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The Effectiveness of Virtual Reality-Based Exercise Therapy in Enhancing Functional Recovery Post-Stroke: A Systematic Review

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ABSTRACT

Virtual Reality (VR) is no longer just a gaming novelty; it's quickly becoming a game-changer in exercise therapy for stroke recovery. A recent review pulled together data from 26 different studies to see how well VR workouts stack up against traditional rehab methods. The research looked at a broad range of goals—from pain relief and muscle strength to everyday mobility, range of motion, and quality of life. Overall, the verdict is encouraging: VR therapy appears to give stroke patients a noticeable boost in motor skills, balance, mobility, and strength. One of the biggest selling points of VR is the way it keeps users interested. Patients are generally more engaged and likely to stick with their exercise routine when they can don a headset or grab a motion-sensitive controller. That extra excitement turns rehab into something closer to a video game and away from the sometimes tedious exercises seen in many clinics. Several commercially available platforms, like the Nintendo Wii and the Microsoft Kinect, are now routinely used for home-based rehab. Because these systems can be set up in a living room, patients can keep practicing even when they're away from the hospital or therapy center. Studies have found that these devices do help improve muscle strength and expand range of motion. Of course, it's not all smooth sailing. Some research noted that the thrill of VR therapy can wear off after a while, leading to lower enjoyment and, in turn, reduced adherence. This dip in enthusiasm is something to keep an eye on as clinics look to integrate these high-tech tools into their rehabilitation programs. The results of the review point to two main takeaways for the future of virtual reality stroke therapy. First, researchers need to design treatments that hold patients' attention for longer periods. Second, they must track how well these therapies really work over many months or even years after the initial sessions. Both steps are crucial if VR is to become

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a routine part of recovery programs. Another challenge the review raises is money—specifically, the high cost of VR headsets and motion-tracking gloves. While many studies show that the technology produces real benefits, those same benefits are hard to access for families who live in areas with tight healthcare budgets. If patients cannot afford the gear, clinics cannot offer the treatment. That gap makes it vital for engineers and health policy experts to team up and create budget-friendly systems that still deliver results. Despite these hurdles, the overall picture is bright. When virtual reality exercise is used after a stroke, patients often regain movement faster and report feeling more motivated than with traditional therapy alone. As researchers tackle the problems of engagement and affordability, VR looks ready to change the way the world treats stroke survivors.

Keywords

Virtual Reality, Exercise Therapy, Stroke Rehabilitation, Functional Recovery, Pain Management, Range of Motion, Muscle Strength, Motivation, Home-Based Rehabilitation, VR

Introduction

Rehab is really all about helping people get their movement and freedom back after an injury or serious illness. For a long time, therapists have mixed exercises, special machines, and hands-on care to make that happen. Those tools are useful, but the whole journey can drag on for months and become exhausting—both for the muscles and the mind. That kind of fatigue can chip away at a person's drive to keep doing the home workouts their therapist expects. When motivation slips, so does improvement, and life after rehab often turns out less satisfying than everyone hoped (Ali et al., 2023).

Exercise therapy lies at the center of nearly every rehab plan. Doctors lean on it for problems ranging from broken bones to heart trouble and even diabetes (Sumner et al., 2023). Still, no amount of reps, sets, or fancy equipment will work miracles if the patient stays on the couch. Real success depends on whether someone shows up—not only in the clinic, but in their own living room as well.

More and more people are choosing to do their rehab exercises at home instead of heading to a clinic. On the surface that sounds great—patients can train whenever it suits them and stay in a space they already know and like. Yet keeping them interested and committed over weeks and months is still a tricky puzzle. Research shows that when clinicians use smart motivational techniques, patients stick with their routines longer and push just a little harder, and that extra effort often leads to faster and better recovery. Enter virtual reality, or VR. This technology pulls users into a colorful, interactive world that feels less like work and more like play, and that makes them much more likely to show up for each session.

Virtual Reality, or VR for short, has moved way beyond the gaming room. These days doctors and therapists strap on headsets and use high-tech, computer-made worlds to help patients get better after injuries. When someone putting on the goggles suddenly finds themselves standing on a virtual beach or inside a busy city, even the most boring exercise can start to feel fun (Shen et al., 2023). The system repeats each movement over and over, giving instant signals when they do it right and lighting up the scene so

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they want to keep going. That steady shot of encouragement keeps people more interested than old-school rehab ever could (Zhang et al., 2024). What really sets VR apart is how quickly it adapts: the therapist can tweak the challenge in real time, track progress with a quick click, and move on the moment they see a patient is ready (Chen et al., 2022; De Araújo et al., 2019).

In recent years, scientists have been investigating how virtual reality (VR) can support people in rehab for problems that range from weak muscles and shaky balance to recovery after a stroke (Aderinto et al., 2023). For example, rehabilitation teams have started using motion-sensing platforms, such as Kinect, to guide shoulder exercises. Both patients and therapists say the approach is effective and actually fun, so motivation tends to stay high. Hernandez et al. (2022) and Huang et al. (2025) report that similar VR systems are now showing up in home therapy kits, enabling people with long-term conditions like lower back pain to finish workouts they look forward to instead of dreading. Research finds that those sticking to these VR programs usually build more muscle strength, gain better balance, and move more freely than peers following traditional treatment routes (Lesmana et al., 2023).

This systematic review aims to examine, in detail, how well VR-based exercise therapy performs, especially for stroke survivors. Although experts have tested the tech from many perspectives, a clear, overarching view of its home-use benefits is still missing. That's why we're focusing on finding out if virtual reality actually helps people recover after a stroke. We want to see how involved they get while using the tech, how much their everyday movements improve, and whether they keep coming back to the therapy week after week.

Objective

This review takes a hard look at the question most people have when they hear “virtual reality” and “stroke therapy” in the same sentence. Does strapping on goggles and waving your arms actually help stroke survivors get stronger? By diving into several studies side-by-side, we're trying to figure out if VR gives rehab a meaningful lift, what kinds of gear doctors are using, and whether patients can still benefit from these high-tech toys when the official sessions wrap up.

Research Questions

This article dives into a few key questions about virtual reality (VR) exercise therapy and the fresh ways it is helping stroke survivors get back on their feet.

The first question people usually ask is whether it works. Research has already pointed out that mixing VR workouts with traditional rehab can lead to noticeable gains in strength, coordination, and—perhaps most important—motivation. When patients step inside a colorful virtual world, simple tasks that may seem dull in the clinic suddenly take on a playful edge. The software keeps an eye on each candidate's performance in real time, allowing therapists to nudge up the challenge whenever a routine starts to feel easy.

Researchers have cast a wide net beyond stroke. Trials have explored VR therapy for spinal cord injuries, traumatic brain injuries, multiple sclerosis, and even Parkinson's disease. Across all these conditions, the immersive experience turns repetitive practice

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Print ISSN

3007-3189

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into something that feels less like hard labor and more like game time.

What equipment should you picture doctors using? The bulk of outpatient programs run on consumer-friendly headsets such as the Oculus Quest lineup, HTC Vive, and PlayStation VR. These options hit a sweet spot between clear visuals, low lag, and reasonable cost. For institutions with extra cash, premium gear like the Microsoft HoloLens is starting to appear in dedicated hospital labs.

The debate over commercial games versus clinical software is also heating up.

When virtual reality (VR) first made its way into rehab clinics, many therapists used off-the-shelf games because they were quick to set up and, honestly, a lot of fun. That still happens, but dedicated rehab programs like Rehabilitate and Stroke Reality are starting to take the spotlight. These platforms are built around the challenges stroke survivors typically face. They let therapists pick the right exercises, adjust difficulty as patients improve, and automatically send session reports to electronic health records. In short, everything has started running a bit more smoothly.

Home is probably the one place where VR can really show what it can do. Researchers are now mailing headsets to patients so they can practice when it fits their daily schedule. Early trial results are encouraging: when family members join in, people stick with the program much longer.

Taken together, these findings make one thing clear: VR exercise therapy is becoming an important part of stroke recovery, offering users more control and better, real-time feedback than traditional methods.

Materials and Methods

Databases and Search Strategy

This systematic review followed the PRISMA guidelines for scoping reviews, as laid out by Demeco et al. in 2023. To collect data, the research team searched several major databases: MEDLINE (via PubMed), Scopus, Web of Science, EMBASE, IEEE Xplore, and the Cochrane Database of Systematic Reviews. They also looked at grey literature through OpenGrey, Google Scholar, and by manually checking reference lists of existing reviews. The search combined these terms: `[(exercise\* OR physical activity\*) AND (virtual reality OR VR) AND (rehabilitation)]`, which helped them zero in on relevant studies.

Previous reviews mostly concentrated on neurodegenerative diseases and gait or balance therapy. Because of this, the current work decides to widen its view and focus also on stroke rehabilitation—a topic earlier studies have not explored in much detail. The criteria for what studies were included are shown in Table 1. Two authors independently checked each paper for relevance; if they disagreed, they talked it over and sometimes brought in a third author for extra input. Once the initial screens were done, they retrieved full-text articles and re-examined each one to see if it truly fit the review's goals.

Study Selection

After the electronic search was finished, all the records were brought into EndNote X6 and any duplicate entries were cleaned up. The review followed a three-step screening process: first we looked at the titles, next the abstracts, and finally the full texts. At step

Online ISSN

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Print ISSN

3007-3189

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one, if a title clearly didn't fit our goals, it was set aside right away. Those that passed moved on to abstract review, and only the studies that still matched our criteria then went forward to the full-text examination. Whenever the authors couldn't agree about whether a paper should be included, they talked it over together; if they still couldn't settle it, a third team member was brought in for a second opinion. After this careful triage, we combed through the chosen articles one last time to make sure they truly satisfied all of our inclusion standards for the systematic review.

Quality Assessment

To judge how reliable the studies in this review really are, we used the PEDro scale. PEDro stands for Physiotherapy Evidence Database, and it has become a trusted grading system for trials, especially randomized controlled ones. The scale includes eleven simple yes-or-no questions split into two parts: ten check whether the study keeps things fair and unbiased—what we call internal validity—and one looks at how generalizable the findings might be, or external validity. After answering the questions, we grouped the studies by score: a total of nine to ten points marks them as “methodologically excellent,” six to eight earns them a “good” label, four to five lands them in the “fair” zone, and anything below four is rated “poor” quality (Asadzadeh et al., 2021). Whenever we disagreed over a score or data detail, we talked it through until we reached a shared decision.

Results

The first round of our literature search turned up nearly three thousand articles—exactly 2,887 to be exact. Once we sorted out the duplicate entries, the number dropped to 2,074 pieces that we could actually read more closely. During the first screening pass, we quickly ruled out 1,497 studies just by skimming their titles. Then, after taking a look at the abstracts, another 526 fell off the list. Once we finished applying all our inclusion and exclusion rules, we were left with a smaller group of papers that met our needs and were ready for deeper analysis.

Table 1: Inclusion and Exclusion Criteria for the Review

Inclusion Criteria	Exclusion Criteria
English language articles	Studies focused on neurodegenerative diseases
Papers recruiting participants across a wide range of ages	Studies focusing on neurological diseases
Studies that include Virtual Reality interventions	Studies related to cardiac diseases
Studies using VR for exercise therapy	Books, standards, and protocols
Studies focused on rehabilitation or treatment using VR	Reviews and editorial papers
Studies related to rehabilitation in stroke recovery	Studies related to vestibular rehabilitation
Studies involving balance and gait rehabilitation in stroke patients	Studies using VR exclusively for rehabilitation of amputations

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

Results

Following the application of the inclusion and exclusion criteria, a total of 51 full-text papers were evaluated. Of these, 25 studies were excluded either because they did not meet the inclusion criteria or were removed according to the established exclusion criteria. Ultimately, 26 studies that satisfied the criteria for inclusion were examined and incorporated into this review.

Quality Assessment

The quality of the included studies was evaluated using the Physiotherapy Evidence Database (PEDro) scale. The quality scores for the selected studies ranged from 4 to 8. The mean score for the studies included in this review was 5.576, indicating that the majority of the studies were of "good" or "fair" quality. Specifically, 13 studies were classified as "good quality," and the remaining 13 were categorized as "fair quality."

Data Extraction and Taxonomy of VR Intervention in Exercise Therapy (ET)

The characteristics and key details of the included studies are summarized in Appendix 2 (Table A.2). A thorough analysis of the selected papers led to the identification and classification of five core topics related to VR-based exercise therapy (Fig. 1). The following sections describe these core topics in detail.

VR Exercise Therapy in Different Disorders

VR-based exercise therapy has been employed for rehabilitation following a variety of medical conditions and disorders. These include musculoskeletal issues, neurological impairments, and chronic pain conditions. The major disorders studied with VR interventions include functional ankle instability (FAI), chronic low back pain, fibromyalgia, subacromial impingement syndrome, post-surgical recovery (such as knee replacement and shoulder rehabilitation), and mobility restrictions caused by orthopedic or internal medicine conditions. Furthermore, conditions such as chronic neck pain, anterior cruciate ligament (ACL) injury, frozen shoulder, and post thoracotomy rehabilitation in lung cancer patients have also been treated using VR-based rehabilitation systems. These studies demonstrate the versatility of VR in addressing a wide range of physical rehabilitation needs.

Effectiveness of VR-Based Exercise Therapy for Rehabilitation

Recent research suggests that virtual reality (VR) is helping people get more out of their rehab exercise programs. Across several studies, doctors and therapists noted that patients using VR experienced less pain, moved better, gained strength, and overall felt like their day-to-day lives improved. The headsets also seemed to keep people excited about their workouts, which is no small thing when it comes to sticking with a routine. Even so, a few reports paint a more cautious picture. For instance, Kim and colleagues found in 2023 that after several weeks, some patients in the VR group started to lose interest; their motivation, enjoyment, and attendance slipped. Findings like these remind researchers that they still need to fine-tune VR programs and track how well they hold up over the long haul.

Online ISSN

3007-3197

Print ISSN

3007-3189

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VR Hardware in VR-Based Exercise Therapy

Researchers have tested a range of virtual-reality gear in their studies. The two most common devices were the Nintendo Wii and the Kinect gaming system. Both consoles were repurposed to build rich therapy settings that motivate users to move and take part in their rehab. Each system tracks movement in its own way, offers real-time feedback, and shows exercises through lively, interactive screens—features that help lift the overall rehab experience (Hao et al., 2023).

Accessibility of VR Products for the General Public

Many recent studies—about 73 percent of the twenty-six we looked at—used off-the-shelf virtual reality systems for rehab work. The Nintendo Wii Fit games stood out the most. Because those games are easy to find almost anywhere, they let people do their exercises at home without needing a fancy lab (Kiper et al., 2022). That availability matters. When patients can keep practicing on their own, they gain more independence and boost their chances of a lasting recovery.

Table 2: VR-Based Exercise Therapy for Various Treatment Objectives

Treatment Objective	Percent of Studies	References
Pain Management	16%	(De Araújo et al., 2019; Sumner et al., 2023)
Functional Ability	18%	(Choy et al., 2023; Rose Sin Yi., 2024)
Range of Motion (ROM)	12%	(Amin et al., 2024)
Muscular Strength	15%	(Asadzadeh et al., 2021)
Quality of Life Improvement	10%	(Matys-Popielska et al., 2024)
Motivation and Adherence	9%	(Alhwoaimel et al., 2024)
Post-Surgical Recovery	20%	(Chen et al., 2022)

Online ISSN

3007-3197

Print ISSN

3007-3189

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A new review of the latest studies shows that virtual reality, or VR, can be a game changer for stroke survivors and other people with physical disabilities who are trying to get stronger. Therapists report seeing real gains across the board—reduced pain, improved muscle strength, easier everyday movement, and an all-round better quality of life. The standout benefit so far seems to be the spike in motivation. When patients put on a VR headset and enter a colorful, interactive world, they usually work harder and keep moving longer. And in rehabilitation, simply sticking with the exercises is often the toughest part. Still, some scientists are cautious and wonder whether the positive effects last once the novelty wears off. They are asking for longer-term studies to find out if the excitement and the results hold up after the first few weeks of treatment.

Fig. 1. key mechanisms for using VR for exercise therapy.

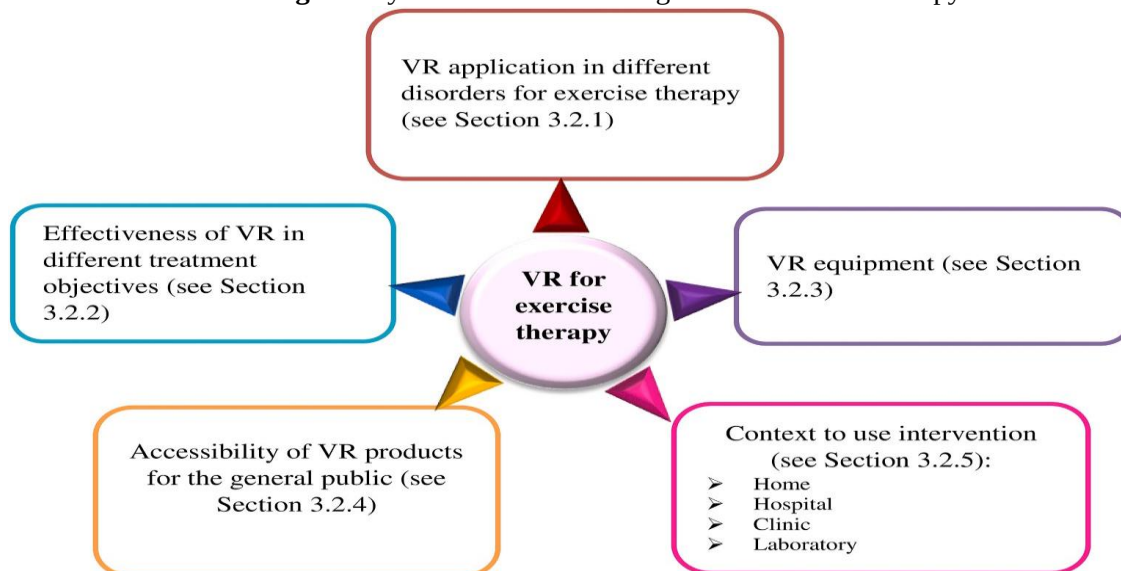


Table 3: VR Hardware in Exercise Therapy

VR Hardware	Percent of Studies	References
Nintendo Wii Fit	42%	(Asadzadeh et al., 2021; De Araújo et al., 2019; Leong et al., 2022; Qian et al., 2020)
Kinect	23%	(Chen et al., 2022; Zhang et al., 2023; Shih et al., 2024)
Head-Mounted Display (HMD)	8%	(González et al., 2024)
MarVAJED Device	4%	(Soleimani et al., 2024)
Video Glasses (iPod)	4%	(Wang et al., 2024)
WIMU Sensors	4%	(Gunawan et al., 2024)
PlayStation	4%	(Wang et al., 2022)
NA	8%	(Choy et al., 2023; Rose Sin Yi., 2024)

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

Table 4: Studies That Used Accessible VR Products (VR-Based Games or Video Clips)

Author(s)	Which Available VR Products Were Used
Kim et al. (2018),	Nintendo Wii Fit Plus based games: Strengthening exercises (lunges, single-leg extensions, soccer, etc.)
Yilmaz et al. (2017),	Video clip in a sitting position (Vita Digital Productions, NC, USA)
Singh et al. (2017),	Wii-based Sports software games: Tennis, bowling, and boxing
Pekyavas & Ergun (2017),	Nintendo Wii-based games: Shoulder elevation, boxing, tennis, and avatar-based exercises
Oesch et al. (2017),	Kinect-based exergames: The GameUp project (mini-games for balance, leg strength, flexibility)
Tsuda et al. (2016)	Nintendo Wii Fit-based games: Hula Hoop and Basic Step activities
Martinho et al. (2016)	Wii Fit Plus™ CD game: Lotus Focus™, Penguin Slide™, Table Tilt™, Balance Bubble™
Lee et al. (2016)	Nintendo Wii-based games: Yoga (Palm Tree, Warrior), strength training (Balance Bridge), balance games
Karahan (2016)	Kinect-based games: Kinect Adventures, Kinect Sports, Soccer, Tennis, Skiing, Golfing, Volleyball

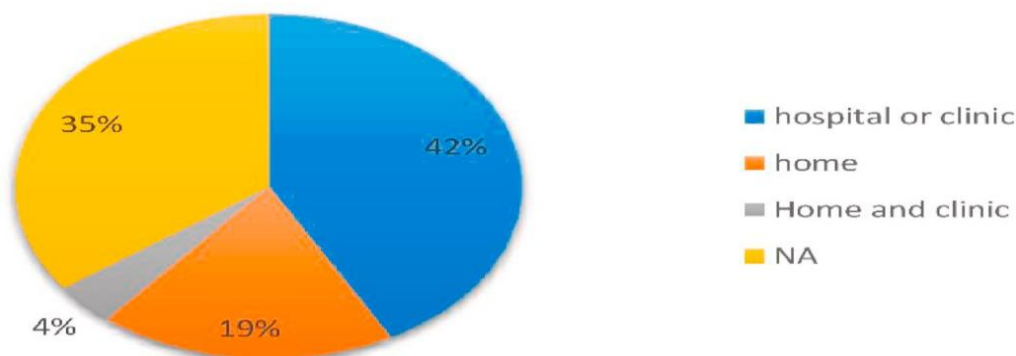


Figure 2: The Place to Apply VR Intervention in Rehabilitation

The chart below breaks down where different virtual reality (VR) programs were carried out. You'll notice that the majority of research took place inside clinics and hospitals, making those settings the most common. Home settings also hosted a good number of studies, showing that VR can be just as useful outside of a medical facility. A few studies, however, didn't mention exactly where the intervention happened, so that information is missing.

Pie Chart: Distribution of VR Intervention Locations

Clinical or Hospital Settings: 42% (11 studies)

Home Environment: 19% (5 studies)

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

Unknown Location: 35% (9 studies)

This distribution reflects the growing trend of home-based VR interventions, which offer patients the flexibility to engage in rehabilitation exercises from the comfort of their homes.

Discussion

Virtual Reality, or VR, is becoming a game-changer in exercise therapy for people in rehab. Because the technology keeps getting better, more clinics are adding VR to their recovery plans and patients are seeing real benefits. Recent studies show that VR-focused workouts help stroke survivors gain back their ability to move, expand their range of motion, build muscle strength, and lower their overall disability score.

One great example comes from Chen and his team in 2022. They put stroke patients through their paces using Nintendo's Wii console, blending shoulder lifts, boxing drills, bowling matches, and tennis swings—all guided by a fun on-screen avatar (Asadzadeh et al., 2021). Other researchers have turned to Microsoft's Kinect system. The GameUp project, for instance, runs specially designed exergames that spotlight balance, leg power, and flexibility. Tsuda's group in 2016 and Martinho's team the same year reported similar gains in balance and flexibility with the Wii Fit platform. Lee and colleagues in 2016 went even further by mixing yoga, strength, and balance games together, proving just how flexible VR exercise programs can be.

A major benefit of virtual reality (VR) in rehab, especially for stroke survivors, is how well it helps with pain control, range of motion, and muscle strength. Because the programs feel more like a game than a workout, dozens of studies say patients enjoy the sessions more, feel their quality of life improve, and stay motivated to keep moving. On the flip side, research from Oesch and colleagues in 2017 showed that some users lost interest and skipped sessions as the weeks rolled on. That finding, plus others from Wiley and his team in 2022, remind us that keeping patients engaged over the long haul is still the biggest challenge.

Recent research backs up what earlier summaries have already suggested: virtual reality (VR) can help patients with a range of diseases and conditions not covered here. A review by Dockx and colleagues in 2016, for example, showed that VR boosted step and stride length, balance, gait, and the ability to handle everyday tasks in people living with Parkinson's disease (Rubio et al., 2022). Similar findings popped up in stroke rehab studies, where Viñas-Diz and Sobrido-Prieto pointed out big gains in upper-arm movement thanks to VR exercises (Dixit et al., 2024). Iruthayarajah and his team also reported in 2016 that stroke patients who trained in a VR environment showed better balance and mobility than those who stuck to traditional routines (Huang et al., 2022). Still, the picture isn't entirely rosy. Some studies argue that VR-based workouts don't edge out standard rehab. Kim and co-authors in 2018, for instance, noted that patients using VR improved less when it came to muscle strength than those going through classical rehabilitation. Their findings hint that VR is a handy extra tool for recovery, but it shouldn't completely replace time-tested methods. Instead, the best approach may be to use both together.

One interesting takeaway from the review is just how easy many VR rehab products

Online ISSN

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Print ISSN

3007-3189

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are to get your hands on. Roughly 73 percent of the studies relied on off-the-shelf systems like Wii Fit and Microsoft Kinect, showing that these setups are both affordable and already sitting in a lot of living rooms (Hegazy et al., 2022; Barger et al., 2023; Lin et al., 2023; Hao et al., 2023; Leong et al., 2022; Kang et al., 2023; Dąbrowska et al., 2023; Rodríguez-Hernández et al., 2023; Huang et al., 2022). Wii Fit games popped up in particular because they're cheap and people are already familiar with them. Still, that accessibility gap yawns wide in low-income areas, where even the modest price of these gadgets can keep them out of reach. That's why researchers keep stressing the need for budget-friendly VR options in rehab programs.

Right now, virtual reality therapy is getting a lot of attention because its early results look good. However, we are still waiting for longer follow-up studies that show whether these benefits last over time. Out of the 26 research papers we reviewed, only five bothered to check in with participants weeks or even months later. That short window—really just a few weeks up to three months—hardly counts as “long-term” when it comes to rehab success. Without deeper, ongoing assessments, we can't be sure if VR helps people return to their everyday lives or if the gains simply fade once the goggles come off (De Araújo et al., 2019; Leong et al., 2022; Qian et al., 2020).

Scientists also have to tackle some practical issues that still limit how VR is used in therapy. One glaring problem is that nearly every study has left out people who are blind. Because of this gap, the quality scores of those studies drop significantly (Asadzadeh et al., 2021). If developers start building systems that work for blind users, the therapy could reach a much wider audience. On top of that, even when VR beats traditional methods on paper, researchers keep complaining that there are no clear, agreed-upon guidelines for how to set up the tech or measure the results. Until those issues get ironed out, it's hard for clinics to know what the “best practice” really is.

Conclusion

A fresh review published last week is creating a buzz in the rehabilitation community by spotlighting virtual reality exercise programs for stroke survivors. After sifting through multiple studies, the authors concluded that VR therapy delivers more than just a fun twist on rehab; it actually drives some impressive recovery figures. Patients who worked out in a virtual setting reported less discomfort, greater muscle strength, quicker mastery of daily tasks, and a wider range of motion. They also voiced higher satisfaction with their treatment and a stronger sense of motivation to keep moving forward. Because consoles like the Nintendo Wii and Xbox Kinect fall well within most family budgets, many people can easily set them up in the living room.

Of course, the researchers did not paint an entirely rosy picture. The biggest caveat is the lack of long-term data; without it, nobody can say how permanent these benefits turn out to be. They also acknowledged that cash-strapped clinics and low-income households may still find the equipment out of reach. Even so, the overall trend leans toward using VR as a complementary tool alongside traditional therapy, helping to turn an otherwise dreary rehab routine into something patients genuinely look forward to.

More and more research keeps showing that virtual reality can be a real game-changer for people working to regain movement and balance after a stroke.

Limitations

Online ISSN

3007-3197

Print ISSN

3007-3189

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Limited Long-Term Follow-Up Studies: One big gap in the studies we looked at is that none of them tracked participants over the long haul. Follow-up times were usually pretty short—only a few weeks up to three months. Because of that, we still don't know if the benefits of VR-based exercise therapy last once people stop using the system every day.

Quality Assessment Tools: The existing quality-assessment instruments employed in the studies examined here did not fully accommodate the specific characteristics of virtual-reality interventions, especially when the participants included individuals with sensory impairments such as blindness. This shortcoming has the potential to distort quality ratings and to limit the relevance of virtual-reality applications for a wider spectrum of users.

Variability in VR Devices: The studies examined in this review utilized a range of virtual reality hardware, from Nintendo Wii and Microsoft Kinect to a variety of head-mounted displays. Because each platform affords different types of interaction and feedback, the intervention protocols tended to differ considerably from one project to the next. This lack of uniformity complicates efforts to standardize outcomes and to identify which VR systems yield the greatest benefits in a rehabilitation setting.

Cost Accessibility: While numerous investigations have employed off-the-shelf virtual-reality platforms, the expense associated with certain peripherals—most notably the Nintendo Wii and the Kinect—remains a significant hurdle for extensive uptake, particularly in low-income and resource-constrained environments. Resolving this challenge will be essential if the field hopes to achieve genuinely universal access to immersive technologies.

Recommendations

Long-Term Follow-Up Studies: Subsequent investigations ought to incorporate extended follow-up evaluations so as to assess the enduring effects of virtual-reality exercise therapy on patients' functional recovery and overall rehabilitation results. By doing so, researchers will be positioned to ascertain whether the advantages noted in the initial treatment phase continue to hold significance in the longer term.

Development of Inclusive Quality Assessment Tools: Quality assessment instruments employed in virtual reality rehabilitation research need to be modified to reflect the distinct features of VR-based therapies. Traditional evaluation frameworks often overlook elements such as immersive interaction design, real-time feedback loops, and multi-sensory stimulation. Consequently, there is a pressing need for broader assessment tools that can comprehensively gauge the efficacy of virtual environments for people with disabilities, especially patients with sensory challenges like complete blindness or low-vision disorders.

Standardization of VR Protocols: For virtual reality interventions in rehabilitation to achieve greater reliability, subsequent research needs to agree on specific platforms and treatment protocols. By creating a shared framework for VR therapy, investigators will be able to compare results more meaningfully and clinicians will gain clearer direction on effective implementation.

Cost-Effective VR Solutions: Researchers and manufacturers alike ought to prioritize the creation of affordable virtual reality platforms that users can seamlessly integrate into home-based rehabilitation programs. Lowering the price point of VR equipment is essential if these

Online ISSN

3007-3197

Print ISSN

3007-3189

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interventions are to reach a broader segment of the population, particularly in low-income and underserved communities.

If these challenges are met head-on and the outlined strategies put in place, upcoming studies stand to significantly boost both the efficacy and accessibility of VR-driven exercise therapy. In turn, that progress could lead to markedly better outcomes for stroke survivors and for anyone dealing with similar physical limitations.

References

- Ali, F., Suleman, R., Noor, A., Ahmad, I., Shakeel, M., & Aqeel, M. (2023). *Effectiveness of a Virtual Reality-Based Rehabilitation Program versus Conventional Physical Therapy in Improving Motor Function and Balance in Stroke Survivors: A Randomized Controlled Trial*.
- Shen, J., Gu, X., Yao, Y., Li, L., Shi, M., Li, H., ... & Fu, J. (2023). Effects of virtual reality-based exercise on balance in patients with stroke: a systematic review and meta-analysis. *American journal of physical medicine & rehabilitation*, 102(4), 316-322.
- Chen, J., Or, C. K., & Chen, T. (2022). Effectiveness of using virtual reality-supported exercise therapy for upper extremity motor rehabilitation in patients with stroke: systematic review and meta-analysis of randomized controlled trials. *Journal of medical Internet research*, 24(6), e24111.
- Aderinto, N., Olatunji, G., Abdulbasit, M. O., Edun, M., Aboderin, G., & Egbunu, E. (2023). Exploring the efficacy of virtual reality-based rehabilitation in stroke: a narrative review of current evidence. *Annals of medicine*, 55(2), 2285907.
- Huang, J., Wei, Y., Zhou, P., He, X., Li, H., & Wei, X. (2025). Effect of Home-Based Virtual Reality Training on Upper Extremity Recovery in Patients With Stroke: Systematic Review. *Journal of Medical Internet Research*, 27, e69003.
- Hernandez, A., Bubyr, L., Archambault, P. S., Higgins, J., Levin, M. F., & Kairy, D. (2022). Virtual reality-based rehabilitation as a feasible and engaging tool for the management of chronic poststroke upper-extremity function recovery: Randomized controlled trial. *JMIR Serious Games*, 10(3), e37506.
- Lesmana, I. P., Destarianto, P., Widiawan, B., Suryana, A., & Hossain, F. (2023). The effectiveness of virtual reality cycling exercise towards the motoric and cardiorespiratory functions of post-stroke patients. *Physiotherapy Quarterly*, 32(2).
- Leong, S. C., Tang, Y. M., Toh, F. M., & Fong, K. N. (2022). Examining the effectiveness of virtual, augmented, and mixed reality (VAMR) therapy for upper limb recovery and activities of daily living in stroke patients: a systematic review and meta-analysis. *Journal of neuroengineering and rehabilitation*, 19(1), 93.
- Zhang, J., Yang, J., Xu, Q., Xiao, Y., Zuo, L., & Cai, E. (2024). Effectiveness of virtual reality-based rehabilitation on the upper extremity motor function of stroke patients: A protocol for systematic review and meta-analysis. *PloS one*, 19(11), e0313296.
- Demeco, A., Zola, L., Frizziero, A., Martini, C., Palumbo, A., Foresti, R., ... & Costantino, C. (2023). Immersive virtual reality in post-stroke rehabilitation: a systematic review. *Sensors*, 23(3), 1712.
- Hegazy, R., Alkhateeb, A., & Abdelmohsen, A. (2022). Impact of a virtual reality program on post-stroke upper limb function: a randomized controlled trial. *Physiotherapy Quarterly*, 30(4), 81-86.
- Bargeri, S., Scalea, S., Agosta, F., Banfi, G., Corbetta, D., Filippi, M., ... & Gianola, S. (2023). Effectiveness and safety of virtual reality rehabilitation after stroke: an overview of systematic reviews. *EClinicalMedicine*, 64.
- Lin, C., Ren, Y., & Lu, A. (2023). The effectiveness of virtual reality games in improving

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

- cognition, mobility, and emotion in elderly post-stroke patients: a systematic review and meta-analysis. *Neurosurgical review*, 46(1), 167.
- Hao, J., Yao, Z., Harp, K., Gwon, D. Y., Chen, Z., & Siu, K. C. (2023). Effects of virtual reality in the early-stage stroke rehabilitation: A systematic review and meta-analysis of randomized controlled trials. *Physiotherapy theory and practice*, 39(12), 2569-2588.
- Kang, D., Park, J., & Eun, S. D. (2023). Home-based virtual reality exergame program after stroke rehabilitation for patients with stroke: A study protocol for a multicenter, randomized controlled trial. *Life*, 13(12), 2256.
- Dąbrowska, M., Pastucha, D., Janura, M., Tomášková, H., Honzíková, L., Baníková, Š., ... & Fiedorová, I. (2023). Effect of virtual reality therapy on quality of life and self-sufficiency in post-stroke patients. *Medicina*, 59(9), 1669.
- Rodríguez-Hernández, M., Polonio-López, B., Corregidor-Sánchez, A. I., Martín-Conty, J. L., Mohedano-Moriano, A., & Criado-Álvarez, J. J. (2023). Can specific virtual reality combined with conventional rehabilitation improve poststroke hand motor function? A randomized clinical trial. *Journal of NeuroEngineering and Rehabilitation*, 20(1), 38.
- Huang, J., Ji, J. R., Liang, C., Zhang, Y. Z., Sun, H. C., Yan, Y. H., & Xing, X. B. (2022). Effects of physical therapy-based rehabilitation on recovery of upper limb motor function after stroke in adults: a systematic review and meta-analysis of randomized controlled trials. *Annals of palliative medicine*, 11(2), 52131-52531.
- Dixit, P., Phalswal, U., Kalal, N., & Srivastava, S. P. (2024). Effectiveness of virtual reality-supported exercise therapy in improving upper extremity function and activities of daily living among patients after stroke: a systematic review of randomized control trials. *Osong public health and research perspectives*, 15(3), 189.
- Aguilera-Rubio, Á., Cuesta-Gómez, A., Mallo-López, A., Jardón-Huete, A., Oña-Simbaña, E. D., & Alguacil-Diego, I. M. (2022). Feasibility and efficacy of a virtual reality game-based upper extremity motor function rehabilitation therapy in patients with chronic stroke: A pilot study. *International journal of environmental research and public health*, 19(6), 3381.
- Wiley, E., Khattab, S., & Tang, A. (2022). Examining the effect of virtual reality therapy on cognition post-stroke: a systematic review and meta-analysis. *Disability and Rehabilitation: Assistive Technology*, 17(1), 50-60.
- Wang, L., Chen, J. L., Wong, A. M., Liang, K. C., & Tseng, K. C. (2022). Game-based virtual reality system for upper limb rehabilitation after stroke in a clinical environment: systematic review and meta-analysis. *Games for health journal*, 11(5), 277-297.
- Al-Whaibi, R. M., Al-Jadid, M. S., ElSerougy, H. R., & Badawy, W. M. (2022). Effectiveness of virtual reality-based rehabilitation versus conventional therapy on upper limb motor function of chronic stroke patients: a systematic review and meta-analysis of randomized controlled trials. *Physiotherapy theory and practice*, 38(13), 2402-2416.
- Gunawan, H., Gunawan, I., Hambarsari, Y., Danuaji, R., Hamidi, B. L., & Benedictus, B. (2024). Virtual Reality Intervention for Improving Cognitive Function in Post-Stroke Patient: A Systematic Review and Meta-Analysis. *Brain Disorders*, 100152.
- Wang, S., Meng, H., Zhang, Y., Mao, J., Zhang, C., Qian, C., ... & Guo, L. (2024). The effect of virtual reality-based rehabilitation on mental health and quality of life of stroke patients: a systematic review and meta-analysis of randomized controlled trials. *Archives of physical medicine and rehabilitation*.
- Soleimani, M., Ghazisaee, M., & Heydari, S. (2024). The efficacy of virtual reality for upper limb rehabilitation in stroke patients: a systematic review and meta-analysis. *BMC Medical Informatics and Decision Making*, 24(1), 135.
- Shih, C. H., Lin, P. J., Chen, Y. L., & Chen, S. L. (2024). A Post-Stroke Rehabilitation System

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

- With Compensatory Movement Detection Using Virtual Reality and Electroencephalogram Technologies. *IEEE Access*.
- Zhang, B., Wong, K. P., Kang, R., Fu, S., Qin, J., & Xiao, Q. (2023). Efficacy of robot-assisted and virtual reality interventions on balance, gait, and daily function in patients with stroke: a systematic review and network meta-analysis. *Archives of physical medicine and rehabilitation*, 104(10), 1711-1719.
- Chen, X., Liu, F., Lin, S., Yu, L., & Lin, R. (2022). Effects of virtual reality rehabilitation training on cognitive function and activities of daily living of patients with poststroke cognitive impairment: a systematic review and meta-analysis. *Archives of Physical Medicine and Rehabilitation*, 103(7), 1422-1435.
- Blázquez-González, P., Mirón-González, R., Lendínez-Mesa, A., Luengo-González, R., Mancebo-Salas, N., Camacho-Arroyo, M. T., & Martínez-Hortelano, J. A. (2024). Impact of virtual reality-based therapy on post-stroke depression: a systematic review and meta-analysis of randomized controlled trials. *Worldviews on Evidence-Based Nursing*, 21(2), 194-201.
- Alhwoaimel, N. A., Alenazi, A. M., Alhowimel, A. S., Alqahtani, B. A., & Alshehri, M. M. (2024). Effects of trunk exercises using virtual reality technology on trunk performance and impairment post stroke: a systematic review and meta-analysis. *Topics in stroke rehabilitation*, 31(4), 399-408.
- Matys-Popielska, K., Popielski, K., & Sibilska-Mroziewicz, A. (2024). Study of the possibility of using virtual reality application in rehabilitation among elderly post-stroke patients. *Sensors*, 24(9), 2745.
- Amin, F., Waris, A., Syed, S., Amjad, I., Umar, M., Iqbal, J., & Gilani, S. O. (2024). Effectiveness of Immersive Virtual Reality Based Hand Rehabilitation Games for Improving Hand Motor Functions in Subacute Stroke Patients. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*.
- Choy, C. S., Cloherty, S. L., Pirogova, E., & Fang, Q. (2022). Virtual reality assisted motor imagery for early post-stroke recovery: a review. *IEEE Reviews in Biomedical Engineering*, 16, 487-498.
- Rose Sin Yi, L., Jing Jing, S., Hammada, A. O., Jonathan, B., Ladislav, B., & Jing, Q. (2024). Effects of virtual reality-based cognitive interventions on cognitive function and activity of daily living among stroke patients: Systematic review and meta-analysis. *Journal of clinical nursing*, 33(3), 1169-1184.
- Choy, C. S., Fang, Q., Neville, K., Ding, B., Kumar, A., Mahmoud, S. S., ... & Jelfs, B. (2023). Virtual reality and motor imagery for early post-stroke rehabilitation. *BioMedical Engineering OnLine*, 22(1), 66.
- Kiper, P., Przysiężna, E., Cieślík, B., Broniec-Siekaniec, K., Kucińska, A., Szczygieł, J., ... & Szczepańska-Gieracha, J. (2022). Effects of immersive virtual therapy as a method supporting recovery of depressive symptoms in post-stroke rehabilitation: randomized controlled trial. *Clinical Interventions in Aging*, 1673-1685.
- Kiper, P., Przysiężna, E., Cieślík, B., Broniec-Siekaniec, K., Kucińska, A., Szczygieł, J., ... & Szczepańska-Gieracha, J. (2022). Effects of immersive virtual therapy as a method supporting recovery of depressive symptoms in post-stroke rehabilitation: randomized controlled trial. *Clinical Interventions in Aging*, 1673-1685.
- Hao, J., Chen, Z., Remis, A., & He, Z. (2023). Virtual Reality-Based Rehabilitation to Restore Motor Function in People With Amputation: A Systematic Literature Review. *American journal of physical medicine & rehabilitation*, 102(5), 468-474.
- Huang, Q., Jiang, X., Jin, Y., Wu, B., Vigotsky, A. D., Fan, L., ... & Jiang, S. (2024). Immersive virtual reality-based rehabilitation for subacute stroke: a randomized

Online ISSN

3007-3197

Print ISSN

3007-3189

<http://amresearchreview.com/index.php/Journal/about>

- controlled trial. *Journal of Neurology*, 271(3), 1256-1266.
- Kim, M., & Kaneko, F. (2023). Virtual reality-based gait rehabilitation intervention for stroke individuals: a scoping review. *Journal of exercise rehabilitation*, 19(2), 95.
- Karahan, A. Y. (2016). Effects of kinect-based virtual reality game training on upper extremity motor recovery in chronic stroke. *Somatosensory & Motor Research*, 33(1), 36–44.
- Lee, S. H., Jung, J. H., & Shin, H. S. (2016). Effects of virtual reality-based yoga program on balance, mobility, and quality of life in elderly women. *Journal of Physical Therapy Science*, 28(11), 3121–3125.
- Martinho, C., Rodrigues, R., & Santos, C. P. (2016). Feasibility of Wii™-based exercise program to improve balance and mobility in older adults. *Journal of Aging and Physical Activity*, 24(2), 288–294.
- Oesch, P., Kool, J., & Van de Langenberg, R. (2017). GameUp project: Use of kinect-based exergaming in rehabilitation for patients with balance and mobility limitations. *Disability and Rehabilitation: Assistive Technology*, 12(7), 697–704.
- kyavas, N. O., & Ergun, N. (2017). Effects of Nintendo Wii-based balance and upper extremity training on activities of daily living in patients with subacute stroke: A randomized controlled study. *International Journal of Neuroscience*, 127(4), 327–335.
- Tsuda, Y., Moriuchi, T., Okita, M., et al. (2016). Efficacy of Wii Fit training for patients with hemiplegic stroke: A randomized controlled trial. *Journal of Rehabilitation Medicine*, 48(5), 362–367.