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The association between social networks and functional recovery after stroke

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Abstract

Background and Purpose: Social determinants of health (SDOH), including social networks, impact disability and quality of life post-stroke, yet the direct influence of SDOH on functional change remains undetermined. We aimed to identify which SDOH predict change on the modified Rankin Scale (mRS) within 90 days after stroke hospitalization.

Methods: Stroke patients from the Transitions of Care Stroke Disparities Study (TCSDS) were enrolled from 12 hospitals in the Florida Stroke Registry. TCSDS aims to identify disparities in hospital-to-home transitions after stroke. SDOH were collected by trained interviewers at hospital discharge. The mRS was assessed at discharge, 30- and 90-day post-stroke. Multinomial logistic regression models examined contributions of each SDOH to mRS improvement or worsening (compared to no change) from discharge to 30- and 90-day, respectively.

Results: Of 1190 participants, median age was 64 years, 42% were women, 52% were non-Hispanic White, and 91% had an ischemic stroke. Those with a limited social support network had greater odds of functional decline at 30 days (aOR = 1.39, 1.17–1.66), adjusting for age and onset to arrival time and at 90 days (aOR = 1.50, 1.10–2.05) after adjusting for age. Results were consistent after further adjustment for additional SDOH and participant characteristics. Individuals living with a spouse/partner had reduced odds of functional decline at 90 days (aOR = 0.74, 0.57–0.98); however, results were inconsistent with more conservative modeling approaches.

Conclusion: The findings highlight the importance of SDOH, specifically having a greater number of individuals in your social network in functional recovery after stroke.

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Declaration of conflicting interests
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Keywords

Stroke; social network; functional recovery

Introduction

Stroke is the leading cause of permanent adult disability worldwide.[1] The United States' National Institute of Neurological Disorders and Stroke (NINDS) has outlined a framework for addressing health disparities and specifically highlights the influence of determinants of social status (race/ethnicity/gender/education/income), healthcare access, and sociocultural environment on equity in neurologic health and well-being.[2] Social determinants of health (SDOH) outlined in this model, specifically race/ethnicity, educational level, socioeconomic disparities, and social support play a direct role in increased stroke incidence and mortality.[3–8] After stroke, SDOH continue to impact outcomes, such as all-cause readmission rates and 30- and 90-day post-stroke mortality. For example, individuals of Hispanic and non-Hispanic Black race/ethnicity, those with lower educational levels, and those with smaller social networks have higher readmission and mortality rates post-stroke.[7,9–11]

In addition to readmission rates and mortality, Quality of life (QoL) has become a crucial measure to objectively characterize post-stroke outcomes.[12–15] QoL metrics have been used to illustrate the beneficial relationship between physical function and various SDOH after stroke, including sociodemographic factors, social isolation, educational level, and psychosocial factors to name a few. Favorable SDOH have been associated with higher post-stroke QoL measures.[12,15–17] The International Classification of Functioning, Disability, and Health (ICF) model further highlights the interplay between environmental and personal factors, or rather SDOH, physical function, activity, and community participation.[18] The recovery of physical function after stroke, including independent walking, balance, and independence with activities of daily living, remains a high priority for stroke survivors.[19] While the impact of specific SDOH on post-stroke outcomes has been illustrated, the direct association between multiple SDOH and functional recovery after stroke remains largely unexplored. The purpose of this study is to examine multiple SDOH within differing domains of the NINDS Framework, including social status determinants (race/ethnicity, age, gender, educational level, work status), healthcare access (self-reported ability to pay for medical care), and sociocultural environment (social network size, living arrangements, language spoken in home) as predictors of functional recovery post-stroke measured by change in the modified Rankin Scale (mRS) from hospital discharge to 30- and 90-day follow-up after stroke event.

Methods

Study population

The Transitions of Care Stroke Disparities Study (TCSDS) is a National Institutes of Health (NIH)-funded prospective cohort study designed to identify determinants of effective transition of hospital-to-home stroke care (full study methods described in previously published works).[20] Between 2018 and 2021, we enrolled stroke patients at hospital discharge who were admitted to 1 of 12 comprehensive stroke centers (CSCs) throughout the state of Florida. We enrolled patients with a discharge diagnosis of acute ischemic stroke (AIS) or intracerebral hemorrhage (ICH) who were ⩾ 18 years of age and who were willing and able to provide informed consent by themselves or by a legally authorized representative and able to receive follow-up calls. We excluded patients (1) with other stroke types, (2) those with no stroke-related diagnoses, and (3) those hospitalized for elective carotid interventions. In addition, (4) institutionalized patients and (5) those discharged to locations other than their homes, assisted living, or inpatient rehabilitation facilities were excluded from enrollment (see Figure 1). Our final sample consisted of n = 1190 individuals after duplicates, and individuals with missing primary outcomes were removed. The University of Miami Institutional Review Board approved the study protocol (IRB Approval Number 20170892). All participants provided informed consent to participate in this study.

Outcomes

The mRS-9Q version was used to collect mRS at all time points (i.e. at hospital discharge, 30 and 90 days after discharge) to optimize reliability.[21] The mRS is the most prevalent post-stroke outcome and has been commonly used to measure functional recovery after stroke.[22–25] For this study, we operationalized functional change as either an improvement, no change, or worsening mRS from discharge to 30-day and from discharge to 90-day follow-up, respectively.[25] Improvement was defined as having mRS of > 1 at hospital discharge to having mRS of 0 or 1 at 30- or 90-day follow-up, or if individuals had a ⩾ 2 point improvement in mRS from hospital discharge to 30- or 90-day follow-up. We defined worsening as an increase in ⩾ 2 in mRS from discharge to 30-, or discharge to 90-day follow-up, or a 30- or 90-day mRS > 1 if discharge mRS was 0 or 1. Individuals were classified as having no functional change if the above criteria for improvement or worsening were not met. We trichotomized functional change as either improvement or worsening compared to a reference of no change in our regression models. Because no deaths (mRS = 6) were observed at any time point, the range of mRS scores on which we based our definition of functional change was 0–5.

SDOH

SDOH at discharge were obtained via self-report. SDOH characteristics included (1) language spoken at home (English, Non-English (including Spanish, Haitian Creole, or Other)), (2) level of education (less than high school, completed high school or greater), (3) pre-stroke work status (full-time, part-time/retired, unemployed), (4) perceived difficulty in paying for medical care (very hard/hard, somewhat hard, not very hard), (5) cohabitation (living alone, with sibling(s), with spouse/partner, with child(ren), other family, or other), and (6) social network, or the number of persons the participant felt s/he could reach out to (0–2, 3 or more). Table 1 provides a description of each of the SDOH characteristics by mRS improvement/no change/worsening.

Additional data used as covariates included participant demographics (sex, race/ethnicity of the Social Status domain in the NINDS SDOH Framework), insurance, stroke characteristics, and vascular risk factors, which were obtained by linkage to the Florida

Stroke Registry (FSR), from which all participants were selected. The FSR is a multi-hospital collaboration that uses the American Heart Association's Get with the Guidelines-Stroke® (GWTG-S) data collection instruments, with the goal of reducing disparities in and improving the quality of acute stroke care throughout the state of Florida. Data collection methods have been detailed previously.[8] Demographics included self-reported age (18–60, 61–79, and 80 years old or greater), sex (male, female), and race/ethnicity (non-Hispanic Black (NHB), non-Hispanic White (NHW), Hispanic). We also obtained insurance status (Medicare, not Medicare). Stroke characteristics included stroke type (ischemic, hemorrhagic), stroke severity (NIHSS 0–4, 5–14, >15), and onset-to-arrival time (OAT; 4.5 h, > 4.5 h). Vascular risk factors included smoking, hypertension, obesity, diabetes mellitus, atrial fibrillation/flutter, and dyslipidemia. Table 2 includes additional covariates related to participant demographics, stroke characteristics, and vascular risk factors that are characterized by mRS improvement/no change/worsening.

Statistical analyses

Descriptive statistics for participant characteristics. Categorical variables were summarized with frequencies and percentages. Continuous variables were characterized by medians with the associated interquartile range.

Statistical modeling. A least absolute shrinkage and selection operator (LASSO) approach was used to minimize the presence of multicollinearity when selecting covariates to generate a more parsimonious model.[26] The LASSO model from discharge to 30 days adjusted for age and OAT. The LASSO model from discharge to 90 days adjusted for age. We then used multinomial logistic regression models with generalized estimating equations to determine the odds of improvement with a reference of no change and odds of worsening with a reference of no change. Changes from discharge to 30 and from discharge to 90 days were examined using separate models to account for clustering arising from differential stroke center treatment efficacies and practices. As a more conservative approach, a fully adjusted model included demographic (age, race/ethnicity, sex, and insurance type), stroke characteristics (stroke type, stroke severity, OAT), and vascular risk factors (history of smoking, hypertension, obesity, diabetes, dyslipidemia, atrial fibrillation/flutter). We restricted our analyses to patients with complete discharge, 30-, and 90-day mRS scores (n = 229 individuals excluded with missing mRS). A missing indicator approach was used to account for data missingness (race, n = 51 (4%); insurance status, n = 41 (4%); stroke severity, n = 25 (2%); OAT, n = 162 (14%)). A flowchart of data included/excluded for final analysis is illustrated in Figure 1.

Results

Descriptive statistics

A total of 1190 participants were included in the final analysis. Patient demographics, stroke characteristics, and vascular risk factors at time of discharge are detailed in Table 2. In sum, the sample was composed of predominantly older adults (median age, IQR = 64, (55–74) years), NHW (52%), and females (42%), and 53% arrived > 4.5 h from symptom onset. Participants presented with primarily mild stroke symptoms (median admission NIHSS, IQR

= 2, 1–6) and most had an ischemic stroke (91%). Scores on discharge mRS were low (median, IQR = 1, 1–2). From discharge to 30 days, 17% (n = 201) worsened, 12% (n = 140) improved, and 71% (n = 849) remained functionally stable. From discharge to 90 days, 14% (n = 168) worsened, 19% (n = 224) improved, and 67% (n = 798) remained functionally stable. See Supplementary Tables 1 and 2 for a crosstabulation of mRS from discharge to 30 days and discharge to 90 days after stroke, respectively.

LASSO models of functional change

From discharge to 30 days (aOR = 1.39, 1.17–1.66) and from discharge to 90 days (aOR = 1.50, 1.10–2.05), individuals with a smaller (0–2 persons) social network were more likely to worsen in functional status. Individuals who lived with a spouse/partner were less likely to worsen in functional status from discharge to 90 days (aOR = 0.74, 0.57–0.98). No other SDOH significantly impacted change in mRS. Results of the LASSO models of discharge to 30 and discharge to 90 days for all SDOH are included in Table 3.

Conservative/fully adjusted models of functional change

In the fully adjusted model from discharge to 30 days (aOR = 1.6, 1.24–2.07) and from discharge to 90 days (aOR = 1.66, 1.1–2.51) individuals with less (0–2 persons) social network were more likely to functionally worsen. From discharge to 30 days, individuals who lived with children were less likely to functionally worsen; however, this association was attenuated and lost statistical significance by 90 days. Table 3 includes the results of the fully adjusted discharge to 30- and 90-day models. Variance Inflation Factor (VIF) results revealed moderate collinearity of stroke type (ischemic vs hemorrhagic, VIF = 5.01 at 30 days; VIF = 5.59 at 90 days) and minimal multicollinearity (VIF < 5.0) of all other variables included in the discharge to 30- and discharge to 90-day models.

Discussion

Social network size has been shown to play an important role post-stroke.[10,11] In this prospective observational study of functional change within the first 90 days post-discharge after stroke hospitalization, we observed that function was more likely to worsen, both by 30 and 90 days from hospital discharge for individuals who had a smaller social support network (0–2 persons vs 3 or more persons). The importance of social networks was robust, and findings were consistent between the LASSO and conservative modeling approaches, independent of other SDOH, stroke characteristics, and vascular risk factors, with minimal to moderate collinearity. Previous studies identified social networks as an important factor in quality-of-life measures, specifically how a limited social network impacts perceived quality of life[11] but not necessarily as a predictor of functional recovery post-stroke.[11,27] Our results further highlight the value of a social network after stroke, illustrating the impact of social networks on functional recovery. Given the prevalence of post-stroke depression[28] and functional impairments commonly associated with stroke, it is plausible that our findings reflect how social networks affect accessibility and encourage patients to use healthcare services post-stroke[29] within the state of Florida. Limited social networks could negatively impact an individuals’ ability to follow through on appointments with care providers, to complete rehabilitative therapy, or to make lifestyle changes that improve functionality at home.[20,29] Transitional care resources such as community health workers and stroke navigators facilitate access to care services, improve care quality and cultural competence, and promote healthy positive lifestyle behaviors, such as participation in post-stroke care. The implementation of care transition resources could prove useful to further foster functional recovery, especially for individuals with a limited social network.

Different results were noted between LASSO and conservative modeling approaches in respect to living situations. In conservative models that fully adjusted for covariates of age, SDOH, stroke characteristics, and vascular risk factors, we observed that persons who lived with children were less likely to functionally worsen between hospital discharge and 30 days; however, the influence of living with children was lost by 90 days from discharge. In the LASSO model, those who lived with a spouse/partner were less likely to functionally worsen by 90 days from hospital discharge, which effect was not significant in the more conservative approach. The disparity in significance between the LASSO and conservative models suggests that living with others may be associated with better functional outcomes after stroke, but the specific elements of family support that may be associated with functional recover may depend on which other covariates are included in the model. For example, women tend to outlive men and therefore may be more likely to be widowed and live with children, or individuals who are still working may be younger and may live with spouses. Furthermore, our sample largely consisted of stroke survivors with mild stroke and minimal functional impairments, so it is possible that the inconsistent results surrounding different living situations across different statistical modeling approaches could have been more robust with a larger, more diverse sample.

In contrast to our results, previous literature underscored the roles education level and individual income play in post-stroke recovery.[12,16,17] Retrospective cohorts in Brazil, Mexico, and the United States have found that lower educational levels and lower socioeconomic status yielded poor prognosis for stroke recovery.[30–34] Income level has also been shown to influence quality of life measures post-str oke.[16,17,35–37] Our analysis did not explicitly include income level; however, individuals rated "difficulty paying for medical expenses" as a marker for income. It is possible that the subjective nature of the question may have influenced our results. It is also plausible that the lack of association between educational level or income and functional change show promise that successful strides are being made to reduce barriers historically associated with SDOH. Regardless, work remains to ensure health equity, specifically across race/ethnic groups and in respect to sex/gender.

There are several limitations of our study. An important limitation of this study is the relatively small sample size, limiting the statistical power of our categorical analyses. To preserve statistical power, we used a LASSO approach to determine the significant contributors to functional change and controlled only for those significant contributors identified. We also report the results of a conservative modeling approach that controls for sociodemographic and stroke-related characteristics and common risk factors of stroke to confirm results. Results for self-reported social network size (i.e. 0–2 persons vs 3 or more persons) remained consistent between modeling approaches, with mild to moderate collinearity; however, as noted above, the beneficial effects of living situation varied across the two modeling approaches (i.e. living with spouse/partner in the LASSO model; living with children in the fully adjusted model). In addition, our cohort included only ischemic and ICH stroke types, and was predominantly comprised individuals with mild stroke who had relatively good functional outcomes at hospital discharge (55% had mRS of 0–1 at hospital discharge). Limitations of the mRS are also noted. The mRS is a gross scale with limited sensitivity to change. Given the mild severity of our study cohort underscored by the overall good functional scores (low mRS) at discharge, there was a ceiling effect on functional improvement. Our results highlight the importance of social networks for those with mild stroke, yet the role social networks play in post-stroke recovery could be magnified for those who suffer more severe, disabling strokes. Another limitation is that our results reflect only participating stroke centers throughout the state of Florida, which are largely located near urban centers. Thus, findings may not be generalizable to stroke centers in more rural locations, or those located in areas with limited demographic and SDOH diversity.

There are also some notable strengths to this study. Since this study recruited from multiple facilities across the state, it is unlikely that these findings are the result of practice paradigms at any given institution. Furthermore, our use of LASSO as a data reduction approach to select model variables further accounted for institution-specific practices. In addition, using the more objective mRS as opposed to the subjective Health-Related Quality of Life index provides insight into the biophysical impact of these social determinants.

Conclusion

In conclusion, our study highlights the importance of SDOH, namely an individuals' social support network, on functional recovery after stroke. Whether the effects of limited social networks can be mitigated by additional transitional care resources such as navigators and community health workers should be evaluated in future studies. These findings serve as a starting point for exploring what interventions could be done outside of the medical context for improving the recovery process for stroke survivors. For example, rehabilitation strategies and interventions that strengthen social networks, or that incorporate group activities that leverage existing relationships with family members and caregivers, may benefit recovery in stroke patients, in the first 3 months after discharge from a stroke.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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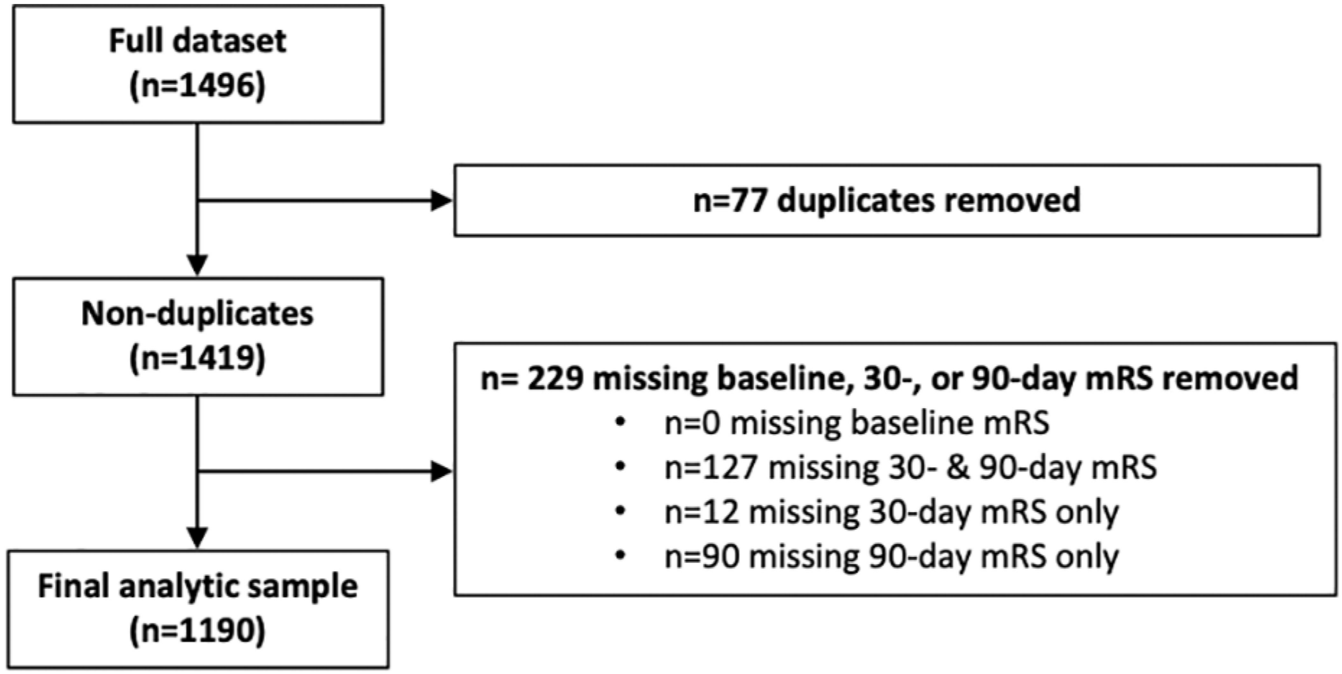

Figure 1.
Duplicate data and data with missing mRS scores were removed from the final analysis. A total of n = 1190 were used for the final sample. mRS: modified Rankin Score.

Table 1.

SDOH by functional change.

SDOH characteristic		Discharge-30 days			Discharge-90 days			
		Worsen, n = 201	No change, n = 849	Improve, n = 140	Worsen, n = 168	No change, n = 798	Improve, n = 224	Total, n = 1190
Education level, n (%)	Less than High school	27 (19%)	98 (70%)	16 (11%)	19 (13%)	95 (67%)	27 (19%)	141 (12%)
	High school or above	174 (17%)	752 (72%)	124 (12%)	149 (14%)	703 (67%)	197 (19%)	1049 (88%)
Pre-stroke work status, n (%)	Full-time	78 (18%)	312 (71%)	47 (11%)	66 (15%)	296 (68%)	75 (17%)	437 (37%)
	Part time/retired	102 (17%)	435 (70%)	81 (13%)	82 (13%)	407 (66%)	129 (21%)	618 (52%)
	Unemployed	21 (16%)	102 (76%)	12 (8.9%)	20 (15%)	95 (70%)	20 (15%)	135 (11%)
Difficulty paying for medical care, n (%)	Very hard/hard	64 (21%)	205 (67%)	38 (12%)	53 (17%)	194 (63%)	60 (20%)	307 (26%)
	Somewhat hard	31 (20%)	106 (70%)	15 (9.9%)	21 (14%)	107 (70%)	24 (16%)	151 (13%)
	Not very hard	103 (15%)	511 (73%)	82 (12%)	92 (13%)	474 (68%)	130 (19%)	696 (58%)
Social support, n (%)	0–2 persons	48 (20%)	156 (66%)	31 (13%)	42 (18%)	145 (62%)	48 (20%)	235 (20%)
	>3 persons	153 (16%)	693 (73%)	109 (11%)	126 (13%)	653 (68%)	176 (18%)	955 (80%)
Lives with, n (%)	Alone	47 (18%)	180 (68%)	36 (14%)	42 (16%)	167 (63%)	54 (21%)	263 (22%)
	Spouse/partner	111 (17%)	463 (71%)	79 (12%)	82 (13%)	454 (70%)	117 (18%)	653 (55%)
	Sibling	6 (18%)	24 (73%)	3 (9.1%)	6 (18%)	19 (58%)	8 (24%)	33 (3%)
	Children	22 (13%)	126 (77%)	16 (9.8%)	27 (16%)	108 (66%)	29 (18%)	164 (14%)
	Other family	8 (16%)	36 (73%)	5 (10%)	4 (8.2%)	35 (71%)	10 (20%)	49 (4%)
	Other	7 (25%)	20 (71%)	1 (3.6%)	7 (25%)	15 (54%)	6 (21%)	28 (2%)
Language spoken in the home, n (%)	English	152 (16%)	678 (72%)	111 (12%)	129 (14%)	631 (67%)	181 (19%)	941 (79%)
	Spanish/Haitian Creole/ Other	49 (20%)	171 (69%)	29 (12%)	39 (16%)	167 (67%)	43 (17%)	249 (21%)

Table 2.

Additional covariates by functional change.

Covariates		Discharge-30 days			Discharge-90 days			Total, n = 1190
		Worsen, n = 201	No change, n = 849	Improve, n = 140	Worsen, n = 168	No change, n = 798	Improve, n = 224	
Demographics								
Age (years), n (%)	18–60	88 (18%)	343 (72%)	45 (9.5%)	69 (14%)	328 (69%)	79 (17%)	Median (IQR) 64 (55–74)
	61–79	80 (14%)	402 (72%)	75 (13%)	67 (12%)	371 (67%)	119 (21%)	
	>80	33 (21%)	104 (66%)	20 (13%)	32 (20%)	99 (63%)	26 (17%)	
Sex, n (%)	Male	114 (17%)	494 (72%)	77 (11%)	90 (13%)	470 (69%)	125 (18%)	685 (58%)
	Female	87 (17%)	354 (70%)	63 (13%)	78 (15%)	327 (65%)	99 (20%)	505 (42%)
Race/ Ethnicity, n (%)	White	98 (16%)	431 (70%)	84 (14%)	77 (13%)	406 (66%)	130 (21%)	613 (52%)
	Black	45 (17%)	198 (74%)	23 (8.6%)	51 (19%)	168 (63%)	47 (18%)	266 (22%)
	Hispanic	48 (18%)	186 (72%)	26 (10%)	36 (14%)	188 (72%)	36 (14%)	260 (22%)
Insurance type, n (%)	Medicare	88 (15%)	408 (71%)	76 (13%)	72 (13%)	384 (67%)	116 (20%)	572 (48%)
	Non-Medicare	112 (18%)	438 (72%)	62 (10%)	94 (15%)	411 (67%)	107 (17%)	612 (51%)
Stroke characteristics								
Stroke type, n (%)	ICH	16 (15%)	75 (69%)	18 (17%)	11 (10%)	76 (70%)	22 (20%)	109 (9%)
	Ischemic	185 (17%)	774 (72%)	122 (11%)	157 (15%)	722 (67%)	202 (19%)	1081 (91%)
Stroke severity, n (%)	Mild, NIHSS 0–4	141 (18%)	561 (71%)	87 (11%)	118 (15%)	540 (68%)	131 (17%)	789 (66%)
	Moderate, NIHSS 5–14	44 (15%)	209 (71%)	41 (14%)	34 (12%)	189 (64%)	71 (24%)	294 (25%)
	Severe, NIHSS > 15	11 (13%)	61 (74%)	10 (12%)	12 (15%)	51 (62%)	19 (23%)	82 (7%)
Onset-to-arrival time, n (%)	Within 4.5 h	56 (14%)	298 (75%)	45 (11%)	50 (13%)	269 (67%)	80 (20%)	399 (34%)
	>4.5 h	115 (18%)	436 (69%)	78 (12%)	91 (14%)	417 (66%)	121 (19%)	629 (53%)
Vascular risk factors								
Smoking history, n (%)	Yes, a smoker	46 (18%)	180 (71%)	26 (10%)	43 (17%)	161 (64%)	48 (19%)	331 (28%)
	Not a smoker	155 (17%)	669 (71%)	114 (12%)	125 (13%)	637 (68%)	176 (19%)	938 (79%)
Hypertension, n (%)	Yes, hypertension	161 (18%)	640 (71%)	101 (11%)	130 (14%)	604 (67%)	168 (19%)	902 (76%)
	No hypertension	40 (14%)	209 (73%)	39 (14%)	38 (13%)	194 (67%)	56 (19%)	288 (24%)
Obesity, n (%)	Yes, obese	58 (15%)	283 (72%)	50 (13%)	52 (13%)	261 (67%)	78 (20%)	391 (33%)
	Not obese	143 (18%)	566 (71%)	90 (11%)	116 (15%)	537 (67%)	146 (18%)	799 (67%)
Diabetes history, n (%)	Yes, diabetes	64 (17%)	272 (73%)	35 (9.4%)	54 (15%)	255 (69%)	62 (17%)	371 (31%)

Covariates		Discharge-30 days Worsen, n = 201	No change, n = 849	Improve, n = 140	Discharge-90 days Worsen, n = 168	No change, n = 798	Improve, n = 224	Total, n = 1190
	No diabetes	137 (17%)	577 (70%)	105 (13%)	114 (14%)	543 (66%)	162 (20%)	819 (69%)
Dyslipidemia history, n (%)	Yes, dyslipidemia	90 (16%)	391 (71%)	67 (12%)	77 (14%)	361 (66%)	110 (20%)	548 (46%)
	No dyslipidemia	111 (17%)	458 (71%)	73 (11%)	91 (14%)	437 (68%)	114 (18%)	642 (54%)
Atrial fibrillation/flutter history, n (%)	Yes, atrial Fib/ flutter	23 (15%)	112 (71%)	22 (14%)	26 (17%)	97 (62%)	34 (22%)	157 (13%)
	No atrial fib/ flutter	178 (17%)	737 (71%)	118 (11%)	142 (14%)	701 (68%)	190 (18%)	1033 (87%)

IQR: interquartile range; ICH: Intracerebral hemorrhage; NIHSS: National Institute of Health Stroke Scale.

Table 3.

Adjusted odds ratios of functional change from discharge to 30 and 90 days.

	Discharge-30 days		Discharge-90 days	
	LASSO model[a]	Fully adjusted model[b]	LASSO model[c]	Fully adjusted model[b]
	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)	aOR (95% CI)
Education status				
Improve				
Less than High school	0.99 (0.62–1.58)	1.13 (0.61–2.1)	1.07 (0.64–1.81)	1.16 (0.65–2.05)
High school or above	Reference	Reference	Reference	Reference
Worsen				
Less than high school	1.17 (0.92–1.5)	1.18 (0.88–1.59)	0.9 (0.68–1.18)	0.88 (0.67–1.15)
High school or above	Reference	Reference	Reference	Reference
Home language				
Improve				
English	Reference	Reference	Reference	Reference
Spanish/HCreole/Oth	1.01 (0.69–1.47)	1.13 (0.62–2.03)	0.92 (0.68–1.24)	1.05 (0.63–1.75)
Worsen				
English	Reference	Reference	Reference	Reference
Spanish/HCreole/Oth	1.24 (0.92–1.68)	1.04 (0.65–1.65)	1.07 (0.76–1.52)	1.12 (0.66–1.9)
Lives with				
Improve				
Alone	Reference	Reference	Reference	Reference
Spouse/partner	0.88 (0.59–1.33)	0.87 (0.55–1.39)	0.79 (0.54–1.16)	0.81 (0.5–1.32)
Sibling	0.67 (0.23–1.9)	0.54 (0.2–1.49)	1.3 (0.51–3.33)	0.76 (0.29–2)
Children	0.65 (0.4–1.06)	0.8 (0.51–1.23)	0.85 (0.58–1.26)	0.94 (0.59–1.49)
Other family	0.79 (0.29–2.19)	0.71 (0.29–1.71)	1 (0.4–2.53)	0.98 (0.42–2.33)
Other	0.27 (0.06–1.27)	0.34 (0.08–1.52)	1.37 (0.56–3.36)	1.41 (0.39–5.09)
Worsen				
Alone	Reference	Reference	Reference	Reference
Spouse/partner	0.91 (0.59–1.42)	1.17 (0.77–1.78)	0.74 (0.57–0.98)*	0.89 (0.7–1.13)
Sibling	0.99 (0.34–2.92)	1.21 (0.57–2.59)	1.39 (0.75–2.55)	1.3 (0.72–2.33)
Children	0.63 (0.33–1.2)	0.61 (0.4–0.94)*	0.96 (0.53–1.74)	0.83 (0.52–1.33)
Other family	0.82 (0.29–2.33)	0.83 (0.34–2.04)	0.46 (0.1–2.06)	0.36 (0.08–1.71)
Other	1.27 (0.57–2.83)	1.23 (0.47–3.23)	1.82 (0.57–5.8)	1.55 (0.4–6.01)
Difficulty paying for medical				
Improve				
Very hard/hard	1.29 (0.88–1.88)	1.6 (0.99–2.58)	1.23 (0.85–1.78)	1.44 (0.94–2.22)
Somewhat hard	0.94 (0.47–1.91)	0.94 (0.49–1.8)	0.87 (0.56–1.36)	0.86 (0.54–1.39)
Not very hard	Reference	Reference	Reference	Reference

	Discharge-30 days		Discharge-90 days	
	LASSO model[a]	**Fully adjusted model[b]**	**LASSO model[c]**	**Fully adjusted model[b]**
	aOR (95% CI)	**aOR (95% CI)**	**aOR (95% CI)**	**aOR (95% CI)**
Worsen				
Very hard/hard	1.56 (0.99–2.45)	1.58 (0.99–2.54)	1.44 (0.9–2.3)	1.36 (0.83–2.21)
Somewhat hard	1.46 (0.89–2.39)	1.49 (0.87–2.55)	1.01 (0.84–1.23)	0.9 (0.67–1.2)
Not very hard	Reference	Reference	Reference	Reference
Social support network size				
Improve				
0–2 persons	1.29 (0.9–1.85)	1.47 (0.99–2.17)	1.25 (0.88–1.78)	1.29 (0.77–2.15)
3 or more persons	Reference	Reference	Reference	Reference
Worsen				
0–2 persons	1.39 (1.17–1.66) *	1.6 (1.24–2.07) *	1.5 (1.1–2.05) *	1.66 (1.1–2.51) *
3 or more persons	Reference	Reference	Reference	Reference
Work status				
Improve				
Full-time	Reference	Reference	Reference	Reference
Part-time/retired	1.06 (0.68–1.63)	0.89 (0.52–1.51)	1.22 (0.94–1.59)	1.1 (0.78–1.55)
Unemployed	0.78 (0.43–1.41)	0.8 (0.37–1.7)	0.88 (0.53–1.46)	0.92 (0.54–1.58)
Worsen				
Full-time	Reference	Reference	Reference	Reference
Part-time/retired	0.97 (0.6–1.57)	0.9 (0.6–1.36)	0.77 (0.5–1.18)	0.69 (0.45–1.05)
Unemployed	0.81 (0.46–1.4)	0.72 (0.39–1.33)	0.88 (0.58–1.33)	0.85 (0.54–1.33)

aOR: adjusted odds ratio; CI: confidence interval; HCreole: Haitian/Creole Speaking; Oth: Other; OAT: Onset-to-arrival time; SDH: Social Determinants of Health.

[a]Adjusted for age, OAT (missing indicator).

[b]Fully adjusted for all SDH.

[c]Adjusted for age.

*Denotes statistical significance.