DR LYNDA LISABETH (Orcid ID : 0000-0001-5539-5933)

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Research: Complications

Diabetes and ischaemic stroke outcome

E. L. MacDougal[1], W. H. Herman[1,2], J. J. Wing[1], L. B. Morgenstern[1,3] and L. D Lisabeth[1,3]

Departments of [1]Epidemiology and [2]Internal Medicine, University of Michigan, and [3]Stroke Programme, University of Michigan, Ann Arbor, MI, USA

Correspondence to: Lynda Lisabeth. E-mail: llisabet@umich.edu.

What's new?

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- Although diabetes is an established risk factor for incident ischaemic stroke, its role in stroke outcomes remains uncertain, with inconsistent findings across studies and limited data from diverse, population-based studies.
- In our ethnically diverse population-based study, we found that diabetes was associated with higher stroke mortality and worse functional outcome but not with stroke recurrence.
- Results suggest that interventions are needed to decrease the adverse stroke outcomes associated with diabetes, particularly in Mexican-American people who experience a high prevalence of diabetes.

Abstract

Aim To compare all-cause mortality, stroke recurrence and functional outcomes in people who have experienced stroke, with and without diabetes.

Methods We captured data on population-based ischaemic strokes (2006–2012) in Nueces County, Texas. Data were collected from participant interviews and medical records. Differences in cumulative mortality and stroke recurrence risk by diabetes status were estimated at 30 days and 1 year using Cox models. Differences in 90-day functional outcomes (activities of daily living/instrumental activities of daily living score: range 1–4; higher scores worse) by diabetes status were assessed using Tobit regression. Effect modification by ethnicity was examined.

Results There were 1301 ischaemic strokes, 46% with history of known diabetes. The median (interquartile range) age was 70 (58–81) years and 61% were Mexican American. People with diabetes were younger and more likely to be Mexican American compared with those without diabetes. After adjustment, diabetes predicted mortality (30-day hazard ratio 1.44, 95% CI 0.97–2.12; 1-year hazard ratio 1.47, 95% CI 1.09–1.97) but not stroke recurrence (1-year hazard ratio 1.27, 95% CI 0.78–2.07). People with diabetes had a worse functional outcome score that was explained by cardiovascular risk factors and pre-stroke factors. Diabetes was not associated with functional outcome in the fully adjusted model (final adjusted activities of daily living/instrumental activities of daily living score difference 0.11, 95% CI –0.07 to 0.30). Effect modification by ethnicity was not significant (P>0.3 for all models).

Conclusions Diabetes was associated with higher mortality and worse functional outcome but not stroke recurrence. Interventions are needed to decrease the adverse outcomes associated with diabetes, particularly in Mexican-American people.

Introduction

Stroke is a major cause of disability in the USA [1]. A dramatic increase in the prevalence and cost of stroke is predicted to occur over the next few decades as the population ages [2]. Reducing the stroke burden in the USA will demand not only better control of risk factors and prevention, but also more effective interventions to improve outcomes following stroke.

Although diabetes is a well-established risk factor for incident ischaemic stroke [3], results regarding its role in stroke outcomes have been inconsistent. Some reasons for discrepant results between studies include differences in study populations, length of follow-up, selection of covariates to account for possible confounding, and methods for ascertaining diabetes and stroke outcome status. Because the prevalence of diabetes is expected to increase dramatically over the next few decades, it is important to evaluate comprehensively the effect of diabetes on multiple stroke outcomes, preferably in population-based studies, which have been limited to date [4].

Mortality has been extensively studied as a stroke outcome, but a number of studies have considered only the crude association between diabetes and mortality, which limits the interpretability of the estimates. Among studies that have adjusted for confounders, some but not all population-based studies have found diabetes to be a significant predictor of 30-day [5–7] and 1-year mortality [6–10]. Understanding predictors of stroke mortality remains important, but the declining stroke mortality in the USA [1] suggests a need for a broader focus on improving patient-centred outcomes among stroke survivors, such as stroke recurrence and functional outcomes.

Fewer studies have assessed the effect of diabetes on stroke recurrence. Because the rate of stroke recurrence is low, lack of power is a significant limitation for estimating the effect of diabetes on stroke recurrence in individual studies. A 2015 meta-analysis of 14 studies found a significantly increased hazard ratio of 1.44 (95% CI 1.28, 1.61) for the effect of diabetes on stroke recurrence after ischaemic stroke [11]; however, the majority of the studies in this meta-

analysis were older, including studies conducted in the 1980s and 1990s, and many were focused on very select populations. Further, the meta-analysis included results from only one population-based study, which considered a combined ischaemic and haemorrhagic stroke population identified for the period 1995 to 2008. Thus, contemporary data from population-based studies on the association of diabetes with stroke recurrence are lacking.

The effect of diabetes on functional outcome has been more consistent, with most but not all population- and registry-based studies finding that diabetes predicts worse function or disability after ischaemic stroke [5,10,12–15]; however, the majority of these studies were not specifically designed to investigate differences in outcome by diabetes status and therefore, confounding of the diabetes association by other factors was not explicitly considered. Further, in the few studies that sought to estimate the association between diabetes and functional outcome, adjustment for confounding factors was accomplished through a backwards selection procedure or by including all adjustment factors in a multivariable model simultaneously [5,14]. Use of these methods precludes an understanding of the reasons for worse functional outcome among people with diabetes who experience stroke, information that could aid in the design of post-stroke recovery strategies for those with diabetes.

Diabetes is a nationwide problem but disproportionately affects minorities. Mexican-American people have a higher prevalence of diabetes than non-Hispanic white people and experience worse post-stroke outcomes [15]. Additionally, Mexican-American people may have greater genetic susceptibility to insulin resistance and poorer access to care than non-Hispanic white people, which could lead to more severe diabetes and worse stroke outcomes [16–18]. If ethnicity modifies the association between diabetes and stroke outcomes, it would identify a need for targeted interventions for Mexican-American people with diabetes who experience stroke.

Given the inconsistent findings to date and lack of population-based research in diverse populations and in Mexican-American people specifically, the primary objective of the present study was to test whether people with diabetes who experience ischaemic stroke have poorer stroke outcomes than those without diabetes in a bi-ethnic population-based stroke study. We hypothesized that people with diabetes would have higher mortality, higher stroke recurrence, and worse functional outcome than people without diabetes. Additionally, we hypothesized that diabetes would have a greater impact on stroke outcomes in Mexican-American people

compared with non-Hispanic white people. Additional background on the literature linking diabetes to stroke outcomes is included in the Supporting Information (File S1).

Participants and methods

Data are from the Brain Attack Surveillance in Corpus Christi (BASIC) project, a population-based stroke surveillance study in Nueces County, Texas. Nueces County is a geographically isolated bi-ethnic and non-immigrant community with a population of roughly 350 000, the majority of whom are Mexican American. The methods used in the BASIC project have been described previously [19]. Briefly, trained abstractors identified stroke cases through active and passive surveillance methods. All possible strokes were validated by stroke fellowship-trained physicians blinded to race/ethnicity. Strokes were identified between April 2006 and June 2012. Only ischaemic stroke cases, defined by a standard clinical definition, were included. Exclusion criteria for the BASIC project included age <45 years, traumatic stroke, and residence outside of Nueces County. All those with ischaemic stroke were approached for participation in an in-person baseline interview and had their medical records reviewed. If an individual was unable to complete the interview, a proxy interview was conducted. Only those with a complete baseline interview were included. People with a race/ethnicity other than Mexican American or non-Hispanic white were excluded because of small numbers.

Stroke outcomes

Stroke outcomes included all-cause mortality, recurrent stroke and functional outcome. All-cause mortality was ascertained through the Texas Department of State Health Services and linked to participants in the BASIC project using first and last name, date of birth, sex, race/ethnicity and permanent address. Recurrent strokes, defined as a newly validated ischaemic stroke or intracerebral haemorrhage after the initial ischaemic stroke, were ascertained through BASIC surveillance methods. If an individual had multiple recurrent strokes, only the first was considered. Beginning in November 2008, participants were followed for their outcomes at 90 days. Self-reported scales measuring activities of daily living (ADLs) and instrumental activities of daily living (IADLs) were used to assess functional outcome. ADLs included walking, bathing, grooming, eating, dressing, moving, and toileting. IADLS included pulling/pushing, stooping, lifting, reaching, getting up from stopping, standing up after sitting, walking up one

stair, writing or handling small objects, walking a quarter mile, walking up 10 steps, using a telephone, managing money, doing all cooking, doing heavy housework, and doing all shopping. Participants or proxies self-reported the level of difficulty they experienced with the seven ADLs and 15 IADLS. Response options included 1 (no difficulty), 2 (some difficultly), 3 (a lot of difficulty), and 4 (can only do with help). Responses were used to create an average score, with higher scores representing worse functional outcome. To further aid in the interpretation of the functional outcome results, we re-ran models dichotomizing functional outcome as dependent (average ADL/IADL score ≥3) vs independent (average ADL/IADL score<3).

Diabetes and other variables

History of known diabetes mellitus was ascertained from the medical record. This method has shown good agreement (κ=0.86) with self-report of diabetes in this community [20]. Baseline interview data included race/ethnicity, marital status (married or living together, single, widowed, divorced or separated), education (lower than high school level vs high school or higher), pre-stroke function (modified Rankin scale, categorized as 0–1, 2–3, 4–6; higher scores represent worse function), and pre-stroke cognitive status [16-item Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) [21]; range 1–5, higher scores represent worse cognitive function]. Medical record data included, sex, insurance status, risk factors [history of stroke/transient ischaemic attack, hypertension, coronary artery disease, atrial fibrillation, high cholesterol, smoking status (never/former vs current), excessive alcohol consumption], comorbidities (myocardial infarction or congestive heart failure, cancer, chronic obstructive pulmonary disease, dementia or Alzheimer's disease, epilepsy, Parkinson's disease, end-stage renal disease), BMI, treatment with tissue-type plasminogen activator (tPA), and nursing home residence before stroke. The aforementioned risk factors and comorbidities, excluding diabetes, were summed to create a pre-stroke comorbidity index (range 0–14; higher score represents more comorbidities). This index has previously been shown to be associated with post-stroke functional outcome in this population [15]. Initial stroke severity, measured by the National Institutes of Health Stroke Scale (NIHSS), was abstracted from the medical record or retrospectively calculated using validated methods (range 0–42; higher scores represent greater severity) [22].

Statistical analysis

Descriptive statistics were calculated for all variables by diabetes status, and differences were assessed using chi-squared and Wilcoxon rank-sum tests. Cox proportional hazards models were used to compare all-cause mortality and stroke recurrence by diabetes status at 30 days and 1 year after ischaemic stroke. Events were censored at the end of follow-up, and stroke recurrence was additionally censored for death. Because functional outcome was constrained by lower and upper bounds, Tobit regression was used to examine differences in 90-day ADL/IADL scores by diabetes status, and logistic regression was used to compare the dichotomous functional outcome [23]. For all outcomes, we first ran an unadjusted model including only diabetes. Models were then sequentially adjusted for sets of prespecified potential confounders identified from the literature (Supporting Information). In addition, to aid in the interpretation of the results for the models of functional outcome, we calculated Cohen's standardized effect size by dividing the difference in ADL/IADL score by the overall standard deviation of the ADL/IADL score [24].

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

Results

Figures 1 and 2 show the analytical samples for the outcome models. Samples sizes were lower for 1-year mortality because these models were adjusted for cardiovascular risk factors and thus required complete data for risk factors, whereas 30-day mortality and 1-year stroke recurrence were not adjusted for cardiovascular risk factors because of a limited number of outcome events. There was no difference between those who did and did not complete a baseline interview by diabetes status (P=0.12) or initial stroke severity (P=0.29).

Forty-six percent of people included in the study had a history of known diabetes, the median (interquartile range) age was 70 (58–81) years, and 61% were Mexican American. People with diabetes were younger, more likely to be Mexican American, had a higher average BMI, and a higher proportion had a history of myocardial infarction/coronary artery disease, hypertension, high cholesterol, end-stage renal disease, and congestive heart failure than people without diabetes (Table 1; P<0.01 for all). People with diabetes were less likely to have attained an educational status of more than high school, be a current smoker, use alcohol excessively or receive tPA treatment, and a lower proportion had a history of atrial fibrillation and

Alzheimer's/dementia (P<0.01 for all). Baseline characteristics for the subset used in the functional outcome analysis (n=509) were similar to those in the larger stroke population (Table S1).

All-cause mortality

Risk of 30-day and 1-year mortality was 8.4% and 20.5% for people with diabetes who experienced stroke and 9.5% and 20.8% for people without diabetes who experienced stroke, respectively (Table S2). In unadjusted models, diabetes was not significantly associated with 30-day (hazard ratio 0.89, 95% CI 0.61–1.28) or 1-year (hazard ratio 1.04, 95% CI 0.81–1.33) all-cause mortality (Table 2). After adjustment for demographics, the association between diabetes and all-cause mortality became stronger (30-day hazard ratio 1.44, 95% CI 0.97–2.12; 1-year hazard ratio 1.47, 95% CI 1.09–1.97). This change in association was attributable primarily to age. The associations between diabetes and 30-day and 1-year all-cause mortality were largely unchanged with additional adjustment for socio-economic status, stroke severity, stroke treatment and risk factors. Initial NIHSS was associated with an increased risk of 30-day mortality, while Mexican-American ethnicity was associated with a lower risk of 30-day mortality. Age, initial NIHSS, congestive heart failure, and Alzheimer's/dementia were associated with a higher risk of 1-year mortality. Mexican-American ethnicity and tPA treatment were associated with a lower risk of 1-year mortality. Effect modification by ethnicity was not significant for either mortality endpoint (P for interaction = 0.61 and 0.31 for 30-day and 1-year mortality, respectively).

Stroke recurrence

There were 122 recurrent strokes within 1 year of the initial ischaemic stroke, of which 115 (94%) were recurrent ischaemic stroke. Risk of 30-day and 1-year stroke recurrence was 1.2% and 7.5% for people with diabetes and 1.5% and 5.8% for people without diabetes, respectively (Table S3). Diabetes was not associated with stroke recurrence in crude or adjusted analyses (Table 2). No factors were significantly associated with 1-year recurrence. Effect modification by ethnicity was not significant (P=0.37).

Functional outcome

On average, people with and without diabetes had a mean (SD) ADL/IADL score of 2.48 (0.99) and 2.36 (1.08), respectively (higher score worse), reflecting mild to moderate disability (scores reflect 'some' to 'a lot of' difficulty with ADLs and IADLs). In the crude model, diabetes was not significantly associated with functional outcome (β=0.15, 95% CI –0.07 to 0.36; Table 3). After adjustment for demographics, diabetes became significantly associated with worse functional outcome, primarily as a result of age adjustment. Further adjustment for socio-economic status, stroke severity and tPA treatment resulted in little change in the association (β=0.25, 95% CI 0.06–0.44). This translated into a Cohen's standardized effect size of 0.24 [considered 'small' (0.20) to 'medium' (0.50)] [24]. Adjustment for cardiovascular risk factors attenuated the association between diabetes and functional outcome, causing it to become borderline significant. Final adjustment for pre-stroke factors further attenuated the association, resulting in a final mean ADL/IADL score difference of 0.11 (95% CI –0.07 to 0.30). Age, female sex, Mexican-American ethnicity, initial NIHSS, history of stroke/transient ischaemic attack, history of Alzheimer's/dementia, comorbidity index, IQCODE, and baseline modified Rankin scale were associated with worse ADL/IADL score at 90 days, whereas tPA treatment was associated with better ADL/IADL score at 90 days. Effect modification by ethnicity was not significant (*P*=0.46). In models considering the dichotomous functional outcome measure, diabetes was not associated with dependency in unadjusted or adjusted models (Table 4).

Discussion

In this population-based study of people who had experienced ischaemic stroke, the prevalence of diabetes was 46%, which is higher than estimates from other US population-based studies [25,26]. Risk of 30-day and 1-year all-cause mortality was 8.4% and 20.5%, respectively, for people with diabetes who experienced stroke. These estimates are similar to those found in another diverse, US population-based stroke study [26]. People who had experienced stroke with diabetes were roughly 1.5 times more likely to die at 1 year compared with those without diabetes after accounting for confounders. A similar pattern was found for 30-day mortality, although it did not reach significance. We saw a positive but insignificant association between diabetes and stroke recurrence that fell within the range presented by Shou *et al*. [11] in their meta-analysis. Mild to moderate disability was noted in people with diabetes, and there was an association between diabetes and worse functional outcome that can be interpreted to be a small to medium difference. This association was explained by cardiovascular risk factors and pre-

stroke physical and cognitive function, as evidenced by the attenuation of the association after adjustment for these factors. We did not find that ethnicity modified the association between diabetes and stroke outcomes.

In the present study, there was no association between diabetes and mortality in crude analysis; however, participants with diabetes were significantly younger than those without diabetes, and younger age was associated with lower mortality; therefore, after accounting for age and other demographic factors, diabetes was associated with higher post-stroke mortality. The inverse association between diabetes and age, however, may be unique to populations with significant minority representation. One US study, with a sizable proportion of African-American participants, also found that people with diabetes who experienced ischaemic stroke were younger than those without diabetes [25]. Other studies in ischaemic stroke populations found either no age difference by diabetes status or that participants with diabetes were significantly older [5,27]. These findings suggest that the presence and degree of confounding by age in the association of diabetes and mortality is highly dependent on the population, and speaks to the critical need to consider age adjustment when comparing results across studies.

After adjustment for sociodemographic factors, initial stroke severity and tPA treatment, diabetes was associated with worse functional outcome, consistent with prior studies [10,13,28]; however, after adjustment for the higher burden of cardiovascular risk factors and worse pre-stroke physical and cognitive function in those with diabetes, the diabetes–functional outcome association was attenuated and no longer significant; therefore, improving adherence to existing guidelines for treating cardiovascular risk factors and preventing comorbidities in people with diabetes may improve post-stroke functional outcomes [29]. Unlike many studies, which have used the modified Rankin scale to assess function, in the present study we used a measurement of ADLs/IADLs. The modified Rankin scale is typically categorized so that poor outcome includes disability or death. Because diabetes is associated with post-stroke mortality, it is not possible to disentangle the impact of diabetes on function vs mortality when a combined endpoint, such as the modified Rankin scale, is used. Measuring functional outcome using a scale that focuses on the ability to perform ADLs and IADLs among survivors allowed us to identify an association between diabetes and functional disability separate from the association with mortality.

Although not part of our original hypothesis, we found that people with diabetes were significantly less likely to receive tPA treatment than people without diabetes, consistent with findings from other studies [30,31]. A possible explanation for this is that differences in eligibility for tPA treatment existed for those with and without diabetes. Alternatively, there may be physician concern about an increased risk of haemorrhage in people with diabetes after tPA treatment [31]; however, it has been shown that tPA improves outcomes in people with diabetes [30]; therefore, improving thrombolytic treatment in eligible people with diabetes who experience stroke should be a priority. Additionally, because Mexican-American people who experience stroke have both a higher prevalence of diabetes and worse functional outcomes compared with non-Hispanic white people, increasing the frequency of tPA treatment in eligible people with diabetes could improve functional outcomes in Mexican-American people and lessen the disparity in stroke outcomes [15].

The strengths of the present study include its population-based design, ethnic diversity and thorough adjustment for confounding factors. Limitations include the fact that, because of the low number of events, we were not able to adjust for all confounders in models for 30-day mortality and 1-year recurrence. In addition, we did not have information on diabetes treatment and medication adherence or severity and duration of diabetes. Ascertainment of known diabetes was based solely on history in the medical record and therefore it is possible that some people had undiagnosed diabetes. We have previously documented, however, that access to care in this community is high, which suggests that this is not a major concern [20]. We also did not have information on HbA_{1c} or glucose levels, and were not able to differentiate between Type 1 and Type 2 diabetes, although the majority of participants would be expected to have Type 2 diabetes. Given the observational nature of this study, we cannot exclude the possibility of residual confounding. It is also possible that we over-adjusted in that some variables in our multivariable models may be on the causal pathway between diabetes and stroke outcomes. Furthermore, we did not have data on ischaemic stroke subtype, which is associated with diabetes and could therefore confound the observed associations.

The present study provides a comprehensive overview of the association between diabetes and stroke outcomes in a bi-ethnic population. We found positive associations between diabetes and all-cause mortality and between diabetes and worse functional outcome, and no

significant association between diabetes and stroke recurrence. Although associations between diabetes and stroke outcomes were similar by ethnicity, the high prevalence of diabetes in Mexican-American people who experienced stroke suggests that diabetes is an important target for addressing stroke outcome disparities in this population.

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Competing interests

None declared.

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Supporting information

Additional Supporting Information may be found in the online version of this article:

File S1 .

Table S1 Baseline characteristics of patients with ischaemic stroke followed for ninety day outcomes by diabetes status (*n*=569).

Table S2 Crude and Age-stratified 30-day and 1-year all-cause cumulative mortality following ischaemic stroke by diabetes status.

Table S3 Crude and age-stratified 30-day and 1-year stroke recurrence following ischaemic stroke by diabetes status.

FIGURE 1 Flow diagram for people who experienced ischaemic stroke who were included in mortality and recurrence analysis. BASIC, Brain Attack Surveillance in Corpus Christi project.

FIGURE 2 Flow diagram for people who experienced ischaemic stroke who were included in the functional outcome analysis. BASIC, Brain Attack Surveillance in Corpus Christi project.

Table 1 Baseline characteristics of participants with ischaemic stroke by diabetes status (*n*=1301)

	History of known diabetes

	Yes (*N*=602)	No (*N*=699)	*P*
Median (Q1–Q3) age, years	65 (57–77)	73 (61–83)	<0.001
Women, *n* (%)	299 (49.7)	357 (51.1)	0.613
Mexican-American, *n* (%)	450 (74.8)	339 (48.5)	<0.001
Education: more than high school*, *n* (%)	189 (31.4)	269 (38.7)	0.006
Insured, *n* (%)	538 (89.4)	638 (91.3)	0.245
Atrial fibrillation, *n* (%)	70 (11.6)	133 (19.0)	<0.001
Myocardial infarction or coronary artery disease* , *n* (%)	251 (41.7)	201 (28.8)	<0.001
Hypertension, *n* (%)	547 (90.9)	499 (71.4)	<0.001
High cholesterol, *n* (%)	340 (56.5)	254 (36.3)	<0.001
History of stroke or TIA, *n* (%)	166 (27.6)	169 (24.2)	0.162
Cancer, *n* (%)	62 (10.3)	93 (13.3)	0.095
End-stage renal disease, *n* (%)	57 (9.5)	18 (2.6)	<0.001
Alzheimer's or dementia*, *n* (%)	51 (8.5)	95 (13.6)	0.003
Chronic obstructive pulmonary disease, *n* (%)	66 (11.0)	90 (12.9)	0.290
Congestive heart failure, *n* (%)	104 (17.3)	75 (10.7)	<0.001
Current smoker*, *n* (%)	105 (17.5)	168 (24.1)	0.004
Excessive alcohol use, *n* (%)	21 (3.5)	56 (8.0)	<0.001
Treated with tPA, *n* (%)	31 (5.2)	63 (9.0)	0.007
Median (Q1–Q3) initial NIHSS score*, *n* (%)	4 (2–8)	5 (2–9)	0.244
Median (Q1–Q3) BMI*	30.1 (26.2–35.7)	26.6 (23.6–30.3)	<0.001

NIHSS, National Institutes of Health Stroke Scale; TIA, transient ischaemic attack; tPA, tissue-type plasminogen activator. Data from the Brain Attack Surveillance in Corpus Christi (BASIC) project (April 2006 to June 2012). *Missing: Education, 0.3%; Myocardial infarction or coronary artery disease, 0.2%; Alzheimer's or dementia, 0.2%; Smoking status, 0.3%; Initial NIHSS, 0.1%; BMI, 2.3%.

Table 2 Hazard ratios for the association of diabetes mellitus on all-cause mortality and stroke recurrence after ischaemic stroke

Model	1-year recurrence (*n*=1295) Hazard ratio (95%	30-day mortality (*n*=1295) Hazard ratio (95%	1-year mortality (*n*=1260) Hazard ratio (95%

	CI)	CI)	CI)
Model 1: unadjusted	1.29 (0.81, 2.05)	0.89 (0.61, 1.28)	1.04 (0.81, 1.33)
Model 2: adjusted for demographics	1.30 (0.79, 2.11)	1.41 (0.96, 2.07)	1.55 (1.19, 2.01)
Model 3: Model 2 + socio-economic status	1.28 (0.79, 2.09)	1.41 (0.96, 2.07)	1.55 (1.19, 2.01)
Model 4: Model 3 + stroke severity	1.27 (0.78, 2.07)	1.44 (0.97, 2.12)	1.63 (1.25, 2.13)
Model 5: Model 4 + tPA	-	-	1.61 (1.23, 2.09)
Model 6: Model 5 + cardiovascular risk factors	-	-	1.47 (1.09, 1.97)

tPA, tissue-type plasminogen activator.

Data from the Brain Attack Surveillance in Corpus Christi (BASIC) project (April 2006 to June 2012). Due to limited events, 1-year recurrence and 30-day mortality were only adjusted through stroke severity, and 30-day recurrence was not considered. Demographics include: age, sex, race-ethnicity. Socio-economic status includes: education, insurance status. Cardiovascular risk factors include: history of stroke/ transient ischaemic attack, myocardial infarction/coronary artery disease, atrial fibrillation, chronic obstructive pulmonary disease, congestive heart failure, end-stage renal disease, cancer, Alzheimer's/dementia, high cholesterol, hypertension, alcohol excess, smoking status, BMI.

Table 3 Results of multivariable models of the association of diabetes and 90-day functional outcome following ischaemic stroke

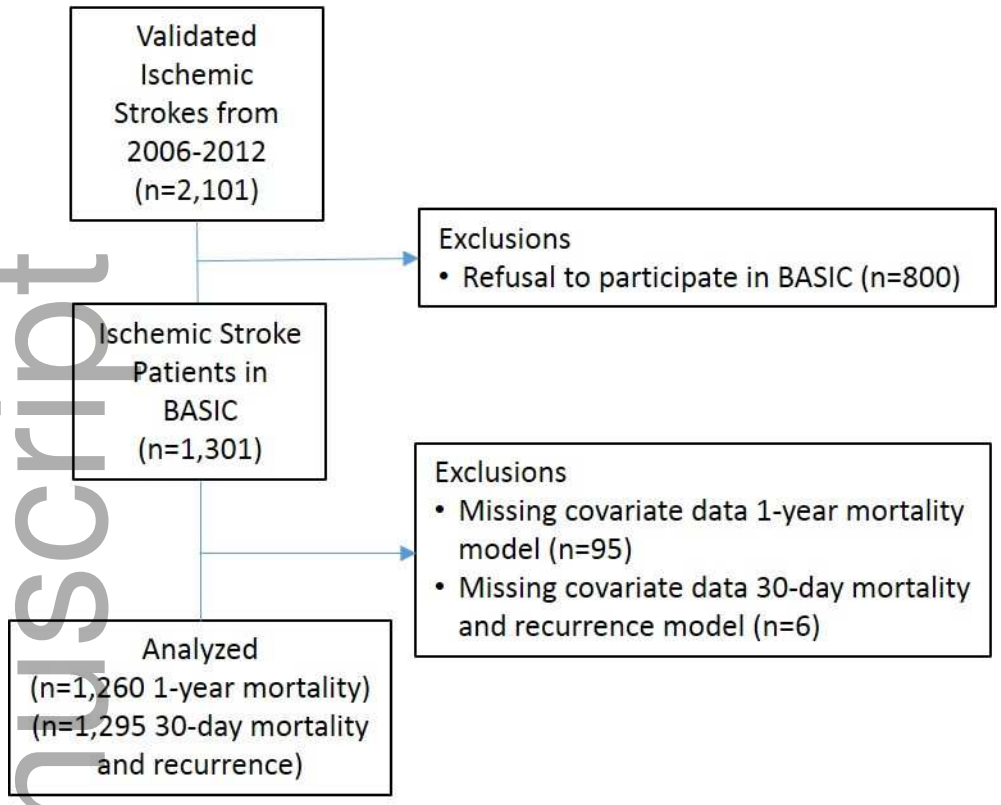
	Functional outcome (*n*=509)
Model	Estimate (95% CI)
Model 1: unadjusted	0.15 (-0.07 to 0.36)
Model 2: adjusted for demographics	0.22 (0.01 to 0.43)
Model 3: Model 2 + socioeconomic status	0.21 (0.00 to 0.41)
Model 4: Model 3 + stroke severity	0.27 (0.08 to 0.45)
Model 5: Model 4 + tPA	0.25 (0.06 to 0.44)
Model 6: Model 5 + cardiovascular risk factors	0.17 (-0.02 to 0.36)
Model 7: Model 6 + pre-stroke factors*	0.11 (-0.07 to 0.30)

TIA, transient ischaemic attack; tPA, tissue-type plasminogen activator.

Data from the Brain Attack Surveillance in Corpus Christi (BASIC) project (April 2006 to June 2012). Estimates given were derived as the regression coefficients from the model for average activities of daily living (ADL)/instrumental activities of daily living (IADL) score. Estimates represent the difference in mean ADL/IADL comparing people with diabetes to people without diabetes. Demographics include: age, sex, race-ethnicity, marital status. Socio-economic status includes: education, insurance status. Cardiovascular risk factors include: history of stroke/ transient ischaemic attack, myocardial infarction/coronary artery disease, atrial fibrillation, high cholesterol, hypertension, smoking status, BMI. Pre-stroke factors include: pre-stroke nursing

home residence, modified Rankin scale, Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE), comorbidity index.

*Pseudo-R^2 = 0.19.



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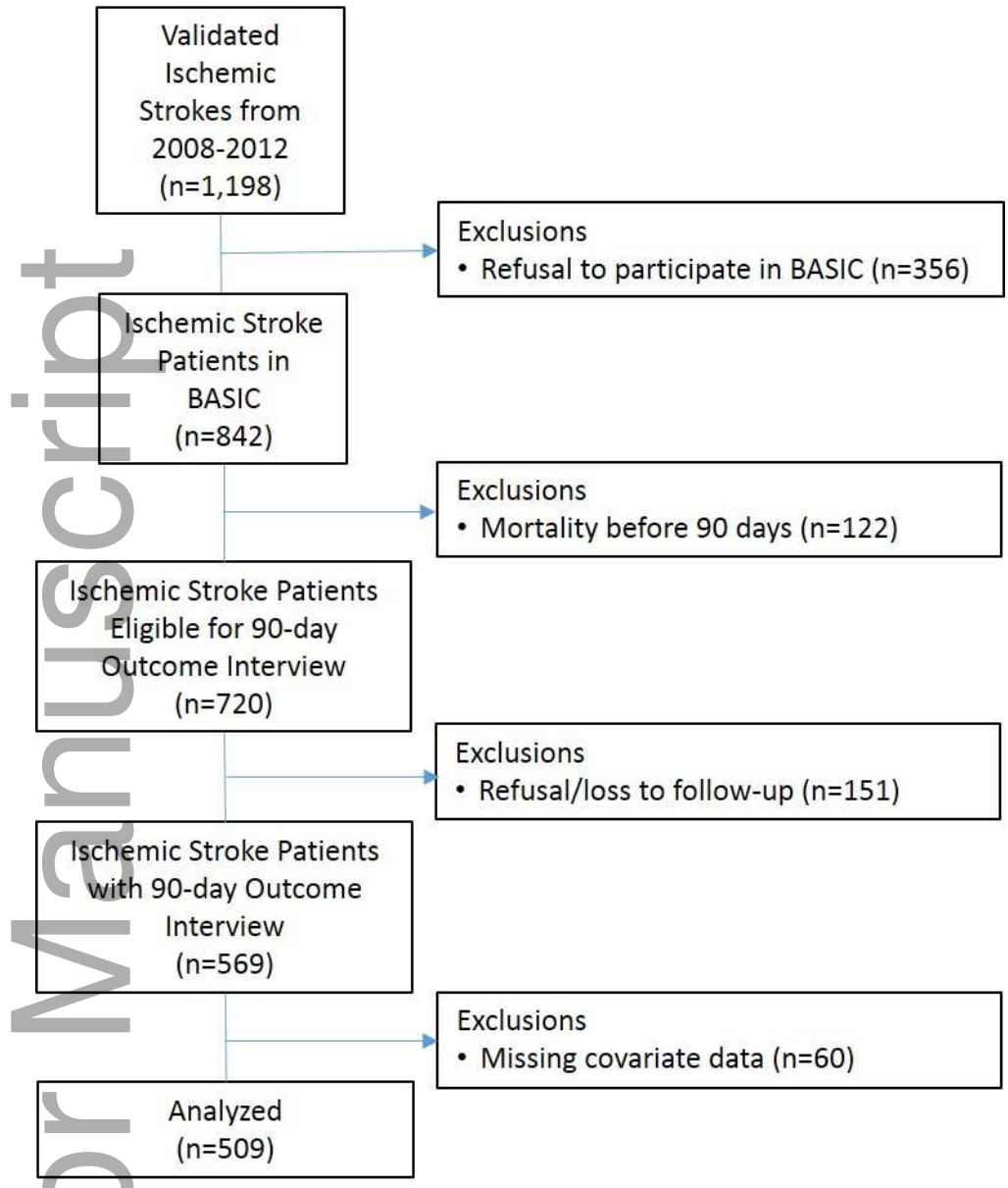

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