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ASSOCIATION OF COGNITIVE FUNCTION WITH STATIC AND DYNAMIC BALANCE AMONG STROKE PATIENTS

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ABSTRACT:

Background: Stroke is a leading cause of disability worldwide, often resulting in significant impairments in both cognitive function and physical balance. Among stroke survivors, particularly those in the subacute phase, the interplay between cognitive abilities and balance is critical to understanding their rehabilitation needs and potential recovery trajectories. Cognitive functions, such as attention, executive function, and memory, are essential for maintaining both static and dynamic balance, which are crucial for performing daily activities and preventing falls.

Objective: To determine the Association of cognitive function with static and dynamic balance among stroke patients.

Methodology: Analytical cross-sectional study was conducted in Lahore, Pakistan. MMSE and BBS questionnaire were used to collect data from patients of stroke. A total of 238 subjects aged 40-60 years were included in this study.

Results: Out of 238 participants in which 148(62.2%) are male and 90(37.8%) are female. The mean age was 51.9 with standard deviation of 6.34. The frequency of participants with severe cognitive impairment were 155(65.1%) with mild cognitive impairment were 46(19.3%) and with no cognitive impairment were 37(15.5%). The frequency of participants with high fall risk were 22(9.2%), moderate fall risk 191(80.3%) and with low-risk fall were 25(10.5%). Cognition and balance showed significant association with P value of 0.002. The results of our study declares that any change in cognitive functioning leads to change in static and dynamic balance.

Conclusion: This study shows that a significant association exist between cognitive function with static and dynamic balance among stroke patients.

Key Words: Cognitive Impairment, Dynamic balance, Static balance, Subacute stroke.

Introduction:

Stroke is a clinically defined syndrome of acute, focal neurological deficit attributed to vascular injury (infarction, hemorrhage) of the central nervous system. Stroke is the second leading cause of death and disability world wide.(1) It is a complex condition caused by a variety of risk factors, disease processes, and mechanisms. Major contributors to stroke risk include hypertension, diabetes, lack of physical activity, substance abuse, alcohol consumption, and advancing age.(2) Stroke is categorized into mainly 2 types: ischemic and hemorrhagic. Hemorrhagic stroke occurs when blood from an artery suddenly begins bleeding into the brain. As a result, the part of the body controlled by the damaged area of the brain cannot work properly.(3) Hemorrhagic stroke is further divided into intracerebral hemorrhage and subarachnoid hemorrhage, more specifically, traumatic and nontraumatic. Ischemic strokes occur when there is a blockage in a blood vessel, resulting in a restricted blood supply to the brain. There are three stages of stroke. Acute, Sub acute and chronic stage. The clinical staging of stroke is the first 2 weeks are acute stage; 3–11 weeks post-stroke is termed the subacute stage in which most changes occur.12–24 weeks post-stroke is the early chronic stage and more than 24 weeks post-stroke is the chronic stage.(4) The complications and problems faced by stroke patients are post stroke seizures, urinary incontinence, bowel incontinence and cognitive impairments.(5) Stroke is a leading cause of long-term disability worldwide, and cognitive impairment is a common consequence of stroke. Understanding the connection between stroke and cognitive impairment is crucial for effectively managing symptoms and improving patient quality of life.(6) The location of stroke and the severity of stroke plays an important role to determine the severity and specificity of stroke and specific cognitive deficits experienced by individuals. Vascular risk factors, including hypertension, diabetes, and atrial fibrillation, contribute to cognitive decline after stroke. Mechanisms such as cerebral hypoperfusion, white matter damage, and neuroinflammation also play a role in compromised cognitive functions. The compromised cognition may also affect balancing problems in stroke patients. These cognitive processes play a crucial role in how we perceive, interpret, and respond to the environment around us, including maintaining balance. Static and dynamic balance are both heavily influenced by cognitive function.(7) For instance, attention and executive function are essential for coordinating movements and making real-time adjustments to prevent falls during dynamic activities such as walking or reaching. Similarly, spatial awareness and memory play critical roles in accurately perceiving one's position in space and anticipating potential obstacles or hazards.(8) Balance, which involves maintaining the body's center of gravity within the base of support with minimal movement, relies on the integration of visual, vestibular, and somatosensory inputs to the central nervous system. Reports indicate that approximately 83% of stroke survivors suffer from balance impairments. Balance is crucial for various skills, such as soccer, where it promotes functional stability through a complex process involving visual, vestibular, and proprioceptive stimuli. Balance impairment is common after a stroke and is associated with worsened physical impairments, increased disability, and reduced quality of life.(9) Modifiable risk factors, which can account for a significant proportion of the population's attributable risk of stroke across different age groups, genders, and ethnicities, include hypertension, smoking, dyslipidemia, unhealthy diet, physical inactivity, obesity, diabetes mellitus, cardiac disease, excessive alcohol intake, psychosocial factors, and atrial fibrillation (AF). Nearly 80% of acute stroke patients experience motor dysfunction in the upper extremities. Although upper extremity paralysis is likely to see substantial improvement within six months, up to 50-60% of stroke survivors may continue to experience persistent motor dysfunction in the upper extremities after six months.(10) This ongoing dysfunction significantly impacts many post-stroke patients and is strongly linked to reduced activities. Stroke is a major contributor to global disability, frequently leading to severe deficits in cognitive abilities and physical equilibrium. Among stroke survivors, the interplay between cognitive abilities and balance is critical to understanding their rehabilitation needs and potential recovery trajectories. Cognitive functions, such as attention, executive function, and memory are essential.(11)

Stroke is a leading cause of long-term disability worldwide, often resulting in impairments that affects both cognitive function and physical abilities like balance. Understanding the interplay between cognition and balance is crucial to improve functional outcomes. Cognitive processes are integral to balance control mechanisms

While there is existing research on cognitive and motor impairments post-stroke, there remains a gap in understanding the specific relationship between cognition and balance during the subacute phase. Most studies have focused on either cognition or balance separately, with limited integration of these domains. Investigating this association can fill this gap and contribute to a more comprehensive understanding of post-stroke recovery trajectories.

Methodology:

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Data was sought from 238 stroke patients of age 40 to 60 years. Patients who were able to understand command and able to stand independently without support were included in the study and patients visual, vestibular and proprioception problems were excluded from the study. The data was gathered between April 2024 and June 2024 in Lahore, Pakistan following guided protocols and ethical considerations. All individuals were given a thorough explanation of study goal and methods before willingly deciding to participate in it through an informed consent. Cognitive function was assessed by MMSE Questionnaire and static and dynamic balance was assessed by BBS among stroke patients which was filled by each participant. Data was analyzed by SPSS version 29; the mean values and standard deviation of the measured data were computed. Mean and SD were used for continuous data, frequency statistics were used to evaluate categorical data. Chi square was used to find association between categorical variables and $p<0.05$ was kept as level of significance.

Inclusion criteria:

- Individuals who are in the subacute phase of stroke recovery (ischemic / hemorrhagic), typically within a specific timeframe after the stroke (7 days to 6 months)
- The capacity to sustain a standing position independently for at least one minute without support (7)
- Individuals with cognitive impairment, which can be evaluated using standardized cognitive tests or clinical assessments.
- People of age above 40-60 years.

Exclusion criteria:

- A visual disturbance, presence of other neurological conditions (Parkinson’s disease, motor neuron disease, Alzheimer’s disease)
- Peripheral neuropathy
- Serious underlying disease including cardiac arrest(8)
- Participants who are unable to give informed consent due to cognitive or communication impairments.
- Any pain that could restrict participation in balance testing.

Results:

This research included 238 participants in which (62.2%) are male and (37.8%) are female. Those participants that meet the inclusion criteria and consented for the study was chosen on priority basis. Data was collected by using Berg Balance Scale and Mini-Mental State Examination. The mean age was 51.9 with standard deviation of 6.34. The participants who were employed were (50.4%) and those who were unemployed were (49.6%). The participants who experienced change in memory were (73.5%) and those who experienced no change were (26.1%). The participants who experienced any balance difficulty were (63.9%) and those who didn't experience any balance difficulties were (36.1%). The frequency of participants who experienced fall were (65.1%) and those who experienced no history of fall were (34.9%). The no of participants who received rehabilitation services since stroke were (48.7%) and those who did not receive any rehabilitation services were (51.3%). The participants who were taking any medications were (76.1%) and those who were not taking any medication were (23.9%). The frequency of participants with severe cognitive impairment were (65.1%) with mild cognitive impairment were (19.3%) and with no cognitive impairment were (15.5%). The frequency of participants with high fall risk were (9.2%), moderate fall risk (80.3%) and with low risk fall were (10.5%). The Chi-square test indicated a statistically significant association between Mini-Mental State Examination (MMSE) scores and Berg Balance Scale (BBS) scores ($p = 0.002$, $p < 0.05$). The results of our study suggests that variations in cognitive function correlate with alterations in both static and dynamic balance capabilities.

Table 1: Distribution of Age

Distribution of Age	**Mean**	**SD**
Age	51.96	6.34

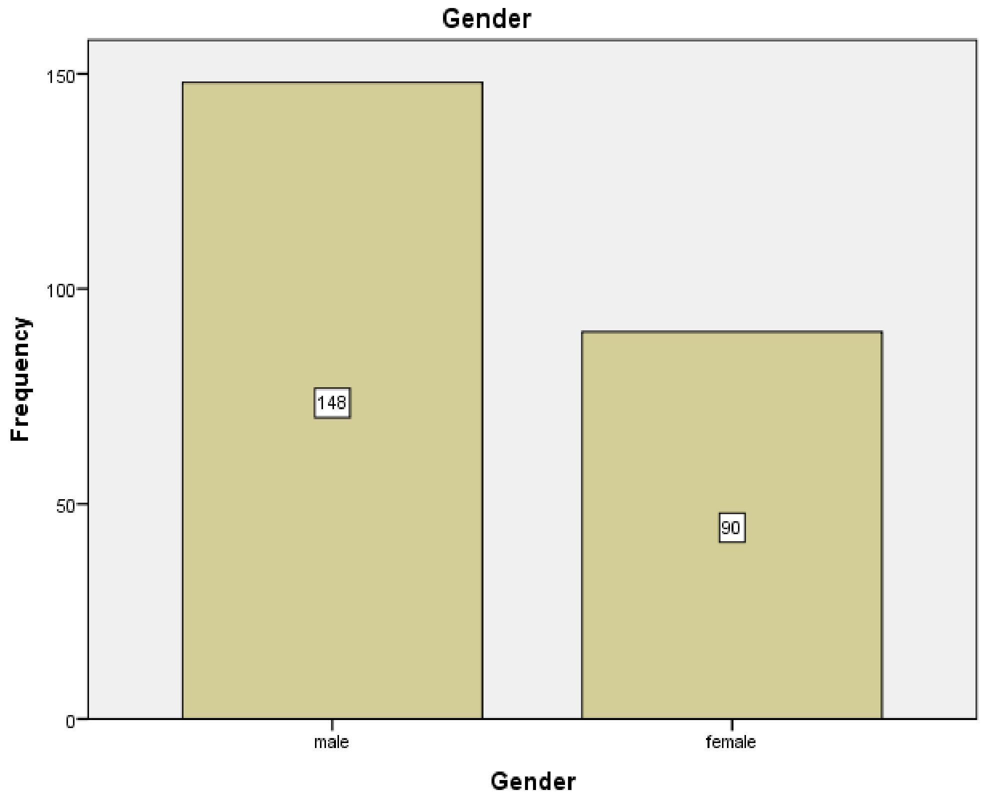

Figure 2: Frequency of Gender

Table 2: Frequency of falls since Stroke.

	Frequency	**Percent**
Yes	155	65.1
No	83	34.9
Total	238	100.0

Table 3: Frequency of Mini-Mental State Examination

	Frequency	Percent
severe cognitive impairment	137	57.6

moderate cognitive impairment	46	19.3
mild cognitive impairment	37	15.5
no cognitive impairment	18	7.6
Total	238	100

Table 4: Frequency of Berg Balance Scale.

	Frequency	**Percent**
High Fall Risk	22	9.2
Moderate Fall Risk	191	80.3
Low Fall Risk	25	10.5
Total	238	100.0

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Table 5: Association between balance and cognition.

		Berg Balance scale			
		High Fall risk	Moderate Fall risk	Low Fall Risk	**P value:**
Mini mental state examination	Total				
Severe cognitive impairment	17(12.4%)	17(12.4%)	113(82.5%)	7(5.1%)	**0.002**
Moderate cognitive impairment	3(6.5%)	3(13.6%)	35(18.3%)	8(32.0%)	
Mild cognitive impairment	1(2.7%)	1(4.5%)	27(14.1%)	9(36.0%)	
No cognitive impairment	1(5.6%)	1(4.5)	16(8.4)	1(4.0%)	
Total	238(100.0)	22(9.2%)	191(80.3%)	25(10.5%)	

DISCUSSION:

The Current study was conducted to find out the association of cognitive function with static and dynamic balance among subacute stroke patients. The current study of 238 Participants was recruited as sample. 148 was male Participants and 90 were female participants. The results of current study showed that participants having any decline in cognitive functioning can adversely affect balance, therefore increasing the risk of fall. The findings suggest that cognitive function has a negative impact on static and dynamic balance in stroke patients. The analysis revealed the significant association (p = 0.002), indicating that changes in cognitive function are significantly related to changes in both static and dynamic balance. Our results were consistent with previous research conducted by (Kwakkel et al., 2015), highlighting the importance of cognitive function in motor control and learning implications for rehabilitation programs which should prioritize cognitive training alongside balance exercises to improve overall functional recovery.(12) They recommend that healthcare professionals take into account cognitive function when devising personalized treatment strategies aimed at enhancing balance and mitigating the risk of falls in subacute stroke patients. This study also documented that impairment in cognitive function is a significant predictor of risk of fall in stroke patients. Consistent with previous research, these findings show that poor balance is linked to decreased cognitive performance (Goto et al., 2018; Meunier et al., 2021).(13, 14) For example, balance was found to be strongly associated with new-onset dementia (hazard ratio = 1.9–2.5, $p = 0.02$) in a population-based longitudinal study that evaluated the relationship between physical performance (4 m walk, five-chair stand, handgrip, and standing balance) and dementia (Bullain et al., 2016).(15) Furthermore, after adjusting for confounders, people with poor balance had a faster rate of cognitive decline compared to the control group ($\beta = -0.21$, 95% CI = −0.37, −0.05) in the Cardiovascular Health Study, which included 4,811 participants aged ≥67 years and followed them for 6 years (Meunier et al., 2021).(13)

Our findings showed that among middle-aged and older Chinese individuals, the results of balancing tests were an independent predictor of changes in cognitive function. According to our findings, if participants experienced limitations with their physical function, cognitive impairment prevention therapies have to be implemented concurrently.

It is yet unknown what processes underlie the link between standing balance and cognitive deterioration. Hausdorff et al., stated that, the coordination of the musculoskeletal, neurological, cardiovascular, and sensory (vestibular, proprioceptive, and visual) systems is necessary for static equilibrium.(16) Makizako et al., 2013 concluded that the relationship between static balance and cognitive performance may be explained by abnormalities in the architecture and processes of the brain.(17) Furthermore, the vestibular system may act as a mediating factor in this connection.(18)

By combining data from the vestibular brain, visual cortex, and somatosensory system, the vestibulo-ocular reflex and musculoskeletal system regulate posture. Deterioration and malfunction of the vestibular system are linked to impaired balance and cognitive decline.(19) However, more research has to be done on the processes behind this connection and preventative measures for cognitive impairment.

There are advantages to this study. First, strict quality control measures were used in the study, and participants followed established protocols. Secondly, a long-term follow-up period was employed to evaluate whether standing balance predicted changes in cognition using a longitudinal technique.

There are limitations on this study. First, additional variables, such as genetic characteristics, were not taken into account in the analysis, even though the regression models corrected for demographics, health habits, and chronic conditions. Secondly, selection bias may have occurred as a result of some individuals being eliminated due to incomplete data. Third, the degree of cognitive impairment was not determined by the cognitive function test. Thus, further research is required to determine how standing balance and cognitive function relate to one another.

CONCLUSION:

Patients who have had strokes tend to have decreased cognitive function when they have poor balance. Furthermore, a larger deterioration in mental state, global cognition, and episodic memory was linked to worse performance on balancing tests. Furthermore, the identification and treatment of these deficiencies may be enhanced by a deeper comprehension of the connection between postural balance and cognition.

Ethics Statement and Approval:

The study was approved by the Institutional Review Board of the University of South Asia (Reference No. USA/FAHS/2024/805; Dated: 8 April, 2024). It aimed to investigate the association of cognitive function with static and dynamic balance among subacute stroke patients. The following outlines the ethical consideration for this research project.

a. **Informed consent:**

- All participant were provided with a detailed written informed form explaining the study's purpose, procedure, potential risk and benefits and their right to withdraw at any point.
- The consent from clarified that participation is voluntary and anonymous

b. Privacy and Confidentiality:

- All data was collected anonymously. No identifiable information was linked to participants.
- Data was stored securely and confidentially according to institutional guidelines.
- Participant confidentiality was maintained throughout the research process and in any publications resulting from this study.

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