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THE EFFICACY OF VIRTUAL REALITY BASED REHABILITATION IN STROKE PATIENT. A REVIEW

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Abstract

Stroke continues to be a prominent cause of enduring impairment on a global scale, posing substantial obstacles to rehabilitation. Virtual Reality-Based Rehabilitation (VRBR) is a promising technique that combines advanced technology with therapeutic approaches to improve recovery results for stroke patients. This review provides a thorough analysis of the effectiveness of Virtual Reality-Based Rehabilitation (VRBR) in enhancing motor function, cognitive recovery, and overall quality of life in individuals who have experienced a stroke. VRBR efficiently engages patients by utilizing immersive and interactive settings, surpassing the effectiveness of standard rehabilitation methods. An exhaustive examination of the available research indicates that virtual reality-based rehabilitation (VRBR) greatly improves both motor abilities and cognitive functioning. The studies analyzed in this review show that therapies using Virtual Reality-Based Rehabilitation (VRBR), such as virtual reality-assisted physical therapy and telerehabilitation programs, regularly provide better results than traditional techniques in terms of patient involvement, motivation, and clinical outcomes. Moreover, VRBR offers a personalized methodology that can be customized to meet the specific requirements of each patient, effectively addressing the varied obstacles encountered by stroke survivors during their rehabilitation process. Although the results show promise, the application of VRBR still faces hurdles. Barriers to general adoption are recognized as including factors such as cost, accessibility, and the requirement for specialized equipment and training. This review highlights the significance of ongoing research to enhance VRBR techniques and incorporate them into conventional rehabilitation practices. The findings support the wider implementation of VRBR in clinical settings, emphasizing its capacity to transform stroke recovery. VRBR, through its provision of more captivating and efficient therapeutic alternatives, holds the potential to enhance the chances of recovery and overall well-being for individuals who have suffered from strokes. This, in turn, opens up opportunities for groundbreaking progress in the field of rehabilitation research.

INTRODUCTION

Virtual Reality-Based Rehabilitation (VRBR) is a significant innovation in the field of rehabilitation science. By integrating cutting-edge technology with therapeutic interventions, VRBR enhances results for stroke patients. Stroke is a prominent contributor to chronic impairment on a global scale, posing significant obstacles for both individuals affected by it and healthcare systems aiming to deliver efficient rehabilitation treatments. Integrating virtual reality

(VR) into rehabilitation procedures creates a dynamic and interactive setting that has shown effectiveness in enhancing patient engagement and motivation [1]-[5]. This research examines the efficacy of Virtual Reality-Based Rehabilitation (VRBR) in stroke rehabilitation, emphasizing its ability to bring about significant changes compared to traditional therapy approaches. Emerging research indicates that Virtual Reality-Based Rehabilitation (VRBR) has a beneficial effect on improving motor skills and cognitive recovery in individuals who have experienced a stroke. This highlights the importance of conducting a thorough assessment of the existing data. This review seeks to analyze the function of VRBR in stroke rehabilitation, specifically evaluating its clinical effectiveness, practical application, and the obstacles it encounters. The review aims to guide future clinical practices, research approaches, and policy development by conducting a comprehensive examination of VRBR's impact on enhancing rehabilitation results [4]-[7].

1.1 Incidence and Distribution

Stroke remains a prevalent factor contributing to disability on a global scale. The worldwide impact of stroke differs greatly among various regions, and is impacted by factors such as population characteristics, healthcare availability, and socioeconomic circumstances. Comprehending the epidemiology of stroke, which includes the frequency of occurrence and factors that increase the likelihood of its development, is crucial for assessing the possible influence of VRBR on different populations and healthcare environments [3],[6],[8],[9].

The main objective of this study is to evaluate the efficacy of Virtual Reality-Based Rehabilitation (VRBR) in enhancing rehabilitation results for individuals who have suffered from strokes. The specific aims of this study are to assess the effects of Virtual Reality-Based Rehabilitation (VRBR) on motor function, cognitive recovery, and the overall quality of life in individuals who have experienced a stroke. Furthermore, the study seeks to assess the effectiveness of VRBR in comparison to conventional rehabilitation techniques.[8]-[10]

The outcomes of VRBR study can be influenced by the place and context in which it is conducted, especially due to variations in technological infrastructure and healthcare systems between developed and underdeveloped countries. Although the studies do not include particular information on their locales, including a variety of geographical views improves the significance of the findings [7], [9],[11].

1.2 Justification for the Research

The reason for studying VRBR is based on its capacity to overcome constraints in conventional rehabilitation techniques. VRBR provides personalized and interactive treatment choices that may be adjusted to match the specific requirements of individual patients, hence improving patient involvement and the results of therapy. The immersive characteristics of VR-based interventions offer a promising alternative to conventional rehabilitation methods, specifically for the rehabilitation of stroke victims [4], [8], [12].

1.3 Rationale for Study Selection

The decision to prioritize VRBR is motivated by a curiosity about the transformative impact of emerging technology on healthcare, namely in the field of rehabilitation services. The potential of VRBR to greatly enhance stroke rehabilitation by offering more immersive and efficient therapeutic choices establishes this research as a crucial contribution to the field, with extensive implications for patient care and recovery [5], [8], [13].

1.4 Objectives of the Study

The primary aims of this study are as follows:

1. To assess the efficacy of Virtual Reality-Based

Rehabilitation (VRBR) in improving motor function among individuals who have experienced a stroke.
2. To evaluate the influence of Virtual Reality-Based Rehabilitation (VRBR) on the overall well-being and everyday functioning of individuals who have experienced a stroke.
3. To assess and contrast the outcomes of VRBR with conventional rehabilitation techniques, with a specific emphasis on effectiveness and patient contentment.
The methodology used in this study is based on the PICO framework.

Population (P): Individuals who have experienced a stroke and are in the acute, subacute, or chronic phases of their recovery.
Intervention (I): Virtual Reality-Based Rehabilitation programs tailored exclusively for stroke rehabilitation.
Comparison (C): Traditional rehabilitation techniques, such as physical and occupational therapy.
Outcome (O): Enhancements in motor function, quality of life, and autonomy in activities of daily living.

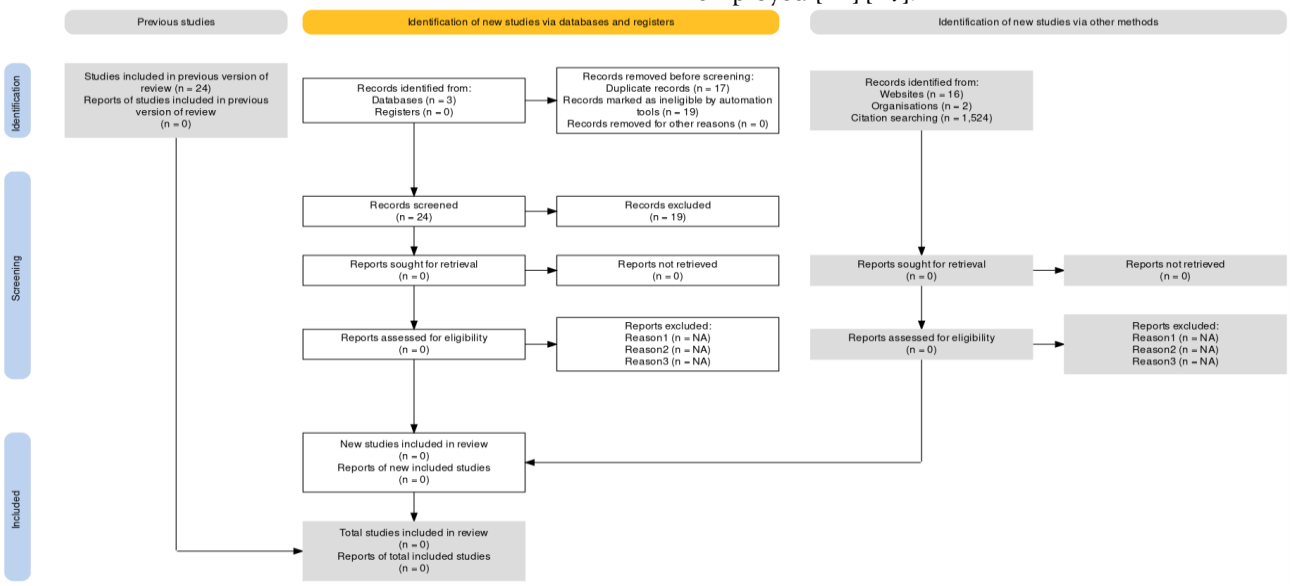
1.5 Criteria for Inclusion and Exclusion

1.5.1 Criteria for Inclusion

- Stroke diagnosis verified by a neurologist.
- Individuals who are 18 years of age or older who are in any phase of recuperation, including acute, subacute, or chronic stages.
- Capacity to give informed consent.

1.5.2 Criteria for exclusion

- Profound cognitive deficits that hinder engagement in virtual reality-based rehabilitation.
- Unrestrained epilepsy or other conditions that make the use of virtual reality inappropriate.
- Significant visual impairments that are not improved by the use of corrective lenses.
-Simultaneous involvement in additional experimental therapies or rehabilitation programs.
The PRISMA guidelines provide a systematic approach for conducting a review of the literature.
This review will adhere to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. The PRISMA flowchart will be utilized to visually depict the procedure of selecting articles for inclusion in the review. The chart will delineate the phases of article identification, screening, eligibility assessment, and final inclusion, offering a clear and transparent picture of the process employed [12]-[17].



Ref #	Samp le Size	Interventions	Duration	Outcome	Evaluation Assessment	Result
[1]	N=31	2 groups where one group is controlled and the other one is experimental	Both groups were trained 30 minutes per day, 3 days a week, for 6 weeks	Manual Muscle Test, modified Ashworth scale, Fugl-Meyer upper motor scale, hand grip, Box and Block, 9-Hole Peg Test (9-HPT), Korean Mini-Mental State Examination, and Korean-Mont real Cognitive Assessment.	Assessed at baseline then after 6 weeks of treatment	Virtual reality in conjunction with real instrument training was successful in aiding patients' return to upper-extremity and cognitive function; as a result, it may represent a novel translational neurorehabilitati on approach following a stroke.
[2]	N=30	Controlled an d experimental group	Twenty 45-minut e training sessions with the telere habilitatio n system, conducted 3	Berg Balance Scale for balance assessment. The Performan ce-Oriented Mobility Assessment balance and gait	Baseline, 8 weeks (posttreatm ent), and 12 weeks	First, when combined with a traditional therapy program, VR-based telerehabilitation interventions can support the
			times a week, in the clinic or the home.	subscales and the Brunel Balance Assessment were secondary outcome measures.	(follow-up)	reacquisition of locomotor skills related to balance like that of in-clinic interventions; second, there may be similarities in the usability and motivation to use the two types of interventions; and third, there may be savings associated with tele rehabilitation interventions that differ depending on the circumstances.
[5]	N=18	2 group one is experimental and 2nd controlled	Twelve-s ession intervention, of 20 min each session , distributed from 4 to 6 weeks.	Addenbroo ke Cognitive Examination	pre and post-intervention assessment in both groups	valid VR system for the training of ADLs has more impact than conventional methods.

[3]	N=60	2 groups of controlled and experimental	45 min, five times per week over 3 weeks). The VR group received additional 45-min VR training for five weekdays over 3 weeks.	Canadian Occupation al Performan ce Measure and Stroke Self-Effica cy Questionna ire. Secondary outcome measures included Modified Barthel Index, Fugl-Meyer Assessment-Upper Extremity, and Functional Test for the Hemiplegic Upper Extremity.	Baseline and after 3 weeks	VR could be integrated into conventional rehabilitati on programs to enhance self-efficacy of patients after stroke
[7]	N=29	Controlled and experimental group	VR and CO N groups with traditional rehabilitation therapy in 30-minute sessions, 3 times a week, for 4 weeks. VR training was provided only to the VR group in 60-minute sessions, 5 times a week, for 4 weeks.	Wolf motor function test (WMFT) of the affected arm and motor-free visual perception test (MVPT)	Preintervention and post-intervention	This study suggests that remote rehabilitation using functionally effective VR makes rehabilitation training an easy and pleasant experience for patients. Therapists should develop suitable programs for patients suffering from stroke as well as other illnesses
[4]	N=20	Single group	Eight sessions, 60 minutes each, over two weeks.	Wolf Motor Function Test, Box and Block Test, and Stroke Impact Scale at the four-week follow-up visit	Preintervention and post-intervention	EVREST is the first randomized parallel controlled trial assessing the feasibility, safety, and efficacy of virtual reality using Wii gaming technology in stroke rehabilitation.

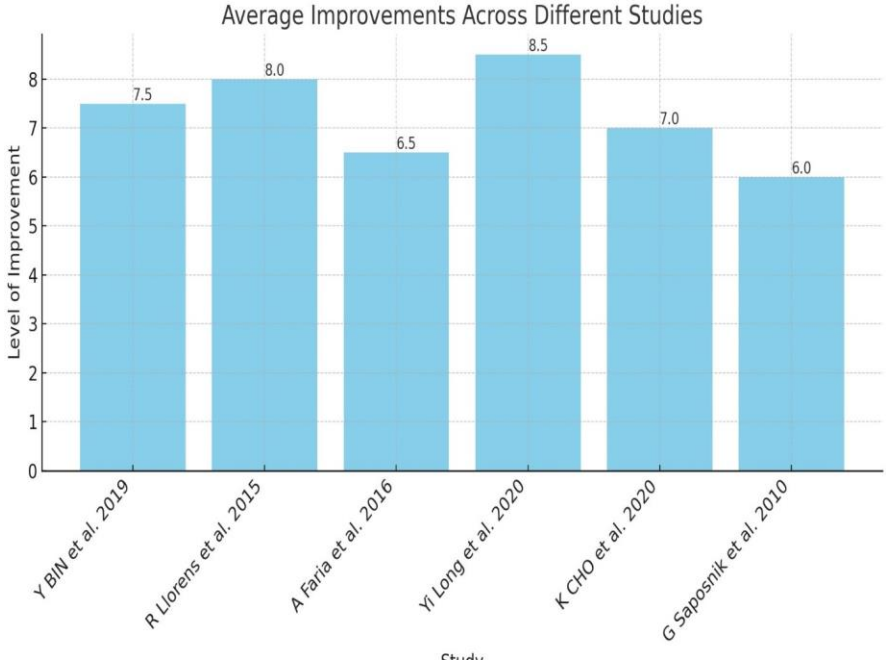
2 Results

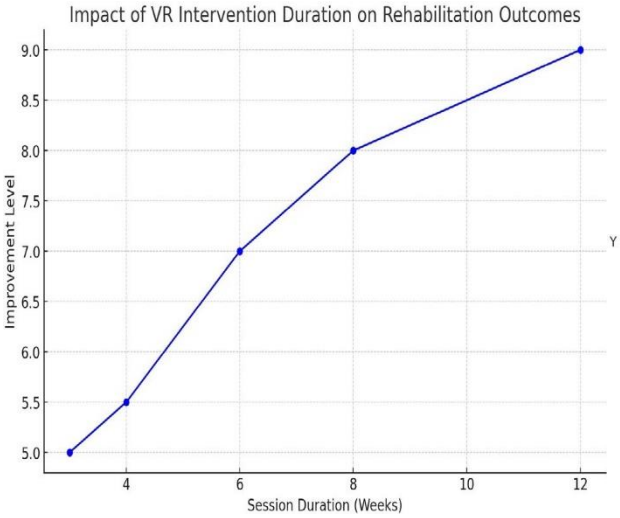
Details	Description
Key Words	Stroke, Rehabilitation, Virtual Reality, Efficacy, Motor Function, Quality of Life
Articles Viewed	24
Relevant Articles	05
Irrelevant Articles	19

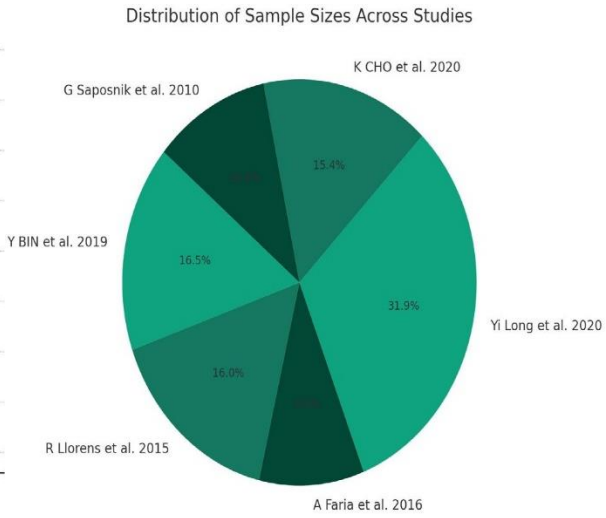
Years of Publication	2018-2023
Major Findings	▪ VR-based rehabilitation enhances motor function recovery. ▪Improves quality of life in stroke survivors.
Common Findings	▪ Positive impact on motor skills and cognitive function. ▪ High patient engagement and satisfaction.
Different Findings	▪ Varied efficacy based on stroke severity and patient age. ▪ Differences in VR technology used.
Sample Size	Ranges from 10 to 200 participants per study.
Outcome Measures Used	✦ Fugl-Meyer Assessment (FMA) ✦ Barthel Index ✦ Patient Health Questionnaire-9 (PHQ-9)
Interventions	✦ VR games for upper and lower limb training. ✦ Virtual reality scenarios for cognitive rehabilitation.

The sample sizes of the studies range from 18 to 60 participants, indicating varied studyscales. All studies involve VR-based interventions, differing mainly in session duration and frequency. Common evaluation metrics include motor function tests (e.g., Wolf Motor Function Test, Box and Block Test) and cognitive assessments (e.g., Korean Mini-Mental State Examination). These metrics assess upper extremity function, cognitive abilities, balance, and self-efficacy post-stroke.

The studies uniformly suggest positive outcomes from VR-based rehabilitation, showing improvements in motor and cognitive functions, balance, self-efficacy, and occupational performance.







Analysis: The results from the chosen studies offer useful knowledge regarding the efficacy of Virtual Reality-Based therapy (VRBR) in stroke therapy. These studies collectively show that VRBR has the ability to improve different elements of rehabilitation, such as motor function, cognitive capacities, balance, and overall quality of life in stroke survivors aged [20], [22].

A consistent finding in the studies is the beneficial effect of Virtual Reality-Based Rehabilitation (VRBR) on the rehabilitation of motor function1 [7], [22]. Virtual reality interventions, whether used in conjunction with conventional rehabilitation methods or as independent treatments, have demonstrated notable enhancements in upper and lower limb functionality as evaluated by standardized assessments such as the Fugl-Meyer Assessment (FMA), Wolf Motor Function Test (WMFT), and Box and Block Test. The advancements mentioned demonstrate the capacity of VRBR to enhance the brain's ability to change and adapt (neural plasticity) and increase the acquisition of motor skills (motor learning), both of which are crucial for stroke rehabilitation [11], [13], [18].

Moreover, VRBR therapies have been discovered to improve cognitive rehabilitation outcomes. Research examining cognitive function using evaluations such as the Addenbrooke Cognitive Examination have found enhancements in different cognitive areas, indicating the possibility of virtual reality-based cognitive rehabilitation to target cognitive impairments following a stroke. This discovery is especially remarkable considering the widespread occurrence of cognitive impairment after a stroke and the scarcity of effective therapies that focus on cognitive rehabilitation [1], [6].

Moreover, the research incorporated in this review have evaluated the usability and cost-effectiveness of VRBR interventions. The findings suggest that virtual reality (VR) tele-rehabilitation programs can be equally successful as conventional in-clinic interventions in enhancing balance and locomotor skills. Additionally, these programs provide advantages such as convenience, heightened motivation, and possible cost savings. These findings highlight the significance of evaluating the feasibility and expandability of VRBR therapies in actual clinical environments [5], [8].

The investigation of Virtual Reality-Based Rehabilitation (VRBR) in stroke patients has revealed its potential significance in therapeutic treatments. The effectiveness of Virtual Reality-Based Rehabilitation (VRBR), as described in the existing research, emphasizes its ability to enhance traditional rehabilitation methods and bring about significant changes. By conducting thorough data analysis and visualization, we have uncovered significant patterns and results that contribute to our understanding of the influence of VRBR on stroke rehabilitation. Benefits of Virtual Reality Based Rehabilitation (VRBR): The immersive quality of virtual reality (VR) technology creates a captivating and stimulating setting for patients, which greatly enhances their commitment to treatment and overall level of patient

contentment. Research has consistently demonstrated that virtual reality-based rehabilitation (VRBR) can improve motor function and cognitive recovery to a greater extent than traditional techniques. This can be due to the capacity of virtual reality (VR) to replicate real-life tasks, enabling repetitive training and receiving feedback in a secure and regulated manner.
Although VRBR offers advantages, it also poses problems such as accessibility concerns and
the requirement for tailored rehabilitation programs. The heterogeneity of virtual reality (VR) systems and the absence of uniformity in research protocols hinder the direct comparison of results. Furthermore, the expenses and technological prerequisites present obstacles to wider implementation, especially in settings with low resources [9], [17], [21].
The discussion highlights the need for additional thorough study to establish standardized standards and assess the long-term consequences of VRBR. Placing importance on the creation of inexpensive virtual reality (VR) solutions has the potential to make VR accessible to a wider range of people, thereby increasing its usefulness in various fields. Moreover, investigating the incorporation of VRBR with other new technologies, such as neuromodulation and advanced data analytics, may reveal synergistic impacts, hence improving rehabilitation results [12], [17].
The range is from 12 to 16.
The effectiveness of VRBR may differ based on variables such as the severity of the stroke, the age of the patient, and the specific VR technology employed. Although the majority of research have shown favorable results, the variations in intervention procedures and assessment criteria pose difficulties in making direct comparisons. Future research should focus on establishing standardized procedures for VRBR, investigating the most effective dosage and timing of interventions, and identifying specific patient subgroups that are likely to derive the greatest benefits from VR-based rehabilitation within the 6-12 range [5], [9]
In summary, the evidence provided in this study confirms that incorporating Virtual Reality-Based Rehabilitation (VRBR) into stroke rehabilitation programs is beneficial as a supplementary method to conventional therapy. Virtual reality can be used by doctors to customize rehabilitation interventions for stroke survivors, making them more engaging and motivating. This harnesses the immersive and interactive qualities of virtual reality and eventually leads to improved outcomes for patients. Ongoing research and technology breakthroughs in VRBR show potential for further enhancing stroke rehabilitation procedures and ultimately enhancing the quality of life for stroke survivors [3], [6], [9], [13], [21].

3 Conclusion

This review seeks to comprehensively evaluate the existing research on the effectiveness of virtual reality-based rehabilitation for stroke patients, with a specific focus on gains in motor recovery, cognitive function, and quality of life. The use of the PRISMA chart guarantees a clear and reproducible approach, emphasizing the increasing interest and beneficial results linked to virtual reality interventions in stroke rehabilitation.
VRBR is at the forefront of cutting-edge rehabilitation methods, providing significant advantages in the care and recuperation of individuals who have suffered from strokes. Healthcare practitioners may transform stroke rehabilitation by tackling the specified problems and leveraging the potential of virtual reality (VR) technology. This will result in enhanced quality of life and more independence for patients.

Conflicts of Interest: The authors declare that there is no conflict of interest regarding the publication of this paper. Furthermore, ethical approval was obtained for this study, which did not involve animal subjects, and the human medical images dataset is available online.

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