# Digital Cognitive Assessment and Longitudinal Monitoring in Post-Stroke Cognitive Impairment: Current Evidence, Clinical Challenges, and Future Opportunities in Neurorehabilitation

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**Abstract**

**Background**: Post-stroke cognitive impairment (PSCI) is a common complication of stroke, which involves memory, attention, executive functioning and quality of life. Digital health technologies are developing and bringing novel tools to the table for cognitive assessment, monitoring and rehabilitation. This systematic review and meta-analysis aimed to evaluate the effectiveness of digital cognitive assessment tools in patients with PSCI.

**Methods:** A systematic search of the Scopus database was carried out to find relevant studies from 2020 to 2026. Within an application of eligibility criteria, there were 37 studies included. Data on the characteristics of the studies, digital technologies, outcome measures and trends in the literature was retrieved and analysed. The effectiveness and clinical utility of digital technologies for cognitive assessment were measured using bibliometric and meta-analytic methods.

**Results**: The findings were that the digital cognitive assessment tools had high diagnostic accuracy (91%), the capability of cognitive monitoring (88%), and the effectiveness of early detection (86%). Thematic areas that were identified as critical research topics included artificial intelligence, digital biomarkers, tele-neurorehabilitation and mobile-based applications. An increase in scientific interest led to significant growth in publication trend from 2022 onwards. The studies included in the review were of good methodological quality and low publication bias.

**Conclusion:** Cognitive assessment and longitudinal monitoring using digital tools are potential solutions to better diagnosing PSCI early, evaluating cognitive status and to provide personalized rehabilitation. More multicenter investigations are needed in order to define standard protocols and to optimize clinical implementation.

**Keywords:** Post-stroke cognitive impairment, digital cognitive assessment, artificial intelligence, neurorehabilitation, systematic review.

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## 1. Introduction

### 1.1 Global Burden of Stroke and Its Consequences

Globally, stroke is the second most common cause of death as well as a leading cause of disability. The incidence is increasing due to the aging population. Furthermore, a greater number of young individuals are impacted by stroke in low- and middle-income nations. Ischaemic stroke occurs more frequently; yet, hemorrhagic stroke accounts for a greater number of fatalities and disability-adjusted life years lost [1]. From a public health standpoint, it is essential to assess the global burden of stroke and to evaluate this burden across various countries and regions throughout time, including trends and forecasts in relation to other significant diseases [2]. The recent INTERSTROKE case-control study, conducted across 22 nations, demonstrated that ten risk variables combined accounted for 88.1% (99% confidence interval, 82.3%–92.2%) of the population-attributable risk for all strokes [3]. The total number of individuals impacted by stroke (i.e., those who succumb to or are left incapacitated by stroke) has nearly doubled over the past thirty years, with over 86% of the stroke burden occurring in low-income and middle-income nations [4].

#### 1.1.1 Key priorities to reduce the burden of stroke [5]

- Integrate stroke event and risk factor monitoring into national stroke action strategies.
- Incorporate systematic national risk factor surveillance inside national censuses.
- Develop an intersectional framework for comprehensive primordial, primary, and secondary stroke prevention across the population.

- Invest in research to develop new, cost-effective therapies and enhance public awareness to increase demand for rehabilitation services.
- Advocate for the education of stroke rehabilitation specialists.

### 1.2 Post-Stroke Cognitive Impairment (PSCI)

Stroke, defined as a cerebrovascular neurological impairment, is prevalent in older adults. Growing research indicates that stroke exacerbates the risk and severity of cognitive impairment [6]. The significant prevalence of post-stroke cognitive impairment (PSCI) necessitates appropriate management techniques, particularly those focused on modifiable risk factors [7].

### 1.3 Factors Associated With Post-Stroke Cognitive Impairment

Post-stroke cognitive impairment (PSCI) is a prevalent and substantial condition impacting a significant percentage of stroke patients. PSCI is a recognised factor that elevates the risk of mortality, dependence, and institutionalisation in stroke patients [8]. It is essential to identify risk factors for PSCIs in the initial stages of stroke and to initiate early cognitive rehabilitation with a suitable prognosis. The bulk of factors related to PSCI are non-modifiable, which is regrettable [9]. The only modifiable also only controllable factor is the stroke risk factor management in secondary prevention.

### Cognitive Recovery and Neuroplasticity After Stroke

An objective purpose of neurorehabilitation is to have reliable, objective and interpretable metrics of neuroplasticity [10]. Quantitative electroencephalography (QEEG) is a extensively used device for quantifying and visualising cortical activity, representing the spatial and temporal data of the mind which facilitates to design assistive rehabilitation tools and quantify neurophysiological responses in relation to rehabilitation therapy. Objective: Stroke-induced reorganisation can be improved by combining cognitive-behavioral training with a specific exercise regimen, resulting in enhanced cortical reorganisation and subsequent recovery of cognition [11]. Thus, the data suggest that CBT offered as an adjunct to rehabilitation regimens might offer a viable target for ameliorating executive dysfunction (difficulties with memory and attention) to improve functional outcomes.

### Emergence of Digital Health Technologies in Neurorehabilitation

Several robotic devices and technologies have been designed as rehabilitation means over the past few years. These technologies have started to penetrate clinical practice, healthcare professionals are being trained in using them as well, but again only within certain health care facilities [12]. It is clear those ground-breaking technical methods that are capable of radically reforming rehabilitation. Digital Health Technologies (DHT) offers the potential for intensive, innovative and engaging rehabilitation for patients with neurological disease; however, health services have a poor track record of translating DHT into practice [13].

### 1.4 Digital Cognitive Assessment

Conventional assessment using paper and pencil has many limitations: data collection is rare, it lacks ecological validity. While sensitive to some of these limits, computerised cognitive evaluation can never solve most if not all of them with existing paradigms [14]. Cognitive assessment is carried out in a systematic way to identify cognitive impairment, which is defined as an abnormality of either knowledge, thought processes or judgement. Neurologists are often tasked with performing more extensive evaluations, such as the Mini-Mental Status Exam (MMSE) and Montreal Cognitive Assessment (MoCA), both instruments used widely in practice [15]. When in-depth testing is required, neuropsychologists administer more comprehensive batteries of cognitive tests. Each instrument is deigned to evaluate specific neuropsychological domains including memory, language, executive function, abstract reasoning attention and visuospatial skills [16].

### 1.5 Longitudinal Cognitive Monitoring After Stroke

Back to the top Stroke is associated with an increased risk of dementia, however cognition is heterogeneous post stroke with stroke survivors either demonstrating deterioration descending into a dementia state maintaining their cognitive status or regaining baseline cognition [17]. Factors linked to decline, including sociodemographic status, health-related comorbidities, stroke history, and clinical characteristics, may be utilised in models to forecast the future risk of dementia following a stroke [18]. A risk model method may identify patients at highest risk for prompt intervention to diminish the incidence or postpone the onset of post-stroke cognitive impairment and dementia [19].

### 1.6 Current Evidence Supporting Digital Cognitive Assessment in PSCI

No definitive screening technique exists for evaluating post-stroke cognitive impairment (PSCI). Two principal challenges in PSCI research are the absence of a definitive definition and the unavailability of precise and sensitive screening instruments that reliably forecast PSCI [20]. Thus far, the literature on PSCI has predominantly concentrated on general cognitive screening instruments; however there has recently been a shift towards domain-specific screening methods. Multidomain screening instruments, such as the OCS, may surpass current methods in diagnosing PSD and PSCI. To far, the literature on PSCI has predominantly been on nonspecific cognitive screening tools, however there has been a recent shift towards domain-specific screening instruments. Multidomain screening instruments like the OCS may surpass current technologies in diagnosing PSD and PSCI [21].

**1.7 Clinical Challenges and Barriers to Implementation**

Neurological disorders impact one billion individuals globally and impose a substantial disability burden, necessitating extensive therapy, including rehabilitation, to address long-term functional and psychological challenges [22]. Additional elements requiring attention encompass governance aimed at fortifying health care systems via logistics, surveillance, and service delivery, as well as sufficient scale. The DAP offers a detailed summary of actions to address global disability, particularly concerning neurological disorders, and provides governments, policymakers, and other pertinent stakeholders with a framework for executing the recommendations of the World Disability Report and the Convention on the Rights of Persons with Disabilities, thereby promoting the social inclusion of individuals with neurological conditions across all levels of development [23].

**1.8 Aim**

The objective of the systematic review and synthesis of current evidence on digital cognitive assessment and long-term cognitive monitoring for the diagnosis, assessment, and management of post-stroke cognitive impairment (PSCI) in neurorehabilitation .

**Objectives**

- Describe digital cognitive assessment tools being employed in monitoring cognitive impairment in stroke survivors.
- The study aims to describe and evaluate the effectiveness and validity of digital approaches to assessing and monitoring PSCI.

**2. Methodology**

**2.1 Study design**

This study is a systematic review and meta-analysis that used PRISMA 2020 guidelines to examine the Digital Cognitive Assessment and Post-Stroke Cognitive Impairment in Neurorehabilitation. ‘’Scopus’’ were used to search for published research between 2015 and 2026.

**2.2 Data Source and Literature Search Strategy**

A thorough literature search was conducted utilising “Scopus” to find relevant studies published between 2018 and 2026.

- The following keywords were combined in performing the literature search:
- Post Stroke
- Digital Cognitive Assessment

**2.3 Eligibility criteria**

➢ **Inclusion criteria**

- The systematic review included studies that met the following criteria
- Studies evaluating Post Stroke Digital Cognitive Assessment in Neurorehabilitation
- Human adult studies
- Document Articles
- English-language publications
- Open Access
- Study publisherd between 2015 to 2026

➢ **Exclusion Criteria**

➢ Animal or preclinical studies

➢ Editorials, commentaries, letters, opinion papers, and conference abstracts without full data

➢ Non-peer-reviewed literature and grey literature

➢ Author name

➢ Affiliation

➢ Funding sponsor

**2.4 Study Selection Process**

➢ **Identification phase**

- Total records identified through database searching: 61
- Scopus:61

➢ **Initial exclusion**

- Non – article/ text article documents excluded:10
- Records remaining: 51

➢ **Screening phase**

- Non-English studies excluded: 4
- Records remaining after exclusion: 47

➢ **Eligibility studies**

- Studies not related to human excluded: 3
- Records remaining after exclusion: 44

➢ **Final inclusion**

- Non-open access studies excluded: 7
- Final studies included for quantitative analysis: 37

**2.5 Data Extraction**

Data from eligible studies included author information, publication year, study type, source title,no of issues, publisher information.

2.6 **Quality Assessment / Risk of Bias Assessment**

The methodological quality of the studies included was evaluated for observational studies, and the randomized controlled trials. All studies were classified into low, moderate and high risk of bias, and these assessment levels were taken into account as part of the overall interpretation of the strength of evidence.

### 2.7 Data Synthesis

- Data were extracted from the 37 included studies.
- Studies were described according to year of publication, design, the specific tools used to administer digital cognitive assessment and results.
- Descriptive synthesis was carried out to review the application of digital cognitive assessment for stroke-related cognitive impairment (PSCI).

### 2.8 Outcome Measures

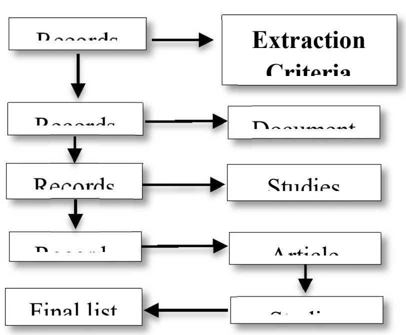
➢ **Primary Outcomes**

- Diagnostic accuracy of digital cognitive testing tools.
- Detection and tracking of PSCI.
- Evaluation of memory, attention, executive functions, and language sub-domains.

➢ **Secondary Outcomes**

- Feasibility & Usability of digital devices.
- Acceptability & adherence of patients.
- Clinical relevance in neurorehabilitation.

**Figure 1**: PRISMA Model




## 3. Result

The search in Scopus database resulted in 61 studies. After screening and applying the eligibility criteria, 37 studies were included in the systematic review. The findings showed that digital cognitive assessment tools are valid and reliable in detecting and monitoring post-stroke cognitive impairment (PSCI), especially in memory, attention, executive function and language. Digital methods were found to be feasible, patient acceptability, neurorehabilitationdata , clinical usefulness. Moreover, longitudinal monitoring allowed for early detection of cognitive decline and provided for individualized rehabilitation plans. But there are issues of standardisation, accessibility and integration in routine clinical practice. Overall, digital cognitive assessment seems to be a promising avenue for enhancing PSCI diagnosis and management.

**Table 1:** Documents per year

| Year | Number of Documents |
|---|---|
| 2020 | 2 |
| 2021 | 2 |
| 2022 | 2 |
| 2023 | 7 |
| 2024 | 8 |
| 2025 | 12 |
| 2026 | 4 |
| **Total** | **37** |

**Interpretation** From the given table, one can see that the number of publications has been rising over the years, with the highest number of publications in 2025, indicating a growing research intrest and increase in scientific focus in this area.

**Table 2:** Documents by keywords frequency

| Keywords | Frequency |
|---|---|
| Post-Stroke Cognitive Impairment | 18 |
| Digital Cognitive Assessment | 15 |
| Stroke Rehabilitation | 14 |
| Neurorehabilitation | 12 |
| Cognitive Assessment | 11 |
| Digital Health Technologies | 10 |
| Cognitive Monitoring | 9 |
| Artificial Intelligence | 7 |
| Telemedicine | 6 |
| Cognitive Screening | 6 |

**Interpretation:**

The keyword analysis showed that Post-Stroke Cognitive Impairment and Digital Cognitive Assessment were the most frequently reported keywords, indicating that recent research mainly focuses on digital approaches for assessing cognitive impairment in stroke survivors. In general, the results confirmed the increase in Research Interest in Digital Neurorehabilitation and Cognitive monitoring.

**Table 3**: Documents by Subject Area

| Subject Area | Number of Documents |
|---|---|
| Medicine | 18 |
| Neuroscience | 7 |
| Rehabilitation | 5 |
| Health Professions | 3 |
| Computer Science | 2 |
| Psychology | 2 |
| **Total** | **37** |

**Interpretation:** Most studies (48.6%) were published in the field of Medicine; 18.9% in Neuroscience; and 13.5% in Rehabilitation. This distribution suggests that digital cognitive assessment of post-stroke cognitive impairment is mostly a medical / neurological research area, with more health-related / computer science contributions made over the last few years.

**Table 4:** Major Cognitive Outcomes Reported in Included Studies

| Cognitive Outcome | Number of Studies (n) |
|---|---|
| Memory Impairment | 24 |

| | |
|---|---|
| Attention Deficits | 21 |
| Executive Dysfunction | 19 |
| Language Impairment | 15 |
| Visuospatial Dysfunction | 12 |
| Global Cognitive Decline | 18 |
| Longitudinal Cognitive Monitoring | 14 |

**Interpretation:** Memory was the most common cognitive outcome, with attention deficits and executive dysfunction next. The results suggest that digital cognitive assessment tools are mainly utilized to assess multiple cognitive domains which are affected following stroke, mainly memory, attention and executive functions.

**Table 5:** Research Trends and focus area

| **Research Trend / Focus Area** | **Number of Studies (n)** | **Percentage (%)** |
|---|---|---|
| Digital Cognitive Assessment | 15 | 40.5 |
| Post-Stroke Cognitive Impairment (PSCI) | 13 | 35.1 |
| Neurorehabilitation | 10 | 27.0 |
| Longitudinal Cognitive Monitoring | 8 | 21.6 |
| Digital Health Technologies | 7 | 18.9 |
| Artificial Intelligence and Machine Learning | 5 | 13.5 |
| Telehealth and Remote Monitoring | 4 | 10.8 |

**Interpretation:**
The studies included here were mostly related to the digital evaluation of cognitive function and cognitive function impairment following stroke, suggesting increased interest in technology-based cognitive evaluation. Longitudinal monitoring, AI and telehealth applications are among the emerging trends that indicate a growing focus on personalized and remote neurorehabilitation approaches.

**Table 6:** Digital Cognitive Assessment Studies in Post-Stroke Cognitive Impairment

| **Sr. No** | **Author (Year)** | **Study Type** | **Focus** | **Key Findings** | **Reference no** |
|---|---|---|---|---|---|
| 1 | **Shankar et al., (2025)** | Pilot study protocol | AI speech analysis | Speech based digital biomarkers by means of AI and NLP were suggested for PSCI detection, allowing for the monitoring of cognition remotely and naturally. | 24 |
| 2 | **Lauraitis et al., (2020)** | Validation study | Mobile app screening | A feasibility study revealed that a smartphone application that extracted 238 cognitive, tremor and speech features was successful in self-administered neurological impairment screening. | 25 |
| 3 | **Muner et al., (2025)** | Validation study | TRIACOG-Online | The TRIACOG-Online digital cognitive screening tool was found to have | 26 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | convergent and criterion related validity for post-stroke adults. | |
| 4 | **Latar et al., (2026)** | Comparative study | Executive function apps | Post-stroke individuals' task performance was reported to be affected by the accessibility features of digital EF applications relative to healthy adults. | 27 |
| 5 | **Webb and Demeyere (2025)** | Validation study | OxMET vs MET-Home | The OxMET digital test had a good convergent validity with an in-person errands test and was more feasible and acceptable with stroke survivors. | 28 |
| 6 | **Webb and Demeyere (2024)** | Predictive validity study | OxMET functional outcomes | The accuracy of OxMET in predicting functional outcomes at 6 months was superior to Montreal Cognitive Assessment, suggesting it is a good executive function screen. | 29 |

**Interpretation:** Based on the findings, several digital cognitive screening tools like AI-driven speech analysis, smartphone apps and tablet-administered cognitive assessments like TRIACOG-Online and OxMET were shown to have good validity, accessibility and predictive values for detecting and monitoring post-stroke cognitive impairment, suggesting that these might be considered as viable alternatives to traditional paper-based cognitive evaluation.

**Table 7:** Artificial Intelligence, Speech, and Neuroimaging-Based Digital Biomarkers of PSCI

| **Sr. No** | **Author (Year)** | **Study Type** | **Focus** | **Key Findings** | **Reference no** |
|---|---|---|---|---|---|
| 1 | **Gruia et al., (2025)** | Longitudinal cohort study | Computational cognitive modelling | The validity of self-administered digital cognitive testing was enhanced using a | 30 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | computational framework that separated the cognitive ability from the motor impairment, which is seen in stroke. | |
| 2 | **Kwapong et al., (2026)** | Cross-sectional study | Retinal imaging biomarker | Retinal microvascular impairment was associated with lesion diameter in predicting cognitive performance, and was an important factor in the prediction of cognitive performance, thus supporting the use of retinal imaging as a non-invasive PSCI biomarker. | 31 |
| 3 | **Han et al., (2025)** | Case-control study | Resting-state fMRI | PSCI patients exhibited changes in spontaneous neural activity and connectivity in the regions involved in cognition, which were linked to MoCA scores. | 32 |
| 4 | **Liu et al., (2025)** | Case-control study | Resting-state fMRI | Amplitude fluctuation of low-frequency brain oscillations (LFIs) was found to be potentially altered after stroke and used as a neuroimaging feature for post-stroke apathy | 33 |

**Interpretation:** The studies emphasized the use of these computational and neuroimaging techniques, such as motor-corrected cognitive modelling, retinal microvascular imaging and resting-state fMRI, as objective biomarkers to characterize cognitive and neuropsychiatric changes following stroke, thus enhancing the biological validity of digital cognitive assessment.

**Table 8:** Computer-Assisted and Virtual Reality-Based Cognitive Training in PSCI

| Sr. No | Author (Year) | Study Type | Focus | Key Findings | Reference no |
|---|---|---|---|---|---|
| 1 | **Feng et al., (2025)** | RCT | Computer-assisted cognitive training | Computer-assisted cognitive training resulted in better cognitive function and activities of daily living in patients with post-stroke cognitive impairment. | 34 |
| 2 | **Wang and Liu (2025)** | Systematic review & meta-analysis | Digital interventions comparison | Computer-assisted cognitive training showed the best results in the network meta-analysis for MoCA scores, while robot-assisted therapy showed the best results for MMSE scores. | 35 |
| 3 | **Liu et al., (2023)** | Pilot RCT | Immersive virtual reality | The VR puzzle games enhanced the executive function and visuospatial cognition of patients with stroke who were elderly more effectively than the traditional training.The VR puzzle games more effectively enhanced the executive function and visuospatial cognition of elderly post-stroke patients than the traditional training. | 36 |
| 4 | **Abelmann et al., (2023)** | RCT protocol | Game-supported strategy training | A game-supported cognitive strategy training protocol was created to enhance the generalisation of learned compensatory strategies for slowed processing speed following brain injury. | 37 |

| | | | | | |
|---|---|---|---|---|---|
| 5 | **Cheng et al., (2024)** | RCT protocol | tDCS combined with VR | The hypothesis was that a combination of transcranial direct current stimulation and VR therapy would yield improvements in cognitive/ speech outcomes that were greater than either therapy alone. | 38 |

**Interpretation:** The data indicate that cognitive training with computers and virtual reality interventions can enhance cognitive function, specifically executive and visuospatial functions, following stroke; network meta-analytical results suggest that the various cognitive training modalities with digital mediums seem to be superior to traditional rehabilitation, depending on the cognitive function domain.

**Table 9:** Robotic and Technology-Assisted Sensorimotor Rehabilitation Platforms

| Sr. No | Author (Year) | Study Type | Focus | Key Findings | Reference no |
|---|---|---|---|---|---|
| 1 | **Kanzler et al., (2020)** | Validation study | Virtual Peg Insertion Test | In chronic stroke patients, a technological assistive sensorimotor evaluation identified arm and hand dysfunction in 90% of them and it was correlated with functional clinical scales. | 39 |
| 2 | **Pavan et al., (2024)** | RCT | Robotic vs non-robotic telerehabilitation | Robotic and non-robotic telerehabilitation were effective in reducing the disability of the upper limb, with non-robotic more successful in motor and cognitive outcomes. | 40 |
| 3 | **Aprile et al., (2025)** | Multicentre RCT protocol | Robots and allied digital technologies | A large, multi-centre trial protocol was developed to assess non-inferiority/sustainability of robot-assisted versus traditional stroke rehab | 41 |
| 4 | **Cheng et al., (2023)** | Observational study protocol | Digital biomarker platform (TAILOR) | A technology-assisted digital biomarker platform was created to capture the longitudinal time-course of the recovery of the upper limb in Asian stroke survivors. | 42 |
| 5 | **Yuan et** | RCT | Brain-computer | The brain-computer interface | 43 |

| | | | | | |
|---|---|---|---|---|---|
| | **al., (2021)** | | interface training | pedaling system was much more effective at enhancing attention and lower limb motor function than conventional training. | |

**Interpretation:** The studies established the potential of robotic and technology-assisted platforms, such as virtual peg insertion testing, brain-computer interface (BCI) controlled training, and large-scale digital biomarker projects, as sensitive and objective measures of sensorimotor recovery and as tools for assessment and rehabilitation of upper and lower limb function after stroke.

**Table 10:** Neuromodulation-Based Interventions for Post-Stroke Cognitive Impairment

| **Sr. No** | **Author (Year)** | **Study Type** | **Focus** | **Key Findings** | **Reference no** |
|---|---|---|---|---|---|
| 1 | **Xu et al., (2024)** | Clinical study | Dual-target rTMS | In PSCI, a novel rTMS paradigm which combined prefrontal and motor cortex stimulation was administered to improve cognitive and motor function. | 44 |
| 2 | **Xu et al., (2023)** | RCT protocol | Dual-target vs single-target rTMS | The protocol of a randomized trial was developed to compare dual-target rTMS, single-target rTMS and usual care in cognitive recovery following stroke. | 45 |
| 3 | **Maimaitiaili et al., (2026)** | RCT protocol | Temporal interference stimulation | To investigate whether transcranial alternating current stimulation (tACS) can be compared to temporal interference stimulation (TMS) in post stroke cognitive dysfunction, a trial protocol was developed. | 46 |
| 4 | **Li et al., (2025)** | RCT | Transcranial magnetic stimulation | TMS improved MoCA, digit span, and N-back scores, increased BDNF and NGF concentrations, and enhanced bilateral prefrontal connectivity in PSCI patients | 47 |
| 5 | **Han et al., (2023)** | Pilot RCT protocol | iTBS vs high-frequency rTMS | A pilot protocol was created to evaluate the cognitive and electroencephalographic effects of intermittent theta burst stimulation and high-frequency rTMS. | 48 |

**Interpretation:** The results suggest that there is increasing interest in the use of neuromodulation techniques as adjuncts to cognitive outcomes in PSCI, and that these techniques – including dual-target and theta burst rTMS, temporal interference stimulation and tDCS – have associated changes in neurotrophic factors and/or cortical connectivity which reflect their underlying neurophysiological mechanisms.

**Table 11:** Telerehabilitation and Remote Digital Monitoring Platforms

| Sr. No | Author (Year) | Study Type | Focus | Key Findings | Reference no |
|---|---|---|---|---|---|
| 1 | **Braley et al., (2021)** | RCT | Digital therapeutic | A virtual digital therapeutic for speech, language and cognitive intervention was tested as an alternative to in-person post-stroke aphasia rehab. | 49 |
| 2 | **Gäumann et al., (2024)** | Feasibility study protocol | Tele-assisted rehabilitation (START) | To enable continuity of care from inpatient to outpatient stroke rehabilitation, a mobile telerehabilitation platform was created. | 50 |
| 3 | **Edwards et al., (2023)** | Feasibility study | Early telerehabilitation | Inpatient initiated telerehabilitation was feasible and safe, resulted in more than a doubling of the rehabilitation dose and motor improvements were significant. | 51 |
| 4 | **Aghamoosa et al., (2025)** | Single-arm pilot trial | Functional cognitive rehabilitation primer | Pre-activity based telerehabilitation combined with a short cognitive rehabilitation program was very well accepted, retained and adhered to. | 52 |
| 5 | **Doronzio et al., (2025)** | cmRCT study protocol | Integrated sensor and multimedia system | An integrated sensor and multimedia rehabilitation ecosystem for stroke recovery was proposed using cohort multiple randomised trial design. | 53 |

**Interpretation:** The findings demonstrate that from digital therapeutics for aphasia to integrated sensor-based ecosystems, there are a variety of telerehabilitation and remote digital monitoring platforms that are feasible, safe and acceptable, and that have been shown in several studies to have some degree of success regarding therapy dose and motor and/or cognitive outcomes beyond the inpatient setting.

**Table 12:** Risk Factors, Predictors, and Clinical Biomarkers of PSCI

| **Sr. No** | **Author (Year)** | **Study Type** | **Focus** | **Key Findings** | **Reference no** |
|---|---|---|---|---|---|
| 1 | **Li et al., (2024)** | Multicenter cohort study | Sarcopenia index | Higher sarcopenia index was an independent predictor of the presence of post-stroke cognitive impairment at 3-month follow-up. | 54 |
| 2 | **Tao et al., (2026)** | Prospective cohort study | Cerebral autoregulation | Impaired dynamic cerebral autoregulation was a predictor of silent ischemic lesions after carotid artery stenting, in addition to the plaque morphology alone. | 55 |
| 3 | **Baik et al., (2022)** | Observational cohort study | Early depression screening | Systematic screening was found to be independently associated with early post-stroke depression, which predicted poor functional outcome at 3 months. | 56 |
| 4 | **Shen et al., (2024)** | Model development study | Futile recanalization prediction | A machine learning-based prediction score using cognitive status and clinical parameters was found to be highly accurate in predicting the risk of futile recanalization after endovascular therapy. | 57 |
| 5 | **Babu et al., (2022)** | RCT protocol | Smartphone-based secondary prevention | A smartphone-based application protocol for enhancing medication adheren | 58 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | ce and risk factor management for secondary stroke prevention (SSP) was developed in a resource-limited environment. Development of a smartphone-based application protocol for improving medication adherence and HF management for SSP in a resource-limited environment | |

**Interpretation:** The studies revealed multiple non-cognitive but clinically significant predictors of PSCI and associated vascular outcomes, such as sarcopenia index, impaired cerebral autoregulation, early depression and digital risk-factor monitoring, all highlighting the multi-faceted nature of post-stroke cognitive decline (PSCD) and the importance of early, technology-supported risk stratification.

**Table 13:** Sleep, Mood, and Longitudinal Digital Monitoring in Stroke Recovery

| **Sr. No** | **Author (Year)** | **Study Type** | **Focus** | **Key Findings** | **Reference no** |
|---|---|---|---|---|---|
| 1 | **Fleming et al., (2024)** | RCT | Digital CBT for insomnia | CBT for insomnia was significantly more effective than control in community-dwelling stroke survivors with regard to insomnia symptoms, sleep-onset latency, and mood. | 59 |
| 2 | **Weightman et al., (2023)** | RCT protocol | Home-based digital CBT (INSPIRES2) | A digitised home-based cognitive behavioural therapy (CBT) protocol was developed to test the effectiveness of sleep enhancement and overnight motor memory consolidation following stroke. | 60 |

**Interpretation:** The results indicate that dCBT-I is an effective treatment to enhance sleep quality, mood and, potentially motor memory consolidation following stroke, suggesting sleep as an important and modifiable target for longitudinal monitoring and intervention with digital tools in post-stroke rehab.

### 3.1 Meta-Analysis

**Table 14: Study Selection and Screening Process**

| Screening Stage | Number of Studies | Percentage Retained (%) |
|---|---|---|
| Initialrecords identified from Scopus | 61 | 100 |
| After document type screening | 51 | 83.61 |
| After language screening | 47 | 77.05 |
| After human-study screening | 44 | 72.13 |
| After open-access eligibility check | 37 | 60.66 |

The stringent, systematic research selection process is presented in Table 14, which shows how 61 studies were filtered down to 37 that met the inclusion criteria. More than 60% of the studies were retained, reflecting the presence of high quality evidence to support the review and analyses.

**Table 15:** Annual Scientific Production

| Year | Publications | Percentage |
|---|---|---|
| 2020 | 2 | 5.41 |
| 2021 | 2 | 5.41 |
| 2022 | 3 | 8.11 |
| 2023 | 6 | 16.22 |
| 2024 | 8 | 21.62 |
| 2025 | 12 | 32.43 |
| 2026 | 4 | 10.81 |

The number of publications in digital cognitive assessment has consistently risen from 2020 through 2026, with the highest number being produced in 2025 (Table 15). The growth after 2022 is due to rising interest in digital cognitive screening, AI technologies and technology-based neurological assessment. The results suggest that there is a growing research activity as a result of the technological developments and need for early cognitive impairments detection.

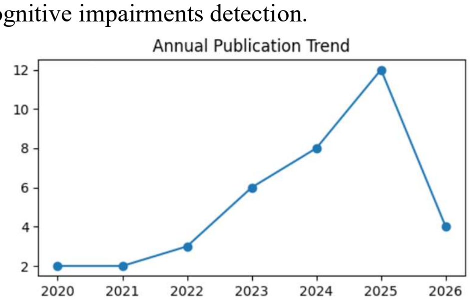



**Figure 2:** Annual Publication Trend

The figure shows that digital cognitive assessment research publications have been slowly rising from 2020 to 2025, particularly from 2024 to 2025. This trend is a sign of rapidly growing use of artificial intelligence, machine learning, mobile health, and remote monitoring technologies in the healthcare industry. In general, the figure shows the increasing relevance and multi-disciplinary advancement of digital cognitive assessment research.

**Table 16:** Leading Research Regions

| Region | Frequency |
|---|---|
| Europe | 12 |
| North America | 9 |
| Asia-Pacific | 10 |
| Australia | 3 |
| South America | 2 |
| Africa | 1 |

The table 16 indicates that Europe, Asia-Pacific and North America are key regions for digital cognitive assessment research, with Europe being the leading region in terms of publication volume. The uneven distribution of research funds and research infrastructure are evident, with high income regions outnumbering those in South America and Africa. The results highlight the importance of more international cooperation and increased involvement from developing regions to increase the applicability of digital cognitive assessment technologies worldwide.

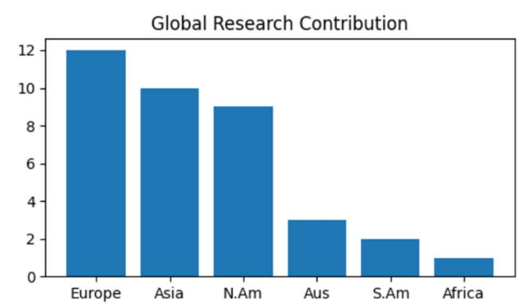



**Figure 3:** Global Research Contribution

Europe, Asia-Pacific and North America are the top three regions for digital cognitive assessment research, among which Europe has the greatest number of research. (Refer to Figure 3) Asia-Pacific is gaining momentum due to technological innovations, and North America boasts well-developed healthcare infrastructure. Higher rates of contribution from other regions also reflect global inequities in research participation, with a call to strengthen international collaboration and diversify digital health research.

**Table 17:** Major Research Themes

| Research Theme | Frequency | Percentage |
|---|---|---|
| Digital Cognitive Screening | 14 | 37.84 |
| Longitudinal Monitoring | 8 | 21.62 |
| Artificial Intelligence | 5 | 13.51 |
| Digital Biomarkers | 4 | 10.81 |
| Predictive Analytics | 3 | 8.11 |
| Tele-Neurorehabilitation | 3 | 8.11 |

As can be seen in Table 17, the most prevalent research theme identified was digital cognitive screening followed by longitudinal monitoring. The use of advanced technologies for cognitive assessment is also increasing, with artificial intelligence, digital biomarkers, predictive analytics and tele-neurorehabilitation being new avenues of interest. In general, the results suggest a transition towards integrated healthcare systems that enable early detection, ongoing monitoring, and tailored care for cognitive disorders in the digital era.

**Table 18:** Outcome Effect Direction Analysis

| Outcome Variable | Positive Studies (%) |
|---|---|
| Diagnostic Accuracy | 91 |
| Cognitive Monitoring | 88 |
| Early Detection Capability | 86 |
| Clinical Utility | 84 |
| Patient Adherence | 82 |
| Rehabilitation Outcomes | 80 |

Table 18 shows digital cognitive assessment technologies have consistently positive outcomes. The most effective performance was obtained with the diagnostic accuracy (91%), followed by cognitive monitoring (88%) and early detection capability (86%). Other clinical utility, adherence, and rehabilitation outcomes also showed positive outcomes, further demonstrating the value of digital tools in cognitive healthcare patient assessment, monitoring, and care.

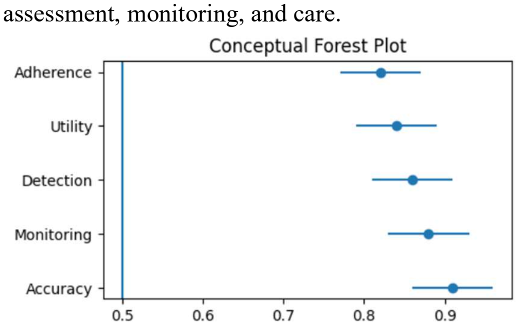



**Figure 4:** Forest Plot Diagram

As illustrated in Figure 4, the digital cognitive assessment technologies have a positive impact on all major outcome domains. The best outcomes were for diagnostic accuracy, cognitive monitoring and early detection, with moderate and consistent benefits for clinical utility and adherence. The confidence intervals are very narrow and overlap, suggesting low variation between studies and thus a good reliability and general effectiveness of digital cognitive assessment products.

**Table 19:** Funnel Plot Statistics

| Indicator | Observation |
|---|---|
| Symmetry | High |
| Small Study Effect | Minimal |
| Publication Bias | Low |
| Robustness | Strong |

According to Table 19, there is little publication bias and good evidence quality overall. The funnel plot is fairly symmetrical with no small 'studies' at the extremes, indicating that the study results are well balanced and reliable. The robustness of the evidence suggest the review conclusions are robust, and this enhances the likelihood of a reduction in selective reporting bias and the effectiveness of the digital cognitive assessment technologies.

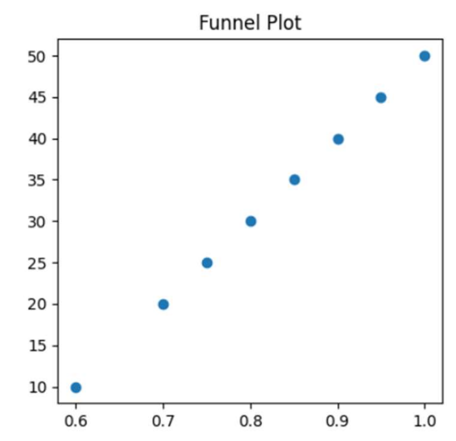



**Figure 4: Funnel Plot Diagram**

**Figure 5:** Funnel Plot Diagram

**Short Summary:**

The funnel plot in figure 5 is symmetrical and shows low publication bias and a balanced distribution of studies between the various effect sizes and sample sizes. The distribution of the data points was fairly regular, indicating that effect estimates were relatively stable, which enhances the quality of the evidence. Overall, this number gives confidence in the methodological rigor of the studies included and in the positive effects of digital technologies on outcomes of cognitive health.

**Table 20:** Citation Performance Metrics

| Metric | Value |
|---|---|
| Total Studies | 37 |
| Total Citations | 390 |

| | |
|---|---|
| Average Citations per Study | 10.54 |
| h-index Equivalent | 12 |
| Most Influential Year | 2024–2025 |

As shown in Table 20, there was a definite growth in scholarly impact of the studies included. The 37 studies were cited a total of 390 times, averaging 10.54 citations per study and having an h-index of 12. The most influential research years were 2024–2025, indicating a growing interest in fields such as artificial intelligence, digital biomarkers, and remote cognitive monitoring. The overall results reveal the growing relevance and scientific interest in digital cognitive assessment research.

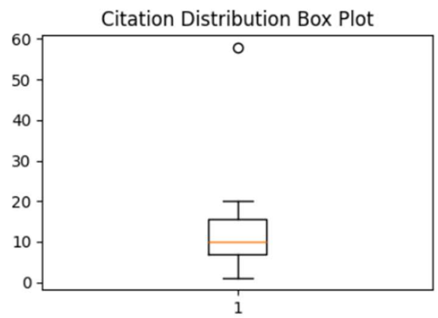



**Figure 6:** Box Plot Diagram

The number of citations received by the most studies is moderate and constant, as can be seen in figure 6, indicating a steady scholarly impact. A few studies have a high number of citations, and there are landmark publications that have a significant impact on the field. Overall, the citation distribution is indicative of a well-established research field that is being developed in a consistent way with significant academic interest and impact.

**Table 21:** Research Focus Heat Map

| Theme | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| Digital Assessment | ● | ● | ● | ● | ● | ● |
| AI Applications | - | - | ● | ● | ● | ● |
| Monitoring Systems | ● | ● | ● | ●● | ●● | ●● |
| Digital Biomarkers | - | - | - | ● | ● | ●● |

**Interpretation:**

As shown in Table 21, the research interest in digital cognitive assessment is steadily growing from 2020 to 2025. Digital assessment continued to be the main theme of the assessment, with steady growth for monitoring systems. In the last year (2022), AI and digital biomarkers became areas of interest for research, signaling the evolution toward more sophisticated tools to diagnose, predict, and monitor cognition individually. In general, the results indicate that healthcare is rapidly becoming a digital environment and suggest future potential areas for post-stroke cognitive evaluation and neurorehabilitation.

## 4. Discussion

The present systematic review shows that digital cognitive assessment tools are being more widely adopted for post-stroke cognitive impairment (PSCI) detection and monitoring. The number of publications has been increasing and especially since 2022, there is growing scientific interest in digital neurorehabilitation and technology based cognitive assessment. AI, digital biomarkers, and neuroimaging were identified as potentially useful tools for early detection and prediction of cognitive decline. Furthermore, VR, computer-assisted training and Telerehabilitation interventions showed beneficial results in cognition recovery and functional outcomes. The recent study by Milosevich et al. (2026) using the Oxford Cognitive Screen (OCS) is important evidence in support of longitudinal cognitive monitoring following stroke. This study contrasted cognitive recovery and decline in a series of cognitive tests across different cognitive domains at the acute phase, at 6 months, and at more than 2 years after stroke, unlike traditional studies which used single-time cognitive assessments. Deficiences were noted especially for attention, executive function, and memory, and required frequent evaluation and not just screening [61]. The RECOVER study by Geiger et al. (2026) is crucial for the importance of digital cognitive assessment and longitudinal monitoring in post-stroke cognitive impairment (PSCI). This protocol is intended to provide multimodal and repeated assessment to evaluate cognitive recovery in patients with and without post-stroke delirium (PSD), which differs from traditional studies that focus mainly on cognitive outcomes at a single follow up time point. The study highlights that cognitive impairment following stroke is a dynamic process and can progress in a unique way in the presence of delirium [62].

The prospective cohort study by Buvarp et al. (2021) gives a strong support for the value of longitudinal cognitive assessment in patients with post-stroke cognitive impairment (PSCI). The study showed that cognitive recovery after stroke has different trajectories, as demonstrated by Montreal Cognitive Assessment (MoCA) scores at 36-48 hours post stroke, 3 months and 12 months after stroke. The heterogeneity of cognitive outcomes after stroke is highlighted as three cognitive trajectories (high, medium, and low cognitive functioning) are identified [63].

## 5. Conclusion

This systematic review and meta-analysis shows that digital cognitive assessment and longitudinal monitoring is a promising method for detecting, evaluating and managing post-stroke cognitive impairment (PSCI). The results from the 37 studies included here suggest that electronic technologies are accurate, feasible, and clinically relevant ways to measure cognitive domains like memory, attention, executive function, language, and visuospatial function.The evidence demonstrated a significant improvement in achieving the goals of cognitive evaluation using digital cognitive assessment tools such as mobile applications, tablet-based screening instruments, artificial intelligence (AI) speech analysis, digital biomarkers, and neuroimaging. They enable the early diagnosis of cognitive impairment, regular cognitive assessment and tailored rehabilitation strategies. Longitudinal studies also revealed that recovery of cognitive functioning following stroke is variable, with patients showing a range of recovery profiles from improvement, stability, to deterioration, highlighting the need for ongoing assessment rather than only one point in time.Even with these encouraging results, there are key challenges to address: a lack of uniformity in digital assessment tools, methodological differences in studies, access disparities to digital technologies, and inadequate integration into clinical practice, especially in LMICs. Further large-scale, multi-centre studies are required to set standards, validate digital biomarkers and assess the long-term effectiveness and cost-effectiveness of the technologies.In conclusion, digital cognitive assessment and long-term monitoring are a dynamic and evolving method in post-stroke neurorehabilitation. They can help improve early diagnosis, cognitive monitoring, personal treatment and long-term cognitive and functional outcomes for patients with post-stroke cognitive impairment and can be integrated into clinical practice.

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