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The Role of Virtual Reality in Improving Health Outcomes for Community-Dwelling Older Adults: Systematic Review

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Abstract

Background

Virtual reality (VR)-delivered through immersive headsets creates an opportunity to deliver interventions to improve physical, mental, and psychosocial health outcomes. VR app delivery to older adults is feasible, however, its effectiveness for improving health outcomes is unclear. This review examines the effectiveness of VR apps using immersive headsets to improve health outcomes among community-dwelling older adults.

Objective

The objective of this review was to evaluate the effectiveness of VR apps delivered using commercially available immersive headsets to improve physical, mental, and psychosocial health outcomes among older adults.

Methods

Four revised publications that included community-dwelling older adults aged ≥60 years residing in mainland Europe and using and testing immersive head-mounted VR systems were included in accordance with the Joanna Briggs Institute (JBI) methodology for scoping reviews. Data on participant characteristics, VR app characteristics, and health outcomes were extracted and synthesized using narrative and thematic analysis.

Results

In total, 7 studies that specifically included community-dwelling older adults were included in the review. VR apps using a head-mounted display had a improvement in a number of health outcomes, including pain management, posture, cognitive functioning specifically related to Alzheimer disease, and a decreased risk of falls. It was also found that VR was a feasible and acceptable way to deliver health interventions to older adults living in the community. However, there were mixed results for usability and acceptability of the intervention delivered through VR. Adverse events such as motion sickness were mostly mild/transient, some of the studies noted getting technology to participate independently.

Conclusions

Immersive VR has the potential to improve physical and mental health outcomes in older adults. Evidence is inconclusive regarding its primary outcomes for the older adult population in real-world. A number of factors, especially related to ability, usability, and acceptability, were found to be explored before more substantial implementation of the intervention in VR interventions for older adults and the wider.

Trial Registration

PROSPERO CRD42023419105; https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=419105

Keywords: virtual reality, aged, older adult, immersive, head-mounted, health, independent living, systematic review

Introduction

Background

Understanding how to best support the health and well-being of older adults is an important social concern. With increasing age, natural physical, psychological, and cognitive changes occur, which can lead to a decline in functional ability and quality of life [1-3]. Falls are a major risk for older adults, with 1 in 3 adults aged ≥65 years reporting a fall each year [4], and approximately 20% of falls resulted in a serious injury, such as a fracture, head injury, or hip injury, requiring medical treatment or prolonged healthcare [5]. Pain is also identified as the most prevalent and significant chronic condition [6]. Prominent musculoskeletal changes include a loss of muscle mass, strength, and bone density, which can lead to frailty, increased risk of falls, and fractures, ultimately affecting mobility and independent living [7]. Cognitive changes are also prevalent, with about 10% of adults aged ≥65 years experiencing dementia [8]. Falls and accidents are a leading cause of hospitalization for dementia patients, with a significant portion of these incidents occurring at home [9]. Social isolation and loneliness are also prevalent among older adults, with research indicating that about one-third of individuals aged ≥65 years experience social isolation, which can lead to a heightened risk of various health issues, including cognitive decline and depression, particularly increasing the risk of falls [10].

Changes in sensorimotor function and proprioceptive deficits further exacerbate the risk of falls and cognitive impairment, underscoring the multifaceted challenges faced by older adults. These interventions aim to mitigate the adverse effects of aging, such as cognitive decline and physical frailty, which are critical for maintaining independence and quality of life [11]. Technology-based interventions have emerged as promising solutions to address these challenges, leveraging advanced technologies to provide tailored support and enhance the overall well-being of older adults [12].

The degree of presence and sense of flow in virtual environments is important as the characteristics of the VR technology that support it, such as immersion, interactivity, and sensory feedback, can significantly enhance the user experience and engagement with the virtual environment. The immersive nature of VR allows participants to feel fully immersed in a digital environment, which can lead to increased motivation and enjoyment [13]. Interactive features in VR allow for real-time feedback and adaptive challenges, which can be tailored to individual needs and capabilities, ensuring a personalized experience that promotes learning and skill development [14]. Sensory feedback, including visual, auditory, and tactile stimuli, further enhances the immersive experience, making it more engaging and impactful [15]. These elements collectively contribute to the overall VR experience, ultimately influencing the effectiveness of the technology in various applications.

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Immersive VR has the potential to improve physical and mental health outcomes for older adults by providing engaging, interactive, and sensory-rich experiences that promote learning and skill development [13-15]. The immersive nature of VR allows participants to feel fully immersed in a digital environment, which can lead to increased motivation and enjoyment [13]. Interactive features in VR allow for real-time feedback and adaptive challenges, which can be tailored to individual needs and capabilities, ensuring a personalized experience that promotes learning and skill development [14]. Sensory feedback, including visual, auditory, and tactile stimuli, further enhances the immersive experience, making it more engaging and impactful [15

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Figures and Tables

Table 1

Details of study design, virtual reality therapy, and health outcomes.

Study	Study design	Sample size	Sample characteristics	Virtual reality application	Virtual reality exposure	Outcomes assessed	Outcomes measured
Benham [53]	Mixed methods exploratory study	12	8 female, 4 male, majority of the sample were white, majority had exposure to technology weekly, 8 participants had musculoskeletal pain, and 4 had neurological pain	The immersive VR[a] system utilized the HTC[b] Vive HMD[c] with 2 hand controllers. A variety of games could be played, although those using movements or standing were excluded for safety reasons. Popular games included interactions with animals, music, and travel. Used range of commercially available VR apps	Participants completed 12 VR sessions over a 6-week period. These ranged from 15 to 45 min long.	Pain management, QoL[d], depression, overall physical health, overall psychological health, and social life	Patient-reported outcomes, measurement information system, Item Bank v. 1.0–emotional distress–depression, World Health Organization Quality of Life Scale Brief Version (assessing overall health, physical, psychological, and social health), numeric pain rating scale
Gago [54]	Quasi-experimental	39	20 participants with AD[e] (11 fallers and 9 nonfallers) and 19 control participants. Groups were equally matched for demographic and anthropometric data.	Immersive Oculus Rift VR headset showed a view as if the person was standing at the top of a staircase. The perspective in the headset was shifted forward down the stairs to mimic the displacement during a fall. Used the commercially released "Tuscan Villa" demo from Unity, which is no longer available	One session with a total of five 10-second trials per subject, with each trial involving 1 shift in perspective down the stairs (approximate distance of 1.17 m)	Posture and falls in AD	Kinematic and time-frequency distribution sensor data to assess posture and falls
Levy [55]	RCT[f]	16	10 women and 6 men, randomly	Immersive V8 VR HMD was used with wireless mouse for exposure therapy, followed by the use of	12 weekly sessions lasting 40 min (VR exposure=15 min)	Falls, depression, anxiety, and	Fear of falling measure, Beck depression inventory, Spielberger state-trait anxiety inventory, and Sheehan disability scale

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[a]VR: virtual reality.

[b]HTC: high-tech computer.

[c]HMD: head-mounted display.

[d]QoL: quality of life.

[e]AD: Alzheimer disease.

[f]RCT: randomized controlled trial.

Table 2

Summary of findings table.

Outcomes assessed; study	Key findings	Grading of recommendations, assessment, development, and evaluation[a]
Pain management; Benham [53]	Between presession 1 and postsession 12 VR[b] sessions, there were significant improvements in pain scores with a large effect size (−1.54, 95% CI −2.50 to −0.58; P=.002; Effect size >0.8=large effect).	Moderate
Quality of life; Benham [53]	WHOQOL-BREF[c] did not find any significant differences over 6 weeks of VR therapy on overall health (−0.06, 95% CI −0.91 to 0.78; P=.66), no significant differences on overall physical health (0.41, −0.45 to 1.26; P=.08), no significant differences on social life (0.08, 95% CI −0.77 to 0.93; P=.87), and no significant differences on overall psychological health (0.33, 95% CI −0.52 to 1.18; P=.15).	Moderate
Posture; Gago [54]	The AD[d] faller group had a higher power regarding use of mechanical properties of oscillation for postural adjustments compared with the control group, alluding to worse postural stability in this group (−4 to 0s: P=.02; 0 to 4s: P=.01; and 4 to 8s: P=.008). AD participants had a time lag in cognitive strategies for postural correction compared with healthy subjects (−4 to 0s: P=.002; 0 to 4s: P=.01).	Moderate
Falls; Gago [54]	The AD fallers groups had a delayed reaction time for changes in power compared with the control group, with a change in power seen only in the last interval (0 to 4s vs 4 to 8s; LB[e] P=.008; HB[f] P=.01).	Moderate
Falls; Levy [55]	There were statistically significant differences between the 2 groups for fear of falling scores. Fear of falling scores over the 12 weeks reduced by 2.78 (SD 4.82) in the VR group and increased by 4.14 (SD 4.30) in the control group (P=.007).	Moderate
Falls; Parijat [57,58]	VR training led to significantly better balance on slippery surfaces with VR therapy reducing slip distance (slip distance 1: $F_{1,18}$=10.34, P=.01; slip distance 2: $F_{1,18}$=5.27, P=.03), reducing peak slide heel velocity ($F_{1,18}$=4.54, P=.05), and reducing peak trunk extension post slip ($F_{1,18}$=12.46, P=.01). Slip distance 1 and 2 are the anterior-posterior distance traveled (in cm, based on the location of the heel) from the start of the slip to when heel acceleration peaks (slip distance 1) and then from this point until the heel velocity peaks (distance 2) VR with the treadmill supported realistic walking gait after 15 to 20 min (step duration: $F_{6,76}$=10.56, P=.002; step width: $F_{6,76}$=9.56, P=.02). There were no significant effects on ankle, hip, or knee kinematics.	Moderate
Memory and cognitive function; Optale [56]	Combining music therapy with exploration of spatial and personally relevant environments in VR led to improved memory ($F_{2,58}$=17.40; P<.001) and general cognitive functions (MMSE[g] scores $F_{2,58}$=23.01, P<.001; mental status in neurology score $F_{2,58}$=30.16, P<.001); executive function (cognitive estimation test group difference: $F_{1,29}$=11.12, P=.002; dual task performance test group and time interaction: $F_{2,58}$=10.92, P<.001; phonemic verbal fluency test group and time interaction: $F_{2,58}$=14.6, P<.001); verbal memory (digital span test group and time interaction $F_{2,58}$=17.4, P<.001; verbal story recall test group and time interaction $F_{2,58}$=36.66, P<.001), but not in spatial abilities ($F_{2,58}$=3.14, P=.05).	Low

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[a]GRADE assessment reported per outcome, not per study.

[b]VR: virtual reality.

[c]WHOQOL-BREF: World Health Organization Quality of Life Scale Brief Version.

[d]AD: Alzheimer disease.

[e]LB: low-frequency band within kinematic time-frequency analysis.

[f]HB: high-frequency band within kinematic time-frequency analysis.

[g]MMSE: mini-mental state examination.

[h]PROMIS: patient-reported outcomes measurement information system.

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