

ARTICLE INFORMATION

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**Effectiveness of various rehabilitation exercises for improving muscle strength
in patients with stroke: A literature review**

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Abstract

Background: Muscle weakness is frequent after stroke and can restrict daily functioning, independence, and long-term recovery. The rehabilitation approaches used to address weakness differ considerably in type and dose, making direct comparison difficult.

Purpose: To identify studies of exercise-based rehabilitation that directly measured muscle strength and to describe features shared by interventions with favorable findings.

Method: A PICO-guided structured narrative literature review was undertaken. Due to resource constraints, searches were restricted to PubMed, ScienceDirect, and Springer Nature for English full-text controlled and quasi-experimental studies published from January 2017 through April 2026. Screening and data extraction were completed by one reviewer, and findings were summarized narratively. No formal critical appraisal, risk-of-bias assessment, or meta-analysis was undertaken due to substantial clinical and methodological heterogeneity across the included studies.

Results: Nine studies with a combined sample of 595 participants met the criteria. The interventions included passive range of motion (ROM), resistance or strengthening exercise, sit-to-stand practice, cylindrical gripping, sling-supported shoulder exercise, bilateral computer-game training, upper-limb cycle ergometry, and Erigo robotic tilt-table exercise. Some studies demonstrated significant between-group benefits, whereas others reported only within-group improvement or incomplete comparative statistics.

Conclusion: Exercise-based rehabilitation appears to have potential for improving muscle strength after stroke; however, restricted database coverage, high rates of unretrieved full texts (64% of sought reports), single-reviewer procedures, and the absence of formal critical appraisal limit certainty. The available evidence is hypothesis-generating rather than definitive and does not establish one exercise type as superior.

Keywords: Exercise Therapy; Literature Review; Muscle Strength; Stroke; Stroke Rehabilitation.

INTRODUCTION

Stroke contributes substantially to mortality and persistent disability worldwide. More than 12 million new strokes occur annually, and approximately 101 million people live with the consequences of stroke (Feigin et al., 2021). In Indonesia, stroke remains an important cause of mortality and neurological disability that requires continuing rehabilitation (Ministry of Health of the Republic of Indonesia, 2023).

Reduced muscle strength is a common consequence of stroke because damage to motor-control networks limits voluntary activation and force production (Bernhardt et al., 2017). Sukma et al. (2022) reported that all 25 participants in their Indonesian sample had some degree of muscle-strength impairment and that muscle strength was significantly associated with activities of daily living ($p = 0.041$). Because the original study used categorical

strength ratings, these findings indicate impairment within that sample but should not be generalized beyond its setting.

Reduced muscle strength may limit walking, transfers, balance maintenance, and object grasping, thereby increasing dependence on family members and healthcare professionals (Feigin et al., 2021). Persistent weakness may also contribute to muscle atrophy, contracture, functional decline, and long-term disability (Langhorne et al., 2017).

Exercise-based rehabilitation is an important component of post-stroke care and may improve neuromuscular activation, muscle strength, and functional ability. Approaches include range-of-motion exercise, strengthening and resistance training, grip exercise, sit-to-stand training, and technology-assisted exercise. Their feasibility and effects vary according to the patient's clinical status, stroke phase, supervision requirements, equipment, and training dosage (Hosseini et al., 2019; Pinheiro et al., 2021).

Previous reviews have often emphasized broad motor or functional outcomes, while direct muscle-strength outcomes have been measured using different instruments and intervention protocols. Consequently, it remains unclear which exercise characteristics are most consistently associated with favorable muscle-strength outcomes after stroke. This structured narrative literature review therefore aimed to examine how exercise-based rehabilitation interventions, compared with usual care, conventional rehabilitation, or alternative exercise, were associated with directly measured muscle-strength outcomes and to describe exercise characteristics reported in studies with favorable findings.

RESEARCH METHOD

This manuscript employed a structured narrative literature review approach with narrative synthesis, rather than a systematic review or meta-analysis, due to the substantial heterogeneity in intervention protocols, outcome measures, and stroke phases across the included studies. The review question was guided by PICO: Population—adults with stroke and muscle weakness or motor impairment; Intervention—exercise-based rehabilitation; Comparator—usual care, conventional rehabilitation, no additional exercise, or another rehabilitation exercise; and Outcome—directly measured muscle strength. Article identification and selection were

documented using a flow diagram adapted from PRISMA 2020 for transparency (Page et al., 2021). The review was not registered because it was conducted as a literature review.

Searches were conducted in PubMed and the ScienceDirect and Springer Nature publisher platforms for studies published from January 1, 2017, to April 30, 2026. These sources were selected on based on the review team's institutional access; ScienceDirect and Springer Nature were used as publisher platforms rather than comprehensive bibliographic databases. The principal search string was: (stroke OR ischemic stroke) AND (range of motion OR strengthening exercise OR early mobilization) AND (muscle strength OR motor recovery). The final search was completed on April 30, 2026. No additional databases (CINAHL, Embase, PEDro) were searched. The limited number and type of search sources and the narrow search terminology are acknowledged as limitations because potentially relevant terms such as hemiparesis, hemiplegia, resistance training, exercise therapy, grip training, and stroke rehabilitation were not comprehensively represented in the original search string.

Studies were eligible when they: (1) included adults aged 18 years or older with ischemic or nonhemorrhagic stroke and muscle weakness or motor impairment; (2) evaluated an exercise-based rehabilitation intervention; (3) included usual care, conventional rehabilitation, no additional exercise, or an alternative exercise comparator; (4) directly measured muscle strength using Manual Muscle Testing, the Oxford or Medical Research Council scale, grip dynamometry, handheld dynamometry, isokinetic testing, or another direct strength measure; (5) used a controlled trial or quasi-experimental design; (6) were conducted in hospital, rehabilitation, outpatient, or community settings; (7) were published in English; and (8) were published from 2017 to 2026. Full text available was treated as an operational retrieval limitation rather than a strict eligibility criterion, though inaccessible texts were ultimately excluded. Mixed populations were eligible only when data for participants with stroke could be identified separately. The English-language and accessible-full-text restrictions reflected the review team's available resources and may have introduced language and availability bias. Terms such as

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“randomized controlled trial” and “randomized clinical trial” were retained as reported by the original studies but were treated within the broader category of controlled trials for this review.

Reports were excluded when they: (1) involved an ineligible population; (2) evaluated a non-exercise or otherwise ineligible primary intervention; (3) lacked an eligible comparator or study design; (4) did not directly measure muscle strength; (5) were reviews, meta-analyses, editorials, case reports, protocols without final results, or other noneligible publication types; or (6) could not be retrieved in full text. These categories were also used to classify reasons for exclusion at full-text assessment.

One reviewer extracted data using a structured form. Extracted items included author, year, country, study design, sample and participant characteristics, intervention and comparator, exercise type, frequency and duration, muscle-strength measurement instrument, assessment time point, and reported muscle-strength findings. Data extraction was not independently verified by a second reviewer. Narrative synthesis grouped studies into strengthening/resistance, passive range-of-motion, functional weight-bearing, gripping/upper-

limb, and device- or technology-assisted categories. Findings were described according to the direction of change and whether a statistically significant between-group result was explicitly reported. No formal critical appraisal, methodological-quality scoring, or risk-of-bias assessment was conducted, consistent with the design of a structured narrative review; this is treated as a major limitation.

One reviewer conducted title-and-abstract screening and full-text assessment. Duplicate records were removed before screening. Screening was not performed independently by a second reviewer, and no formal consensus procedure was used. Of 108 database records, 12 duplicates were removed and 96 records were screened. Fifty-two records were excluded by title/abstract, leaving 44 reports sought for retrieval. Twenty-eight full texts could not be obtained through the sources accessible to the review team, and 16 reports were assessed for eligibility. Eight database reports were included after full-text assessment. Citation searching identified two additional reports; both were assessed and one was included. The final literature review therefore included nine studies.

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RESEARCH RESULTS

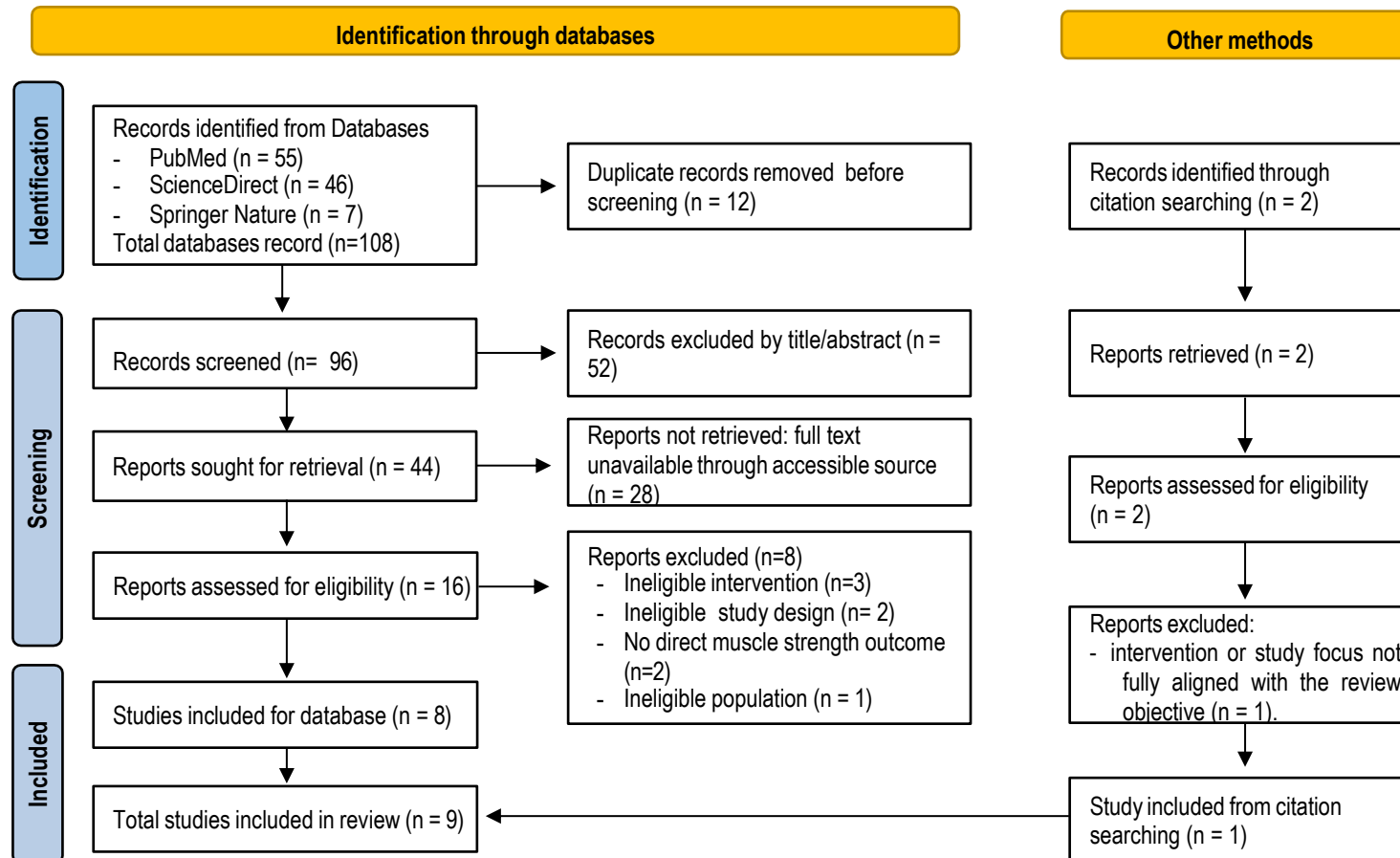


Figure 1. PRISMA 2020 Flow Diagram of the Study-Selection Process

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Table 1. Characteristics of the Included Studies

(Author, Year) Country	Design, Population, and Sample	Intervention, and Comparator	Exercise protocol, Duration, and Frequency	Strength measure and assessment time	Between-group quantitative finding
(Shao et al., 2023) China	Design: Single-blind randomized controlled trial. Population: first-ever stroke, onset ≤ 6 weeks. Sample: 139 patients.	Intervention: elastic-band strength training performed on the nonhemiplegic side. Comparator: control/usual rehabilitation as reported.	Resisted lower-limb stepping and upper-limb pulling; 45 min/ session; once daily; 5 days/week; 6 weeks.	Isokinetic strength system assessing biceps brachii, iliopsoas, and quadriceps; measured at baseline and after 6 weeks.	Improvement in hemiplegic-side biceps, iliopsoas, and quadriceps strength was greater in the trial group than in control. Exact mean change, CI, and strength-outcome p-value: NR.
(Feng et al., 2024) China	Design: randomized controlled trial. Population: stroke onset 1-2 months. Sample: 77 patients.	Intervention: resistance-band training on the unaffected side. Comparator: control/usual rehabilitation as reported.	Resisted elbow flexion and shoulder abduction; 2 sets/day; 5 days/week; 4 weeks.	Handgrip strength measured at baseline and after 4 weeks; muscle thickness was additionally assessed.	Post-intervention handgrip strength was higher in the intervention group ($F = 3.571$, $p < 0.05$). Affected-side muscle thickness also favored intervention ($F = 13.501$, $p < 0.001$).
(Hosseini et al., 2019) Iran	Design: randomized controlled trial. Population: first acute ischemic stroke. Sample: 52 patients (33 intervention; 19 control).	Intervention: early passive range-of-motion exercise. Comparator: routine care/control.	Passive upper- and lower-limb ROM including flexion-extension, abduction-adduction, rotation, dorsiflexion-plantarflexion, positional mobilization, and early-mobility support; 30 min/ session; 6-8 sessions; started within 48 hours.	Oxford strength grading for upper and lower extremities; assessed before intervention and at 1 and 3 months.	At 1 month, change in upper-extremity strength was greater with intervention (1.09 ± 0.84 vs 0.58 ± 0.91 , $p = 0.04$), as was lower-extremity strength (0.75 ± 0.71 vs 0.00 ± 1.11 , $p = 0.004$).
(de Sousa et al., 2019) Australia	Design: multicenter randomized controlled trial; assessor-blinded; intention-to-treat. Population: stroke patients unable to stand independently. Sample: 30 patients.	Intervention: intensive sit-to-stand training. Comparator: usual care.	Repeated sit-to-stand practice plus movement components, sliding tilt-table squats, weight-bearing reach, assisted standing, balance work, and progressive lower-limb strengthening; 2 extra sessions/day for 2 weeks.	Composite strength of key affected lower-limb muscles and gross lower-limb extension strength; baseline and 2-week assessment.	Gross lower-limb extension strength favored intensive sit-to-stand practice; mean between-group difference 6.2 degrees (95% CI 0.5 to 11.8).

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(Author, Year) Country	Design, Population, and Sample	Intervention, and Comparator	Exercise protocol, Duration, and Frequency	Strength measure and assessment time	Between-group quantitative finding
(Lam et al., 2022) Hong Kong	Design: single-blind randomized controlled trial. Population: subacute stroke survivors. Sample: 93 patients.	Intervention: bilateral movement-based computer games plus conventional rehabilitation. Comparator: conventional rehabilitation.	Symmetrical bilateral upper-limb tasks, specialized-handle gripping, grip-strength practice, coordination/ endurance activities, and game-based sensorimotor exercise; 2 days/ week for 8 weeks.	Grip strength, including the paretic hand; baseline, after 8 sessions, after 16 sessions, and at 4-week follow-up.	Earlier improvement in paretic grip strength from mid- intervention through 1-month follow-up was reported for bilateral game training plus conventional rehabilitation. Exact mean change, CI, and p-value: NR.
(Kumar et al., 2020) India	Design: randomized controlled trial. Population: acute stroke, onset 7-28 days. Sample: 110 patients (55 intervention; 55 control).	Intervention: Erigo robotic tilt-table exercise. Comparator: conventional physiotherapy.	Progressive upright positioning, step-like and passive cyclic leg movement, cyclic loading, bilateral weight bearing, antigravity work, ROM, and strengthening; 1-2 sessions/day for about 4 weeks.	MMT of affected upper and lower limbs; baseline/ day 0, day 30, and day 90.	Lower-limb strength improvement at day 90 was greater with Erigo than with conventional physiotherapy (p = 0.030). Mean change and CI: NR.
(Pinheiro et al., 2021) Brazil	Design: randomized clinical trial. Population: adults aged 40-80 years with acute ischemic stroke and hemiparesis. Sample: 20 patients (10 intervention; 10 control).	Intervention: upper-limb cycle ergometer plus conventional physiotherapy. Comparator: conventional physiotherapy.	Upper-limb cycling in passive, active-assisted, active, and resisted modes, targeting shoulder abductors, elbow flexors, wrist extensors, and grip; 20 min/ session; 2 sessions/day; 5 days.	Manual dynamometry for shoulder abductors, elbow flexors, and wrist extensors plus grip strength; assessed before and after the 5-day program.	Compared with control, the cycle - ergometer group improved significantly in grip strength and shoulder-abductor, elbow-flexor, and wrist-extensor strength (p < 0.05). Mean change and CI: NR.
(Kim et al., 2024) South Korea	Design: randomized controlled trial. Population: subacute stroke with shoulder subluxation. Sample: 30 patients.	Intervention: active shoulder exercise with sling suspension. Comparator: motorized upper-extremity exercise; both groups also received general therapy and FES.	Active-assisted shoulder flexion, abduction, and external rotation using sling suspension; 30 min/ session; 5 times/week; 8 weeks.	Lafayette/manual muscle tester for shoulder flexors, extensors, abductors, adductors, internal rotators, and external rotators; assessed before and after the 4-week intervention.	Time-group effects favored sling suspension for flexors (F(1,26) =13.211, p=0.001), abductors (F(1,26)=4.974, p=0.035), and external rotators (F(1,26)=9.674, p=0.004). Mean changes were 1.61 vs 0.99 kg, 1.48 vs 0.99 kg, and 1.25 vs 0.70 kg, respectively.

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(Author, Year) Country	Design, Population, and Sample	Intervention, and Comparator	Exercise protocol, Duration, and Frequency	Strength measure and assessment time	Between-group quantitative finding
(Wulandari et al., 2026) Indonesia	Design: quasi-experimental pretest- posttest control-group study. Population: nonhemorrhagic stroke with upper-limb weakness. Sample: 44 participants (22 intervention; 22 control).	Intervention: cylindrical grip exercise. Comparator: control/usual care as reported.	Repeated cylindrical-object gripping with the paretic hand; 10 min/day for 3 days.	MMT assessed at pretest and posttest.	Both groups improved from baseline. The Mann-Whitney between-group test was not significant ($p=0.157$), indicating no demonstrated comparative benefit.

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Study Characteristics

Nine studies satisfied the eligibility requirements. Publication years ranged from 2019 to 2026. The studies represented eight countries: two were conducted in China, while Iran, India, Australia, Hong Kong, Brazil, South Korea, and Indonesia contributed one study each. Seven reports identified their design as randomized controlled trials, one as a randomized clinical trial, and one as a quasi-experimental pretest-posttest study with a control group.

Population and Sample Characteristics

Participants represented both acute and subacute stages of stroke. Some studies enrolled individuals experiencing a first stroke within six weeks, whereas others focused on nonhemorrhagic stroke with limb weakness. Specific clinical groups included participants with hemiparesis, inability to stand without assistance, or shoulder subluxation.

A total of 595 patients participated in the nine included studies, with individual sample sizes ranging from 20 to 139. The largest sample comprised 139 patients (Shao et al., 2023), whereas the smallest comprised 20 patients (Pinheiro et al., 2021). Wulandari et al. (2026) included 44 patients with nonhemorrhagic stroke, divided equally between the intervention group ($n = 22$) and the control group ($n = 22$).

Intervention Characteristics

The interventions were grouped into five nonoverlapping categories: (1) strengthening and resistance exercise using elastic resistance bands (Feng et al., 2024; Shao et al., 2023), (2) passive range-of-motion exercise (Hosseini et al., 2019), (3) functional weight-bearing exercise, represented by intensive sit-to-stand training (de Sousa et al., 2019), (4) gripping and upper-limb exercise, represented by cylindrical grip exercise (Wulandari et al., 2026), and (5) device- or technology-assisted exercise, including bilateral computer-game training, Erigo robotic tilt-table training, upper-limb cycle ergometry, and sling-suspension shoulder exercise (Kim et al., 2024; Kumar et al., 2020; Lam et al., 2022; Pinheiro et al., 2021).

Movements included shoulder flexion and abduction, elbow flexion, upper-limb pulling, stepping against elastic resistance, joint flexion-extension and rotation, repeated sit-to-stand movements,

progressive verticalization, cyclic leg movements, lower-limb loading, upper-limb cycling, and repetitive gripping.

Intervention duration ranged from three days to eight weeks. Reported sessions lasted approximately 10–45 minutes, with frequencies ranging from one to two sessions per day or two to five days per week. These frequencies should not be interpreted as directly comparable effective doses because stroke phase, clinical status, exercise intensity, and study protocols differed.

Synthesis of Findings

The direction of findings generally favored exercise-based rehabilitation, but the strength and form of reporting varied. Some studies reported statistically significant between-group differences in selected muscle-strength outcomes, whereas others reported pre-post improvement without extractable between-group effect estimates or confidence intervals. Consequently, within-group change was not interpreted as equivalent to superiority over a comparator.

Passive range-of-motion exercise initiated during the acute phase improved upper- and lower-limb muscle strength, particularly at the one- to three-month follow-up assessments (Hosseini et al., 2019). Because passive ROM involves limited voluntary contraction and mechanical loading, the finding is more appropriately interpreted as supportive evidence for early mobility and preparation for active exercise rather than proof of an effect equivalent to resistance training.

Bilateral computer-game training was associated with improved grip strength and upper-limb motor function (Lam et al., 2022). Erigo robotic tilt-table training produced a greater improvement in lower-limb muscle strength than conventional physiotherapy in the included trial ($p = 0.030$) (Kumar et al., 2020).

Upper-limb cycle ergometer training significantly improved grip strength and the strength of the shoulder abductors, elbow flexors, and wrist extensors compared with the control group (Pinheiro et al., 2021). Sling-suspension shoulder exercise showed significant group-by-time interactions for selected shoulder muscle groups (Kim et al., 2024). Cylindrical grip exercise improved upper-limb strength within the intervention group; however, the

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between-group difference compared with the control group was not statistically significant ($p = 0.157$), indicating no demonstrated comparative benefit (Wulandari et al., 2026).

Taken together, active contraction, repetition, external resistance, weight bearing, and function-oriented movement were commonly present in interventions with favorable findings. This pattern is descriptive rather than a formal ranking because studies differed in participants, measurement instruments, comparators, dosage, and completeness of quantitative reporting.

DISCUSSION

Effectiveness of Rehabilitation Exercises According to Movement Type

The nine included studies evaluated range-of-motion exercise, strengthening and resistance exercise, functional weight-bearing exercise, gripping and upper-limb exercise, bilateral repetitive movement, and device- or technology-assisted exercise. Findings varied according to the muscle group trained, stroke phase, exercise dose, comparator, measurement instrument, and baseline ability.

Range-of-Motion Movements

Passive ROM was used primarily during the acute phase when participants could not yet generate optimal voluntary contraction. Movements included flexion–extension, abduction–adduction, rotation, dorsiflexion–plantarflexion, positional mobilization, and support for early mobility. Hosseini et al. (2019) reported that 30-minute sessions, administered 6-8 times from within the first 48 hours were associated with improved upper- and lower-limb muscle-strength ratings at later follow-up.

Passive ROM may help maintain joint mobility, reduce the consequences of immobilization, and prepare patients for active exercise. However, it provides less voluntary contraction and loading than strengthening or resistance exercise. Its relationship with improved strength should therefore be interpreted cautiously and should not be considered equivalent to direct progressive strengthening.

Strengthening and Resistance Movements

Strengthening and resistance exercise uses active contraction against an external load. Included movements comprised elbow flexion, shoulder

abduction, upper-limb pulling, resisted stepping, and lower-limb strengthening. Shao et al. (2023) reported favorable strength, balance, and mobility outcomes after six weeks of nonhemiplegic-side resistance training. Feng et al. (2024) reported improved grip strength and upper-limb outcomes after four weeks of resistance-band training ($p < 0.05$). These findings suggest that active contraction and external resistance may support force production; however, direct comparison is limited by different muscle groups, measures, and protocols.

Functional and Weight-Bearing Movements

Functional exercise combines strengthening with movement patterns used in daily life. de Sousa et al. (2019) evaluated intensive sit-to-stand training that included repeated sit-to-stand practice, movement-component training, assisted standing, balance activities, weight-bearing reaching, and progressive lower-limb strengthening. Two additional sessions per day for two weeks were associated with improved sit-to-stand ability and lower-limb strength.

Sit-to-stand practice engages the hip, knee, and ankle extensors while requiring body-weight loading, postural control, balance, and task repetition. Its potential value therefore extends beyond isolated strength to transfer ability. Nevertheless, the magnitude and certainty of benefit cannot be established from a single small study, particularly because this literature review did not include a formal critical appraisal.

Gripping Movements and Upper-Limb Exercise

Wulandari et al. (2026) reported improved upper-limb strength after repetitive cylindrical gripping. The exercise directly involves the finger flexors, wrist muscles, and supporting upper-limb musculature. Before independent practice is considered, clinicians should assess grasping ability, spasticity, pain, fatigue, skin integrity, and injury risk, and provide initial supervision. The finding should be interpreted in light of the small sample and short intervention period.

Kim et al. (2024) evaluated sling-suspension active shoulder exercise for 30 minutes once daily, five days per week, over four weeks. Compared with motorized upper-extremity exercise, significant group-by-time interactions were reported for shoulder flexors, abductors, and external rotators, together

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with selected pain and upper-limb function outcomes. Sling suspension reduces gravitational demand and allows the direction and intensity of assistance or resistance to be adjusted.

Bilateral and Repetitive Movements

Lam et al. (2022) evaluated bilateral movement-based computer games involving simultaneous upper-limb movements, gripping, coordination, endurance, and sensorimotor tasks. Training was delivered two days per week for eight weeks and was associated with favorable grip-strength and upper-limb motor outcomes.

Bilateral and repetitive practice may support sensorimotor learning through repeated task exposure and visual feedback. This mechanism remains an interpretation of the observed intervention characteristics rather than a direct comparison of neurophysiological effects across the included studies.

Exercise Characteristics Associated with Favorable Findings

Across studies, favorable findings were commonly observed in interventions involving active contraction, repeated movement, progressive or adjustable resistance, weight bearing, and task-oriented practice. Because effect estimates, confidence intervals, measurement instruments, and methodological quality were not consistently available, these characteristics cannot be ranked or used to identify a single superior intervention.

Active contraction can increase motor-unit recruitment, repeated practice may support motor relearning, and gradually increased loading may promote neuromuscular adaptation (Dorsch et al., 2018; Grefkes & Fink, 2020; Saunders et al., 2020). Function-oriented exercise may also transfer more readily to activities of daily living because the practiced movements resemble everyday tasks (de Sousa et al., 2019). The mechanistic explanations for these findings (motor relearning, neuromuscular adaptation) are plausible interpretations rather than direct comparative findings demonstrated by the included trials.

ROM exercise and early mobilization remain foundational during the acute phase because they may help maintain mobility, reduce contracture risk, and prepare patients for more active training

(Hosseini et al., 2019; Zhang et al., 2021). Exercise selection should therefore consider the patient's phase of recovery, voluntary motor ability, hemodynamic stability, pain, fatigue, and rehabilitation goals.

Synthesis of Movement Efficacy

The available evidence suggests that active and progressively loaded exercises may provide more direct stimulation for force production than passive exercise, while functional and weight-bearing tasks may simultaneously address strength and activity. Technology-assisted approaches may increase repetition or provide graded support, but their superiority cannot be inferred solely from equipment complexity. Clinical and methodological heterogeneity precluded quantitative comparison across exercise types.

Passive ROM may be useful as an initial intervention in the acute phase, particularly for patients who cannot yet perform active movement. Strengthening, resistance, gripping, cycling, sling-assisted, and weight-bearing exercises may be introduced or progressed according to clinical readiness. These conclusions represent a narrative interpretation of heterogeneous studies and should be reconsidered after formal risk-of-bias assessment.

Implications for Nursing Practice and the Development of Rehabilitation Education

Nurses play a critical role in post-stroke rehabilitation that extends beyond the physical exercises evaluated in these nine studies (Bernhardt et al., 2017; Saunders et al., 2020). Nursing implications include: (1) assessing patient readiness, hemodynamic stability, pain, and fatigue before exercise; (2) reinforcing safe techniques and monitoring for adverse signs during activity; (3) supporting adherence through structured, repeated patient and caregiver education; and (4) coordinating interdisciplinary care with physiotherapists and rehabilitation physicians. These nursing roles are foundational to safe rehabilitation, though they were not the primary focus of the included trials.

STUDY LIMITATIONS

This structured narrative review has substantial limitations that preclude strong causal inferences. First, searches were restricted to PubMed and two

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publisher platforms, omitting major rehabilitation databases (CINAHL, PEDro, Embase), and may have introduced language and availability bias. Second, 28 of 44 sought reports (64%) could not be retrieved, creating a severe potential for availability and publication bias and increasing the possibility that relevant evidence was missed. Third, the original search terminology was relatively narrow and did not comprehensively include several potentially relevant stroke-rehabilitation terms. Fourth, one reviewer conducted screening and data extraction without independent verification, increasing the possibility of selection and extraction error. Fifth, no formal critical appraisal, methodological-quality assessment, risk-of-bias assessment, or certainty-of-evidence assessment was performed. Furthermore, substantial clinical and methodological heterogeneity (varying stroke phases, intervention doses, and strength measurement instruments) precluded any meaningful quantitative synthesis or meta-analysis. Consequently, the conclusions drawn are hypothesis-generating rather than definitive.

CONCLUSION

The available evidence suggests that exercise-based rehabilitation may improve muscle-strength outcomes after stroke. Active contraction, repeated practice, resistance, weight bearing, and function-oriented movement were commonly present as observed patterns in interventions with favorable between-group findings, while passive ROM appeared most relevant as an early foundational approach. However, confidence in these findings is severely limited by restricted database coverage, high rates of unretrieved full texts (64%), single-reviewer procedures, the absence of formal critical appraisal, and the lack of quantitative synthesis (meta-analysis). No single exercise type can be identified as superior on the basis of this narrative literature review.

RECOMMENDATIONS

Rehabilitation teams may consider exercise characteristics associated with favorable findings, including active contraction, repetition, graded loading, and function-oriented activity, while basing exercise selection on clinical assessment, stroke phase, patient goals, contraindications, fatigue, pain, and appropriate supervision. These

recommendations should be interpreted cautiously because the literature review did not formally appraise methodological quality or risk of bias and because comparative quantitative reporting was incomplete in several studies.

Future trials should evaluate structured rehabilitation-education strategies, including audiovisual media, using prespecified outcomes such as adherence, safety, acceptability, muscle strength, activities of daily living, and patient participation. Trials should use adequate comparators, blinded outcome assessment where feasible, standardized strength measures, complete effect estimates with confidence intervals, and follow-up sufficient to assess sustained benefit.

ADMINISTRATIVE DECLARATIONS

Author contributions, funding, conflicts of interest, and acknowledgments are provided on a separate title page for blinded review. Ethical approval and informed consent were not applicable because this literature review analyzed published studies. Data availability: All data synthesized in this review are presented in the article and cited source publications.

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