

Virtual Reality on Balance in Patients with Parkinson's Disease: A Systematic Review and Meta-Analysis

Realidade Virtual no Equilíbrio de Pacientes com Doença de Parkinson: Uma Revisão Sistemática e Metanálise

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ABSTRACT

Introduction: Parkinson's disease (PD) is caused by a reduction in dopamine production, a neurotransmitter responsible for communication between neurons and coordination of movements. As PD progresses, patients tend to develop postural instability, which affects balance and exacerbates functional limitations. Physiotherapeutic interventions using Virtual Reality (VR) aim to improve and prevent complications associated with PD.

Objective: To review the impact of virtual reality on balance in patients with Parkinson's disease.

Methods: This is a systematic review and meta-analysis. A search was conducted in the PubMed, SciELO, LILACS, CENTRAL, and PEDro databases, including only randomized clinical trials published that investigated the use of virtual reality on balance in patients with Parkinson's disease. The keywords used were: virtual reality, Parkinson's disease, virtual reality rehabilitation, balance training, postural control, and postural balance, along with synonyms and related terms combined using the Boolean operators "AND" and "OR."

Results: Ten studies were included after selection. Overall, all studies analyzed demonstrated benefits of VR on the balance of individuals with PD, although there were variations in the magnitude of effects and in the assessment tools used. Virtual reality proved effective in improving balance in PD patients, showing an average improvement of 1.71 points (95% CI: 0.40 to 3.01).

Conclusion: The results of the randomized clinical trials included in this review indicate that virtual reality is an effective tool to improve balance in patients with Parkinson's disease.

Keywords: Parkinson Disease; Postural Balance; Virtual Reality.

RESUMO

Introdução: A doença de Parkinson (DP) é causada pela redução da produção de dopamina, um neurotransmissor responsável pela comunicação entre os neurônios e pela coordenação dos movimentos. Com a progressão da DP, os pacientes tendem a desenvolver instabilidade postural, o que compromete o equilíbrio e agrava as limitações funcionais. As intervenções fisioterapêuticas utilizando Realidade Virtual (RV) têm como objetivo melhorar o equilíbrio e prevenir complicações associadas à DP.

Objetivo: Revisar o impacto da realidade virtual sobre o equilíbrio de pacientes com doença de Parkinson.

Métodos: Trata-se de uma revisão sistemática e meta-análise. Foi realizada uma busca nas bases de dados PubMed, SciELO, LILACS, CENTRAL e PEDro, incluindo apenas ensaios clínicos randomizados publicados que investigaram o uso da realidade virtual sobre o equilíbrio de pacientes com doença de Parkinson. Foram utilizadas as seguintes palavras-chave: realidade virtual, doença de Parkinson, reabilitação com realidade virtual, treinamento de equilíbrio, controle postural e equilíbrio postural, juntamente com seus sinônimos e termos relacionados, combinados por meio dos operadores booleanos "AND" e "OR".

Resultados: Dez estudos foram incluídos após o processo de seleção. De modo geral, todos os estudos analisados demonstraram benefícios da realidade virtual sobre o equilíbrio de indivíduos com DP, embora tenham sido observadas variações na magnitude dos efeitos e nos instrumentos utilizados para avaliação. A realidade virtual mostrou-se eficaz na melhora do equilíbrio de pacientes com DP, apresentando uma melhora média de 1,71 pontos (IC 95%: 0,40 a 3,01).

Conclusão: Os resultados dos ensaios clínicos randomizados incluídos nesta revisão indicam que a realidade virtual é uma ferramenta eficaz para melhorar o equilíbrio de pacientes com doença de Parkinson.

Palavra-chave: Doença de Parkinson; Controle Postural; Equilíbrio; Realidade Virtual.

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INTRODUCTION

Parkinson's disease (PD) is caused by the death of dopaminergic neurons in the substantia nigra, leading to reduced cortical stimulation and decreased dopamine production, which is essential for motor coordination¹. This condition affects approximately 1.5–2% of the population over 65 years of age, with higher prevalence in men, making it the second most common neurodegenerative disease in this age group². Clinical signs include bradykinesia, rigidity, tremor, and postural changes, such as forward flexion of the trunk and head, in addition to festinating gait and postural instability, which significantly increase the risk of falls^{3,4} and impose limitations on balance and mobility⁵.

Impairments in balance and mobility lead to progressive functional disability⁶. Physiotherapeutic interventions, combined with pharmacological treatment, aim to improve daily activities, minimize complications, and delay functional decline, particularly with respect to balance and mobility^{7,8}. In addition to traditional programs including motor exercises, gait training, relaxation techniques, and visual, auditory, and somatosensory stimulation to promote safe and efficient motor patterns^{9,10} virtual reality (VR) has emerged as a new form of rehabilitation, representing a promising tool both for diagnostic and therapeutic purposes, particularly in rehabilitation¹¹.

VR has emerged as a promising approach to enhance balance rehabilitation in PD, providing multimodal stimuli and real-time feedback that foster motor learning and neuroplasticity¹². Non-immersive systems, such as the Nintendo Wii Fit and gamified platforms, as well as surface recordings and telerehabilitation tasks, have shown benefits in mobility, balance, and postural confidence¹³⁻¹⁵. Randomized clinical trials have demonstrated immediate improvements in balance scores and the Timed Up and Go (TUG) test, with effects comparable to or greater than those of conventional therapy¹⁶⁻¹⁹.

Recent meta-analyses indicate that VR training produces moderate to large gains in Berg Balance Scale scores and a reduction in TUG completion time, along with additional improvements in gait and postural confidence^{17,18}. Non-immersive VR telerehabilitation has also proven effective for static and dynamic balance, achieving outcomes comparable to face-to-face therapy in multicenter trials¹⁶.

However, further research with standardized protocols, larger sample sizes, and long-term follow-up is needed to consolidate evidence on efficacy, define optimal dosage, and assess sustainability of results^{14,17,19}. Therefore, this study aims to identify, through a systematic review and meta-analysis, the impacts of virtual reality on balance in patients with Parkinson's disease.

METHODS

Study Design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines²⁰. It is registered in PROSPERO (International Prospective Register of Systematic Reviews) under the registration number CRD420251103170.

Eligibility Criteria

For this systematic review, the PICOS strategy (Population, Intervention, Comparison, Outcomes, and Study design)²¹ was applied. The population consisted of patients diagnosed with Parkinson's disease. The intervention included virtual reality-based rehabilitation programs, compared either with conventional rehabilitation, no intervention, or other therapeutic approaches. The primary outcomes were balance-related measures, including static and dynamic balance assessments. Only randomized clinical trials were included.

Studies involving healthy individuals, pharmacological interventions alone, exercise programs without virtual reality, or interventions unrelated to balance rehabilitation in Parkinson's disease were excluded. There were no restrictions regarding language or year of publication.

Information Sources

A systematic search was conducted in the following electronic databases: PubMed (National Library of Medicine – NLM), SciELO (Scientific Electronic Library Online), LILACS (Latin American and Caribbean Health Sciences Literature), Cochrane Central Register of Controlled Trials (CENTRAL), and PEDro (Physiotherapy Evidence Database). The searches were performed from database inception until July 2025. In addition, the reference lists of relevant systematic reviews and eligible randomized clinical trials were manually screened to identify additional studies.

Search Strategy

The search was based on the previously described PICOS strategy²¹ and used the Boolean operators AND and OR. Specific descriptors were applied for the target population. The full PubMed search strategy was: ("Parkinson Disease"[Mesh] OR "Parkinson's disease") AND ("Virtual Reality"[Mesh] OR "Virtual Reality Rehabilitation")

AND ("Balance" OR "Postural Balance" OR "Postural Control").

Study Selection

Randomized clinical trials involving patients with Parkinson's disease were included in this systematic review. To be eligible, trials had to include patients with Parkinson's disease undergoing virtual reality interventions. Studies with adults (≥ 18 years), regardless of sex, were considered. Exclusion criteria included non-randomized studies, pharmacological therapies, balance disorders caused by other pathologies, exercise-based treatments without the use of virtual reality, studies applying virtual reality unrelated to Parkinson's disease, and balance disorders.

Data Collection Process

Titles and abstracts were initially screened by two independent reviewers, followed by full-text assessment of potentially eligible studies. After study selection, data extraction was performed using a standardized form. The extracted information included author, year of publication, country, study design, sample size, participant characteristics, intervention and comparison groups, assessment instruments, and main results. Disagreements were resolved by discussion, and when necessary, a third reviewer was consulted.

Data Items

Two authors independently extracted data from the included studies using a standardized data extraction form. The following items were collected: (1) study identification (author, year, country); (2) methodological characteristics (study design); (3) sample characteristics (sample size and participant groups); (4) intervention and comparator characteristics; (5) assessment instruments; and (6) main outcomes/results.

Quality of Each Study

Methodological quality was assessed using the PEDro scale¹⁵, which evaluates 11 items: (1) eligibility criteria; (2) random allocation; (3) concealed allocation; (4) baseline comparability; (5) blinding of participants; (6) blinding of therapists; (7) blinding of assessors; (8) adequate follow-up; (9) intention-to-treat analysis; (10) between-group statistical comparisons; and (11) point estimates and variability. Each item (except the first) is scored as present (1) or absent (0), resulting in a maximum score of 10.

Whenever possible, PEDro scores were extracted directly from the PEDro database. When articles were not

available in the PEDro database, two trained independent reviewers assessed the study using the PEDro scale. Studies scoring ≥ 6 were considered high quality, while those scoring < 6 were considered low quality.

Synthesis of Results

An evidence table was created containing information from the included studies. Due to heterogeneity among the studies, the results are described narratively, and a meta-analysis was performed only for outcomes related to static balance. It was not possible to assess publication bias using funnel plots.

Regarding balance outcomes, heterogeneity was assessed using the Chi-square test and the I^2 statistic. This statistic illustrates the percentage of variability in effect estimates attributable to heterogeneity rather than sampling error.

Statistical Analysis

The mean difference between groups and the corresponding 95% confidence intervals were calculated and used to quantify the effect of continuous outcomes. For meta-analyses in which the studies used the same scales, the results were presented as mean difference (MD) with 95% confidence intervals. Otherwise, effect sizes were calculated using standardized mean difference (SMD) with 95% confidence intervals.

The magnitude of intervention effects was defined as small ($MD < 10\%$ of the scale or $SMD < 0.4$), moderate ($MD = 10\% - 20\%$ of the scale or $SMD = 0.41 - 0.7$), or large ($MD > 20\%$ of the scale or $SMD > 0.7$)¹⁶.

RESULTS

Selection of the Studies

The database search identified a total of 70 records, including 41 from PubMed, 162 from PEDro, 14 from CENTRAL, 3 from SciELO, and 6 from LILACS. After removal of 5 duplicates, 65 records remained for title and abstract screening. Of these, 46 were excluded for not meeting the eligibility criteria. Seventeen full-text articles were assessed for eligibility. Nine studies were excluded because they combined virtual reality with other exercise-based interventions without isolating the effects of VR on balance outcomes. Consequently, ten randomized clinical trials were included in the qualitative synthesis (systematic review). Among these, seven studies provided sufficient and homogeneous data regarding balance outcomes to be included in the meta-analysis (Figure 1).

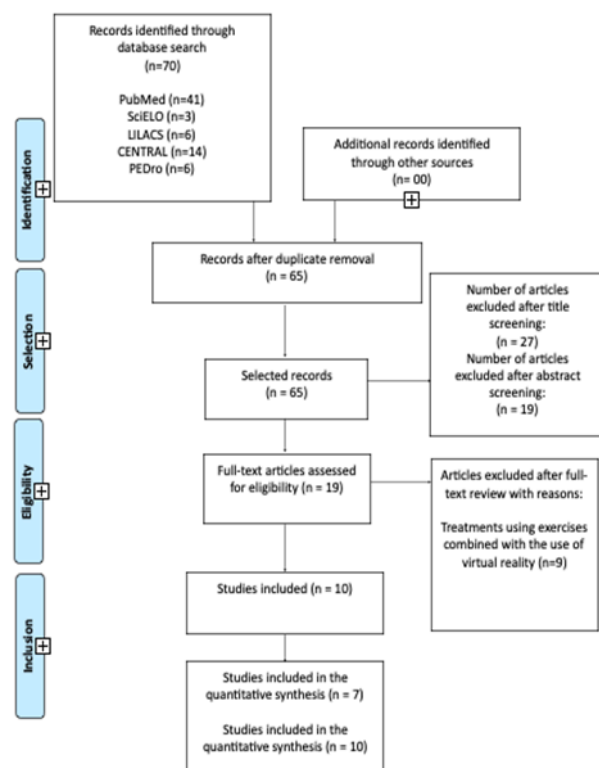


Figure 1: Flowchart of the study selection process.

Table 1. General data of the articles selected for obtaining the results.

Study (Author/year)	Study design Country	Sample	Participants	Groups		Mensure	Results	PEDro scale
				Intervention	Control			
Yen et al.(2011) ¹⁶	Prospective, single-blind, randomized, controlled clinical trial Taiwan	42	42 patients with Parkinson's disease (33 men and 9 women) Mean age: 70 ± 6	Received VR training – 30 minutes, twice a week, for 6 weeks	Conventional balance training – each session included 10 minutes of stretching exercises and 20 minutes of intervention.	SOTs	The VR group increased the equilibrium score of SOT-6 (vestibular organization under unreliable vision) after training significantly more ($P<.001$) than the control group	6
Santos et al.(2019) ¹⁷	Randomized clinical trial Brazil	45	45 patients with Parkinson's disease (31 men and 14 women) Mean age: 64 ± 8	Received VR training – sessions lasted 50 minutes, twice a week, with evaluations conducted before and after the 2-month intervention.	Performed only conventional exercises. These were carried out through diagonal, active-assisted, and resisted active movements, based on proprioceptive neuromuscular facilitation (PNF) patterns in the upper limbs, scapula, pelvis, and lower limbs.	BBS	The combination of Nintendo Wii and CE was statistically as effective as each intervention alone in improving balance.	7
Feng et al.(2019) ¹⁸	Randomized, single-blind controlled trial China	28	28 patients with Parkinson's disease (17 men and 11 women) Mean age: 67 ± 4.7	Received VR training – 45-minute sessions, 5 days a week, for 12 weeks.	Received conventional physiotherapy (traditional rehabilitation training according to the 2014 edition of the Chinese Guide to Treatment of PD)	BBS	After treatment, BBS improved significantly in both groups ($P < 0.05$).	6

Participants:

A total of 486 patients received the intervention in the studies included in this review. Age ranged from 44 to 72 years, encompassing both sexes. Table 1 provides a summary of the main studies related to the topic and their results.

Methodological Quality Results

Methodological quality assessed by the PEDro scale is summarized in Table 2, while the complete item-by-item PEDro scoring is provided in Supplementary Table S2. Five studies were classified as moderate quality and three as high quality.

Yang <i>et al.</i> (2016) ¹⁹	Randomized controlled trial	23	23 patients with Parkinson's disease (14 men and 9 women) Mean age: 74 ± 7 years	Trained with a customized VR-based balance training system – 50-minute training sessions during a 6-week training period.	Trained by a licensed physiotherapist.	BBS	A significant main effect of time was found ($p < 0.001$), although no significant group main effect ($p = 0.893$) or group × time interaction ($p = 0.786$) was observed.	8
Liao <i>et al.</i> (2015) ²⁰	Randomized, stratified, single-blind controlled trial Taiwan	36	36 patients with Parkinson's disease (17 men and 19 women) Mean age: 65 ± 7 years	Wii Fit-based virtual reality exercise (45 minutes), followed by 15 minutes of treadmill training in each session, for a total of 12 sessions over 6 weeks.	Did not receive any structured exercise program.	Limits of stability.	Both the VRWii and the TE groups exhibited significant improvements in MV and SOT compared with the control group after training and at the 1-month follow-up	8
Pazzaglia <i>et al.</i> (2020) ²¹	Prospective, single-blind, randomized controlled trial Italy	51	51 patients with Parkinson's disease 35 men and 16 women Mean age: 71 ± 8 years	Virtual Reality (VR) rehabilitation program for 6 consecutive weeks, 40-minute sessions, three times per week	Conventional rehabilitation program	BBS	The VR rehabilitation program resulted in a significant improvement in BBS scores compared with conventional rehabilitation (45.6 [SD 7.9] vs. 49.2 [SD 8.1]; mean difference 3.6; 95% CI 1.3 to 5.9; $P = 0.003$).	5
Kashif <i>et al.</i> (2024) ²²	This two-arm, parallel-design clinical trial Pakistan	60	60 patients with Parkinson's disease (33 men and 27 women; mean age 63 ± 4 years)	The experimental group underwent three 60-minute sessions per week for 12 weeks, which included 15–20 minutes of VR training in addition to 40 minutes of conventional physiotherapy.	Conventional physiotherapy.	BBS	In the VR + physiotherapy group, the mean BBS score increased from 37.15 ± 3.437 at baseline to 50.10 ± 4.897 at week 12, with a statistically significant improvement ($p = 0.019$).	6
Gandolfi <i>et al.</i> (2017) ²³	Multicenter single-blind randomized clinical trial Italy	76	76 patients with Parkinson's disease 51 men and 25 women Mean age: 68 ± 8 years	Home-based VR telerehabilitation (21 sessions of 50 minutes each, 3 days/week for 7 consecutive weeks).	Sensory integration balance training in the clinic.	BBS	The analysis revealed significant differences between groups in Berg Balance Scale improvement, favoring the VR telerehabilitation group ($p = 0.04$).	6
Shin <i>et al.</i> ²⁴	Subject-blinded, randomized controlled trial Taiwan	20	20 patients with Parkinson's disease 16 men and 4 women	BE group received a 30-min balance-based exergaming intervention using the Kinect sensor (two sessions every week, for 8 weeks)	Participants in the BT group underwent a 30-min conventional balance training session	BBS	Balance-based exergaming training resulted in a greater improvement in postural stability compared with conventional balance training	6
Goffredo <i>et al.</i> ²⁵	multicentre randomized controlled trial Italy	105	105 patients with Parkinson's disease 51 men and 46 women Mean age: 68 ± 6 years	The TG consisted of 30 sessions lasting approximately 45 minutes (3-5/week for 6-10 weeks) of motor, and cognitive rehabilitation exercises in non-immersive VR-based TR modality	The CG carried consisted of 30 sessions lasting approximately 45 minutes (3-5 days/week for, 6-10 weeks) of at home self-administered structured conventional exercises	BEST	Our results showed that non-immersive virtual reality-based telerehabilitation improves static and dynamic balance	7

VR – Virtual Reality; CT – Conventional Training; PD – Parkinson's Disease; CE – Conventional Exercise; BBS – Berg Balance Scale; PT – Physical Therapy

Table 2. Methodological quality analysis of the studies based on the PEDro scale, which qualifies and quantifies randomized clinical trials.

Classification of Articles on the PEDro Scale												
Study	1*	2	3	4	5	6	7	8	9	10	11	Total
Yen et al. ¹⁶	-	1	0	1	0	0	1	0	1	1	1	6
Santos et al. ¹⁷	-	1	0	1	0	0	1	1	1	1	1	7
Feng et al. ¹⁸	-	0	0	1	0	0	1	1	1	1	1	6
Yang et al. ¹⁹	-	1	0	1	0	0	1	1	1	1	1	8
Liao et al. ²⁰	-	1	1	1	0	0	1	1	1	1	1	8
Pazzaglia et al. ²¹	-	1	0	1	0	0	1	0	0	1	1	5
Kashif et al. ²²	-	1	0	1	0	0	1	1	0	1	1	6
Gandolfi et al. ²³	-	1	0	1	0	0	1	1	0	1	1	6
Shin et al. ²⁴	-	1	0	1	0	0	1	1	0	1	1	6
Goffredo et al. ²⁵	-	1	1	1	0	0	1	1	0	1	1	7

PEDro Scale Items: (1) Eligibility criteria were specified (* – this item is not used to calculate the PEDro score); (2) Subjects were randomly allocated to groups; (3) Allocation was concealed; (4) The groups were similar at baseline regarding the most important prognostic indicators; (5) All subjects were blinded; (6) All therapists who administered the therapy were blinded; (7) All assessors who measured at least one key outcome were blinded; (8) Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups; (9) All subjects for whom outcome measures were available received the treatment or control condition as allocated, or when this was not the case, data for at least one key outcome were analyzed by intention to treat; (10) The results of between-group statistical comparisons are reported for at least one key outcome; (11) The study provides both point measures and measures of variability for at least one key outcome.

Abbreviations: 1 = Item present; 0 = Item absent; a = High methodological quality; b = Moderate methodological quality; c = Low methodological quality.

Table 2 Supplementary Information:**PICOS Strategy**

- Population: Patients with Parkinson's disease
- Intervention: Virtual reality rehabilitation
- Comparison: Conventional rehabilitation, no intervention, or other therapies
- Outcomes: Balance and postural control
- Study design: Randomized clinical trials

Databases Searched

- PubMed
- SciELO
- LILACS
- CENTRAL
- PEDro

Search Period

From database inception to July 2025.

Example of PubMed Search Strategy

("Parkinson Disease"[Mesh] OR "Parkinson's disease") AND ("Virtual Reality"[Mesh] OR "Virtual Reality Rehabilitation") AND ("Balance" OR "Postural Balance" OR "Postural Control")

Intervention

The VR protocols involved structured sessions held 2 to 5 times per week, over periods ranging from 4 to 12 weeks, with an average duration of 30 to 60 minutes per session. The interventions generally used immersive or semi-immersive virtual environments, delivered through commercial platforms (such as the Nintendo Wii™) or VR systems specifically developed for therapeutic purposes. The tasks included movements aimed at training dynamic and static balance, gait, weight shifting, anticipation and response to obstacles, as well as interactive games that required attention, motor coordination, and rapid

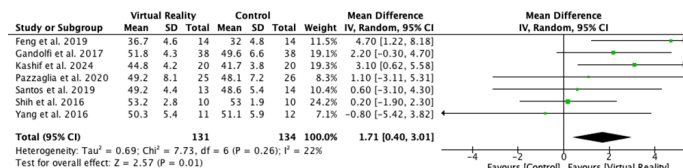
responses to multisensory stimuli.

The Nintendo Wii™, for instance, was widely used as a low-cost tool for balance and motor coordination training, combining games such as Wii Fit, Table Tilt, and Ski Slalom with conventional exercises¹⁷. Other approaches used motion capture systems or VR-based telerehabilitation to promote real-time postural adjustments, providing immediate visual feedback to the patient^{19,23}.

In addition, several studies emphasized the use of progressive tasks with increasing levels of difficulty, aiming to stimulate neuroplasticity and motor learning. Gamification elements were incorporated to enhance motivation, adherence, and participant engagement.

Virtual reality and balance

Six studies^{17-19,21-23} analyzed the impact of virtual reality on balance in patients with Parkinson's disease. For the meta-analysis of this comparison, a random-effects model was used ($I^2 = 2\%$, $df = 5$, $p = 0.41$), which showed a statistically significant difference between groups when comparing virtual reality and control (mean difference = 2.26 points; 95% CI, 0.94 to 3.57; Fig. 2).

**Figure 2.** Forest plot of the impact of virtual reality on balance

SD = Standard Deviation; IV = Inverse Variance; CI = Confidence Interval; Z = Estatística do teste Z; χ^2 = Teste do qui-quadrado para heterogeneidade; I^2 = Índice de heterogeneidade.

DISCUSSION

The present study aimed to compare the results of different randomized clinical trials investigating the effects of virtual reality (VR) on balance in patients with Parkinson's disease (PD). Overall, all the studies analyzed demonstrated benefits of VR on balance in individuals with PD, although variations were observed in the magnitude of the effects and in the assessment instruments used.

Feng et al.¹⁸, Yang et al.¹⁹, Kashif et al.²², and Pazzaglia et al.²¹ reported significant improvements in BBS scores following VR interventions. In the study by Kashif et al.²², the improvement in the group that combined VR with conventional physiotherapy was robust, with the mean score increasing from 37.15 to 50.10, a clinically meaningful gain. Pazzaglia et al.²¹ also highlighted a relevant increase of 3.6 points in the BBS score in the VR group compared with conventional rehabilitation. These findings suggest that the incorporation of VR into clinical practice may enhance the traditional effects of physiotherapy on functional aspects related to balance.

The study by Gandolfi et al.²³ provides an important contribution by demonstrating that

telerehabilitation with virtual reality was more effective than traditional sensory training conducted in clinical settings. This finding highlights the feasibility of using VR in home-based environments, particularly for populations with limited access to in-person rehabilitation. Such a strategy may increase adherence and continuity of treatment, which are key elements for the long-term management of Parkinson's disease.

On the other hand, Santos *et al.*¹⁷, when investigating the combination of VR and conventional exercises, observed that both isolated and combined interventions were effective in improving balance, with no statistically significant differences between them. This result may reflect a possible saturation of the therapeutic effect, suggesting that the addition of further motor stimuli (such as combining methods) does not always lead to incremental benefits.

In the study by Yen *et al.*¹⁶, which used the Sensory Organization Test as the outcome measure, improvements in sensory integration were observed following VR training, an important finding that complements other studies by suggesting a physiological mechanism underlying balance improvement. By providing multisensory environments with visual and proprioceptive challenges, VR appears to promote the reorganization of sensory inputs and their functional integration, particularly in a population with sensory and motor deficits such as patients with PD.

The use of commercial systems such as Wii Fit, as demonstrated by Liao *et al.*²⁰, was also shown to be effective, even when compared with a control group without structured intervention. This raises a discussion about the role of engagement and motivation, often stimulated by the playful elements of VR, as facilitating factors for adherence and therapeutic outcomes.

It is also important to consider the heterogeneity among the studies, such as intervention duration, session frequency, and the severity of PD in participants. Despite these methodological differences, the consistency of the results suggests a strong positive effect of VR on improving functional balance.

Thus, the findings discussed here reinforce that VR, whether applied alone, in combination with conventional therapy, or adapted for home use, is an effective and versatile tool in the management of postural instability in Parkinson's disease. However, future studies should investigate the long-term effects, strategies to individualize VR programs, and the cost-effectiveness of incorporating VR into clinical practice.

Despite the positive findings, this review presents some limitations that should be considered. The small number of randomized clinical trials included may limit the generalizability of the results. In addition, there was heterogeneity among studies regarding intervention protocols, duration and frequency of sessions, as well as the tools used to assess balance, which may have influenced the magnitude of the observed effects. Another relevant

point is the lack of standardization in the virtual reality technology employed, ranging from immersive to semi-immersive and non-immersive systems, which makes direct comparisons across results difficult. Finally, the relatively small sample sizes of some studies and the absence of long-term follow-up restrict the understanding of the sustainability of the observed benefits.

CONCLUSION

The results of the randomized clinical trials analyzed in this study indicate that virtual reality is an effective tool for improving balance in patients with Parkinson's disease. VR therefore emerges as a promising resource in neurological rehabilitation, particularly due to its ability to promote engagement, motor repetition, and multisensory stimulation. However, future research with larger samples, standardized interventions, and long-term follow-up is recommended to consolidate the effectiveness and sustainability of the benefits of virtual reality in this population.

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