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Intervention Model to Increase Muscle Strength in Stroke Patients: A Systematic Literature Review

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Abstract

Background: Stroke remains the most common cause of death and disability. Stroke may suffer from several neurological disorders, including hemiplegia, communication disorders, cognitive disorders, and visual-spatial cognitive disorders.
Objective: The purpose of this study was to look at how strength training affected stroke patients' muscle strength.
Methods: A systematic search for this review used PubMed, ProQuest, Science Direct, Springer Open, Directory of Open Access Journal (DOAJ), and Wiley Online Library using the keywords "strength training (strength training OR strength exercise)" AND "muscle strength" AND "stroke" AND "randomized controlled trial" NOT (systematic review OR meta-analytic). Journals are appraised using the Critical Appraisal Skills Programme (CASP) JBI 2020 the synthesis method used is narrative synthesis. To analyze the agreement between reviewers using the Interclass Correlation Coefficients (ICC) test, with the ICC result being good (r = 0.79; 95% CI, 0.53, 0.92) against the quality assessment of the selected article
Results: 15 articles fully reviewed from 2018-2023. Muscle strengthening exercises are the most effective method for enhancing muscle strength in stroke patients. The research results show that strength training tends to increase the patient's muscle strength if it is done from the start of a stroke and is carried out for 4-6 weeks of training.
Conclusion: The results emphasize the value of strength training regimens for stroke victims in order to avert life-threatening impairment

Keywords: exercise; muscle strength; nurse; strength training; stroke

INTRODUCTION

The second leading cause of mortality worldwide and the primary cause of disability is stroke. According to The Global Stroke Factsheet 2002, the lifetime risk of stroke has increased by 50% over the past 17 years, and it is now estimated that one out of four individuals will experience a stroke in their lifetime (World Stroke, 2023). There was a 70% increase in stroke incidence, a 43% increase in stroke-related mortality, a 102% increase in stroke prevalence, and a 143% increase in disability-adjusted life years (DALYs) between 1990 and 2019. Most strikingly, most of the global stroke burden (86% of stroke deaths, 89% annually) occurs in low- and lower-middle-income countries (J. Wang et al., 2022). The disproportionate burden faced by low- and nations with lower-middle incomes creates unprecedented challenges for families with limited resources (World Stroke, 2023). In 2022, more than 12 million people worldwide are expected to suffer a first stroke, and 6.5 million people will die from stroke. Strokes affect more than 100 million individuals globally. The incidence of stroke increases significantly with age, but more than 60% of strokes occur before the age of 70 years, and 16% occur before the age of 50 years (World Stroke, 2023). More than half of stroke sufferers die from stroke. The impact can be severe for survivors, affecting physical mobility, eating habits, language, emotions, and thought processes. These complex needs can create care and financial challenges for individuals and their care, placing significant demands on health and social services (World Stroke, 2023).

According to Global Burden Disease (GDB) 2019 data, stroke is the second leading cause of death (Feigin et al., 2022) and causes disability (J. Wang et al., 2022). Hemiparesis, communication problems, cognitive impairments, or altered visuospatial perception are among the neurological conditions that stroke survivors may have (Chanavirut et al., 2017). Persistent hand dysfunction is frequently caused by hemiparesis, the most prevalent motor impairment among stroke survivors (Sabbah et al., 2020). Everyday tasks and functional activities depend heavily on upper limb mobility, impacting quality of life. Paresis of the upper extremities after stroke can cause limitations in daily activities, limited functional activities, and impaired social roles (El-Nashar et al., 2019). Problems with hand and upper extremity function affect over 50% of stroke patients, and nearly 74% of them become permanently dependent on others to do daily tasks (Sabbah et al., 2020). Paresis of the upper extremities causes 65% of people to be unable to do daily tasks six months after a stroke; up to 40% of patients do not regain upper extremity function (Kerimov et al., 2021).

Rehabilitation following a stroke is essential for patients' motor and functional recovery (Bordoloi & Deka, 2019). Physical and occupational therapy are necessary rehabilitation procedures for stroke patients in order to enhance motor function and activities of daily living and hasten the healing process (J. Wang et al., 2022). Recovery of motor function in the upper extremities occurs mainly during the initial phase, specifically a few months following the stroke (Lieshout et al., 2020). After six months of physical treatment, up to 40% of stroke patients who had significant initial paresis will regain optimal hand function. The advantages of interventions based on particular exercises done frequently have been demonstrated. The first three months following a stroke are crucial for recovery and offer the best chance for nervous system remodeling (Hunter et al., 2018).

Recovering a person with a stroke to their optimal level of cognitive, physical, emotional, linguistic, interpersonal, and functional functioning is the goal of rehabilitation. The procedure is dynamic and progressive. For lifelong deficits related to spasticity, lower and upper extremity disorder, shoulder and central pain, movement and walking, difficulty swallowing, seeing, thinking, and interaction, patients often still require rehabilitation, even with advancements in the treatment of acute and hyperacute strokes (Hebert et al., 2016). Stroke therapy begins as soon as the patient is medically stable and ready to set goals for their rehabilitation and recovery. It can be delivered in various settings, including programs and leisure centers, outpatient and ambulatory care clinics, community clinics, acute and post-acute care, early assisted discharge (ESD) services, and outreach teams. Using a range of rehabilitation techniques, members of a specially trained rehabilitation team, such as physicians, physiotherapists, occupational therapists, speech-language pathologists, and nurses, assist individuals in overcoming the impairments caused by a stroke. The duration of stay and the services needed are determined by the needs of the individual and the resources available in the specific environment. Although the majority of recovery and rehabilitation takes place in the first three months after the stroke, some people continue to make progress months or even years after the stroke. When rehabilitation is started on time, patients' results can be improved, and they can keep living, working, and participating in their communities (Hebert et al., 2016). For the rest of their lives, they would struggle to return to their previous social roles, which would involve mental, emotional, and financial challenges. The lack of resources in rehabilitation centers contributed to the rise that followed the stroke. Patients and healthcare policy services bear the brunt of medical costs. The majority of stroke patients do not need long-term rehabilitation therapy because they have medical health insurance, and the facilities have few resources. As a result, the majority of stroke survivors go home or back to their communities after leaving the hospital, often without needing enough time for rehabilitation to help patients and their loved ones adjust to their new circumstances (Lim et al., 2021).

Much literature has been done to establish rehabilitation approaches for post-stroke patients. Several methods have been clearly proven to be effective, such as induction therapy for movement and therapy using robotics (H. Wang et al., 2023).

Patients with severe arm paresis may benefit from robotic therapy; however, these devices are expensive (Coscia et al., 2019). Therefore, in order to improve upper extremity motor function in stroke patients who have paresis, a rehabilitation technique approach is required (H. Wang et al., 2023). Limb dysfunction caused by stroke will significantly affect the patient's daily life, as well as causing a significant burden on health services (F. Wang et al., 2022). Hemiparesis is a common sequelae of stroke. Patients who experience hemiparesis do not experience total paralysis. The mechanisms that cause motor disorders in patients with hemiparesis include loss of strength, muscle hyperactivity, and soft tissue retraction (Lattouf et al., 2021). Upper extremity motor problems affect 73–88% of stroke patients who have had their first stroke and 55-75% of patients who have had a persistent stroke (Coscia et al., 2019).

The main target in stroke rehabilitation is to improve upper extremity function. There is a golden period for starting a rehabilitation program at the onset of stroke symptoms, and it continues for several weeks (Hosseini et al., 2019). Rehabilitation focuses on restoring and reconstructing upper extremity function, and there is not much information regarding hand function restoration (Xia et al., 2023). Exercise therapy, also known as physiotherapy, focuses on systematic, planned, structured, repetitive physical activities, both active and passive, that follow proper movement patterns. One exercise therapy that can be applied to increase muscle strength is strength training. Strength training has been shown to improve muscle strength in stroke patients; however, very little clinical data currently supports this claim, and no systematic review has been conducted. Systematic reviews can provide a thorough and impartial presentation of the study findings and a summary. Furthermore, physicians and policymakers might benefit from the study's findings, which offer a synopsis of the research on physical activities or therapies that improve muscle strength in stroke survivors. The purpose of this study was to look at how strength training affected stroke patients' muscle strength.

METHOD

This article's design is a literature review, and the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) were used to identify the articles. The data synthesized was a strength training intervention specifically to treat the severity of hemiparesis in stroke patients in the form of a Randomized Control Trial (RCT). I used The author searched for articles using the following keywords: "strength training (strength training OR strength exercise)" AND "muscle strength" AND "stroke" AND "randomized controlled trial" NOT (systematic review OR meta-analytic). The literature search for this review used the databases PubMed, ProQuest, Science Direct, Springer Open, Directory of Open Access Journal (DOAJ), and Wiley Online Library. The articles were selected in compliance with the inclusion and exclusion criteria. Inclusion criteria include: publishes studies between 2018 and 2023. Full-text original research articles involving strength training interventions, randomized controlled trial design methods, random clinical trials, or quasi-experimental designs with control groups are used. Exclusion criteria are criteria outside the inclusion criteria. Articles based on literature reviews, systematic reviews, or meta-analyses, as well as those with problem themes unrelated to strength training on muscle strength in post-stroke patients, were excluded from this review. We eliminated irrelevant articles using the search statement, inclusion and exclusion criteria, and title and abstract screening.

The study design with randomized controlled trials was assessed for quality using the Critical Appraisal Skills Program (CAPS) instrument. This instrument aims to determine the quality of the paper. The synthesis method used is narrative synthesis. Narrative synthesis is a methodology that systematically reviews and synthesizes results using a text-based or word-based approach. A matrix table was made to methodically extract data from the chosen study, concentrating on essential facets of muscle-strengthening exercises for stroke patients.

The inclusion and exclusion criteria are compared with the titles and abstracts of the identified research in the literature, two researchers (H.K.H. and A.S.) carried out the selection procedure separately. Afterward, these scientists examined the chosen studies on their own. Should two researchers disagree, a third researcher (M.D.A.) was consulted before deciding. Notably, there were no arguments about the papers chosen for this evaluation. To analyze the agreement between reviewers using the Interclass Correlation Coefficients (ICC) test (Koo & Li, 2016), with the ICC result being good (r = 0.79; 95% CI, 0.53, 0.92) against the quality assessment of the selected article.

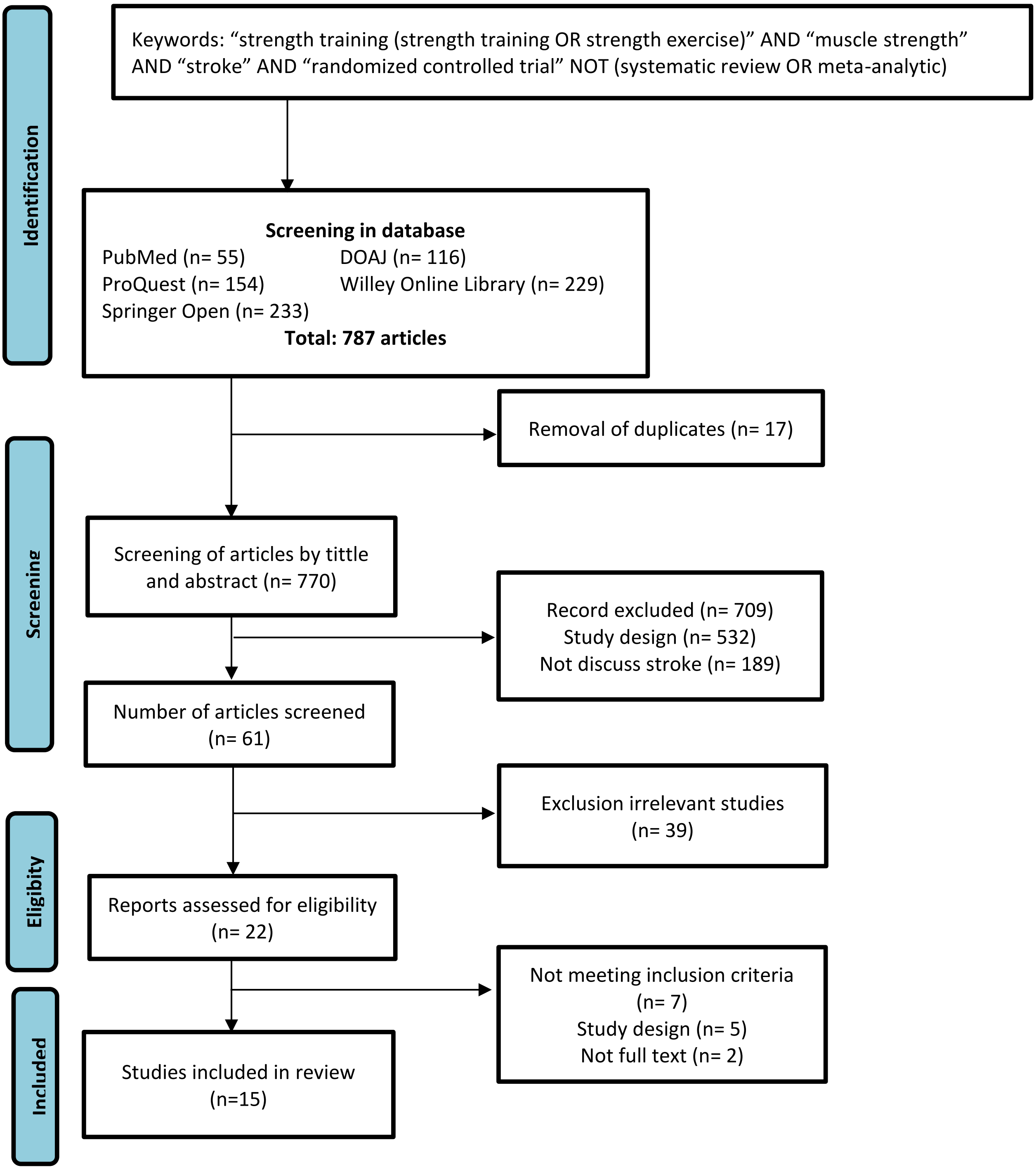

Figure 1. Articles Selection Process

Table 1. Randomized Controlled Trial for Article Quality Assessment

	Q1	Q2	Q3	Q4	Q5	Q5	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Score
Article 1	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	84.61%
Article 2	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	84.61%
Article 3	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	84.61%
Article 4	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	Y	**76.9%**
Article 5	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	84.61%
Article 6	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	84.61%
Article 7	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**100%**
Article 8	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	**76.9%**
Article 9	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	84.61%
Article 10	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	**76.9%**
Article 11	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	**92.3%**
Article 12	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	**76.9^**
Article 13	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	84.61%
Article 14	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	84.61%
Article 15	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	84.61%

Q1. When assigning people to treatment groups, did proper randomization take place?
Q2. Was the treatment group assignment hidden?
Q3.At baseline, were treatment groups comparable?
Q4. Did participants not know which treatment they were receiving?
Q5.Was treatment assignment hidden from those administering it?
Q6. Did outcomes assessors not know which treatments were being used?
Q7. Apart from the intervention of interest, were treatment groups given the same treatment?
Q8. Was the follow-up comprehensive, and if not, were the variations in follow-up between the groups sufficiently explained and examined?
Q9. Did participants get examined in the groups they were randomly assigned to?
Q10. Were treatment groups' outcomes assessed similarly?
Q11. Were the results accurately measured?
Q12. Was suitable statistical analysis applied?
Q13. Were any modifications from the typical RCT design (parallel groups, individual randomization) taken into consideration in the trial's conduct and analysis, and was the trial design appropriate?

* Y : Yes; N : No; NA : Not Applicable

Table 2. Strength Training Among 15 Articles

Study Characteristics			Intervention Characteristics							
			Participants		Intervention Types					
No	First Author, Year	Title	Sample Size (N)	Stroke Onset (month or days)	Intervention Group	Control Group	Frequency/ Duration of Intervention	Intervention Length (weeks)	Follows-up length (month or week)	Outcome
1	(Hendrey et al., 2018)	Feasibility of Ballistic Strength Training in Subacute Stroke	30	NA (first-ever stroke)	Received Ballistic strength training exercises	Standard treatment	3 times a week/ 45 minutes	6 weeks	Baseline and 6 weeks	Feasibility, muscle strength, mobility outcomes, quality of life, qualitative feedback
2	(Bordoloi & Deka, 2019)	Effectiveness of Home Exercise Program with Modified Rood's Approach on Muscle Strength in Post Cerebral Haemorrhagic Individuals of Assam	236	NA	Received Home Exercise Program with modified rood's approach	Standard treatment	6 days a week/ 30 repetitions once a day	12 weeks	Baseline and 12 weeks	Muscle strength
3	(de Sousa et al., 2019)	Two Weeks of Intensive Sit-To-Stand Training in Addition to Usual Care Improves Sit-To-Stand Ability in Unable To Stand Up Independently After Stroke: A Randomised Trial	30	< 6 months	Received intensive sit-to-stand training	Standard treatment	7 days a week / 1 hour per day during the week; and 2 hours per day on the weekend	2 weeks	Baseline and 2 weeks	The Goal Attainment Scale, the composite strength of the major lower limb muscles, the gross lower limb extension strength, the clinician's assessment of the patient's change in capacity to go

Study Characteristics					Intervention Characteristics					
			Participants		Intervention Types					
No	First Author, Year	Title	Sample Size (N)	Stroke Onset (month or days)	Intervention Group	Control Group	Frequency/ Duration of Intervention	Intervention Length (weeks)	Follows-up length (month or week)	Outcome
										from sitting to standing, and the ranking of the change in ability to go from sitting to standing
4	(Hosseini et al., 2019)	The Effect of Early Passive Range of Motion Exercise in Motor Function of People with Stroke: A Randomized Controlled Trial	70	The first 6 hours of the onset of stroke	Received passive range of motion exercises	Standard treatment	During the first 48 hours after admission, six to eight 30-minute workouts	NA	Baseline, 1 month, and 3 months	Muscle strength
5	(Simpson et al., 2019)	Unilateral Dorsiflexor Strengthening with Mirror Therapy to Improve Motor Function After Stroke: A Pilot Randomized Study	31	12 months post-stroke	Received mirror therapy strength training	Standard treatment	Three times a week, held for five seconds, with a three-minute break in between sets and a five-second rest in between repetitions	4 weeks	Baseline and 4 weeks	Feasibility, effectiveness
6	(Lin et al., 2020)	Effectiveness of Early Rehabilitation Combined with Virtual Reality	152	3 days after the onset of the stroke	Received virtual reality training	Standard treatment	Beginning 24 hours to 3 days after the stroke, 15 minutes	NA	Initial (within 4 hours of admission) and	Strength of muscles, emotional state, and functional state

Study Characteristics					Intervention Characteristics					
			Participants		Intervention Types					
No	First Author, Year	Title	Sample Size (N)	Stroke Onset (month or days)	Intervention Group	Control Group	Frequency/ Duration of Intervention	Intervention Length (weeks)	Follows-up length (month or week)	Outcome
		Training on Muscle Strength, Mood State, and Functional Status in Patients with Acute Stroke					twice a day, with an additional 5 days of virtual reality training		discharge (between 7 and 21 days)	
7	(Cho et al., 2021)	Effects of Bi-Axial Ankle Strengthening on Muscle Co-Contraction During Gait In Chronic Stroke Patients: A Randomized Controlled Pilot Study	25	NA	Received bi-axial ankle strengthening on muscle co-contraction with Ankle Muscle Training (AMT)	Standard treatment	5 times per week/ 40 minutes per day	4 weeks	Baseline and 4 weeks	Ankle strength, proprioception, walking speed, Berg balance scale score, Fugl-Meyer lower extremity score, and ankle co-contraction index are all evaluated using isometric ankle contraction force.
8	(Da Rosa Pinheiro et al., 2021)	Upper Limb Cycle Ergometer Increases Muscle Strength, Trunk Control, and Independence of Acute Stroke Subjects	20	Post-stroke in acute hospital phase	Received upper limbs cycle ergometer	Standard treatment	1 time a day/ 20 minutes per day	5 days	Baseline and 5 days	Upper limb strength, trunk control, and level of independence

Study Characteristics					Intervention Characteristics					
			Participants		Intervention Types					
No	First Author, Year	Title	Sample Size (N)	Stroke Onset (month or days)	Intervention Group	Control Group	Frequency/ Duration of Intervention	Intervention Length (weeks)	Follows-up length (month or week)	Outcome
9	(Hyun et al., 2021)	The Effect of Sit-to-Stand Training Combined with Real-Time Visual Feedback on Strength, Balance, Gait Ability, and Quality of Life in Patients with Stroke	30	3 – 6 months after onset	Using a Wii Balance Board, they received sit-to-stand instruction along with real-time visual feedback	Standard treatment	20 minutes once a day, five days a week	6 weeks	Baseline and 6 weeks	Lower extremity muscle strength test, balance, gait, and quality of life
10	(Kerimov et al., 2021)	The Effect of Upper Extremity Isokinetic Strengthening in Post-Stroke Hemiplegia	28	6 months	Exercised wrist extensor and flexor strengthening with isokinetic	Standard treatment	3 times a week/ NA	4 weeks	Baseline, between weeks four and eight	The wrist extensor and flexor peak isometric and isokinetic torques or strengths Stroke Impact Scale (SIS) score, Disabilities of Arm, Shoulder, and Hand (DASH) score, Fugl Meyer Upper Extremity (FM-UE) motor subscore, and hand grip strength
11	(Kim & Jang, 2021)	Effects of Cognitive Sensory Motor Training on Lower Extremity Muscle Strength and Balance in	35	6 months	Trained in lower extremity cognitive and sensory motor skills	Standard treatment	5 times per week/ 30 minutes of training each time	6 weeks	Baseline and 6 weeks	Muscle strength and balance

Study Characteristics					Intervention Characteristics					
			Participants		Intervention Types					
No	First Author, Year	Title	Sample Size (N)	Stroke Onset (month or days)	Intervention Group	Control Group	Frequency/ Duration of Intervention	Intervention Length (weeks)	Follows-up length (month or week)	Outcome
		Post Stroke Patients: A Randomized Controlled Study								
12	(Lattouf et al., 2021)	Eccentric Training Effects for Patients with Post-Stroke Hemiparesis on Strength and Speed Gait: A Randomized Controlled Trial	37	NA	Received eccentric training	Standard treatment	2 x 30 minutes per day 5 times per week	NA	Baseline and after-treatment	Strength and speed gait
13	(Yang et al., 2021)	Effect of different vibration frequencies on muscle strength, bone turnover, and walking endurance in chronic stroke	84	NA	Received whole body vibration with high frequency	Low frequency	3 training sessions per week	8 weeks	Baseline and 8 weeks	Walking endurance, serum levels of cross-linked-N-telopeptides of type I collagen (NTx), and isokinetic knee concentric and eccentric extension strength
14	(Zhao et al., 2022)	Tailored Sitting Tai Chi Program for Subacute Stroke Survivors:	160	First-over stroke, Subacute stage of stroke	Received the Tailored Sitting Tai Chi Program	Standard treatment	NA	12 weeks	Baseline, 1 week, 8 weeks, 12 weeks and 16 weeks	Function of the upper limbs, balance, seated balance, depression

Study Characteristics					Intervention Characteristics						
			Participants		Intervention Types						
No	First Author, Year	Title	Sample Size (N)	Stroke Onset (month or days)	Intervention Group	Control Group	Frequency/ Duration of Intervention	Intervention Length (weeks)	Follows-up length (month or week)	Outcome
		A Randomized Controlled Trial								symptoms, shoulder range of motion, shoulder pain, daily living activities, and quality of life
15	(Shao et al., 2023)	Strength Training of the Non-Hemiplegic Side Promotes Motor Function Recovery in Patients with Stroke: A Randomized Controlled Trial	139	Within 6 weeks after onset	Received strength training on the non-hemiplegic side	Standard treatment	45 minutes once a day, five days a week	6 weeks	Baseline and 6 weeks	Balance function, mobility, activities, daily living, and muscle strength

RESULT

Article search results using keywords, phrases, document subjects using Boolean Operators (OR, AND, NOT) and found 787 articles (55 articles in PubMed, 154 articles in ProQuest, 233 articles in Springer Open, 116 articles in DOAJ, and 116 articles in Wiley Online Library of 229 articles). Next, article screening was carried out by reading the title and abstract and selecting the full-text category so that 78 articles were obtained; 17 were duplicate articles. 39 articles were rejected as research variables for strengthening exercises in stroke patients. Next, 27 articles were screened for articles that were not relevant and did not include exclusion criteria. In the end, 15 articles satisfied the requirements for inclusion. These papers were then examined, and the article search results were critically evaluated, as explained in Figure 1. The list of articles from the search results is also explained in Table 1. There were 11 articles of good quality; of the 13 questions asked, 13 were answered with the answer "yes" with a score of 100%, namely articles from (Cho et al., 2021); 12 questions were answered with "yes" with a score of 92.30%, namely articles belonging to (Kim & Jang, 2021); and 11 questions answered with "yes" with a score of 84.61% were articles from (Hendrey et al., 2018), (Bordoloi & Deka, 2019), (de Sousa et al., 2019), (Simpson et al., 2019), (Lin et al., 2020), (Hyun et al., 2021), (Yang et al., 2021), (Zhao et al., 2022), (Shao et al., 2023). Four articles were of sufficient quality where of the 13 questions asked, 10 questions were answered "yes" with a score of 76.92%, namely articles from (Hosseini et al., 2019), (Da Rosa Pinheiro et al., 2021), (Kerimov et al., 2021), (Lattouf et al., 2021).

Intervention Techniques

According to the evaluated papers, various therapies could be implemented to improve stroke patients' upper and lower extremity muscular strength. Interventions to increase upper extremity muscle strength are Home Exercise Program with Modified Rood's Approach (Bordoloi & Deka, 2019), passive Range of Motion (ROM) exercises on the upper extremities (Hosseini et al., 2019), Virtual Reality Training (Lin et al., 2020), Upper Limb Cycle Ergometer (Da Rosa Pinheiro et al., 2021), Upper Limb Extremity Isokinetic Strengthening (Kerimov et al., 2021), and Sitting Tai Chi (Zhao et al., 2022). Interventions that can be carried out to increase lower extremity muscle strength are Ballistic Strength Training (Hendrey et al., 2018), Home Exercise Program with Modified Rood's Approach (Bordoloi & Deka, 2019), Intensive Sit-to-Stand Training (de Sousa et al., 2019), passive Range of Motion (ROM) exercises on the lower extremities (Hosseini et al., 2019), Unilateral Dorsiflexor Strengthening with Mirror Therapy (Simpson et al., 2019), Virtual Reality Training (Lin et al., 2020), Bi-Axial Ankle Strengthening (Cho et al., 2021), Sit-to-Stand Training Combined with Real-Time Visual Feedback (Hyun et al., 2021), Cognitive Sensory Motor Training on Lower Extremity (Kim & Jang, 2021), Eccentric Training (Lattouf et al., 2021), Strength Training of Non-Hemiplegic Side (Shao et al., 2023).

Time or Duration of Intervention

In research conducted by (Lin et al., 2020), Virtual Reality Training was carried out in the intervention group starting 24 hours to 3 days after stroke for 5 days. Research conducted by (Da Rosa Pinheiro et al., 2021), provided intervention in the form of an upper limb cycle ergometer with a duration per training session of 20 minutes and carried out for 5 days. In research conducted by (de Sousa et al., 2019), for two weeks, the intervention group's sit-stand exercises were performed on top of their regular treatment during two extra physiotherapy sessions per day. These sessions lasted at least thirty minutes each week, or one hour more each day, and an additional hour on the weekends, or two hours per day. Research conducted by (Simpson et al., 2019), offered a unilateral dorsiflexor strengthening treatment that was performed three times per week for four weeks. Research conducted by (Cho et al., 2021) for four weeks, a bi-axial ankle strengthening intervention utilizing visual feedback was given for forty minutes each day, five days a week. Research conducted by (Kerimov et al., 2021), provided an upper extremity isokinetic strengthening intervention over four weeks, three times every week. Research conducted by (Lattouf et al., 2021), offered an eccentric training intervention conducted twice a day for 30 minutes each day for four weeks. Research conducted by (Hendrey et al., 2018), offered a 45-minute ballistic strength training intervention three times a week for six weeks. Research conducted by (Hyun et al., 2021), the intervention consisted of sit-to-stand training with real-time visual feedback, conducted once daily for six weeks for a total of 20 minutes per training session. Research conducted by (Kim & Jang, 2021), offered a half-hour Cognitive Sensory Motor Training (CSMT) intervention conducted five times a week for six weeks. Research conducted by (Shao et al., 2023), conducted a 45-minute strength training program for the Non-Hemiplegic Side (NHS) five times a week for six weeks. Research conducted by (Yang et al., 2021), provided Whole Body Vibration (WBV) three times a week for eight weeks, an intervention with a comparatively higher frequency (frequency 30 Hz, amplitude 0.60 mm). Research conducted by (Bordoloi & Deka, 2019), offered a 12-week, 20-minute daily, six-day-a-week home exercise program solution using a modified Rood's technique. Research conducted by (Hosseini et al., 2019), provided early passive ROM intervention starting in the first 48 hours after the onset of symptoms; training with a duration of 30 minutes per training session was carried out 6 – 8 times for 12 weeks. Research conducted by (Zhao et al., 2022), provided a Tai Chi sitting intervention program which was carried out for 12 weeks.

Comparative Intervention to Control Group

In the study (Hendrey et al., 2018), Ballistic strength training was offered as an intervention; however, the publication did not specify how the control group was treated, merely stating that they received conventional therapy. Research (de Sousa et al., 2019) provides intervention in the form of sit-to-stand training, but the journal does not explain how the control group was treated; it only stated that the control group received usual care. Research (Hosseini et al., 2019) provides intervention in the form of passive ROM, but the journal does not explain how the control group was treated; fill out the Oxford Scale to assess muscle strength before and after the intervention. Research (Da Rosa Pinheiro et al., 2021) provides an upper limb cycle ergometer intervention, but the publication merely mentions that the control group received traditional physiotherapy without going into detail about how they were treated. Studies carried out by (Lattouf et al., 2021) provided intervention in the form of eccentric training, but the journal did not explain how the control group was treated; it only stated that the control group received standard rehabilitation. Studies carried out by (Zhao et al., 2022) facilitated a sitting Tai Chi program as an intervention, but the journal did not explain how the control group was treated; it only stated that the control group received upper extremity movement exercises according to hospital recommendations.

Output Measurement

In research conducted by (Hendrey et al., 2018), muscle power was measured using jump height and maximum driving speed when jumping from footwear using a sled machine after the intervention. Research (Bordoloi & Deka, 2019), (de Sousa et al., 2019), and (Lin et al., 2020) measured muscle strength both before and after the intervention using the Medical Research Council Manual Muscle Testing (MMT) tool. Research (Hosseini et al., 2019) measured muscular strength before and after intervention using the Oxford Scale. Studies carried out by (Simpson et al., 2019), (Kerimov et al., 2021), and (Yang et al., 2021) muscle strength was measured using an isokinetic dynamometer. Research conducted by (Cho et al., 2021) used a portable manual muscle strength testing device to assess the strength of isometric contractions in ankles with paresis before and after intervention. Research conducted by (Da Rosa Pinheiro et al., 2021) used a portable dynamometer meter to assess the strength of the upper arms, shoulder abductors, elbow flexors, and wrist extensors. Research conducted by (Hyun et al., 2021) measured the strength of the lower extremity muscles before and after the intervention using a handheld dynamometer. Research conducted by (Kim & Jang, 2021) used a digital muscular dynamometer to measure lower extremity muscle strength before and after intervention and evaluate the strength of the hip, knee, and ankle muscles using the Medical Research Council Manual Muscle Testing (MRC-MMT).

Intervention Effectiveness

The results of the overall literature study show that strength training effectively increases muscle strength in stroke patients. Clinical evidence from research (Hendrey et al., 2018), there is a significant difference in the mean peak jump value on the side experiencing paresis before and after giving ballistic strength training with a p-value of 0.001 (p-value < 0.05); There was a significant difference in the mean driving speed value on the side experiencing paresis between before and after giving ballistic strength training with a p-value of 0.009 (p-value < 0.05). In research conducted by (Bordoloi & Deka, 2019), after 3 months of intervention, in the study, it was discovered that the average strength of the upper extremity muscles in the control group varied from 1.57 ± 0.908 to 0.41 ± 0.623. On the other hand, the intervention group exhibited a range of strength that varied from 2.07 ± 1.174 to 0.37 ± 0.646; When comparing the control group to the intervention group, the average lower extremity muscle strength after the intervention ranged from 2.21 ± 1.416 to 0.30 ± 0.502, while the intervention group had a range that was between 2.79 ± 0.880 and 0.45 ± 0.539. In research conducted by (de Sousa et al., 2019), according to the 95% confidence interval, there was a difference of 0.6/6 points between the groups in terms of their average capacity to sit and stand; the combined strength of the main muscles in the afflicted lower limbs varied by an average of 0.1/15 points (95% CI 21.4 to 1.5) across the groups; the groups' mean differences in lower extremity strength were 6.2 degrees (95% CI 0.5 to 11.8); For the ability to transition from a sitting to a standing position, the mean difference between groups was 0.7/5 points (95% CI 20.2 to 1.7).

In studies carried out by (Hosseini et al., 2019), the strength of the upper extremity muscles was significantly higher in the intervention group than in the control group, precisely 1.09 (0.84) versus 0.58 (0.90), with a p-value of 0.045; for the lower extremities, in the first month following the intervention, the experimental group's muscle strength was 0.76 (0.71) vs. 0.00 (1.11), with a p-value of 0.004. In research conducted by (Simpson et al., 2019), RTD on the trained side increased significantly in the intervention group, with a score of 86.44 ± 45.53 before and after the intervention. Research conducted by (Lin et al., 2020), following intervention, both the healthy side and the upper and lower extremities that had paresis showed an increase in muscle strength (ß = 0.40–0.87, p <0.05); Nevertheless, when examining the measurement group-time interaction, the intervention group's ß = 0.34, p < 0.001 gain was limited to the healthy side's upper extremity muscle strength.

In research conducted by (Cho et al., 2021), ankle isometric contraction strength increased significantly in all directions in the intervention group (DF, PF, INV, and EV, p-value < 0.01); The overall strength of the isometric ankle contraction varied significantly between the groups (p-value < 0.05). Research conducted by (Da Rosa Pinheiro et al., 2021) discovered significant differences between groups (p = 0.005) with a substantial effect size (d = 1.11); only the intervention group showed a meaningful difference between before and after the intervention (p = 0.012). Research conducted by (Hyun et al., 2021), demonstrated a noteworthy improvement in lower extremity muscle strength measured by hip flexors (F = 6.690; p < 0.015), hip abductors (F = 6.930; p < 0.014), and knee extensors (F = 6.152; p < 0.02) when compared to the control group. In research conducted by (Kerimov et al., 2021), the wrist extensors' peak isometric strength at the end of week four was substantially higher in the isokinetic group than in the control group (p = 0.007).

Research conducted by (Kim & Jang, 2021), LEMTA score (F = 6.760, p = 0.014) and MRC score (F = 96.243, p = 0.000) showed significant differences between the intervention group and the control group. Significant participant differences were observed between the intervention and control groups in LEMTA (F = 94.053, p = 0.000) and MRC scores (F = 380.193, p = 0.000). Research conducted by (Lattouf et al., 2021), the specific training intervention group's post-intervention weight was significantly higher than that of the control group (57.22 +/- 13.47 kg vs. 49.06 +/- 8.29 kg, p ≤ 0.014). In research conducted by (Yang et al., 2021), knee extensor capacity in paretic eccentrics was significantly impacted by the time x group interaction, with a medium effect size (0.44; 95% CI: 0.01, 0.87); intervention with a frequency of 20 Hz was less likely to be superior (95% CI: -0.08, 0.78). In research conducted by (Zhao et al., 2022), upper extremity function significantly improved in the intervention group (group interaction regression coefficient by time, B= –21.415 [95% CI, –31,000 to –11,831]). Research conducted by (Shao et al., 2023), the intervention group outperformed the control group in terms of muscular strength gains in the quadriceps (31.68±12.16 vs. 22.80±11.57, P<.001), iliopsoas (19.11±9.04 vs. 13.08±7.85, P<.001), and biceps brachii (9.83±3.95 vs. 6.58±4.11, P<.001).

DISCUSSION

Damage to the central nervous system's blood vessels (infarction, bleeding) results in stroke, an acute and localized neurological condition. There are several risk factors, disease processes, and disease mechanisms that can cause stroke, which is not a singular illness (Murphy & Werring, 2020). The risk of death from a stroke is high. Survivors may become confused or disoriented, lose their ability to see and speak and become paralyzed. Individuals who have experienced a stroke are significantly more likely to experience another one. The type of stroke affects the chance of death (WHO, 2023). Strokes are a prevalent cause of disability, limiting social involvement and activities of daily living (ADL). The most crucial rehabilitation objective for stroke patients is the restoration of motor function. Strokes impair muscle strength on the opposing side in addition to paralyzing the affected side (Shao et al., 2023).

One independent and effective nursing intervention in increasing the muscle strength of stroke patients is by implementing strength training or strength exercises. The results of a review of 15 papers assessing the impact of strength training interventions on stroke patients' muscle strength using a Randomized Controlled Trial (RCT) design demonstrated that strength training was generally successful in boosting stroke patients' muscle strength (Bordoloi & Deka, 2019; Cho et al., 2021; Da Rosa Pinheiro et al., 2021; de Sousa et al., 2019; Hendrey et al., 2018; Hosseini et al., 2019; Hyun et al., 2021; Kerimov et al., 2021; Kim & Jang, 2021; Lattouf et al., 2021; Lin et al., 2020; Shao et al., 2023; Simpson et al., 2019; Yang et al., 2021; Zhao et al., 2022).

The Randomized Controlled Trial (RCT) was one of the research design methods employed, according to the combined features of the 15 articles. The reason for this is that the degree of evidence-based research is taken into consideration, particularly research that falls into the following categories, in order of decreasing to increasing: a cross-sectional, cohort study, case-control, quasi-experimental design, randomized control trial/clinical trial, systematic review, and meta-analysis. Every study type has unique qualities and advantages. Better research results from higher levels of investigation. Apart from that, the choice of sample size also impacts the article's quality. The research will be more accurate and superior with more samples used. (Leung & Hu, 2016).

Additionally, the synthesis's findings about the kinds and methods of intervention revealed that the duration of strength training sessions varied among the reviewed articles. Based on the results of the review, it was found that there was no significant difference before strength training was given to stroke patients. There are several types of strength training mentioned in 15 review articles: Ballistic strength training, a modified Rood's approach home exercise program, comprehensive sit-to-stand training, passive range of motion, unilateral dorsiflexor strengthening with mirror therapy, virtual reality training and early rehabilitation, bi-axial ankle strengthening, upper limb cycle ergometer, sit-to-stand training with real-time visual feedback, upper extremity isokinetic strengthening, cognitive sensory-motor training on the lower extremities, eccentric training, whole body vibration, and a sitting Tai Chi program are a few examples. Most of the 15 articles stated that strength training techniques have the exact duration of training. In general, the fifteen procedures can increase stroke patients' muscle strength.

According to 15 articles, the strength training intervention's overall implementation time ranged from 20 to 60 minutes over five days to 12 weeks. Treatment is given when the patient is undergoing a physiotherapy process. When doing strength training, knowing the right amount of time to do the exercise is very important. Each exercise's time is chosen according to the patient's particular condition, the type of disease, and its severity—patients who have had an acute stroke benefit significantly from early mobilization. Prior studies have demonstrated the beneficial effects of early rehabilitation on patient mobility, typically occurring during the first two weeks following an ischemic stroke (Lin et al., 2020).

In order to determine the patient's muscle strength, the Medical Research Council Manual Muscle Strength (MRC-MMT) is the most commonly used tool for assessing muscle strength. The population category studied was stroke patients who experienced hemiparesis or hemiplegia. The methods used are self-reporting and observation. Scoring is done by averaging all statement items on the BFI. Reliability uses Cronbach's alpha with a value of 0.97, which means this questionnaire is reliable. Strength training is therapeutically helpful in improving muscle strength in stroke patients, according to synthesis studies. The findings of studies that support this clinical evidence come from (Chanavirut et al., 2017), who claimed that for six weeks, wrist flexor and extensor strength may be increased by performing specific strengthening exercises with 60% 1-RM three days a week.

The studies reviewed provide essential findings regarding the benefits of strength training in stroke patients. It is hoped that strength training interventions can be implemented by nurses, especially in stroke units, as an essential part of nursing care and physical therapy management for stroke patients who experience hemiparesis/hemiplegia (Vaughn et al., 2016). Implementing this strategy can enhance nursing care quality by helping stroke patients become stronger muscles, lowering their chance of stroke-related disability. Clinical evidence demonstrating the efficacy of strength training suggests that this therapy has successfully addressed stroke patients' complaints of limb weakness (Theofanidis & Gibbon, 2016). Strength training can be an alternative non-pharmacological option that is low-cost and does not cause side effects (Bjartmarz et al., 2017). However, management with strength training cannot be done haphazardly; there needs to be assistance from experts or practitioners regarding this therapy because it involves individual physical activity.

"Semi-supervised practice," or performing rehabilitation work under the guidance of other medical experts but not under the direct supervision of therapists, is one method to reduce the shortage of rehabilitation therapists and expand patient access to rehabilitation. Along with continuously offering treatment around the clock, nurses have also improved access to care for patients from disadvantaged backgrounds and effectively bridged the gap between the supply and demand of healthcare professionals (J. Wang et al., 2022). Nurses have effectively reduced the gap between the supply and demand of healthcare providers, increased access to care for underprivileged patients, and consistently offered treatment around the clock (Chavez et al., 2018). However, the current guidelines for stroke rehabilitation are based on high-income country healthcare systems, so it is difficult to translate the evidence into other settings. As a result, there is uncertainty about including nurses in rehabilitation interventions during the acute phase (Platz, 2019). Therefore, research on the potential functions and procedures of nurses in acute rehabilitation is necessary. It is unclear how nurses function in stroke treatment (Zerna et al., 2020). Previous studies have enumerated these functions as conserving, interpreting, comforting, and integrating (Clarke, 2014). The integrative role of nurses requires that they focus on mobility and ADLs and integrate task-oriented training into daily activities to enhance rehabilitation exercise training (Bjartmarz et al., 2017). It has been expected that inpatient physical therapy will be employed to treat aberrant posture, build muscle strength, and enhance time spent exercising (Chimatiro & Rhoda, 2019). Exercise to help patients improve self-care and occupational therapy therapeutic activities have been the most often employed interventions. However, they are only available to a limited number of patients (Shi & Howe, 2016). As part of their integrated function, nurses can pursue education in physical therapy or occupational therapy (J. Wang et al., 2022). In rural China, a stroke rehabilitation program given by caregivers and led by nurses was effectively put into place (Zhou et al., 2019). Another mobility program found more nurse-led sessions after the intervention (Anton & Richard, 2018). Nevertheless, rehabilitation exercises and training have become more popular as nurses have expanded and redefined their role in providing rehabilitation care (Bjartmarz et al., 2017).

Nursing rehabilitation is a specialty practice that requires a professional competency model. Outpatient settings, skilled nursing facilities, home health, acute rehabilitation, and long-term acute care are some contexts where rehabilitation occurs. Therefore, a model or framework for professional rehabilitation nursing should include domains corresponding to the competencies required in each type of practice (Vaughn et al., 2016). The Association of Rehabilitation Nurses states that nurses must utilize the competency model to integrate rehabilitation evidence professionally (Vaughn et al., 2016). A theoretical framework should be used to direct the development of intervention programs, and checklists or protocols for stroke treatment should also be used (Theofanidis & Gibbon, 2016).

The multidisciplinary rehabilitative effort can be shaped by nurses using their expertise and awareness of each patient's needs, which they get via working with patients and their caregivers, in addition to offering interventions that preserve and assure physical integrity for recovery (Vaughn et al., 2016). The type of patient-nurse interaction explicitly linked to rehabilitation results was defined as a partnership to enhance coping, well-being, and meaningful activities of daily life (Chavez et al., 2018). During therapy, these interventions included guiding the contributions of various professional groups to the unique circumstances of each patient. Nurses can significantly influence the quality of rehabilitation services and the outcomes that stroke patients experience since they interact with patients regularly. In order to expand on and forge new alliances with patients and caregivers outside of the conventional confines of rehabilitation, nurses must use this aspect of their job (Theofanidis & Gibbon, 2016). The literature has emphasized the possibility of forging new alliances with stroke victims and their families. This advancement would draw attention to the therapeutic facets of a nurse's work in stroke recovery. Then, nurses would be better equipped to help patients make sense of the situation by utilizing their skills and expertise from working with specific patients.

The study's results are anticipated to include references and information about the impact of intervention or physical training on enhanced post-stroke muscle strength. Researchers can also conduct comparable research by including additional databases, replicating the articles under analysis, and determining the expenses and resources employed in the papers assessed.

The following is the Professional Rehabilitation Nursing Competency Model.

Domain 1 – Interventions Under the Direction of Nurses

Managing the care of individuals with impairments and chronic illnesses throughout their lifetime is acknowledged as the specialization of rehabilitation nursing practice. Regardless of experience level, Rehab nurses look for and apply the most recent research and valuable technologies to give their customers and their families the finest care possible. Nurse-led care and client-caregiver education can improve the quality of life for people with disabilities and chronic illnesses, as supported by current evidence. According to rehabilitation nurses, every client's family is their support system, and they view each individual as a family member (Vaughn et al., 2016).

Domain 2 - Encouragement of Health and Well-Being

Rehabilitation nurses identify the health and wellness needs of patients and caregivers, as well as the factors that promote and hinder health improvement, and they integrate community care services to manage chronic illness and sustain health throughout time. This domain focuses on rehabilitation nurses' role in fostering a successful life in general by minimizing risks, preventing harm, and maintaining optimal health (Vaughn et al., 2016).

Domain 3 – Being a leader

In the third model domain, the rehabilitation nurse focuses on advocacy, accountability, and sharing nursing expertise with clients, families, and other team members. Rehab nurses are valuable members of the interdisciplinary team who use their leadership skills to enhance the highest caliber of treatment for patients and their families. They must develop their leadership abilities. Rehabilitation nurses' practice development initiatives (PDI) changed the rehabilitation unit's culture and promoted leadership, teamwork, and other aspects. There are four primary competencies within the leadership area (Vaughn et al., 2016).

Domain 4 – Interprofessional Care

In this area, the rehabilitation nurse promotes interprofessional connections through tactics such as team conferences and huddles and strong communication skills. Trust and respect are essential in the interactions between the nurse and the client as the interprofessional team members establish the team-client relationship. Care given by multidisciplinary expert teams has been demonstrated to improve rehabilitation patients' outcomes (Vaughn et al., 2016).

Nursing is crucial to providing comprehensive rehabilitation to stroke patients.

The limitations of the review synthesis in this report include the fact that the research article is restricted to the randomized controlled trial method, the publication year is 2018–2023, and the author only produced a review synthesis article in the form of a systematic review without conducting a meta-analysis.

CONCLUSION

Strength training has been demonstrated to improve stroke patients' quality of life, gait, balance, muscle strength, and supported living activities. The results emphasize the value of strength training regimens for stroke victims in order to avert life-threatening impairment. It is expected of nurses to be competent in assisting stroke patients in performing these strengthening exercises.

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