<tr>
<td>Extinction And Inattention (0-2)</td>
<td>0.04 (0.23)</td>
<td>0.06 (0.29)</td>
<td>-0.01 (0.02)</td>
<td>0.7889</td>
</tr>
</tbody>
</table>

MA = Mexican American, NHW = non-Hispanic white, NIHSS = National Institutes of Health Stroke Scale, SD = standard deviation, SE = standard error, LOC = level of consciousness
*Represents mean difference between MAs and NHWs
Supplemental Table III. Ninety-day Post-stroke Functional Outcomes by Ethnicity.

<table>
<thead>
<tr>
<th>ADL and IADL items (range:1-4)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MA (N=370)</td>
<td></td>
<td>NHW (N=199)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>% Reporting</td>
<td></td>
<td>% Reporting</td>
<td></td>
<td>b* (SE)</td>
<td>p-value</td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td></td>
<td>Mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADL and IADL items (range:1-4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average ADL</td>
<td>2.11 (1.13)</td>
<td>.</td>
<td>1.81 (1.00)</td>
<td>.</td>
<td>0.41 (0.09)</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Walking Across Room</td>
<td>2.26 (1.34)</td>
<td>22.14</td>
<td>2.03 (1.25)</td>
<td>8.61</td>
<td>0.38 (0.11)</td>
<td>0.001</td>
</tr>
<tr>
<td>Bathing</td>
<td>2.43 (1.38)</td>
<td>26.89</td>
<td>2.10 (1.32)</td>
<td>10.54</td>
<td>0.48 (0.11)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Brushing</td>
<td>1.76 (1.17)</td>
<td>11.78</td>
<td>1.58 (1.05)</td>
<td>4.75</td>
<td>0.30 (0.10)</td>
<td>0.002</td>
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<tr>
<td>Eating</td>
<td>1.91 (1.23)</td>
<td>14.76</td>
<td>1.56 (0.98)</td>
<td>3.87</td>
<td>0.43 (0.10)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Dressing</td>
<td>2.30 (1.33)</td>
<td>22.32</td>
<td>1.94 (1.20)</td>
<td>7.56</td>
<td>0.47 (0.11)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Moving</td>
<td>2.06 (1.31)</td>
<td>18.63</td>
<td>1.75 (1.18)</td>
<td>6.85</td>
<td>0.44 (0.11)</td>
<td>&lt;0.0001</td>
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<tr>
<td>Using Toilet</td>
<td>2.01 (1.31)</td>
<td>18.10</td>
<td>1.75 (1.25)</td>
<td>7.91</td>
<td>0.41 (0.11)</td>
<td>0.000</td>
</tr>
<tr>
<td>Average IADL</td>
<td>2.71 (1.06)</td>
<td>.</td>
<td>2.41 (1.05)</td>
<td>.</td>
<td>0.42 (0.09)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Pulling/Pushing</td>
<td>2.89 (1.29)</td>
<td>34.62</td>
<td>2.68 (1.28)</td>
<td>15.29</td>
<td>0.30 (0.11)</td>
<td>0.006</td>
</tr>
<tr>
<td>Stooping</td>
<td>2.96 (1.20)</td>
<td>33.57</td>
<td>2.73 (1.25)</td>
<td>15.64</td>
<td>0.32 (0.10)</td>
<td>0.002</td>
</tr>
<tr>
<td>Lifting</td>
<td>2.91 (1.29)</td>
<td>34.80</td>
<td>2.61 (1.31)</td>
<td>14.76</td>
<td>0.39 (0.11)</td>
<td>0.001</td>
</tr>
<tr>
<td>Activity</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>p-value</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>-----------</td>
<td>---------</td>
</tr>
<tr>
<td>Reaching</td>
<td>2.37 (1.33)</td>
<td>23.20</td>
<td>1.95 (1.20)</td>
<td>7.38</td>
<td>0.50 (0.11)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Getting Up From Stooping</td>
<td>3.15 (1.16)</td>
<td>39.37</td>
<td>2.94 (1.20)</td>
<td>18.45</td>
<td>0.30 (0.10)</td>
<td>0.004</td>
</tr>
<tr>
<td>Standing Up After Sitting</td>
<td>2.31 (1.24)</td>
<td>19.16</td>
<td>2.00 (1.18)</td>
<td>7.38</td>
<td>0.44 (0.10)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Walking Up One Stair</td>
<td>2.96 (1.26)</td>
<td>36.03</td>
<td>2.55 (1.35)</td>
<td>14.59</td>
<td>0.54 (0.11)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Writing or Handling Small Objects</td>
<td>2.22 (1.27)</td>
<td>18.80</td>
<td>1.83 (1.13)</td>
<td>5.62</td>
<td>0.50 (0.10)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Walking Quarter Mile</td>
<td>3.00 (1.27)</td>
<td>37.79</td>
<td>2.74 (1.36)</td>
<td>17.57</td>
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<td>0.001</td>
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<tr>
<td>Walking Up 10 Steps</td>
<td>2.87 (1.33)</td>
<td>36.03</td>
<td>2.58 (1.38)</td>
<td>15.82</td>
<td>0.41 (0.11)</td>
<td>0.000</td>
</tr>
<tr>
<td>Using Telephone</td>
<td>1.89 (1.26)</td>
<td>15.29</td>
<td>1.69 (1.15)</td>
<td>5.98</td>
<td>0.33 (0.10)</td>
<td>0.001</td>
</tr>
<tr>
<td>Managing Money</td>
<td>2.49 (1.43)</td>
<td>29.70</td>
<td>2.13 (1.39)</td>
<td>11.60</td>
<td>0.51 (0.12)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Doing All Cooking</td>
<td>2.71 (1.39)</td>
<td>33.22</td>
<td>2.42 (1.44)</td>
<td>15.29</td>
<td>0.42 (0.12)</td>
<td>0.001</td>
</tr>
<tr>
<td>Doing Heavy Housework</td>
<td>3.09 (1.27)</td>
<td>40.77</td>
<td>2.73 (1.38)</td>
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<td>0.47 (0.11)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Doing All Shopping</td>
<td>2.90 (1.35)</td>
<td>37.43</td>
<td>2.56 (1.41)</td>
<td>16.17</td>
<td>0.47 (0.12)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

MA = Mexican American, NHW = non-Hispanic white, ADL = Activities of Daily Living, IADL = Instrumental Activities of Daily Living
* Represents mean difference between MAs and NHWs