Occupational Therapy Interventions for Adults with Hemiplegic Shoulder Injuries: A Systematic Review

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Abstract

Importance: Hemiplegic shoulder pain is a common injury following a stroke in adults that can significantly limit upper-extremity function and mobility. With occupational therapy interventions, individuals may experience improvements in function and participation; however, research on the effectiveness of specific interventions remains varied.

Objective: To identify, evaluate, and synthesize the current literature to determine the effectiveness of occupational therapy interventions used to improve upper-extremity function and reduce pain in adults with hemiplegic shoulder conditions.

Data Sources: A literature search was conducted between May 15, 2026, and May 20, 2026. Databases and sites included Academic Search Complete, CINAHL, and MEDLINE using Hawai‘i Pacific University's online library databases. Search terms included occupational therapy intervention, occupational therapy, occupational therapy treatment, hemiplegic shoulder, upper limb, hemiplegic shoulder pain, shoulder subluxation, pain management, pain relief, pain control, pain reduction, and function.

Study Selection and Data Collection: This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Published studies on the topic were included in the systematic review. Systematic reviews, scoping reviews, dissertations, conference proceedings, presentations, and non-peer-reviewed literature were excluded.

Findings: Six studies were included: two Level I, two Level II, one Level III, and one Level IV study. The outcomes of these studies suggest that occupational therapy interventions have the potential to improve upper-extremity function and occupational performance in adults with

hemiplegic shoulder conditions following stroke. However, evidence regarding pain reduction remains limited.

Conclusion and Relevance: Occupational therapy interventions may be an appropriate therapeutic approach for improving upper-extremity function and occupational performance in adults with hemiplegic shoulder conditions following stroke; however, there is not enough evidence to suggest which intervention is most effective for reducing pain.

Key words: Hemiplegic shoulder, occupational therapy, rehabilitation, stroke, upper-extremity function, upper limb

Occupational Therapy Interventions for Adults with Hemiplegic Shoulder Injuries: A Systematic Review

Stroke is the third-leading cause of combined death and disability worldwide (Feigin et al., 2019), highlighting the importance of effective treatments to aid those with stroke-related disability whose daily activities and roles are impacted. Every year, roughly 795,000 people in the United States are victims of stroke, with 610,000 cases being that of a first stroke (Tsao et al., 2023). The American Heart Association predicts a significant increase in stroke prevalence over the next 30 years, increasing from 3.9% in 2020 to 6.4% by 2050 (Joynt Maddox et al., 2024). This is due at least in part to the projected increase in the aging population (Joynt Maddox et al., 2024). Rehabilitation is a valuable method to improve quality of life for stroke victims. A systematic review and meta-analysis of physical rehabilitation methods found that adding specific techniques to conventional stroke therapy improved pain for stroke patients with hemiplegic shoulder (de Sire et al., 2019). In addition to physical therapy, occupational therapy provides several evidence-based avenues for stroke rehabilitation to improve patient outcomes (Hildebrand et al., 2023).

The American Journal of Occupational Therapy (AJOT) provides practice guidelines for occupational therapy methods to increase efficacy of interventions (Hildebrand et al., 2023). A systematic review published on AJOT to provide evidence-based guidelines found strong evidence for using mirror therapy, task-oriented therapy, mental imagery, balance training, self-management training, a multidisciplinary three-stages–of-care rehab program, and constraint-induced therapy to improve activities of daily living and/or functional mobility for stroke patients (Hildebrand et al., 2023). These methods are encouraged due to the strength of evidence for their efficacy. There was moderate evidence for using an upper-extremity sensory device and

games for social participation (Hildebrand et al., 2023). These methods may also be used, although they may not be quite as effective. The current guidelines are helpful for practitioners to plan interventions. However, as new technology emerges, the guidelines can and should be updated to reflect the best possible interventions available to practitioners.

Indeed, there are several emerging technologically advanced rehabilitation methods for stroke survivors. These methods provide new avenues for physical therapists and occupational therapists to improve patient outcomes. They include gamified methods, robot-assisted therapy, telerehabilitation, virtual reality and augmented reality, wearable sensors, and handheld devices such as smartphones (Malik et al., 2022). These methods are promising, but rigorous testing is needed to ensure that they are effective at improving outcomes for stroke patients. This is especially important when considering cost-effectiveness and the effort required by practitioners to learn new interventions. Considering the current occupational therapy guidelines and the emerging methods for rehabilitation, it is necessary to explore which interventions are most useful for the stroke population. Shoulder hemiplegia is a major concern for stroke survivors and impacts functioning in a myriad of ways (Ase et al., 2025). Thus, evidence-based practice necessitates ongoing, specific, systematic assessment of treatment methods and their efficacy. This systematic review examined and analyzed the strength of the evidence for occupational therapy interventions that improve function and reduce pain for adults with a hemiplegic shoulder.

Method

The systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and incorporated recommended processes for conducting a

systematic review. The guiding research question for this systematic review was: Which OT interventions are most effective to improve function and reduce pain for adults with a hemiplegic shoulder?

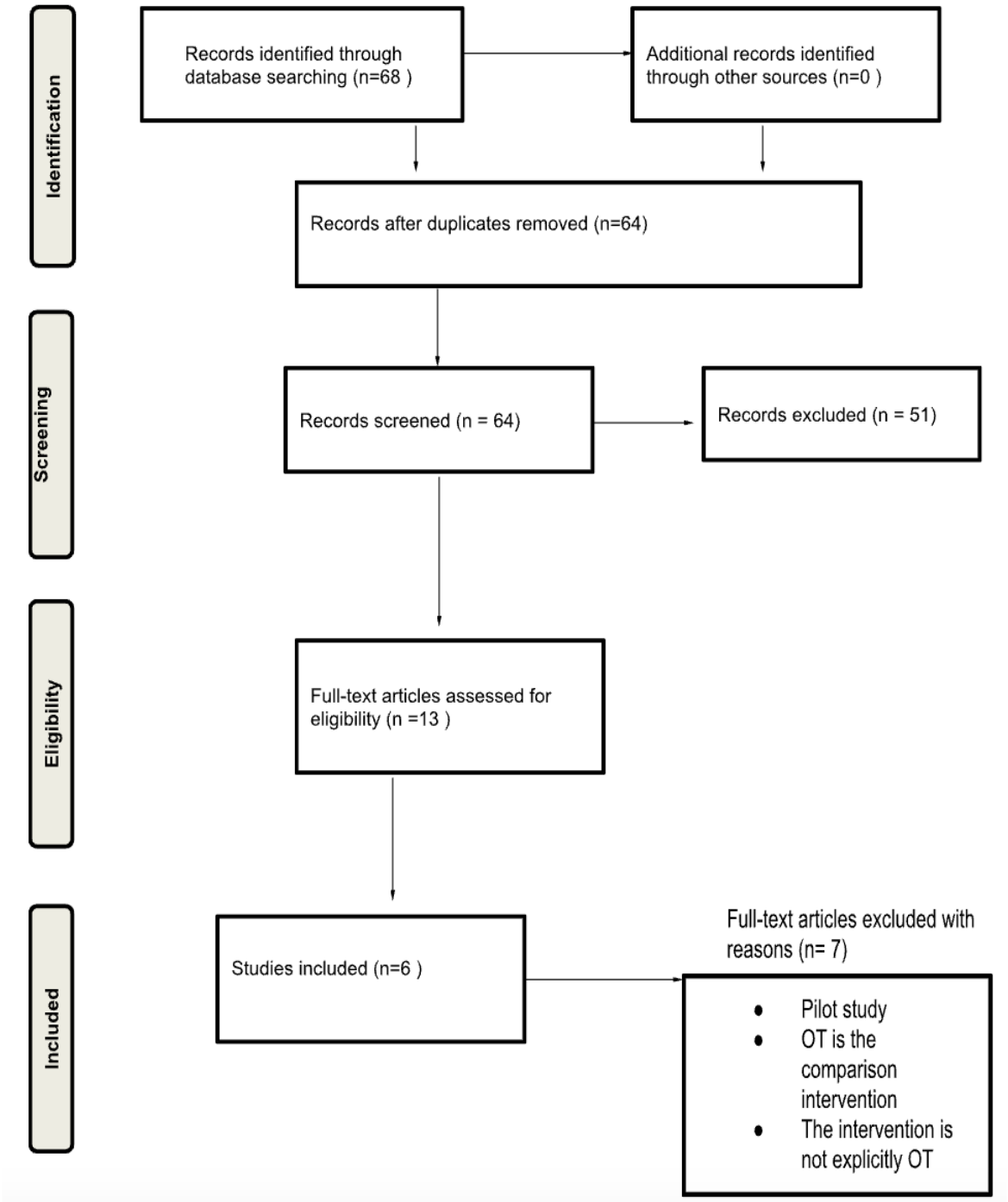
A broad search of the literature occurred between May 15, 2026, and May 20, 2026. The inclusion criteria for studies in this systematic review were as follows: peer-reviewed, published in English, related to occupational therapy interventions for adults with hemiplegic shoulder conditions following stroke, and dated between 2021–2026. Exclusion criteria, in addition to those studies that did not meet the inclusion criteria, included articles that were systematic reviews, scoping reviews, dissertations, conference proceedings, presentations, and non-peer-reviewed literature.

A search for relevant literature was completed using electronic databases: Academic Search Complete, CINAHL, and MEDLINE through Hawai‘i Pacific University’s online library database. Search terms included occupational therapy intervention, occupational therapy, occupational therapy treatment, hemiplegic shoulder, upper limb, hemiplegic shoulder pain, shoulder subluxation, pain management, pain relief, pain control, pain reduction, and function, as well as combinations of these terms. Appendix A provides the search terms used for this systematic review.

The initial search included 68 articles related to the research topic (Figure 1). Four independent reviewers completed the screening and selection of the studies, assessed their quality, and extracted the data.

Figure 1

PRISMA Flow Diagram



Results

Six studies met the inclusion criteria. The articles were assessed according to their risk of bias, level of evidence, and quality. This systematic review included six studies that contained relevant information regarding technology-assisted interventions to improve function and reduce pain for adults with a hemiplegic shoulder. An evidence table is provided in Appendix B. The Cochrane risk-of-bias guidelines were used to assess each article and are provided in Appendix C.

Ase et al. (2025) conducted a randomized controlled trial examining the effects of a home-based virtual reality rehabilitation program using the RAPAEL Smart Glove in 14 adults with chronic stroke. Participants complete 30 minutes of training five days per week for four weeks. Compared with the control group, the virtual reality intervention resulted in significantly greater improvements in upper-extremity motor recovery and functional performance. These improvements were measured by the Fugl-Meyer Assessment of Upper Extremity Motor Function (FMA-UE), Motor Activity Log-14 (MAL-14), Jebsen-Taylor Hand Function Test (JTT), and Box and Block Test (BBT). The intervention resulted in better use of the paretic hand during daily activities (Ase et al., 2025). The authors linked these outcomes to the task-oriented and repetitive nature of virtual reality exercises, which offered immediate feedback and encouraged active participation in rehab. No adverse events were reported, indicating that the program was safe and practical for home use (Ase et al., 2025). These findings suggest that combining home-based virtual reality interventions with periodic occupational therapy may effectively improve upper-extremity function and encourage participation in everyday activities for individuals with chronic stroke.

Danz et al. (2024) examined the effectiveness of a bimanual arm trainer (BAT) in 27 individuals with ischemic stroke receiving inpatient rehabilitation. The participants in the intervention group completed at least three 10-minute training sessions with the device in addition to their regular rehabilitation program. Meanwhile, the control group received standard occupational therapy services. Both groups demonstrated significant improvements in upper-extremity function as measured by the Action Research Arm Test (ARAT). However, the BAT group had significant gains in FMA-UE scores from admission to discharge (Danz et al., 2024). No statistically significant differences were found between the groups, which suggests that adding the BAT did not produce better upper-extremity outcomes compared to traditional occupational therapy. The authors believe that the BAT could still be helpful because it uses principles of bilateral movement, repetition, real-time feedback, and virtual reality. The elements are known to help motor recovery after a stroke. Additionally, the device may boost patient motivation and allow for more intense practice during rehabilitation sessions (Danz et al., 2024). However, the study's findings had limitations due to the small sample size, lack of randomization, and missing FMA-UE data for the control group. This makes it hard to compare the effectiveness of the intervention fully (Danz et al., 2024). Overall, the results indicate that the BAT might be a useful addition to occupational therapy. Still, more research is needed to assess its long-term effectiveness and potential benefits in various rehabilitation settings.

Gerhardt et al. (2024) presented a case report that looked at the use of the NuroSleeve during occupational therapy for a 38-year-old man with chronic upper-extremity hemiparesis after a stroke. The participant attended 24 occupational therapy sessions over 10 weeks. These sessions included neuromuscular reeducation, occupation-based activities, device management, and training with the powered orthosis. The researchers noted improvements in occupational

performance, functional arm use, and the participant's reported ability to perform daily activities, especially when using the NuroSleeve (Gerhardt et al., 2024). Clinically meaningful improvements appeared in six out of eight Canadian Occupational Performance Measure (COPM) performance goals and in seven out of eight satisfaction goals. Additionally, there was an 11-point increase on the Action Research Arm Test (ARAT), surpassing the minimum clinically important difference for people with chronic stroke. The participant also showed significant improvements in manual ability, as measured by the ABILHAND, and better upper-extremity functioning while using the device was reported (Gerhardt et al., 2024). However, no changes in muscle strength were noted during manual muscle testing. This suggests that the improvements were likely due to better task performance and compensatory strategies rather than recovery of neuromuscular function alone. The researchers highlighted the importance of occupational therapy in helping users successfully engage with the NuroSleeve through client-centered, occupation-based interventions and training in meaningful daily tasks (Gerhardt et al., 2024). While the findings are based on a single participant and cannot be applied broadly, this case report indicates that combining occupational therapy with the NuroSleeve may enhance functional participation and upper extremity use for individuals with chronic stroke.

Hsieh et al. (2025) looked at how usable and practical an immersive virtual reality mirrored-hand rehabilitation system was for 15 adults who had strokes. The participants completed guided rehabilitation activities using a virtual reality headset. This headset mimicked tasks like cooking, shopping, driving, and household chores. The results showed moderate usability, positive user experiences, high engagement levels, and little virtual reality sickness. Most participants reported minimal discomfort while using the system (Hsieh et al., 2025). They also found the system easy to use and felt confident navigating the virtual reality environment,

even without prior experience with this technology. The realistic, task-based activities and immediate feedback seemed to boost motivation and attention during rehabilitation sessions. Moreover, the system allowed stroke survivors to practice activities that could be tough or unsafe to do in reality, like driving or cooking, within a safe setting. While the effectiveness of the treatment was not measured, the findings support the use of immersive virtual reality as a rehabilitation tool for stroke patients. They show its potential for use in upper-extremity rehabilitation. The authors suggested that future research should investigate the short- and long-term impacts of this intervention on motor recovery and daily activities after a stroke (Hsieh et al., 2025).

Jeong et al. (2026) studied how a telerehabilitation program delivered the LSVT-BIG intervention to three adults with chronic motor impairments as a result of a stroke. The study employed a single-subject experimental design. Participants took part in sixteen one-hour treatment sessions over four weeks through a remote rehabilitation platform while continuing their usual rehabilitation services. The program focused on high-amplitude, repetitive movements and functional tasks that matched each participant's personal goals (Jeong et al., 2026). After the intervention, all participants showed improvements in physical function. This was shown by lower Timed Up and Go (TUG) scores and higher Box and Block Test (BBT) and Fugl-Meyer Assessment (FMA) scores, which indicated better balance, mobility, and upper-body function. Participants also had better performance and satisfaction on the Canadian Occupational Performance Measure (COPM) and increased independence in daily activities, as reported by the Modified Barthel Index (MBI). The authors suggested that the repetitive, task-focused approach of LSVT-BIG and the use of meaningful activities likely helped improve functional outcomes and boost motivation among participants (Jeong et al., 2026). The study also showed that real-

time feedback and supervision from therapists can effectively happen through telehealth platforms. Telehealth improves access to intensive rehabilitation services for people who face challenges in obtaining in-person care (Jeong et al., 2026). Despite the findings being limited by the small sample size and lack of long-term follow-up, the results suggest that telerehabilitation-delivered LSVT-BIG could be a promising and practical option for improving motor function, occupational performance, and participation in individuals with chronic motor impairments due to a stroke.

Sade et al. (2021) conducted a randomized controlled trial with 43 individuals who had a stroke to evaluate the effects of whole-body vibration therapy (WBVT) combined with regular rehabilitation. The participants in the intervention group received vibration treatment along with range of motion exercises, strengthening, stretching, and occupational therapy. The control group only received standard rehabilitation. The WBVT treatment took place five times a week for three weeks and was well tolerated, with no reported side effects (Sade et al., 2021). After the intervention, the treatment group showed significantly greater improvements in elbow extension range of motion and all parts of the Jebsen-Taylor Hand Function Test (JTHFT) compared to the control group. The greatest improvements were observed in page-turning, lifting lightweight objects, and stacking tasks, indicating enhanced hand dexterity and upper-extremity functional performance. The researchers suggested that the extra sensory stimulation from WBVT might boost muscle activation and strengthen the effects of traditional rehabilitation (Sade et al., 2021). Better upper-extremity function can greatly help individuals gain independence in daily activities and reduce their dependence on caregivers after a stroke (Sade et al., 2021). While the study had limitations, like a small sample size and lack of muscle strength measurements, the findings

imply that whole-body vibration could be an effective additional treatment for improving upper-extremity function when included in a stroke rehabilitation program.

Several limitations were identified across the included studies. Small sample sizes limited the generalizability of findings to the broader stroke population (Ase et al., 2025; Hsieh et al., 2025; Jeong et al., 2026). Additionally, single-subject and case-report designs reduced the ability to establish causality and apply findings to larger populations (Gerhardt et al., 2024; Jeong et al., 2026). Methodological concerns, including nonrandomized designs, lack of blinding, and moderate-to-high risk of bias, may have increased the potential for systematic error (Danz et al., 2024; Hsieh et al., 2025; Jeong et al., 2026). Several studies also included short intervention periods and lacked long-term follow-up assessments, limiting understanding of the sustainability of treatment effects (Ase et al., 2025; Jeong et al., 2026; Sade et al., 2021). Finally, some studies focused primarily on feasibility or device-assisted performance rather than long-term occupational outcomes, limiting conclusions regarding intervention effectiveness in everyday participation (Gerhardt et al., 2024; Hsieh et al., 2025).

Discussion

The findings of this systematic literature review suggest that occupational therapy interventions may improve upper-extremity function and occupational performance following stroke, particularly for individuals with hemiplegic shoulder impairments. Although evidence supporting pain reduction remains limited, participants across the included studies demonstrated improvements in motor recovery, arm and hand use, dexterity, independence, and participation in daily activities (Ase et al., 2025; Danz et al., 2024; Gerhardt et al., 2024; Jeong et al., 2026; Sade, 2021). Despite the variability in intervention approaches, including virtual reality,

bimanual training, wearable technology, telerehabilitation, and vibration-based interventions, most studies reported positive functional outcomes. Collectively, these findings support the role of occupational therapy in facilitating participation in meaningful occupations after stroke.

Hemiplegic shoulder impairments are common after stroke and can substantially limit upper-extremity function and occupational engagement. These impairments may negatively affect an individual's ability to perform activities of daily living, participate in work and leisure activities, and maintain independence within the home and community. Occupational therapists commonly address these limitations during stroke rehabilitation by promoting movement, functional use of the upper extremity, and participation in meaningful activities. Therefore, identifying effective occupational therapy interventions for upper-extremity rehabilitation remains important for evidence-based clinical practice.

Across the included studies, interventions emphasizing repetitive movement, task-oriented practice, and active participation appeared to contribute to improvements in upper-extremity outcomes following stroke. Both traditional rehabilitation approaches and technology-assisted interventions, such as virtual reality, wearable devices, and telerehabilitation, demonstrated positive findings related to upper-extremity function and occupational performance (Ase et al., 2025; Gerhardt et al., 2024; Hsieh et al., 2025; Jeong et al., 2026). These findings are consistent with previous literature suggesting that repeated engagement in meaningful activities supports motor relearning and functional recovery after stroke. Furthermore, the studies included in this review demonstrated improvements not only in motor performance, but also in occupational participation and perceived functional ability.

Despite these promising findings, several limitations should be considered when interpreting the results of this review. The included studies varied considerably in intervention type, outcome measures, study design, and sample size, making direct comparisons difficult (Ase et al., 2025; Danz et al., 2024; Hsieh et al., 2025; Sade, 2021). In addition, several studies included small sample sizes and lower levels of evidence, such as case reports and single-subject experimental designs, which may limit the generalizability of the findings (Gerhardt et al., 2024; Jeong et al., 2026). Methodological limitations, including nonrandomized designs, limited blinding procedures, and moderate-to-high risk of bias in some studies, may also have influenced the reported outcomes. Another important limitation was the lack of standardized pain-specific outcome measures across studies, which made it difficult to determine which occupational therapy interventions were most effective for reducing hemiplegic shoulder pain.

Future research should incorporate larger randomized controlled trials, standardized outcome measures, and longer follow-up periods to better evaluate the effectiveness of occupational therapy interventions for both functional recovery and pain management after stroke. Additional research examining the long-term impact of technology-assisted interventions on occupational performance and participation may further strengthen the evidence supporting occupational therapy practice in stroke rehabilitation.

Strengths and Limitations

This systematic review had several strengths. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which provided a structured and transparent process for identifying, screening, and selecting studies. Multiple databases were searched, including Academic Search Complete, CINAHL, and

MEDLINE, increasing the likelihood of identifying relevant literature. In addition, four independent reviewers participated in the screening, selection, quality appraisal, and data extraction processes, helping to improve consistency and reduce selection bias.

Several limitations should be considered. Only six studies met the inclusion criteria, resulting in a limited evidence base and reducing the ability to draw broad conclusions regarding the effectiveness of technology-assisted interventions for adults with hemiplegic shoulder following stroke. Although the included studies examined a variety of technology-assisted interventions, they primarily focused on similar populations, outcomes, and upper-extremity rehabilitation approaches following stroke. Consequently, the review may not fully represent the breadth of occupational therapy interventions available for individuals with hemiplegic shoulder. As a result, the review captured a narrow range of intervention types and may not fully represent the breadth of occupational therapy interventions used for hemiplegic shoulder conditions. Additionally, the review was limited to peer-reviewed articles published in English between 2021 and 2026, which may have excluded relevant studies published in other languages or outside the selected timeframe. Finally, several included studies consisted of lower levels of evidence, including case reports and single-subject designs, which may limit the strength, reliability, and generalizability of the review's conclusions.

Implications for Occupational Therapy Practice

This review found that occupational therapy interventions can help adults with hemiplegic shoulder conditions after a stroke to improve their upper-extremity function and occupational performance. Some studies reported good results when virtual reality, telerehabilitation, wearable devices, or whole-body vibration were used together with

occupational therapy. These results show that therapists have several ways to support recovery, individualizing interventions to each client's unique strengths, challenges, and goals.

Key Takeaway Points for Occupational Therapy Practice:

- Technology-assisted interventions may be useful additions to traditional occupational therapy services.
- Meaningful, task-based activities should remain a focus of intervention planning.
- Repetition and active participation appear to support upper-extremity recovery after stroke.
- Treatment plans should be individualized to address each client's unique goals and needs.

Conclusion

The studies included in this systematic review suggest that occupational therapy interventions may improve upper-extremity function and occupational performance in adults with hemiplegic shoulder conditions following stroke. Across the included studies, participants demonstrated improvements in motor recovery, functional arm use, and participation in daily activities using a variety of intervention approaches. However, there is still limited evidence regarding the effectiveness of these interventions for reducing pain associated with hemiplegic shoulder conditions. Although the findings are encouraging, additional research with larger sample sizes, stronger study designs, and standardized pain outcome measures are needed to strengthen the current evidence. Overall, this review supports the role of occupational therapy in helping adults following stroke improve function and participation in meaningful daily activities while highlighting the need for continued research in this area.

AI Disclosure Statement: During the preparation of this systematic review, the authors used Chat GPT to improve grammar and readability. After using this tool, the authors reviewed and edited the content. The authors take full responsibility for the final content. ￼

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Appendix A

Systematic Review Search Terms

occupational therapy intervention or occupational therapy or occupational therapy treatment AND “hemiplegic shoulder” OR "upper limb" OR “hemiplegic shoulder pain” OR “shoulder subluxation" AND pain management or pain relief or pain control or pain reduction or function

Appendix B

Evidence Table

Author/Year	Level of Evidence Study Design Risk of Bias	Participants Inclusion Criteria Study Setting	Intervention and Control Groups	Outcome Measures	Results
Danz et al. (2024) https://research.aota.org/ajot/article/78/6/7806205130/25965/Bimanual-Arm-Trainer-Versus-Traditional	Level of Evidence: Level 2B Study Design: Clinical trial, two-group, nonrandomized repeated-measures design. Risk of Bias: low	Participants: 27 persons with ischemic stroke and an Action Research Arm Test (ARAT) score ≤17. Inclusion Criteria: Participants were required to have a diagnosis of ischemic stroke and an ARAT score of 17 or less, indicating significant upper extremity impairment.	Intervention 1: Bimanual Arm Trainer (BAT) Group Participants in the BAT group completed a minimum of three training sessions using the bimanual arm trainer. Sessions lasted at least 10 min each and averaged approximately 10	Upper Extremity Function • Action Research Arm Test (ARAT) • Upper Extremity Fugl-Meyer Assessment of Motor Recovery after Stroke (FMA–UE)	Significant Findings: Both groups demonstrated significant improvement in ARAT scores, while the BAT group also showed significant improvement in FMA–UE scores. Nonsignificant Findings: No statistically significant

		Study Setting: 33-bed inpatient rehabilitation facility (IRF)	repetitions per minute. Intervention 2: Participants in the control group received standard occupational therapy services addressing ADLs, IADLs, functional mobility, transfers, and upper extremity deficits.		differences were found between groups, and there was no significant Time × Group interaction effect (p = .63).

Gerhardt et al. (2024) https://scholarworks.wmich.edu/ojot/vol12/iss1/12/	Level of Evidence: Level 4 Study Design: Case report Risk of Bias: low	Participants: n=1; Single-subject design 38-year-old White male 1.5 years post-hemorrhagic stroke involving the basal ganglia Chronic right-sided spastic hemiparesis Right-hand dominant before stroke Severe upper-extremity impairment with 0–1/5 strength on MMT Unable to functionally use the affected upper extremity because of a flexor synergy pattern	Intervention: The intervention consisted of 24 occupational therapy sessions over 10 weeks (45–60 minutes each, approximately 3 sessions per week) using the NuroSleeve. The treatment included: Neuromuscular rehabilitation and reeducation (ROM, weight-bearing,	Canadian Occupational Performance Measure (COPM) ABILHAND Patient-Reported Outcomes Measurement Information System Upper Extremity Short Form 7a (PROMIS UE SF) Action Research	Significant Findings: Functional performance, self-reported ability, and arm use improved with OT + NuroSleeve, especially in grasp and daily activities. Nonsignificant Findings: No change in muscle strength, and some outcomes were limited or inconsistent without the device.

		Inclusion Criteria: Diagnosis of stroke, presence of chronic upper-extremity impairment/hemiparesis, impaired functional use of the affected arm, ability to participate and provide informed consent Study Setting: Not specified; research/occupational therapy rehabilitation setting	motor control activities) Device management and education (safe donning/doffing and use) Occupation-based training using the NuroSleeve Gross motor and fine motor upper-extremity activities (e.g., donning a jacket, opening containers, meal preparation, childcare tasks)	Arm Test (ARAT) Manual Muscle Testing (MMT)	

Hsieh et al (2025) https://www-nature-com.hpu.idm.oclc.org/articles/s41598-025-90698-6	Level of Evidence: Level 4 Study Design: cross-sectional observational design usability study Risk of Bias: Moderate	Participants: N = 15 Patients with stroke were recruited for the clinical usability and feasibility test Inclusion Criteria: (1) Diagnosis of unilateral stroke; (2) Age between 20 and 80 years; (3) Baseline Fugl-Meyer Assessment of the Upper Extremity (FMA-UE) score between 20 and 60; (4) Ability to follow the study instruction and provide verbal feedback on user experiences; (5) Normal or corrected-to-normal vision	Intervention: Use of an immersive VR mirrored-hand system during guided activity sessions Participants used an immersive VR mirrored-hand rehabilitation system through the HTC VIVE Focus 3 headset and controllers. The system provided realistic, interactive 3D environments with	Outcome measures were focused on usability, user experience, and adverse symptoms. Fugl-Meyer Assessment-Upper Extremity (FMA) System Usability Scale (SUS) Self-designed user	Significant Findings: The VR mirrored-hand system demonstrated moderate usability, fair-to-good user experiences, high engagement, and minimal VR sickness. Nonsignificant Findings: Participants showed lower willingness for future use, reported some eye strain and discomfort with the

		Study Setting: Doesn't specify location; A supervised clinical setting	functional upper-extremity activities such as cooking, driving, housework, and shopping. The program included unilateral and bilateral therapy modes, mirrored visual feedback of the affected hand, adjustable difficulty levels, customization options, and performance feedback to enhance	feedback questionnaire Virtual Reality Sickness Questionnaire (VRSQ)	headset, and treatment effectiveness was not assessed.

			engagement and support individualized stroke rehabilitation. Sessions lasted approximately 30–45 minutes with researcher guidance		

Jeong et al. (2026) https://onlinelibrary.wiley.com/doi/10.1155/oti/2901762	Level of Evidence: 3B Study Design: Single-Subject Experimental Study Risk of Bias: Mod-High	Participants: N = 3 patients with chronic stroke diagnosed more than 6 mo prior to the study. Inclusion Criteria: Participants were adults with chronic stroke (>6 mo), independent mobility, adequate cognition (MMSE-K ≥24), upper extremity recovery at Brunnstrom stage 3 or higher, and no cardiopulmonary limitations. Study Setting: General hospital in Jeollabuk-do, South Korea.	Intervention 1: Telerehabilitation-Delivered LSVT-BIG Participants completed a telerehabilitation-delivered LSVT-BIG intervention consisting of sixteen 1-hr sessions over a 4-wk period. Sessions were conducted four times per week from 2:00 PM to 3:00 PM.	Physical Function and Occupational Performance Timed Up and Go Test (TUG) Box and Block Test (BBT) Fugl-Meyer Assessment (FMA) Modified Barthel Index (MBI)	Significant Findings All participants demonstrated improvements in physical function, upper-extremity performance, occupational performance, satisfaction, and independence following telerehabilitation-delivered LSVT-BIG intervention. Nonsignificant Findings None reported.

				Canadian Occupational Performance Measure (COPM)	

Sade (2021) https://www.noropsikiyatriarsivi.com/makaleOzet?id=2391	Level of Evidence: 1B Study Design:Randomized controlled trial (RCT) Risk of Bias: low risk	Participants: n=43 post-stroke patients at the University Hospital Department of Physical and Rehabilitation Medicine Inclusion criteria: 18-70 years old, medically stable, post-stroke interval of at least 3 months, balance score of >40 according to Berg Balance Scale, affected upper extremity of Brunnstrom stage of 3 or higher. Study setting: University Hospital Department of	Intervention Group: n=26. Participants received whole body vibration treatment with a power plate vibration platform, in addition to ROM, strengthening, stretching, and OT. Control Group: n=17. Participants received ROM, strengthening, stretching, and OT.	ROM measurement: Shoulder flexion, shoulder abduction, elbow flexion, elbow extension, wrist extension JTHFT: simulated page turning, lifting small objects, simulated feeding, stacking backgammon pieces, lifting large-	Significant findings: There was significant improvement for the treatment group for elbow extension ROM compared to the control group. The treatment group also improved average performance in all JTHFT categories. In the control group, a similar effect was found in all categories except simulated

		Physical and Rehabilitation Medicine		lightweight objects, lifting large-heavy objects	feeding and stacking backgammon pieces. There was significance in favor of the treatment group for all components of the JTHFT. Nonsignificant findings: Shoulder flexion, shoulder abduction, elbow flexion, wrist extension

Appendix C

Risk-of-Bias Table

Risk-of-Bias Table for Randomized Controlled Trial (RCT) and Non-RCT (Two or More Group Design)										
	Selection Bias (Risk of bias arising from randomization process)			Performance Bias (effect of assignment to intervention)		Detection Bias		Attrition Bias	Reporting Bias	Overall risk-of-bias (low, moderate, high
Citation	Random Sequence Generation	Allocation Concealment (until participants enrolled and assigned)	Baseline difference between intervention groups	Blinding of Participants During the Trial	Blinding of Study Personnel During the Trial	Blinding of Outcome Assessment: Self-reported outcomes	Blinding of Outcome Assessment: Objective Outcomes (assessors aware of intervention received?)	Incomplete Outcome Data (data for all or nearly all participants	Selective Reporting (results being reported selected on basis of the results?)	
Danz, P., Wesselman, K., Bradbury-Faulkner, T., Kvedar, T., Roemmich, R., & Babunovic, M. (2024). Bimanual Arm Trainer Versus Traditional Occupational Therapy Services in Upper Extremity Function. *American*	High risk nonrandomized	High risk No randomization	Low risk No baseline differences between groups	Unclear risk Not reported	Unclear risk Not reported	Unclear risk Not reported	Unclear risk Not reported	Low risk Two participants dropped out	Low risk Both significant and nonsignificant findings	Low risk

Journal of Occupational Therapy, *78*(6), 1–8. https://doi-org.hpu.idm.oclc.org/10.5014/ajot.2024.050784									were reported	
Ase, H., Honaga, K., Tani, M., Takakura, T., Wada, F., Murakami, Y., Isayama, R., Tanuma, A., & Fujiwara, T. (2025). *Effects of home-based virtual reality upper extremity rehabilitation in persons with chronic stroke: A randomized controlled trial. Journal of NeuroEngineering and Rehabilitation, 22*(1), 20. https://doi.org/10.1186/s12984-025-01564-5	Low risk Participants were "randomly assigned.. Using a computerized substitution block method"	Unclear risk Randomization was described, but there was no explanation of concealed allocation procedures (sealed envelopes, third-party assignment, etc).	Moderate/high risk Groups were somewhat imbalanced at baseline. Authors reported the control group had lower FMA-UE and MAL scores at baseline.	High risk Participants could not really be blinded because one group used a VR glove device and the other performed standard exercises. Authors acknowledged blinding difficulty.	High risk Occupational therapists delivering the intervention were aware of group assignment. No therapist blinding was described. (it says they were blind but since	High risk Self-reported measures (MAL-14 exercise logs) could be influenced because participants knew their intervention group	Low risk Outcome assessors were blinded "assessed… by a physician or OT who was unaware of the assignment"	Low risk All 14 participants completed the intervention analysis. No loss to follow-up.	Low risk Outcomes listed in methods were reported in results and trial registration was provided.	Moderate Strengths include randomization, blinded assessors and no attrition. However small sample size, lack of allocation concealment details, inability to blind participants/ personnel, and baseline imbalances

					they are using physical devices that's not really possible)					increase bias risk.
Sade, I.Çekmece, Ç., İnanir, M., & Dursun, N. (2021). The Effect of Whole Body Vibration Treatment on Upper Extremity Functions Compromised by Stroke. *Archives of Neuropsychiatry / Nöropsikiyatri Arşivi*, *58*(3), 189–192. https://doi-org.hpu.idm.oclc.org/10.29399/npa.24753	Low risk Simple randomization was used	Unclear risk Not described	Low risk No significant difference was found between groups during pretreatment testing for any variables	Unclear risk Not described	Unclear risk Not described	N/A	Unclear risk Not described	Low risk Three patients dropped out; 46 total were included in analysis	Low risk Both significant and nonsignificant results reported	Low risk

Note. Categories for risk of bias are as follows: Low risk of bias (+), unclear risk of bias (?), high risk of bias (–). Scoring for overall risk of bias assessment is as follows: 0–3 minuses, low risk of bias (L); 4–6 minuses, moderate risk of bias (M); 7–9 minuses, high risk of bias (H).

Citation. Table format adapted from Higgins, J. P. T., Sterne, J. A. C., Savović, J., Page, M. J., Hróbjartsson, A., Boutron, I., . . . Eldridge, S. (2016). A revised tool for assessing risk of bias in randomized trials. Cochrane Database of Systematic Reviews 2016, Issue 10 (Suppl. 1), 29–31. https://doi.org//10.1002/14651858.CD201601

Risk of Bias for Before-After (Pre-Post) Studies with No Control Group (One Group Design)												
Citation	Study question or objective clear	Eligibility or selection criteria clearly described	Participants representative of real-world patients	All eligible participants enrolled	Sample size appropriate for confidence in findings	Intervention clearly described and delivered consistently	Outcome measures pre-specified, defined, valid/reliable, and assessed consistently	Assessors blinded to participant exposure to intervention	Loss to follow-up after baseline 20% or less	Statistical methods examine changes in outcome measures from before to after intervention	Outcome measures were collected multiple times before and after intervention	Overall risk of bias assessment (low, moderate, high risk)
Gerhardt, N. M., Armstrong, J. P., Serruya, M. D., & Mulcahey, M. J. (2024). Outcomes of the NuroSleeve and occupational therapy on upper limb function of an individual with chronic hemiparesis following a stroke: A case report. *The Open Journal of Occupational Therapy, 12*(1), 1–8. https://doi.org/10.15453/2168-6408.2166	Yes	No Subject was selected from a larger cohort study; how he was selected was not	Yes	N/A This was a case study of a single subject	No Single participant	Yes	Yes COPM, PROMIS UE SF 7a, ABILHAND, ARAT	Yes Assessor was an OT not involved in the intervention	Yes	Yes	No	low

		described										
Hsieh, Y.-W., Howe, T.-H., Lee, M.-T., Tai, R.-Y., & Chen, C.-C. (2025). Design and usability evaluation of an immersive virtual reality mirrored hand system for upper limb stroke rehabilitation. *Scientific Reports, 15*, 5781. https://doi.org/10.1038/s41598-025-90698-6	Yes	Yes	Yes	No Participants were recruited.	Yes However, a sample size calculator did recommend only 10 participants	Yes	Yes Mostly yes, outcome measures were pre-specified and included validated tools which supported reliability and validity. However, the self-designed user feedback questionnaire lacked established validity and	No Researchers provided instruction and assisted participants in the study.	Yes	No	No	High

							reliability.					
Jeong, S.-A., Hong, D.-G., & Choi, I.-T. (2026). *Effectiveness of telerehabilitation-delivered LSVT-BIG on motor function in chronic stroke patients: A single-subject experimental study. Occupational Therapy International, 2026*, 2901762. https://doi.org/10.1155/oti/2901762	Yes	Yes	Yes Chronic stroke patients receiving rehab services.	Unclear Does not specifically state whether all eligible patients were enrolled.	No Only 3 participants included	Yes	Yes	No/ unclear No mention of assessor blinding.	Yes All 3 participants completed the study.	Yes	Yes	Moderate to high Very small sample size and no assessor blinding increase bias risk despite detailed methods and repeated measures design.

Note. Y = yes; N = no; NR = not reported. Scoring for overall risk of bias assessment is as follows: 0–3 N, Low risk of bias (L); 4–8 N, Moderate risk of bias (M); 9–11 N, High risk of bias (H).

Citation. Table format adapted from National Heart Lung and Blood Institute. (2014). Quality assessment tool for before–after (pre–post) studies with no control group. Retrieved from https://www.nhlbi.nih.gov/health-topics/study-quality-assessment-tools