Racial Disparities in Stroke Recovery Persistence in the Post-Acute Stroke Recovery Phase: Evidence from the Health and Retirement Study

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Background and Purpose: Blacks have a higher burden of post-stroke disability. Factors associated with racial differences in long-term post-stroke disability are not well-understood. Our aim was to assess the long-term racial differences in risk factors associated with stroke recovery.

Methods: We examined Health and Retirement Study (HRS) longitudinal interview data collected from adults living with stroke who were aged >50 years during 2000-2014. Analysis of 1,002 first-time, non-Hispanic, Black (210) or White (792) stroke survivors with data on activities of daily living (ADL), fine motor skills (FMS) and gross motor skills (GMS) was conducted. Ordinal regression analysis was used to assess the impact of sex, race, household residents, household income, comorbidities, and the time since having a stroke on functional outcomes.

Results: Black stroke survivors were younger compared with Whites (69 ± 10.4 vs 75 ± 11.9). The majority (~65%) of Black stroke survivors were female compared with about 54% White female stroke survivors (P=.007). Black stroke survivors had more household residents (P<.001) and comorbidities (P<.001). Aging, being female, being Black and a longer time since stroke were associated with a higher odds of having increased difficulty in ADL, FMS and/or GMS. Comorbidities were associated with increased difficulty with GMS. Black race increased the impact of comorbidities on ADL and FMS in comparison with Whites.

Conclusion: Our data suggest that the effects of aging, sex and unique factors associated with race should be taken

Introduction

Stroke is a leading cause of severe long-term disability that manifests as cognitive and mobility impairments.[1] It is well-established that disparities in stroke incidence and prevalence persist within the Black population in the United States.[2] Evidence also suggests that Blacks experience more severe post-stroke disability in ambulatory settings compared with Whites.[3] Although racial disparities in stroke-related illness persists throughout the continuum of care, the differential impacts of community-living, co-morbid conditions, sex and sociodemographic

factors[4,5] on the chronic phase of stroke are not well-understood.

The World Health Organization's international classification of functioning, disability, and health (ICF) is a framework that describes functioning and disability as a universal experience involving complex interactions between health conditions, personal factors, and environmental factors that impact functioning at an individual's daily activity level as well as community-level functioning.[6] Evidence suggests that Black patients are more limited in activities of daily living (ADL)[7] and generally experience slower and less complete recovery,[8,9] a phenomenon not fully accounted for

by increased stroke severity. Social support protects against a variety of chronic and behavioral diseases and the lack thereof has been associated with hospital re-admittance,[10,11] depression, and poorer outcomes due to stress.[11] The literature suggests that social support in the form of a large household, or professional or family caregivers, is positively as-

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sociated with successful discharge from hospital or rehabilitation,[10,12] and with more recovery of motor function.[13,14] Further, decreased family support and increased family dysfunction are associated with poorer stroke recovery outcomes.[15]

Sex in racial disparities is also an important factor. Women experience increased difficulties with stroke recovery due to various factors. First, at the time of stroke, women have a higher burden of pre-morbid disabilities which increases vulnerability to stroke-related motor function decline.[16] Irrespective of pre-stroke disability status, the longer lifespan of women may render recovery more difficult when they do have stroke.[17] Moreover, some elements within the scope of the socioeconomic status (SES) paradigm have been associated with post-stroke recovery.[18] Lower income patients are less likely to access outpatient and ambulatory health care services.[19] In addition, these patients are presented with challenges regarding medication acquisition and proper nutrition optimal for recovery.[20-22] Collectively, these findings suggest that modifiable and non-modifiable risk factors may contribute to long-term post-stroke outcomes. Whether these factors impact Black stroke survivors' recovery is unclear.

Typically, stroke-related hospital data collection ends 90 days after discharge, limiting a more comprehensive assessment of recovery.[23,24] Documentation of longitudinal stroke outcomes and factors associated with long-term stroke prognosis is an important consideration when seeking to understand factors emerging after hospitalization that impact stroke recovery in specific populations. The Health and Retirement Study (HRS) is a longitudinal dataset with unique epidemiological variables that may be important in understanding stroke recovery disparities. Thus, identification of potentially modifiable factors on

the family/community and environmental levels that improve stroke recovery outcomes are critical for the development of strategies to reduce racial disparities in stroke-induced disability. This study assessed the racial disparities in post-stroke functional outcomes in the HRS dataset.

METHODS

Data Source

The HRS is a nationally representative longitudinal study of 37,495 US residents aged >50 years with 11,094 variables as of 2016.[25] Chronic disease variables were selected based on the reliability of these variables in past major health surveys. At the time of this analysis, the HRS dataset contained 12 biennial interviews conducted between 1992 and 2014 over the telephone or in person throughout all 48 contiguous states and the District of Columbia. Methodology and consent for the original protocol was approved by the University of Michigan institutional review board. The HRS includes a multistage area probability sample design and oversamples households with Black adults. The self-reported disease survey model shares high correspondence with physician reports.[26] The HRS also has a well-documented procedure of recruitment and retention of minority participants with incident stroke.[27] More importantly, HRS participants were interviewed about sociodemographic and environmental variables as well as economic resources, social ties, and household composition. These

parameters are assessed with the stroke participant physical health, functioning and disability indicators. The sample used in the current analyses was limited to community-dwelling adults who self-reported first-time stroke and who participated in at least two waves of observation between 2000 and 2014. This time frame was selected because it coincides with initial approval and clinical implementation of intravenous tissue plasminogen activator (IV tPA) for treatment of stroke.[28-30] Survey design, questionnaires, and additional details about HRS can be found on the HRS web portal (http://hrsonline.isr.umich.edu/).

Participants

For the current study, data from 1,002 HRS participants or a proxy for the person living with stroke who met specific criteria were included in the analysis. Non-Hispanic Blacks (210) and Whites (792) with baseline data who reported a first-ever stroke during the interview calendar year and who volunteered information about demographic, socioeconomic status, and health variables of interest were included. Participants who were not classified as respondents or a proxy for the stroke participant were excluded from the analyses. Individuals who had a stroke at baseline or in the last wave were also excluded.

Function Outcome Variables

Functional recovery outcomes data were collected using self-reported scores of post-stroke motor function difficulty. Due to the absence of the FIM score within the HRS dataset, we assessed functional recovery using three categories from the HRS data based on validated indices[19] as a proxy for the FIM score. These included: 1) activities of daily living (walking across a room, getting into and out of bed, dressing, bathing, and eating); 2) fine motor skills (FMS) (picking up a dime, eating, and dressing); and 3) gross motor skills (GMS) (walking one block, walking across the room, climbing one flight of stairs, and bathing). These indices were assessed for each qualified participant during the year the stroke was reported. The ADL difficulty score, which measures general functional status, was the sum of answers to five yes-or-no questions ("yes" recorded as 1, "no" recorded as 0) about whether patients experienced "some difficulty" in performing certain daily-living activities. The five questions corresponded to five activities: bathing, dressing, eating, entering or exiting bed, and walking across a room. Accordingly, ADL scores ranged from 0 to 5, with larger numbers indicating difficulty in more activities. The fine motor skills difficulty score also combined answers to yes-or-no questions, but applied to three activities (picking up a dime, eating, and dressing) and ranged from 0 to 3. The 0-to-5 range of the gross motor skills difficulty score is based on the five activities of walking one block, walking across a room, walking up one flight of stairs, entering or exiting bed, and bathing.

Independent Variables

Non-Hispanic Black and White racial groups were identified based on self-reported race and ethnicity. Sex, number of people in household, and comorbidities were included in the analyses as factors that contribute to post-stroke function difficulty. The number of people in the household served as a proxy for social support of the patient. The comorbidity score was derived from five validated chronic conditions shown to impede stroke recovery.[1] Included in the score was diabetes, hypertension, heart disease (heart attack, coronary heart disease, angina, congestive heart failure, or other heart illnesses), obesity (body mass index [BMI] >30) and cigarette smoking. The comorbidity score was calculated for patients summarizing responses to five binary questions ("yes" recorded as 1, "no" recorded as 0), with a final composite score ranging from 0 to 5. Covariates included age at the time of reported stroke (calculated in years and measured from birth year), household income, and time since stroke (time in years between the calendar year of the interview and stroke occurrence the time of function difficulty score).

Stroke Assessment

The analysis included ten biennial interview waves (IW). Stroke subjects were defined as subjects who had a first-ever nonfatal stroke in one of the interview waves between 2000 (5th IW) and 2014 (12th IW). The stroke diagnosis was acquired through self-report of a doctor's diagnosis of stroke (Has a doctor ever told you that you had a stroke?") and subsequent self-report of ever having a stroke or transient isch-
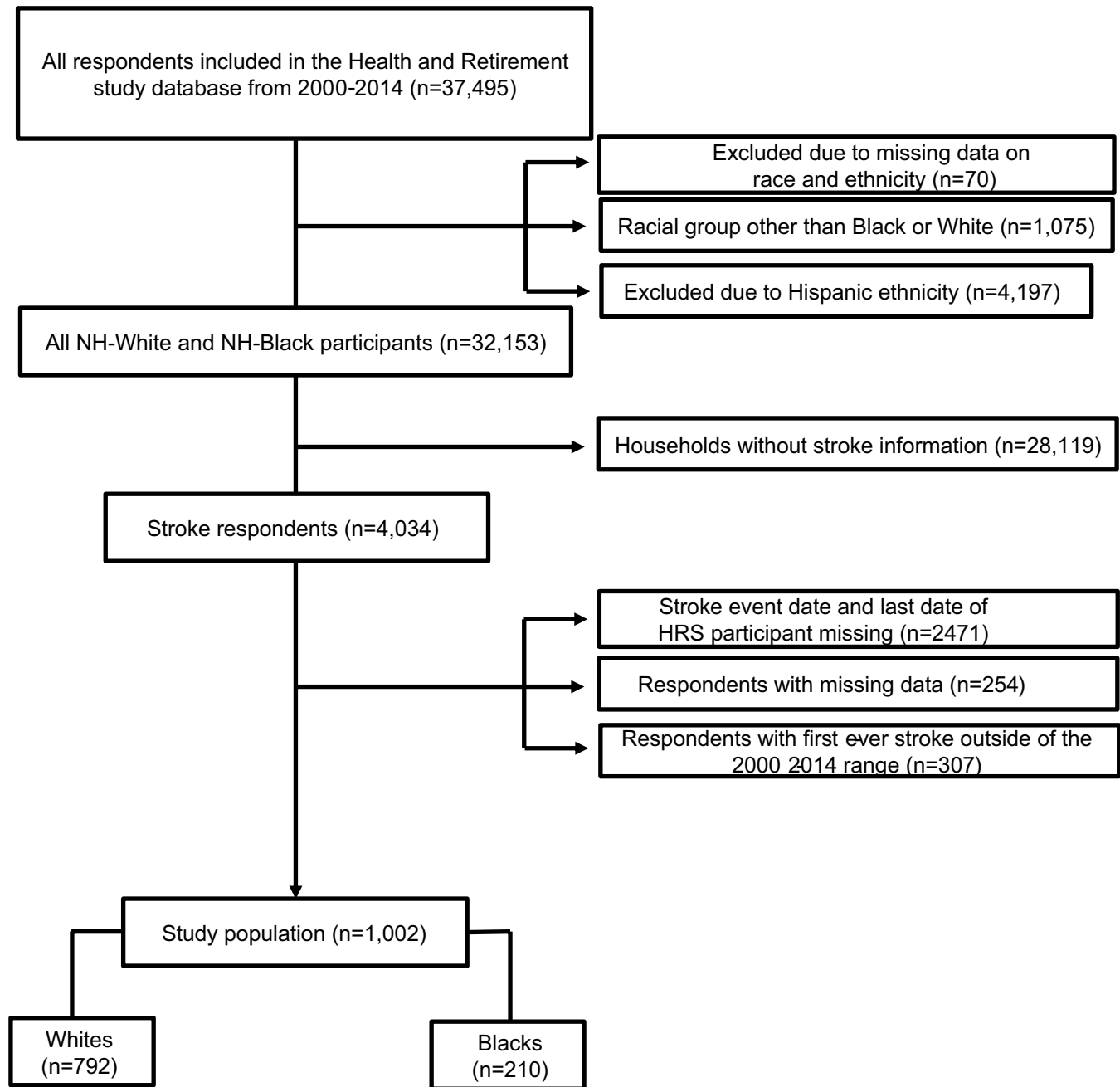
Figure 1. Flowchart for the selection of stroke respondents and/or proxies from the Health and Retirement Study database. Inclusion and exclusion criteria based on race and ethnicity, stroke status, and availability of specific measures were utilized to select the study population.

emic attack (TIA). Previous analysis of the validity of reliability of stroke reports with the HRS study showed that the frequency was similar to other cohort database studies using physician-verified stroke.[26] Stroke survivors were identified as respondents reporting a stroke during a follow-up interview and completed the interview in a later interview.

Statistical Analysis

Statistical analyses were performed using R statistical package, version 3.4.3 (R Foundation, https://www.r-project.org/foundation/). To analyze the demographic and health-related risk variables collected during the interview when stroke was initially reported, percentages (for categorical variables)

or medians and the median absolute deviations (for continuous variables) were calculated and compared across race using chi-square (c^2) test or a 2-sample t-test where appropriate. Ordinal logistic regression analysis was used to model the relationship between motor function difficulty scores (dependent variables) and sociodemographic factors (independent variables). Log odds ratios (ORs) and 95% CIs were calculated for function difficulty score in each functional recovery measurement for each of the predictors that included factors such as race, number of people in household, and sex as well as covariates such as age, household wealth, comorbidities and time since stroke. Values were converted to OR and 95% CI ORs.

RESULTS

Background Characteristics of the Study Population

A flow diagram outlining inclusion and exclusion criteria for the analytic sample included in our analysis is outlined in Figure 1. From the 37,495 total participants who completed the telephone interview and surveys, complete datasets for Whites and Blacks living with stroke was 1,002. The analytic sample consisted of 210 Black and 792 White respondents. Compared with Whites, Blacks were younger (69 ± 10.4 vs 75 ± 11.9 median years, P<.001). Blacks also reported more household residents (P<.001), less household wealth (P<.001), and higher comorbidity scores (P<.001)

Table 1. Baseline characteristics of study sample by race (N=1002)

Variables	Total, N=1002	Blacks, N=210	Whites, N=792	P
Age, in years				<.001[a]
Median (MAD)	74 (11.9)	69 (10.4)	75 (11.9)	
Sex, n (%)				.007[b]
Male	437 (43.6%)	74 (35.2%)	363 (45.8%)	
Female	565 (56.4)	136 (64.8%)	429 (54.2%)	
Number of household residents, n (%)				<.001[b]
1-5	978 (97.6%)	195 (92.9%)	783 (98.9%)	
6-9	22 (2.2%)	13 (6.2%)	9 (1.1%)	
10-13	2 (0.2%)	2 (1%)	0 (0%)	
Household wealth, in thousands				
Median (MAD)	118 (174)	26 (38.9)	167 (234)	<.001[a]
Comorbidity score, n (%)				<.001[b]
0-2	698 (69.7%)	119 (56.7%)	579 (73.1%)	
3-5	304 (30.3%)	91 (43.3%)	213 (26.9%)	
Time since stroke, in years				.032[a]
Median (MAD)	3.9 (1.5)	3.4 (1.5)	3.9 (1.5)	

These data are acquired from the Health and Retirement Study, 2000-2014. Data are calculated from individual-level and household-level responses in the HRS database. The number of observations for each variable is represented by "n." All variables are based on self-reported information.
a. 2-sided Student's T-test was used for continuous variables to determine significant differences
b. Chi-Square was used to determine significant differences in categorical variables.
MAD, median absolute deviation.

compared with Whites. The time since stroke (median years) was significantly lower for Black respondents compared with Whites (3.4 ± 1.5 vs 3.9± 1.5; P=.032) (Table 1).

Covariates of Function Difficulty Status

The crude odds ratios of functional status based on activities of daily living, fine motor skills and gross motor skills are presented in Table 2. The factors associated with more difficulty in activities of daily living were aging (although small but significant), (OR: 1.05; 95% CI: 1.04-1.07), being female (OR: 1.50; 95% CI: 1.1-1.82), being Black (OR: 1.49; 95% CI: 1.1-2.05) and time since stroke (OR: .99; 95% CI: .91-.93). The factors associated with higher fine motor skill difficulty scores included aging (OR: 1.04; 95% CI: 1.03-1.06), being female (OR: 1.35; 95% CI: 1.03-1.68) and being Black (OR:

1.34; 95% CI: 1.01-1.86). Lastly, factors associated with more difficulty with gross motor skills included aging (OR: 1.05; 95% CI: 1.04-1.07), being female, (OR: 1.65; 95% CI: 1.35-2.13), being Black (OR: 1.35; 95% CI: 1.03-1.82), and having a higher number of comorbidities (OR: 1.22; 95% CI: 1.11-1.31). Household size (OR: 1.10; 95% CI: .99-1.22) also trended toward a significant association with GMS difficulty score (P=.054). Surprisingly, household wealth did not impact the odds of having a higher or lower function difficulty score. Examining two-way interactions of race, age, sex, number of household residents, household wealth, number of comorbidities, and time since stroke and their association with function difficulty score, we found that the impact of comorbidities on activities of daily living and fine motor skills was shown to be more detrimental

for Blacks compared with Whites (OR: 1.49; 95% CI: 1.11-2.14 and OR: 1.49; 95% CI: 1.11-1.95, respectively) in the full model (these data are not presented in Table 2). We did not identify any other significant interactions with race.

DISCUSSION

Our analysis of stroke survivors within the HRS cohort revealed that Blacks living with stroke had increased odds of experiencing difficulty with ADL, FMS and GMS function. Black race was also found to increase the detrimental impacts of comorbidities on post-stroke function, specifically ADL and FMS. These analyses further refined and confirmed existence of racial disparities after a stroke.[8,30,31] In addition, these findings suggest that factors associated with Black race must be taken into consideration when iden-

Table 2. Ordinal logistic regression analysis summary for age, sex, race, socioeconomic factors, and interaction terms predicting post-stroke function difficulty scores

Variable	Post-Stroke Motor Function Difficulty Odds Ratio (95%CI)					
	ADL OR (95% CI)	P	FMS OR (95% CI)	P	GMS OR (95% CI)	P
Age, in years	1.05 (1.04-1.07)	<.001	1.04 (1.03-1.06)	<.001	1.05 (1.04,1.07)	<.001
Sex						
Male	1 (reference)		1 (reference)		1 (reference)	
Female	1.50 (1.1-1.82)	.002	1.35 (1.03-1.68)	.027	1.65 (1.35- 2.13)	<.001
Race						
White	1 (reference)		1 (reference)		1 (reference)	
Black	1.49 (1.1, 2.05)	.005	1.34 (1.01, 1.86)	.042	1.35 (1.03,1.82)	.033
Household size	1.10 (.96-1.18)	.23	1.04 (.93-1.15)	.48	1.10 (.99-1.22)	.054
Household wealth	.99 (.9997- 1.00)	.23	.999 (.9997-1.00)	.18	.9998 (.9996-1.00)	.083
Comorbidities	1.01 (.98-1.22)	.1	1.10 (.99-1.23)	.078	1.22 (1.11-1.31)	.002
Time since stroke (in years)	.99 (.91-.93)	<.001	.99 (.9-1.08)	0.85	1.03 (.9-1.11)	0.51

This table represents crude odds ratios (ORs) and 95% CIs. Household size refers to the number of people living in the household at the time of the survey and comorbidities refers to the number of comorbidities present at the time of the survey.
ADL, activities of daily living; FMS, fine motor skills; GMS, gross motor skills.

tifying post-stroke therapy options.

Our results contribute new findings of racial disparities in long-term post-stroke functional difficulty scores and further confirm previous studies that identified poorer outcomes in stroke recovery for Blacks.[32,33] The finding that Blacks with comorbidities were more likely to have higher post-stroke motor function difficulties may be due to the early development of comor-

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bidities such as hypertension at a younger age.[31] Moreover, specific comorbid conditions such as hypertension and diabetes tend to be more severe in Blacks and stem from the presence of modifiable risk factors present in young adulthood.[31,32]

In addition to race, our study confirmed that being female was also a major factor that was associated with increased odds of difficulty in post-stroke ADL, FMS and GMS function. This is significant because the Black population in the

analytic cohort was approximately two-thirds female. Thus, female gender may partially explain the increased odds of experiencing post-stroke function difficulty among Blacks. Unfortunately, we did not adjust for age or sex in our analysis. Still, male vs female disparities in stroke recovery have been previously reported.[9] A previous study showed that declines in estrogen and subsequent androgen excess makes women more susceptible to the development of cardiovascular risk factors.[33-35] Moreover, studies suggest that women are more likely to report depression after a stroke, a factor that influences the rate and quality of recovery.[36] Women stroke survivors tend to outlive their spouses, often placing them in a one-person household with less social support.[17]

Wealth is a correlate of access to quality health care and quantity of services. Similarly, low socioeconomic status is commonly associated with increased cardiovascular disease events and poorer health outcomes.[37-39] In our current study, Blacks had significantly lower household wealth compared with Whites. However, wealth was not identified as a predictor of post-stroke motor function difficulty scores, which is different from previous studies.[41,42]

High levels of physical and emotional support contribute to improvements in functional outcomes post-stroke, but mainly in severely impaired patients.[14] In the current analyses, the number of people living in the household did not increase the odds of experiencing post-stroke motor function difficul-

ty. Multiple stroke studies suggest that social support networks, represented by the number of household residents, are conducive for improvements in function after a stroke.[43] Social support was not directly assessed in the HRS analysis, which may explain the lack of parity between our results and others.

Study Limitations

While our current analysis has the strength of long-term post stroke follow-up, there are several limitations. The HRS database study is based on self-report surveys and lacks information on stroke subtypes. Other studies suggest that the validity and reliability of self-report is high, as much of the data presented within large databases corresponds to physician reports and matches percentages within the larger population.[26] While some of the results aligned with the literature, the internal and external validity were limited by the number of stroke-related data records in the HRS. In addition, the HRS lacked dates for critical stroke events such as onset, hospital discharge, and rehabilitation discharge. To establish the year of stroke onset, it was necessary to estimate the year based on patient answers to three onset-related questions. In addition, since the full dataset was a national sample with census region as the geographic unit, stroke survivors were in various hospitals and rehabilitation facilities with different levels of quality of care.[40,41] The HRS data have inconsistent assessment time periods for interviews, which limits the time se-

quence of the data. Nonetheless, the HRS provides data on long-term stroke follow-up and recovery.

CONCLUSIONS

Post-stroke disability is complex, multifaceted, and may result from an array of contributing sociodemographic and environmental factors.[42,43] However, there remains a paucity of literature examining the presence of disparities and potential factors associated with long-term functional outcomes, particularly among community-dwelling stroke survivors.[44-46] Future studies examining differences in common environmental (individual/community level) barriers in stroke recovery are needed. Moreover, modifications to existing databases that focus on a longer follow-up period with specific questions around recovery and functional/cognitive outcomes in stroke patients are needed. These current results indicate that Blacks with comorbidities are more likely to have poorer post-stroke function outcomes than Whites. The findings support the need for future studies focused on factors associated with the racial disparities in long-term stroke recovery.

CONFLICT OF INTEREST
No conflicts of interest to report.

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