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Post-COVID-19 Stroke Rehabilitation in Qatar: A Retrospective, Observational Pilot Study

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ABSTRACT

Background and Purpose: A growing field of interest is exploration of the functional outcomes of post-coronavirus disease 2019 (COVID-19) patients with stroke after rehabilitation. The association between stroke and COVID-19 infection is still being studied. We had explored the functional gain in post-COVID-19 patients with stroke following active rehabilitation services in Qatar to understand the possible predictors of functional gain.

Methods: We had included twenty patients diagnosed with post-COVID-19 with stroke in this retrospective pilot study conducted at a Qatar rehabilitation setting. We had used preexisting data from electronic medical records. We had included the Functional Independence Measure (FIM), post-COVID-19 functional status (PCFS), Action Research Arm Test (ARAT), Functional Ambulation Category (FAC), and Borg Rating of Perceived Exertion (RPE) as outcome measures. We had used descriptive statistics to summarize the baseline characteristics. A paired t-test had been used to compare the pre and posttests of the study group at admission and discharge. Multiple regression analyses had been performed to assess the predictors of functional gain, including age, employment status, impaired side, family history, and length of stay (LOS). All the results had been presented with associated 95% confidence intervals.

Results: This study had revealed an increase in functional gain (mean FIM gain, 32.9 ± 8.9) and improvements in functional performance throughout active rehabilitation (LOS, 62.45 ± 37.61). Significant differences had been noted in all outcome measures from admission until discharge ($p < 0.05$). Age ($\beta = -0.769$, $p = 0.022$) and impaired side ($\beta = 0.573$, $p = 0.007$) had significantly predicted

National Institutes of Health Stroke Scale (NIHSS) scores. Age (β = −0.764, $p = 0.047$) had been a major factor that significantly predicted FIM gain. LOS (β = −0.990, $p = 0.002$) had predicted FAC. The mean age was 56 ± 8 years.

Conclusion: Various factors are independently associated with functional gain after rehabilitation. Our findings suggest that active rehabilitation services and immediate intervention will be required to rehabilitate post-COVID-19 patients with stroke, a vulnerable population, to achieve adequate functional improvement.

Keywords: COVID-19, stroke, rehabilitation, Qatar, function

INTRODUCTION

The World Health Organization announced that the Coronavirus Disease-2019 (COVID-19) outbreak was a public health emergency of international concern on January 30, 2020. Since then, the transmission and spread of the pandemic have been on a steep rise. On March 13, 2020, the Qatar Government responded early to the COVID-19 pandemic. The "Qatar national preparedness and response plan for communicable diseases" produced by the Ministry of Public Health was a comprehensive plan to manage potential outbreaks and pandemics.[1] The Government of Qatar took swift action throughout the pandemic by implementing strict public health measures, which led to its success in having the lowest case fatality rates in the world. As of July 2020, the recovery rate and fatality rate of COVID-19 cases in Qatar were 97.1% and 0.2%, respectively.[2] COVID-19 is an extremely contagious respiratory illness.[3] Due to isolation, required lock-downs, and quarantines, millions of lives have been affected. Thus, these restrictions created formidable challenges worldwide, affecting well-being, the economy, and society.[4,5]

COVID-19 survivors and critically ill patients are more likely to have preexisting disabling conditions, including functional, social, and mental or psychological effects associated with severe illness and a prolonged stay in an Intensive Care Unit (ICU) or hospital.[6,7,8] One such study mentioned that musculoskeletal deconditioning occurs with decreased physical activity while being hospitalized.[9] Recovery is often gradual, and in addition to the hospital or ICU stay, ICU survival impacts the short-term and long-term quality of life after discharge.[10] One study showed that in survivors of Acute Respiratory Distress Syndrome, an 8-week pulmonary rehabilitation program was seen to improve the exercise capacity and quality of life of patients significantly.[11] Therefore, essential rehabilitation services are required for improving their overall quality of life. Considering the difference in life habits, healthcare systems, and rehabilitation settings for each country, the recovery of most critically ill patients must be investigated.[12]

Recently, cerebrovascular events (CVE) associated with COVID-19 emerged as a major observation among COVID-19 survivors.[13] Acute ischemic stroke is now a major complication of COVID-19 disease. Even though there are increasing reports of such cases, the underlying mechanisms remain uncertain.[14] An initial retrospective case series study from Wuhan, China, reported that 5.7% of cases showing neurological involvement could be attributed to acute CVE.[13] Also, secondary stroke risk may be related to pathophysiologic reasons and physical inactivity resulting from isolation and quarantine.[15,16] Another recent paper from the same center analyzed 221 participants and found that 5.88% of cases had new-onset CVE.[17] Moreover, cases of ischemic stroke as the presenting symptom in non-critically ill COVID-19 patients without significant risk factors have been reported.[18]

As the pandemic intensifies, the current management practice of acute ischemic stroke will need modifications and guidelines to deliver the highest quality care.[19] Strong predictors of functional gain must be explored to rehabilitate stroke survivors effectively during the pandemic. Predictors of functional gain in long-term stroke survivors included the Functional Independence Measure (FIM) as a tool to measure functional capacity. Significant predictors of functional improvement were the time from stroke onset, age, sitting balance, and the level of responsiveness.[20] Since this study discusses survivors of stroke due to COVID-19 infection, the predictors of functional gain may vary. They depend solely on clinical characteristics, prognosis, length of stay (LOS), and functional independence level, as they differ considerably from stroke survivors without COVID-19 infection.

Management and rehabilitation of stroke survivors secondary to COVID-19 infection are quite different from those without COVID-19. Recent studies have mentioned that the clinical outcomes of those with

COVID-19 were worse than stroke patients without COVID-19.[17,21] This could be because stroke survivors with COVID-19 may present with multiple comorbidities. Apart from the usual clinical presentation in stroke patients, one with COVID-19 infection may show additional clinical features concerning breathing difficulties (dyspnea), severe fatigue, low endurance tolerance, musculoskeletal changes, and reduced cardiovascular and respiratory functions. In one study, 51.2% of patients infected with COVID-19 with stroke died, while the remaining were sent to rehabilitation facilities for further intervention.[22] In another study, the median National Institutes of Health Stroke Scale (NIHSS) was higher in patients with COVID-19 than those without COVID-19. Also, stroke patients with COVID-19 had a higher risk of severe disability and death than those without COVID-19.[23] This would justify why the rehabilitation of stroke patients with COVID-19 differs from those without COVID-19. Therefore, this study explored the rehabilitation process of post-COVID-19 stroke patients and their functional outcomes.

Rehabilitation is a problem-solving process,[24] with considerable evidence supporting its effectiveness.[25] It includes assessing the patient's primary problems and concerns and understanding how they arise and may be solved. Using the holistic biopsychosocial model of illness as a framework,[26] a multidisciplinary team collaborated to deliver the suitable expertise to treat and intervene.[27] Recent studies have suggested rehabilitation strategies and care for patients with stroke during the pandemic to prevent a secondary stroke and further complications.[16] One study made a stroke care model during the COVID-19 pandemic. Its overall goal was to preserve patient outcomes while decreasing the potential exposure of patients and healthcare providers to COVID-19.[28] Currently, limited evidence is available exploring rehabilitation in COVID-19 stroke patients in Qatar. Thus, rehabilitation becomes more complicated and challenging when considering treating a patient with ischemic stroke in the background of coronavirus infection.

This study aims to provide a deeper understanding of the rehabilitation process and goal setting in such a vulnerable population. In line with that, we analyze functional gain in physical performance and well-being of a post-COVID-19 stroke patients population and their functional independence levels achieved before and after rehabilitation services in a tertiary care rehabilitation setup. Therefore, the primary objective of the study is to understand and measure functional gain attained over the rehabilitation process in post-COVID-19 stroke patients. This would enable us to understand the overall effectiveness of interdisciplinary rehabilitation of post-COVID-19 stroke patients admitted at Qatar Rehabilitation Institute. The secondary objective is to explore the functional gain predictors among post-COVID-19 stroke survivors. The predictive power of these factors may help to foresee and plan rehabilitation goals, both with the interdisciplinary team and the patient's family. If not addressed early, it will increase the disability burden of the patient and prevent them from achieving their maximum potential from other rehabilitation interventions.

MATERIALS AND METHODS

A total of 20 male inpatients diagnosed as post-COVID-19 stroke from the inpatient rehabilitation unit, Qatar Rehabilitation Institute, HMC, Doha, Qatar, during 2020 were included retrospectively for this study. Ethical approval was obtained from the Medical Research Center (MRC) before conducting the study (MRC-01-20-873). The subject data was coded by alphanumeric notations and the patients' names were kept confidential. Only the research team that included the principal investigator and coprincipal investigators had access to the data. The Medical Research Center (MRC) reviewed the study and did not object from an ethical perspective, after which the study was initiated.

Sociodemographic variables, such as age, marital status, occupation, were taken from documented records. Other clinical variables might affect the outcome, such as the extent of infection, LOS in the ICU or treating hospital, LOS in quarantine facilities, date of infection onset, and associated conditions, such as stroke, polyneuropathy, or myopathy, were also taken.

A nonidentifiable number was assigned to every patient. The investigators collected the sociodemographic details and all the study outcome measures scores at baseline and discharge from the Cerner documentation system. They also recorded these data under the assigned nonidentifiable participant number. All outcome measures used in this study were reliable and valid in minimizing instrument bias.

OUTCOME MEASURES

The Functional Independence Measure is the primary tool to document a client's functional independence (administered at baseline and every month – seven time points).[29] The post-COVID-19 functional status

(PCFS) scale is a tool to measure functional status over time after COVID-19. It is an ordinal scale assessing the full range of functional limitations to capture the heterogeneity of post-COVID-19 outcomes. These scales are used to track improvement over time and answer meaningful clinical questions, e.g., "How will I come out of this corona infection?" or for research purposes. They may be self-reported or assessed in a formal standardized interview.[30] This "PCFS scale" is currently not validated, and its usefulness will depend on the local conditions under which it is implemented.

The Mini-Mental Status Examination (MMSE) questionnaire[31] is a set of 30 questions commonly used by doctors and other healthcare professionals to check for cognitive impairment. The entire test takes approximately 5 to 10 min. The maximum score for the MMSE is 30, and a score of 25 or higher is normal. If the score is below 25, the result is abnormal (indicating possible cognitive impairment). Impairment may be classified as mild – (MMSE score between 21 and 24), Moderate – (MMSE score between 10 and 20), or severe – (MMSE score less than 10).

The Functional Ambulation Categories (FAC) is a functional walking test that evaluates ambulation ability. This 6-point scale assesses ambulation status by determining how much human support the patient requires when walking, regardless of whether they use a personal assistive device or not. The FAC does not evaluate endurance, as the patient is only required to walk approximately 10 feet.[32] The Borg Rating of Perceived Exertion (RPE) is another outcome measure scale used to know exercise intensity prescription. It is used to monitor progress and mode of exercise in cardiac patients and other patient populations undergoing rehabilitation and endurance training. The Borg RPE scale was developed by Gunnar Borg[33] for rating exertion and breathlessness during physical activity; that is, how difficult the activity is, as indicated by high heart and respiration rates, profuse perspiration, and muscle exertion. The Action Research Arm Test (ARAT) is a 19-item observational measure used by physical therapists and other healthcare professionals to assess upper extremity performance (coordination, dexterity, and functioning) in stroke recovery, brain injury, and multiple sclerosis populations.[34] Items comprising the ARAT are categorized into four subscales (grasp, grip, pinch, and gross movement) and arranged according to decreasing difficulty, with the most difficult task being examined first, followed by the least difficult task.[34]

RESULTS

Baseline characteristics are reported in Table 1. The mean FIM gain was 32.9 ± 8.9 points. The mean LOS at the rehabilitation facility was 62.45 (37.61) days (Table 1).

Table 2 shows significant differences in the pre- and postscores of the various outcome measures used.

Table 1. Baseline characteristics

Age, year, mean (SD)	56 (8)
Male sex, %	100
Marital status	
Married, %	100
Employment status	
Retired, %	25
Not retired, %	75
Impaired side	
Right, %	35
Left, %	65
Family history/Comorbidities	
With family history, %	15
No family history, %	85
Hospital LOS (Days), mean (SD)	62.45(37.61)

Table 2. Difference in outcome measures before and after rehabilitation and its significance.

	Pretest score	Posttest score	Difference score	Correlation	Sig.
NIHSS score, mean (SD)	9.30(2.45)	8.40(2.41)	0.900(1.48)	0.814	0.014
Total FIM score, mean (SD)	62.35 (21.84)	95.30 (21.03)	32.95(8.9)	1.174	0.000
Cognition MMSE score, mean (SD)	24.35(1.56)	25.05(1.23)	0.700 (1.17)	0.671	0.015
Borg RPE, mean (SD)	2.80(1.64)	1 (0.97)	1.8(1.28)	0.626	0.003
PCFS score, mean (SD)	3.55(0.82)	2.05(1.19)	1.5(1.1)	0.452	0.045
ARAT score, mean (SD)	0.55(0.60)	1.75(1.07)	1.2(0.77)	0.712	0.000
FAC score, mean (SD)	2.20(1.10)	4.10(1.48)	1.9(0.97)	0.758	0.000

The FIM was the primary outcome measure, and the mean differences in scores showed a gain in functional independence between admission and discharge status (correlation = 1.174, $p = 0.000$). A significant change in the PCFS scores (correlation = 0.452; $p = 0.045$) also indicates significant improvements in the overall functional status. Arm and hand functions as assessed by the ARAT measure and cognitive functions as measured by MMSE showed positive changes from admission to discharge, respectively (correlation = 0.712; $p = 0.000$, correlation = 0.671; $p = 0.015$). As measured by the Borg RPE, the exertion rate showed improved results (correlation = 0.626; $p = 0.003$), and the ambulation scores also seemed to improve significantly over the rehabilitation phase (correlation = 0.756; $p = 0.00$). The overall NIHSS score (correlation = 0.814; $p = 0.014$) also showed that patient neurological functioning improved significantly. The significant functional gain was attained by each patient on the various outcome measures. This shows that rehabilitation effectively produced improvements regarding functionality, dyspnea, arm function, and patient ambulation status.

Figure 1 shows the regression analysis of FIM. In contrast, Figure 2 depicts a scatterplot of the predicted variables about FIM and shows that most variables are toward the positive side of impacting the overall FIM.

Table 3 shows a multiple regression analysis comparing the effect of outcome measures on the overall FIM gain. The results show that the age of participants (Correlation coefficient = −0.769; $p = 0.022$) negatively affected NIHSS scores, and the impaired side (Correlation coefficient = 0.573; $p = 0.007$) positively affected NIHSS scores. Age

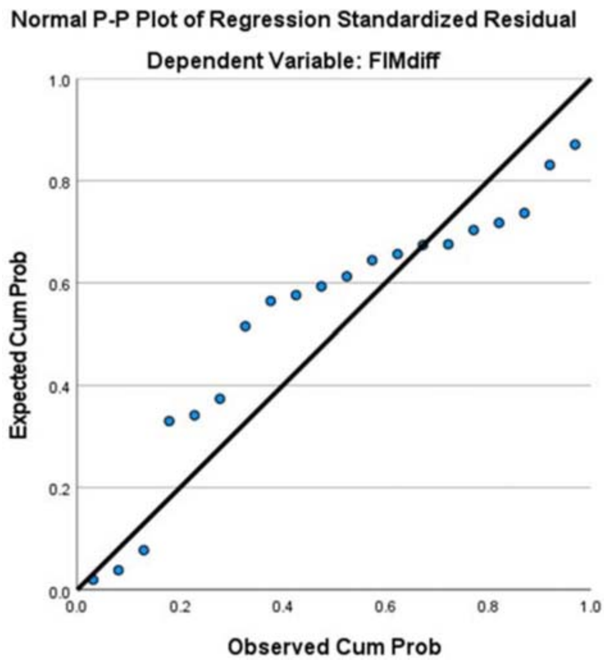

Figure 1. Regression analysis of FIM.

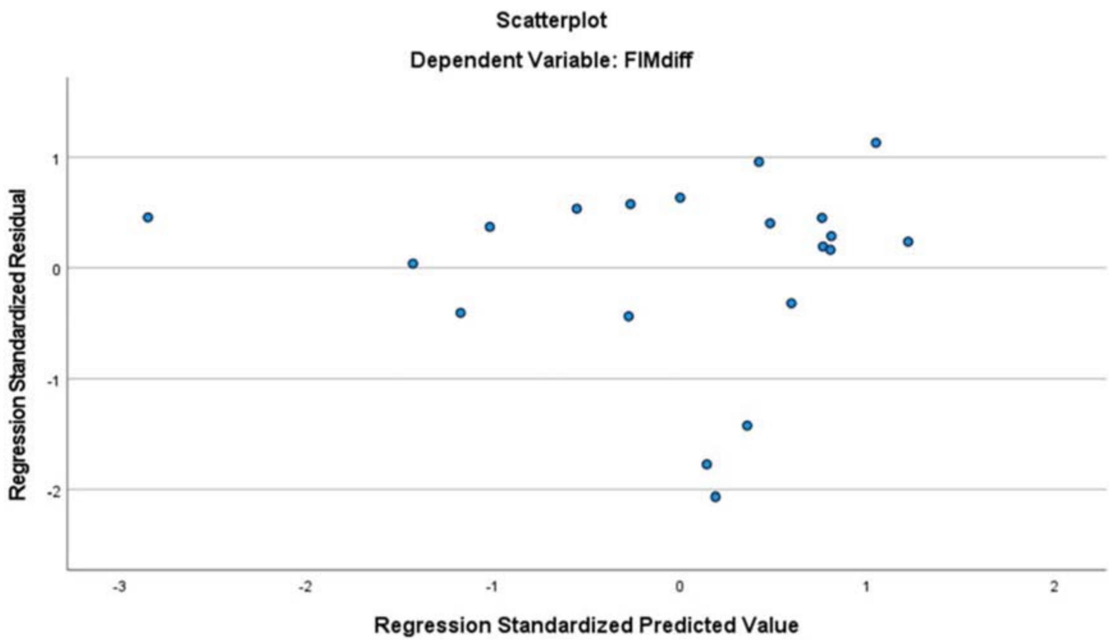

Figure 2. Scatterplot of the predicted variables about FIM.

Table 3. Comparison of demographics with functional gain.
3a) Cognition (MMSE)

Demographics	Coefficient	*t*	Sig
Age	0.650	1.738	0.104
Employment status	0.699	1.684	0.114
LOS (days)	−0.295	−0.908	0.379
Impaired side	0.029	0.126	0.901
Family history/Comorbidities	0.112	0.315	0.758

3b) NIHSS Score

Demographics	Coefficient	*t*	Sig
Age	−0.769	−2.584	0.022*
Employment status	−0.475	−1.438	0.172
Hospital LOS (days)	0.112	0.432	0.673
Impaired side	0.573	3.185	0.007*
Family history/Comorbidities	−0.093	−0.328	0.748

3c) FIM

Demographics	Coefficient	*t*	Sig
Age	−0.764	−2.173	0.047*
Employment status	−0.437	−1.120	0.281
LOS (days)	−0.179	−0.587	0.567
Impaired side	−0.263	−1.235	0.237
Family history/Comorbidities	−0.314	−0.942	0.362

3d) Borg Rating of Perceived Exertion (RPE)

Demographics	Coefficient	*t*	Sig
Age	0.087	0.228	0.823
Employment status	0.053	0.126	0.901
LOS (days)	0.050	0.150	0.883
Impaired side	−0.240	−1.039	0.316
Family history/Comorbidities	0.529	1.460	0.166

3e) PCFS

Demographics	Coefficient	*t*	Sig
Age	0.111	0.242	0.812
Employment status	0.034	0.066	0.948
LOS (days)	0.090	0.227	0.824
Impaired side	0.127	0.458	0.654
Family history/Comorbidities	−0.010	−0.024	0.981

3f) ARAT

Demographics	Coefficient	*t*	Sig
Age	0.517	1.223	0.242
Employment status	0.278	0.594	0.562
LOS (days)	0.272	0.741	0.471
Impaired side	0.191	0.748	0.467
Family history/Comorbidities	−0.026	−0.066	0.948

3g) FAC

Demographics>	Coefficient	*t*	Sig
Age	−0.338	−1.139	0.274
Employment status	−0.098	−0.297	0.771
LOS (days)	−0.990	−3.842	0.002*
Impaired side	0.017	0.097	0.924
Family history/Comorbidities	0.365	1.297	0.216

*Denotes significance ($p < 0.05$)

negatively affected functional independence (Correlation coefficient = −0.764; $p = 0.047$). LOS also negatively affected functional ambulation (Correlation coefficient = −0.990; $p = 0.002$). Age, employment status, LOS, the impaired side, and family history did not significantly affect cognition, Borg RPE, PCFS, and ARAT scores.

DISCUSSION

The major findings in this study are: (1) the significant correlation between admission and discharge scores of all outcome measures ($p < 0.05$) (Table 2); and (2) determining how predictor variables influence outcome measures (Table 3). Age, the impaired side, family history/comorbidities, LOS, employment status, cognition, NIHSS scores were studied to see their influence on the functional gain in patients with post-COVID-19 stroke. Table 2 explains the difference in outcome measures before and after rehabilitation and its significance. Table 3 compares demographics with FIM gain, predicting a significant difference in test scores at admission and discharge.

Improvements in motor and functional status of patients with rehabilitation potential are essential to estimate prognosis and predict rehabilitation goals and self-care independence.[35] This study used FIM as the primary outcome measure to assess functional status. It is a reliable and valid tool for measuring functional capacity and was also one of the predictors of functional gain in long-term stroke survivors.[20] In a recent study by Brown et al.,[36] functional independence as measured by FIM scores dominated the prediction of the outcome at discharge. Our study also indicates a significant change in the FIM scores from admission until discharge (Table 2). The total FIM scores at admission and discharge were 62.35 ± 21.84 and 95.30 ± 21.03 points, respectively. The significant improvement in FIM scores ($p < 0.05$) indicated that most patients were discharged home safely. They were at a level they could manage self-care tasks with minimal assistance to close supervision or by modifying the environment or home according to their abilities. Therefore, since the FIM scores showed a significant difference at admission and discharge, they were defined as an FIM gain. A study by Paolucci et al.[37] also mentioned that better functional recovery is associated with early and prompt rehabilitation. Therefore, early rehabilitation provided by our interdisciplinary team showed positive change and greatly influenced the functionality of patients undergoing rehabilitation.

One study mentioned cognitive status changes of the patients during hospitalization.[38] Also, cognitive impairment seemed to predict and significantly influence FIM in another study.[39] All 20 patients in our study were cognitively intact, although mild disorientation presented temporarily due to the environment or setting change. This is consistent with a study that discusses cognitive limitations after COVID-19 infection, having considerable implications on functional outcomes.[40] The results supported that positive changes in cognitive function occurred and were positively associated with over all functional gain. A minimal but significant change (pretest = 24.35(1.56); posttest = 25.05(1.23); $p = 0.015$) in the cognitive status of patients was seen, as assessed by the MMSE tool.

Functional status was also measured using the PCFS tool. The PCFS was a recommended new scale that could be used to assess functional residue.[41] Apart from the FIM, the PCFS was used to understand the ultimate consequences of COVID-19 on functional status. A study by Manuel et al.[42] reported that many of them had decreased functional status six months after hospitalization, as measured by the PCFS. Also, age and LOS were factors associated with limitations in functional status, impacting the overall quality of life. The mean PCFS score on admission was 3.55 ± 0.82 ($p = 0.045$), indicating moderate to severe functional limitations. Inpatients could not perform certain activities that needed to be taken over by others and required assistance in instrumental activities of daily living. With subsequent rehabilitation, the PCFS score was 2.05 ± 1.19 ($p = 0.045$), assessed at the time of discharge, indicating mild to negligible functional limitations. Patients improved function as they could independently perform all usual activities but at a lower intensity with mild limitations. Therefore, there seemed to be an overall improvement in the functional status of patients after rehabilitation.

Another important clinical feature post-COVID-19 stroke patients experienced was fatigue. Halpin et al.[43] showed that fatigue was one of the most significant symptoms patients experienced 4–8 weeks after hospital discharge. In this study, fatigue was measured using the Borg RPE scale. The positive changes in the Borg RPE scores from admission (2.80 ± 1.64) to discharge (1 ± 0.97) showed that fatigue levels reduced significantly among patients after rehabilitation.

The use of the ARAT on stroke patients was a valid measure and can be used as an appropriate measure in upper extremity rehabilitation, as discussed by Lang et al.[44] Therefore, the ARAT was used in a study of 20 inpatients with significant upper limb dysfunction, ranging from mild to severe. However, with subsequent upper limb rehabilitation, the function improved. The difference between admission (0.55 ± 0.60) and discharge (1.75 ± 1.07) ARAT scores were statistically significant ($p < 0.05$). The SD is higher than the mean score in the admission ARAT score, which could be because of the high variation in the test scores. Another possibility is that there is a stronger association between the variables. This proved that therapeutic intervention was effective in functionally improving upper limb function.

One other primary functional outcome was functional ambulation, as measured by FAC. A prospective study found that patients with severe COVID-19 infection had poorer exercise tolerance and functional ambulation.[45] This was true in the present study that showed poor tolerance to therapy and limitation in ambulation. The difference between the scores on admission (2.20 ± 1.10) and discharge (4.10 ± 1.48) was statistically significant ($p < 0.05$).

Consistent with previous studies[46] related to stroke patients, age and NIHSS scores were significant predictors of functional gain. In this study, the mean age was 56 ± 8 years. Studies have shown that age alone is a significant factor for COVID-19 and other severe diseases.[47] This supports the current finding in this study, showing that age, among the other variables, was found to influence functional gain positively ($p < 0.05$). Looking at the predictors of functional gain, only age seemed to influence and predict FIM gain ($F(5,14) = 2.110, p = 0.047$, $R2 = 0.430$), as seen in Figures 1 and 2. All other variables, including employment status, LOS, side of impairment, and family history, did not show any significance in influencing FIM potential. This could be because the COVID-19 affected older individuals more than younger people, and the younger the individual, the greater the potential for recovery. Therefore, age played an important factor in predicting FIM gain in this study. This is supported by a study by Manuel et al.,[42] who also explained that gender, age, hospital LOS, and ICU admission were strongly associated with limitations in functional status. Also, the time from stroke onset to patient admission is positively associated with functional gain.[46] Therefore, patients must get admitted at the earliest for immediate intervention to show significant functional gain along their rehabilitation journey. Studies have shown that the median NIHSS scores were higher in stroke patients with COVID-19 infection than those without COVID-19. This was because the functional outcomes of those with

COVID-19 were poorer when compared to those without COVID-19 due to the clinical characteristics and severity of disability caused by COVID-19.[23] This could be seen in our study, with the difference in admission NIHSS scores (9.30 ± 2.45) and discharge scores (8.40 ± 2.41) being statistically significant. As seen in previous studies,[42] the mean NIHSS scores in stroke patients (NIHSS score = 8) is lower when compared to our study results, supporting previous literature. A study among stroke survivors found that age and NIHSS scores at rehabilitation admission were independently associated with FIM gain.[48] This study showed that age was significantly associated with FIM gain, but not with NIHSS scores. This could be due to the heterogeneity of the study population and the combination of stroke and post-COVID-19 clinical characteristics instead of stroke patients only.

Employment status was part of the baseline characteristics studied, as shown in Table 1. COVID-19 shutdowns have had a negative impact on employment and working hours among all groups.[49] Studies have concluded that those who have lost jobs and reemployed had increased risks for ischemic and hemorrhagic stroke incidence,[50] causing depression,[51] financial strain,[52] stress, triggering a stroke. In this study, 75% of patients were working, of which 50% were reemployed after a brief period, which is in line with previous studies.[50] As a predictor of functional gain, overall employment status did not affect FIM gain ($p = 0.281; p < 0.05$). Whether being employed or not, most patients showed significant FIM gain from admission to discharge.

The other major findings of this study were to explore the predictor variables influencing FIM gain. The results show that the age of the participants (Correlation coefficient $= -0.769; p = 0.022$) negatively affected NIHSS scores, and the impaired side (Correlation coefficient $= 0.573; p = 0.007$) positively affected NIHSS scores. Age negatively affected functional independence (Correlation coefficient $= -0.764; p = 0.047$). LOS also negatively affected functional ambulation (Correlation coefficient $= -0.990; p = 0.002$). Age, employment status, LOS, the impaired side, and family history did not significantly affect the cognition, Borg RPE, PCFS, and ARAT scores. According to a study,[45], the length of ICU stay was associated with dependent ambulation upon discharge. Since this study was conducted in a rehabilitation setup, the patients received progressive and extensive therapy that improved their ambulation. Therefore, out-of-bed activities must be initiated as soon as the patient is stable regarding saturation and vital parameters, so that functional ambulation can be focused and intervened.

Family history, the impaired side, LOS, employment status, and age did not predict or positively influence cognition, Borg RPE, PCFS, and ARAT scores. This could mean that all these dependent variables (outcome measures) improved and showed positive results at the end of the rehabilitation process irrespective of the predictor variables (age, employment status, LOS, impaired side, and family history/ comorbidities). One study mentioned a substantial variance between PCFS and age, gender, and LOS and the presence of any comorbid disorders.[39] However, in the current study, PCFS was not influenced by any predictors. This could be due to the heterogeneity of the group, severity of the stroke, and the small sample size.

The small sample size was a major limitation to effective analysis.[53] Therefore, the limited sample size cannot draw a clear-cut conclusion. However, this study would be one of the first to study post-COVID-19 stroke patients in Qatar and how their rehabilitation processes affected their functionality. Further research needs to be performed to study and gain an in-depth understanding of how COVID-19 causes stroke and what other factors can determine patients' potential for improvement.

CONCLUSION

Stroke due to COVID-19 is on a steep rise. The treatment options and rehabilitation guidelines to manage such a vulnerable population is varied. A multidisciplinary team approach with a holistic point of view is recommended and required to examine the rehabilitation needs of patients. Team goals and prompt actions need to be taken to manage such mixed diagnoses effectively. This study would be one of the first to explore the rehabilitation potential and effectiveness of post-COVID-19 stroke patients in the State of Qatar. This pilot study provides a picture of clear and progressive functional gain from admission until discharge among post-COVID-19 stroke patients. Various factors, such as age, gender, the impaired side, employment status, family history, NIHSS score, LOS, and cognition level, were seen to influence function in one way or another. Older adults were identified as being at a higher risk of getting affected

by the condition and had lower functional outcomes. Therefore, preventive measures need to be prioritized in dealing with the COVID-19 situation.
In addition to this pandemic and its ensuing after effects, such as exacerbating a stroke, care must be taken by hospitals and rehabilitation centers to be adequately equipped with the required strategies to deal with such a vulnerable population. A prompt and immediate response is required to manage the ongoing pandemic.

Data Availability

The statistical analysis and the data used to support the findings of this study are included in the article. The other raw data used can be provided upon request.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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