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Meta-Analysis on the Impact of Virtual Reality Technology on Limb Function and Quality of Life in Stroke Patients

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ADMINISTRATIVE INFORMATION

Support - No.

Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 17 February 2025 and was last updated on 17 February 2025.

INTRODUCTION

Review question / Objective Review Question/Objective using the PICOS Framework: Population (P): Stroke patients with impaired limb function. Intervention (I): Virtual Reality (VR) technology in rehabilitation training. Comparison (C): Traditional rehabilitation methods or no rehabilitation. Outcomes (O): Improvement in limb function, as measured by standardized assessment tools (e.g., Fugl-Meyer Assessment, Wolf Motor Function Test). Enhancement in quality of life, as evaluated by validated questionnaires (e.g., Stroke Impact Scale, Short Form-36). Study Design (S): Systematic review and meta-analysis of randomized controlled trials (RCTs) and quasi-RCTs. Objective: To systematically assess and synthesize the evidence regarding the impact of VR technology in rehabilitation training on limb function and quality of life in stroke patients, compared to traditional rehabilitation methods or no rehabilitation.

Condition being studied Condition Being Studied: Stroke. Stroke is a medical condition characterized by the sudden onset of neurological deficits due to the interruption of blood flow to the brain, either by ischemia (lack of blood supply due to clot formation or embolism) or hemorrhage (bleeding into the brain tissue). This interruption leads to the death of brain cells within minutes, resulting in permanent damage to the affected areas. The severity and specific effects of a stroke depend on which part of the brain is affected and the extent of the damage.

Common symptoms of stroke include weakness or paralysis of one side of the body, loss of sensation, difficulty speaking or understanding language, vision problems, balance issues, and cognitive impairments. These symptoms can significantly impact an individual's ability to perform daily activities and reduce their overall quality of life.

Stroke is a leading cause of disability and mortality worldwide, with a high economic and societal burden. Therefore, effective rehabilitation

strategies are crucial for stroke patients to regain function, improve mobility, and enhance their quality of life. One such strategy that has gained increasing attention in recent years is the use of virtual reality (VR) technology in rehabilitation training. VR technology provides a safe, controlled, and engaging environment for stroke patients to practice and improve their motor skills, potentially leading to better outcomes in terms of limb function and quality of life.

METHODS

Participant or population The study subjects were stroke patients aged ≥18 years.

Intervention Virtual reality technology was used for intervention.

Comparator Traditional rehabilitation therapy.

Study designs to be included Randomized controlled trial.

Eligibility criteria Inclusion Criteria: ①The study subjects were stroke patients aged ≥18 years; ②Virtual reality technology was used for intervention; ③The study reported quantitative results on motor function and/or quality of life before and after virtual reality intervention; ④Randomized controlled trials (RCTs); ⑤Full text was available.
Exclusion Criteria: ①Animal studies; ②Studies focusing solely on other effects of virtual reality technology (such as cognitive or psychological treatment); ③Review articles, case reports, etc.; ④Lack of necessary data; ⑤Duplicately published studies.

Information sources PubMed, Web of Science, and Elsevier.

Main outcome(s) The meta-analysis results showed that VR technology significantly improved the Fugl-Meyer Upper Extremity (FMUE) score [MD=7.47, 95%CI (5.38-9.57), Z=7.00, P<0.001], Block and Box Test score [MD=5.84, 95%CI (2.49-9.20), Z=3.41, P=0.001], Berg Balance Scale score [MD=3.54, 95%CI (0.56-6.53), Z=2.33, P=0.020], Action Research Arm Test score [MD=6.07, 95%CI (-0.66-12.79), Z=1.77, P=0.008], and Barthel Index score [MD=4.57, 95%CI (1.33-7.80), Z=2.77, P=0.006] in stroke patients.

Quality assessment / Risk of bias analysis The Cochrane Collaboration's Risk of Bias Tool was used to assess the quality of randomized controlled trials (RCTs). This tool evaluates various aspects of the study, including the randomization process, blinding design, data integrity, selective reporting, and other potential sources of bias. Two reviewers independently completed the quality assessment, and in case of disagreement, a consensus was reached after discussion.

Strategy of data synthesis This study used Review Manager 5.3 statistical software for data analysis. For the effect sizes of the included studies, the Standardized Mean Difference (SMD) was used as the primary effect indicator to assess the impact of virtual reality interventions on motor function and quality of life in stroke patients. All data were estimated using a 95% confidence interval (CI) and subjected to heterogeneity testing. If the I^2 value was less than 50%, a fixed-effects model was used for combined analysis; if the I^2 value was greater than 50%, a random-effects model was used for analysis. Sensitivity analysis was conducted to test the robustness of the results, and funnel plot analysis was performed when necessary to assess publication bias. A P-value < 0.05 was considered statistically significant.

Subgroup analysis Subgroup analyses will be conducted to explore the impact of various factors on the effectiveness of VR technology in stroke rehabilitation. These factors may include:
Type of stroke (ischemic vs. hemorrhagic)
Severity of stroke (e.g., mild, moderate, severe)
Time since stroke onset (e.g., acute, subacute, chronic)
Age of patients
Type of VR intervention (e.g., immersive vs. non-immersive, game-based vs. task-oriented)
Duration and frequency of VR training
By conducting subgroup analyses, we aim to identify which subgroups of stroke patients may benefit most from VR technology and to explore potential moderators of treatment effectiveness.

Sensitivity analysis Sensitivity analyses will be conducted to assess the robustness of the meta-analytic results. These analyses may include:
Excluding studies with a high risk of bias
Excluding studies with small sample sizes
Excluding studies with wide confidence intervals
Using a fixed-effects model instead of a random-effects model
By conducting sensitivity analyses, we aim to identify any potential biases or inconsistencies in the results and to ensure that the conclusions drawn from the meta-analysis are reliable and valid.

Country(ies) involved China.

Keywords Virtual Reality; Stroke Patients; Limb Function; Quality of Life;Meta-Analysis.

Contributions of each author
Author 1 - Xiaoping Wu.
Author 2 - Wenyou Pang.