Review Article

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Post-stroke fatigue interventions for stroke survivors: A scoping review

Belitung Nursing Journal
Volume 10(6), 601-613

https://doi.org/10.33546/bnj.3526

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Abstract

Background: Fatigue following a stroke, known as post-stroke fatigue (PSF), is a frequent complication experienced by individuals recovering from a stroke, with its incidence steadily increasing over time. The long-term presence of PSF significantly hinders the rehabilitation process and quality of life for these individuals. However, the most effective intervention strategies for PSF remain unclear. Therefore, it is crucial to implement appropriate intervention strategies at an early stage to prevent and manage PSF, thereby mitigating its negative impacts and promoting recovery in stroke survivors.

Objective: This scoping review aimed to explore and chart the interventions available for managing post-stroke fatigue in individuals recovering from stroke, providing healthcare professionals with evidence to guide the development of optimal treatments.

Design: A scoping review.

Data Sources: This review conducted a systematic search across six databases—PubMed, Web of Science, Cochrane Library, Scopus and CINAHL (via EBSCO), and CNKI, for articles published from 10 January 2012 to early May 2024.

Review Methods: This review followed the PRISMA-ScR reporting guidelines. Studies were selected based on the PCC framework, focusing on specific participants, concepts, and contexts. Exclusion criteria included ongoing studies without results, articles without full text, posters, reviews, and protocols. Tables and narrative descriptions were used to present relevant information on the interventions and their outcomes during the review process.

Results: Twenty-seven studies were included, categorizing interventions for post-stroke fatigue into ten types: pharmacological treatments, physical activity, physical therapy, cognitive behavioral therapy, respiratory training, music therapy, mindfulness-based stress reduction, health education management, Traditional Chinese Medicine, and environmental enrichment.

Conclusion: The interventions for post-stroke fatigue have demonstrated positive effects in alleviating fatigue symptoms among stroke survivors. However, some approaches have limitations, and the most effective treatment strategy remains unclear. The multidisciplinary collaboration between nurses and healthcare professionals plays a critical role in managing post-stroke fatigue by providing patients with education on fatigue prevention and treatment, along with personalized care plans, including one-on-one or group interventions. Future research should focus on increasing sample sizes and conducting multicenter trials to identify the most effective intervention strategies for managing post-stroke fatigue.

Keywords

stroke; survivors; fatigue; intervention studies; scoping review

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Article info:
Received: 16 July 2024
Revised: 19 August 2024
Accepted: 10 October 2024

E-ISSN: 2477-4073 | P-ISSN: 2528-181X

Background

A stroke, or cerebrovascular accident (CVA), occurs when there is a localized interruption in blood flow to the brain. This neurological condition is the second most common cause of death globally. Clinically, stroke is classified into ischemic and hemorrhagic types (Kjeverud, 2024). Ischemic stroke, resulting from a disruption in blood flow to the brain, constitutes nearly 70% of all stroke occurrences (Maida et al., 2020). Globally, stroke impacts 1,240 out of every 100,000 individuals, with ischemic stroke occurring at twice the rate of hemorrhagic stroke (McDonald & Mead, 2023).

Based on the findings of the Stroke Prevention and Treatment in China Writing Group (2023), the stroke burden in China is increasing, with a growing prevalence of ischemic stroke. The disability-adjusted life years (DALYs) lost due to ischemic stroke in China remain significantly higher than in other developed countries, including the United States, the United Kingdom, and Japan (Xue et al., 2024). Hemorrhagic stroke, primarily resulting from the rupture of cerebral arteries, accounts for 27.9% of all stroke events (Tu & Wang, 2023). Although hemorrhagic stroke occurs less frequently than ischemic stroke, it is linked to a higher mortality rate (Cheon et al., 2023). Data indicate that the 5-year mortality rate for ischemic stroke is approximately 16%, whereas for hemorrhagic stroke, it is about 28% (Feigin et al., 2021).

Due to the significant differences in pathogenesis, incidence, and mortality between ischemic and hemorrhagic strokes, managing post-stroke complications is especially critical. Among these complications, post-stroke fatigue is notably one of the most common conditions following a stroke, manifesting in stroke survivors through physical or mental exhaustion following activity, which is typically resistant to alleviation through rest (English et al., 2024). Research has shown that PSF affects between 25% and 85% of stroke survivors (Wang et al., 2024), with a meta-analysis reporting a 43.5% prevalence among Chinese stroke survivors (Xue et al., 2024). Additionally, longitudinal studies have demonstrated that the occurrence of PSF remains substantial at 42% and 34% at six months and a year post-stroke, respectively (Jolly et al., 2023; Su et al., 2021).

PSF is not only prevalent but, as a subjective condition, often lacks clear clinical manifestations, leading to frequent underestimation by healthcare professionals and caregivers. When left untreated, post-stroke fatigue (PSF) can significantly affect a patient's activities of daily living (ADLs), including tasks like walking, eating, and getting dressed; this impairment may lead to considerable challenges in managing routine self-care., and it may also cause persistent fatigue during regular tasks (Larsson et al., 2023). The condition can negatively impact mental health, contributing to emotional disturbances like anxiety and depression. The combined physical and psychological toll significantly diminishes patients' quality of life and delays their recovery, further increasing the burden on stroke survivors (Zhan et al., 2023).

Most existing literature on PSF interventions has focused on individual approaches. For example, Chu et al. (2023) performed a systematic review focusing on pharmacological treatments for PSF, while Su et al. (2020) summarized non-pharmacological interventions. However, both reviews were limited to one type of intervention, and the majority of the literature covered only English-language studies, overlooking the contributions of Chinese research. Similar findings have been reported by McGeough et al. (2009) and Wu et al. (2015). Therefore, there is an urgent need for a comprehensive review that systematically describes and summarizes all PSF interventions, encompassing both completed trials and relevant studies from Chinese literature. Such a review would fill current gaps in the literature, providing healthcare professionals with an extensive evidence base to guide the selection of the best therapeutic strategies, ultimately improving the future management of PSF.

Methods

Study Design

Since this scoping review is neither a systematic review nor a meta-analysis, it does not fall under their specific scope. We chose not to register the study protocol. The scoping review was designed in alignment with the study's objectives, and the reporting followed the standards set by the PRISMA-ScR (Tricco et al., 2018). While the study protocol was not formally registered, adherence to these guidelines ensured rigor and enhanced the credibility of the review process. Because this scoping review is based solely on publicly available literature, no ethical approval or informed consent was required.

This study adopted the scoping review methodology outlined by Arksey and O'Malley (2005), following their proposed framework, which involves five essential steps: formulating research questions, performing a comprehensive literature search, selecting relevant studies, organizing the data, synthesizing the findings, and summarizing the outcomes.

In developing the review questions, the PCC (Population/Concept/Context) framework was adopted, as suggested by Peters et al. (2020), to ensure logical and systematic inquiry. First, the "Participants" were defined as stroke survivors experiencing post-stroke fatigue, who represent the target subjects of this study. Next, the "Concept" was defined as interventions aimed at alleviating PSF, which forms the core of the investigation. Lastly, the "Context" refers to the clinical and therapeutic environments in which these interventions are applied. This structured approach allowed us to define the research questions more precisely, ensuring that the study design is both scientific and focused. The details are provided in **Table 1**, addressing the following specific research questions:

a) What types of interventions are available for post-stroke fatigue (PSF), and what are their implementation methods and characteristics?
b) What are the main outcomes reported in the existing literature regarding these interventions for PSF?

Table 1 PCC Format

PCC format	
Participants	Stroke survivors who have post-stroke fatigue at any age
Concept	Post-stroke fatigue interventions
Context	Not limited by the study setting, including hospitals, communities, outpatient facilities, and any other type of health service in any location

Search Methods

An extensive search was performed across six major databases: PubMed, Web of Science, Cochrane Library, Scopus, CINAHL (via EBSCO), and CNKI. Our search strategy employed a combination of MeSH/Emtree terms and free-text keywords, targeting concepts such as "stroke," "fatigue," and "intervention." This approach ensured a comprehensive exploration of the relevant literature. The search strategies for databases, including PubMed, Web of Science, Cochrane Library, Scopus, CINAHL (via EBSCO), and CNKI, can be found in the **Supplementary File**.

We included articles discussing interventions for post-stroke fatigue survivors of any age, without restrictions on the study setting, including hospitals, communities, outpatient facilities, or any other type of healthcare services. The time frame for the literature search was from 10 January 2012 to early May 2024, and we considered publications in both English and Chinese. Exclusion criteria involved ongoing studies without published results, articles lacking full-text access, posters, reviews, and protocols. The search across PubMed, Web of Science, and the Cochrane Library was finalized on 1 June 2024, while the search in Scopus, CINAHL (via EBSCO), and CNKI was conducted on 2 June 2024.

Study Selection Process

Throughout the review process, two independent reviewers (DY and TLX) utilized Endnote X9 to evaluate the titles and abstracts of the retrieved articles. This screening was conducted according to pre-established inclusion criteria, focusing on studies related to fatigue interventions for stroke survivors. Studies in posters, reviews, or protocols were excluded to ensure objectivity and rigor. Additionally, the reviewers were responsible for eliminating any duplicate records. Following this, DY and TLX independently thoroughly reviewed the full texts of the selected studies. The reviewers reached a consensus through discussion.

In cases where discrepancies arose between the two reviewers (DY and TLX) during the independent screening process, they participated in either face-to-face or virtual discussions to share and support their perspectives, determining whether the studies met the inclusion criteria. In cases where the reviewers could not reach a consensus, a third reviewer (Salwis) was introduced to conduct an independent evaluation. She assessed the studies and provided recommendations based on professional judgment.

The reviewers recorded key discussion points and decision-making rationales at every step to ensure comprehensiveness and accuracy throughout the screening and evaluation process. After Salwis's independent review, the three reviewers held further discussions to ensure that all viewpoints had been adequately considered. All studies—quantitative, qualitative, and mixed-method—published in both English and Chinese that met the inclusion criteria were included in this review. This approach ensured comprehensiveness and maintained a high standard of methodological rigor.

Data Extraction and Analysis

The data from the selected studies were systematically collected and entered into a specially designed Microsoft Excel spreadsheet. Two independent reviewers (DY and TLX) employed a double-entry method for key information, such as intervention details, where each entered the same data independently. The entries were then cross-checked to ensure consistency. The extracted data encompassed: 1) Key characteristics of the studies include the first author, year of publication, country of origin, study design, and sample size; 2) Intervention details: study population (stroke type, stage, and age), setting, intervention type, delivery mode, provider, follow-up duration, and study results. The data were subsequently organized, synthesized, and reported following the Arksey and O'Malley (2005) framework to ensure that interventions for stroke survivors were effective in managing or preventing post-stroke fatigue.

Quality Appraisal

We chose suitable tools to evaluate the methodological quality of the 27 studies included in this review, taking into account their specific study designs. Two reviewers independently performed the quality assessment. A third reviewer was brought in to reach a final decision if any disagreements arose.

For the randomized controlled trials (RCTs), we employed the Risk of Bias (RoB) tool (Higgins et al., 2011) to assess six domains of potential bias, categorizing the risk as low, unclear, or high, and generated the corresponding risk of bias graph using RevMan 5.4 software. For non-randomized experimental studies, we applied the JBI Checklist (Munn et al., 2020), which consists of nine criteria. The quality was evaluated following the scoring guidelines from Reilly et al. (2016), with results categorized as poor (<50%), moderate (50-80%), and good (>80%). For the quality assessment of the cohort studies (8 studies), we utilized the Newcastle-Ottawa Scale (NOS) as described by Peterson et al. (2011). This scale assigns a score between 0 and 9 stars, with higher scores reflecting superior study quality.

The selection of each tool was based on its design purpose and applicability, ensuring appropriate quality assessment for different types of studies. All reviewers (DY, TLX, and Salwis) independently assessed each study and documented their quality scores during the evaluation process. In cases of disagreement, the two primary reviewers (DY and TLX) first engaged in discussions to clarify their perspectives. If an agreement could not be achieved, a third reviewer (Salwis) was brought in to provide the final decision, ensuring accuracy and reliability in the quality assessment outcomes.

Results

Study Selection

A total of 5,737 articles were initially identified across six databases. After removing duplicates, 2,417 unique records remained. Of these, 2,170 were excluded during the title and abstract screening process. The full texts of 247 articles were then reviewed for eligibility, resulting in the exclusion of 220 studies due to various reasons. Ultimately, 27 articles met the inclusion criteria and were included in this review. The results of each screening round were meticulously documented in the PRISMA flowchart (see **Figure 1**)

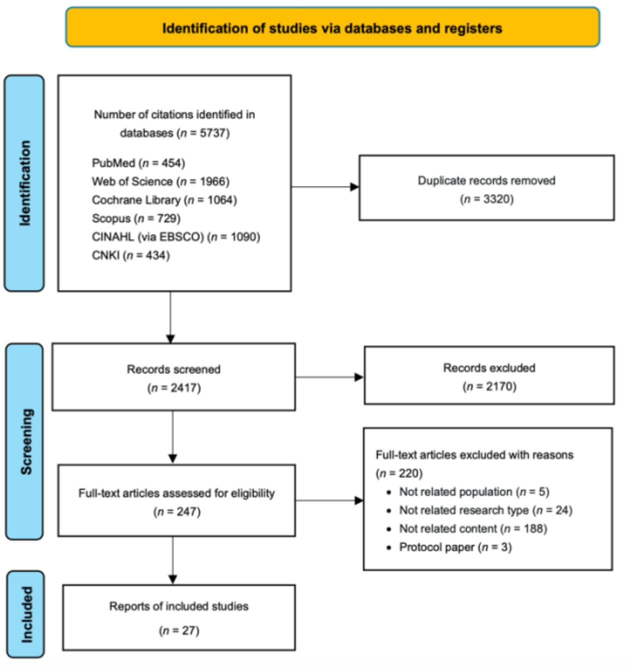

Figure 1 Study identification and inclusion process: PRISMA flow diagram

Quality Appraisal Results

Figure 2 and **Figure 3** summarize the risk of bias for the 21 RCTs included. Regarding the method of random sequence generation, 15 trials (Johansson et al., 2012a; Johansson et al., 2012b; Li et al., 2018; Lin et al., 2020; Liu et al., 2016; Liu et al., 2017; Ma et al., 2016; Mead et al., 2022; Nguyen et al., 2019) (Palsdottir et al., 2020; Poulsen et al., 2015; Visser et al., 2019; Zedlitz et al., 2012; Zhou & Wei, 2019; Zhou et al., 2010) presented specific randomization methods, and six other trials (Clarke et al., 2012; De Doncker et al., 2021; Pan et al., 2016; Sun et al., 2016; Van de Port et al., 2012; Van Vugt et al., 2014) showed that they were unclear in generating random sequences. Three trials (De Doncker et al., 2021; Lin et al., 2020; Sun et al., 2016) were evaluated as having a high risk of bias (14.3%) for allocation concealment, ten trials (Johansson et al., 2012b; Li et al., 2018; Liu et al., 2016; Mead et al., 2022; Nguyen et al., 2019; Palsdottir et al., 2020; Pan et al., 2016; Poulsen et al., 2015; Visser et al., 2019; Zedlitz et al., 2012)as low risk (47.6%) and eight trials (Clarke et al., 2012; Johansson et al., 2012a; Liu et al., 2017; Ma et al., 2016; Van de Port et al., 2012; Van Vugt et al., 2014; Zhou & Wei, 2019; Zhou et al., 2010) were evaluated as unclear risk of bias (38.1%) for allocation concealment. Because PSF intervention by medical professionals is necessary for stroke survivors, blinding is inevitable in such intervention studies, which increases the potential for performance bias to occur.

A total of twenty trials (Clarke et al., 2012; Johansson et al., 2012a; Johansson et al., 2012b; Li et al., 2018; Lin et al., 2020; Liu et al., 2016; Liu et al., 2017; Ma et al., 2016; Mead et al., 2022; Nguyen et al., 2019; Palsdottir et al., 2020; Pan et al., 2016; Poulsen et al., 2015; Sun et al., 2016; Van de Port et al., 2012; Van Vugt et al., 2014; Visser et al., 2019; Zedlitz et al., 2012; Zhou & Wei, 2019; Zhou et al., 2010) presented a low risk of incomplete outcome data, and a further twenty trials (Clarke et al., 2012; De Doncker et al., 2021; Johansson et al., 2012a; Johansson et al., 2012b; Li et al., 2018; Lin et al., 2020; Liu et al., 2017; Ma et al., 2016; Nguyen et al., 2019; Palsdottir et al., 2020; Pan et al., 2016; Poulsen et al., 2015; Sun et al., 2016; Van de Port et al., 2012; Van Vugt et al., 2014; Visser et al., 2019; Zedlitz et al., 2012; Zhou & Wei, 2019; Zhou et al., 2010) had a low risk of selective reporting.

This scoping review included a quality assessment of five non-randomized experimental studies, of which two (Mushtaq et al., 2020; Wu et al., 2017) were rated as good, and three studies (Hofer et al., 2014; Kim, 2012; West et al., 2019) as moderate quality. Additionally, a cohort study (Wang et al., 2021) was also assessed, receiving a score of 7 points. The example of assessment can be found in the **Supplementary File**.

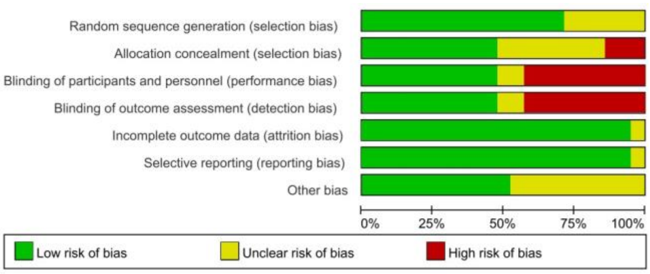

Figure 2 Bias Risk Chart for RCTs

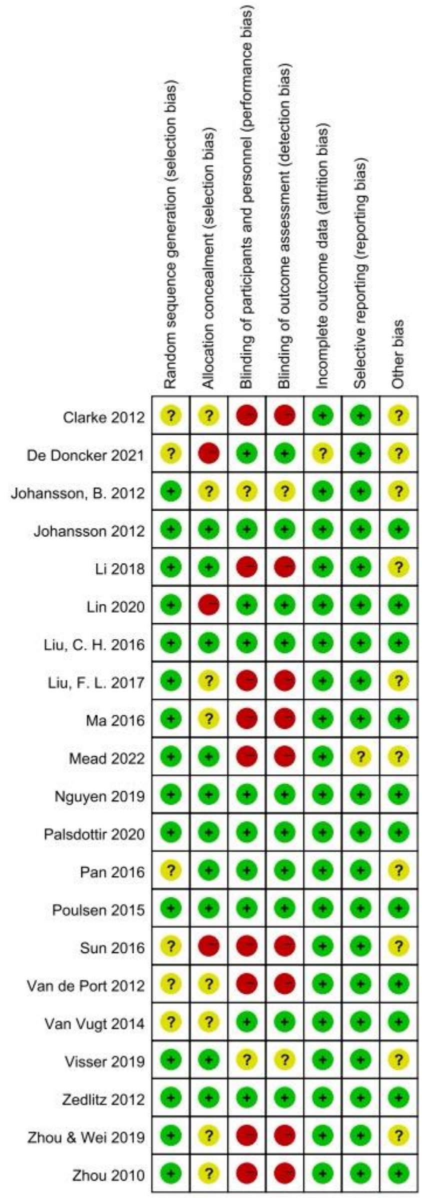

Figure 3 Summary of Risk of Bias in RCTs

Study Characteristics

Table 2 provides a summary of the detailed information extracted from the studies included in this review. The 27 studies in this review were published between 2010 and 2022. All of the included studies compared interventions using one PSF alone or a combination of both interventions to alleviate fatigue symptoms in stroke survivors. A total of 1721 participants were enrolled; 10 studies (Li et al., 2018; Lin et al., 2020; Liu et al., 2016; Liu et al., 2017; Ma et al., 2016; Pan et al., 2016; Sun et al., 2016; Wang et al., 2021; Zhou & Wei, 2019; Zhou et al., 2010) were conducted in China; three in Sweden (Johansson et al., 2012a; Johansson et al., 2012b; Palsdottir et al., 2020) and the United Kingdom (De Doncker et al., 2021; Mead et al., 2022; Wu et al., 2017); two in New Zealand (Clarke et al., 2012; Visser et al., 2019), the Netherlands (Van de Port et al., 2012; Zedlitz et al., 2012), and Denmark (Poulsen et al., 2015; West et al., 2019); and one in South Korea (Kim, 2012), Switzerland (Hofer et al., 2014), Australia (Nguyen et al., 2019), Germany (Van Vugt et al., 2014), and India (Mushtaq et al., 2020). This review encompassed 21 RCTs, five non-RCTs, and a single retrospective cohort study.

Description of Interventions

A wide variety of interventions aimed at reducing fatigue symptoms in stroke survivors. The nature of these interventions varies in settings (e.g., hospital or community), content (e.g., one-to-one or group education), and delivery mode (e.g., In-person or telephone). This study is based on the previous classification of PSF interventions in the relevant literature (McGeough et al., 2009; Su et al., 2020; Wu et al., 2015), which is categorized and summarized in this scoping review, the interventions can be divided into ten intervention categories: 1) pharmacological interventions (*n* = 6); 2) physical activity (*n* = 3); 3) physical therapy (*n* = 1); 4) cognitive behavioral therapy (*n* = 3); 5) respiratory training (*n* = 2), 6) music therapy (*n* = 2); 7) mindfulness-based stress reduction (*n* = 2); 8) health education management (*n* = 3); 9) Traditional Chinese Medicine (*n* = 3), and 10) environmental enrichment (*n* = 2).

Pharmacological Interventions

Six studies investigated pharmacological interventions to alleviate PSF. Modafinil has consistently demonstrated significant reductions in fatigue among patients suffering from post-stroke fatigue (Poulsen et al., 2015; Visser et al., 2019). Johansson et al. (2012b)demonstrated that monoaminergic stabilizer (-)-OSU6162 was effective in managing post-stroke fatigue (PSF), vitamin D supplementation was effective in alleviating PSF symptoms, especially in vitamin D-deficient patients, according to Wang et al. (2021). Two independent studies (Liu et al., 2016; Pan et al., 2016) demonstrated that traditional Chinese medicines, including Buyang Huanwu decoction and Astragalus Membranaceus, effectively reduced fatigue.

Physical Activity

Three studies assessed the effects of physical activity on PSF. Van de Port et al. (2012) reported that a 12-week task-oriented training improved walking ability and reduced fatigue symptoms. Mushtaq et al. (2020) found that modified constraint-induced movement therapy (m-CIMT) enhanced fatigue adaptation in stroke survivors. Kim (2012) implemented a nurse-led group intervention using toys for training, which improved fatigue.

Physical Therapy

De Doncker et al. (2021) conducted a study evaluating the effectiveness of transcranial direct current stimulation in alleviating fatigue.

Cognitive Behavioral Therapy

Three studies explored CBT for fatigue reduction in stroke survivors. Significant improvement in fatigue among stroke survivors through Nguyen et al. (2019) implemented a comprehensive approach integrating psychoeducation, behavioral activation, and cognitive restructuring. Zedlitz et al. (2012) proposed a novel approach combining cognitive therapy with graded activity training (COGART), outperforming single-mode interventions to reduce fatigue. Mead et al. (2022) implemented a telephone-delivered CBT intervention consisting of seven sessions, helping patients reduce fatigue.

Respiratory Training

Both interventions have demonstrated potential in alleviating fatigue, with Sun et al. (2016) approach, in which thoracic and abdominal breathing exercises show significant benefits in fatigue reduction, and Ma et al. (2016) diaphragm training proving effective in diminishing PSF symptoms.

Music Therapy

There are two studies on music therapy. Van Vugt et al. (2014) found that playing familiar children's songs on the piano reduced fatigue. Zhou and Wei (2019) showed that combining music therapy with dance aerobics effectively alleviated PSF symptoms.

Mindfulness-Based Stress Reduction

Two studies assessed mindfulness-based interventions for PSF. Johansson et al. (2012a) conducted an 8-week MBSR program that significantly improved fatigue symptoms in stroke survivors. Hofer et al. (2014) utilized an integrated neuropsychological therapy approach that combined mindfulness with cognitive-behavioral and positive thinking therapies, resulting in significant improvements in fatigue.

Health Education Management

Three studies focused on health education management to reduce PSF. Clarke et al. (2012) implemented personalized fatigue management sessions, which improved patients' adjustment to fatigue. Wu et al. (2017) created a PSF-focused psychological intervention with follow-up visits and telephone encouragement, resulting in significant fatigue reduction. Liu et al. (2017) designed a health management program led by a multidisciplinary team, which effectively reduced fatigue incidence in stroke survivors.

Traditional Chinese Medicine

Three studies explored the efficacy of traditional Chinese Medicine (TCM) therapies. Zhou et al. (2010) found that electroacupuncture and cupping reduced PSF symptoms significantly. Li et al. (2018) used auricular plaster therapy to minimize fatigue, while Lin et al. (2020) showed that ginger-separated moxibustion improved fatigue levels in stroke survivors.

Environmental Enrichment

Two studies examined the impact of environmental enrichment on PSF. West et al. (2019) demonstrated that stroke survivors exposed to natural light experienced significantly less fatigue. Palsdottir et al. (2020) found that nature-based rehabilitation programs improved fatigue in stroke survivors through multisensory stimulation.

Impact of Interventions on Patient Outcomes

Across the 27 studies on interventions for post-stroke fatigue, all results consistently demonstrated that these interventions significantly improved fatigue levels in stroke survivors and positively affected other health aspects. Specifically, regarding pharmacological interventions, Poulsen et al. (2015) found that Modafinil significantly improved patients' quality of life and cognitive function in daily activities. Similarly, Visser et al. (2019) showed that Modafinil therapy enhanced brain connectivity in severely fatigued patients, promoting neural recovery. Wang et al. (2021) reported that vitamin D supplementation had positive effects on neurological outcomes. Johansson et al. (2012b) noted that the monoaminergic stabilizer OSU6162 had a significant positive impact on patients with traumatic brain injuries. Furthermore, traditional Chinese medicine therapies, including the modified Buyang Huanwu Decoction and Astragalus, have significantly reduced fatigue symptoms (Liu et al., 2016; Pan et al., 2016).

These treatments also contributed to notable improvements in patient's quality of life and overall life satisfaction.

Concerning physical activity, Van de Port et al. (2012) suggested that circuit training offers greater flexibility and adaptability to patient needs compared to conventional physical therapy. Mushtaq et al. (2020) found that m-CIMT (modified Constraint-Induced Movement Therapy) indirectly improved motor skills and effectively alleviated fatigue in subacute stroke patients. Kim (2012) utilized interactive gaming to enhance patients' activity levels, which led to improved motor function, mood, and sleep quality. Regarding physiotherapy, De Doncker et al. (2021)showed that adjusting neurophysiological mechanisms helped alleviate patients' anxiety. Nguyen et al. (2019) highlighted that Cognitive Behavioral Therapy (CBT) maintained stable sleep quality and reduced depressive symptoms through personalized assessments in the short term. Zedlitz et al. (2012) reported that the COGRAT method effectively prolonged physical endurance in stroke survivors and was suitable for various stroke types. Moreover, Mead et al. (2022) observed that interventions delivered via telephone helped reduce anxiety while enhancing patients' quality of life and participation in social activities.

Regarding respiratory training, Sun et al. (2016) and Ma et al. (2016) highlighted the advantages of diaphragmatic breathing exercises in improving diaphragmatic function, which in turn enhanced patients' physical performance and daily self-care abilities. In terms of music therapy, Van Vugt et al. (2014) pointed out that alternately playing instruments positively affected patients' emotions and social interactions. Moreover, Jiamusi Happy Step Aerobics significantly improved patients' endurance and ability to perform daily activities (Zhou & Wei, 2019).

For psychological interventions, Johansson et al. (2012a) found that Mindfulness-Based Stress Reduction (MBSR) improved patients' cognitive function and social skills, while Hofer et al. (2014) reported that integrated neuropsychological therapy enhanced patients' self-efficacy. Regarding fatigue management education, most stroke survivors experienced improvements in social functioning and depressive symptoms (Clarke et al., 2012; Wu et al., 2017). Interdisciplinary teamwork was also found to play an active role in promoting patient recovery and enhancing quality of life (Liu et al., 2017).

Regarding traditional Chinese medicine, Zhou et al. (2010) reported that electroacupuncture combined with cupping effectively regulated the sympathetic and parasympathetic nervous systems, thereby improving patients' subjective sensations and psychological states. Li et al. (2018) also used non-pharmacological physical stimulation methods to improve blood circulation and endocrine function. Lin et al. (2020) found that moxibustion with ginger significantly improved sleep quality and alleviated depressive symptoms.

Discussion

This review aims to offer a comprehensive summary of the existing literature on PSF and outline various interventions designed to reduce fatigue in individuals recovering from stroke. Our review compiles and categorizes the findings from 27 studies across 11 different countries, providing a comprehensive summary of intervention strategies for PSF.

PSF is a prevalent but frequently neglected issue faced by individuals recovering from a stroke. Studies suggest that around 25% to 85% of stroke survivors experience varying degrees of fatigue during their recovery, a condition that may last for months or even years (Kjeverud, 2024). Prolonged fatigue greatly affects both the physical and psychological well-being of patients, leading to a marked decline in their quality of life (Wang et al., 2024). Long-term fatigue is linked to increased incidences of depression and anxiety, further exacerbating the psychological burden on patients and hindering their recovery process (Jaywant & Keenan, 2024). Therefore, this review provides critical guidance for clinical practice. Given that many clinicians may overlook the symptoms of PSF, its high prevalence, and its substantial effect on the well-being of individuals who have suffered a stroke (Lindsäter et al., 2023), early identification and intervention by healthcare professionals are crucial. Timely management can effectively alleviate PSF symptoms and enhance the quality of life for individuals recovering from stroke

While this review outlines a range of interventions for PSF, geographical location and cultural background may also significantly influence the effectiveness of these interventions. For instance, in Eastern countries, particularly in Asian cultures, Traditional Chinese Medicine approaches, such as herbal therapies, acupuncture, and cupping, provide various treatment options that are frequently combined to alleviate fatigue. This reflects the emphasis in TCM on natural therapies and a holistic approach, integrating prevention and treatment to promote lifestyle adjustments and recovery (Nando et al., 2024; Singh et al., 2024).

In contrast, in many Western countries, individuals tend to prefer Western pharmaceuticals for treating conditions. Differences in health perceptions and cultural practices may influence both the acceptance and efficacy of these treatments (Huemer et al., 2024). Therefore, when designing PSF interventions, clinical practitioners should consider these geographical and cultural factors to provide more tailored treatments for patients from diverse backgrounds.

Additionally, the study highlights the critical role of multidisciplinary and collaborative team efforts in effectively managing PSF. Combining pharmacological treatments with non-pharmacological approaches, such as physical activity, health education, and psychological support, is particularly critical. A mixed model that integrates individualized interventions with group-based interventions is especially recommended. Individualized interventions provide more targeted management (Rababah et al., 2021), while group interventions offer the advantages of high efficiency and low cost, making them suitable for large-scale applications, particularly in resource-limited regions or countries (Clarke et al., 2012).

Lastly, greater collaboration between community health workers and family physicians is essential to alleviate the pressure on large hospital systems, especially for patients requiring long-term rehabilitation (Magwood et al., 2020). Considering PSF's typically prolonged recovery process, extending interventions to community and family settings enhances the sustainability of treatment and improves patient recovery outcomes.

Implications and Limitations of this Study

Nurses and healthcare professionals play a pivotal role in the management of PSF. Educating patients and their families about fatigue prevention and treatment enhances their understanding of PSF and fosters patients' self-management skills. In addition, these professionals craft individualized care plans based on each patient's unique needs, integrating both one-on-one and group interventions. This personalized approach enables nurses to monitor patient progress closely and make timely modifications to interventions, ensuring both their effectiveness and adaptability. Moreover, multidisciplinary collaboration strengthens coordination and maintains continuity across various interventions, further empowering patients in managing PSF.

This review acknowledges several limitations. First, it only included studies published in English and Chinese, which may have excluded relevant research available in other languages. Additionally, a number of the studies reviewed involved relatively small sample sizes, potentially affecting the generalizability of the outcomes. Lastly, the diverse characteristics of PSF patients, such as variations in stroke types and severity, introduce challenges in reliably evaluating the effectiveness of various interventions.

Table 2 Summary of the included studies (*n* = 27)

NO	Author (Year) / Country	Design / Sample size (T/C)	Type and phase of stroke / Age (years)	Setting / Intervention description (T/C)	Delivery mode / Providers	Follow-up	Main results
1	Poulsen et al. (2015) Denmark	RCT 21/20	Stroke within 14 days; Aged ≥18	Hospital IG: oral modafinil; CG: oral placebo.	One-to-one; In-person Nurse, pharmacist	90-day	There was no significant difference in MFI-20 scores, but the Modafinil group showed better FSS scores (p = 0.02). Modafinil has been shown to alleviate fatigue symptoms in individuals recovering from a stroke significantly.
2	Visser et al. (2019) New Zealand	RCT 14/14	Ischemic; Aged >18	Hospital IG: oral modafinil; CG: oral placebo.	One-to-one; In-person Pharmacist	N/A	The IG experienced a significant reduction in MFI-20 scores compared to the CG, with a mean difference of −24.9 (p <0.001). Modafinil reduces perceived fatigue in stroke patients by alleviating motivational deficits.
3	Johansson et al. (2012b) Sweden	RCT 6/6	Stroke or traumatic brain injury; 30~65	Hospital IG: oral monoaminergic stabilizer (-)-OSU6162; CG: oral placebo.	One-to-one; In-person Neurologist	2-month	Notable differences in MFS were identified between the two groups (F = 5.37, p = 0.031). Monoaminergic stabilizer (-) -OSU6162 may be effective in improving mental fatigue after stroke or traumatic brain injury.
4	Wang et al. (2021) China	Retros-pective Cohort 139	Primary acute ischemic; 40~75	Hospital IG: vitamin D supplementation + usual care; CG: usual care.	One-to-one; In-person Neurologist	1,3-month	After one month (t = -4.731) and three months (t = -7.937) of treatment, the IG showed a significant reduction in FSS scores compared to the CG (p <0.01). Additionally, vitamin D supplementation improved symptoms and neurological outcomes in patients with PSF who had vitamin D deficiency.
5	Pan et al. (2016) China	RCT 47/45	PSF; 18~80	Hospital IG: conventional rehabilitation treatments + modified BYHWD; CG: conventional rehabilitation treatments + BYHWD.	One-to-one; In-person N/A	N/A	In the IG group, FSS and VAFS scores were significantly lower than the CG (p <0.05). The modified Buyang Huanwu Decoction can significantly relieve the symptoms of PSF patients.
6	Liu et al. (2016) China	RCT 29/32	Hemorrhagic- or infraction 40~80	Hospital IG: oral Astragalus membranaceus; CG: oral placebo Astragalus embranaceus.	One-to-one; In-person Physician	N/A	In the IG, notable differences in BFI scores were observed between Visit 2 and Visit 1 (–17.83 ± 17.70), as well as between Visit 3 and Visit 1 (–16.48 ± 16.41). These changes were greater than those in the CG (–8.03 ± 9.95; p = 0.01 and –9.47 ± 13.39; p = 0.05, respectively). Astragalus membranaceus can treat the symptoms of patients with PSF.

Table 2 *(Cont.)*

7	Van de Port et al. (2012) Netherlands	RCT 122/124	Stroke 56~58	Outpatient rehabilitation centers IG: circuit training; CG: usual physiotherapy.	One-to-one；In-person Physiotherapist and sports therapists	24-week	No notable differences in FSS were observed between the two groups. Task-oriented circuit training can reduce fatigue symptoms in stroke patients.
8	Mushtaq et al. (2020) India	Quasi-experiment pre- and post- test design 10/10	Subacute phase; 51.90 ± 15.27	Hospital IG: modified constraint-induced movement therapy; CG: movement therapy	One-to-one；In-person Physiotherapy	N/A	The fatigue scores did not differ significantly between the two groups. The mCIMT in the subacute phase did not aggravate PSF, and this therapy had a certain effect on fatigue symptoms in stroke patients.
9	Kim (2012) South Korea	Quasi-experiment pre-and post-test design 20/25	Acute or subacute phase; 61.70 ± 10.18	Hospital IG: a nurse-led with children's toys); CG: conventional rehabilitation.	Group；In-person Nurses	N/A	Fatigue levels in the IG showed significant improvement compared to the CG. Interventions that positively impacted physical activity also contributed to improved fatigue, sleep quality, and depression among stroke patients.
10	De Doncker et al. (2021) United Kingdom	RCT 20/10	Stroke >3-month, first-time stroke; Aged >18 years;	Hospital and community IG: real tDCS CG: sham tDCS	One-to-one；In-person Neurologist	a week, 2-month	After a week, the anodal tDCS of real stimulation improved fatigue more significantly than that of sham stimulation (*p* = 0.024). The tDCS is a useful tool for managing PSF.
11	Nguyen et al. (2019) Australia	RCT 9/6	PSF; 16~70	Rehabilitation setting IG: adapted cognitive behavioral therapy； CG: treatment as usual.	One-to-one；In-person Psychologist, therapists	4-month	By the 4-month mark, fatigue levels in the IG were noticeably lower compared to the CG, with a mean FSS-7 difference of 1.92. Furthermore, cognitive behavioral therapy has been shown to alleviate fatigue, improve sleep quality, and reduce depression in stroke survivors.
12	Zedlitz et al. (2012) Netherlands	RCT 38/45	PSF; 18~70	Community IG: CO + GRAT, called COGRAT; CG: CO.	One-to-one；In-person Neuropsychologist, physiotherapists	6-month	Both groups demonstrated significant effects on CIS-f scores (*p* <0.001), with the COGRAT group achieving superior outcomes compared to the CO group (≥8 points: 58% vs. 24%). COGRAT proved to be the most effective approach for alleviating persistent fatigue in stroke survivors.
13	Mead et al. (2022) United Kingdom	RCT 39/37	Ischemia or hemorrhage; ≥18	Stroke services IG: telephone calls + a booster session; CG: None	One-to-one；In-person or telephone General practitioners, nurses, physiotherapists, and psychotherapists	4, 6-month	At the 6-month, no significant variation in FAS scores was observed between the two groups (adjusted mean difference = 0.619, 95% CI -4.9631 to 3.694; *p* = 0.768). Cognitive behavioral therapy intervention trials are feasible for PSF patients
14	Sun et al. (2016) China	RCT 67/31	Ischemic or hemorrhagic; 58.2 ± 3.1	Hospital IG: thoracic breathing training + abdominal breathing training + conventional rehabilitation training； CG: conventional rehabilitation training	One-to-one；In-person Therapist	N/A	Following three months of training, the IG experienced a notably lower level of fatigue than the CG. FVC, FEV1, and FEV1/FVC ratios showed significant increases, with statistically significant differences (*p* <0.05). Breathing training, especially abdominal breathing, effectively reduces fatigue in PSF patients.

Table 2 *(Cont.)*

15	Ma et al. (2016) China	RCT 39/39	PSF; 57.1 ± 3.3	Hospital IG: diaphragm muscle training + conventional rehabilitation treatment; CG: conventional rehabilitation	One-to-one； In-person Therapist	N/A	Compared with the CG, the FSS score of the IG (3.39 ± 0.53) was significantly improved (*p* <0.05), and the respiratory function indexes, including VC, FVC, FEV1, and MVV, also increased significantly (*p* <0.05). Diaphragm training can reduce fatigue in stroke patients and improve their motor function and daily life.
16	Van Vugt et al. (2014) Germany	RCT 14/14	Ischemic or hemorrhagic; 30~75	Hospital IG: playing one after the other (in-turn group). CG: playing in synchrony (together group)	Mixed mode; In-person Therapist	N/A	Fatigue levels differed significantly between the two groups (*p* = 0.02). Music therapy improved fatigue and movement in PSF patients more effectively in the IG than in the CG.
17	Zhou and Wei (2019) China	RCT 30/30	PSF; 58.1 ± 4.3	Hospital IG: Jiamusi happy dance aerobics intervention + conventional nursing care; CG: conventional nursing care	One-to-one； In-person Nursing staff	N/A	After three months, FSS scores in both groups significantly decreased, with the experimental group showing a statistically significant greater reduction than the control group (*p* >0.05). Jiamusi happy dance aerobics has been shown to effectively enhance motor function, reduce fatigue, and improve daily living abilities in patients with PSF.
18	Johansson et al. (2012a) Sweden	RCT 12/14	Stroke or traumatic brain injury; 30~65;	Community and home IG: Mindfulness-based stress reduction (MBSR) program CG: Wait-list	Group; In-person N/A	N/A	Following eight weeks of the MBSR program, a notable difference in MFS scores emerged between the two groups (F = 8.47, *p* = 0.008), with notable reductions in MFS for both the experimental group (*p* = 0.004) and the CG (*p* = 0.002). MBSR is a beneficial non-pharmacological intervention for individuals suffering from PSF and traumatic brain injury.
19	Hofer et al. (2014) Switzerland	Preliminary study 8	Hemorrhage and ischemia; 20~61	Hospital Mindfulness-based integrative neuropsycho-therapy program (neuropsychological, psychoeducation, cognitive-behavioral therapy, and mindfulness practices).	One-to-one; In-person Psychotherapist, neuropsychologist	N/A	There was a significant difference in SQfMF before and after treatment (*p* <0.017). The mindfulness-enhanced integrative neuro-psychotherapy program aids patients in adjusting to PSF symptoms.
20	Clarke et al. (2012) New Zealand	RCT 9/7	Hemorrhage and ischemia； 69	Stroke clinic, community IG: fatigue management psychoeducation; CG: general stroke education psychoeducation	One-to-one； In-person Psychologist	3-month	Following the intervention, the FSS scores of both groups decreased significantly, with the IG showing a greater reduction than the CG (*p* <0.05). The Fatigue Management Group intervention is suitable for PSF patients.
21	Wu et al. (2017) United Kingdom	Feasibility study 8	PSF; ≥18	Hospital A manualized psychological intervention: 6 treatment sessions + a booster session.	One-to-one； In-person or telephone Clinicians, psychologists, cognitive behavioral psychotherapists, and nurses.	3-month	Fatigue improved after three months of treatment (*p* < 0.05). The psychological intervention effectively addresses symptoms in post-stroke fatigue patients.

Table 2 *(Cont.)*

22	Liu et al. (2017) China	RCT 45/45	Stroke survivors; 62.7±3.2	Community IG: community health management; CG: conventional treatment.	One-to-one; In-person or telephone Nurses, neurologists, rehabilitation doctors and psychologists	1, 2, 5, 8 and 12-week	Following the intervention, the FSS score in the IG (25.45±4.06) was notably lower than that of the CG, with the difference reaching statistical significance ($p < 0.05$). Community health management reduces PSF incidence and enhances patients' quality of life.
23	Zhou et al. (2010) China	RCT 64/64	Stroke within three years; 56.8±12.1	Hospital IG: electroacupuncture (EA) + cupping; CG: medication	One-to-one; In-person Physician	N/A	Following treatment, both groups showed improvement in the energy domain of the SS-QOL, with the IG scoring higher than the CG ($p < 0.05$). Electroacupuncture with cupping effectively reduces fatigue in stroke patients, proving more effective than oral drug therapy.
24	Li et al. (2018) China	RCT 32/32	PSF; 30~80	Hospital IG: conventional care + auricular plaster therapy with cowherb seed; CG: conventional care + auricular plaster therapy with Juncus effuses.	One-to-one; In-person Physician	N/A	Following the intervention, both groups experienced a reduction in CIS scores ($p < 0.01$), while the FSS score in the IG was notably lower than that of the CG ($p <0.05$). Both auricular plaster therapies with cowherb seed and Juncus effuses improve PSF, but the cowherb seed therapy is more effective.
25	Lin et al. (2020) China	RCT 28/29	Chronic fatigue syndrome; 18~60	Hospital IG: normal diet + physical exercise + ginger-separated moxibustion; CG: normal diet + physical exercise.	One-to-one; In-person Physician	N/A	Following treatment, the SF-36 score in the IG showed a significant improvement compared to pre-treatment levels ($p <0.01$) and was also higher than that of the CG ($p <0.01$). Ginger-separated moxibustion effectively improves fatigue, depression, and sleep quality in patients.
26	West et al. (2019) Denmark	Quasi-randomized controlled trial 39/32	In hospital for more than two weeks; 55~96	Hospital IG: a unit equipped with naturalistic lighting; CG: a unit with standard indoor lighting.	One-to-one; In-person Physician	N/A	At discharge, MFI-20 scores in the intervention group were lower than in the control group (difference - 20.6%, 95% CI [-35.0%, 3.0%]; $p = 0.025$). Stroke patients exposed to natural light at admission showed a significant reduction in fatigue symptoms.
27	Palsdottir et al. (2020) Sweden	RCT 51/50	Sub-acute phase; 50~80	Hospital IG: standard care + nature-based rehabilitation; CG: standard care.	One-to-one; In-person or phone Occupational therapist, stroke physician, nurse and horticulturalist, psychotherapist and physiotherapist.	8, 14-month	Fatigue values in the intervention group were below the mental fatigue cutoff (< 10.5), unlike the control group. Nature-based rehabilitation reduces fatigue symptoms in PSF patients.

Notes: PSF - Post-Stroke Fatigue; RCT - Randomized Controlled Trial; Non-RCT - Non-Randomized Controlled Trial; IG - Intervention Group; CG - Control Group; N/A - Not Available; BYHWD - Buyang Huanwu Decoction; tDCS - transcranial Direct Current Stimulation; CO - Cognitive Therapy; GRAT - Graded Activity Training; COGRAT - Combination of Cognitive Therapy and Graded Activity Training; mCIMT- modified constraint induced movement therapy; MFI-20 - Multidimensional Fatigue Inventory-20; FSS - Fatigue Severity Scale; MFS - Mental Fatigue Scale; VAFS - Visual Analogue Fatigue Scale; BFI - Brief Fatigue Inventory; FSS-7 - Fatigue Severity Scale-7; CIS-f - Checklist Individual Strength, Fatigue Subscale; FAS - Fatigue Assessment Scale; FVC - Forced Vital Capacity; FEV1 - Forced Expiratory Volume in 1 Second; VC - Vital Capacity; MVV - Maximal Voluntary Ventilation; SQfMF - Self-Assessment Questionnaire for Mental Fatigue; CIS - Checklist Individual Strength; SF-36 - MOS 36-Item Short Form Health Survey

Conclusion

This review systematically summarizes the current evidence on interventions for post-stroke fatigue, demonstrating that various approaches are significantly effective in alleviating fatigue symptoms in stroke survivors. However, despite the observed positive outcomes, the most effective intervention has not yet been clearly identified, necessitating further investigation. Therefore, future research should prioritize large-scale, multicenter randomized controlled trials to rigorously evaluate the long-term efficacy and sustainability of these interventions, thereby determining the optimal treatment strategies for post-stroke fatigue. Ultimately, these findings will provide healthcare professionals with robust evidence to inform the development of the most effective treatment plans for post-stroke fatigue.

Declaration of Conflicting Interest

The authors declare no conflict of interest.

Funding

None.

Acknowledgment

The authors would like to express their gratitude to those who provided support and encouragement throughout the writing of this article.

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All authors of this study contributed equally, except for the literature search in databases, which was performed by the first author (Yuan Dong).

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Data Availability

All data generated and analyzed for this study have been incorporated into this published article. Furthermore, the search strategy is available in the **Supplementary File**.

Ethical Considerations

Not Applicable.

Declaration of Use of AI in Scientific Writing

Nothing to declare.

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Cite this article as: Dong, Y., Badrin, S., Badrin, S., & Tang, L. (2024). Post-stroke fatigue interventions for stroke survivors: A scoping review. *Belitung Nursing Journal, 10*(6), 601-613. https://doi.org/10.33546/bnj.3526