

The Triad of Post-Stroke Fatigue, Cognition, and Motor Performance: A Study in Chronic Stroke Survivors

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ABSTRACT

Background: In chronic stroke survivors, post-stroke fatigue (PSF) is a common but underdiagnosed illness that has a major impact on recovery, motor function, and cognitive function. Comprehending these associations is crucial for focused rehabilitation tactics.

Methods: 41 chronic stroke survivors between the ages of 46 and 65 participated in a cross-sectional study. The Montreal Cognitive Assessment (MoCA), Fugl-Meyer Assessment (FMA), the 6-Minute Walk Test (6MWT), and the Fatigue Scale for Motor and Cognitive Functions (FSMC) were among the tests used. The PHQ-9 was used to screen for depression. For data analysis, Pearson's correlation was used.

Result: The findings showed that fatigue was significantly correlated negatively with walking endurance ($r = -0.428$, $p = 0.000128$), upper limb motor performance ($r = -0.4389$, $p = 0.000082$), and cognitive function ($r = -0.5973$, $p < 0.00001$). Compared to motor exhaustion, cognitive fatigue was more strongly associated with these outcomes.

Discussion: According to the results, cognitive fatigue has a significant influence on both physical recovery and cognitive function in chronic stroke survivors. To enhance functional outcomes, effective rehabilitation should incorporate cognitive retraining, endurance-building exercises, and fatigue management techniques.

Conclusion: Cognitive function, motor function, and endurance are all greatly impacted by post-stroke fatigue. Chronic stroke survivors' quality of life and rate of recovery can be improved by including fatigue management techniques into rehabilitation programs.

Keywords: Chronic Stroke, Cognitive Impairment, Motor Performance, Post-Stroke Fatigue, Stroke Rehabilitation.

INTRODUCTION

A stroke is an abrupt loss of brain function brought on by an interruption in the blood flow to the brain. The most prevalent kind of stroke, which makes up around 80% of all stroke occurrences, is an ischemic stroke, which happens when a clot restricts or stops blood flow, depriving the brain of vital

nutrients and oxygen. On the other hand, hemorrhagic stroke happens when a blood artery bursts, causing blood to seep into or around the brain.⁽¹⁾ There are three different phases to its recovery process: Acute phase: This is the first stage, which lasts for roughly two weeks following the stroke; the sub-acute phase, which lasts for up to six months

after the acute period, after six months, the patient enters the chronic phase, which could continue for the rest of their lives.⁽²⁾

Over the past ten years, the estimated incidence of stroke in India has ranged from 105 to 152 per 100,000 people annually, with a prevalence that varies by location from 44.29 to 559 per 100,000 persons.⁽³⁾

Hemiplegia (paralysis) and hemiparesis (weakness), which typically affect the side of the body opposite the side of brain trauma, are common issues. The location and extent of the brain lesion, the blood flow in the surrounding areas (collateral circulation), and the kind of care received just after the stroke all affect how severe these problems are.⁽¹⁾

For both men and women, the risk of stroke doubles beyond the age of 55. The risk is further increased by having diseases including high blood pressure, heart disease, and excessive cholesterol. Additionally, mini-strokes (TIAs) are experienced by 60% of stroke patients. Numerous contributing elements fall under the category of non-modifiable risk factors. Modifiable risk factors, including age, gender, race, family history, and prior TIA history: Hypertension, diabetes, inactivity, drug or alcohol misuse, elevated cholesterol, poor diet, and certain hereditary variables.⁽⁴⁾

About 40 percent of stroke survivors say that fatigue is one of their worst symptoms, making it a prevalent and distressing condition following a stroke. Fatigue frequently interferes with physical therapy and impacts the healing process on both a mental and physical level. People often become less active after having a stroke, which lowers their level of fitness overall.⁽⁵⁾

A sense of exhaustion that interferes with day-to-day functioning is known as post-stroke fatigue. Lack of motivation, mental and physical exhaustion, and trouble initiating or sustaining tasks are some of its symptoms. Diagnosing these symptoms can be challenging because they might occasionally overlap with depression.⁽⁶⁾ Two primary categories of post-stroke fatigue exist: Fatigue from exertion: aggravated by

stress, brought on by mental or physical exertion, and alleviated by relaxation and sleep. It happens soon after a stroke, and it takes little time to recover. Chronic fatigue: Develops later and is frequently associated with emotional and mental stress instead of physical activity. About 40% of survivors' experience chronic fatigue for years, but acute exhaustion can last up to six months.⁽⁷⁾ It's unclear exactly what causes post-stroke weariness. Nonetheless, a combination of biological and psychological variables is thought to be responsible for it.⁽⁵⁾

A well-known side effect of stroke is cognitive impairment, which affects around one-third of survivors within the first year and has a major negative influence on their functional independence and quality of life.⁽⁸⁾ Memory, attention, reasoning, and judgement are all components of cognition.⁽⁹⁾ Within a year following a stroke, over 30% of survivors' experience dementia. This can impact language, orientation, memory, and attention.⁽¹⁰⁾ The following are risk factors for PSCI (post-stroke cognitive impairment): demographic characteristics: advanced age, less education, and a history of cognitive problems; Clinical factors: diabetes, atrial fibrillation, high blood pressure, and repeated stroke; radiological factors: particular forms of brain injury that can be detected by scans and Biological aspects include genetic risks such as the ApoE4 gene and inflammation.⁽¹¹⁾ People describe confusion, weakness, numbness, and problems with speech and memory even after mini-strokes (TIA). These small strokes have the potential to drastically impair social involvement, work capacity, and quality of life.⁽¹²⁾

Muscle weakness, abnormal muscle tone, and poor motor control are all consequences of stroke.⁽¹³⁾ Arm weakness is particularly prevalent and impairs one's capacity to carry out daily tasks that require for both hands.⁽²⁾ More than 80% of stroke victims first suffer arm weakness, and 40% continue to have it after the event.⁽¹⁴⁾ Within the first several months, the majority of arm function recovers.⁽²⁾ Muscle weakness also makes it

harder to walk, stand, climb stairs, and do other useful actions.⁽¹⁵⁾

After a stroke, functional independence depends on the lower limbs' ability to retain postural control, balance, and mobility.⁽¹⁶⁾ However, lower limb function is severely compromised by stroke-related muscular weakness, decreased motor control, and sensory abnormalities, making it difficult for survivors to stand, walk, and climb stairs. One of the main objectives for stroke survivors is to walk on their own. Good balance, stability, and effective movement are necessary for safe walking.⁽¹⁷⁾ Stroke survivors are more likely to stumble because they find it difficult to adapt their gait to uneven terrain or obstacles.⁽¹⁸⁾ Walking after a stroke also takes a greater amount of effort than it does for healthy people, which causes exhaustion more quickly and reduces community mobility.^(17,18)

A prevalent but often overlooked problem, post-stroke fatigue (PSF) has a major influence on the cognitive and physical functioning of chronic stroke survivors. The three factors of motor function, cognitive function, and fatigue all have a significant impact on functional independence and general quality of life. Fatigue can further impair cognitive and physical functioning, impede recovery, and interfere with rehabilitation participation. By knowing how these three elements interact, physiotherapists may create all-encompassing rehabilitation plans that incorporate motor retraining, cognitive stimulation, and fatigue management, ultimately improving the quality of life for long-term stroke patients. This study aims to investigate the triad of post-stroke fatigue, cognition, and motor performance, and to assess their correlation in chronic stroke survivors.

MATERIALS & METHODS

This cross-sectional study was conducted among chronic stroke survivors to assess the relevant variables. The study was carried out in various hospitals across Surat city over a duration of six months, from November 2021 to April 2022. The sample size was determined using the formula⁽¹⁹⁾ provided at a 95% confidence level. The prevalence rate used for the calculation was 4.87 per 100, as reported in Dharavi, Mumbai during 2006–2008.⁽³⁾

The formula used was:

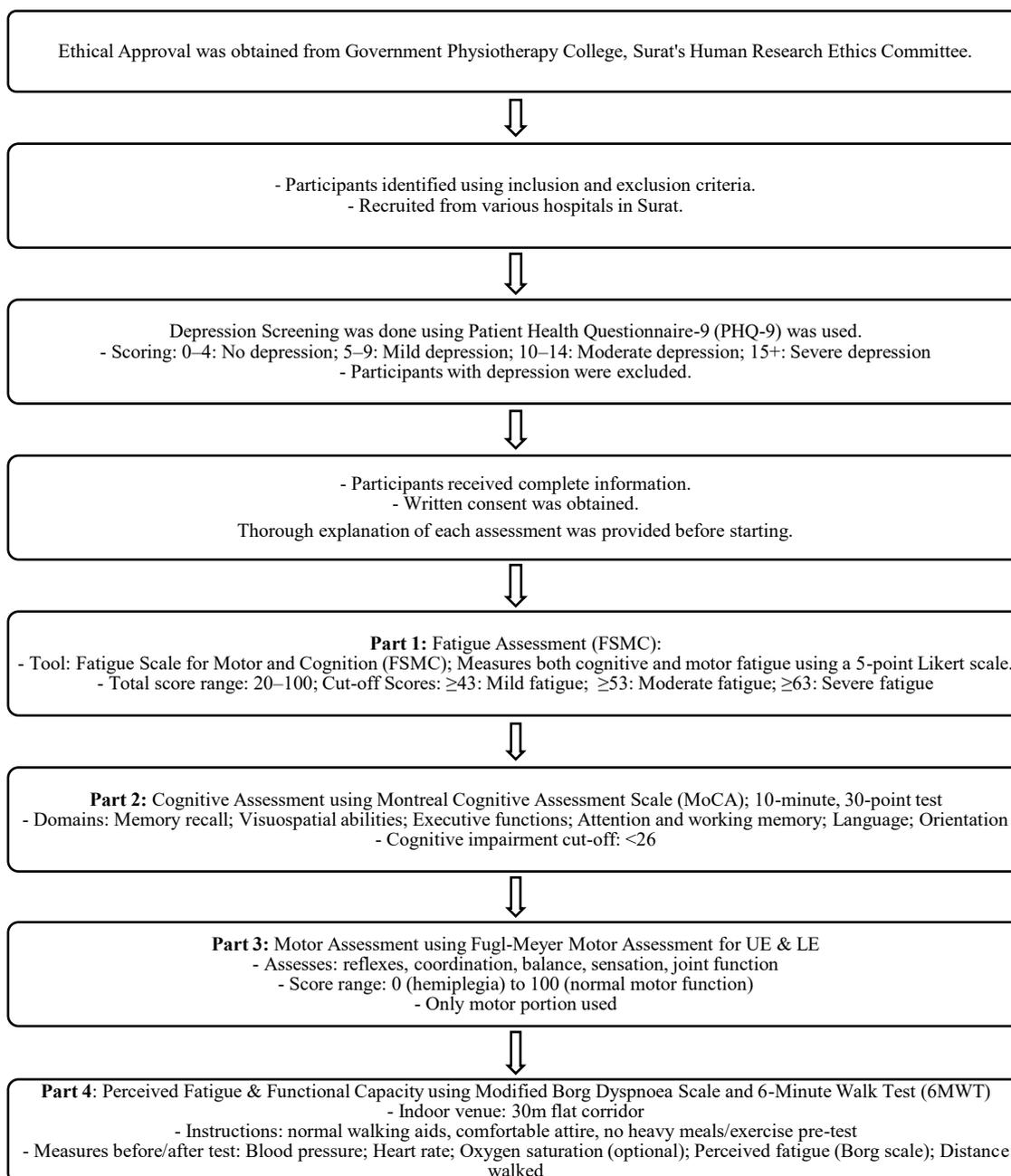
$$n = Z^2 \times P (1 - P) / d^2$$

where n is the sample size, Z is the Z -value corresponding to the 95% confidence level (1.96), P is the expected prevalence (4.87%), and d is the level of precision ($\pm 5\%$). A purposive sampling technique was employed to recruit participants for the study.

Participants were chronic stroke survivors aged 46–65 years, of either gender⁽²⁰⁾, with left or right-side involvement, and a stroke duration of over six months.⁽²⁾ Both ischemic and hemorrhagic types, including recurrent strokes, were included if the individual could stand, walk (with or without aids), follow a 3-step command, and provide written consent. Exclusion criteria involved unstable vitals, severe spasticity, flaccidity, other neurological or orthopedic conditions, bilateral strokes, peripheral vascular disease, chronic fatigue syndrome, or depression (PHQ-9 score >9).⁽²¹⁾

The outcome measures used in the study included the Fatigue Scale for Motor and Cognitive Functions (FSMC)^(22, 23), Montreal Cognitive Assessment Scale (MoCA)^(24, 25), Fugl-Meyer Motor Assessment for both upper and lower extremities (FMA-UE & FMA-LE)^(26, 27), 6-Minute Walk Test.⁽²⁸⁾

The following steps were followed to complete the whole procedure.



STATISTICAL ANALYSIS

Following data collection, the data was cleaned to eliminate any errors or inconsistencies. The variables were then examined and divided into two categories: For 41 Chronic Stroke Survivors, numerical data were expressed using mean and standard deviation, while categorical variables were

displayed as percentages. Prior to performing correlation analysis, it was important to ascertain whether the data was distributed normally. The Kolmogorov-Smirnov test was used for this. The test verified that the data was normally distributed, enabling additional analysis using Pearson's Correlation Coefficient.

Table 1: Descriptive characteristics of different variables of Chronic Stroke.

VARIABLE	MEAN ± STANDARD DEVIATION
FATIGUE SCALE FOR MOTOR AND COGNITION (FSMC):	
FSMC - MOTOR SCORE	37.73 ± 6.140

FSMC – COGNITION SCORE	34.98 ± 6.758
FSMC – TOTAL SCORE	72.98 ± 10.885
COGNITION:	
MONTREAL COGNITIVE ASSESSMENT SCALE	20.90 ± 4.317
MOTOR PERFORMANCE:	
FUGL-MEYER ASSESSMENT-UPPER EXTREMITY (FMA-UE)	41.24 ± 14.849
FUGL-MEYER ASSESSMENT-LOWER EXTREMITY (FMA-LE)	22.78 ± 4.725
6 – MINUTE WALK TEST	174.554 ± 94.1096

Table 1 represents the mean and standard deviations of Fatigue, Cognition and Motor Performance in Chronic stroke.

Table 2: Correlation of FSMC-Motor Score with Cognition and Motor Performance in Chronic Stroke Survivors.

VARIABLE	PEARSON'S CORRELATION (r)	p-value
MoCA	-0.5932*	<0.00001**
FMA-UE	-0.3859*	0.000628**
FMA-LE	-0.2391*	0.38833**
6MWT	-0.3176*	0.005493**

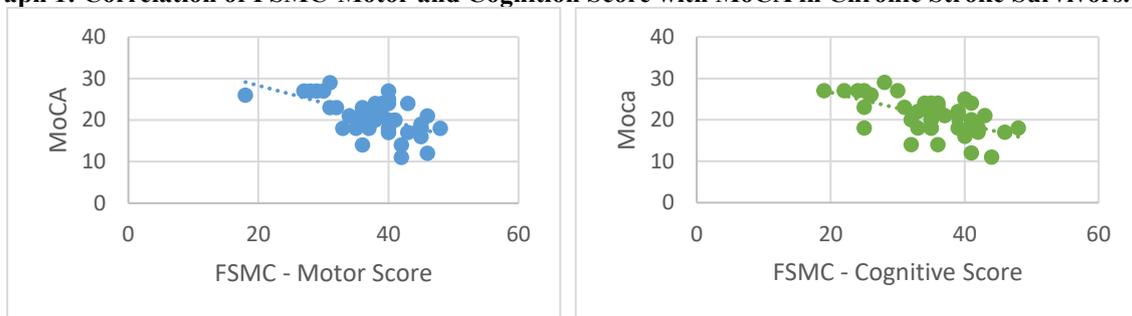
*Correlation is significant at 0.05 level (2-tailed); ** The result is significant at p<0.05.

Table 3: Correlation of FSMC-Cognition Score with Cognition and Motor Performance in Chronic Stroke Survivors.

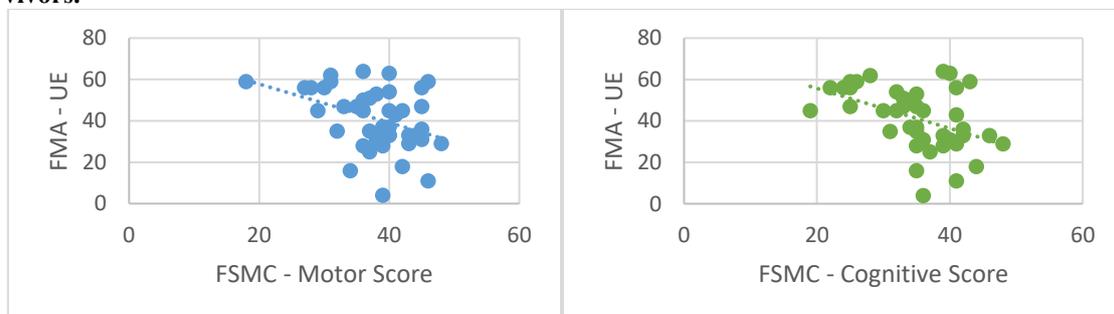
VARIABLE	PEARSON'S CORRELATION (r)	p-value
MoCA	-0.5973*	<0.00001
FMA-UE	-0.4389*	0.000082
FMA-LE	-0.3697*	0.001097
6MWT	-0.428*	0.000128

*Correlation is significant at 0.05 level (2-tailed); ** The result is significant at p<0.05.

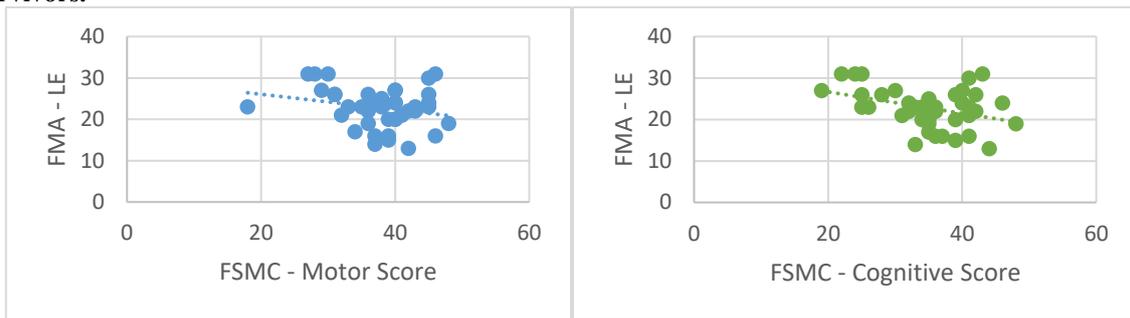
Graph 1: Correlation of FSMC-Motor and Cognition Score with MoCA in Chronic Stroke Survivors.



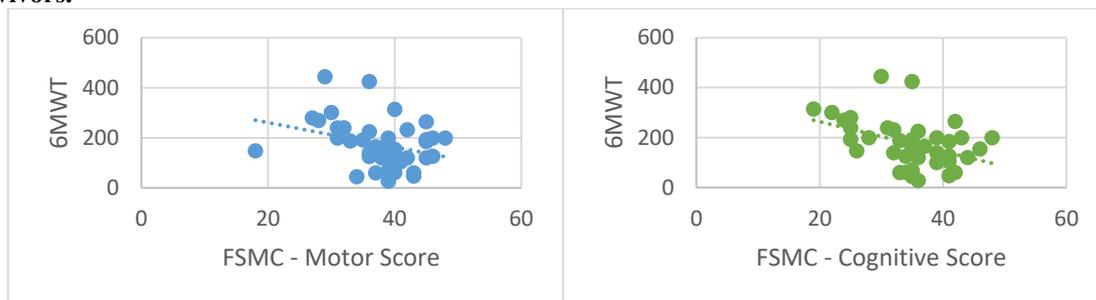
Graph 2: Correlation of FSMC-Motor and Cognition Score with FMA-UE in Chronic Stroke Survivors.



Graph 3: Correlation of FSMC-Motor and Cognition Score with FMA-LE in Chronic Stroke Survivors.



Graph 4: Correlation of FSMC-Motor and Cognition Score with 6MWT in Chronic Stroke Survivors.



Graphs 1, 2, 3 and 4 demonstrate a strong inverse relationship between post-stroke motor and cognitive exhaustion and important outcomes, including walking endurance, upper and lower limb motor performance, and cognition in chronic stroke survivors. Nonetheless, the moderate strength of these associations suggests that weariness is not the main element influencing these functions. While other factors like muscle strength, balance, and neurological impairment affect walking and motor performance, cognitive tiredness has a stronger effect on cognition. The association is stronger in chronic stroke survivors, suggesting that persistent fatigue may gradually impair walking capacity, motor function, and cognitive function.

RESULT

This study set out to investigate the connection between motor performance, cognitive function, and Post-Stroke Fatigue (PSF) in people going through chronic stroke phases.

Microsoft Excel was used to organise the gathered data, while SPSS software, version 23, was used for statistical analysis.

Participants in the chronic stroke group were 53 ± 6 years old on average. The participants' ages ranged from 46 for the youngest to 65 for the oldest.

Among individuals who had a chronic stroke, there was a negative correlation between FSMC-Motor Score and MoCA ($r = -0.5932$), FMA-UE ($r = -0.3859$), FMA-LE ($r = -0.2391$), and 6MWT ($r = -0.3176$). These included a statistically significant association with 6MWT and upper limb function (FMA-UE), highlighting the fact that even in the chronic phase, physical endurance and upper limb function remain sensitive to tiredness levels.

Similar negative correlations were seen between the FSMC-Cognition Score and MoCA ($r = -0.5973$), FMA-UE ($r = -0.4389$), FMA-LE ($r = -0.3697$), and 6MWT ($r = -0.428$) when compared to Cognition & Motor Performance.

With the exception of FMA-LE, all relationships were statistically significant, indicating that cognitive fatigue has a major effect on walking capacity (6MWT), upper limb function, and cognitive performance in chronic stroke survivors.

DISCUSSION

Even months or years after an initial stroke event, fatigue is one of the most prevalent and disabling signs that stroke survivors endure. The purpose of this study was to investigate how post-stroke fatigue (PSF) affects chronic stroke survivors' motor and cognitive abilities. The results of this investigation showed that fatigue significantly impacted stroke participants' cognitive and motor abilities during both phases. Interestingly, there was less of a link between cognitive fatigue (FSMC-Cognition Score) and MoCA in chronic stroke survivors, suggesting that factors other than fatigue might be more important in long-term cognitive loss. This result is consistent with the findings of Macintosh B.J. (2017)⁽⁶⁾, who proposed that fatigue had a more indirect impact on cognition in chronic stroke patients through the mediating effects of depression and other psychosocial factors. It emphasises that, rather than exhaustion being the only factor, long-term emotional coping issues, social isolation, and a lack of cognitive activity may all contribute to the progressive decline of cognitive ability.

The study also discovered a substantial negative relationship between fatigue and motor performance in groups of people who had had a chronic stroke. Higher levels of fatigue had a significant influence on walking capacity (measured by 6MWT) and upper limb function (measured by FMA-UE). This is consistent with Van Eijsden et al. (2012)⁽²⁹⁾, who found a direct correlation between stroke patients decreased upper limb strength and greater weariness. Goh et al. (2019)⁽³⁰⁾, on the other hand, did not find a clear correlation between fatigue and upper limb motor function. This could be explained by variations in the sample characteristics and the severity of rehabilitation.

According to Winstein et al. (2016)⁽³¹⁾, fatigue still affects physical performance in chronic stroke survivors, but it is exacerbated by secondary factors such as depression, decreased physical activity, and muscular disuse. Avoiding physical activity because of fatigue promotes functional decline by

further reducing muscular strength and endurance. This is especially important for walking endurance (6MWT), where Miller K.K. et al. (2013)⁽³²⁾ also found a strong correlation between lower walking capacity and higher degrees of fatigue.

This study emphasises that fatigue is a complex condition influenced by physical, cognitive, emotional, and social factors, going beyond straightforward correlations. These multidimensional concerns have also been reflected in stroke survivors' own voices, as seen in Pollock et al. (2012), where fatigue, cognition, and mobility were ranked among the top research priorities for life after stroke.⁽³³⁾

The weaker association between FSMC-Cognition Score and MoCA in chronic stroke survivors suggests that fatigue is not acting alone. Emotional wellbeing, mood disturbances, and social factors likely have a stronger influence on cognitive performance in the long term. This underlines the need to address these broader aspects when managing fatigue in stroke rehabilitation.⁽⁶⁾

Clinical Implications:

This study emphasises the necessity of all-encompassing fatigue management techniques that take into account emotional and cognitive exhaustion in addition to physical fatigue. The emphasis should be broadened to include the following for chronic stroke survivors:

- Physical reconditioning programs that assist break the cycle of exhaustion and physical inactivity by progressively regaining strength and endurance.
- Consistent cognitive stimulation activities, such as social engagement, mental games, and creative recreational activities, can preserve cognitive health in the face of persistent exhaustion.
- Cognitive behavioural therapy (CBT) or psychological counselling to treat anxiety, depression, and maladaptive coping.⁽³¹⁾
- Combining Holistic Stroke Care with Fatigue Management.

CONCLUSION

Post-Stroke Fatigue (PSF), cognition, and motor function were evaluated in this study, which involved 41 chronic stroke survivors. The 6-Minute Walk Test (6MWT), the Fugl-Meyer Assessment (FMA) for upper and lower extremities, the Montreal Cognitive Assessment (MoCA), and the Fatigue Scale for Motor and Cognitive Functions (FSMC) were used to measure fatigue, cognition, and motor performance, respectively. The results showed a strong inverse relationship between motor performance and fatigue, meaning that lower walking endurance and worse upper and lower limb motor function were linked to higher levels of weariness. The association between cognitive fatigue and cognition (MoCA), however, was relatively less, indicating that cognitive impairment in chronic stroke survivors may also be caused by reasons other than fatigue, such as anxiety, depression, and other psychosocial impacts.

The findings validate the alternative hypothesis, highlighting the necessity of integrating fatigue management techniques into rehabilitation programs for improved functional recovery and demonstrating that fatigue has a substantial impact on both cognitive and motor performance in chronic stroke survivors.

LIMITATIONS

Even if the study's conclusions were noteworthy, there are a few things to keep in mind:

- Only chronic stroke survivors were included in the study; acute and subacute stages were not.
- The adoption of a purposeful sample technique may have limited the generalizability.
- There was a comparatively limited sample size.
- There was no follow-up to track long-term changes because the study was cross-sectional.
- It's possible that participant bias affected PHQ-9 questionnaire responses, with

some patients underreporting depression symptoms to seem more upbeat.

- The effects of post-stroke fatigue on cognition and motor function were not compared by gender in this investigation.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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