Investigating the Long-Term Cognitive Impairments of Stroke: A Systematic Review

Abstract

Stroke is a major cause of long-term morbidity, a cognitive impairment that affects instrumental activities of daily living and quality of life for survivors and caregivers. It is imperative that patients with the risk of Post-stroke cognitive impairment (PSCI) are identified early and interventions instituted as soon as possible. This study aims to demystify cognitive domains affected after a stroke, discover features on imaging that suggest the likelihood for the development of PSCI, assess survivors' quality of life, and examine the impact of non-pharmacological and pharmacological interventions on Post-stroke Cognitive impairment (PSCI). Using the PRISMA 2020 guideline, three databases were used: PubMed, Cochrane, and Google Scholar. 1,773 articles were identified; however, after applying inclusion and exclusion criteria and other filters, 13 articles were used for this study: 4 being observational studies, three systematic reviews and meta-analyses, and two narrative literature. The characteristics of each article that passed the quality check were analyzed in tabular form, and the discussion followed afterward. This study found that at three months following a stroke, survivors' Montreal Cognitive Assessment (MoCA) improves. It also sheds more light on the various cognitive assessment tools available and the many nonpharmacologic interventions available to post-stroke victims and caregivers as more investigations are still being carried out to ascertain the usefulness of pharmacological intervention.

Keywords: Stroke, Cerebrovascular Accident, Rehabilitation, Long term, Cognitive impairment.

Introduction and Background

Stroke or cerebrovascular accident is a trending cause of mortality and long-term disability worldwide, with approximately 15 million people experiencing a stroke each year: 5 million die, and 5 million are left with disability[1]. Many stroke survivors encounter physical difficulties and cognitive impairments that greatly influence their quality of life. Such cognitive impairments encompass difficulties with focus and attention, impairments in memory function, challenges in planning and problem-solving abilities (executive function), troubles with spatial awareness and neglecting one side, difficulties in coordinating and controlling body movements (apraxia), issues with movement control and spatial orientation (visual perception), confusion and denial of impairments (anosognosia), difficulties in recognizing and identifying objects (agnosia)[2]. It happens when there is an interruption in the blood flow to the brain, giving rise to a deprivation of oxygen and nutrients to brain cells.

While the immediate consequences of a stroke can be devastating, emerging evidence suggests that stroke survivors often face long-term cognitive impairments that significantly impact their quality of life and functional independence [3].

Understanding the long-term cognitive consequences of stroke is crucial for healthcare professionals, caregivers, and policymakers to develop appropriate interventions and support systems for stroke survivors. There are some knowledge gaps in the scope and characteristics of cognitive impairment in post-stroke patients. This review aims to examine these and shed light on the specific cognitive domains affected and potential factors influencing cognitive recovery or decline [4]. The cognitive impairments observed in stroke survivors can have wide-ranging consequences, including difficulties in activities of daily living, increased dependency on caregivers, and reduced capacity to reenter the workforce or engage in social activities. Moreover, these cognitive deficits can be associated with an increased risk of future strokes and other vascular events, highlighting the importance of comprehensive long-term management strategies [5].

This systematic review of the long-term cognitive impairment of stroke patients aims to contribute to the expanding understanding of post-stroke cognitive impairment, its pathophysiology, and available interventions. The findings of this study offer the potential for developing evidence-based interventions and support services that can enhance cognitive functioning and the overall quality of life of stroke survivors. Furthermore, this research underscores the need for long-term follow-up and comprehensive management strategies for stroke patients, extending beyond the initial acute phase of care.

Methodology

This research used the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines[6].

Search Strategy and Sources

The following database was used to search for relevant literature with different combinations of our keywords: PubMed, PubMed Central (PMC), Google Scholar, and Cochrane, and search strings were applied using AND/OR. Studies conducted until May 17, 2023, were included in this study. Focusing on primary research studies, systematic reviews, meta-analyses, and other relevant references.

Search Strategy	Database	Number of articles
("Stroke/complications"[Majr:NoExp] OR "Stroke/prevention and control"[Majr:NoExp] OR "Stroke/therapy"[Majr:NoExp]) AND("Cognitive Dysfunction/classification"[Majr:NoExp] OR "Cognitive Dysfunction/complications"[Majr:NoExp] OR "Cognitive Dysfunction/etiology"[Majr:NoExp] OR "Cognitive Dysfunction/prevention and control"[Majr:NoExp] OR "Cognitive Dysfunction/rehabilitation"[Majr:NoExp] OR "Cognitive Dysfunction/therapy"[Majr:NoExp])	PubMed(MeSH)	1,005
Long-term cognitive effects of stroke after rehabilitation OR Chronic AND Stroke AND Cognitive	Cochrane	53
Long term Post-stroke cognitive impairment in humans 18 years and above	Google Scholar	715

Total number of articles identified		1,773

List 1: Search Strategy with Keywords and the number of identified papers**.**

Eligibility Criteria

Only articles written in the English language were used. Studies involving adults above 18 years who suffered a stroke with a post-stroke period of greater than six months were included in this review. Excluded articles were: those for which full text could not be retrieved, articles with patients with a history of neurological or psychiatric disorders, and participants who were receiving treatment that could impair cognition or had severe cognitive or communication impairment.

Selection Process

Duplicate articles were removed, and every other article was screened by title and abstracts. In the case of doubt about eligibility, other co-authors were consulted, and a mutual consensus was reached. Shortlisted articles were transferred to an Excel sheet and Endnote for further eligibility check using full text, inclusion, and exclusion criteria.

Quality Assessment

Shortlisted articles were checked for quality using appropriate quality appraisal tools. The JBI qualitative checklist was used for Observational studies, Assessment of Multiple Systematic Review (AMSTAR) tools for systematic reviews, and meta-analysis articles. The Scale for the Assessment of Narrative Review (SANRA) was used to assess the quality of narrative reviews. Only studies that satisfied the quality appraisal were included in the systematic review.

Data Collection Process

All authors were involved in finalizing the collected data and the outcomes retrieved using the data extraction questionnaires.

Results

Study Identification and Selection

A total of 1,773 relevant articles were identified from various databases. From these, 820 duplicate articles were eliminated before conducting a detailed screening. 108 articles were assessed for eligibility. Elimination by title, Quality check, and full-text availability was performed, and 13 articles were used for the final review. The selection process of the studies can be visualized in *Figure 1* (PRISMA flowchart).

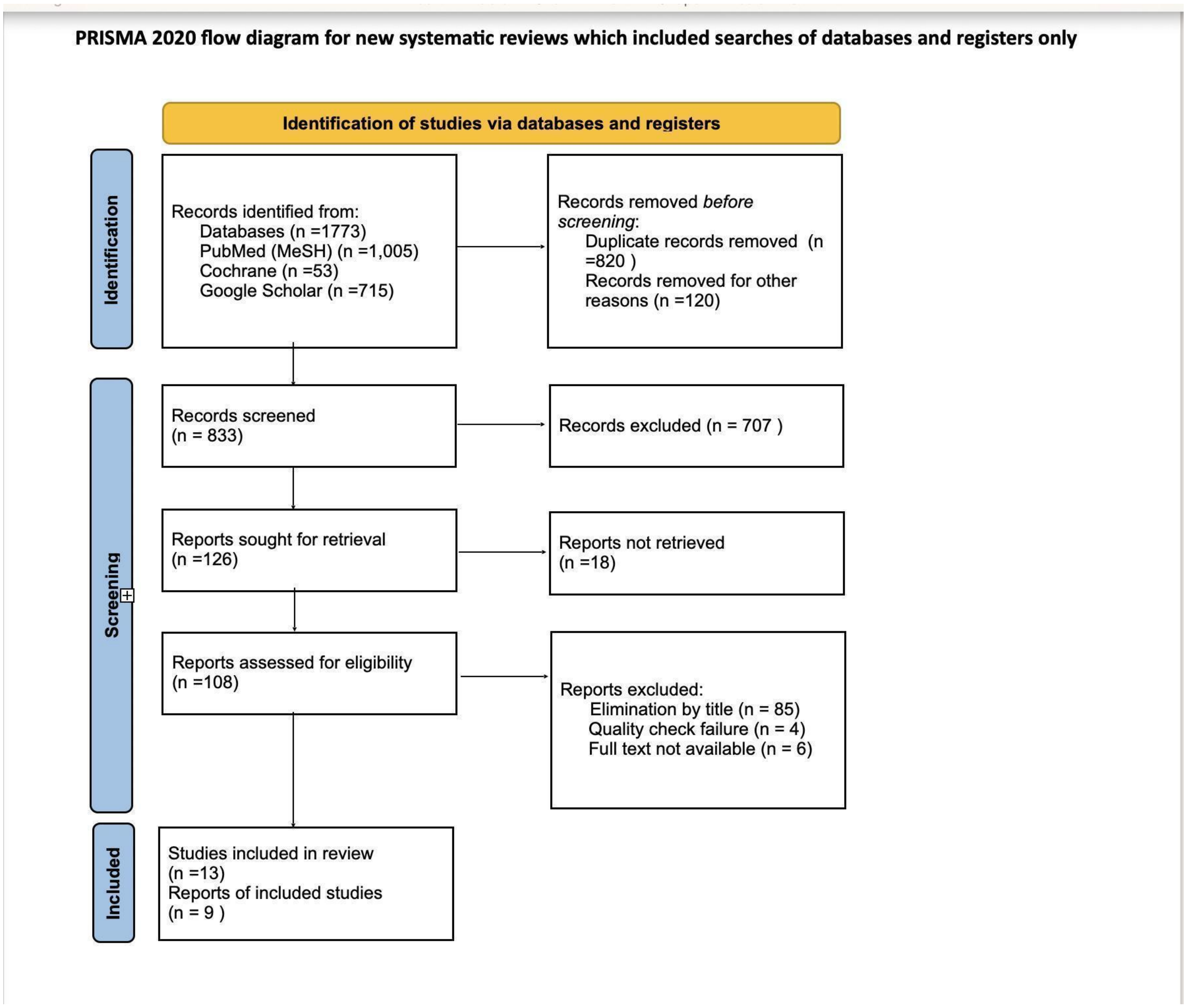

Figure 1: PRISMA flowchart showing the process of article selection.
PRISMA: Preferred Reporting Items for Systematic Review and Meta-Analysis

Each article was assessed using different quality appraisal tools

Table 1 **JBI Critical Appraisal Checklist for Cohort Studies**

Question number on JBI Critical Appraisal Checklist	Blomgren et al. 2019[7]	Boutros et al. 2022[8]	Buvarp et al. 2021[9]	Marsh et al. 2022[10]
1	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes

3	Yes	Yes	Yes	Yes
4	Yes	No	Yes	Yes
5	Yes	No	No	-
6	Yes	No	No	No
7	Yes	Yes	Yes	Yes
8	Yes	Yes	Yes	Yes
9	Yes	Yes	Yes	Yes
10	No	Yes	-	-
11	Yes	Yes	Yes	Yes

Table 2 **AMSTAR** (A Measurement Tool to Assess Systematic Reviews) Checklist

Question number on AMSTAR checklist	Sexton et al. 2019[11]	Merriman et al. 2019[12]	Ball et al. 2021[13]

1	Yes	Yes	Yes
2	No	Yes	Yes
3	Yes	Yes	Yes
4	Yes	Yes	Yes
5	Yes	Yes	Yes
6	-	Yes	No
7	Yes	Yes	Yes
8	No	Yes	No
9	Yes	Yes	Yes
10	Yes	Yes	Yes
11	No	Yes	No
12	No	Yes	-
13	Yes	Yes	Yes
14	No	No	-
15	Yes	Yes	Yes

The Cochrane Quality checklist was used for Kolska et al. 2022 and Maier et al. 2020 while the Scales for the Assessment of Narrative Review Articles was used to assess the quality of Lim et al. 2021.

Characteristics of the Studies
Table 3 is a summary of the articles used in this review which includes the type of study and its aim, participant number, and the study's results and conclusion.

Table 3**:** Summary of Included Articles

Authors and publication Year	**Study Type**	**Study Aim**	**Number of Participants**	**Results**	**Conclusion**

Blomgren et al. 2019[7]	Retrospective Observational study	To study the effect of cognitive dysfunction, emotional problems, and fatigue on the instrumental activities of daily living in young and middle-aged stroke survivors	356	Cognitive dysfunctions showed the strongest correlation with the Frenchay Activities Index (FAI) used to assess the Instrumental Activities of Daily Living (IADL)	At seven years post-stroke, cognitive dysfunction, amongst other factors, negatively impacted Activities of Daily Living (ADL) in young and middle-aged patients.
Boutros et al. 2022[8]	Longitudinal Prospective Study	To assess the rate of cognitive impairment post-stroke in Lebanese patients at three months, six months, and 12 months	150	Using the Mini-Mental Score Examination (MMSE) to assess Post-stroke Cognitive Impairment (PSCI), 27 died at 3 months post-stroke. 74.8% of survivors had a low MMSE at three months,46.7% at six months, and 37.6% at 12 months. In the 3-month period after the stroke, all cognitive domains was impacted. The most significant impairment was observed in attention/concentration, however, over the next 6 to 12 months,	In individuals experiencing their first stroke, the prevalence of post-stroke cognitive impairment (PSCI) was found to be substantial, with rates ranging from 74.8% in the early stage to 37.6% in the late stage. Cognitive impairment in Lebanese stroke survivors improved over time.

				there was a substantial improvement in these domains, except for attention/concentration, which experienced a slight decrease from 10% to 20% in impairment.	
Buvarp et al. 2021[9]	Prospective Cohort Study	To study the course of cognitive function in the first year post-stroke using The Montreal Cognitive Assessment (MoCA)	94	There were improvements in MoCA scores at three months and at 12 months post-stroke, but none was observed in between these periods. Survivors with low cognitive functioning had a larger impact on their memory performance, and with ADL, vice versa.	In the first three months after the stroke, cognition starts to improve. However, this is not the case for older survivors with the worst cognition or memory problems before a stroke.
Marsh et al. 2022[10]	Prospective Cohort	To study the pattern of the cognitive deficit over a year in survivors of mild stroke (using the NIH Stroke Scale (NIHSS))	80	In the first month of follow-up, cognition scores were low for every cognition domain. Between 1 to 6 months, 98% improved in global cognition and recovery varied from 6 to 12 months.	Impairment in cognition improves, but this recovery depends on some baseline factors of each stroke survivor.

Sexton et al. 2019[11]	Systematic review and Meta-analysis	To explore the prevalence of post-stroke cognitive impairment no dementia (CIND) in survivors up to a year.	4,152	The Meta-analysis found the prevalence of CIND in the first year post-stroke to be 38%.	About 4 in 10 stroke patients will have CIND in the first year. The number is lower in younger patients.
Merriman et al. 2019[12]	Systematic review and Meta-analysis	To discover psychological approaches through non-randomizeded study that aim to enhance cognitive function after a stroke and validate their effectiveness.	201	Findings of this study indicated that psychological interventions could be successful in improving cognitive function, notably in the memory and attention domains. However, because of limited data, this effectiveness could not be determined for other areas like subjective memory, self-efficacy, subjective executive function, and language comprehension, instruments, ADL, and perceptual reasoning.	There is the ability for psychological interventions to improve post-stroke cognitive deficits.
Ball et al. 2021[13]	Systematic review and Meta-analysis	Using computed tomographic scans to identify what stroke or pre-stroke feature is linked to post-stroke	7078	After evaluating various CT brain imaging features that are typically accessible following stroke, it was discovered	CT scan head done at the time of stroke is necessary as it is able to predict patients at high risk of post-stroke cognitive impairment.

		cognitive impairment (PSCI)		that White Matter Lesion (WML) increases the likelihood of developing PSCI three-fold.	
Kolska et al. 2022[14]	Cross-sectional study	To analyze the link between structural disconnectivity of a post-stroke brain and cognitive impairment.	102	Results from the 102 stroke survivors showed that post-stroke cognitive impairment might be attributed, in part, to the absence of distinct boundaries between extensive brain networks like right insular and frontal operculum, superior temporal gyrus, and putamen. These survivors had poorer MoCA activity.	degrees and patterns of structural disconnectivity following a stroke are responsive to cognitive impairments and can offer valuable clinical insights into predicting post-stroke cognitive consequences.
Maier et al. 2020[15]	Randomized Controlled Pilot trial	To ascertain the effect of adaptive conjunctive cognitive training (ACCT) using Rehabilitation Gaming System(RGS) on post-stroke cognitive impairment.	38	There was improvements in attention, spatial awareness, and generalized cognitive function in the experimental group. No substantial change was seen in the domains of memory and	ACCT positively impacts attention and spatial awareness and reduces depressive mood among individuals with chronic stroke.

				executive function.	
Lim et al. 2021[16]	Literature review.	Explore the pathophysiology of post-stroke and possible therapeutic intervention.	-	Functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI) for post-stroke brain functional and structural connectivity, even though cumbersome, is better than lesion-network mapping in assessing PSCI.	-

Discussion

Post-stroke cognitive impairment (PSCI) is a range of cognitive deficits occurring after a stroke. It can have a measurable impact on a patient's quality of life. Various brain domains are affected, leading to difficulties with memory, attention, executive function, visuospatial abilities, and language, which can be a significant barrier to the patient's recovery, often leading to depression and anxiety. The severity of PSCI varies from patient to patient, and several factors play a role. For example, previous history of stroke, pre-existing cognitive status, location and size, type of stroke, the individual's age, and caregiver availability.

The Pathophysiology of Post-Stroke Cognitive Impairment.

The pathophysiology of cognitive impairment following a stroke is multifactorial, involving several mechanisms that can be classified as primary and secondary, as highlighted by Danovska M et al.
The primary mechanisms involve the effects of the stroke on the brain leading to lack of oxygen, nutrients, and ultimately brain tissue damage.
The secondary mechanisms involve; Inflammation and oxidative stress, which follows an acute disruption of blood supply to the brain, either in the form of hemorrhage or ischemia, immediate inflammatory responses, and oxidative stress begin. Releasing cytokines, complement factors, and chemokines leads to neuronal injury and contributes to a deficit in cognition[17]. Next is a functional and structural disconnection occurring post-stroke. The brain's structurally and functionally interconnected regions or resting-state networks (RSN) are disconnected. These disruptions increase the risk of developing PSCI by causing changes in integration (the swift merging of specialized information from various brain regions) and segregation (the capacity for specialized processing to take place within densely interconnected groups of brain regions, and it serves as a quantifiable indicator of functional units within a network)[16]. Finally, Chronic Cerebral Small Vessel Disease, which includes white matter lesions (WML), microinfarcts, and lacunar infarcts, contributes to cognitive impairment after stroke. They interfere with white matter tracts and subcortical structures, affecting cognitive processing. Identifying WMLs on CT or MRI after a stroke is associated with a 3-fold increase in the chance of developing a PSCI[13].

Types of Cognitive Impairments Observed in PSCI

Cognition, which refers to the brain's capacity to comprehend, arrange, and retain information, can be disrupted by a stroke. A stroke can impact the brain's ability to process and store information effectively. According to the DSM-5, there are six cognitive domains with subdomains. These domains are Executive functions involved in decision-making, problem-solving, planning, flexibility, and inhibition. Perceptual motor function is a domain that deals with the ability to integrate sensory information (auditory, visual, and tactile stimuli) with motor skills for coordinated movement and action. The language domain involves the ability to find the right words, correctly identify and name objects, smoothness, and flow of speech, and the ability to understand spoken or written language. Another recognized domain by the DSM-5 is for memory and learning, which involves the ability to retrieve information from memory without or with cues or prompts, acquire knowledge without conscious awareness, retain information, the ability to retain information over an extended duration, and capacity to recognize previously encountered stimuli. The social cognition (understanding and interpreting social information) domain deals with the skill of identifying and perceiving emotions (via body language, voice intonations, and other non-verbal cues) from oneself and others. The complex attention domain: This cognitive skill entails focusing on one task while coordinating others. It also involves maintaining focus over an extended period, selectively focusing on particular stimuli and the speed at which information is perceived, processed and responded to[18]. These cognitive domains have interconnected functions and are crucial in enhancing one's quality of life. Nas et al., after conducting a study on 190 patients by examining their cognitive domains, concluded that executive function (38%) and perceptual disorders (38%) are most frequently implicated in PSCI[19]. At the same time, Boutros et al. observed worse cognition outcomes in the attention and memory domain from 6-12 months of Lebanese post-stroke patients[8].

Factors Associated with Long-Term PSCI

Certain factors increase the risk of long-term post-stroke cognitive impairment, contributing to its severity and the ability to recover quickly. They can be classified into modifiable and non-modifiable factors.

Table 4 Non-modifiable factors that determine the severity of long-term post-stroke cognitive impairment.

Non-modifiable factors	
Age	Stroke survivors who were greater than 75 years showed poorer cognitive impairment[9].
Sex	Evidence shows that females had lesser cognitive impairment following a stroke[8,9].
Location of the stroke	having a left-sided hemisphere stroke increases the risk of severe cognitive impairment[8]. Some other studies implicated structural disconnections in the right insula and frontal operculum, right superior temporal gyrus, and right putamen with poorer general cognitive performance when measured using the MoCA[14].

Table 5 Modifiable factors that determine the severity of long-term post-stroke cognitive impairment.

Modifiable factors	
Body mass index (BMI)	Some evidence supports higher BMI or obesity as an independent risk factor that improves PSCI[20].
Having a job	Patients who resumed work post-stroke had less risk of having severe PSCI[8].
Physical activities	Those physically active (sedentary behavior of fewer than 12 hours a day) had mild PSCI[8].
Education (Secondary or College)	A higher education level is identified as a protective factor against cognitive decline[8].
Medications for Diabetes	Individuals who were on anti-diabetic medications post-stroke were found to have mild long-term cognitive effects[8].
PCS of QoL (Physical Component Summary of the Short Form Health Survey (SF12) for evaluation of the quality of life)	Survivors with higher scores were less likely to develop PSCI[8].
Cohabitation status	Psychological and emotional support from a caregiver reduces the risk of developing severe cognitive deficits after a stroke[8].
The presence of other comorbidities like depression, atrial fibrillation, hypertension, multiple cerebral infarcts, and amyloidosis,	These comorbidities increased the risks of cognitive impairment[8].

To enhance post-stroke cognitive impairment (PSCI), we suggest focusing on improving modifiable factors during the recovery and rehabilitation process. This may include encouraging survivors to engage in physical activity, utilizing appropriate medications to address any comorbidities, providing support from caregivers, and maintaining a healthy BMI.

Impact of PSCI on the Instrumental Activities of Daily Living (IADL) and Quality of Life(QoL).

This can be assessed by a couple of screening (explanatory and outcome) methods.

Table 6: Screening tools for assessing IADL in Post-stroke patients with cognitive impairment.

Hospital Anxiety and Depression Scale (HADS)	A 14-item assessment tool with a score range of 0-21 is used to assess the patient's anxiety and depression level. 0 to 7 indicates a normal level, 8

	to 10 represents a borderline level, and 11 to 21 indicates an abnormal level of depression or anxiety[8]. The higher the score, the more inferior the mood[7].
Frenchay Activities Index (FAI)	This is a 15-item assessment tool that measures the outcomes of IADL in the range of 0-45, with 0 representing a state of inactivity and 45 a state of highest activity[7].
National Institute of Health Stroke Scale (NIHSS)	It consists of 15 components that evaluate various aspects, including consciousness, language, motor function, sensory loss, visual fields, extraocular movements, coordination, neglect, and speech. The scale is divided into five levels: 0 indicates no stroke, 1–4 represents a minor stroke, 5–14 indicates a moderate stroke, 15–20 suggests moderate to severe stroke, and 21–42 signifies a severe stroke[8]. It is used to grade stroke severity.
Fatigue related to daily activities was evaluated using the Fatigue Impact Scale (FIS).	The FIS comprises 40 items designed to capture the effects of fatigue on various activities and common situations encountered in everyday life. Scores on the FIS range from 0 to 160, with higher scores indicating a greater impact of fatigue[7].
Swedish translation of the Barrow Neurological Institute Screen for higher cerebral functions (BNIS)	BNIS is used to measure cognitive function. score ranges from 0-50, with 50 being the total cognitive function of the individual[7].
The Short Form Survey (SF-12)	This is a questionnaire used to assess the quality of life. The assessment includes two summary scores: the Physical Component Summary (PCS) and the Mental Component Summary (MCS). These summaries indicate an individual's mental and physical functioning as well as their overall health-related quality of life. The PCS and MCS are derived from the scores obtained from 12 questions and range from 0 (indicating the lowest level of health) to 100 (representing the highest level of health)[8].

The FAI score is an outcome screening tool. At the same time, the HAD, NIHSS, FIS, and BNIS are explanatory assessment tools such that in the multivariable logistic regression analyses performed by Blomgren et al., the BNIS score emerged as an independent predictor of the FAI summary score and work/leisure activities. Specifically, as cognitive dysfunction increased, the odds of experiencing a worse outcome also increased. Similarly, a higher score on the FIS was independently associated with a worse outcome on the FAI summary score and domestic chores. Furthermore, a higher score on the HAD-D indicated a worse outcome, specifically within the work/leisure activities of the FAI[7]. Different combinations of screening tools for outcomes and explanatory purposes can be employed to evaluate the quality of life of post-stroke survivors and assess the influence of the stroke on their daily activities. Experiencing a decline in cognitive function within the initial three months following a stroke raises the likelihood of unfavorable long-term outcomes, in contrast to maintaining cognitive stability without further deterioration. Post-stroke cognitive impairment is shared and linked to elevated mortality risks, dependency, depression, and institutionalization over five years [21].

Screening and Assessment Methods for Post-Stroke Cognitive Impairment

To confirm a diagnosis of post-stroke cognitive impairment, it is necessary to identify the presence of cerebrovascular disease. Diagnostic procedures involving brain imaging techniques, like computed tomography or magnetic resonance imaging, are employed for this purpose. Among these two imaging methods, MRI is generally considered more sensitive in detecting vascular changes[22], even though structural CT neuroimaging continues to be the internationally recognized standard technique for neuroimaging due to its advantages of being faster, more cost-effective, and readily available[13].

In cases where imaging is not accessible, the Canadian best practices support that clinical history and examination findings that align with a stroke can serve as objective evidence of cerebrovascular disease. These non-imaging factors can support the diagnosis when unavailable imaging results [22].

Certain features on MRI or CT scans, even when taken several months post-stroke, have been linked to the development of PSCI in survivors, and these include, White matter lesions (WML) and atrophy of the temporal lobe globally and its medial part. This finding was established by Ball et al. They also established no significant association between previous stroke lesions on CT/MRI and PSCI[13].

Some other studies went ahead to look into advanced neuroimaging techniques like the resting state functional MRI (rs-fMRI) for detecting functional disconnectivity after stroke, and the diffuse tensor imaging (DTI) that measures structural disconnectivity can also be used to predict and monitor patients at risk of post-stroke cognitive impairment[16].

The Mini-Mental State Examination (MMSE) is a widely employed tool for assessing post-stroke cognitive function. It evaluates seven cognitive domains: orientation to time, orientation to place, memory registration, memory recall, attention/concentration, language, and visual construction. A cutoff point of 24 is typically used to define normal cognitive function. The severity of cognitive impairment is classified into three levels: 24–30 indicates no cognitive impairment, 18–23 signifies mild cognitive impairment and 0–17 represents severe cognitive impairment[8].

The Montreal Cognitive Assessment (MoCA) is another screening tool used to assess cognitive function at baseline. MoCA is a dependable instrument for screening global cognition in patients with mild to moderate stroke. Consisting of subdomains following visuospatial/executive, naming, attention, abstraction, delayed recall or memory, and orientation. A maximum score is 30, with lower scores indicating worse cognition[9].

Benaim et al. carried out a clinical trial on 102 post-stroke patients and 50 controls to evaluate the reliability and validity of the CASP (Cognitive Assessment Scale for Stroke Patients) in the French population. Various psychometric properties, such as internal consistency, to assess the measurement properties of the French version of CASP, the study examined the test-retest reliability and construct validity. It is a quick screening tool and can be administered at the patient's bedside, even by non-expert examiners. They concluded that the assessment is best for chronic post-stroke survivors. A CASP score lower than 35 out of 36 may indicate the presence of cognitive impairment[23].

For a more comprehensive evaluation, authors like Marsh et al. carried out trials on other assessments that can be conducted using specific neuropsychological tests. These included the Delis-Kaplan

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Executive Function System (D-KEFS), Fluency and Trail Making Tests, Hopkins Verbal Learning Test (HVLT), Brief Visuospatial Memory Test-Revised (BVMT-R), Symbol Digit Modalities Test (SDMT), and Grooved Pegboard Test (GPT). They concluded that whenever feasible, a combination of these tests can provide a more comprehensive assessment of cognitive abilities[10].

Interventions and Future Directions

Following a stroke, quite several authors have concluded that cognitive impairment is a common consequence, affecting more than half of patients at the 6-month mark[12]. By one year, 38% develop cognitive impairment that doesn't meet the criteria for dementia[11]. Hickey et al. pointed out that it is closely linked to higher levels of disability and a lower quality of life for survivors and caregivers.

PSCI treatment can be broadly classified into: Non-pharmacologic, commonly used, and pharmacologic.Hickey et al. compared the effects of three psychological interventions, focusing on their effects on improving global cognition. Cognitive Rehabilitation is a type of target-oriented intervention that takes advantage of the brain’s ability to change and adapt over time to new experiences and information. It involves a structured and systematic approach to help individuals regain or compensate for their cognitive abilities. Cognitive rehabilitation programs may include techniques such as memory training, attention exercises, problem-solving strategies, and organizational skills training. The goal is to enhance cognitive abilities and promote independent functioning in daily life[24].

The Hickey et al. review also recognized cognitive training as a psychological intervention. It refers to structured activities or exercises designed to improve specific cognitive domains, such as attention, memory, processing speed, and executive functions, using written exercises that are therapist-led or computerized tasks. These interventions enhance cognitive abilities in deficit areas through repeated practice and challenging tasks that require problem-solving, pattern recognition, or memory exercises. The goal is to improve cognitive performance and transfer the gains to real-life situations[24]. Maier et al. conducted a study to evaluate the effect of adaptive conjunctive cognitive training (ACCT) on four domains of cognition. They concluded that this method positively influenced spatial awareness and attention and improved depression in chronic post-stroke survivors[15]. Lastly, the behavioral intervention strategy that concentrates on the survivors’ ability to develop compensatory strategies by combining educational information and therapeutic techniques to achieve several goals that help individuals comprehend their cognitive strengths and weaknesses, ultimately enhancing their quality of life and psychological well-being[24]. Other non-pharmacological interventions for PSCI are music therapy, aerobic exercise, acupuncture, noninvasive brain stimulation, and caregiver education [25].

Some pharmacologic remedies for the post-stroke cognitive deficit are Donepezil, Rivastigmine, Galantamine (cholinesterase inhibitors), and Memantine, an N-methyl-D-aspartate (NMDA) receptor antagonist. The Canadian best practices have advised that these medications be used with caution and when absolutely necessary because there is not enough data to support their use in PSCI, and their side effect profile could be deleterious to stroke survivors[22]. However, Zhao et al. pointed out that The American Heart Association/American Stroke Association supports the use of donepezil as it has been shown to improve cognition in stroke patients. Antidepressants, Antihypertensives, and Antiplatelets are other pharmacological remedies for PSCI, as some of them target the patients’ comorbidities[25].

Conclusion

Cognitive impairment is a common sequela that happens after a stroke that can impact the patient and caregiver’s quality of life. Patients and their family members play a crucial role in understanding and being aware of this problem and seeking support to promote recovery. Healthcare workers, on the other hand, should envisage this morbidity and offer support and education to survivors and their caregivers. Although further research is in progress to discover the most effective form of PSCI rehabilitation, nonpharmacological interventions can be explored as they have been shown to improve certain domains of cognition.

Limitations

Our study had limitations. Articles not written in English and those that did not have open access could not be included in this study even though they looked promising in providing relevant information for our study per title and abstract.

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