

Review

Effectiveness of Virtual Reality Training in Improving Outcomes for Dialysis Patients: Systematic Review and Meta-Analysis

Xin Kang^{*}, MScN; Yiping Zhang^{*}, MScN; Chaonan Sun, MScN; Jiaxin Zhang, MScN; Zhe Che, MScN; Jinhui Zang, MScN; Rongzhi Zhang, BN, MSc

Department of Center for Hemodialysis, The Second Hospital of Dalian Medical University, Dalian, China

^{*}these authors contributed equally

Corresponding Author:

Rongzhi Zhang, BN, MSc

Department of Center for Hemodialysis

The Second Hospital of Dalian Medical University

467, Zhongshan Road

Shahekou District, Liaoning Province

Dalian, 116000

China

Phone: 86 17709870601

Email: zhangxinzhi169@163.com

Abstract

Background: Virtual reality (VR) training uses computer-generated simulations that enable users to engage with immersive virtual environments, simulating real-world activities or therapeutic exercises. This technology is increasingly recognized as a promising intervention to address the physical and psychological challenges faced by dialysis patients, who frequently experience diminished physical function, social isolation, and emotional distress associated with prolonged treatment regimens. Given the increasing prevalence of dialysis patients and the limitations of conventional rehabilitation approaches, VR presents a novel, interactive method that has the potential to enhance patient well-being and improve quality of life.

Objective: This meta-analysis aimed to evaluate the effectiveness of VR training interventions for dialysis patients, with a focus on assessing their impact on motor abilities, psychological symptoms (specifically anxiety and depression), social functioning, and self-efficacy. This analysis also explores whether VR can offer comprehensive benefits to support both the physical and mental health of dialysis patients.

Methods: The meta-analysis was conducted following Cochrane guidelines. Comprehensive searches were performed across major databases, including China National Knowledge Infrastructure, Wanfang database, China Science and Technology Journal Database, China Biomedical Literature database, Cochrane library, Web of Science, PubMed, and Embase, encompassing all studies up to December 2023. Inclusion criteria targeted studies assessing VR's impact on motor performance, psychological well-being, social functioning, and self-efficacy in dialysis patients. Two reviewers independently extracted data and assessed methodological quality using Cochrane's risk of bias criteria, ensuring data synthesis reliability.

Results: A total of 12 studies, involving 625 dialysis patients in total, met the inclusion criteria. The meta-analysis demonstrated that VR training led to significant improvements across multiple domains. VR interventions were associated with improved physical capacity, evidenced by higher scores in the 6-minute walk test (standardized mean difference [SD]=29.36, 95% CI 14.32-44.4, $P<.001$, $I^2=46%$). VR training was associated with significant reductions in depression (SD=-6.30, 95% CI -7.14 to -5.47, $P<.001$, $I^2=96%$) and anxiety (SD=-8.91, 95% CI -9.69 to -8.14, $P<.001$, $I^2=95%$). In addition, VR interventions enhanced social functioning (SD=16.20, 95% CI 14.49-17.9, $P<.001$, $I^2=72%$), and improved self-efficacy (SD=20.47, 95% CI 18.55-22.39, $P<.001$, $I^2=99%$). However, VR training did not yield significant differences in gait speed, balance, or functional tests (Ten Sit-to-Stand Test, Five Sit-to-Stand Test, Sixty Sit-to-Stand Test, Timed Up and Go Test, and fatigue) compared with control groups.

Conclusions: The findings suggest that VR training is a promising intervention for dialysis patients, providing benefits in physical endurance, social engagement, and psychological well-being. Despite these advantages, VR remains underused among peritoneal dialysis patients compared with hemodialysis patients. Further studies with larger sample sizes and more refined

experimental designs are recommended to validate these results and support VR as a complementary tool in the holistic care of dialysis patients.

(*J Med Internet Res* 2025;27:e58384) doi: [10.2196/58384](https://doi.org/10.2196/58384)

KEYWORDS

virtual reality; VR; training; dialysis; hemodialysis; peritoneal dialysis; chronic kidney disease; rehabilitation; quality of life; meta-analysis

Introduction

End-stage renal disease (ESRD) signifies a severe impairment in kidney function, rendering the body incapable of meeting normal metabolic demands. This condition is chronic and progressive, with a global prevalence reaching 442.13 per million [1]. Dialysis, encompassing both hemodialysis (HD) and peritoneal dialysis (PD), serves as a common therapeutic approach for ESRD, substituting renal filtration function albeit necessitating frequent hospital visits, significantly impacting patients' lives. Prolonged dialysis treatment often precipitates complications such as anemia, muscle wasting, skeletal disorders, and cardiovascular ailments. Exercise therapy plays a pivotal role in managing patients with ESRD by yielding multifaceted benefits, including enhancements in cardiovascular function [2], alleviation of fatigue and sleep disturbances, bolstering mental health by mitigating anxiety and depression [3], regulating blood pressure, managing anemia [4], and optimizing dialysis adequacy [5]. Furthermore, regular exercise effectively retards the deterioration of muscle strength [6] and maintains superior physical function. Despite extensive research corroborating the merits of exercise in augmenting hemodialysis patients' quality of life, there remains a notable deficiency in exercise awareness, knowledge application, and adherence among patients with ESRD [7] predominantly attributable to inadequate comprehension, deficient self-management skills, and low compliance levels.

Virtual reality (VR) technology represents a computer-generated simulation environment enabling user interaction within virtual realms, engendering an immersive experience that transports individuals into diverse environments [8]. Within the medical sphere, VR has gained traction and is increasingly adopted. VR facilitates immersive encounters that divert patients' attention from the discomfort and anxiety associated with medical procedures, such as dialysis treatment [9]. By creating immersive and interactive virtual environments, VR offers a unique platform to improve operational skills, health knowledge, and psychological resilience among these patients.

The application of VR in dialysis begins with its role in enhancing operational skills and ensuring treatment safety. Patients can engage in simulated environments that replicate dialysis machine operations and scenarios. This allows them to practice procedures and familiarize themselves with equipment without the inherent risks associated with real-world settings. Such training not only reduces procedural errors but also boosts confidence and competence in managing treatments, ultimately contributing to better treatment adherence and patient safety.

In addition, VR serves as a powerful educational platform in dialysis care. It facilitates the delivery of comprehensive health education, covering critical aspects such as medication management, dietary guidelines, and health monitoring techniques [10]. By engaging patients in interactive simulations, VR enables them to acquire a deeper understanding of their treatment regimen and develop essential self-management skills. This educational empowerment is pivotal in encouraging patients to take an active role in their health management, thereby improving treatment outcomes and enhancing overall quality of life.

Furthermore, VR addresses the significant psychological challenges faced by dialysis patients. Long-term treatment often leads to emotional stress and psychological burdens, including conditions such as anxiety and depression. VR environments provide a therapeutic avenue for relaxation and emotional support. Patients can participate in virtual mindfulness exercises, guided relaxation sessions, or social interactions within a controlled setting. These activities help alleviate stress, improve mood, and foster emotional resilience among patients, thereby enhancing their psychological well-being.

VR training offers significant advantages over traditional physical therapy for treating dialysis patients. First, VR technology provides highly immersive experiences that enhance patient engagement and motivation. Dialysis patients often face long-term treatments and physical limitations, and VR environments immerse them in compelling experiences that encourage greater participation in rehabilitation training. Second, VR allows for personalized treatment plans tailored to individual patient needs, including adjusting training difficulty and environment to accommodate varying abilities and therapeutic requirements. This personalized approach enhances treatment efficacy and specificity.

Furthermore, VR training provides a safer therapeutic environment with better control mechanisms. Conducting exercises and rehabilitation in virtual environments reduces real-world safety risks for patients, while health care teams can monitor progress and responses in real time to adjust treatment plans promptly. In addition, VR systems can collect detailed data such as movement skills and physiological responses, offering crucial insights for health care professionals to optimize treatment plans and deliver personalized care.

Conducting a meta-analysis on the application of VR in dialysis patients holds significant clinical implications. Systematically synthesizing data from multiple studies allow for a comprehensive evaluation of VR therapy's actual impact on improving quality of life and enhancing rehabilitation outcomes in dialysis patients. Such meta-analysis not only compares VR

training with traditional physical therapy but also identifies potential biases and inconsistencies in research, providing scientific grounds for designing future clinical trials and refining treatment strategies. Therefore, exploring the effectiveness of VR through meta-analysis in dialysis patients not only deepens understanding of its clinical role but also informs future clinical decisions and rehabilitation strategies based on robust scientific evidence.

Methods

Overview

This meta-analysis was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. The PRISMA checklist is provided in [Multimedia Appendix 1](#).

Textbox 1. Inclusion and exclusion criteria.

Inclusion criteria

- Study design: randomized controlled trials following the Population, Intervention, Comparison, Outcome framework.
- Population: adults aged ≥ 18 years undergoing dialysis (hemodialysis or peritoneal dialysis).
- Intervention: exercise training incorporating virtual reality.
- Comparison: conventional hemodialysis care interventions (including health education and routine exercise) or exercise not based on virtual reality.
- Outcome measures: motor ability, psychological symptoms, social functioning, and self-efficacy.
- Language: studies published in Chinese or English.

Exclusion criteria

- Duplicate publications.
- Non-Chinese or non-English literature.
- Studies with incomplete data (eg, missing outcome indicators).
- Conference abstracts and review articles.

Data Extraction

Two researchers independently extracted data from the included studies, including details such as author, publication year, country, sample size, intervention specifics, and outcome measures. Studies were initially screened based on titles and abstracts, followed by a full-text review to ensure they met the inclusion criteria. Discrepancies between the 2 researchers were resolved through discussion, and if consensus could not be reached, a third researcher was consulted for final arbitration.

To ensure comprehensive data extraction, we contacted study authors by email to request missing or unclear data. Studies with unresolved data issues were excluded from the meta-analysis.

Quality Assessment of Literature

The quality of included studies was assessed using the Cochrane Collaboration's risk of bias tool. We evaluated studies on several criteria, such as random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective

Search Strategy

We conducted a comprehensive literature search across 8 databases, namely China National Knowledge Infrastructure (CNKI), Wanfang database, China Science and Technology Journal Database, China Biomedical Literature database (SinoMed), Cochrane library, Web of Science, PubMed, and Embase. We used a combination of subject terms and free terms tailored to each database. The search was performed for studies published from inception up to December 2023. Two researchers independently executed the searches and managed the retrieved literature using EndNote software. Detailed search strategies for each database are provided in [Multimedia Appendix 2](#).

Inclusion and Exclusion Criteria

[Textbox 1](#) shows the inclusion and exclusion criteria.

reporting, and other potential biases. Each criterion was classified as low risk, unclear risk, or high risk of bias [11].

Statistical Methods

Statistical analyses were performed using RevMan (version 5.4) software and State (version 17) provided by the Cochrane Collaboration. We analyzed both continuous and dichotomous variables, reporting relative risk with 95% CIs. A fixed-effects model was used for the meta-analysis of outcome indicators. We assessed heterogeneity among studies using the chi-square test and I^2 -squared (I^2) statistic, with I^2 values of 25%, 50%, and 75% indicating low, moderate, and high levels of heterogeneity, respectively. Publication bias was evaluated through funnel plots and Egger regression test [12]. A 2-tailed P value of ≤ 0.05 was considered statistically significant [13]. Due to the limited number of studies, further subgroup and sensitivity analyses were not performed.

In cases where data were incomplete or unclear, we sought additional information from the authors. Studies for which relevant data could not be obtained were excluded from the systematic review and meta-analysis.

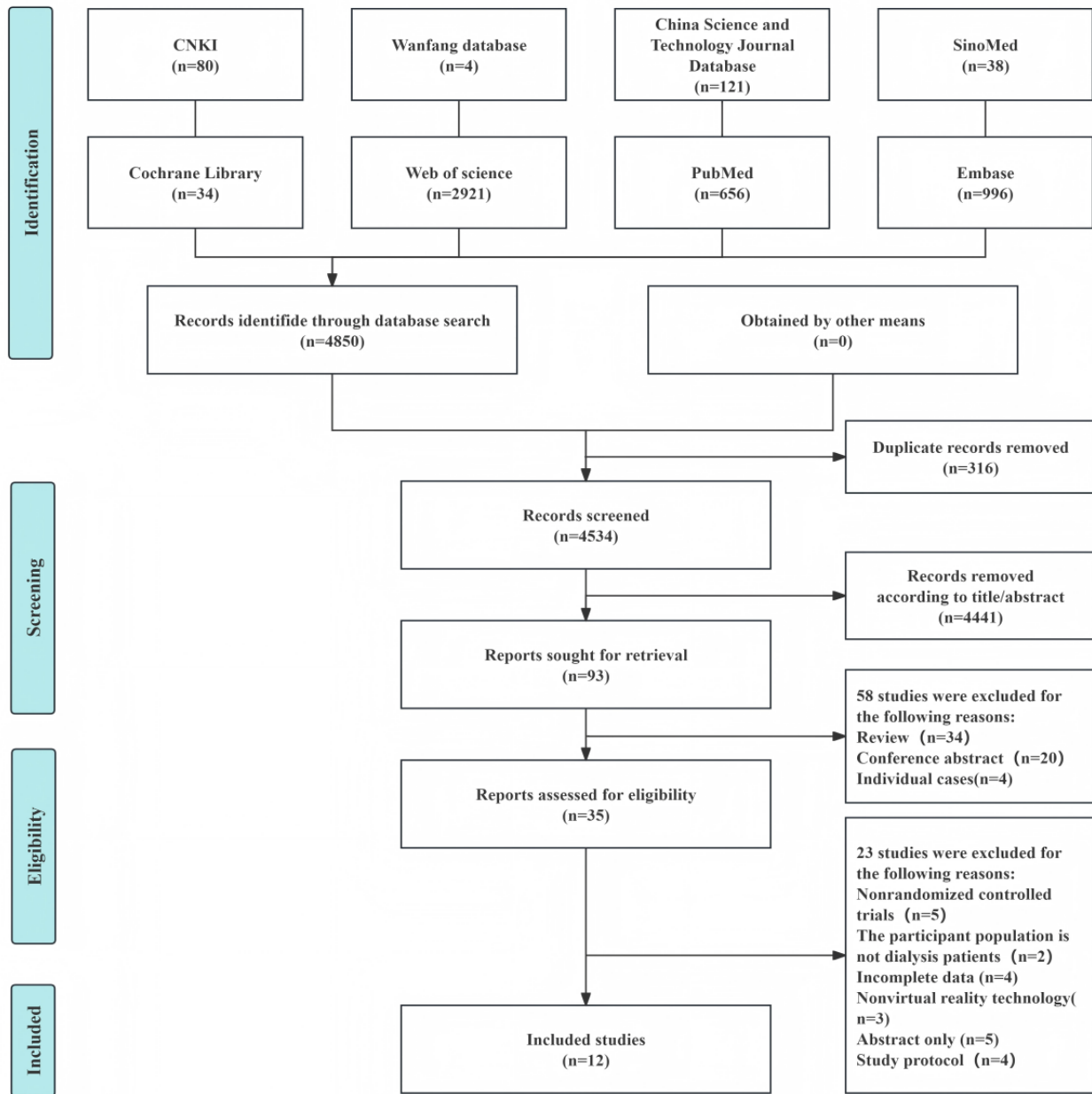
Results

Results of Literature Search

A total of 4850 articles were initially retrieved from the literature search, comprising 80 from CNKI, 4 from Wanfang database,

121 from China Science and Technology Journal Database, 38 from SinoMed, 34 from the Cochrane library, 2921 from Web of Science, 656 from PubMed, and 996 from Embase. After a systematic screening process, 12 articles were ultimately included. The detailed screening process and the reasons for exclusion are illustrated in Figure 1.

Figure 1. Flowchart of the study selection process.



Basic Characteristics of Included Studies

The included studies were conducted across 7 countries: namely, Poland [14], Spain [15,16], China [17-21], Qatar [22], South Korea [23], Germany [24], and Brazil [25]. One study used a 3-arm design [24], while the remaining 11 studies used a 2-arm design. Of the 12 trials, 2 focused on patients undergoing PD, while the remaining 10 involved patients undergoing HD [17,21]. Five trials compared VR training with conventional care [18-21,23], 2 trials included specified interventions in the

control group [14,16], and the remaining trials compared VR training with other types of interventions, such as printed materials [17], exercise programs based on daily habits [15,18], and nurse-led exercise programs [16,22]. Summary of included studies are provided in Multimedia Appendix 3. Details regarding the number of participants, interventions, and outcomes are presented in Table 1. Further information on the interventions under experimental and control conditions is detailed in Multimedia Appendix 2.

Table 1. Characteristics of the 12 included studies.

Study	Country	Type	Number (n)			Duration	Time of data collection	Outcomes
			Total	Experimental group	Control group			
Turoń-Skrzypińska et al [14]	Poland	HD ^a	85	39	46	1 year	At the time of entering the research project and following month 3	Depression and anxiety
Lee et al [17]	China	PD ^b	23	12	11	8 times	At baseline (pretreatment), within the first week after recruitment, and at posttreatment	Knowledge proficiency, procedure competence, and self-efficacy
Segur - Ortí et al [15]	Spain	HD ^a	18	9	9	20 weeks	At baseline, after 16 weeks of intradialysis combined exercise, and by the end of four additional weeks of exercise	STS-10 ^c , STS-60 ^d , gait speed, one-leg heel-rise tests, and 6MWT ^e
Martínez-Olmos et al [16]	Spain	HD ^a	56	28	28	12 weeks	At baseline, at 12 weeks, and at 24 weeks	The 4-m gait speed test, SPPB ^f , TUG ^g test, OLST ^h for balance, STS-10 ^c , STS-60 ^d , 6MWT ^e , and adherence to the exercise program
Lei et al [18]	China	HD ^a	42	21	21	6 months	Before enrollment, at 3 months, and 6 months after enrollment	Self-efficacy for exercise, risk of falls, and quality of life
Zhou et al [22]	Qatar	HD ^a	73	37	36	4 weeks	At baseline and at 4 weeks	Depression and user experience
Chou et al [19]	China	HD ^a	64	32	32	4 weeks	Before intervention and after 4 weeks of intervention	Fatigue, BUN ⁱ , creatinine, albumin, and hemoglobin
Cho and Sohng [23]	South Korea	HD ^a	46	23	23	8 weeks	At baseline and after intervention	Physical fitness, body composition, and fatigue
Schinner et al [24]	Germany	HD ^a	32	12+9	11	12 weeks	— ^j	Functional capacity, serum biochemistry, muscle strength, muscle circumference, and body composition
Maynard et al [25]	Brazil	HD ^a	40	20	20	12 weeks	After intervention	Functional capacity, quality of life, and depressive symptoms
Xuelian et al [20]	China	HD ^a	70	35	35	— ^j	Before intervention and after intervention	Anxiety, depression, quality of life, and treatment compliance
Lina and Ke [21]	China	PD ^b	76	38	38	3 months	— ^j	Activity level and 6MWT ^e

^aHD: hemodialysis.

^bPD: peritoneal dialysis.

^cSTS-10: sit-to-stand 10.

^dSTS-60: sit-to-stand 60.

^e6MWT: 6-min walking test.

^fSPPB: short physical performance battery.

^gTUG: timed up-and-go.

^hOLST: one-legged stance test.

ⁱBUN: blood urea nitrogen.

^jNot applicable.

Risk of Bias Assessment

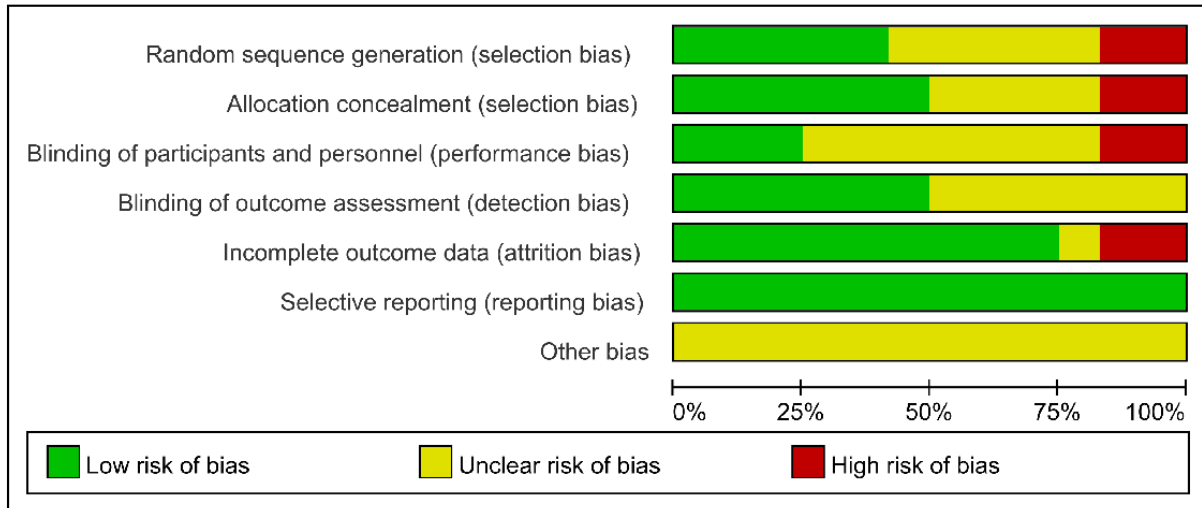
According to Cochrane criteria, the risk of bias assessment is illustrated in Figures 2 [14-25] and 3. Of the 12 studies, 7/12 (58.3%) studies [14,15,17,18,21,22,24] were rated as having “some concerns” of bias, and 5/12 (41.7%) studies [16,19,20,23,25] were rated as high risk of bias. In the domain of “random sequence generation,” 5/12 (41.7%) studies [16,17,22,24,25] had low bias, 5/12 (41.7%) studies [14,15,18,20,21] had unclear risk of bias, and 2/12 (16.7%) studies [19,23] had high risk of bias. In the domain of “allocation concealment,” 6/12 (50%) studies [16-18,22,24,25] had low bias, 4/12 (33.3%) studies [14,15,20,21] had unclear risk of bias, and 2/12 (16.7%) studies [19,23] had high risk of bias. In the domain of “blinding of participants and personnel,” 3/12

(25%) studies [21,23,24] had low bias, 7/12 (58.3%) studies [14-19,22] had unclear risk of bias, and 2/12 (16.7%) studies [20,25] had high risk of bias. Blinding participants was not feasible due to the nature of the intervention methods used in all trials. In the domain of “blinding of outcome assessment,” 6/12 (50%) studies [16,19-21,23,24] had low bias and 6/12 (50%) studies [14,15,18,20,22,25] had unclear risk of bias. The absence of blinding outcome assessors or data analysts was observed in studies with some bias. In the domain of “incomplete outcome data,” 9/12 (75%) studies [14,15,17-23] had low bias, 1/12 (8.3%) studies [24] had unclear risk of bias, and 2/12 (16.7%) studies [16,25] had high risk of bias. In the domain of “selective reporting,” 12/12 (100%) studies [14-25] had a low bias.

Figure 2. Risk of bias analysis of each included study [14-25].

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Cho 2014	High	High	Low	Low	Low	Low	Some concerns
Chou 2020	High	High	Some concerns	Low	Low	Low	Some concerns
FengLei 2021	Some concerns	Low	Some concerns	Some concerns	Low	Low	Some concerns
Lee 2022	Low	Low	Some concerns	Low	Low	Low	Some concerns
LiXueLian 2022	Some concerns	Some concerns	High	Some concerns	Low	Low	Some concerns
Martínez-Olmos 2022	Low	Low	Some concerns	Low	High	Low	Some concerns
Maynard 2019	Low	Low	High	Some concerns	High	Low	Some concerns
Schinner 2023	Low	Low	Low	Low	Some concerns	Low	Some concerns
Segura-Ortí 2019	Some concerns	Some concerns	Some concerns	Some concerns	Low	Low	Some concerns
Turoń-Skrzypińska 2023	Some concerns	Some concerns	Some concerns	Some concerns	Low	Low	Some concerns
WangLiNa 2023	Some concerns	Some concerns	Low	Low	Low	Low	Some concerns
Zhou 2020	Low	Low	Some concerns	Some concerns	Low	Low	Some concerns

Figure 3. Overall risk of bias analysis of included studies.



Meta-Analysis Results

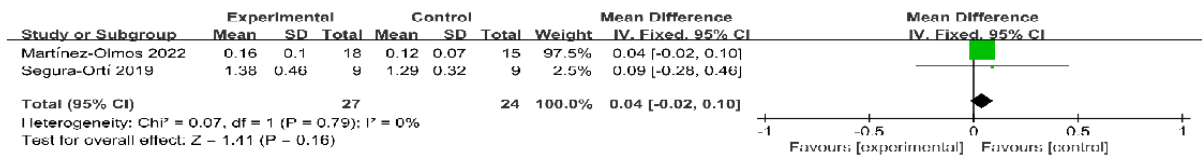
Motor Ability

Gait Speed

Two trials used gait speed as a measurement outcome [15,16]. The results indicate no significant difference in gait speed

improvement between VR training and other training methods (standardized mean difference [SD]=0.04, 95% CI -0.02 to 0.1, $P=.16$) with low heterogeneity ($I^2=0\%$, $P=.79$; Figure 4 [15,16]). Since there were fewer than 3 studies, publication bias was not assessed.

Figure 4. Forest plot of virtual reality on exercise capacity of gait speed [15,16].



6-Minute Walk Test

Three trials measured walking ability using the 6-minute walk test (6MWT) [15,16,21]. Results showed that VR training improved walking ability significantly more than the control

group (SD=29.36, 95% CI 14.32-44.4, $P<.001$) with middle heterogeneity ($I^2=46\%$, $P=.16$; Figure 5 [15,16,21]). Egger regression test and funnel plot showed that there was no significant publication bias between the included studies ($P=.99$; Figure 6).

Figure 5. Forest plot of virtual reality on exercise capacity of 6-minute walk test [15,16,21].

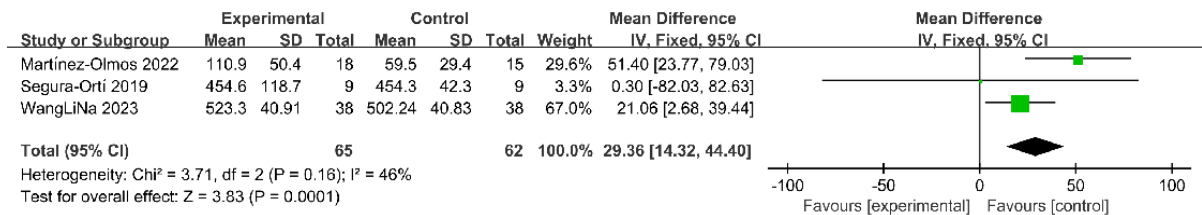
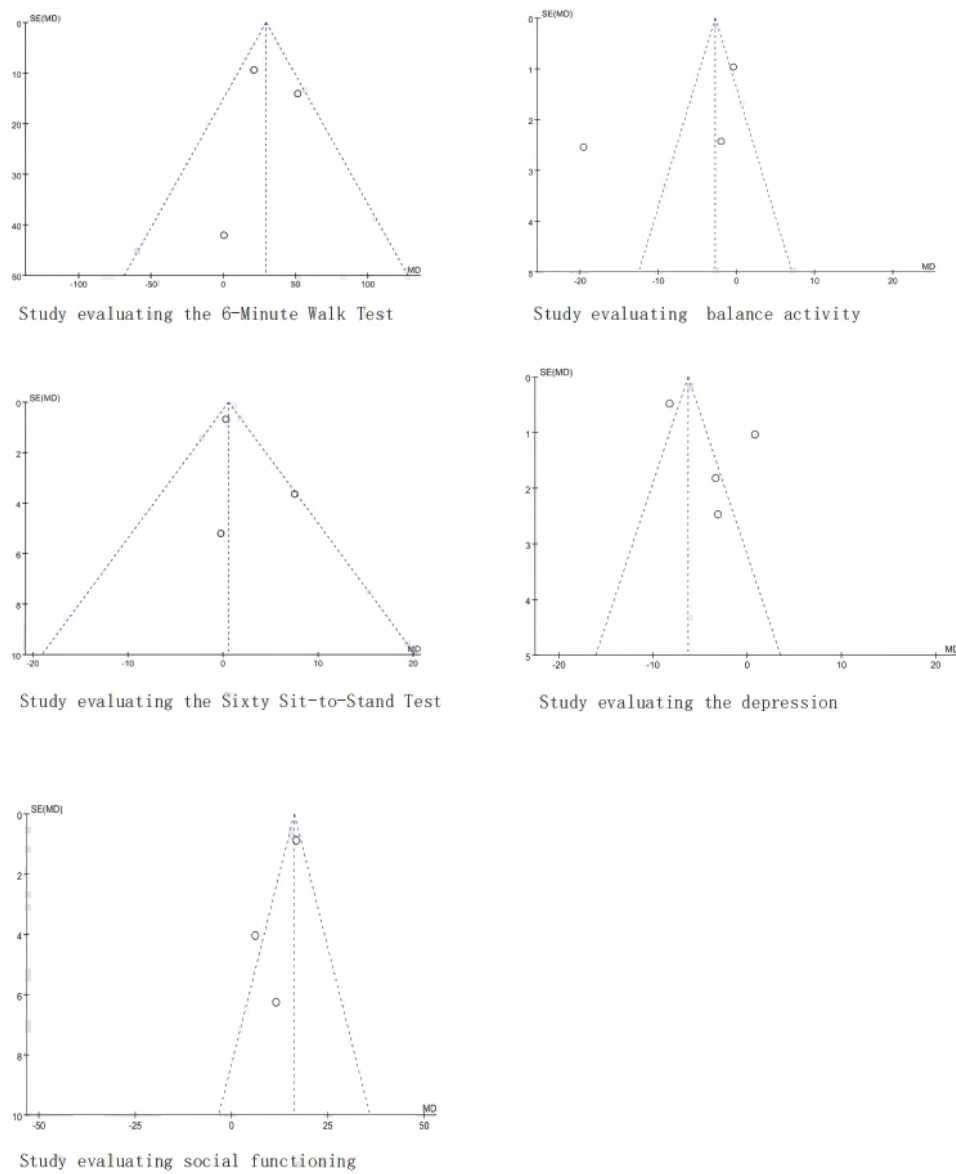


Figure 6. The funnel plot of the effect of virtual reality on dialysis patient.

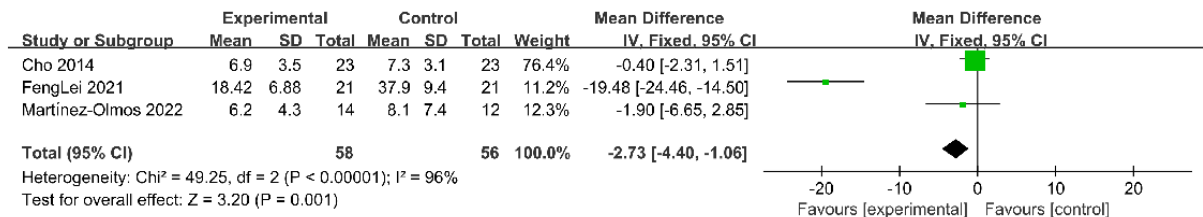


Balance Ability

Three trials included the measurement of balance ability as an outcome [16,18,23]. The findings suggest that VR training did not lead to an improvement in the balance ability of the subjects when compared with the control group (SD=-2.73, 95% CI

-4.40 to -1.06, $P < .001$), and considerable heterogeneity was found ($I^2 = 96%$, $P < .001$; Figure 7 [16,18,23]). Egger regression test and funnel plot showed that there was no significant publication bias between the included studies ($P = .48$; Figure 6).

Figure 7. Forest plot of virtual reality on exercise capacity of balance [16,18,23].



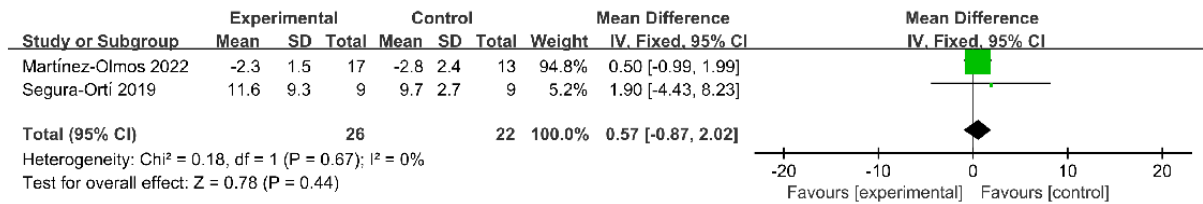
Five Sit-to-Stand Test

Two studies were conducted using the Sit-to-Stand Test 5 (STS-5) as a measurement outcome [15,16]. The results indicate

that there was no significant difference in Sit-to-Stand Test performance between VR training and the control group (SD=0.57, 95% CI -0.87 to 2.02, $P = .44$) with low heterogeneity

($I^2=0\%$, $P=.67$; Figure 8 [15,16]). However, since there were fewer than three studies, publication bias was not assessed.

Figure 8. Forest plot of virtual reality on exercise capacity of Five Sit-to-Stand Test [15,16].

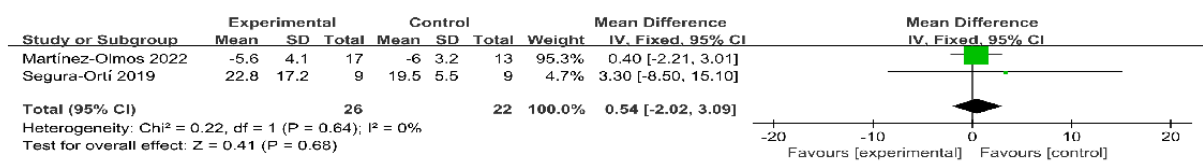


Ten Sit-to-Stand Test

In 2 trials [15,16], Sit-to-Stand Test 10 (STS-10) was used as a measurement outcome to compare the Sit-to-Stand Test performance between the VR training group and the control

group. The results did not show any significant difference ($\text{SD}=0.54$, 95% CI -2.02 to 3.09 , $P=.68$) with low heterogeneity ($I^2=0\%$, $P=.64$; Figure 9 [15,16]). As there were fewer than 3 studies, publication bias was not assessed.

Figure 9. Forest plot of virtual reality on exercise capacity of Ten Sit-to-Stand Test [15,16].

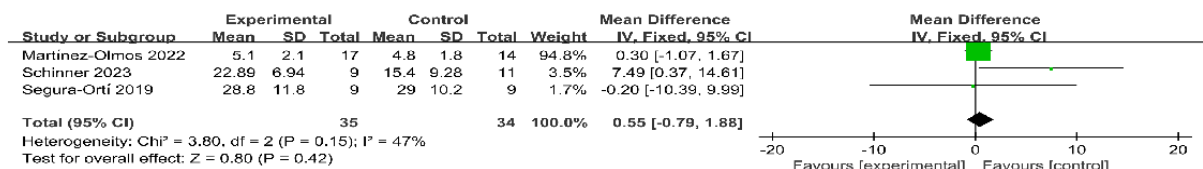


Sixty Sit-to-Stand Test

Three trials were conducted with the Sit-to-Stand Test 60 (STS-60) as the measurement outcome [15,16,24]. The results suggest that there was no significant difference in the STS-60 test performance between VR training and other training

methods for dialysis patients ($\text{SD}=0.55$, 95% CI -0.79 to 1.88 , $P=.42$) with middle heterogeneity ($I^2=47\%$, $P=.15$; Figure 10 [16,18,24]). Egger regression test and funnel plot showed that there was no significant publication bias between the included studies ($P=.57$; Figure 6).

Figure 10. Forest plot of virtual reality on exercise capacity of Sixty Sit-to-Stand Test [16,18,24].

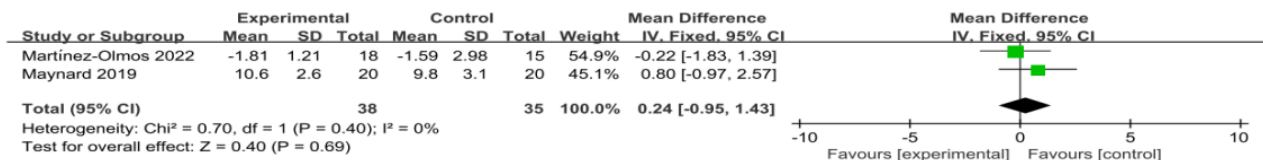


Timed Up and Go Test

Two trials included the Timed Up and Go Test (TUG) test as a measurement outcome [16,25]. The results showed that there was no significant difference between the VR training and

control groups ($\text{SD}=0.24$, 95% CI -0.95 to 1.43 , $P=.69$) with low heterogeneity ($I^2=0\%$, $P=.40$; Figure 11 [16,25]). However, since there were fewer than 3 studies, publication bias was not assessed.

Figure 11. Forest plot of virtual reality on exercise capacity of Timed Up and Go Test [16,25].



Psychological Outcomes

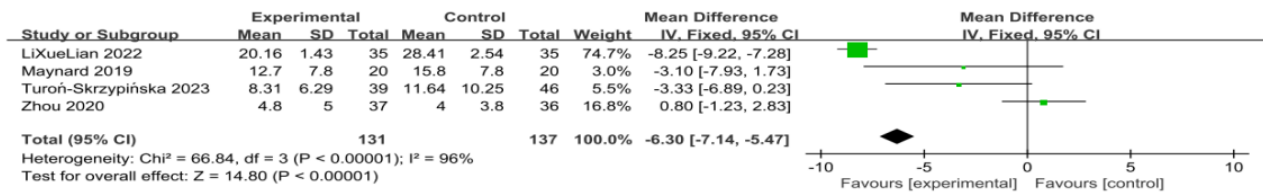
Depression

Four trials used depression scores as outcome measures [14,20,22,25]. The results show that patients undergoing VR training had lower depression symptoms compared with the

control group, indicating that VR was more effective in improving the participants' depressive condition ($\text{SD}=-6.30$, 95% CI -7.14 to -5.47 , $P<.001$) and considerable heterogeneity was found ($I^2=96\%$, $P<.001$; Figure 12 [14,20,22,25]). Egger regression test and funnel plot showed that there was no

significant publication bias between the included studies ($P=.34$; Figure 6).

Figure 12. Forest plot of virtual reality on psychological outcome of depression [14,20,22,25].

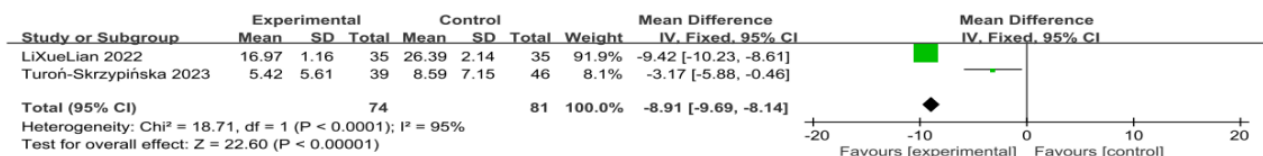


Anxiety

Two trials used anxiety scores as outcome measures [14,20]. The results show that patients undergoing VR training had lower anxiety levels compared with the control group, indicating that

VR was more effective in improving the participants' anxiety condition ($\text{SD}=-8.91$, 95% CI -9.69 to -8.17 , $P<.001$) with high heterogeneity ($I^2=95\%$, $P<.001$; Figure 13 [14,20]). Since there were fewer than 3 studies, publication bias was not assessed.

Figure 13. Forest plot of virtual reality on psychological outcome of anxiety [14,20].

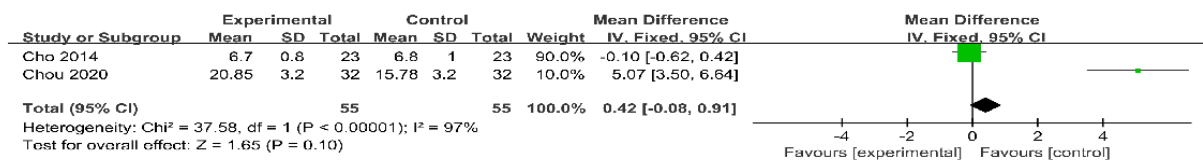


Fatigue

Two trials used fatigue scores as outcome measures [19,23]. The results indicate no significant difference in improving fatigue among dialysis patients between VR training and other

training methods ($\text{SD}=0.42$, 95% CI -0.08 to 0.91 , $P=.01$) with high heterogeneity ($I^2=97\%$, $P<.001$; Figure 14 [19,23]). Since there were fewer than 3 studies, publication bias was not assessed.

Figure 14. Forest plot of virtual reality on psychological outcome of fatigue [19,23].

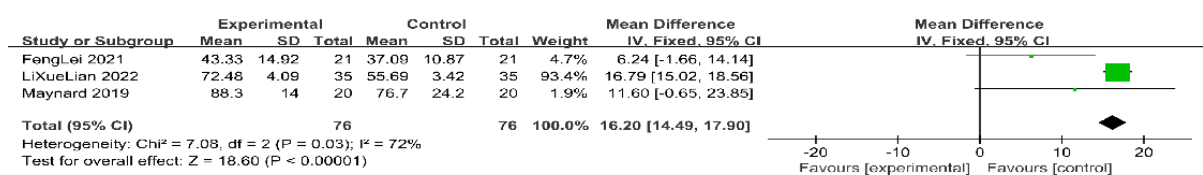


Social Functioning

Three trials used social functioning scores as outcome measures [18,20,25]. The results demonstrate that VR training was more effective than the control group interventions in improving

patients' social functioning ($\text{SD}=16.20$, 95% CI 14.49 - 17.90 , $P<.001$) with middle heterogeneity ($I^2=72\%$, $P=0.03$; Figure 15 [18,20,25]). Egger regression test and funnel plot showed that there was no significant publication bias between the included studies ($P=.35$; Figure 6).

Figure 15. Forest plot of virtual reality on social function [18,20,25].



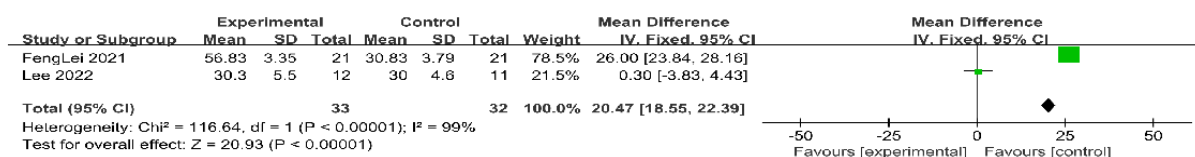
Self-Efficacy

Two trials used self-efficacy scores as outcome measures [17,18]. The results indicate that VR training was more effective

than the control group interventions in improving patients' self-efficacy ($\text{SD}=20.47$, 95% CI 18.55 - 22.39 , $P<.001$) with high heterogeneity ($I^2=99\%$, $P<.001$; Figure 16 [17,18]). Since

there were fewer than 3 studies, publication bias was not assessed.

Figure 16. Forest plot of virtual reality on self-efficacy [17,18].



Discussion

Summary of Main Findings

This meta-analysis encompassed 12 trials involving 625 participants, of whom (99/625; 15.8%) were PD patients. All studies used VR training as the intervention, while control groups received conventional methods such as health education, routine care, and exercise adapted to patients’ daily routines. Of these 12 studies, 5 reported the use of random sequence generation.

This meta-analysis offers a thorough evaluation of the effectiveness of VR training in comparison with traditional methods across various outcome measures, including motor abilities, balance, and psychological well-being. The findings indicate that VR training significantly enhances walking ability, as measured by the 6MWT, with an SD of 29.36. This effect is notably more pronounced compared with gait speed and other motor ability measures, where VR training did not produce significant improvements. Furthermore, VR training was linked to significant reductions in symptoms of depression and anxiety, along with enhancements in social functioning and self-efficacy. However, VR training did not show significant benefits for balance, Sit-to-Stand tests, or the TUG.

Physical Mobility

The substantial improvement observed in the 6MWT with VR training stands in stark contrast to the absence of significant results in gait speed. The 6MWT evaluates endurance and walking capability over a period, which may be well-suited to the interactive and engaging nature of VR environments. The immersive qualities of VR training may enhance patients’ motivation and engagement during prolonged walking tasks, thereby contributing to better performance on the 6MWT. Silva et al [26] demonstrated that visual and auditory stimuli in virtual environments encourage active participation in training, leading to increased exercise, walking distance, and time, which enhances the effectiveness of the 6MWT and improves patients’ walking ability. Research indicates that gait rehabilitation programs using VR can aid dialysis patients with muscle weakness and joint pain in improving walking speed and quality by simulating diverse walking environments and obstacles, thereby enhancing their independence in daily life [27]. The inclusion of dynamic, goal-oriented tasks in VR may better simulate real-world walking scenarios, motivating participants to exert greater effort and maintain activity for extended periods. In contrast, gait speed, a measure of immediate walking performance, may not benefit as substantially from the immersive features of VR training. The effectiveness of VR in enhancing gait speed may be influenced by the intensity and

duration of training sessions, which varied across studies. Consequently, the lack of significant differences in gait speed improvement may suggest a need for more specific training protocols or supplementary interventions to optimize gait speed outcomes.

Psychological Symptoms

The observed significant improvement in walking ability among dialysis patients underscores the potential of VR training to address key aspects of patient care. Improving walking capability can significantly impact daily functioning and overall quality of life, particularly in individuals with mobility impairments [28]. The capacity to enhance physical function while concurrently addressing psychological factors, such as depression and anxiety, highlights the comprehensive benefits of VR training. Research by Schröder et al [29] further demonstrates that VR training can alleviate patients’ negative emotions, including anxiety and depression. By offering a multifaceted therapeutic approach, VR has the potential to enhance both physical performance and mental well-being, essential components of holistic patient care. Furthermore, the effectiveness of VR in reducing depression and anxiety suggests that VR training may serve as a valuable tool for mitigating the broader psychosocial impacts of chronic illness [30]. The immersive and interactive features of VR provide an engaging and motivating environment that fosters positive changes in mood and self-perception, thereby contributing to improved overall patient outcomes [31].

Social Functioning

The findings of this meta-analysis demonstrate that VR training significantly improves social functioning in patients, as evidenced by a SD of 16.2. This result suggests that VR training can substantially enhance social interaction and integration, which are crucial aspects of overall well-being. The positive effect of VR on social functioning may be attributed to various factors inherent to the VR experience. VR environments frequently offer engaging and interactive scenarios that promote social engagement and collaboration, even among individuals with limited mobility or social anxiety. VR training usually includes interactive tasks and group-based activities that encourage active participation, thereby enhancing patients’ social skills and interactions. The immersive nature of VR provides opportunities for patients to practice social scenarios in a controlled environment, thereby enhancing their confidence and comfort in real-world social interactions. Furthermore, participation in VR-based social activities may foster a sense of community and support, further enhancing social functioning. Despite these promising results, it is crucial to consider the variability in social functioning outcomes reported across

studies. The observed heterogeneity ($I^2=72\%$) indicates that factors such as the design of VR interventions, the nature of social interactions, and the duration of training may affect the effectiveness of VR in enhancing social functioning. Future research should focus on exploring these variables in detail and identifying the specific components of VR training that most effectively improve social interaction and integration [32].

Self-Efficacy

Virtual reality training demonstrated a significant improvement in self-efficacy, with an SD of 20.47, indicating that VR interventions substantially enhance patients' confidence in their ability to manage various tasks and challenges. Self-efficacy, defined as the belief in one's ability to achieve goals, is a crucial determinant of both physical and psychological health. The observed improvement in self-efficacy with VR training can be attributed to the interactive and engaging nature of VR environments, which frequently include goal-setting, feedback, and achievement [33]. VR training typically integrates elements such as progress tracking, rewards, and virtual challenges, which can enhance patients' confidence in their abilities. By offering immediate feedback and a sense of accomplishment, VR can reinforce positive behaviors and attitudes, thereby contributing to improved self-efficacy. Furthermore, the immersive and supportive features of VR environments may help patients overcome fears and build confidence in a controlled setting, potentially translating into improved self-efficacy in real-world situations [34]. However, the high heterogeneity ($I^2=99\%$) in the self-efficacy outcomes suggests that the effectiveness of VR in enhancing self-efficacy may be influenced by several factors, including the design of the VR interventions and individual patient characteristics. Future research should focus on identifying the most effective VR components for enhancing self-efficacy and investigating how different patient characteristics may influence the outcomes of VR training.

Challenges and Limited Use of VR in PD Patients

The use of VR training among PD patients has been relatively limited compared with other patient populations. Several factors are likely to contribute to this limited use. PD patients face distinct challenges, such as the requirement for specialized equipment and potential complications related to fluid management, which may complicate the integration of VR training. In addition, this patient population may have unique physical and psychological conditions that necessitate tailored interventions. Current research on VR training for this population is still emerging, and the application of VR may need adaptation to address these specific needs effectively.

Furthermore, PD patients may experience varying levels of physical capability and psychological stress compared with other patient groups, which may influence the outcomes of VR interventions. Future research should focus on developing and testing VR programs specifically tailored for this population, considering their unique requirements and limitations to ensure that the interventions are both safe and effective.

Advantages and Limitations

This meta-analysis highlights the potential of VR training as an adjunctive therapy for enhancing walking ability and

psychological well-being in dialysis patients. The substantial improvements in walking endurance and psychological outcomes observed in this analysis suggest that VR training may be a valuable addition to existing therapeutic strategies. Nevertheless, the observed variability in results and heterogeneity in certain outcomes underscores the need for further research.

The strengths of this study include (1) it is the first meta-analysis to assess the impact of VR training on dialysis patients and (2) we assessed the effectiveness of VR training using 12 outcome measures: gait speed, balance, 6-minute walk test score, STS-5, STS-10, STS-60, TUG, depression, anxiety, fatigue, social functioning, and self-efficacy, providing a comprehensive reference for future research.

This study also has limitations: (1) it included only published articles in Chinese and English, which may impact the meta-analysis results, (2) some studies did not provide details on sequence generation, allocation concealment, and blinding, and (3) the 12 studies included in the analysis used different control interventions and the intervention durations across the studies varied significantly, which may have contributed to significant heterogeneity among the studies.

Future research should focus on refining VR interventions, exploring their optimal implementation, and addressing the specific needs of diverse patient populations. Larger and more diverse sample sizes, coupled with standardized training protocols, will be crucial for comprehensively evaluating the benefits and limitations of VR.

In this study, we used multiple databases for literature retrieval to ensure comprehensive coverage of relevant research in the field. Our selected databases included CNKI, Wanfang, China Science and Technology Journal Database, SinoMed, Cochrane Library, Web of Science, PubMed, and Embase. These databases offer a wealth of research outputs, particularly the Chinese databases, which aggregate a substantial amount of high-quality studies conducted by Chinese scholars, reflecting the region's active contribution to this field. However, we recognize that our current search strategy may not fully represent the entire research landscape, particularly the lack of studies from North America.

Although our initial search did not yield relevant North American research, this may be attributed to the limitations of our search strategy and keyword selection. We acknowledge that this omission could impact the representativeness of our results and potentially influence the conclusions drawn from the study. Therefore, we emphasize this limitation within the article and recommend that future research consider broader literature retrieval strategies to ensure a more holistic understanding of the field.

This reflection provides important guidance for subsequent studies, ensuring that future efforts can better integrate research findings from diverse regions, thereby enhancing the breadth and depth of analysis.

Conclusions

This meta-analysis offers a thorough evaluation of the use of VR training in dialysis patients. The findings indicate that VR training effectively enhances patients' physical fitness, alleviates anxiety and depression, and improves adherence, thereby

facilitating better self-management. However, research focusing on VR training in peritoneal patients is relatively limited compared with that on hemodialysis patients. Future research should involve PD patients and use rigorous, large-scale studies to validate the findings of this review for both hemodialysis and PD populations.

Acknowledgments

The authors would like to acknowledge that all research and manuscript preparation were conducted by the authors themselves, with no external assistance.

Data Availability

All data generated or analyzed during this study are included in this published article and [Multimedia Appendices 1-3](#).

Authors' Contributions

XK contributed to writing the original draft, data curation, validation, software, formal analysis, and investigation. YZ managed writing the original draft, data curation, visualization, software, formal analysis, and investigation. CS handled validation, investigation, and data curation. ZC and JZ contributed to investigation and data curation. RZ managed conceptualization, data curation, writing—review and editing, supervision, project administration, and visualization.

Conflicts of Interest

None declared.

Multimedia Appendix 1

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) checklist.
[\[PDF File \(Adobe PDF File\), 211 KB-Multimedia Appendix 1\]](#)

Multimedia Appendix 2

Search strategies of PubMed, the Cochrane Library, the China National Knowledge Infrastructure (CNKI) and the VIP Journal Database. Supplementary information of intervention in experimental and control groups.
[\[DOC File , 17 KB-Multimedia Appendix 2\]](#)

Multimedia Appendix 3

Summary of included studies.
[\[DOCX File , 27 KB-Multimedia Appendix 3\]](#)

References

1. Zhang L, Zhao MH, Zuo L, Wang Y, Yu F, Zhang H, et al. CK-NET Work Group. China Kidney Disease Network (CK-NET) 2015 Annual Data Report. *Kidney Int Suppl* (2011). Mar 01, 2019;9(1):e1-e81. [\[FREE Full text\]](#) [doi: [10.1016/j.kisu.2018.11.001](https://doi.org/10.1016/j.kisu.2018.11.001)] [Medline: [30828481](#)]
2. Li-xia L, Xiao-lei H, Bao-chun G, Jing Q, Lian-yu Z, Xin-zhou Z. Effects of aerobic exercise on oxidative stress and quality of life in maintenance hemodialysis patients. *Chinese Journal of Blood Purification*. Feb 26, 2013;12(08):419-424. [doi: [10.3969/j.issn.1671-4091.2013.08.004](https://doi.org/10.3969/j.issn.1671-4091.2013.08.004)]
3. Orcy R, Antunes MF, Schiller T, Seus T, Böhlke M. Aerobic exercise increases phosphate removal during hemodialysis: a controlled trial. *Hemodial Int*. Jan 20, 2014;18(2):450-458. [doi: [10.1111/hdi.12123](https://doi.org/10.1111/hdi.12123)] [Medline: [24438516](#)]
4. Henrique DMN, Reboredo MDM, Chaoubah A, Paula RBD. [Aerobic exercise improves physical capacity in patients under chronic hemodialysis]. *Arq Bras Cardiol*. May 28, 2010;94(6):823-828. [\[FREE Full text\]](#) [doi: [10.1590/s0066-782x2010005000043](https://doi.org/10.1590/s0066-782x2010005000043)] [Medline: [20428710](#)]
5. QIGE Q, JIANRONG Z. The effects of combined aerobic-resistance training on dialysis adequacy and quality of life in maintenance hemodialysis patients. *Chinese Journal of Blood Purification*. Mar 18, 1976:646-651. [Medline: [1671](#)]
6. de Lima MC, Cicotoste CDL, Cardoso KDS, Forgiarini LA, Monteiro MB, Dias AS. Effect of exercise performed during hemodialysis: strength versus aerobic. *Ren Fail*. Apr 08, 2013;35(5):697-704. [\[FREE Full text\]](#) [doi: [10.3109/0886022X.2013.780977](https://doi.org/10.3109/0886022X.2013.780977)] [Medline: [23560491](#)]

7. JIANYING L, YANLIN H, YANJUAN T. Application progress of exercise therapy in hemodialysis patients with uremia. *The Journal of Medical Theory and Practice*. Jun 26, 2012;35(5):697-704. [[FREE Full text](#)] [doi: [10.19381/j.issn.1001-7585.2013.01.012](https://doi.org/10.19381/j.issn.1001-7585.2013.01.012)]
8. Peeters D. Virtual reality: A game-changing method for the language sciences. *Psychon Bull Rev*. Feb 07, 2019;26(3):894-900. [[FREE Full text](#)] [doi: [10.3758/s13423-019-01571-3](https://doi.org/10.3758/s13423-019-01571-3)] [Medline: [30734158](https://pubmed.ncbi.nlm.nih.gov/30734158/)]
9. Colombo D, Díaz-García A, Fernandez-Álvarez J, Botella C. Virtual reality for the enhancement of emotion regulation. *Clin Psychol Psychother*. Jun 23, 2021;28(3):519-537. [doi: [10.1002/cpp.2618](https://doi.org/10.1002/cpp.2618)] [Medline: [34048621](https://pubmed.ncbi.nlm.nih.gov/34048621/)]
10. Ahmadpour N, Randall H, Choksi H, Gao A, Vaughan C, Poronnik P. Virtual Reality interventions for acute and chronic pain management. *Int J Biochem Cell Biol*. Jul 12, 2019;114:105-568. [doi: [10.1016/j.biocel.2019.105568](https://doi.org/10.1016/j.biocel.2019.105568)] [Medline: [31306747](https://pubmed.ncbi.nlm.nih.gov/31306747/)]
11. Higgins JPT, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, Cochrane Bias Methods Group, et al. Cochrane Statistical Methods Group. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ*. Oct 18, 2011;343:1-9. [[FREE Full text](#)] [doi: [10.1136/bmj.d5928](https://doi.org/10.1136/bmj.d5928)] [Medline: [22008217](https://pubmed.ncbi.nlm.nih.gov/22008217/)]
12. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ*. Sep 13, 1997;315(7109):629-634. [[FREE Full text](#)] [doi: [10.1136/bmj.315.7109.629](https://doi.org/10.1136/bmj.315.7109.629)] [Medline: [9310563](https://pubmed.ncbi.nlm.nih.gov/9310563/)]
13. Weber L, Kämp-Becker I, Christiansen H, Mingeback T. Treatment of child externalizing behavior problems: a comprehensive review and meta-meta-analysis on effects of parent-based interventions on parental characteristics. *Eur Child Adolesc Psychiatry*. Jun 28, 2018;28(8):1025-1036. [doi: [10.1007/s00787-018-1175-3](https://doi.org/10.1007/s00787-018-1175-3)] [Medline: [29948228](https://pubmed.ncbi.nlm.nih.gov/29948228/)]
14. Turoń-Skrzypińska A, Tomska N, Mosiejczuk H, Ryl A, Szylińska A, Marchelek-Myśliwiec M, et al. Impact of virtual reality exercises on anxiety and depression in hemodialysis. *Sci Rep*. Aug 01, 2023;13(1):12435-12435. [[FREE Full text](#)] [doi: [10.1038/s41598-023-39709-y](https://doi.org/10.1038/s41598-023-39709-y)] [Medline: [37528161](https://pubmed.ncbi.nlm.nih.gov/37528161/)]
15. Segura-Ortí E, Pérez-Domínguez B, Ortega-Pérez de Villar L, Meléndez-Oliva E, Martínez-Gramage J, García-Maset R, et al. Virtual reality exercise intradialysis to improve physical function: A feasibility randomized trial. *Scand J Med Sci Sports*. Jan 01, 2019;29(1):89-94. [[FREE Full text](#)] [doi: [10.1111/sms.13304](https://doi.org/10.1111/sms.13304)] [Medline: [30230041](https://pubmed.ncbi.nlm.nih.gov/30230041/)]
16. Martínez-Olmos FJ, Gómez-Conesa AA, García-Testal A, Ortega-Pérez-de-Villar L, Valtueña-Gimeno N, Gil-Gómez JA, et al. An intradialytic non-immersive virtual reality exercise programme: a crossover randomized controlled trial. *Nephrol Dial Transplant*. Jun 23, 2022;37(7):1366-1374. [doi: [10.1093/ndt/gfab213](https://doi.org/10.1093/ndt/gfab213)] [Medline: [34245292](https://pubmed.ncbi.nlm.nih.gov/34245292/)]
17. Lee CMS, Fong KNK, Mok MMY, Lam MK, Kung Y, Chan PPW, et al. Application of virtual reality for peritoneal dialysis exchange learning in patients with end-stage renal disease and cognitive impairment. *Virtual Real*. Dec 03, 2022;1-13. [[FREE Full text](#)] [doi: [10.1007/s10055-022-00728-1](https://doi.org/10.1007/s10055-022-00728-1)] [Medline: [36533192](https://pubmed.ncbi.nlm.nih.gov/36533192/)]
18. LEI F, YUNSHU L, JIE Y. Virtual reality somatosensory games integrated into the home exercise management and its effects on fall risk and quality of life in dialysis patients [J]. *Chinese Journal of Blood Purification*. May 12, 2021:302-305. [doi: [10.1056/NEJM197603182941206](https://doi.org/10.1056/NEJM197603182941206)] [Medline: [1671](https://pubmed.ncbi.nlm.nih.gov/1671/)]
19. Chou HY, Chen SC, Yen TH, Han HM. Effect of a Virtual Reality-Based Exercise Program on Fatigue in Hospitalized Taiwanese End-Stage Renal Disease Patients Undergoing Hemodialysis. *Clin Nurs Res*. Jul 01, 2020;29(6):368-374. [doi: [10.1177/1054773818788511](https://doi.org/10.1177/1054773818788511)] [Medline: [30009636](https://pubmed.ncbi.nlm.nih.gov/30009636/)]
20. XUELIAN L, JIANYING J, LING L. Application effect of virtual reality technology on psychological negative emotions in maintenance hemodialysis patients. *China Modern Doctor*. Jan 25, 2022:110-113. [Medline: [110](https://pubmed.ncbi.nlm.nih.gov/110/)]
21. Lina W, KE L. Intervention effect of exercise mode based on virtual reality technology on physical activity of peritoneal dialysis patients [J]. *Chinese Nursing Research*. Oct 01, 2023;37(20):3727-3731. [doi: [10.12102/j.issn.1009-6493.2023.20.022](https://doi.org/10.12102/j.issn.1009-6493.2023.20.022)]
22. Zhou H, Al-Ali F, Kang GE, Hamad AI, Ibrahim RA, Talal TK, et al. Application of Wearables to Facilitate Virtually Supervised Intradialytic Exercise for Reducing Depression Symptoms. *Sensors (Basel)*. Mar 12, 2020;20(6):1571-1571. [[FREE Full text](#)] [doi: [10.3390/s20061571](https://doi.org/10.3390/s20061571)] [Medline: [32178231](https://pubmed.ncbi.nlm.nih.gov/32178231/)]
23. Cho H, Sohng KY. The effect of a virtual reality exercise program on physical fitness, body composition, and fatigue in hemodialysis patients. *J Phys Ther Sci*. Oct 28, 2014;26(10):1661-1665. [[FREE Full text](#)] [doi: [10.1589/jpts.26.1661](https://doi.org/10.1589/jpts.26.1661)] [Medline: [25364137](https://pubmed.ncbi.nlm.nih.gov/25364137/)]
24. Schinner L, Nagels K, Scherf J, Schmaderer C, Heemann U, Küchle C, et al. Intradialytic neuromuscular electrical stimulation with optional virtual reality distraction improves not only muscle strength and functional capacity but also serum albumin level in haemodialysis patients: a pilot randomized clinical trial. *BMC Nephrol*. Aug 23, 2023;24(1):240-246. [[FREE Full text](#)] [doi: [10.1186/s12882-023-03283-2](https://doi.org/10.1186/s12882-023-03283-2)] [Medline: [37608265](https://pubmed.ncbi.nlm.nih.gov/37608265/)]
25. Maynard LG, de Menezes DL, Lião NS, de Jesus EM, Andrade NLS, Santos JCD, et al. Effects of Exercise Training Combined with Virtual Reality in Functionality and Health-Related Quality of Life of Patients on Hemodialysis. *Games Health J*. Oct 01, 2019;8(5):339-348. [doi: [10.1089/g4h.2018.0066](https://doi.org/10.1089/g4h.2018.0066)] [Medline: [31539293](https://pubmed.ncbi.nlm.nih.gov/31539293/)]
26. Silva PMM, Silva LWM, Vieira ER, Cavalvanti FAC, Morya E. Go Across Immersive Technology: A Preliminary Study of the Design and Development of a System for Gait Training Using Virtual Reality. *Games Health J*. Dec 06, 2023;12(6):472-479. [doi: [10.1089/g4h.2023.0101](https://doi.org/10.1089/g4h.2023.0101)] [Medline: [37410502](https://pubmed.ncbi.nlm.nih.gov/37410502/)]
27. Ehgoetz Martens KA, Matar E, Phillips JR, Shine JM, Grunstein RR, Halliday GM, et al. Narrow doorways alter brain connectivity and step patterns in isolated REM sleep behaviour disorder. *Neuroimage Clin*. Feb 07, 2022;33:102958-102959. [[FREE Full text](#)] [doi: [10.1016/j.nicl.2022.102958](https://doi.org/10.1016/j.nicl.2022.102958)] [Medline: [35151040](https://pubmed.ncbi.nlm.nih.gov/35151040/)]

28. Gurz D, Coimbatore Dada K, Naga Nyshita V, Aderibigbe FD, Singh M, Yadav KP, et al. The Impact of Virtual Reality (VR) Gaming and Casual/Social Gaming on the Quality of Life, Depression, and Dialysis Tolerance in Patients With Chronic Kidney Disease: A Narrative Review. *Cureus*. Sep 08, 2023;15(9):44904-44910. [FREE Full text] [doi: [10.7759/cureus.44904](https://doi.org/10.7759/cureus.44904)] [Medline: [37814762](https://pubmed.ncbi.nlm.nih.gov/37814762/)]
29. Schröder D, Wrona KJ, Müller F, Heinemann S, Fischer F, Dockweiler C. Impact of virtual reality applications in the treatment of anxiety disorders: A systematic review and meta-analysis of randomized-controlled trials. *J Behav Ther Exp Psychiatry*. Dec 01, 2023;81:101893-101893. [FREE Full text] [doi: [10.1016/j.jbtep.2023.101893](https://doi.org/10.1016/j.jbtep.2023.101893)] [Medline: [37453405](https://pubmed.ncbi.nlm.nih.gov/37453405/)]
30. Carl E, Stein AT, Levihn-Coon A, Pogue JR, Rothbaum B, Emmelkamp P, et al. Virtual reality exposure therapy for anxiety and related disorders: A meta-analysis of randomized controlled trials. *J Anxiety Disord*. Jan 01, 2019;61:27-36. [doi: [10.1016/j.janxdis.2018.08.003](https://doi.org/10.1016/j.janxdis.2018.08.003)] [Medline: [30287083](https://pubmed.ncbi.nlm.nih.gov/30287083/)]
31. Kiper P, Przysiężna E, Cieślik B, Broniec-Siekaniec K, Kucińska A, Szczygiel J, et al. Effects of Immersive Virtual Therapy as a Method Supporting Recovery of Depressive Symptoms in Post-Stroke Rehabilitation: Randomized Controlled Trial. *Clin Interv Aging*. Nov 23, 2022;17:1673-1685. [FREE Full text] [doi: [10.2147/CIA.S375754](https://doi.org/10.2147/CIA.S375754)] [Medline: [36447623](https://pubmed.ncbi.nlm.nih.gov/36447623/)]
32. Park M, Ko MH, Oh SW, Lee JY, Ham Y, Yi H, et al. Effects of virtual reality-based planar motion exercises on upper extremity function, range of motion, and health-related quality of life: a multicenter, single-blinded, randomized, controlled pilot study. *J Neuroeng Rehabil*. Oct 24, 2019;16(1):3443-3445. [doi: [10.1186/s12984-019-0595-8](https://doi.org/10.1186/s12984-019-0595-8)] [Medline: [31651335](https://pubmed.ncbi.nlm.nih.gov/31651335/)]
33. Välimäki M, Hätönen HM, Lahti ME, Kurki M, Hottinen A, Metsäranta K, et al. Virtual reality for treatment compliance for people with serious mental illness. *Cochrane Database Syst Rev*. Oct 08, 2014;2014(10):1-40. [FREE Full text] [doi: [10.1002/14651858.CD009928.pub2](https://doi.org/10.1002/14651858.CD009928.pub2)] [Medline: [25300174](https://pubmed.ncbi.nlm.nih.gov/25300174/)]
34. van der Linde-van den Bor M, Slond F, Liesdek OCD, Suyker WJ, Weldam SWM. The use of virtual reality in patient education related to medical somatic treatment: A scoping review. *Patient Educ Couns*. Jul 15, 2022;105(7):1828-1841. [FREE Full text] [doi: [10.1016/j.pec.2021.12.015](https://doi.org/10.1016/j.pec.2021.12.015)] [Medline: [35000833](https://pubmed.ncbi.nlm.nih.gov/35000833/)]

Abbreviations

6MWT: 6-minute walk test

CNKI: China National Knowledge Infrastructure

ESRD: end-stage renal disease

HD: hemodialysis

PD: peritoneal dialysis

PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses

SD: standardized mean difference

STS-10: Sit-to-Stand Test 10

STS-5: Sit-to-Stand Test 5

STS-60: Sit-to-Stand Test 60

TUG: Timed Up and Go Test

VR: virtual reality

VRT: virtual reality training

Edited by A Coristine; submitted 14.03.24; peer-reviewed by Q Gao, L Pérez-Gisbert; comments to author 18.07.24; revised version received 11.09.24; accepted 13.11.24; published 08.01.25

Please cite as:

Kang X, Zhang Y, Sun C, Zhang J, Che Z, Zang J, Zhang R

Effectiveness of Virtual Reality Training in Improving Outcomes for Dialysis Patients: Systematic Review and Meta-Analysis
J Med Internet Res 2025;27:e58384

URL: <https://www.jmir.org/2025/1/e58384>

doi: [10.2196/58384](https://doi.org/10.2196/58384)

PMID:

©Xin Kang, Yiping Zhang, Chaonan Sun, Jiabin Zhang, Zhe Che, Jinhui Zang, Rongzhi Zhang. Originally published in the Journal of Medical Internet Research (<https://www.jmir.org>), 08.01.2025. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research (ISSN 1438-8871), is properly cited. The complete bibliographic information, a link to the original publication on <https://www.jmir.org/>, as well as this copyright and license information must be included.