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EFFECTS OF NINTENDO WII FIT BALANCE BOARD VIRTUAL REALITY GAMES IN IMPROVING BILATERAL COORDINATION OF UPPER LIMB IN INDIVIDUALS WITH ACUTE STROKE -A PILOT STUDY

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ABSTRACT

Background: Stroke is a leading cause of disability worldwide and often results in impaired upper limb function and reduced bilateral coordination, which can limit independence in daily activities. Virtual reality–based rehabilitation has gained attention as an innovative approach that enhances patient engagement and promotes repetitive, task-oriented training. The Nintendo Wii Fit Balance Board offers interactive virtual reality games that may facilitate motor recovery and improve bilateral coordination in stroke rehabilitation.

Objective: To investigate the effects of Nintendo Wii Fit Balance Board virtual reality games on improving bilateral coordination of the upper limb in individuals with acute stroke.

Methods: A quasi-experimental pilot study was conducted among 20 individuals diagnosed with acute stroke. Participants were recruited based on predefined inclusion and exclusion criteria. All subjects received virtual reality training using Nintendo Wii Fit Balance Board games along with routine physiotherapy. The intervention was administered over a specified treatment period under supervision. Bilateral coordination of the upper limb was assessed before and after the intervention using ABILHAND Questionnaire. Pre- and post-intervention scores were analyzed to determine the effectiveness of the training.

Results: Following the intervention, participants demonstrated a significant improvement in bilateral coordination of the upper limb compared to baseline scores. The mean preintervention score was 30.40 ± 1.24 and the mean post intervention score was 46.85 ± 1.11 . The interactive and task-specific nature of the Nintendo Wii Fit Balance Board games appeared to enhance motor learning, bilateral coordination, and patient motivation during rehabilitation.

Conclusion: The findings of this pilot quasi-experimental study suggest that Nintendo Wii Fit Balance Board virtual reality games is an effective adjunct in improving bilateral coordination of the upper limb in individuals with acute stroke. However, larger randomized controlled studies are recommended to further validate these results and support wider clinical application.

KEYWORDS: Acute stroke, virtual reality rehabilitation, Nintendo Wii Fit Balance Board, bilateral coordination, upper limb, physiotherapy.

1. INTRODUCTION

Stroke is a major global health problem and a leading cause of disability among adults. It occurs due to an interruption of blood supply to the brain, leading to neurological impairments. One of the most common consequences of stroke is impaired upper limb function, which affects approximately 70–80% of stroke survivors during the acute phase. Upper limb impairment often includes muscle weakness, loss of motor control, reduced coordination, and difficulty performing bilateral movements. Bilateral coordination is essential for performing many functional tasks such as dressing, eating, carrying objects, and personal hygiene. Therefore, improving bilateral upper limb coordination is an important goal in stroke rehabilitation. Traditional physiotherapy interventions such as task-oriented training, strengthening exercises, and functional activities are commonly used to improve upper limb function. However, these conventional approaches may sometimes become repetitive and less motivating for patients. In recent years, virtual reality (VR) technology has gained attention in neurorehabilitation due to its ability to provide interactive and engaging therapeutic environments. VR-based interventions allow patients to perform repetitive, goal-directed movements with real-time feedback, which enhances motor learning and neuroplasticity.

The Nintendo Wii Fit Balance Board is a commercially available gaming platform that has been widely explored for rehabilitation purposes. It offers interactive games that encourage movement, coordination, and balance through visual and sensory feedback. The use of Wii-based training has shown promising results in improving motor function, coordination, and motivation in stroke rehabilitation. Despite growing interest in VR-based rehabilitation, limited research

has specifically investigated its effects on bilateral upper limb coordination in individuals with acute stroke. Therefore, this study aimed to evaluate the effectiveness of Nintendo Wii Fit Balance Board virtual reality games in improving bilateral coordination of the upper limb in individuals with acute stroke.

2. Objectives of the Study:
Primary Objective:
To determine the effect of Nintendo Wii Fit Balance Board virtual reality games in improving bilateral coordination of the upper limb in individuals with acute stroke.
Secondary Objective:
To evaluate changes in upper limb functional performance following virtual reality–based rehabilitation.

3. METHODOLOGY
1. Study Design:
A pilot quasi-experimental pre-test and post-test study design was employed. This design was chosen to assess the effect of a structured virtual reality intervention using the Nintendo Wii Fit Balance Board on bilateral upper limb coordination in individuals with acute stroke, while also incorporating conventional physiotherapy as the baseline treatment.

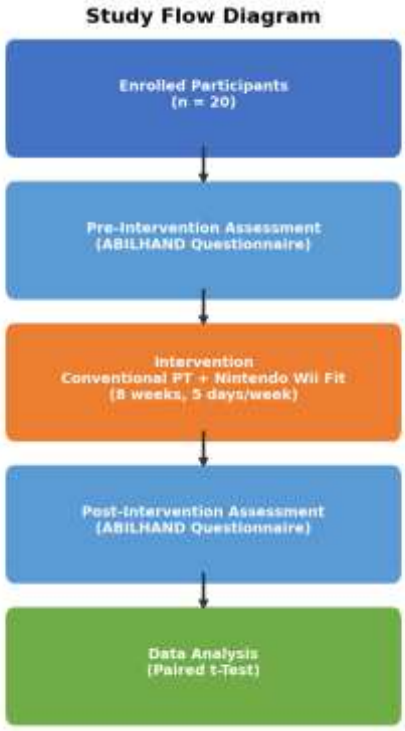

Figure 1: Study Flow Diagram — Participant Journey from Enrollment to Data Analysis

2. Study Setting
The study was conducted at the Department of Physiotherapy, Dr SMCSI Medical College and Hospital , Karakonam. The centre is equipped with standard physiotherapy equipment, balance rehabilitation tools, and virtual reality gaming systems suitable for neurological rehabilitation.

3. Participants:
3.1 Sample Size and Sampling Method:
A total of 20 participants diagnosed with acute stroke were recruited using convenience sampling. The sample size was determined based on the pilot study scope, availability of participants within the study period, and reference to prior VR rehabilitation studies.

3.2 Participant Characteristics:

Characteristic	n / Mean	SD / %	Min	Max
Total Participants	20	—	—	—
Age (years)	57.3	8.4	40	70
Gender – Male	13	65%	—	—

Gender – Female	7	35%	—	—
Side of Hemiplegia – Right	12	60%	—	—
Side of Hemiplegia – Left	8	40%	—	—
Duration of Stroke (days)	18.5	6.2	7	30
Baseline ABILHAND Score	30.4	1.24	28	33

Table 1: Participant Demographic and Baseline Characteristics (n = 20)

3.3 Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Diagnosed with acute stroke	Severe cognitive impairment
Age between 40–70 years	Severe visual or hearing deficits
Medically stable	Severe musculoskeletal disorders
Ability to follow simple instructions	Unstable cardiovascular conditions
Mild to moderate upper limb motor impairment	Participation in other experimental rehabilitation programs

Table 2: Inclusion and Exclusion Criteria

4. Intervention Protocol:

All 20 participants received a dual-track intervention comprising conventional physiotherapy and Nintendo Wii Fit Balance Board virtual reality training over an 8-week period.

4.1 Conventional Physiotherapy:

The conventional component included:

- Range of motion exercises for the upper limb
- Progressive muscle strengthening exercises
- Functional task training (reaching, grasping, manipulation)
- Bilateral coordination exercises

4.2 Virtual Reality Training — Nintendo Wii Fit Balance Board:

Participants performed structured Nintendo Wii Fit Balance Board games requiring bilateral arm movements, reaching, weight shifting, and goal-directed coordination tasks. The games were progressively advanced from therapist-assisted to independent performance.

4.3 Training Parameters:

Parameter	Details
Session Duration	30 minutes (pre/post test) | 45 minutes (training sessions)
Frequency	4 days per week
Total Duration	8 weeks (24 sessions)
Supervision	Qualified physiotherapist present at all sessions
Setting	Dr.SMCSI Medical College,Karakonam
Equipment	Nintendo Wii console, Wii Fit Balance Board, standard TV monitor

Table 3: Training Protocol Summary

4.4 Detailed Session-by-Session Protocol:

Session	Wii Fit Games	Duration
1	Pre-Test Assessment & Wii Sports (Tennis & Boxing) × 3 | Wii Fit Plus × 3 | Rock N' Roll Climber × 3 (Therapist assistance)	75 mins

2–5	Wii Sports (Tennis & Boxing) × 3 | Wii Fit Plus × 3 | Rock N' Roll Climber × 3 (Therapist assistance)	45 mins
6–7	Wii Sports (Tennis & Boxing) × 3 | Wii Fit Plus × 3 | Rock N' Roll Climber × 3 (Therapist assistance)	45 mins
8–9	Wii Sports (Tennis & Boxing) × 3 | Wii Fit Plus × 3 | Rock N' Roll Climber × 3 (Therapist assistance)	45 mins
10–11	Wii Sports × 3 | Wii Fit Plus × 3 | Rock N' Roll Climber × 3 (Independently)	45 mins
12–13	Wii Sports × 3 | Wii Fit Plus × 3 | Rock N' Roll Climber × 3 (Independently)	45 mins
14–15	Rock N' Roll Climber × 3 (Independent) | Incredible Maze × 3 | Equilibrio × 3 (Therapist assistance)	45 mins
16–18	Rock N' Roll Climber × 3 (Independent) | Incredible Maze × 3 | Equilibrio × 3 (Therapist assistance)	45 mins
19–20	Rock N' Roll Climber × 3 | Incredible Maze × 3 | Equilibrio × 3 (Independently)	45 mins
21–23	Rock N' Roll Climber × 3 | Incredible Maze × 3 | Equilibrio × 3 (Independently)	45 mins
24	Post-Test Assessment & Rock N' Roll Climber × 3 | Incredible Maze × 3 | Equilibrio × 3 (Independently)	75 mins

Table 4: Session-by-Session Wii Fit Game Protocol

5. Outcome Measure

Bilateral coordination of the upper limb was evaluated using the ABILHAND Questionnaire, a standardized, validated instrument widely used in stroke rehabilitation research to measure manual ability for bimanual activities.

Attribute	Description
Instrument	ABILHAND Questionnaire
Construct Measured	Bimanual manual ability in daily life activities
Scale Type	Rasch-built ordinal scale (logit scores)
Reliability	Good test-retest reliability (ICC > 0.90)
Validity	Validated for upper limb assessment in stroke populations
Assessment Timepoints	Pre-intervention (Day 1) and Post-intervention (Week 8)
Administrator	Trained physiotherapist blinded to session outcomes

Table 5: ABILHAND Outcome Measure — Key Attributes

6. Data Analysis:

Data were analyzed using descriptive and inferential statistics. Descriptive statistics (mean and standard deviation) summarized the ABILHAND scores at baseline and after intervention. A paired t-test was used to compare pre- and post-intervention scores to determine statistical significance.

6.1 Statistical Formula (Paired t-Test):

The paired t-test was computed as follows:

$$\mathbf{D = POST - PRE \rightarrow \Sigma D = 328 \rightarrow \bar{D} = 16.4}$$

$$SD = \sqrt{[\Sigma(D - \bar{D})^2 / (n-1)]} = 1.23$$

$$SE = SD / \sqrt{n} = 1.23 / \sqrt{20} \approx 0.275$$

$$\mathbf{t = \bar{D} / SE = 16.4 / 0.275 \approx 59.6}$$

6.2 Statistical Results Summary:

Parameter	Value	Interpretation

Number of Subjects (n)	20	Pilot study sample
Mean Pre-Intervention Score	30.40 ± 1.24	Baseline ABILHAND score
Mean Post-Intervention Score	46.85 ± 1.11	Post-intervention ABILHAND score
Mean Difference ($\bar{D}$)	16.45	Average improvement
Standard Deviation (SD)	1.23	Variability of differences
Standard Error (SE)	0.275	SE = SD / √n
Calculated t-value	59.6	$t = \bar{D} / SE$
Degrees of Freedom (df)	19	df = n – 1
p-value	< 0.001	Highly significant ($p < 0.05$)
Statistical Significance	Yes	Result is clinically significant

Table 6: Statistical Summary — Paired t-Test Results

7. Individual ABILHAND Scores — Pre and Post Intervention

Participant	Age (yrs)	Pre-Intervention Score	Post-Intervention Score	Difference
P1	40	32	48	**+16**
P2	47	30	47	**+17**
P3	54	31	46	**+15**
P4	61	29	47	**+18**
P5	68	33	49	**+16**
P6	45	30	47	**+17**
P7	52	28	44	**+16**
P8	59	31	46	**+15**
P9	66	32	49	**+17**
P10	43	30	46	**+16**
P11	50	29	47	**+18**
P12	57	31	47	**+16**
P13	64	30	47	**+17**
P14	41	32	47	**+15**
P15	48	31	47	**+16**
P16	55	29	46	**+17**
P17	62	30	46	**+16**
P18	69	31	48	**+17**
P19	46	30	46	**+16**
P20	53	29	47	**+18**
Mean	—	**30.40**	**46.85**	**+16.45**

SD	**—**	**1.24**	**1.11**	**1.23**

Table 7: Individual Pre- and Post-Intervention ABILHAND Scores with Differences (n = 20)

8. Graphical Representation of Results:

8.1 Pre vs Post ABILHAND Scores — All Participants:

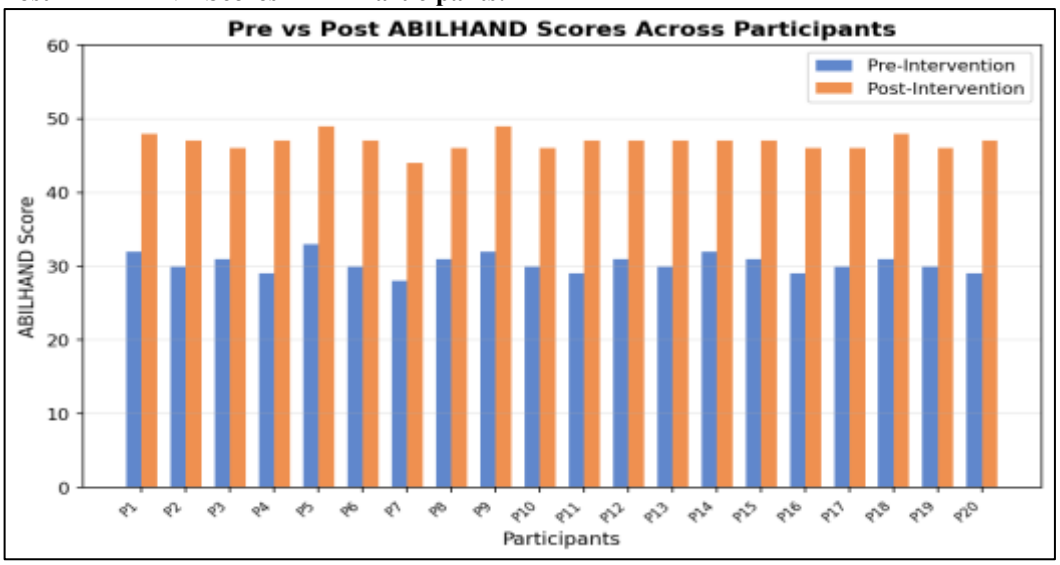

Figure 2: Pre- vs Post-Intervention ABILHAND Scores for All 20 Participants

8.2 Mean Score Comparison with Standard Deviation

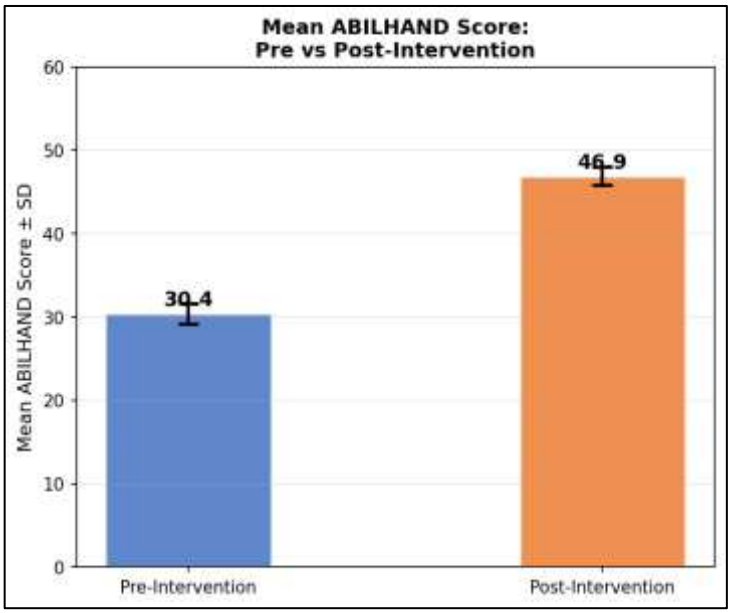

Figure 3: Mean ABILHAND Score Comparison — Pre vs Post-Intervention (Error Bars = ±1 SD)

9. Ethical Considerations:

The study adhered to the Declaration of Helsinki and relevant institutional ethical guidelines. Written informed consent was obtained from all participants prior to enrollment. Participants were free to withdraw at any time without consequence. Data were anonymized and kept confidential throughout the study.

Ethical Component	Details
Informed Consent	Written consent obtained from all 20 participants
Voluntary Participation	Withdrawal permitted at any point without penalty
Data Confidentiality	Participant data de-identified; stored securely
Adverse Effects Monitoring	Physiotherapist supervision throughout all sessions

Ethical Framework	Declaration of Helsinki guidelines followed

Table 8: Ethical Considerations Summary

9. Discussion:

The findings of this study suggest that virtual reality–based rehabilitation using the Nintendo Wii Fit Balance Board can significantly improve bilateral coordination of the upper limb in individuals with acute stroke. The improvements observed may be attributed to several factors. First, VR-based games provide repetitive, task-specific training, which is essential for motor recovery following stroke. Second, the interactive nature of the games increases patient motivation and engagement during therapy sessions. Third, visual and auditory feedback provided by the gaming system enhances motor learning and promotes neuroplastic changes in the brain. Previous studies have also reported positive outcomes with the use of Nintendo Wii–based interventions in stroke rehabilitation. These studies demonstrated improvements in balance, coordination, and upper limb function. As a pilot study, the results provide preliminary evidence supporting the use of virtual reality as an adjunct to conventional physiotherapy.

10. Limitations:

The study had several limitations:

- Small sample size (20 participants)
- Lack of a control group
- Short duration of intervention
- Limited generalizability of results

Future studies should include larger sample sizes and randomized controlled designs.

11. CONCLUSION

This pilot quasi-experimental study indicates that Nintendo Wii Fit Balance Board virtual reality games are an effective and engaging intervention for improving bilateral coordination of the upper limb in individuals with acute stroke. Incorporating virtual reality into conventional physiotherapy may enhance rehabilitation outcomes and improve functional recovery. Further large-scale studies are required to validate these findings and establish standardized VR rehabilitation protocols.

12. Clinical Implications:

- Virtual reality can be integrated into stroke rehabilitation programs.
- Nintendo Wii Fit Balance Board provides a cost-effective and motivating rehabilitation tool.
- It encourages active participation and repetitive movement training.

13. Future Recommendations:

- Conduct randomized controlled trials with larger sample sizes
- Investigate long-term effects of VR training
- Explore different virtual reality systems for stroke rehabilitation

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