

## Racial/ethnic variation in recovery of motor function in stroke survivors: Role of informal caregivers

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**Abstract**—Research documents that African American and Latinos who have experienced an acute stroke recover more slowly than Caucasians in the United States. This descriptive study examines (1) the variation in Caucasian, Puerto Rican, and African American motor function after stroke; (2) the association between caregiver attributes and motor recovery after stroke; and (3) the degree to which caregiver attributes explain the variation in motor recovery between different racial/ethnic groups. One hundred and thirty-five veterans who had been hospitalized after an acute stroke, released home, and identified an informal caregiver were enrolled in the study. Veterans and caregivers were surveyed at five time points over the course of 24 months. Results indicate that Puerto Ricans show greater impairment and African Americans show less impairment at discharge from the hospital compared with Caucasians. Caregiver characteristics mediate the racial/ethnic differences in impairment at discharge and motor recovery across time.

**Key words:** African American, caregivers, Caucasian, longitudinal, Puerto Rican, race/ethnicity, recovery, rehabilitation, stroke, veterans.

### INTRODUCTION

An important aspect of recovery from stroke after discharge from the hospital is the presence of a caregiver. A majority of stroke survivors return home for rehabilitation, usually to an informal caregiver who is a spouse, child, or friend [1]. Little is known about how the number

of caregivers and the amount of care provided is related to the recovery of motor function in stroke survivors. African Americans and Latinos generally have poorer recovery outcomes poststroke, but evidence supports that, for these groups, the number of caregivers and the amount of care positively affects these lower outcomes. This study examines the association between the number of caregivers, the amount of care provided, and impairment at discharge from the hospital and recovery of motor function over the course of 24 months.

### BACKGROUND

#### Racial/Ethnic Differences in Stroke

Stroke is the leading cause of serious long-term disability affecting more than 4 million people in the United States [2–4]. Research indicates that racial/ethnic variations occur in the incidence and mortality of stroke, with

**Abbreviations:** FIM = Functional Independence Measure, IRB = Institutional Review Board, mFIM = motor subscale of the FIM, SD = standard deviation, VA = Department of Veterans Affairs, VAMC = VA medical center.

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African Americans and Latinos having a higher incidence of stroke and greater stroke mortality than Caucasians [5]. Latino and African-American stroke patients are twice as likely as Caucasians to experience a recurrent stroke within 2 years of their first stroke [6]. In addition, African American stroke survivors have greater residual physical impairment after the stroke [7]. Moreover, significant differences are apparent among Latino subgroups, indicating higher levels of stroke mortality among Puerto Ricans than Cuban or Mexican Americans [8]. One study revealed lower Functional Independence Measure (FIM) scores among Mexican Americans than Caucasians or African Americans upon admission for stroke rehabilitation, but comparable FIM scores at discharge [9]. Yet another study of Mexican Americans indicates a lower stroke burden than among Caucasians [10]. A separate study found lower levels of rehospitalization among Mexican Americans and speculated the positive effect of family care [11].

### Caregiver Context

Close to 80 percent of stroke survivors are discharged home with the burden of continuing care and recovery shifting to informal caregivers, often family members with little or no preparation or training. Informal caregivers face difficulties, such as uncertainty, anxiety, depression, eroded health, and poor quality of life, due to the sudden onset of stroke and the new caregiver role [12–14]. Notably, caregivers of all races and ethnicities are at risk for depression, reduced quality of life, and increased anxiety [15–16], but these conditions also vary by race/ethnicity. Caucasian caregivers report feeling more distress and show more depressive symptoms than African-American caregivers [17]. African-American caregivers are more likely to have health problems and have higher mortality rates than Caucasian caregivers [18]. African Americans conversely are more likely to have more favorable perceptions of caregiving than Caucasians in contexts other than stroke rehabilitation (Alzheimer's caregiving) [19] and are more likely to express stronger cultural reasons for providing care than Caucasian caregivers [20].

Some literature suggests that Latino caregivers are less likely to institutionalize those in their care, or delay institutionalization the longest compared with other racial/ethnic groups [21]. Latino caregivers are also more likely to be family members, and culturally, Latinos report a greater sense of duty toward the elderly in their care than do other racial/ethnic groups [22–23]. Latino caregivers

also spend more hours on informal care than Caucasian and African-American caregivers [24].

The role of social support, culturally embedded family systems, and informal family care often has been used to explain unexpectedly better health outcomes among Latinos [25]. Postacute stroke disability and survival among Latinos are beginning to draw similar attention. For example, residence in a high-density Mexican-American neighborhood appears to positively affect survival after a stroke [26]. Further suggestive evidence is indicated in the observation that receipt of informal care by disabled older adults is highest among Latinos and lowest among Caucasians [24].

In this study, we identified a population of veterans hospitalized for acute stroke in several Department of Veterans Affairs (VA) hospitals who returned home for care by an informal caregiver. We add to the literature by constructing a descriptive picture of the relationship between caregiver attributes, the amount of care provided to these racially/ethnically diverse veterans, and their functional recovery outcomes over 24 months.

## METHODOLOGY

### Research Questions

1. How do Caucasian, Puerto Rican, and African-American stroke survivors differ in their motor function after stroke across 24 months following discharge home?
2. Are caregiver attributes and motor recovery associated after acute stroke?
3. Can caregiver attributes explain the variation in motor recovery between different racial/ethnic groups?

### Subjects

The data for this analysis are drawn from a longitudinal study of culturally sensitive models of stroke recovery and caregiving among veterans [27]. Caregivers of stroke survivors were identified in several VA medical centers (VAMCs) in Florida and Puerto Rico from 2000 to 2001. The target sample was veterans who experienced acute stroke who identified a primary informal caregiver upon his or her hospital discharge directly to home. Survivor demographic and baseline health data and caregiver demographic information were collected at discharge from 125 survivor and caregiver pairs. The panel was stratified by race/ethnicity, yielding 49 Puerto Ricans, 33 African Americans, and 43 non-Latino Caucasians.

## Data Collection

This study was approved by the University of Florida Health Science Center Institutional Review Board (IRB) and the individual VAMC IRBs in San Juan, Puerto Rico; Tampa, Florida; and Miami, Florida. Informed consent was obtained prior to enrollment. Subjects were given a copy of the consent form, and a copy was placed in their medical record. Demographic and baseline health data were collected at discharge from patients and measures of recovery were performed on the stroke survivor at 1, 6, 12, 18, and 24 months following the stroke. In addition, the caregivers were given a survey to complete during the home visits. One hundred thirty-five caregiver-stroke survivor dyads were originally enrolled and initial data were collected while the stroke survivor was still in the hospital. At the 1-month follow-up visit, 11 dyads withdrew, reducing our sample to 124 dyads ( $n = 248$ ). Of the 124 caregivers, 45 were Caucasian non-Hispanic, 28 were African American, 2 were Asian American, and 49 were Puerto Rican (8 residing in the United States and 41 residing in Puerto Rico). Of the 124 stroke survivors, 45 were Caucasian non-Hispanic, 30 were African American, and 49 were Puerto Rican (8 residing in the United States and 41 residing in Puerto Rico). Of the stroke survivors, 124 were men and 2 were women, and of the caregivers, 16 were men, and 110 were women. The average age was  $66.6 \pm 10.61$  standard deviation (SD) for care recipients and  $59.0 \pm 14.08$  for caregivers. At the 6-month visit, 12 dyads withdrew; at the 12-month visit, 13 withdrew. Subsequently, 6 more dyads withdrew at the 18-month interview, and 4 more withdrew at 24 months. Of the 46 dyads that did not complete the study, 3 survivors went into a nursing home, 8 survivors died, 16 survivors withdrew consent, 9 survivors moved or were lost to follow-up, 4 survivors were too sick to continue, 1 caregiver died and was not replaced, 4 caregivers ceased to provide care, and 1 caregiver became ineligible. Analyses indicated that survivors and caregivers who withdrew from the study did not statistically differ from those who did not withdraw from the study across multiple domains, with the exception of African-American participants, who were more likely to refuse consent at the 18- and 24-month visits.

## Measures

### Motor Functioning

The FIM is a scale commonly used to measure physical and cognitive recovery after stroke (**Appendix**, available online only). This analysis uses only the motor

subscale of the FIM (mFIM), which measures motor functioning in activities of daily living. The mFIM measures basic motor functioning and consists of 15 questions about toileting, bathing, dressing, eating, and mobility [28]. Trained interviewers administered the mFIM to the stroke survivors at discharge from the hospital and in their homes at 1, 6, 12, and 24 months poststroke. The mFIM scale ranges from 13 to 91, with 13 representing total assistance with motor activities and 91 representing complete independence in motor functioning.

### Time

Time is included in the model to represent each interview time point. Time is coded as a continuous variable that ranges from 0 to 5. On this scale, 0 represents the baseline interview taken at discharge from the hospital, 1 represents the 1-month interviews, 2 represents the 6-month interviews and so on.

### Stroke Survivor Variables

To test for the association between caregivers and stroke recovery, one must control for factors that may simultaneously influence recovery. In this analysis, we controlled for patient age, income, educational level, and comorbid conditions at baseline (discharge from the hospital). Age is measured as a continuous variable in years, income is measured on a scale from 1 to 5 with higher numbers indicating greater income (1 =  $\leq \$14,999$ , 2 =  $\$15,000$ – $\$24,999$ , 3 =  $\$25,000$ – $\$34,999$ , 4 =  $\$35,000$ – $\$44,999$ , 5 =  $\geq \$45,000$ ); educational level is measured on a 7-point ordinal scale with larger numbers indicating higher levels of education (1 =  $< 7$  years, 2 = 7–9 years, 3 = 10–11 years, 4 = high school graduate, 5 = some college or technical school, 6 = college graduate, 7 = graduate school); and patients' comorbid conditions are measured with the Charlson Comorbidity Index. This index ranges from 1 to 6, depending on the severity and number of comorbid conditions.

### Caregiver Demographics

Baseline caregiver demographics used in this analysis are age, educational level, sex, and health status. Age is measured as a continuous variable in years, and educational level is measured on an ordinal scale that ranges from 1 to 7, with higher numbers indicating greater levels of education. Health status is a caregiver self-report variable with higher numbers indicating poorer health and is coded as follows: 1 = excellent, 2 = very good, 3 = good, 4 = fair, and 5 = poor.

### Caregiver Network Characteristics

We used caregiver relationship to stroke survivor, average number of people in caregiver network over 24 months, time spent providing care, and average caregiver need for outside help to measure characteristics of caregiver networks in this study. Stroke survivors identified their relationship to their primary caregiver (spouse/partner, children, friend, other); this variable was coded so that spouse/partners = 1 and all others = 0. At each interview, caregivers were asked to name up to two others who provided caregiving assistance to them. We averaged their responses over 24 months to obtain the average number of caregivers for each stroke survivor. Caregivers also reported the actual number of hours per day they spend providing care. We averaged their responses over the 24 months poststroke to obtain the average time spent providing care. Caregivers were asked whether they could use outside help with caregiving activities at each time point. We averaged their responses across time to arrive at a variable ranging from 0 to 1 measuring need for help.

### Analytic Strategy

The data analyzed in this article represent a longitudinal design with repeated measurements of functional

recovery for individuals at successive points in time. The most appropriate statistical method is a multilevel model (also called hierarchical linear models, mixed models, or random effects models). We tested two components in our multilevel models: within-individual components, which measure one person's functional change over time; and between-individual components, which measure variation between individuals in functional change over time. We selected an autoregressive correlation structure for the repeated measurements and used hierarchical linear modeling (specifically, HLM6 software) [29] for the data analyses.

## RESULTS

### Bivariate

The first analysis examines demographic and caregiver network characteristics and compares them for Caucasian, African American, and Puerto Rican stroke survivors. **Table 1** displays the results of this analysis. The average age of stroke survivors in our sample is 66.6 years and the

**Table 1.**

One-way analysis of variance test for racial/ethnic differences in patient and caregiver characteristics (data shown as mean  $\pm$  standard deviation unless otherwise indicated).

Characteristic	Total (N = 121)	Caucasian (n = 42)	Puerto Rican (n = 49)	African American (n = 30)	F-Statistic	p-Value
mFIM	74.82 $\pm$ 15.77	78.29 $\pm$ 10.14*	67.66 $\pm$ 20.28 <sup>†‡</sup>	80.94 $\pm$ 8.95*	9.96	0.000
Patient Demographics						
Age	66.58 $\pm$ 10.29	66.71 $\pm$ 9.71	69.31 $\pm$ 9.90 <sup>†</sup>	61.97 $\pm$ 10.39*	5.06	0.008
Income	1.88 $\pm$ 1.09	2.10 $\pm$ 1.14	1.61 $\pm$ 0.98	2.03 $\pm$ 1.13	2.67	0.070
Educational Level	4.45 $\pm$ 1.25	4.48 $\pm$ 1.04	4.59 $\pm$ 1.24	4.17 $\pm$ 1.51	1.09	0.34
Comorbidity Index	3.12 $\pm$ 1.53	2.93 $\pm$ 1.33	3.10 $\pm$ 1.57	3.43 $\pm$ 1.70	0.97	0.38
Caregiver Demographics						
Age	59.33 $\pm$ 16.70	62.38 $\pm$ 11.13	58.77 $\pm$ 15.09	56.00 $\pm$ 14.12	2.00	0.14
Educational Level	4.08 $\pm$ 1.59	4.13 $\pm$ 1.03	4.09 $\pm$ 1.99	4.00 $\pm$ 1.55	0.06	0.94
Female	0.88 $\pm$ 0.32	0.92 $\pm$ 0.27	0.86 $\pm$ 0.35	0.87 $\pm$ 0.35	0.42	0.66
Health	3.04 $\pm$ 0.91	3.12 $\pm$ 0.91	3.02 $\pm$ 0.98	2.95 $\pm$ 0.95	0.31	0.74
Caregiver Network						
Caregiver is Spouse	0.65 $\pm$ 0.48	0.71 $\pm$ 0.46	0.64 $\pm$ 0.48	0.57 $\pm$ 0.50	0.84	0.4
Number of Caregivers	1.19 $\pm$ 0.34	1.13 $\pm$ 0.31*	1.31 $\pm$ 0.40 <sup>†</sup>	1.11 $\pm$ 0.27*	4.06	0.0
Caregiver Needs Help	0.22 $\pm$ 0.32	0.17 $\pm$ 0.29	0.27 $\pm$ 0.35	0.24 $\pm$ 0.31	1.13	0.33
Hours Per Day Providing Care	8.53 $\pm$ 6.14	7.78 $\pm$ 7.02	10.21 $\pm$ 5.18 <sup>‡</sup>	6.82 $\pm$ 5.76*	3.35	0.04

\*Distinct from Puerto Ricans.

<sup>†</sup>Distinct from Caucasians.

<sup>‡</sup>Distinct from African Americans.

mFIM = motor subscale of the Functional Independence Measure.

average income corresponds roughly to between \$15,000 and \$25,000 per year. Educational level of stroke survivors corresponds to some college or technical school. Average comorbidity index is 3.1 on a scale from 1 to 6. Caregivers have an average age of 59 years and have an average educational level that corresponds to high school graduates. Eighty-eight percent of caregivers are women and their self-rated health is 3.0 on a scale of 1 to 5, indicating average health. Stroke survivors and caregivers do not differ by race/ethnicity in their demographic characteristics.

Sixty-five percent of caregivers were the spouse of the stroke survivor, and the average number of caregivers in our sample was 1.19 over the course of 24 months. Twenty-two percent of caregivers report the need for help with caregiving activities, and caregivers report spending an average of 8.5 hours per day providing care. The number of caregivers providing care for stroke survivors is higher for the Puerto Rican group. Puerto Ricans have 1.31 caregivers compared with 1.13 for Caucasians and 1.11 for African Americans. In addition, Puerto Rican caregivers provide more hours per day of care for stroke survivors compared with African Americans. Puerto Rican caregivers average 10.2 hours per day compared with 6.8 for African Americans; Caucasians average 7.8 hours per day, which is not statistically distinct from African Americans.

### Multivariate

The second analysis uses hierarchical linear modeling to estimate the average growth trajectory for stroke survivors over the five time points of data collection (24 months) poststroke. Our first model is an unconditional model with only motor function. This unconditional model indicates that the average mFIM score for all veterans across all time points in our sample is 80.24. Model 2 adds time and the quadratic of time to the model to estimate the average mFIM score of stroke survivors in our sample. This model allows us to examine the average trajectory while controlling for time and the quadratic of time. In this model we see that adjusting for time and time 2, the average trajectory is 74.95 with an average change of  $5.58 + 2(-0.90)$  (0–1) from time 0 to time 1. **Figure 1** displays the actual trajectories of 8 individual stroke survivors in this study as an example of how these trajectories can differ between individuals.

Model 3 adds race/ethnicity to examine the average trajectories for Caucasian, African-American, and Puerto Rican stroke survivors. This model demonstrates that, controlling for time, African Americans have an average

mFIM score that is 4.66 points higher than Caucasians ( $p < 0.01$ ) and Puerto Ricans have an average mFIM score that is 5.64 points lower than Caucasians ( $p < 0.05$ ). **Table 2** and **Figure 2** display the average recovery trajectories over time for the average stroke survivor, as well as the average Caucasian, Puerto Rican, and African-American stroke survivor.

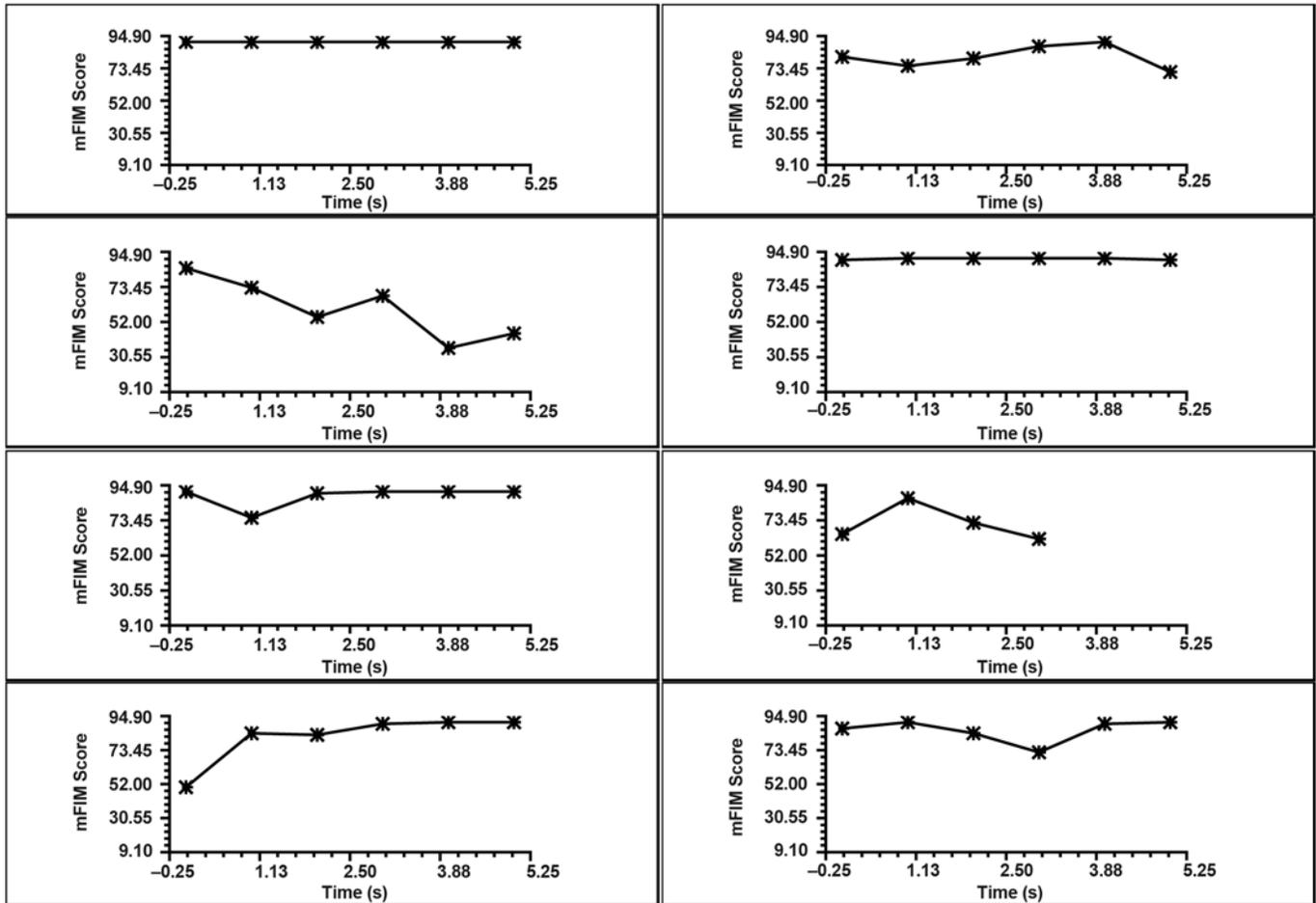
Higher numbers represent greater functional independence, and **Figure 2** demonstrates that the trajectories of stroke survivors are curvilinear. Recovery starts low for all racial/ethnic groups, peaking at 12 months for African Americans and Puerto Ricans and peaking at 6 months for Caucasians before a subsequent decline.

The fourth, fifth, and sixth models add patient demographics, caregiver demographics, and caregiver network characteristics separately in order to examine their effects independently. The seventh and final model adds all variables into the model.

**Table 3** displays the results of these models. These models demonstrate that several patient and caregiver attributes predict mFIM scores at baseline. Racial/ethnic differences in mFIM scores are evident in model 3, but Puerto Ricans become similar to Caucasian stroke survivors when patient demographics (model 4) and caregiver network characteristics (model 6) are added. This indicates that these two sets of covariates can explain the lower mFIM score for Puerto Rican stroke survivors. Conversely, African-American stroke survivors have a higher mFIM score than Caucasians even when holding all covariates constant in the model ( $\beta_{06} = 3.72, p < 0.05$ ). In the full model (model 7), educational level of the stroke survivor, number of caregivers, and number of hours spent providing care are predictors of mFIM. Patients who have lower educational levels have higher mFIM scores ( $\beta_{010} = -1.66, p < 0.05$ ). Patients who have a greater number of caregivers have lower mFIM scores ( $\beta_{01} = -7.74, p < 0.05$ ), and patients with greater hours devoted to providing care have lower mFIM scores ( $\beta_{014} = -0.49, p < 0.01$ ).

The next set of analyses mirrors the first with the exception of the focus of the coefficients. **Table 4** displays the results of these analyses. In these models, the dependent level-2 variable becomes time, and each of the person-level covariates are regressed on time, which represents recovery (mFIM scores) over time.

Results from model 3 indicate that no racial/ethnic differences exist in the recovery of motor function over time as measured by mFIM. Puerto Rican stroke survivors

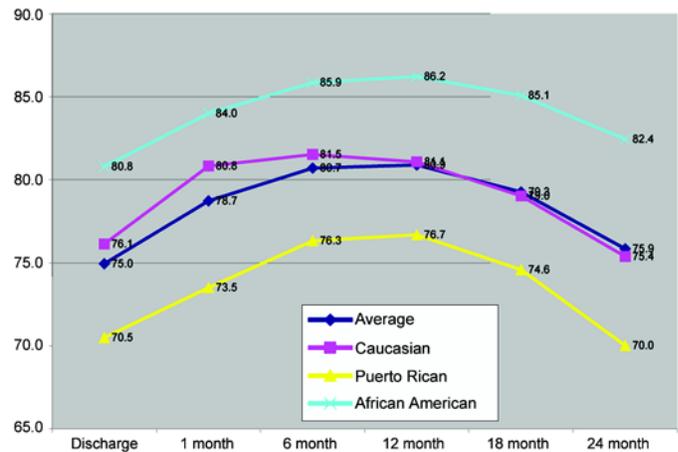


**Figure 1.** Sample of motor recovery trajectories for 8 stroke survivors. mFIM = motor subscale of the Functional Independence Measure.

**Table 2.** Average recovery trajectories by race/ethnicity.

Recovery Time	Trajectories			
	Average	Caucasian	Puerto Rican	African American
Discharge	75.0	76.1	70.5	80.8
1 month	78.7	80.8	73.5	84.0
6 months	80.7	81.5	76.3	85.9
12 months	80.9	81.1	76.7	86.2
18 months	79.3	79.0	74.6	85.1
24 months	75.9	75.4	70.0	82.4

show better growth over time when controlling for patient demographics and caregiver network characteristics, as well as in the full model, model 7. In this final model, controlling for all covariates, we see that patient comorbidity, patient educational level, and the number of hours per day



**Figure 2.** Stroke recovery trajectories: motor subscale of the Functional Independence Measure scores by race/ethnicity.

**Table 3.**

Hierarchical linear modeling: Patient and caregiver characteristics regressed on baseline motor recovery (data shown as unstandardized beta coefficient/standardized beta coefficient).

Characteristic	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	80.25/1.13*	74.95/1.28*	74.94/1.29*	74.96/1.26*	74.96/1.45*	74.94/1.22*	74.96/1.45*
Time	—	5.58/0.72*	5.08/0.77*	5.00/0.76*	4.43/1.09*	5.28/0.82*	4.82/0.81*
Time 2	—	-0.90/0.14*	-0.91/0.14*	-0.93/0.14*	-0.90/0.14*	-0.93/0.14*	-0.93/0.14*
Race/Ethnicity							
African American	—	—	0.87/0.55	0.77/0.56	0.79/0.64	0.70/0.54	0.44/0.50
Puerto Rican	—	—	0.71/0.47	1.01/0.48†	0.72/0.71	1.48/0.48*	1.56/0.64†
Patient Demographics							
Age	—	—	—	-0.06/0.02†	—	—	-0.05/0.03
Income	—	—	—	-0.02/0.19	—	—	-0.13/0.24
Educational Level	—	—	—	-0.32/0.17	—	—	-0.44/0.18†
Comorbidity Index	—	—	—	-0.53/0.14*	—	—	-0.34/0.15†
Caregiver Demographics							
Age	—	—	—	—	-0.03/0.02	—	-0.02/0.02
Educational Level	—	—	—	—	-0.08/0.19	—	-0.04/0.16
Female	—	—	—	—	0.71/0.84	—	0.99/0.78
Health	—	—	—	—	0.34/0.36	—	0.12/0.28
Caregiver Network							
Caregiver is Spouse	—	—	—	—	—	-0.67/0.45	-0.55/0.53
Number of Caregivers	—	—	—	—	—	-2.20/0.66*	-1.93/1.31
Caregiver Needs Help	—	—	—	—	—	-0.68/0.74	-0.24/0.92
Hours Per Day Providing Care	—	—	—	—	—	-0.12/0.03*	-0.12/0.04*
Within Variation	—	73.65	73.23	71.45	72.65	71.24	69.82
Between Variation	—	132.57	134.60	126.47	135.96	117.27	116.27
Deviance	—	4,548.50	4,544.70	4,533.10	4,546.50	4,515.40	4,515.60

\* $p < 0.01$ .

† $p < 0.05$ .

care is provided for patient are predictors of improvement in mFIM. Patients with lower levels of education have greater mFIM growth ( $\beta_{19} = -0.44$ ,  $p < 0.05$ ). Patients who score higher on the comorbidity index have slower growth in mFIM scores over time ( $\beta_{110} = -0.34$ ,  $p < 0.05$ ). Patients whose caregivers spend more hours per day providing care have lower mFIM growth ( $\beta_{113} = -0.12$ ,  $p < 0.01$ ).

## DISCUSSION

Several patterns of recovery among our participants across the 2-year period were of interest. FIM motor scores steadily increase over the course of the first year and then begin to drop again. For African Americans and Puerto Ricans, unadjusted 24-month mFIM scores are lower than baseline scores. The curvilinear pattern across time in functional independence is similar in all three racial/ethnic groups.

Baseline mFIM scores were significantly higher for African Americans than Caucasians in our sample when we adjusted for caregiver factors. This finding is counter to recent studies that show African-American stroke survivors with a lower FIM score than Caucasians at discharge from the hospital [30]. African-American stroke survivors in our sample were younger, had fewer caregivers, and had fewer hours spent on informal care than Puerto Rican stroke survivors. The higher baseline mFIM scores can be due to two factors that have to do with excess stroke burden and family caregiving. African Americans, and African-American men specifically, are most at risk for experiencing a fatal stroke and experience worse poststroke rehabilitation [5,7]. A recent study indicates that African Americans are more likely to be discharged to extended care facilities or nursing homes than other racial/ethnic groups [31]. Being discharged to a nursing home or other institutional facility was an exclusion criterion for our study; therefore the possibility exists that we have an overrepresentation of healthier African Americans in our sample. Additionally, African

**Table 4.**

Hierarchical linear modeling: Patient and caregiver characteristics regressed on motor recovery growth (data shown as unstandardized beta coefficient/standardized beta coefficient).

Characteristic	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Intercept	80.25/1.13*	74.95/1.28*	76.14/1.55*	75.70/1.49*	77.41/2.53*	76.54/1.90*	78.00/2.50*
Time	—	5.58/0.72*	5.59/0.77*	5.57/0.77*	5.58/0.78*	5.59/0.78*	5.57/0.78*
Time 2	—	-0.90/0.14*	-0.90/0.14*	-0.90/0.14*	-0.90/0.14*	-0.90/0.14*	-0.90/0.14*
Race/Ethnicity							
African American	—	—	4.66/1.66*	3.98/1.75†	5.08/1.85*	4.13/1.51*	3.72/1.84†
Puerto Rican	—	—	-5.64/2.62†	2-4.18/2.41	-5.47/2.74†	-2.36/2.24	-1.86/2.10
Patient Demographics							
Age	—	—	—	-0.17/0.11	—	—	-0.08/0.10
Income	—	—	—	1.20/0.74	—	—	0.60/0.80
Educational Level	—	—	—	-1.43/0.85	—	—	-1.66/0.83†
Comorbidity Index	—	—	—	-1.71/0.62*	—	—	-0.99/0.60
Caregiver Demographics							
Age	—	—	—	—	0.23/0.11	—	-0.01/0.10
Educational Level	—	—	—	—	1.11/0.95	—	1.28/0.93
Female	—	—	—	—	-1.65/2.35	—	-2.99/2.83
Health	—	—	—	—	1.19/1.59	—	-0.27/1.50
Caregiver Network							
Caregiver is Spouse	—	—	—	—	—	-2.49/1.80	-0.84/1.82
Number of Caregivers	—	—	—	—	—	-7.13/3.29†	-7.74/3.48†
Caregiver Needs Help	—	—	—	—	—	-6.61/3.88	-5.68/3.83
Hours Per Day Providing Care	—	—	—	—	—	-0.61/0.13*	-0.49/0.14*
Within Variation	—	73.65	73.65	73.67	73.61	73.68	73.64
Between Variation	—	132.57	117.99	109.82	117.63	94.39	93.50
Deviance	—	4,548.50	4,527.10	4,514.00	4,518.10	4,419.20	4,475.80

\* $p < 0.01$ .

† $p < 0.05$ .

Americans as a group are less likely to be married; this lack of spousal and child relationships may make being released to the community more difficult, even if they have a higher relative functional status.

Puerto Rican stroke survivors had lower baseline mFIM scores and similar but lower curvilinear recovery trajectories than Caucasians and African Americans in the unadjusted models. Once the models were adjusted for caregiver network characteristics, we found that Puerto Rican stroke survivors had an average increase in mFIM scores between time points that was significantly greater than for Caucasians. In other words, when caregiver characteristics are taken into account, recovery outcomes across time become better for Puerto Rican stroke survivors. This finding is consistent with a study that speculates caregivers provide a positive effect on recovery for Latinos [11].

Caregiver demographics and network characteristics are associated with baseline motor function for stroke survivors. Controlling for patient demographics, we see that two caregiver network characteristics predict motor

impairment at baseline: number of caregivers and number of hours spent per day providing care. Stroke survivors who have more caregivers also have a lower baseline motor functioning. Stroke survivors who have caregivers who spend more time per day providing care also have a lower baseline motor functioning.

Caregiver demographics and network characteristics are associated with recovery of motor function across time. Our analyses demonstrate that independent of patient and caregiver demographics, the number of hours spent per day providing care for stroke survivors is associated with slower motor recovery across time. The more hours spent per day providing care is associated with slower motor recovery across time. In other words, stroke survivors who receive more informal care have smaller gains in recovery across time.

This study has several limitations that center on the study population. First, males make up our VA population of stroke survivors and only two women participated in the study. Participants were mostly World War II and

Korean War veterans experiencing chronic conditions that are typical of older populations. Women did not begin joining the military in any significant numbers until the 1970s. We expect to see women with these types of health conditions in veteran populations in the future. Second, the majority of caregivers in our sample are spouses and female family members of these male stroke survivors. Thus, the relationship between caregiver characteristics and stroke survivors may not hold true for male spouses of female stroke survivors. The patterns may differ in ways that are related to traditional gender roles and care-taking activities that partners take on in marital relationships. A third limitation is that our sample consisted of stroke survivors living in Florida and Puerto Rico. Specific interest in multiple components of stroke recovery and informal caregiving among veterans in our integrated service network resulted in our choice of sample. Caregivers and stroke survivors may be unique and dissimilar to caregiver-stroke survivor dyads elsewhere on the U.S. Mainland or other portions of the Caribbean.

This article provides a broad portrait of the association between caregiver characteristics and motor function recovery for veterans over 24 months. These findings are of interest to clinicians and researchers who may develop strategies to aid in the recovery process and ease the burden of the caregiving role. Future research should continue to focus on the differential outcomes of stroke recovery and the role of caregivers in this process.

## CONCLUSIONS

This article provides a broad portrait of the association between caregiver characteristics and motor function recovery for veterans over a 24-month period. These findings are of interest to clinicians and researchers who may develop strategies to aid in the recovery process and ease the burden of the caregiver role. Future research should continue to focus on the differential outcomes of stroke recovery and the role of caregivers in this process.

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