Utilizing Virtual Reality to Improve Elderly Well-being

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**Abstract.**  Utilizing computer-generated simulations, commonly referred to as virtual reality or VR, one can construct an engrossing, three-dimensional setting. Users can engage with virtual worlds using a screen-enabled headgear, headphones, or hand controllers. VR with wearable sensors is practical and beneficial for home care physiotherapy rehabilitation. This highlights the significance of user-friendly designs to ensure effective adoption. Cognitive function, including retention, attention, and processing speed, declines with age. The study aims to assess the several advantages of VR in promoting cognitive and physical well-being in older adults. The study will evaluate the existing evidence about the benefits of virtual reality interventions, analyse the challenges linked to their implementation, and suggest potential avenues for further investigation. The study conducted a systematic literature review of the previous study, which included three major databases, namely Web of Science (WOS), Scopus, and PubMed from 2014 to 2024. The utilized keywords include virtual reality, elderly, older adult, and mental well-being. We have identified sixteen papers that have studied virtual reality for the elderly. The result shows that VR have a significant potential for cognitive training and rehabilitation in the elderly, including applications for dementia, neurorehabilitation, stroke, and psychotherapy. Elderly participants generally have positive perceptions and high acceptance of VR, with its therapeutic uses extending to improving postural balance, enhancing episodic memory, and augmenting exercise experiences. The results also suggest that virtual reality does help with cognitive training and physical well-being for the elderly.

**Keywords:** virtual reality, elderly, mental well-being

# INTRODUCTION

Virtual Reality (VR) refers to a computer simulation of a three-dimensional setting that permits user interaction to sense real or physical [1]{Tham, 2018 #1}. This is made possible using specialist equipment such VR headsets, gloves, or controllers. This immersive technology creates sensory experiences [2], including visual [3], auditory [4], and sometimes haptic feedback, which make individuals feel actual presence in the virtual world. VR is used in various fields, including gaming [5], education [6], healthcare [7] and training simulations [8], to provide interactive and engaging experiences. Over a decade, VR exists in healthcare environments with youths [9] and children [10]. VR has appeared as an encouraging tool for enhancing the general level of well-being of elderly population.

VR has the capacity in enhancing the handling of emotional and cognitive impairments in elderly people. However fewer studies have been done on its use with the aging populace [11]. The progress of immersive VR technology has created opportunities for a wide range of applications., including cognitive training [12] and rehabilitation [13] for the elderly. With the aging of the world population, there is a rising need for innovative approaches to promote active aging, improve cognitive abilities, and sustain physical well-being in older individuals. VR known for its lifelike and interactive settings, provides distinct possibilities for creating engaging and impactful interventions that are specifically designed for the aged population. Recent studies have highlighted the versatility of VR aimed at a range of therapeutic uses [14]. For example, VR has been studied for its effectiveness in treating illnesses such as dementia, aiding in the recovery of stroke patients, and delivering psychotherapy interventions [15]. Notably, VR therapy has shown promise in rehabilitating postural balance, a critical aspect of physical health in elderly individuals. The use of VR in these contexts leverages its ability to create controlled, safe, and immersive environments where users can perform various cognitive and physical exercises without real-world consequences. Moreover, VR has been recognized as a valuable tool for cognitive training [16], particularly for elderly people with minimal memory loss or preliminary dementia. The interactive nature of VR can stimulate cognitive processes [17], enhance episodic memory [18], and potentially slow cognitive decline. The immersive nature of this technology enhances the engagement and enjoyment of therapeutic exercises, leading to improved adherence and motivation among elderly users. How well the old can handle and adopt VR is essential for a successful technology application. Studies indicate that older adults generally perceive VR positively and are willing to use it, especially when it contributes to their physical and cognitive well-being. This acceptance is further supported by the development of VR systems like VirtualPT, which integrate wearable sensors and immersive VR to provide home care physiotherapy [19]. Such systems not only guide and monitor exercises but also ensure that the therapeutic process is safe and effective, addressing the specific needs of elderly patients. Although VR has potential benefits in therapeutic settings for the elderly, its successful deployment necessitates thorough evaluation of usability considerations. The effectiveness and success of VR interventions heavily rely on the usability factor [20], as older adults may face challenges related to technology adoption. Therefore, ongoing research is essential to refine VR technologies, ensure they are user-friendly, and maximize their therapeutic potential.

This research paper goals to investigate the numerous advantages of VR improving the mental and physical health of older people. The systematic literature review aims toward synthesize existing research on successful outcomes with VR treatments specifically designed for adults over 60. The review focuses on various aspects, including customization and prevention of injuries, therapeutic applications and cognitive benefits, technological integration, and user experience, simultaneously considering the aspects of physical rehabilitation and social engagement in older individuals. The study will examine the current data about the effectiveness of virtual reality interventions, explore the challenges related to their implementation, and propose prospective areas for further research and progress in this quickly growing field. This research seeks to contribute to the expanding knowledge base on new strategies to improve the standard of living for older individuals by offering a thorough examination of the possibilities of VR in senior care.

# METHODS

## SEARCH STRATEGY

The review examined how VR affects thinking, physical abilities, besides mental well-being among older adult populations. The study examines on the competence of VR to improve customization and prevention of injuries, therapeutic applications and cognitive benefits, technological integration, and user experience, while also considering physical rehabilitation and social engagement among older adults. A full inquiry occurred within multiple files, such as Web of Science, PubMed, and Scopus, to identify appropriate peer-reviewed articles published on the use of VR in older populations. The search terms encompassed combinations of keywords namely "virtual reality", "elderly", "older adults", and "mental well-being". Furthermore, the bibliography of featured works has been reviewed for extra material that were pertinent to the topic.

## INCLUSION OR EXCLUSION PRINCIPLES

The study is chosen based on a precise publication stretch of 10 years to guarantee that the evaluation encompasses the most recent findings while still encompassing relevant historical data. The study conducted a systematic literature review, utilizing three prominent databases namely, Web of Science (WOS), Scopus, and PubMed. The review encompassed studies published between 2014 and 2024 in English language. The subsequent standards were used to include studies such as evaluated the influence of VR interventions on cognitive function, physical abilities, or mental well-being among elderly participants and included participants with an average age range of 60 or more. Research that targeted younger demographics using VR therapies was not included, and did not report outcomes related to cognitive function, physical abilities, or mental well-being and were conference abstracts, case reports, or review articles without original data.

## DATA REMOVAL AND VALUE APPRAISAL

Two independent reviewers retrieved data that the research included using an established method. Information retrieved involved research design, sample size, participant characteristics, VR intervention details, outcome measures, and key findings.

## DATA ANALYSIS

A method known as narrative synthesis was utilized to provide a summary of the findings from the studies that were included. The data gathered from the papers provided is as follows; title, year, and key findings. The paper was titled numerically. We designated the completed paper as Paper 1 through 16. We then classified the studies based on the key findings' function, which indicated the intervention of VR technology. The results were categorized according to the main outcomes of interest; customization and prevention of injuries, therapeutic applications and cognitive benefits, technological integration and user experience, and physical rehabilitation and social engagement.

# RESULTS AND DISCUSSION

**TABLE 1**. The Possible Advantages of Virtual Reality for Elderly

|  |  |  |  |
| --- | --- | --- | --- |
| Paper | Author | Year | Key Findings |
| 1 | [16] | 2020 | VR can be tailored to aging capacities, preventing training-related injuries. |
| 2 | [21] | 2019 | VR use by seniors was impacted by utility, simplicity of use, social norms, besides comfort. |
| 3 | [14] | 2020 | VR therapy has several uses in care the elderly, including for dementia, neurorehabilitation, stroke, and psychotherapeutic management. |
| 4 | [13] | 2017 | VR treatment helped healthy older people improve their postural balance. |
| 5 | [12] | 2015 | VR can be utilized for senior cognitive therapy exercise influenced by minor memory loss and Alzheimer |
| 6 | [22] | 2022 | VR shows ability for delaying physical and cognitive decline in the elderly. |
| 7 | [15] | 2014 | Participants favoured the virtual setting augmented exercise compared near regular workouts experience. |
| 8 | [23] | 2014 | The VR training ensemble demonstrated improvements in stability with eyes open, opposing the experimental group, as shown by the body centre of pressure moving area. |
| 9 | [17] | 2023 | VR has potential as a preventive plan against cognitive impairment in the elderly. |
| 10 | [18] | 2016 | VR is useful for older seniors' irregular mental aid |
| 11 | [11] | 2021 | VR as a method for assessing and teaching cognitively impaired older individuals |
| 12 | [24] | 2018 | VR treatment helped elderly people keep balance, mobility, flexibility, gait, and fall prevention |
| 13 | [25] | 2020 | VR clinical systems generally rated having good usability, acceptance, and effectiveness by older adults, despite technical and interaction problems |
| 14 | [19] | 2020 | VirtualPT as VR platform for home-based physiotherapy rehabilitation for the elderly. |
| 15 | [26] | 2019 | Older adults usually enjoyed the VR experience and would consider using VR again. |
| 16 | [27] | 2015 | The VR experience was manageable for the older individuals without experiencing significant issues with security or fatigue. |

**TABLE 1** indicates the key findings that highlight the potential advantages of VR for elderly. VR has emerged as a versatile tool in elderly care, offering a wide range of applications from cognitive training to physical rehabilitation. This study analyses a various possible benefit besides challenges of VR knowledge in elderly, drawing on various studies and expert opinions. The examination focusses on the capability of VR in enhancing the customization and prevention of injuries, therapeutic applications and cognitive benefits, technological integration, and user experience, while also considering physical rehabilitation and social engagement among older adults. According to studies, senior people find VR useful, pleasant, and overall beneficial. Perceived utility, ease of use, social norms, and enjoyment strongly impact older VR users' intentions [21]. The significant level of acceptance indicates that VR might substantially enhance people's standard of living for older individuals, namely in the domains of entertainment, mental well-being, and social interaction.

### Customization and Prevention of Injuries

One of the key advantages of immersive VR is its capability to be customized according to the shifting abilities of elderly individuals. VR can mitigate training-related injuries, rendering it a safer option for seniors with diverse physical abilities. Paper 1 proposes that VR could have positive effects on cognitive training. Fortunately, more study is needed to determine if the advantages valid to the elderly [16].

### Therapeutic Applications and Cognitive Benefits

Multiple research projects have highlighted virtual reality's effectiveness in improving intellectual abilities in older individuals, especially those with cognitive impairments. A systematic review has found that VR tasks can be used as reliable screening tools for cognitive testing, exhibiting similar outcomes to conventional paper-based examinations. VR's immersive nature facilitates interesting practices for brain development that can improve capacity for recall, focus, and solving problems. Paper 3 demonstrated that VR treatment has been effective in diverse therapeutic contexts, such as dementia care, neurorehabilitation, stroke recovery, and psychotherapy intervention [14]. Despite these benefits, the absence of standardized research protocols complicates the ability to draw definitive conclusions about VR's overall efficacy, especially concerning stability, posture improvements among robust older adults. Paper 4 suggest that VR therapy was effective in improving postural balance in healthy elderly individuals across the studies reviewed [13]. However, the lack of standardization in research protocols made is challenging to sketch definitive assumptions of VR effectiveness. Additional research is required to thoroughly examine the effects of virtual reality therapy for improving postural balance in the elderly [13]. Paper 5 explores the criteria for designing effective VR technology, strategies for development, and protocols and procedures that could be beneficial for using VR in cognitive rehabilitation [12]. The study emphasizes the beneficial and helpful features provided by the dynamic and engaging character of VR in meeting the requirements of the older population with cognitive impairments. VR improved senior gait characteristics like speed and stride length, comparable with prior study on non-immersive VR in Parkinson's disease. Paper 9 proposes using VR to detect mild cognitive impairment or dementia as VR can improves cognitive function in older cognitively impaired patients. [17]. Paper 11 suggests using VR to screen and train older persons for cognitive impairment, with VR-based assessments showing validity comparable to paper-based exams [11]. Nevertheless, further efforts are required to enhance the diagnostic specificity of assessments based on virtual reality. The research discovered many VR environments used across studies, suggesting standardization is needed before VR simulations can be compared.

### Technological Integration and User Experience

The integration of VR with wearable sensors and 3D motion capture, as seen in platforms like VirtualPT, allows for continuous health monitoring and personalized physiotherapy [19]. This system lets physiotherapists teach new exercises and track patient progress in real time, improving rehabilitation. The studies reviewed indicate that VR, particularly image-based rendering systems, is well-tolerated by elderly users, with minimal issues related to security or fatigue. Furthermore, Paper 2 suggest that VR was discovered to be quite well-received by seniors [21]. Studies have demonstrated that familiar virtual environments (FamIBVE) in Paper 16 can improve the retrieval of autobiographical memories, providing extra cognitive advantages [27]. VR, especially FamIBVE, improved autobiographical memory recall compared to other circumstances. Paper 15 suggests VR could be used by older individuals for remembrance, amusement, exploration, education, and socialization [26]. Usability and ethics issues arise when using VR with elderly persons, especially those with health issues. Meanwhile, Paper 13 suggest that non-immersive VR systems are considered better for older adults compared to immersive head-mounted display (HMD) systems, though some older adults do positively accept and tolerate HMD VR [25]. Usability is possible to enhance by swapping out HMDs with CAVE structures and providing clear instructions and feedback to older adults.

### Physical Rehabilitation and Social Engagement

Rehabilitative physical therapy has also made use of virtual reality, particularly in improving stability and stride among the aging population. A comprehensive analysis found that VR therapy significantly enhances static and dynamic balance, as well as gait performance, compared to traditional exercise programs [22]. The interactive and motivating aspects of VR encourage older adults to participate more actively in their rehabilitation, which can lead to better outcomes. VR technology is proposed in Paper 7 as a tool to aid with bodily treatment for retirement home residents [15]. Paper 8 indicates VR training group also showed significant improvements in balance with eyes closed, as measured via the area of motion centred on the body's pressure points, compared to the control group. Using VR for instruction improves how well individuals can maintain their equilibrium, as indicated by the reduced total area of centre of compression movement [23]. According to Paper 12, VR therapy shows promise as an effective technique for improving balance in older adults [24]. Paper 14 suggest that the system continuously monitors the user's health metrics using wearable sensors integrated with the virtual reality environment [19]. A virtual avatar is created from the user's real-time motions using 3D motion capture, allowing physiotherapists to simply add additional exercises. The use of VR in encouraging social interaction among older adults has been another area of interest. Studies show that VR can help elderly people socialize by providing virtual environments for peer interaction and group activities. This helps persons with mobility difficulties connect with others without physical barriers. The findings highlight the potential of immersive VR in various aspects of elderly care, emphasizing its customization capabilities, therapeutic benefits, and technological integration. VR can be tailored to meet the changing physical abilities of seniors, reducing the risk of injuries during training. It has shown promise in cognitive rehabilitation, with studies suggesting its effectiveness in improving memory, focus, and problem-solving skills, particularly in those with cognitive impairments. However, challenges remain due to the lack of standardized research protocols, making it difficult to draw definitive conclusions about VR's overall efficacy. The integration of VR with wearable sensors and 3D motion capture enhances user experience by allowing real-time health monitoring and personalized therapy, which is well-received by elderly users. Additionally, VR's application in physical rehabilitation shows significant improvements in balance and gait, while also promoting social engagement among seniors by facilitating virtual peer interactions. Despite the promising outcomes, further research is necessary to standardize VR applications and fully realize its potential in elderly care.

## CHALLENGES AND FUTURE DIRECTION

Although VR has the capacity to be beneficial, there are challenges that come with integrating it into geriatric care. Usability is a notable consideration, as elderly individuals may encounter difficulties with the technology or see the virtual reality experience as unsettling. This is particularly applicable to people with dementia, as the immersive and occasionally overpowering characteristics of VR could potentially result in confusion or distress. The preference for non-immersive VR systems over immersive head-mounted displays (HMDs) among older adults highlights the importance of user-friendly design. There is also a need for standardization across VR environments to ensure consistent and safe experiences for all users [25]. Extra investigation is essential toward refining VR applications, explore their long-term effects, and develop standardized protocols for their use in elderly care. Furthermore, while the short-term benefits of VR in cognitive training and rehabilitation are evident, there is limited research on the long-term effects. The reliability and significance of such advantages over the long run must be determined on the prevention and treatment of cognitive impairment. In conclusion, VR presents a promising avenue to improve physical and psychological well-being among seniors. However, to fully realize its potential, ongoing research and development are needed to address the challenges and ensure the technology is accessible, safe, and effective for all elderly users.

# CONCLUSIONS

The systematic review highlights the capacity of using VR as a versatile instrument to enhance mental and physical well-being in senior citizens. Despite ample evidence supporting the usefulness of VR therapies in many areas, additional study is required to establish standardized protocols and investigate their suitability for diverse populations. VR holds great potential to boost mental capacity and physical health in older adults. The inclusion of this technology in aged care is highly valuable due to its capacity to offer customized training, enhance cognitive abilities, and aid in physical rehabilitation. However, to fully utilize its capabilities, further research and advancement are required to overcome present challenges and enhance the utilization of VR in this specific population. The evidence suggests that VR might greatly enhance living conditions in older adults, but careful consideration must be given to ensure its safe and effective integration into elderly care practices.

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