EFFECT OF SMARTPHONE-BASED VIRTUAL REALITY TRAINING ON RISK OF FALL, BALANCE, AND QUALITY OF LIFE IN INDIVIDUALS WITH SUBACUTE STROKE

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Abstract

Background

Stroke frequently leads to impaired balance, fear of falling, reduced mobility, and diminished quality of life. Virtual reality (VR) may provide engaging, repetitive, task-oriented practice as an adjunct to conventional physiotherapy. This study evaluated smartphone-based VR training for fall-related efficacy, dynamic balance, and stroke-specific quality of life in individuals with subacute stroke.

Methodology

This controlled study included 30 individuals with subacute stroke, allocated by lottery into an experimental group and a control group (15 participants each). The experimental group received smartphone-based VR training with conventional physiotherapy, while the control group received conventional physiotherapy alone. Treatment was delivered for 50 minutes per session, five days per week, for six weeks. Outcomes were assessed before and after intervention using the Falls Efficacy Scale (FES), Four Square Step Test (FSST), and Stroke-Specific Quality of Life Scale (SS-QOL).

For within-group analyses, pre-intervention values were compared with post-intervention values separately for the experimental and control groups. Between-group analysis compared the groups' post-intervention scores to examine whether the observed outcomes differed following treatment. Demographic information was summarized descriptively, and the dissertation reports chi-square testing for categorical demographic comparisons.

Results are presented as mean ± standard deviation, with reported t-values and p-values reproduced from the dissertation tables. A p-value below 0.05 was treated as statistically significant in the study. Because the source dissertation contains some inconsistencies between narrative interpretations, mean-difference signs, and reported p-values, these values require confirmation against the original statistical output before the manuscript is finalized.

Results

Both groups showed improvement across the three reported outcomes. In the experimental group, FES decreased from 79.78 ± 7.57 to 51.35 ± 6.42, FSST time decreased from 32.14 ± 4.80 to 13.71 ± 1.81 seconds, and SS-QOL increased from 122.14 ± 19.14 to 192.07 ± 22.47. Post-intervention scores favoured the experimental group for FES, FSST, and SS-QOL. Reported significance values are presented in the results tables.

The purposive recruitment strategy and single-centre setting may have introduced selection effects and limit the extent to which the results can be generalized to other stroke populations or rehabilitation settings. The sample size of 30 participants

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also limits precision and the ability to explore whether response differed according to age, stroke characteristics, or baseline function. The dissertation does not establish the durability of the improvements because the reported assessment was performed immediately after the six-week intervention.

The study also relied on the reported scales and test performance rather than documenting long-term falls in the community. Participants and treating therapists could not realistically be blinded to the intervention type, and the source manuscript requires a statistical consistency check before definitive conclusions are drawn. Future research should recruit larger samples, predefine the primary outcome, document adherence and adverse events, include follow-up measurements, and provide complete statistical reporting.

Conclusion

Smartphone-based VR training combined with conventional physiotherapy was associated with greater improvement in fall-related efficacy, dynamic balance, and stroke-specific quality of life than conventional physiotherapy alone in this sample. Larger studies with longer follow-up are required.

Keywords: subacute stroke; smartphone-based virtual reality; falls efficacy; balance; Four Square Step Test; quality of life.

Introduction

Stroke is a major cause of adult disability and may lead to persistent motor and sensory impairments that affect postural control, gait, and functional independence [1,2]. Balance impairment and fear of falling can restrict activity and participation after stroke, while reduced independence may adversely affect quality of life [3,4]. Rehabilitation therefore commonly includes task-specific balance, mobility, and strengthening exercises.

Virtual reality provides visual feedback and repetitive task practice in an interactive environment. Reviews have examined VR as an adjunct to stroke rehabilitation, including its potential effects on balance and mobility [5,6]. Smartphone-based VR may offer a more accessible approach than specialized systems, although evidence specific to subacute stroke and combined fall-related, balance, and quality-of-life outcomes remains limited.

The present study aimed to evaluate the effect of smartphone-based VR training combined with conventional physiotherapy on fall-related efficacy, dynamic balance, and quality of life in individuals with subacute stroke, compared with conventional physiotherapy alone.

Following stroke, balance depends on the integration of visual, vestibular, and somatosensory information with adequate motor responses. Damage affecting motor control, postural reactions, lower-limb coordination, or perception of body position can make activities such as standing, turning, stepping over obstacles, and walking more difficult. These difficulties may contribute to fear of falling and can reduce confidence in everyday movement. Rehabilitation that challenges balance safely and progressively is therefore an important component of recovery during the subacute stage.

Conventional physiotherapy commonly uses repeated functional tasks, strengthening, weight shifting, gait-related practice, and static and dynamic balance activities. Repetition and task specificity are important for motor learning, but patients may differ in motivation, attention, and tolerance for repeated exercise. Virtual reality-based practice can present goal-directed activities in an interactive visual environment and provide immediate feedback that may help maintain engagement. When used with appropriate supervision and progression, it may offer additional opportunities to practise balance-related movements.

Smartphone-based VR is of interest because it can use a readily available mobile device with a head-mounted display, potentially making the approach less dependent on specialized rehabilitation equipment. The immersive visual environment may encourage attention to movement tasks, while repeated practice can complement therapist-guided exercises. However, access to a technology alone does not establish clinical effectiveness, and outcome assessment is needed to determine whether changes occur in fall-related efficacy, dynamic balance, and stroke-specific quality of life. Accordingly, this study compared smartphone-based VR training plus conventional physiotherapy with conventional physiotherapy alone over six weeks.

Materials and Methods

Study design and setting

A controlled two-group study was conducted through the Department of Neurology and College of Physiotherapy, Sri Venkateswara Institute of Medical Sciences (SVIMS), Tirupati, Andhra Pradesh, India.

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Participants and sampling

Thirty individuals with subacute stroke were recruited using purposive sampling and allocated by lottery into an experimental group (n = 15) and a control group (n = 15). Eligibility criteria included age 20–60 years, either sex, stroke diagnosis confirmed by CT or MRI, Mini-Mental State Examination score ≥22, and Postural Assessment Scale for Stroke score ≥20. Exclusion criteria included cognitive impairment or other neurological deficits, sensory impairments, unstable medical conditions, fractures or limb-length discrepancy, and terminal illness.

Intervention procedure

Both groups received supervised physiotherapy for 50 minutes per session, five days per week, for six weeks. The experimental group received a warm-up, 20 minutes of smartphone-based VR training using a mobile head-mounted display, and conventional physiotherapy. VR activities included sitting- and standing-based balance tasks, progressed according to tolerance. The control group received conventional balance and strengthening physiotherapy, including warm-up and functional strength and balance exercises, according to the dissertation protocol.

Outcome measures

The Falls Efficacy Scale (FES) was used to assess fall-related efficacy/fear of falling; the Four Square Step Test (FSST) assessed dynamic stepping balance, with completion time recorded in seconds; and the Stroke-Specific Quality of Life Scale (SS-QOL) assessed stroke-related quality of life [7–9]. Outcomes were measured before and after the six-week intervention.

Ethical considerations

The dissertation reports Institutional Ethics Committee approval and written informed consent from participants or appropriate representatives. The trial registration number listed in the dissertation is CTRI/2026/02/103993.

The intervention period comprised six weeks, with five treatment sessions each week and a planned duration of 50 minutes per session. The experimental protocol combined smartphone-based VR delivered through a head-mounted display with conventional physiotherapy. The control protocol consisted of conventional physiotherapy, including balance and strengthening activities. Exercises were selected to address postural stability and functional mobility, and participants were assessed using the same outcome measures before and after the intervention period.

The study assessed three complementary domains. FES scores were used to represent participants' confidence or concern related to falling during activities; the FSST recorded the time needed to step in multiple directions across a four-square layout, with shorter times generally reflecting better dynamic stepping performance; and the SS-QOL captured the perceived impact of stroke across quality-of-life domains. The dissertation reports ethical approval and written informed consent before enrolment. Intervention descriptions, eligibility details, and registration information should be checked against the final approved study record before journal submission.

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using IBM SPSS Statistics, version 26.0. Continuous variables were summarized as mean and standard deviation (SD). Chi-square tests were used for demographic comparisons, paired-samples t-tests for within-group pre- and post-intervention comparisons, and independent-samples (unpaired) t-tests for between-group comparisons. Statistical significance was set at $p < 0.05$.

Results

All 30 participants completed the six-week intervention, with 15 participants in each group. The overall mean age was 47.43 ± 7.47 years (range, 35–60 years). Each group included 10 male and 5 female participants. Both groups improved across the measured outcomes, while post-intervention values favoured the experimental group.

The sample consisted of 30 participants, with equal numbers assigned to the experimental and control groups. The overall age range reported in the dissertation was 35–60 years, with a mean age of 47.43 ± 7.47 years. Each group included 10 male and 5 female participants, giving the same reported gender distribution across groups.

In the experimental group, the mean FES score declined by 28.43 points and the FSST time declined by 18.43 seconds, while the SS-QOL score increased by 69.93 points from baseline. The control group also improved: FES declined by 5.43 points, FSST time by 10.14 seconds, and SS-QOL increased by 49.72 points. Post-intervention comparison favoured the experimental group on all three reported measures. Interpret these values alongside the source tables and verify their inferential statistics before publication.

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Table 1. Demographic characteristics of the participants

Characteristic	Value
Total participants	30
Age, mean ± SD (years)	47.43 ± 7.47
Age range (years)	35–60
Male participants	20 (66.7%)
Female participants	10 (33.3%)
Experimental group	15 (10 male, 5 female)
Control group	15 (10 male, 5 female)

Table 2. Within-group pre- and post-intervention comparison of outcome measures

Outcome	Group	Pre-test (mean ± SD)	Post-test (mean ± SD)	Mean difference*	t-value	p-value
FES	Experimental	79.78 ± 7.57	51.35 ± 6.42	28.43	15.906	0.001
FES	Control	78.85 ± 7.14	73.42 ± 6.35	5.43	5.67	0.001
FSST (s)	Experimental	32.14 ± 4.80	13.71 ± 1.81	18.43	13.148	0.001
FSST (s)	Control	32.42 ± 4.80	22.28 ± 3.51	10.14	7.16	0.001
SS-QOL	Experimental	122.14 ± 19.14	192.07 ± 22.47	−69.93	−23.290	0.001
SS-QOL	Control	125.42 ± 15.60	175.14 ± 24.45	−49.72	−10.14	0.001

*Mean-difference signs are reproduced from the dissertation tables. Lower FES and FSST scores and higher SS-QOL scores indicate improvement.

Table 3. Between-group comparison of post-intervention outcome measures

Outcome	Experimental (mean ± SD)	Control (mean ± SD)	Mean difference	t-value	p-value
FES	51.35 ± 6.42	73.42 ± 6.35	−22.07	−9.60	0.001
FSST (s)	13.71 ± 1.81	22.28 ± 3.51	−8.57	−8.62	0.001
SS-QOL	192.07 ± 22.47	175.14 ± 24.45	16.93	2.33	0.002

The experimental group had lower post-intervention FES and FSST scores and a higher SS-QOL score than the control group. These findings favour the addition of smartphone-based VR to conventional physiotherapy in this sample.

Discussion

The findings indicate improvement in fall-related efficacy, dynamic balance, and stroke-specific quality of life in both groups after six weeks of treatment. Greater improvement was reported in the experimental group receiving smartphone-based VR with conventional physiotherapy. The observed changes may relate to repetitive, task-oriented practice, visual feedback, and engagement during VR activities, while conventional physiotherapy likely contributed to strength, mobility, and balance gains in both groups.

The direction of the findings is consistent with the broader literature exploring VR as an adjunct to stroke rehabilitation and its potential effects on balance and mobility [5,6,10]. However, the present study's small sample and short intervention period warrant cautious interpretation. The findings should be considered specific to the participants and protocol studied rather than generalized to all people with stroke.

The reduction in FSST time in both groups suggests improvement in the ability to perform multidirectional stepping tasks after the intervention period. The larger numerical reduction in the experimental group may reflect the additional opportunity to engage with visually guided, task-oriented practice alongside conventional physiotherapy. Similarly, the greater increase in SS-QOL in the experimental group suggests that the measured functional changes may have been accompanied by a more positive perceived impact of stroke on daily life. These interpretations remain provisional because the sample was small and the study did not establish whether the changes were maintained over time.

The control group's improvement is also clinically relevant and supports the continued role of conventional physiotherapy in stroke rehabilitation. Repeated strengthening, balance activities, weight shifting, stepping, and functional practice can address impairments that limit mobility. Smartphone-based VR should therefore be understood as a potential adjunct rather than a replacement for individualized therapist-led rehabilitation. Future trials should clearly describe VR content and progression, use blinded outcome assessors where feasible, report confidence intervals and effect sizes, and include follow-up assessments and real-world fall outcomes.

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Limitations

The study included only 30 participants from a single clinical setting and used purposive sampling, which may limit generalizability. The intervention lasted six weeks, and long-term retention of the observed changes was not established. The reported outcomes do not determine whether participants experienced fewer real-world falls over a longer period. In addition, the dissertation tables and narrative contain statistical reporting inconsistencies that should be checked against the original SPSS output before publication.

Conclusion

In this sample of 30 individuals with subacute stroke, smartphone-based VR training combined with conventional physiotherapy was associated with greater improvement in FES, FSST, and SS-QOL outcomes than conventional physiotherapy alone. Smartphone-based VR may be a useful adjunct to conventional stroke rehabilitation, but larger studies with robust statistical reporting and longer follow-up are needed.

The findings support further evaluation of smartphone-based VR as a practical adjunct for balance-focused rehabilitation in individuals with subacute stroke. Its potential advantages include engaging visual tasks and opportunities for repeated practice, while the therapist remains responsible for choosing suitable activities, monitoring safety, and adjusting task difficulty to the individual.

The results should be interpreted cautiously until all statistical values have been verified against the original analysis. Larger, well-reported controlled studies with longer follow-up are needed to determine whether the observed improvements translate into sustained functional independence, reduced real-world falls, and better quality of life.

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