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Review

A Bibliometric Analysis Exploring the Acceptance of Virtual Reality among Older Adults: A Review

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Abstract: In recent years, there has been a widespread integration of virtual reality (VR) technology across various sectors including healthcare, education, and entertainment, marking a significant rise in its societal importance. However, with the ongoing trend of population ageing, understanding the elderly's acceptance of such new technologies has become a focal point in both academic and industrial discourse. Despite the attention it garners, there exists a gap in understanding the attitudes of older adults towards VR adoption, along with evident needs and barriers within this demographic. Hence, gaining an in-depth comprehension of the factors influencing the acceptance of VR technology among older adults becomes imperative to enhance its utility and efficacy within this group. This study employs renowned databases such as WoS and Scopus to scrutinize and analyze the utilization of VR among the elderly population. Utilizing VOSviewer software (version 1.6.20), statistical analysis is conducted on the pertinent literature to delve into research lacunae, obstacles, and recommendations in this domain. The findings unveil a notable surge in literature studies concerning VR usage among older adults, particularly evident since 2019. This study documents significant journals, authors, citations, countries, and research domains contributing to this area. Furthermore, it highlights pertinent issues and challenges surrounding the adoption of VR by older users, aiming to identify prevailing constraints, research voids, and future technological trajectories. Simultaneously, this study furnishes guidelines and suggestions tailored towards enhancing VR acceptance among the elderly, thereby fostering a more inclusive technological milieu. Ultimately, this research aspires to establish an encompassing technological ecosystem empowering older adults to harness VR technology for enriched engagement, learning, and social interactions.

Keywords: virtual reality; user acceptance; older adults; social interaction; technology acceptance

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1. Introduction

The world's population is rapidly aging. In 2020, there were 1 billion people aged 60 years or older. By 2030, this number is projected to rise to 1.4 billion, meaning 1 in 6 people globally will be in this age group. By 2050, the population of those aged 60 and over is expected to double, reaching 2.1 billion. Additionally, the number of individuals aged 80 years or older is anticipated to triple from 2020 to 2050, reaching 426 million [1]. Social isolation and loneliness, affecting about a quarter of older adults, are significant risk factors for mental health conditions in later life [2]. Approximately 14% of community-dwelling older adults over the age of 55 experience depressive symptoms, and older adults over the age of 85 who are physically and socially inactive are at a higher risk of experiencing depressive symptoms [3]. Research has indicated that the engagement of the elderly in virtual social media platforms can enhance their feelings of community support and connection, leading to a rise in life satisfaction [4]. Older adults engage in online social networks, facilitating conversations with family, friends, and peers, and exchanging personal and emotional life stories, which in turn diminishes feelings

of loneliness and enhances their chances for social connections. Furthermore, various web-based social media sites offer digital social engagements, including online games and communal conversations, aiming to enhance the social engagement of older adults and boost their overall well-being [5]. A study revealed that elderly individuals engaging in virtual social interactions enhance their social support and emotional interaction, leading to increased life contentment and joy [6]. Consequently, engaging socially online serves as an effective tool to enhance seniors' life contentment [7].

By analyzing, viewing, or similar research, we found that some studies indicate that the application of virtual reality technology in the geriatric domain is still in its infancy, with a limited number of existing studies and a lack of unified norms and standards [8,9]. The article [10] suggests that the application of virtual reality technology in older users focuses on the health domains of rehabilitation, fall prevention, physical activity participation, and cognitive exercise. Although some studies have found positive impacts of virtual reality interventions, there is a need to further understand the feasibility and acceptability of virtual reality interventions in the elderly population [9]. The paper [11] identified a number of design considerations through a review of the relevant literature, covering design decisions from hardware to software to human–machine configuration [11]. Ref. [10] suggests that future virtual reality programming for older adults should include the use of larger text in the operator interface, lighter weight devices, increased physical interaction during use, and age-appropriate requirements.

Articles [12,13] found that virtual reality had a positive impact on improving balance and functional motor skills in healthy older adults, but these studies focused only on older adults without disabilities, so the findings cannot be generalized to older adults with disabilities [13]. Subjective willingness and experience were found to be important factors influencing the effectiveness of virtual reality use, but previous studies have not explicitly assessed these factors [12]. There may also be publication bias, as studies with positive results are more likely to be published [12]. This limits the breadth of the analysis as the number of included studies remains relatively small [12]. The study was published differently from previous studies.

Virtual reality technology can improve people's ability to process emotionally rich life situations, but further randomized controlled trials are needed to clarify its effectiveness relative to non-virtual reality interventions [14]. Future research should focus on randomized controlled studies to draw conclusions across different populations (with or without cognitive impairment or in different life situations) [15].

Although virtual reality technology provides new entertainment and socialization opportunities for older adults, there are issues of comfort, ease of use, cognitive load, and physical and psychological demands [16]. However, these studies have not delved into how natural virtual representations affect social well-being indicators (especially loneliness and social connectedness), nor have they revealed the psychological processes underlying them [17]. Studies in this area have focused on the short-term effects of virtual reality use and lack in-depth research on long-term use [12,13,16]. The paper [17] mentions the need for further research to fill this gap in the future, and while it points out the shortcomings of the existing research, it does not offer specific solutions or recommendations to overcome these limitations. In addition, the paper does not provide an in-depth critical assessment of each study.

Since the 1990s, there has been a steady emergence of virtual reality technology. Following several years of evolution, it has evolved into a vital instrument in medical, educational, entertainment, and various other areas [18]. In recent years, virtual reality (VR) has been shown to be an effective tool to help older adults with physical training, such as improving balance and preventing falls through interactive simulations [19]. VR can allow for older adults to safely avoid obstacles, and exercise, increasing engagement and motivation. In addition, VR can also be used for cognitive training, helping to improve memory and concentration [20]. In terms of socialization, VR can help older adults connect with family and friends remotely, reduce loneliness through virtual activities such as social

gatherings and virtual tours, rekindle their passion for life, and improve their overall quality of life [21].

With ongoing advancements and enhancements in VR technology, its usage among the elderly is steadily rising. The growing interest in how older users welcome and utilize VR technology has emerged as a key research subject [22]. Despite the widespread use of virtual reality among the elderly, it must be acknowledged that it has certain shortcomings. Firstly, the aged population might encounter physical health constraints like weak vision, hearing, and equilibrium, potentially influencing their utilization and interaction with VR gadgets [19]. Secondly, older adults could struggle with comprehending novel technologies and require additional instruction and assistance for proficient use of VR machinery [23]. Furthermore, older adults might be more wary of technology's security and privacy [24], thereby necessitating their consideration in the design of VR applications to enhance their reception and contentment. Older adults' unique anticipations and requirements for the accuracy and engagement in virtual settings necessitates tailoring VR applications based on their preferences and capabilities to boost their receptivity and interactivity [25].

When designing virtual reality (VR) applications for older adults, design principles are critical. Studies have shown that clear game flow and a pleasant first experience can significantly improve older adults' acceptance of VR technology [26]. In addition, adding social interaction elements, such as playing with friends or communicating in real time, can enhance older adults' sense of engagement and belonging, thereby improving their acceptance of technology [27]. Content design should be tailored to the interests and cultural background of older adults, taking into account game difficulty, style, and background music to ensure that users have a pleasant experience [28]. At the same time, hardware design should adapt to the physical limitations of older adults, enhance their interactive experience, help narrow the digital divide, and promote technology use [29].

Generally, as VR technology continues to develop and become more popular, its adoption by the elderly is steadily increasing. VR, as a new technological means, can improve the social interaction experience of the elderly. Therefore, it is imperative to explore the user acceptance of social interaction of virtual reality technology among the elderly.

2. Background

In recent years, we have witnessed the development of virtual reality technology [30]. Research has explored immersive VR in health [31] by using virtual reality headsets to provide a fully immersive experience, placement stalking, and gesticulation-grounded controllers [32,33], suggesting that it may improve age-related cognitive impairment diseases or other physical health problems, such as stroke and dementia [34]. A large number of VR-applied interventions for older adults are currently being developed [35,36], and recent studies have shown a high quality of satisfactoriness regarding the safety of VR use in the elderly [37].

Nevertheless, applying VR to the medical field will result in the research field focusing only on the elderly with medical conditions, ignoring the potential benefits of VR for the elderly more generally. To provide possibilities in other areas, researchers have demonstrated that VR can serve as an entertainment medium for older adults [24,38], social media [39–42], or help for healthy ageing [20,43]. Nevertheless, till now, there is little research on VR application design for the ageing population [21], with notable exceptions [44]. Finally, while many researchers have developed VR solutions for the elderly, validation on solid, all-inclusive procedures for designing VR for the elderly is lacking [45].

As social aging accelerates, the demand for social interaction and entertainment among older adults is increasingly evident. Conventional social and entertainment methods are insufficient for the elderly's needs; hence, identifying innovative technological tools to enhance their social interaction has gained significant importance. The advent of virtual reality (VR) technology as an entertainment tool introduces novel social interactions for seniors, garnering significant interest in its potential uses. Thus, a comprehensive analysis exploring how VR entertainment technology is embraced and its factors impacting older

adults holds significant value in fostering their social engagement and entertainment enjoyment [46].

Virtual reality with social interaction can boost social engagement, cognitive skills, engagement, and emotional well-being in the elderly. Studies indicate that virtual reality can foster a 3D setting with a pronounced presence, contributing to resolving the social deficit experienced by seniors in digital interactions [47]. Moreover, the application of virtual reality technology may aid in enhancing cognitive training, potentially leading to positive improvements in the cognitive capacities of older adults. Engaging via social VR technologies is linked to the essence of real-life in-person communication, enhancing the engagement and joy of the elderly. Consequently, the influence of social interactive VR on the health of the aged is beneficial and is anticipated to emerge as a significant means to enhance the life quality of the aged population [48]. Exploring and discovering social VR environments for older adults is imperative.

A review of literature systematically helped us identify research works connected to the elderly's experiences while using virtual reality technologies.

3. Method

3.1. Manuscript Selection Criteria

According to the selection criteria, the most cited articles were selected to find the most useful research resources. The selection criteria for manuscripts in the Scopus database are as follows:

- Article title search was performed by selecting virtual reality AND older adults.
- For evaluation, the most cited manuscripts published between 2015 and 2024 were selected.
- After the first screening, 240 articles were selected from the Scopus database.
- After the second screening, 225 papers published between 2015 and 2024 were selected.
- After the third screening, the 100 most cited articles were selected.

3.2. Research Trends

At first, a total of 240 articles connected to this topic were found in the Scopus database. According to the analysis, these 100 articles were chosen because their citation range from 8 to 315, for a total of 3380 citations. Additionally, there were 6 articles receiving more than 100 of them. The Scopus database article with the most citations was published in *Lancet Communication Mag*, "Addition of a non-immersive virtual reality component to treadmill training to reduce fall risk in older adults (V-TIME): a randomized controlled trial", with 315 citations. The top 100 manuscripts were taken into consideration and are shown in Table A1 (Appendix A). Table A1 (Appendix A) lists the complete information of these 100 articles, including (i) author name and publication year; (ii) keywords; (iii) manuscript type; (iv) country; (v) journal name; (vi) publisher; (vii) impact factor; and (viii) total citation.

The journals that had published the most articles are *Frontiers in Virtual Reality*, *Games for Health Journal*, and *Journal of Medical Internet Research* (n = 4, 4%), with impact factors (IFs) of 3.2, 2.2, and 5.8, respectively, followed by *Frontiers in Aging Neuroscience*, *Journal of Clinical Medicine*, *Journal of the American Medical Directors Association*, *Virtual Reality*, *Journal of Transport and Health*, *Archives of Gerontology and Geriatrics*, and *Scientific Reports* (n = 3, 3%), with impact factors (IFs) of 4.1, 3.0, 4.2, 4.4, 3.2, 3.5, and 3.8, respectively. In the USA, the journal with the most published articles was *Games for Health Journal* (n = 4). *Virtual Reality* (n = 3) was the journal that had published the most articles in England. *Frontiers in Virtual Reality* (n = 4) was the journal that had published the most articles in Switzerland. In Canada, the journal with the most published articles was *Journal of Medical Internet Research* (n = 4). Four articles related to research in Germany were published in 4 journals. In Ireland, the journal with the most published articles was *Archives of Gerontology and Geriatrics* (n = 2). Other countries published in different journals. MDPI was the most popular publisher (n = 15), followed by Elsevier (n = 14).

Figure 1 shows the total number of VR-related articles published on older adults in the field of VR in the past decade, which is 225, and that number is trending upward, suggesting that traction is being gained in the VR for seniors space.

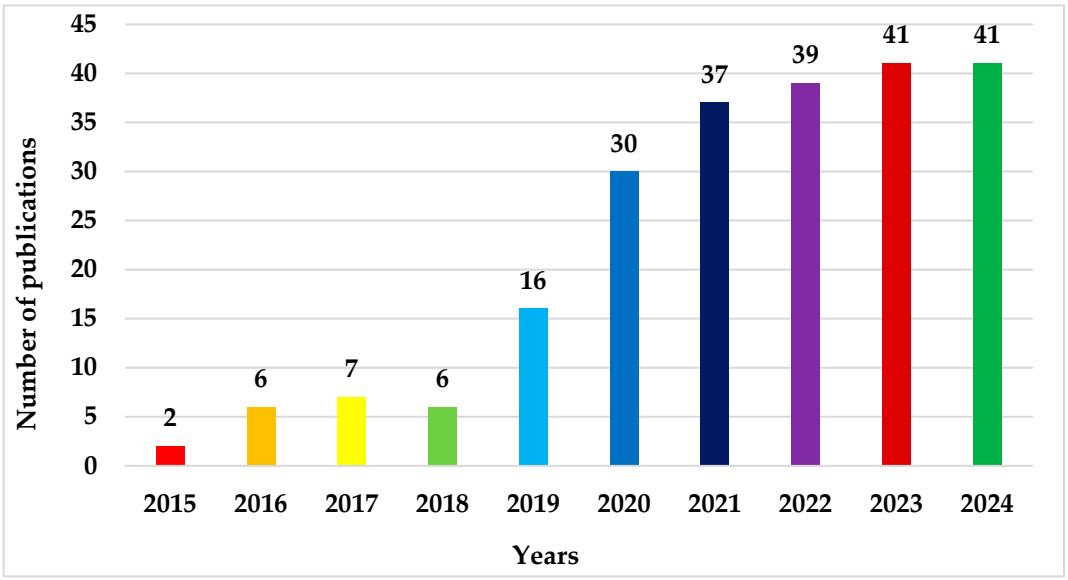

Figure 1. Scan frequency of publications in the field of VR for seniors from 2015 to 2024.

3.3. Analysis of Country

Figure 2 shows, among the top 100 most cited papers, the top 10 countries, regions, institutions, journals, and research categories that published the most papers. The USA (n = 35, 35%) published the most articles, followed by England (n = 28, 28%); third was Switzerland (n = 26, 26%), followed by Canada, Germany, and Ireland with (n = 7, 7%), (n = 6, 6%), and (n = 5, 5%), respectively; Australia, Hongkong, Italy, Lithuania, the Netherlands, New Zealand, and Spain published (n = 1, 1%) each.

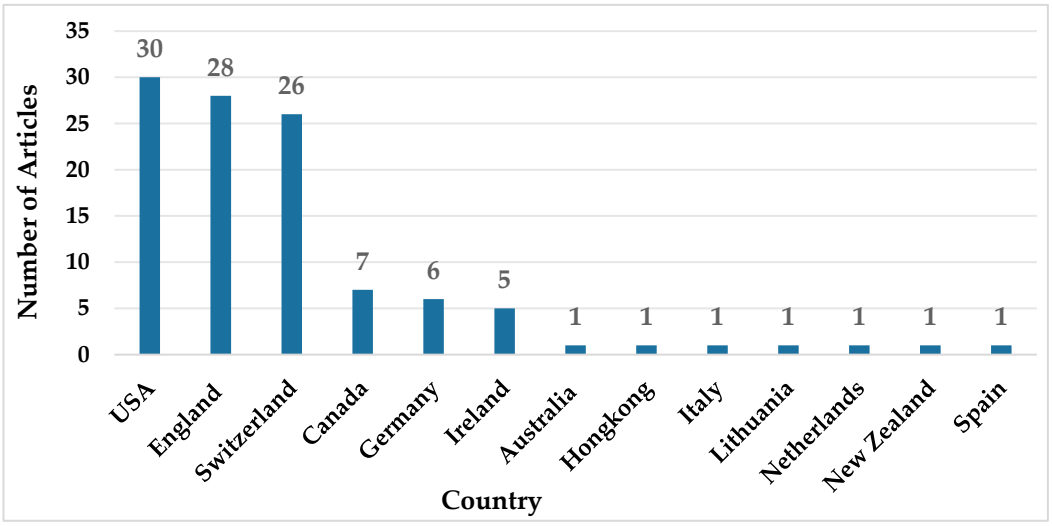

Figure 2. National and regional distribution of the number of publications researching older persons in the field of virtual reality.

3.4. Analysis of Keywords

Figure 3 shows a total of 266 keywords were extracted from the article. The most frequently occurring keyword is "Virtual Reality" (n = 91), followed by "Human" (n = 64) and "Age" (n = 61). Keywords are mainly divided into 5 groups: Group 1 (green) mainly involves virtual reality and older adults; Group 2 (red) mainly involves humans and age; Group 3 (blue) mainly involves controlled studies; Group 4 (purple) mainly involves the very elderly; Group 5 (yellow) mainly involves cognition. It can be seen that the research on the elderly and virtual reality is mainly to improve the cognitive training of the elderly and the treatment of other diseases through game therapy.

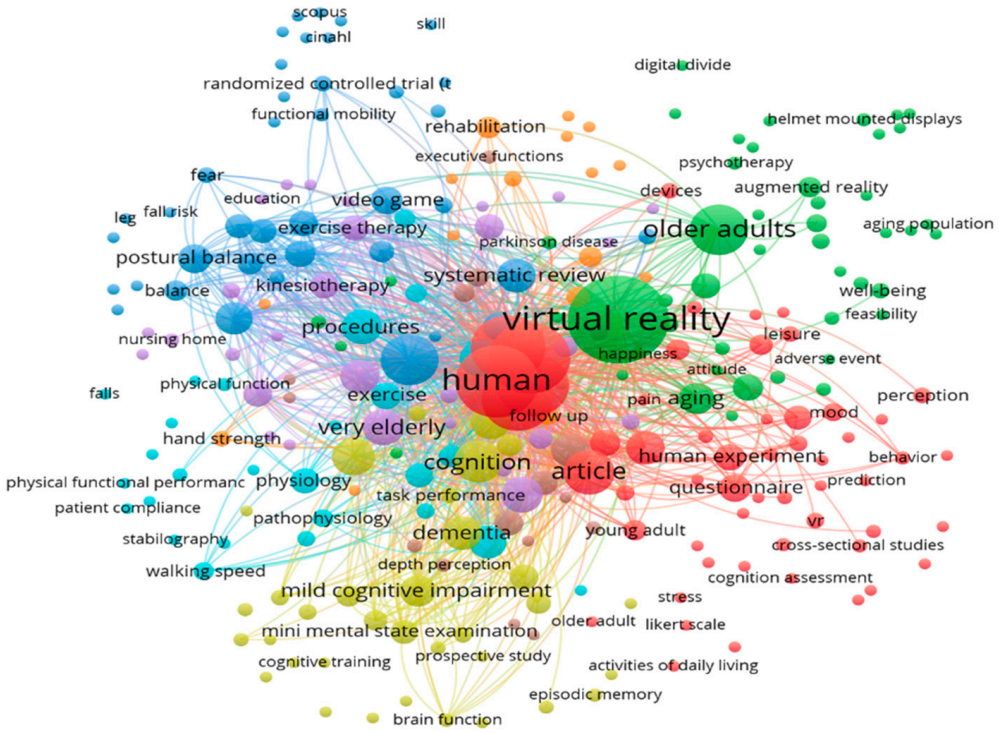

Figure 3. Network visualization view of the occurrence of keywords in virtual reality-related research articles.

3.5. Analysis of Countries and Regions

The network mapping in Figure 4 helps authors discover the strength of citation links between two or more countries on similar documents. The distance between nodes is shorter, indicating a stronger correlation between them, leading to the conclusion that all countries can be divided into 5 groups: United States, South Korea and Taiwan (purple, cluster 1); United Kingdom, China, and Hong Kong (yellow cluster 2); Switzerland, France, and Japan (blue, cluster 3); Germany, Italy, and Greece (red, cluster 4); Australia and Denmark (purple, cluster 5). At the same time, the size of each country node in the visualization reflects the productivity of articles published in the process over the past 10 years. For example, the United States icon is the largest, which indicates that the number and quality of articles related to research in this field of virtual reality and the elderly are relatively high.

Figure 4. Web visualization view of country and region occurrences in virtual reality-related research articles.

We can draw the following conclusion from Table A1 (Appendix A): Firstly, there is relatively more research on the elderly and VR technology in the United States and European countries, indicating that VR technology is in a leading position in the field of elderly care in these countries. Insufficient research in this field, especially in developing countries, may be due to the low popularity of VR technology in other countries and regions. In the future, we can explore the acceptance of VR technology among elderly people from different countries and economic backgrounds. Secondly, in terms of keywords, "virtual reality" and "elderly" appear frequently, but vocabulary related to cognition and rehabilitation also appears frequently, indicating that current research mainly focuses on cognitive and rehabilitation training. However, the keyword of social interaction hardly appears, which is a research gap. In the future, further research and discussion can be conducted on how virtual reality technology can help elderly people provide social support, especially with the intensification of social isolation issues after the COVID-19 pandemic. In addition, there is little research on the long-term impact of virtual reality technology on the elderly. In the future, long-term follow-up visits should be considered to clarify sustainability and effectiveness. Finally, virtual reality technology is mainly designed for young people and not specifically designed for the elderly. In the future, the development of VR devices will need to consider the usage habits of the elderly, such as more accessible interfaces.

4. Analysis and Outcome

Discovering and expanding on a topic first requires identifying and understanding the latest research trends in the field and the most influential research efforts. This paper aims to explore the importance of current research trends and locate the relevant literature related to the acceptance of virtual reality by older adults. We filtered according to the keyword of the title, and the main search keywords used were "Acceptance", "virtual reality", as well as "VR" and "older adult". Seven studies were screened during the period and are summarized in Table 1. This work was motivated the following two research questions: Question 1—"What factors influence the acceptance of VR among older adults?" Question 2—"What are the theoretical frameworks in the study of VR acceptance among older adults?" To fully understand these challenges, we explored the recent literature as a primary source to answer these research questions.

Table 1. References for composite conditions.

Rank	Ref	Title	Authors	Domains of Application	Category of VR	Virtual Environment or VR Software	Research Method	Type of End-Users Addressed	Age Range and Quantity of End Users	Conclusion
1	[26]	Acceptance of gamified virtual reality environments by older adults	Pang and Cheng, 2023	Recreational VR	HTC Vive	Music room, drawing room, backyard, kitchen, restroom, beach. Cleaning tasks: kitchen and restroom tidying	Semi-structured interviews, TAM, controlled experiment	Living autonomously or residing with their significant other	15 older adults (>65): Male 8 Female 7	Participants exhibited positive attitudes and expressed enjoyment upon initial exposure to the VR games.
2	[27]	Acceptance of Virtual Reality Exergames Among Chinese Older Adults	Xu et al., 2023	Recreational VR	Not mentioned	VR exergames involve activities such as punching, slicing, and dancing	TAM, quantitative method with structured questionnaires, controlled experiment	With family: 48; living alone: 3	51 older adults (>65): Male 22 Female 29	The results suggest that older adults who are younger, retired, have higher education levels, better financial status, and good health tend to view VR exergames more positively.
3	[49]	Feasibility, Acceptability, and Efficacy of Virtual Reality Training for Older Adults and People With Disabilities: Single-Arm Pre-Post Study	Chau et al., 2021	Rehabilitation VR	Not mentioned	Realistic scenes (animals, buildings, landscapes)	Qualitative experiment	Institutional and community	135 older adults (average age 62.7) Male 68 Female 67	VR games were well received by older adults in the local community, including those with various disabilities.
4	[28]	Acceptance and Usability of Immersive Virtual Reality in Older Adults with Objective and Subjective Cognitive Decline	Arlati et al., 2021	Rehabilitation VR	HTC Vive Pro	Supermarket	TAM3 questionnaire, controlled experiment	Not mentioned	58 older adults (>60)	Immersive VR is acceptable and enjoyable for both groups of seniors.
5	[19]	Acceptance of a Virtual Reality Headset Designed for Fall Prevention in Older Adults: Questionnaire Study	Mascret et al., 2020	Fall prevention	Not mentioned	Photo	TAM questionnaire	Not mentioned	271 older adults (65–84) Male 100 Female 171	The extent to which older adults receive virtual reality headsets to prevent falls has a significant impact.
6	[50]	Acceptance of immersive head-mounted virtual reality in older adults	Huygelier et al., 2019	Recreational VR	Oculus Rift	Natural scenery, time-lapse videos	Action research, questionnaire, controlled experiment, UTAUT	Community dwellers residing in assisted living	76 older adults (57–94)	The impact of virtual reality applications on the health of older individuals is unaffected by negative attitudes or cyber sickness.
7	[29]	Older adults' experiences with audiovisual virtual reality: perceived usefulness and other factors influencing technology acceptance	Roberts et al., 2019	Recreational VR	Samsung Gear VR	"Jurassic World" and "Cirque du Soleil"	TAM; semi-structured, controlled experiment	Residents of a retirement community	41 older adults	Virtual reality received positive reviews; however, adjustments are required to enhance user experience and maximize potential benefits for this demographic.

4.1. Analysis of Virtual Environment and Older Adults

There were four research papers in the field of VR entertainment [26,27,29,50]; these included two studies on rehabilitation VR [28,49]; a study explored the prevention of falls [19]. All seven studies used VR headsets. While three studies did not mention the device used [19,27,49], a total of two studies used the HTC Vive [26,28]. One study explored the Oculus Rift [50], and another explored the Samsung Gear VR [29]. The test environments were mostly natural and living scenarios; the participants' living situations covered a wide range of situations such as living with family, living alone, and living in a nursing home; and the average age of the test participants was over 60 years old.

Positive attitudes towards VR use amongst the ageing population are evidenced in all seven studies; six studies mention that education level has an impact on the acceptance of VR among older adults [19,26,27,29,49,50]. Older adults with higher levels of education are more inclined to embrace VR technology; people with higher levels of education usually have a greater capacity for learning and openness to new technologies, which makes them more likely to accept and use VR environments [29]. Four studies show that age affects the acceptance of VR devices in older adults [26–28,50]. Older adults may be less receptive to new technologies as they age because their expectations of how the technology will perform and the effort required to use it may not be as positive or little as those of younger adults; the younger the older the person, the greater the likelihood that he or she will use VR [50]. Four studies show that older adults are more likely to accept VR devices if they are easy to use [19,27,29,49]. Three studies have shown that if VR devices are helpful for their lives, elderly people are willing to use them [19,27,29]. Two studies have found that gender can affect older adults' acceptance of VR [26,28], and additionally that men are more likely to accept VR than women [28]. Two studies found that although elderly people with cognitive decline may encounter difficulties in learning new technologies, their willingness to try new technologies is comparable to their peers with better cognitive status. Therefore, cognitive ability is not the main obstacle for elderly people to accept VR, but cognitive impairment may lead to risky behavior and interaction difficulties. The attention of the elderly to cognitive ability is lower than that to technical experience, but the potential impact of overall cognitive decline on the elderly's attitude towards technology is not as important as the impact of technical experience [50]. There was discussion about the impact of health status on elderly people's use of VR in two studies, one of which showed that elderly people with good physical health are more inclined to view the use of VR games positively. On the contrary, elderly people with poor health conditions may have a lower acceptance of VR games, as they may face more physical limitations and discomfort. Therefore, physical condition is one of the important factors affecting the elderly's acceptance of VR games. [27] Another study suggests that poor physical condition may make them feel uncomfortable while using VR, such as experiencing symptoms like dizziness. This indicates that the health status of elderly people directly affects their experience and acceptance of VR games [26]. Two studies have found that more content related to the preferences of older adults can be more attractive for them to use VR, for example, virtual travel, learning new knowledge, reminiscing about beautiful times of the past, etc. [29,49]. Research has found that diverse games and content should be provided to meet the interests and needs of different elderly people. A study shows that social interaction can not only alleviate loneliness, but also enhance cognitive function in the elderly [49]. It is mentioned that the comfort level of wearing VR devices affects the elderly's use of VR. For example, the weight of VR devices and the comfort of the materials used can affect the elderly's choice to use VR [49]. There are also studies showing that elderly people who use VR experience a sense of achievement [27] and happiness [19], and they tend to prefer using VR. Two of the studies mentioned that when the elderly use VR equipment, advance training would have better results [27,49]; one study showed that correct instruction before the use of unaccustomed technology is supportive for elderly people [50]. Receiving help in using VR equipment can foster its quicker adoption [26]. Two of the studies believe that acceptance of VR equipment by the elderly is affected by

computer proficiency [26,50]. More so, proficient computer use experience can make it easier for the elderly to accept VR. It is believed that the interface of the VR program affects the acceptance of VR equipment by the elderly [26,27]. The color, contrast, and interaction method of the interface affects the acceptance rate of VR by elderly people.

In recent research, seven studies have indicated the need for long-term observation to obtain better experimental feedback [19,26–29,49,50]. Current virtual reality technology is not limited to preventing falls but can also be expanded to other health fields related to the elderly, such as cognitive training, exercise rehabilitation, etc. [19]. In the future, the combination of virtual reality technology with other technologies, such as the Internet of Things, big data, etc., can be explored to provide more personalized fall prevention solutions [19], and more research is needed to explore its potential health benefits and practical application effects [27]. Seven studies suggest that future research should focus on cognitive training [19,26–29,49,50], in combination with other rehabilitation methods, [28,49] to evaluate the combined application effect of virtual reality technology and other cognitive training methods [28], promoting the healthy development of the elderly and improving their quality of life. Although virtual reality technology is rapidly developing, its application in the elderly is still relatively limited [27], and existing VR technology studies lack research on social, entertainment, and other aspects of life for the elderly [26,28]. In the future, virtual reality programs suitable for the elderly should be developed [49], and increasing the immersion and interactivity of VR technology is expected to further improve [28]. One suggestion is to design a universal virtual reality training system that adapts to a wider range of people to meet the needs of different populations [27,49]. Currently, research on the acceptance and usage habits of virtual reality technology in the elderly population is not sufficient, especially for the elderly [19]. Firstly, there is a lack of standardized measurement tools and evaluation methods [29,49]. Secondly, more research is needed in the future on the psychological and behavioral responses of the elderly population to the use of virtual reality technology, including overcoming physical and psychological barriers [26,50]. In addition, research on how to effectively apply VR technology in the elderly population still lacks considerations regarding comfort and safety [26], as well as efforts to reduce the potential side effects that may occur when using VR technology [26] like dizziness, etc. Finally, improving acceptance and the ability of elderly people to use VR technology through education and training are also important directions [50].

In summary, our future research on the application of VR technology in the elderly will focus on social interaction and cognitive training. By designing VR programs that meet the physiological and psychological needs of the elderly, and improving standardized measurement tools and evaluation methods, we aim to provide relevant training on VR technology for the elderly to enhance their acceptance of VR.

4.2. Case Analysis Acceptance of Gamified Virtual Reality Environments by Older Adults

Through research on case applications of VR equipment for elderly people, we have drawn some important conclusions: First, we found that elderly people showed positive attitudes and had pleasant experiences when using VR devices [27]. The virtual reality environment can also provide opportunities for social interaction for elderly people, promote their communication and interaction with others, help relieve loneliness and depression, and improve their quality of life [47]. Second, VR equipment can provide opportunities for physical activities and cognitive exercises, helping the elderly keep their minds sharp and their bodies healthy. By participating in virtual reality games and activities, they can perform mental training and physical exercise, enhance concentration and memory, and help prevent falls and cognitive function decline, as well as other accidental injuries [27]. In addition, VR equipment can also provide the elderly with more entertainment options, such as virtual travel, virtual games, etc., allowing for them to enjoy a colorful, entertaining life. This can not only alleviate loneliness in the elderly, but also stimulate their curiosity and add more fun to their lives [51]. Their high-rate acceptance of VR technology provides a positive reference for the future promotion of VR equipment among the elderly people.

Although the elderly find advantages in virtual reality devices, it is crucial to recognize the associated inherent challenges. At first, the costs associated with educating the elderly on utilizing VR devices surpass those of the youth. Elderly users might struggle to grasp a gadget's functionality, including its usage and regulation systems, coupled with a lack of acquaintance with virtual reality's principles, potentially hindering their educational progress and adaptation to emerging technologies. Subsequent studies indicate that older adults often suffer from unease, vertigo included, while operating VR devices [25,52]. Such discomfort could influence the degree of comfort and overall experience, potentially posing both mental and physical hazards to older VR device users. Considering the overall trend of diminishing cognitive and motor abilities in the elderly, they might confront an elevated risk with VR devices, potentially leading to a higher likelihood of falling [35]. Consequently, when advancing and implementing virtual reality (VR) devices for the elderly, a thorough awareness of health risks and appropriate preventative and safety strategies are vital for their protection.

Viewed from a wide angle, even though VR technology benefits the elderly, it is essential to identify health hazards related to VR, particularly in cognitive and motor skills. We propose these ideas regarding the design of VR equipment. To start with, elderly VR devices must be designed in a more straightforward and user-friendly manner, making the devices' procedural options comprehensible and straightforward to minimize educational expenses and operational challenges [53], ultimately enhancing their adoption and readiness to engage with VR equipment [50]. Furthermore, in the promotion of VR devices, it is crucial to account for the features alongside the capabilities of an older demographic and create solutions that more fittingly satisfy these requirements. Ultimately, the significance of prolonged research and subsequent observations lies in understanding the perspective and alterations linked to older adults following prolonged VR device usage [26]. This approach will enhance comprehension of how older individuals embrace technology and serve as a vital source for future design strategies.

4.3. Question 1: What Factors Influence the Acceptance of VR among Older Adults?

Older adults face several barriers when using VR technology. Technical difficulties, such as intricate processes and the operation of devices, may reduce their receptiveness to technology [54]. Challenges like impaired attention, short-term memory, and motor coordination, which are cognitive impairments [55], demand that VR systems be built considering these limitations, thereby requiring systematic training and guidance [24,55]. Prolonged VR usage is further hindered by physical issues like reduced vision, hearing capacity, muscular strength, and balance, leading to experiences like dizziness and discomfort during prolonged headset usage [56]. For boosting the use of VR among the elderly, streamlining operations, offering training, and crafting devices that better suit their distinct requirements and constraints are crucial [56].

4.4. Question 2: What Are the Theoretical Frameworks in the Study of VR Acceptance among Older Adults?

There are many theoretical frameworks for acceptance, including Technology Acceptance Model (TAM), Technology Acceptance Model 2 (TAM2), Technology Acceptance Model 3 (TAM3), Unified Theory of Acceptance and Use of Technology (UTAUT), Unified Theory of Acceptance and Use of Technology 2 (UTAUT 2), Unified Theory of Acceptance and Use of Technology: A synthesis of extensions (UTAUT: A synthesis of extensions), etc., which are widely used. Table 2 shows most of the relevant research on VR acceptance among the elderly adopts the TAM and UTAUT technology acceptance models.

Table 2. Core constructs of each technology acceptance model.

Model	Proposer and Time	Basic Variables
TAM	Fred D. Davis (1989, 1993)	EV, PU, PEU, ATU, BIU, AS [57]
TAM2	Venkatesh and Davis (2000)	SN, I, JR, OQ, RD, E, V, PU, PEU, IU, UB [58]
UTAUT	Venkatesh and Davis (2003)	PEX, EE, BI, UB, SI, FC, G, A, EVU [59]
TAM3	Venkatesh and Bala (2008)	SN, I, JR, OQ, RD, CS, PEC CA, CP, PEN, OU, E, V PU, PEU, IU, UB [60]
UTAUT2	Venkatesh Thong and Xu (2012)	PE, EE, SI, FC, HM, PV, H G, A, E, BI, UB [61]
UTAUT: A synthesis of extensions	Blut, Chong, Tsiga and Venkatesh (2022)	PE, EE, SI, PV, HM, FC, H Compatibility, EPI, costs, BI, UB [62]

EV; externa variables; PU: perceived usefulness; PEU: perceived ease of use; ATU: attitude toward using; BIU: behavioral intention to use; AS: actual system use; SN: subjective norm; I: image; JR: job relevance; OQ: output quality; RD: result demonstrability; E: experience; V: voluntariness; IU: intention to use; UB: usage behavior; PEX: performance expectancy; EE: effort expectancy; BI: behavioral intention; SI: social influence; FC: facilitating conditions; G: gender; A: age; EVU: experience voluntariness of use; CS: computer self-efficacy; PEC: perceptions of external control; CA: computer anxiety; CP: computer playfulness; PEN: perceived enjoyment; OU: objective usability; HM: hedonic motivation; PV: price value; H: habit; EPI: education personal innovativeness.

4.5. Highly Cited Manuscripts on Virtual Reality

Table 3 shows the 10 most cited research articles on older adults in virtual reality over the past 5 years. The research area with the highest number of articles was medicine with six articles, followed by computer science with two articles; Huygelier et al. was the most cited article, followed by Liao et al. One study confirmed the benefits of VR devices in improving the physical health of older adults; three studies confirmed the benefits of VR devices in improving the physical health of older adults; one study confirmed the benefits of VR devices in improving learner engagement. These studies also face a number of challenges, such as small sample sizes and the possibility of expanding the studies to long-term assessments.

Although virtual reality technology can not only improve mild cognitive impairment and enhance physical health index in the elderly but also increase social participation to improve mental health, it can provide feasible intervention measures for language memory and daily life in the elderly. However, there are still shortcomings in the research on the use of VR technology by the elderly, such as a lack of studies on elderly people from different environments and backgrounds, and a scarcity of long-term observational studies.

Table 3. Highly cited manuscripts from the last 5 years on older adults in the field of virtual reality.

Rank	Ref	DOI URL	Conclusion	Last 5 Years Citation	Total Citation Rank	Research Area	Limitation	Participants
1	[50]	10.1038/s41598-019-41200-6	Immersive virtual reality (HMD-VR) offers new opportunities for assessing and treating health problems in older adults with a high degree of safety and acceptability and promotes positive changes in user attitudes through real-world experiences.	131	1	Multidisciplinary	Insufficient attention given to the impact of cognitive decline on older adults' tech attitudes.	76 older people, aged 57 to 94, who were previously unfamiliar with virtual reality.
2	[63]	10.3389/fmed.2019.00329	For functionally impaired older adults, virtual reality experiences are safe and feasible, improve mood, increase social engagement, have flexible applicability and customization, and are enjoyed and willingly recommended by most participants.	109	3	Medicine	1. Unidentified variables affecting participant tolerance and engagement. 2. Lack of understanding regarding tailored VR therapy in diverse settings and populations. 3. The need to explore and assess the potential positive impact of developing more dynamic, social, nostalgic, interactive, multi-sensory, and personalized VR content.	66 older adults, mean age 80.5, with varying cognitive and/or physical impairments.
3	[64]	10.3389/fnagi.2019.00162	The use of virtual reality (VR) combined with physical and cognitive training can significantly improve executive function and dual-task gait performance in elderly patients with mild cognitive impairment.	112	2	Neuroscience	The absence of a control group led to unclear outcome mechanisms. The exercise lacked complexity, failing dual-task induction. Diverse training methods may vary in intensity, needing further study. Multiple statistical tests used with small samples.	34 community-dwelling older adults with MCI.
4	[65]	10.23736/S1973-9087.19.05899-4	Virtual reality training not only significantly improves overall cognitive function, verbal memory, and daily living skills in older adults with mild cognitive impairment, but also enhances neurological efficiency and provides a viable intervention for rehabilitation training.	97	4	Medicine	1. Ensuring enduring intervention impact requires ongoing follow-up evaluation. 2. Solely assessing emotional dynamics in prefrontal regions may overlook changes in other brain regions. 3. Varied treatment effects may arise from different method combinations, warranting further investigation.	42 people aged 65 and above

Table 3. *Cont.*

Rank	Ref	DOI URL	Conclusion	Last 5 Years Citation	Total Citation Rank	Research Area	Limitation	Participants
5	[66]	10.3390/jcm9051283	Virtual reality intervention significantly improves cognitive and physical functioning in patients with mild cognitive impairment.	84	5	Medicine	1. Post-intervention follow-up and differences in sessions/supervision between intervention and control groups were not conducted. 2. Gender differences' effect on VR intervention's effectiveness needs further exploration in future studies.	68 patients with mild cognitive impairment (MCI). Ages ranged from 55 to 85 years.
6	[67]	10.3390/app9173556	In education, augmented reality (AR) and virtual reality (VR) have the advantage of increasing learner engagement and skill retention through immersive and interactive learning.	75	8	Computer science	Ease of use of external devices, physical issues, and mental health issues. (1) Provide a comfortable experience when using AR and VR technology; (2) promote social interaction or social connection; (3) also induce a positive and enjoyable experience.	Not mentioned.
7	[44]	10.1016/ j.ipm.2019.102105	Interactive virtual reality systems in nursing homes are superior to simple virtual reality systems and can provide rich interactive experiences through social, cognitive, and physical engagement. A qualitative research design using a variety of methods can provide insights into its usability and potential benefits, providing an important reference for future research and virtual reality system design.	73	9	Computer science	More extensive mixed-method studies are required to ensure the generalizability of findings, extend study duration for long-term evaluation, and tackle implementation challenges of VR in RACF.	5 RACF residents aged between 74 and 88 Elderly.
8	[29]	10.1080/ 07317115.2018.1442380	Virtual reality technology is proving its potential in the older population by stimulating positive emotions, catering to the interests and needs of older adults, providing a convenient device-use experience, replacing traditional activities, and facilitating social interactions.	76	7	Medicine	Research teams face challenges in data interpretation, theme selection, and naming consistency. Researchers' backgrounds, expertise, and interests influence theme selection and naming, requiring discussion and agreement among team members.	41 seniors, including those in nursing homes, assisted living, and independent living.

Table 3. *Cont.*

Rank	Ref	DOI URL	Conclusion	Last 5 Years Citation	Total Citation Rank	Research Area	Limitation	Participants
9	[68]	10.3390/jcm9061986	Intervention strategies that combine virtual reality (VR) and exercise can enhance the overall health of older adults, increase exercise participation, adapt to home environments, improve rehabilitation, improve mental health, and provide individualized programs, and scientific evidence exists to support their effectiveness.	77	6	Medicine	Many studies had small sample sizes, often no more than 30 participants, which may affect the external validity of the findings.	Not mentioned.
10	[69]	10.1016/j.jamda.2021.03.009	Virtual reality sports games moderately improve cognitive and memory function in older adults, have a significant effect on depressive symptoms, outperform research equipment with commercial systems, and enhance physical activity and social interactions, thereby improving mental health.	63	10	Medicine	The variety of virtual reality exercise games may lead to different results and influence effect comparisons. Some studies did not measure both cognitive function and depressive symptoms, which may lead to bias. The diversity in older age groups may affect the consistency of studies. Lack of details on the intensity of the intervention and mode of participation may affect the assessment of effects.	≥60 older people; no sample size mentioned.

5. Challenges

5.1. Technical Barriers

Among the challenges in implementing VR technology for older adults, technical barriers are an important issue [54]. Research shows that some elderly people may face complex operations of virtual reality devices, such as special controllers or headsets, which may lead to a decrease in their acceptance of technology [70]. In addition, some studies have also found that older people may be confused by complex operations in virtual environments, thus affecting their acceptance of virtual reality technology [45]. Therefore, when promoting virtual reality technology, attention should be paid to the technical obstacles that the elderly may encounter during use and take corresponding measures to simplify the operating process and improve acceptability of VR technologies among the ageing population [56].

5.2. Cognitive Impairment

As we age, older adults commonly encounter the challenge of cognitive impairment [71]. Research indicates that attention, short-term memory, and reaction time among the elderly tend to decline [72,73]. First, some older adults may face limitations in cognitive function, such as reduced attention to details and motor coordination [74]. This means that when implementing virtual reality technology, the cognitive level of the elderly needs to be taken into consideration to ensure that the virtual environment is designed not to cause distress or confusion to them [75]. Second, the elderly have limited rates of acceptance and adaptability to virtual reality technology [56], and they need systematic training and guidance based on their characteristics to improve their cognition and ability to use technology [10,35].

5.3. Physical Conditions

Older adults may face challenges in physical adaptation when using virtual reality technologies. Due to aging, first, older adults may experience a decline in physical functions and perceptual abilities [76], such as diminished vision, hearing, and muscle strength, as well as a gradual decrease in self-care abilities [70]. Second, the use of virtual reality devices may require head or full-body movements, and older adults may have limited motor abilities, especially those with motor impairments [77] or balance challenges [78,79]. In addition, older adults may experience dizziness and vertigo in virtual environments, which may affect their acceptance rate of virtual reality technology [80]. Finally, wearing headgear for long periods of time may put pressure on the head and neck, while gazing at the virtual reality environment for long periods of time may cause eye strain. Therefore, there is a need to investigate how to design comfortable virtual reality devices to alleviate the physical discomfort that older adults may face during use, thereby improving their experiences and acceptance rate [10].

5.4. Social Interaction

Although virtual reality technology has played a positive role in the medical field, including cognitive training and rehabilitation training, there is relatively little research on social interaction [81]. Social interaction is very important for people's psychological and physical health [82], and it can effectively improve the loneliness caused by social isolation in the elderly. Virtual reality technology provides a safe social environment for the elderly, and new design experiences can help reduce anxiety and discomfort. Many studies have not delved into how VR technology enhances social interaction among the elderly; therefore, future research needs to further discuss the role of VR in enhancing social interaction among the elderly and its potential benefits. Researchers need to consider designing VR social programs that are suitable for the elderly and have a positive impact on their social interactions.

In summary, older adults may face a number of technical barriers to the use of virtual reality technology, including operational difficulties, device compatibility, health risk con-

cerns, and a lack of digital technology knowledge. Cognitive barriers include memory loss that accompanies ageing and reduced attention span. There are also physical challenges such as vision loss as well as motion sickness. There is a lack of in-depth research on social interaction. Therefore, to address these challenges, the actual needs and characteristics of older adults need to be considered in an integrated manner in order to promote the healthy development of virtual reality technology for older people.

6. Suggestions and Recommendations

There has been a notable rise in the incorporation of virtual reality (VR) technologies across diverse fields such as healthcare, education, and entertainment in recent times. Yet, the embrace and utilization of virtual reality by the elderly, a group with distinct desires and obstacles, remain largely unexamined. It is essential to grasp the driving elements behind user acceptance to improve the practicality and efficiency of VR technologies tailored for this demographic.

Even though several studies have been identified regarding the uptake of VR by elderly users, certain facets warrant additional investigation: First, we found that there is still a lack of program personalization, and VR manufacturers do not pay attention to the interests of the ageing population enough, which affects the ease of use of VR for the elderly. In addition, due to the decline in physical function and perceptual ability of the elderly, the design of hardware needs to consider the material, weight of the device, volume level, and wearing comfort issues. In addition, professional help and usage guidelines have a positive impact on the acceptance of VR by the elderly.

In summary, future use of VR by the elderly should focus on enhancing social interaction and cognitive training. Social interaction and cognitive training are crucial to the health and quality of life of older adults. By utilizing VR technology, older adults can participate in a variety of social activities, including interactions with family and friends, thereby reducing social isolation and loneliness. In addition, VR can also be used for cognitive training, stimulating the brains of the elderly through various visual and interactive experiences to improve their cognitive abilities and life management skills. Therefore, future VR applications can focus more on how to help the elderly maintain a healthy, active and happy life through social interaction and cognitive training.

Finally, since there is a lack of social interaction in VR entertainment applications, older adults may be more socially oriented towards real interpersonal interactions and emotional exchanges, and the lack of social technologies in the VR entertainment experience may not be able to fully satisfy this need. Therefore, how to add more elements of real human interaction in VR social technology has become a problem that needs to be solved.

7. Conclusions

From the characteristics of the design and data on user experience derived from the chosen studies, certain key factors requiring attention in the development and trials of VR applications for the elderly can be pinpointed. Initially, enhancing the elderly's use of VR technology can enhance their comprehension of VR and alter their perspectives on it. Additionally, enhancing VR technology can heighten its use among senior users. (1) Virtual reality technology's design should account for potential cognitive and perceptual deficits in older adults. In the development of VR applications, the interface needs to be easy to understand and use to improve its usability. (2) In the realm of VR technology, the integration of virtual commands and efficient gesture recognition becomes crucial to meet the diverse tastes and requirements of the elderly and to guarantee the curation of appropriate VR materials. (3) Various online VR apps designed for older individuals require customization to suit their tastes and needs, aiming to attract more interest and enhance their interaction. (4) Wearing VR tools should be of equal importance. It is essential for apparatus to be crafted to be lightweight and comfortable to avert any discomfort due to extended use.

Essentially, it is feasible to increase the recognition of virtual reality technology among elderly users by providing social support. Providing support and education for the elderly can alleviate the difficulties they encounter when using VR technology. Future research should focus more on interdisciplinary integration, such as the integration of VR technology and psychology, which can promote the mental health of the elderly. With the cooperation of engineering, more lightweight and easy-to-use VR devices can be designed to enhance the elderly's confidence and openness to these technological resources.

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Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. 100 most cited manuscripts in Virtual Reality Among Older Adults.

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
1	[40]	Addition of a non-immersive virtual reality component to treadmill training to reduce fall risk in older adults (V-TIME): a randomised controlled trial	Mirelman et al., 2016	accidental falls; aged; aged, 80 and over; aging; confounding factors epidemiology;	Article	England	*Lancet*	Elsevier Science	98.4	315
2	[50]	Acceptance of immersive head-mounted virtual reality in older adults	Huygelier et al., 2019	aged; aged, 80 and over; attitude; female; humans; male; middle aged;	Article	England	*Scientific Reports*	Nature Portfolio	3.8	159
3	[63]	Older Adults With Cognitive and/or Physical Impairments Can Benefit From Immersive Virtual Reality Experiences: A Feasibility Study	Appel et al., 2020	dementia; head-mounted-display; interventional study; long-term care; nature; non-pharmacological therapy; simulation; social isolation	Article	Switzerland	*Frontiers in Medicine*	Frontiers Mediasa	3.1	143
4	[64]	Effects of virtual reality-based physical and cognitive training on executive function and dual-task gait performance in older adults with mild cognitive impairment: A randomized control trial	Liao et al., 2019	cognitive training; combined physical; dual-task gait; executive function; MCI; virtual reality	Article	Switzerland	*Frontiers in Aging Neuroscience*	Frontiers Mediasa	4.1	132
5	[65]	Using virtual reality-based training to improve cognitive function, instrumental activities of daily living and neural efficiency in older adults with mild cognitive impairment	Liao et al., 2020	activities of daily living; aged; cognition; cognitive dysfunction; near-infrared spectroscopy; virtual reality	Article	Italy	*European Journal of Physical and Rehabilitation Medicine*	Edizioni Minerva Medica	3.3	125

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
6	[66]	The effect of a virtual reality-based intervention program on cognition in older adults with mild cognitive impairment: A randomized control trial	Thapa et al., 2020	dementia; electroencephalogram; mild cognitive impairment; virtual reality	Article	Switzerland	*Journal of Clinical Medicine*	MDPI	3.0	111
7	[67]	Potential of augmented reality and virtual reality technologies to promote wellbeing in older adults	Lee et al., 2019	augmented reality; evaluation framework; older adults; virtual reality; wellbeing	Review	Switzerland	*Applied Sciences*	MDPI	-	99
8	[29]	Older Adults' Experiences with Audiovisual Virtual Reality: Perceived Usefulness and Other Factors Influencing Technology Acceptance	Roberts et al., 2019	activity; leisure; retirement community; technology; usefulness; virtual reality	Article	England	*Clinical Gerontologist*	Elsevier Science	2.6	96
9	[44]	Evaluating the use of interactive virtual reality technology with older adults living in residential aged care	Baker et al., 2020	aged care; older adults; virtual reality	Article	England	*Information Processing and Management*	Elsevier Science	7.4	95
10	[68]	Virtual reality exercise as a coping strategy for health and wellness promotion in older adults during the COVID-19 pandemic	Gao et al., 2020	cognition; fall prevention; motor ability; obesity; psychological outcomes	Editorial	Switzerland	*Journal of Clinical Medicine*	MDPI	3.0	94
11	[83]	Do virtual reality games improve mobility skills and balance measurements in community-dwelling older adults? Systematic review and meta-analysis	Neri et al., 2017	accidental falls; elderly; physical therapy; prevention; video games	Review	USA	*Clinical Rehabilitation*	SAGE	2.6	93

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
12	[9]	The role of virtual reality in improving health outcomes for community-dwelling older adults: Systematic review	Dermody et al., 2020	80 and over; aged; aged; health care; independent living; outcome assessment; systematic review; virtual reality	Review	Canada	*Journal of Medical Internet Research*	JMIR	5.8	92
13	[69]	Virtual Reality Exergames for Improving Older Adults' Cognition and Depression: A Systematic Review and Meta-Analysis of Randomized Control Trials	Yen and Chiu, 2021	active ageing; active video game; dementia; depression; mental health; physical activity	Review	USA	*Journal of the American Medical Directors Association*	Elsevier Science	4.2	92
14	[84]	Use of immersive virtual reality to assess episodic memory: A validation study in older adults	Corriveau Lecavalier et al., 2020	aging; episodic memory; neuropsychological assessment; validation study; virtual reality	Article	England	*Neuropsychological Rehabilitation*	Routledge Journals, Taylor & Francis	1.7	68
15	[85]	Balance training using virtual reality improves balance and physical performance in older adults at high risk of falls	Phu et al., 2019	exercise; falls; fractures; posture; virtual reality	Article	New Zealand	*Clinical Interventions in Aging*	Dove Medical	3.5	66
16	[14]	The benefits of emotion regulation interventions in virtual reality for the improvement of wellbeing in adults and older adults: A systematic review	Montana et al., 2020	adults; emotion regulation; systematic review; treatment; virtual reality; wellbeing intervention	Review	Switzerland	*Journal of Clinical Medicine*	MDPI	3.0	66
17	[86]	The effectiveness of a virtual reality-based tai chi exercise on cognitive and physical function in older adults with cognitive impairment	Hsieh et al., 2019	cognitive function; cognitive impairment; dementia; exergame; nonpharmacological therapy; physical function; tai chi; virtual reality	Article	Switzerland	*Dementia and Geriatric Cognitive Disorders*	Karger	2.2	62

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
18	[81]	Interrogating social virtual reality as a communication medium for older adults	Baker, Kelly, et al., 2019	avatars; communication; older adults; virtual reality	Article	USA	*Proceedings of the ACM on Human-Computer Interaction*	ACM	-	61
19	[87]	Immersive Virtual Reality for the Management of Pain in Community-Dwelling Older Adults	Benham et al., 2019	aging; older adults; pain; quality of life; virtual reality	Article	USA	*OTJR-Occupation Participation and Health*	SAGE	-	60
20	[88]	Vestibular rehabilitation in older adults with and without mild cognitive impairment: Effects of virtual reality using a head-mounted display	Micarelli et al., 2019	aging; cognitive decline; fast Fourier transform; vestibular hypofunction; vestibular rehabilitation; virtual reality	Article	Ireland	*Archives of Gerontology and Geriatrics*	Elsevier Ireland	3.5	60
21	[89]	Comparison of the effects of virtual reality-based balance exercises and conventional exercises on balance and fall risk in older adults living in nursing homes in Turkey	Yeşilyaprak et al., 2016	balance; exercise training; older adults; physical therapy; virtual reality	Article	England	*Physiotherapy Theory and Practice*	Taylor & Francis	1.6	53
22	[90]	Exergaming Executive Functions: An Immersive Virtual Reality-Based Cognitive Training for Adults Aged 50 and Older	K.-T. Huang, 2020	executive functions; exergame; older adults; presence; virtual reality	Article	USA	*Cyberpsychology Behavior and Social Networking*	Mary Ann Liebert	4.2	53
23	[91]	Effects of Virtual Reality Intervention on Cognition and Motor Function in Older Adults With Mild Cognitive Impairment or Dementia: A Systematic Review and Meta-Analysis	S. Zhu et al., 2021	cognition; dementia; meta-analysis; mild cognitive impairment; motor; virtual reality	Article	Switzerland	*Frontiers in Aging Neuroscience*	Frontiers Mediasa	4.1	50

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
24	[92]	Impact of Virtual Reality (VR) experience on older adults' well-being	Lin et al., 2018	aging; quality of life; virtual reality; well-being	Conference paper	USA	*Lecture Notes in Computer Science*	Springer-Verlag Berlin	-	49
25	[93]	Augmented Reality for Older Adults: Exploring Acceptability of Virtual Coaches for Home-based Balance Training in an Aging Population	Mostajeran et al., 2020	augmented reality; balance training; health and well-being; older adults	Conference paper	USA	*Conference on Human Factors in Computing Systems—Proceedings*	ACM	-	42
26	[94]	Virtual reality-based cognitive–motor rehabilitation in older adults with mild cognitive impairment: A randomized controlled study on motivation and cognitive function	J.-S. Park et al., 2020	cognitive function; mild cognitive impairment; motivation; virtual reality	Article	Switzerland	*Healthcare*	MDPI	2.4	41
27	[95]	Assessing the use of immersive virtual reality, mouse and touchscreen in pointing and dragging-and-dropping tasks among young, middle-aged and older adults	Chen and Or, 2017	human–computer interaction; older adults; virtual reality	Article	England	*Applied Ergonomics*	Elsevier Sci	3.1	41
28	[96]	Effects of virtual reality-based cognitive training in older adults living without and with mild dementia: A pretest-posttest design pilot study	Zając-Lamparska et al., 2019	vognitive aging; vognitive remediation; dementia; video games; virtual reality	Article	England	*BMC Research Notes*	Springernature	1.6	39
29	[8]	Immersive virtual reality as physical therapy in older adults: present or future (systematic review)	Campo-Prieto et al., 2021	aged; exercise therapy; rehabilitation; virtual reality; virtual reality exposure therapy; virtual reality immersion therapy	Article	England	*Virtual Reality*	Springer London	4.4	36

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
30	[97]	Virtual reality training with three-dimensional video games improves postural balance and lower extremity strength in community-dwelling older adults	Y. Lee et al., 2017	3-dimensional; falls; older adults; postural balance; virtual reality	Article	USA	*Journal of Aging and Physical Activity*	Human Kinetics	1.4	35
31	[98]	Virtual Reality–Based Physical Exercise With Exergames (PhysEx) Improves Mental and Physical Health of Institutionalized Older Adults	Monteiro-Junior et al., 2017	aged; aged, 80 and over; Brazil; exercise; exercise therapy;	Letter	USA	*Journal of the American Medical Directors Association*	Elsevier Science Inc	4.2	34
32	[27]	Acceptance of Virtual Reality Exergames Among Chinese Older Adults	Xu et al., 2023	technology acceptance model; virtual reality; exergaming; Chinese older adults; user acceptance; technology-supported healthy living	Article	USA	*International Journal of Human-Computer Interaction*	Taylor & Francis	3.4	34
33	[54]	The Use of Virtual and Augmented Reality by Older Adults: Potentials and Challenges	Seifert and Schlomann, 2021	augmented reality; digital divide; inequality; seniors; virtual reality	Article	Switzerland	*Frontiers in Virtual Reality*	Frontiers Mediasa	3.2	34
34	[99]	System Immersion in Virtual Reality-Based Rehabilitation of Motor Function in Older Adults: A Systematic Review and Meta-Analysis	Høeg et al., 2021	balance; functional mobility; immersive displays; older adults; pain; rehabilitation; systematic review; virtual reality	Review	Switzerland	*Frontiers in Virtual Reality*	Frontiers Mediasa	3.2	33

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
35	[100]	Understanding Motivations and Player Experiences of Older Adults in Virtual Reality Training	De Vries et al., 2018	exergames; fall prevention; motivation; older adults; user experience; virtual reality	Article	USA	*Games for Health Journal*	Mary Ann Liebert	2.2	32
36	[101]	The Effectiveness of a Virtual Reality-Based Intervention on Cognitive Functions in Older Adults with Mild Cognitive Impairment: A Single-Blind, Randomized Controlled Trial	Torpil et al., 2021	aged; cognition; Kinect; rehabilitation; virtual reality	Article	USA	*Games for Health Journal*	Mary Ann Liebert	2.2	31
37	[102]	Assessment of Instrumental Activities of Daily Living in Older Adults with Subjective Cognitive Decline Using the Virtual Reality Functional Capacity Assessment Tool (VRFCAT)	Atkins et al., 2018	assessment; endpoints; functioning; iADL; preclinical	Article	Germany	*The journal of prevention of Alzheimer's disease*	Springer	-	31
38	[103]	Using a Nature-Based Virtual Reality Environment for Improving Mood States and Cognitive Engagement in Older Adults: A Mixed-Method Feasibility Study	Kalantari et al., 2022	cognitive impairment; mood; nature; virtual gardens; virtual reality	Article	USA	*Innovation in Aging*	Oxford University	4.9	29
39	[104]	Virtual reality and mental health in older adults: a systematic review	Skurla et al., 2022	aging; cognition; geriatrics; mood; technology; virtual reality; VR	Review	USA	*International Psychogeriatrics*	Cambridge University	4.6	29
40	[105]	Virtual and augmented reality applications to improve older adults' quality of life: A systematic mapping review and future directions	Baragash et al., 2022	augmented reality; healthcare; older adults; quality of life; rehabilitation; training; virtual reality	Review	England	*Digital Health*	SAGE	2.9	29

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
41	[106]	Where would you like to eat? A formative evaluation of mixed-reality solitary meals in virtual environments for older adults with mobility impairments who live alone	Korsgaard et al., 2019	augmented reality; food; solitary dining; technology acceptance; undernourishment; virtual reality	Article	USA	*Food Research International*	Elsevier	7.0	27
42	[107]	Virtual reality video game improves high-fidelity memory in older adults	Wais et al., 2021	adult; aged; brain; female; humans	Article	England	*Scientific Reports*	Nature Portfolio	3.8	27
43	[28]	Acceptance and usability of immersive virtual reality in older adults with objective and subjective cognitive decline	Arlati et al., 2021	acceptance; cybersickness; immersive virtual reality; mild cognitive impairment; subjective cognitive decline; usability	Article	Netherlands	*Journal of Alzheimer's Disease*	IOS	3.4	26
44	[108]	Enabling immersive exercise activities for older adults: A comparison of virtual reality exergames and traditional video exercises	Kruse et al., 2021	exergame; older adults; video exercise; virtual reality	Article	Switzerland	*Societies*	MDPI	1.7	26
45	[19]	Acceptance of a virtual reality headset designed for fall prevention in older adults: Questionnaire study	Mascret et al., 2020	acceptability; acceptance; achievement goals; health; elderly; fall; self-efficacy; technology acceptance model; virtual reality	Article	Canada	*Journal of Medical Internet Research*	JMIR	5.8	26
46	[13]	Effectiveness of virtual reality technology on functional mobility of older adults: Systematic review and meta-analysis	Corregidor-Sánchez et al., 2021	exergame; functional mobility; game technology; game-based interventions; older people; rehabilitation; virtual reality	Review	England	*Age and Ageing*	Oxford University	-	25

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
47	[109]	A Scoping Review of Augmented/Virtual Reality Health and Wellbeing Interventions for Older Adults: Redefining Immersive Virtual Reality	Carroll et al., 2021	augmented reality; older adults; physical/mental health; psychology; scoping review; virtual reality	Review	Switzerland	*Frontiers in Virtual Reality*	Frontiers Mediasa	3.2	25
48	[17]	How older adults respond to the use of Virtual Reality for enrichment: A systematic review	Thach et al., 2020	aged care; geron technology; older adults; user experience; virtual reality	Conference paper	USA	*ACM International Conference Proceeding Series*	ACM	-	25
49	[110]	The impact of a multitasking-based virtual reality motion video game on the cognitive and physical abilities of older adults	Li et al., 2020	attention; cognitive enhancement; motion video game; multitasking; older adults; physical activity; physical balance; reasoning; sustainable VR; working memory	Article	Switzerland	*Sustainability*	MDPI	3.3	24
50	[111]	Effects of virtual reality on moods in community older adults. A multicenter randomized controlled trial	Chan et al., 2020	cognitive stimulation; elderly; health technology; user experience; virtual reality	Article	England	*International Journal of Geriatric Psychiatry*	Wiley	3.6	24
51	[16]	Virtual Reality Representations of Nature to Improve Well-Being amongst Older Adults: a Rapid Review	Van Houwelingen-Snippe et al., 2021	connectedness; digital nature; human–technology interaction; people–environment interaction; social well-being	Review	Germany	*Journal of Technology in Behavioral Science*	Springer	-	24
52	[112]	Development and Feasibility of a Virtual Reality Task for the Cognitive Assessment of Older Adults: The ECO-VR	Oliveira et al., 2016	aging; cognitive assessment; executive functions; validity content; virtual reality	Article	Spain	*Spanish Journal of Psychology*	Cambridge University	2.9	24

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
53	[49]	Feasibility, acceptability, and efficacy of virtual reality training for older adults and people with disabilities: Single-arm pre-post study	Chau et al., 2021	evaluation; older adults; people with disabilities; rehabilitation; virtual reality	Article	Canada	*Journal of Medical Internet Research*	JMIR	5.8	24
54	[113]	Comparison of individualized virtual reality- and group-based rehabilitation in older adults with chronic stroke in community settings: a pilot randomized controlled trial	M. Lee et al., 2016	community; group-based rehabilitation; pilot study; randomized controlled trial; stroke; virtual reality	Article	Germany	*European Journal of Integrative Medicine*	Elsevier Science	1.9	23
55	[45]	Immersive Virtual Reality for Older Adults	Abeele V.V et al., 2021	design guidelines; laddering; older adults; virtual reality; VR	Article	USA	*ACM Transactions on Accessible Computing*	ACM	2.5	23
56	[51]	Reminiscence therapy using virtual reality technology affects cognitive function and subjective well-being in older adults with dementia	Tominari et al., 2021	cognitive function; dementia; reminiscence therapy; virtual reality; well-being	Article	England	*Cogent Psychology*	Taylor & Francis	1.6	22
57	[114]	Immersive virtual reality is effective in the rehabilitation of older adults with balance disorders: A randomized clinical trial	Lima Rebêlo et al., 2021	aged; postural balance; virtual reality exposure therapy	Article	England	*Experimental Gerontology*	Pergamon-Elsevier Science	3.3	22
58	[115]	Virtual reality exercise to improve balance control in older adults at risk of falling	Tsang and Fu, 2016	accidental falls; aged; aged, 80 and over; exercise therapy;	Article	Hongkong	*Hong Kong medical journal*	Hong Kong ACAD Medicine	-	21
59	[116]	Virtual reality in pain therapy: A requirements analysis for older adults with chronic back pain	Stamm et al., 2020	chronic back pain; exergame; geriatrics; physiotherapy; psychotherapy; virtual reality treatment program	Article	England	*Journal of Neuro Engineering and Rehabilitation*	BMC	5.2	21

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
60	[117]	Combination of 3-dimensional virtual reality and hands-on aromatherapy in improving institutionalized older adults' psychological health: Quasi-experimental study	Cheng et al., 2020	aromatherapy; happiness; life satisfaction; meditation; older adult; sleep quality; stress; three-dimensional; virtual reality	Article	Canada	*Journal of Medical Internet Research*	JMIR	5.8	20
61	[118]	Virtual Reality Balance Games Provide Little Muscular Challenge to Prevent Muscle Weakness in Healthy Older Adults	De Vries et al., 2020	balance; muscle activity; older adults; virtual reality	Article	USA	*Games for Health Journal*	Mary Ann Liebert	2.2	20
62	[119]	Using Virtual Reality to Improve the Quality of Life of Older Adults with Cognitive Impairments and their Family Members who Live at a Distance	Afifi et al., 2023	dementia; family members; long-distance; MCI; older adults; relationship maintenance; Rendever; senior living communities; the theory of resilience and relational load; virtual reality	Article	USA	*Health Communication*	Routledge Journals, Taylor & Francis	3.0	20
63	[120]	Virtual reality exergame for supplementing multimodal pain therapy in older adults with chronic back pain: a randomized controlled pilot study	Stamm et al., 2022	chronic back pain; multimodal pain therapy; physical therapy; psychotherapy; serious gaming; virtual reality	Article	England	*Virtual Reality*	Springer London	4.4	19
64	[121]	Effects of virtual reality-based spatial cognitive training on hippocampal function of older adults with mild cognitive impairment	J.-H. Park, 2020	cognitive impairment; hippocampus; navigation; spatial cognition; virtual reality	Article	USA	*International Psychogeriatrics*	Cambridge University	4.6	19

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
65	[11]	Design Considerations for Immersive Virtual Reality Applications for Older Adults: A Scoping Review	Ijaz et al., 2022	design considerations; immersive virtual reality; older adults; user experience	Review	Switzerland	*Multimodal Technologies and Interaction*	MDPI	2.4	19
66	[122]	Virtual reality (Vr)-based environmental enrichment in older adults with mild cognitive impairment (mci) and mild dementia	Riaz et al., 2021	cognition; dementia; environmental enrichment; interactivity; mental wellbeing; mild cognitive impairment (MCI); tolerability; virtual reality (VR)	Article	Switzerland	*Brain Sciences*	MDPI	2.7	19
67	[123]	Effectiveness of virtual reality games in improving physical function, balance and reducing falls in balance-impaired older adults: A systematic review and meta-analysis	Ren et al., 2023	balance; fall; old adults; physical function; VR interventions	Review	Ireland	*Archives of Gerontology and Geriatrics*	Elsevier Ireland	3.5	18
68	[124]	Immersive Virtual Reality-Based Cognitive Intervention for the Improvement of Cognitive Function, Depression, and Perceived Stress in Older Adults With Mild Cognitive Impairment and Mild Dementia: Pilot Pre-Post Study	K. Y. Zhu et al., 2022	cognitive impairment; cognitive intervention; dementia; immersive virtual reality; memory; mild cognitive impairment; older patients; stress; usability; virtual reality; VR	Article	Canada	*JMIR Serious Games*	JMIR	3.8	18
69	[125]	Virtual Reality and Exercise Training Enhance Brain, Cognitive, and Physical Health in Older Adults with Mild Cognitive Impairment	Yang et al., 2022	cognition; electroencephalogram; exercise; mild cognitive impairment; virtual reality	Article	Switzerland	*International Journal of Environmental Research and Public Health*	MDPI	-	18

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
70	[126]	Feasibility and Effects of an Immersive Virtual Reality Exergame Program on Physical Functions in Institutionalized Older Adults: A Randomized Clinical Trial	Campo-Prieto et al., 2022	aged 80 and over; digital health; exercise; games for health; older adults; personalized medicine; physical functions; rehabilitation; videogames; virtual reality exposure therapy	Article	Switzerland	*Sensors*	MDPI	3.4	18
71	[127]	Development of an 360-degree virtual reality video-based immersive cycle training system for physical enhancement in older adults: a feasibility study: Development of immersive virtual cycle for older adults	N. Lee et al., 2021	dizziness; equipment and supplies; virtual reality exposure therapy	Article	England	*BMC Geriatrics*	BMC	3.4	17
72	[128]	Using virtual reality to investigate physical environmental factors related to cycling in older adults: A comparison between two methodologies	Lieze et al., 2020	3D-CAVE; active transport; ageing; virtual reality; VR-headset	Article	England	*Journal of Transport and Health*	Elsevier Sci	3.2	16
73	[129]	The factors affecting older adults' intention toward ongoing participation in virtual reality leisure activities	Yeh et al., 2019	experience values; leisure activity; ongoing participation; virtual reality	Article	Switzerland	*International Journal of Environmental Research and Public Health*	MDPI	-	16
74	[130]	In too deep? A systematic literature review of fully-immersive virtual reality and cybersickness among older adults	Drazich et al., 2023	aged; humans; surveys and questionnaires; virtual reality	Review	USA	*Journal of the American Geriatrics Society*	Wiley	4.3	16

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
75	[131]	Does Practicing with a Virtual Reality Driving Simulator Improve Spatial Cognition in Older Adults? A Pilot Study	Masoumzadeh and Moussavi, 2020	Alzheimer's disease; dementia; driving simulator; serious games; spatial cognition; virtual reality	Article	England	*Neuroscience Insights*	SAGE	2.9	15
76	[132]	The effect of virtual reality on executive function in older adults with mild cognitive impairment: a systematic review and meta-analysis	D. Yu et al., 2023	cognitive functioning; executive function; mild cognitive impairment; virtual reality	Review	England	*Aging & Mental Health*	Routledge Journals, Taylor & Francis	2.8	15
77	[133]	Benefits of Virtual Reality Program and Motor Imagery Training on Balance and Fall Efficacy in Isolated Older Adults: A Randomized Controlled Trial	Kim and Cho, 2022	COVID-19; isolation; motor imagery training; older adults; virtual reality	Article	Lithuania	*Medicina (Lithuania)*	MDPI	-	14
78	[134]	Search strategies used by older adults in a virtual reality place learning task	Davis and Weisbeck, 2015	aging; cues; environment; hippocampus; strategies; wayfinding	Article	USA	*Gerontologist*	Oxford University	4.6	14
79	[135]	The Use of Virtual Reality through Head-Mounted Display on Balance and Gait in Older Adults: A Scoping Review	Delgado and Der Ananian, 2021	balance; gait; older adults; review; virtual reality	Review	USA	*Games for Health Journal*	Mary Ann Liebert	2.2	14
80	[80]	Neuropsychological assessment of older adults with virtual reality: Association of age, schooling, and general cognitive status	Oliveira et al., 2018	aging; cognition; executive functions; schooling; virtual reality	Article	Switzerland	*Frontiers in Psychology*	Frontiers Mediasa	2.6	13

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
81	[136]	Testing the Feasibility of Virtual Reality with Older Adults with Cognitive Impairments and Their Family Members Who Live at a Distance	Afifi et al., 2021	dementia; family relationships; livestreaming; networking; virtual reality	Article	USA	*Innovation in Aging*	Oxford University	1.9	13
82	[137]	Immersive Virtual Reality Exergames to Promote the Well-being of Community-Dwelling Older Adults: Protocol for a Mixed Methods Pilot Study	Mehrabi et al., 2022	cognition; community-dwelling older adults; COVID-19; exergames; feasibility; mood; perception; physical activity; pilot protocol; virtual reality; well-being	Article	Canada	*JMIR Research Protocols*	JMIR	1.4	13
83	[138]	Virtual reality prototype for binocular therapy in older children and adults with amblyopia	Elhusseiny et al., 2021	accommodation paralysis; adolescent; adult; adult disease; age;	Article	USA	*Journal of AAPOS*	Mosbt-Elsevier	1.2	13
84	[139]	Using Virtual Reality to Assess and Promote Transfer of Memory Training in Older Adults With Memory Complaints: A Randomized Controlled Trial	Boller et al., 2021	aging; cognitive training; episodic memory; memory complaint; randomized controlled trial; virtual reality	Article	Switzerland	*Frontiers in Psychology*	Frontiers Mediasa	2.6	13
85	[140]	Effects of user experiences on continuance intention of using immersive three-dimensional virtual reality among institutionalized older adults	C.-M. Huang et al., 2021	continuance usage intention; geriatric nursing; institutional care; technology for older adults; virtual reality	Article	England	*Journal of Advanced Nursing*	Wiley	3.8	12

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
86	[12]	Is Virtual Reality Training More Effective Than Traditional Physical Training on Balance and Functional Mobility in Healthy Older Adults? A Systematic Review and Meta-Analysis	Liu et al., 2022	balance; functional mobility; older adults; systematic review and meta-analysis; virtual reality training	Review	Switzerland	*Frontiers in Human Neuroscience*	Frontiers Mediasa	2.4	12
87	[141]	Effects of virtual reality combined cognitive and physical interventions on cognitive function in older adults with mild cognitive impairment: A systematic review and meta-analysis	Yan et al., 2022	aged; cognitive dysfunction; meta-analysis; virtual reality	Review	Ireland	*Ageing Research Reviews*	Elsevier Ireland	12.5	12
88	[142]	Immersive Virtual Reality and Complex Skill Learning: Transfer Effects After Training in Younger and Older Adults	Dobrowolski et al., 2021	cognitive aging; immersive virtual reality; skill training; transfer; work training	Article	Switzerland	*Frontiers in Virtual Reality*	Frontiers Mediasa	3.2	12
89	[143]	Memory Journalist: Creating Virtual Reality Exergames for the Treatment of Older Adults with Dementia	Rings et al., 2020	HCI design and evaluation methods; user studies; interaction devices; [human-centered computing]: human computer interaction (HCI)	Conference paper	USA	*Proceedings—2020 IEEE Conference on Virtual Reality and 3D User Interfaces, VRW 2020*	IEEE	-	11
90	[144]	The feasibility and effectiveness of virtual reality meditation on reducing chronic pain for older adults with knee osteoarthritis	Sarkar et al., 2022	arthritis; knee pain; older adults; virtual reality	Article	USA	*Pain Practice*	Wiley	2.5	11

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
91	[145]	Key Stakeholders' Experiences and Perceptions of Virtual Reality for Older Adults Living With Dementia: Systematic Review and Thematic Synthesis	Flynn et al., 2022	dementia; experience; perception; qualitative evidence synthesis (QES); thematic synthesis; virtual reality; VR	Review	Canada	*JMIR Serious Games*	JMIR	3.8	11
92	[146]	Two Immersive Virtual Reality Tasks for the Assessment of Spatial Orientation in Older Adults with and Without Cognitive Impairment: Concurrent Validity, Group Comparison, and Accuracy Results	Da Costa et al., 2022	Alzheimer's disease; biomedical technology; cognitive dysfunction; neuropsychological tests; spatial navigation; validation studies	Article	USA	*Journal of the International Neuropsychological Society*	Cambridge University	2.6	11
93	[147]	The Technology Explorers: Partnering with Older Adults to Engage with Virtual Reality and Virtual Avatars	Baker, Waycott, et al., 2019	action research; avatars; older adults; technology probes; virtual reality	Book chapter	Germany	*Ageing and Digital Technology: Designing and Evaluating Emerging Technologies for Older Adults*	Springer	-	10
94	[148]	Designing Virtual Reality Assisted Psychotherapy for Anxiety in Older Adults Living with Parkinson's Disease: Integrating Literature for Scoping	Thangavelu et al., 2022	anxiety; cognitive behavior therapy; Parkinson's disease; psychotherapy; virtual reality	Review	Australia	*Clinical Gerontologist*	Routledge Journals, Taylor & Francis	2.6	10
95	[15]	Fully Immersive Virtual Reality Using 360° Videos to Manage Well-Being in Older Adults: A Scoping Review	Restout et al., 2023	360° video; elderly; immersive virtual reality; mental health; well-being	Review	USA	*Journal of the American Medical Directors Association*	Elsevier Science	4.2	10

Table A1. *Cont.*

Rank	Ref	Title	Author Name and Publication Year	Keywords	Manuscript Types	Country	Name of Journal	Publisher	Impact Factor	Total Citation
96	[149]	The continuous intention of older adult in virtual reality leisure activities: Combining sports commitment model and theory of planned behavior	Jeng et al., 2020	leisure activities; sports commitment model; theory of planned behavior; virtual reality	Article	Switzerland	*Applied Sciences (Switzerland)*	MDPI	-	10
97	[150]	The Feasibility of Using Virtual Reality and Eye Tracking in Research With Older Adults With and Without Alzheimer's Disease	Davis, 2021	aging; Alzheimer's disease; eye tracking; feasibility; spatial cognition; virtual navigation	Article	Switzerland	*Frontiers in Aging Neuroscience*	Frontiers Mediasa	4.1	9
98	[151]	Effects of semi-immersive virtual reality-based cognitive training combined with locomotor activity on cognitive function and gait ability in community-dwelling older adults	Hwang et al., 2021	cognitive function; gait; older adult; virtual reality	Article	Switzerland	*Healthcare (Switzerland)*	MDPI	2.4	9
99	[26]	Acceptance of gamified virtual reality environments by older adults	Pang and Cheng, 2023	geron technology acceptance; perceived usefulness; user acceptance; technology; model; experiences; Chinese	Article	USA	*Educational Gerontology*	Taylor & Francis	1.1	8
100	[152]	Cheer for me: effect of non-player character audience feedback on older adult users of virtual reality exergames	K. Yu et al., 2023	audience feedback; elderly users; exergames; non-player characters; virtual reality	Article	England	*Virtual Reality*	Springer London	4.4	8

References

1. *World Population Prospect 2022 Release Note about Major Differences in Total Population Estimates for Mid-2021 between 2019 and 2022 Revisions*; UN DESA: New York, NY, USA, 2022.
2. Teo, R.H.; Cheng, W.H.; Cheng, L.J.; Lau, Y.; Lau, S.T. Global Prevalence of Social Isolation among Community-Dwelling Older Adults: A Systematic Review and Meta-Analysis. *Arch. Gerontol. Geriatr.* **2023**, *107*, 104904. [CrossRef] [PubMed]
3. Kok, R.M.; Reynolds, C.F. Management of Depression in Older Adults A Review. *JAMA—J. Am. Med. Assoc.* **2017**, *317*, 2114–2122. [CrossRef] [PubMed]
4. Hunsaker, A.; Hargittai, E.; Piper, A.M. Online Social Connectedness and Anxiety among Older Adults. *Int. J. Commun.* **2020**, *14*, 697–725.
5. Li, C.; Kang, K.; Lin, X.; Hu, J.; Hengeveld, B.; Hummels, C. Promoting Older Residents' Social Interaction and Wellbeing: A Design Perspective. *Sustainability* **2020**, *12*, 2834. [CrossRef]
6. Jiang, J.; Song, J. Health Consequences of Online Social Capital among Middle-Aged and Older Adults in China. *Appl. Res. Qual. Life* **2022**, *17*, 2277–2297. [CrossRef]
7. Zhou, D.; Xu, Y.; Ai, P. The Effects of Online Social Interactions on Life Satisfaction of Older Chinese Adults: New Insights Based on a Longitudinal Approach. *Healthcare* **2022**, *10*, 1964. [CrossRef]
8. Campo-Prieto, P.; Cancela, J.M.; Rodríguez-Fuentes, G. Immersive Virtual Reality as Physical Therapy in Older Adults: Present or Future (Systematic Review). *Virtual Real.* **2021**, *25*, 801–817. [CrossRef]
9. Dermody, G.; Whitehead, L.; Wilson, G.; Glass, C. The Role of Virtual Reality in Improving Health Outcomes for Community-Dwelling Older Adults: Systematic Review. *J. Med. Internet Res.* **2020**, *22*, e17331. [CrossRef]
10. Santos Silva, R.; Mol, A.M.; Ishitani, L. Virtual Reality for Older Users: A Systematic Literature Review. *Int. J. Virtual Real.* **2019**, *19*, 11–25. [CrossRef]
11. Ijaz, K.; Tran, T.T.M.; Kocaballi, A.B.; Calvo, R.A.; Berkovsky, S.; Ahmadpour, N. Design Considerations for Immersive Virtual Reality Applications for Older Adults: A Scoping Review. *Multimodal Technol. Interact.* **2022**, *6*, 60. [CrossRef]
12. Liu, M.; Zhou, K.; Chen, Y.; Zhou, L.; Bao, D.; Zhou, J. Is Virtual Reality Training More Effective Than Traditional Physical Training on Balance and Functional Mobility in Healthy Older Adults? A Systematic Review and Meta-Analysis. *Front. Hum. Neurosci.* **2022**, *16*, 843481. [CrossRef] [PubMed]
13. Corregidor-Sánchez, A.I.; Segura-Fragoso, A.; Rodríguez-Hernández, M.; Jiménez-Rojas, C.; Polonio-López, B.; Criado-Álvarez, J.J. Effectiveness of Virtual Reality Technology on Functional Mobility of Older Adults: Systematic Review and Meta-Analysis. *Age Ageing* **2021**, *50*, 370–379. [CrossRef]
14. Montana, J.I.; Matamala-gomez, M.; Maisto, M.; Mavrodiev, P.A.; Cavalera, C.M.; Diana, B.; Mantovani, F.; Realdon, O. The Benefits of Emotion Regulation Interventions in Virtual Reality for the Improvement of Wellbeing in Adults and Older Adults: A Systematic Review. *J. Clin. Med.* **2020**, *9*, 500. [CrossRef]
15. Restout, J.; Bernache-Assollant, I.; Morizio, C.; Boujut, A.; Angelini, L.; Tchalla, A.; Perrochon, A. Fully Immersive Virtual Reality Using 360° Videos to Manage Well-Being in Older Adults: A Scoping Review. *J. Am. Med. Dir. Assoc.* **2023**, *24*, 564–572. [CrossRef] [PubMed]
16. Van Houwelingen-Snippe, J.; Ben Allouch, S.; Van Rompay, T.J.L. Virtual Reality Representations of Nature to Improve Well-Being amongst Older Adults: A Rapid Review. *J. Technol. Behav. Sci.* **2021**, *6*, 464–485. [CrossRef]
17. Thach, K.S.; Lederman, R.; Waycott, J. How Older Adults Respond to the Use of Virtual Reality for Enrichment: A Systematic Review. In Proceedings of the 32nd Australian Conference on Human-Computer Interaction 2020, Sydney, Australia, 2–4 December 2020; pp. 303–313.
18. Zhan, T.; Yin, K.; Xiong, J.; He, Z.; Wu, S.-T. Augmented Reality and Virtual Reality Displays: Perspectives and Challenges. *iScience* **2020**, *23*, 101397. [CrossRef] [PubMed]
19. Mascret, N.; Delbes, L.; Voron, A.; Temprado, J.-J.; Montagne, G. Acceptance of a Virtual Reality Headset Designed for Fall Prevention in Older Adults: Questionnaire Study. *J. Med. Internet Res.* **2020**, *22*, e20691. [CrossRef]
20. Sokolov, A.A.; Collignon, A.; Bieler-Aeschlimann, M. Serious Video Games and Virtual Reality for Prevention and Neurorehabilitation of Cognitive Decline Because of Aging and Neurodegeneration. *Curr. Opin. Neurol.* **2020**, *33*, 239–248. [CrossRef]
21. Arlati, S.; Colombo, V.; Spoladore, D.; Greci, L.; Pedroli, E.; Serino, S.; Cipresso, P.; Goulene, K.; Stramba-Badiale, M.; Riva, G.; et al. A Social Virtual Reality-Based Application for the Physical and Cognitive Training of the Elderly at Home. *Sensors* **2019**, *19*, 261. [CrossRef]
22. Sagnier, C.; Loup-Escande, E.; Lourdeaux, D.; Thouvenin, I.; Valléry, G. User Acceptance of Virtual Reality: An Extended Technology Acceptance Model. *Int. J. Hum.–Comput. Interact.* **2020**, *36*, 993–1007. [CrossRef]
23. Kadylak, T.; Cotten, S.R. United States Older Adults' Willingness to Use Emerging Technologies. *Inf. Commun. Soc.* **2020**, *23*, 736–750. [CrossRef]
24. Shao, D.; Lee, I.-J. Acceptance and Influencing Factors of Social Virtual Reality in the Urban Elderly. *Sustainability* **2020**, *12*, 9345. [CrossRef]
25. Delbes, L.; Mascret, N.; Goulon, C.; Montagne, G. Validation of an Immersive Virtual Reality Device Accepted by Seniors That Preserves the Adaptive Behavior Produced in the Real World. *Front. Bioeng. Biotechnol.* **2022**, *10*, 917486. [CrossRef] [PubMed]
26. Pang, W.Y.J.; Cheng, L. Acceptance of Gamified Virtual Reality Environments by Older Adults. *Educ. Gerontol.* **2023**, *49*, 830–841. [CrossRef]

27. Xu, W.; Liang, H.-N.; Yu, K.; Wen, S.; Baghaei, N.; Tu, H. Acceptance of Virtual Reality Exergames among Chinese Older Adults. *Int. J. Hum.–Comput. Interact.* **2023**, *39*, 1134–1148. [CrossRef]
28. Arlati, S.; Di Santo, S.G.; Franchini, F.; Mondellini, M.; Filiputti, B.; Luchi, M.; Ratto, F.; Ferrigno, G.; Sacco, M.; Greci, L. Acceptance and Usability of Immersive Virtual Reality in Older Adults with Objective and Subjective Cognitive Decline. *J. Alzheimers Dis.* **2021**, *80*, 1025–1038. [CrossRef]
29. Roberts, A.R.; De Schutter, B.; Franks, K.; Radina, M.E. Older Adults' Experiences with Audiovisual Virtual Reality: Perceived Usefulness and Other Factors Influencing Technology Acceptance. *Clin. Gerontol.* **2019**, *42*, 27–33. [CrossRef]
30. Cipresso, P.; Giglioli, I.A.C.; Raya, M.A.; Riva, G. The Past, Present, and Future of Virtual and Augmented Reality Research: A Network and Cluster Analysis of the Literature. *Front. Psychol.* **2018**, *9*, 2086. [CrossRef]
31. Riva, G.; Serino, S. Virtual Reality in the Assessment, Understanding and Treatment of Mental Health Disorders. *J. Clin. Med.* **2020**, *9*, 3434. [CrossRef]
32. Ben Abdessalem, H.; Ai, Y.; Marulasidda Swamy, K.S.; Frasson, C. Virtual Reality Zoo Therapy for Alzheimer's Disease Using Real-Time Gesture Recognition. In Proceedings of the GeNeDis 2020, Virtual, 8–11 October 2020; Vlamos, P., Ed.; Springer International Publishing: Cham, Switzerland, 2021; pp. 97–105.
33. Kim, S.Y.; Park, J.; Choi, H.; Loeser, M.; Ryu, H.; Seo, K. Digital Marker for Early Screening of Mild Cognitive Impairment Through Hand and Eye Movement Analysis in Virtual Reality Using Machine Learning: First Validation Study. *J. Med. Internet Res.* **2023**, *25*, e48093. [CrossRef]
34. Kruse, C.S.; Fohn, J.; Umunnakwe, G.; Patel, K.; Patel, S. Evaluating the Facilitators, Barriers, and Medical Outcomes Commensurate with the Use of Assistive Technology to Support People with Dementia: A Systematic Review Literature. *Healthcare* **2020**, *8*, 278. [CrossRef] [PubMed]
35. Blok, M.; van Ingen, E.; de Boer, A.H.; Slootman, M. The Use of Information and Communication Technologies by Older People with Cognitive Impairments: From Barriers to Benefits. *Comput. Hum. Behav.* **2020**, *104*, 106173. [CrossRef]
36. Uchibori, Y.; Handa, N.; Fujiwara, K.; Mitobe, K. Development of a Roadway-Crossing Simulator for Actual Walking and Evaluation of Pedestrian Behavior. *IEEJ Trans. Electr. Electron. Eng.* **2021**, *16*, 1612–1617. [CrossRef]
37. Doré, B.; Gaudreault, A.; Everard, G.; Ayena, J.C.; Abboud, A.; Robitaille, N.; Batcho, C.S. Acceptability, Feasibility, and Effectiveness of Immersive Virtual Technologies to Promote Exercise in Older Adults: A Systematic Review and Meta-Analysis. *Sensors* **2023**, *23*, 2506. [CrossRef]
38. Rash, I.; Helgason, M.; Jansons, D.; Mitchell, L.; Sakakibara, B.M. The Influence of a Virtual Reality Entertainment Program on Depressive Symptoms and Sedentary Behaviour in Inpatient Stroke Survivors: A Research Protocol for a Pilot Randomized Controlled Trial. *Pilot Feasibility Stud.* **2022**, *8*, 230. [CrossRef]
39. Kenyon, K.; Kinakh, V.; Harrison, J. Social Virtual Reality Helps to Reduce Feelings of Loneliness and Social Anxiety during the COVID-19 Pandemic. *Sci. Rep.* **2023**, *13*, 19282. [CrossRef] [PubMed]
40. Mao, W.; Qi, X.; Chi, I.; Wichinsky, L.; Wu, B. Technology-Based Interventions to Address Social Isolation and Loneliness among Informal Dementia Caregivers: A Scoping Review. *J. Am. Med. Dir. Assoc.* **2023**, *24*, 1700–1707. [CrossRef]
41. Walchshäusl, S.; Eichhorn, C.; Plecher, D.A.; Simecek, T.; Klinker, G.; Hiyama, A.; Inami, M. *Generating an Environment for Socializing between Older Adults in a VR Supermarket*; Gesellschaft für Informatik e.V.: Bonn, Germany, 2023; pp. 325–337, ISBN 978-3-88579-731-9.
42. Loke, S.C.; Wunsche, B.C. Qualitative Insights into How Older People and Their Families Use Telecommunications during a Pandemic to Alleviate Social Isolation. *J. Intergener. Relatsh.* **2023**, *21*, 511–530. [CrossRef]
43. Antico, M.; Balletti, N.; Ciccotelli, A.; Ciccotelli, M.; Laudato, G.; Lazich, A.; Notarantonio, M.; Oliveto, R.; Ricciardi, S.; Scalabrino, S.; et al. A Virtual Assistant for Home Rehabilitation: The 2Vita-B Physical Project. In Proceedings of the 2021 21ST IEEE International Conference on Environment and Electrical Engineering and 2021 5th IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe), Bari, Italy, 7–10 September 2021; Leonowicz, Z., Ed.; IEEE: New York, NY, USA, 2021.
44. Baker, S.; Waycott, J.; Robertson, E.; Carrasco, R.; Neves, B.B.; Hampson, R.; Vetere, F. Evaluating the Use of Interactive Virtual Reality Technology with Older Adults Living in Residential Aged Care. *Inf. Process. Manag.* **2020**, *57*, 102105. [CrossRef]
45. Abeele, V.V.; Schraepen, B.; Huygelier, H.; Gillebert, C.; Gerling, K.; Van Ee, R. Immersive Virtual Reality for Older Adults: Empirically Grounded Design Guidelines. *ACM Trans. Access. Comput.* **2021**, *14*, 14:1–14:30. [CrossRef]
46. Flynn, A.; Brennan, A.; Barry, M.; Redfern, S.; Casey, D. Social Connectedness and the Role of Virtual Reality: Experiences and Perceptions of People Living with Dementia and Their Caregivers. *Disabil. Rehabil. Assist. Technol.* **2024**, *19*, 2615–2629. [CrossRef] [PubMed]
47. Kalantari, S.; Xu, T.B.; Mostafavi, A.; Kim, B.; Dilanchian, A.; Lee, A.; Boot, W.R.; Czaja, S.J. Using Immersive Virtual Reality to Enhance Social Interaction among Older Adults: A Cross-Site Investigation. *Innov. Aging* **2023**, *7*, igad031. [CrossRef]
48. Tortora, C.; Di Crosta, A.; La Malva, P.; Prete, G.; Ceccato, I.; Mammarella, N.; Di Domenico, A.; Palumbo, R. Virtual Reality and Cognitive Rehabilitation for Older Adults with Mild Cognitive Impairment: A Systematic Review. *Ageing Res. Rev.* **2024**, *93*, 102146. [CrossRef]
49. Chau, P.H.; Kwok, Y.Y.J.; Chan, M.K.M.; Kwan, K.Y.D.; Wong, K.L.; Tang, Y.H.; Chau, K.L.P.; Lau, S.W.M.; Yiu, Y.Y.Y.; Kwong, M.Y.F.; et al. Feasibility, Acceptability, and Efficacy of Virtual Reality Training for Older Adults and People with Disabilities: Single-Arm Pre-Post Study. *J. Med. Internet Res.* **2021**, *23*, e27640. [CrossRef]

50. Huygelier, H.; Schraepen, B.; van Ee, R.; Vanden Abeele, V.; Gillebert, C.R. Acceptance of Immersive Head-Mounted Virtual Reality in Older Adults. *Sci. Rep.* **2019**, *9*, 4519. [CrossRef] [PubMed]
51. Tominari, M.; Uozumi, R.; Becker, C.; Kinoshita, A. Reminiscence Therapy Using Virtual Reality Technology Affects Cognitive Function and Subjective Well-Being in Older Adults with Dementia. *Cogent Psychol.* **2021**, *8*, 1968991. [CrossRef]
52. Kanyilmaz, T.; Topuz, O.; Ardic, F.N.; Alkan, H.; Öztekin, S.N.S.; Topuz, B.; Ardic, F. Effectiveness of Conventional versus Virtual Reality-Based Vestibular Rehabilitation Exercises in Elderly Patients with Dizziness: A Randomized Controlled Study with 6-Month Follow-Up. *Braz. J. Otorhinolaryngol.* **2022**, *88*, S41–S49. [CrossRef] [PubMed]
53. Damayanti, N.R.; Ali, N.M. Evaluating Game Application Interfaces for Older Adults with Mild Cognitive Impairment. *Int. J. Adv. Comput. Sci. Appl. (IJACSA)* **2023**, *14*, 952–956. [CrossRef]
54. Seifert, A.; Schlomann, A. The Use of Virtual and Augmented Reality by Older Adults: Potentials and Challenges. *Front. Virtual Real.* **2021**, *2*, 639718. [CrossRef]
55. Beraud-Peigne, N.; Maillot, P.; Perrot, A. The Effects of a New Immersive Multidomain Training on Cognitive, Dual-Task and Physical Functions in Older Adults. *GeroScience* **2023**, *46*, 1825–1841. [CrossRef]
56. Barsasella, D.; Malwade, S.; Chang, C.-C.; Liu, M.F.; Srikanth, S.; Panja, A.K.; Jack Li, Y.-C.; Syed-Abdul, S. Opinions Regarding Virtual Reality among Older People in Taiwan. In Proceedings of the 6th International Conference on Information and Communication Technologies for Ageing Well and e-Health (ICT4AWE 2020), Prague, Czech Republic, 3–5 May 2020; pp. 159–165.
57. Davis, F.D. Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Q.* **1989**, *13*, 319–340. [CrossRef]
58. Venkatesh, V.; Davis, F.D. A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Manag. Sci.* **2000**, *46*, 186–204. [CrossRef]
59. Venkatesh, V.; Morris, M.G.; Davis, G.B.; Davis, F.D. User Acceptance of Information Technology: Toward a Unified View. *MIS Q.* **2003**, *27*, 425–478. [CrossRef]
60. Venkatesh, V.; Bala, H. Technology Acceptance Model 3 and a Research Agenda on Interventions. *Decis. Sci.* **2008**, *39*, 273–315. [CrossRef]
61. Venkatesh, V.; Thong, J.Y.L.; Xu, X. Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Q.* **2012**, *36*, 157. [CrossRef]
62. Blut, M.; Chong, A.; Tsiga, Z. Venkatesh Meta-Analysis of the Unified Theory of Acceptance and Use of Technology (UTAUT): Challenging Its Validity and Charting a Research Agenda in the Red Ocean by Markus Blut, Alain Chong, Zayayd Tsiga, Viswanath Venkatesh: SSRN. Available online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3834872 (accessed on 9 January 2024).
63. Appel, L.; Appel, E.; Bogler, O.; Wiseman, M.; Cohen, L.; Ein, N.; Abrams, H.B.; Campos, J.L. Older Adults with Cognitive and/or Physical Impairments Can Benefit from Immersive Virtual Reality Experiences: A Feasibility Study. *Front. Med.* **2020**, *6*, 329. [CrossRef]
64. Liao, Y.-Y.; Chen, I.-H.; Lin, Y.-J.; Chen, Y.; Hsu, W.-C. Effects of Virtual Reality-Based Physical and Cognitive Training on Executive Function and Dual-Task Gait Performance in Older Adults with Mild Cognitive Impairment: A Randomized Control Trial. *Front. Aging Neurosci.* **2019**, *11*, 162. [CrossRef]
65. Liao, Y.-Y.; Tseng, H.-Y.; Lin, Y.-J.; Wang, C.-J.; Hsu, W.-C. Using Virtual Reality-Based Training to Improve Cognitive Function, Instrumental Activities of Daily Living and Neural Efficiency in Older Adults with Mild Cognitive Impairment. *Eur. J. Phys. Rehabil. Med.* **2020**, *56*, 47–57. [CrossRef]
66. Thapa, N.; Park, H.J.; Yang, J.-G.; Son, H.; Jang, M.; Lee, J.; Kang, S.W.; Park, K.W.; Park, H. The Effect of a Virtual Reality-Based Intervention Program on Cognition in Older Adults with Mild Cognitive Impairment: A Randomized Control Trial. *J. Clin. Med.* **2020**, *9*, 1283. [CrossRef]
67. Lee, L.N.; Kim, M.J.; Hwang, W.J. Potential of Augmented Reality and Virtual Reality Technologies to Promotewellbeing in Older Adults. *Appl. Sci.* **2019**, *9*, 3556. [CrossRef]
68. Gao, Z.; Lee, J.E.; McDonough, D.J.; Albers, C. Virtual Reality Exercise as a Coping Strategy for Health and Wellness Promotion in Older Adults during the COVID-19 Pandemic. *J. Clin. Med.* **2020**, *9*, 1986. [CrossRef] [PubMed]
69. Yen, H.-Y.; Chiu, H.-L. Virtual Reality Exergames for Improving Older Adults' Cognition and Depression: A Systematic Review and Meta-Analysis of Randomized Control Trials. *J. Am. Med. Dir. Assoc.* **2021**, *22*, 995–1002. [CrossRef]
70. Gao, Y. Application of Virtual Reality Technology in the Recognition System for Overcoming Anxiety and Psychological Pressure of Family Elderly. *Mob. Inf. Syst.* **2022**, *2022*, e3389039. [CrossRef]
71. Damayanti, N.R.; Ali, N.M. EMOGAME: Digital Games Therapy for Older Adults. *Int. J. Adv. Comput. Sci. Appl. (IJACSA)* **2022**, *13*, 183–191. [CrossRef]
72. Orr, N.; Yeo, N.L.; Dean, S.G.; White, M.P.; Garside, R. "It Makes You Feel That You Are There": Exploring the Acceptability of Virtual Reality Nature Environments for People with Memory Loss. *Geriatrics* **2021**, *6*, 27. [CrossRef]
73. Damayanti, N.R.; Ali, N.M. Mild Cognitive Impairment and Technology for Older Adults: A Review. In *Smart Trends in Computing and Communications: Proceedings of SmartCom 2020*; Zhang, Y.D., Senjyu, T., SO-IN, C., Joshi, A., Eds.; Smart Innovation, Systems and Technologies; Springer: Singapore, 2021; Volume 182.

74. Huber, S.K.; Knols, R.H.; Arnet, P.; de Bruin, E.D. Motor-Cognitive Intervention Concepts Can Improve Gait in Chronic Stroke, but Their Effect on Cognitive Functions Is Unclear: A Systematic Review with Meta-Analyses. *Neurosci. Biobehav. Rev.* **2022**, *132*, 818–837. [CrossRef]
75. Kim, H.; Hong, J.P.; Kang, J.M.; Kim, W.-H.; Maeng, S.; Cho, S.-E.; Na, K.-S.; Oh, S.H.; Park, J.W.; Cho, S.-J.; et al. Cognitive Reserve and the Effects of Virtual Reality-Based Cognitive Training on Elderly Individuals with Mild Cognitive Impairment and Normal Cognition. *Psychogeriatrics* **2021**, *21*, 552–559. [CrossRef]
76. Mohadis, H.M.; Ali, N.M. A study of smartphone usage and barriers among the elderly. In Proceedings of the 2014 3rd International Conference on User Science and Engineering (i-USEr), Shah Alam, Malaysia, 2–5 September 2014; pp. 109–114.
77. Isabel Corregidor-Sanchez, A.; Segura-Fragoso, A.; Rodriguez-Hernandez, M.; Jose Criado-Alvarez, J.; Gonzalez-Gonzalez, J.; Polonio-Lopez, B. Can Exergames Contribute to Improving Walking Capacity in Older Adults? A Systematic Review and Meta-Analysis. *Maturitas* **2020**, *132*, 40–48. [CrossRef]
78. Zahedian-Nasab, N.; Jaberi, A.; Shirazi, F.; Kavousipor, S. Effect of Virtual Reality Exercises on Balance and Fall in Elderly People with Fall Risk: A Randomized Controlled Trial. *BMC Geriatr.* **2021**, *21*, 509. [CrossRef]
79. Babadi, S.Y.; Daneshmandi, H. Effects of Virtual Reality versus Conventional Balance Training on Balance of the Elderly. *Exp. Gerontol.* **2021**, *153*, 111498. [CrossRef]
80. Oliveira, C.R.; Filho, B.J.P.L.; Esteves, C.S.; Rossi, T.; Nunes, D.S.; Lima, M.M.B.M.P.; Irigaray, T.Q.; Argimon, I.I.L. Neuropsychological Assessment of Older Adults with Virtual Reality: Association of Age, Schooling, and General Cognitive Status. *Front. Psychol.* **2018**, *9*, 1085. [CrossRef] [PubMed]
81. Baker, S.; Kelly, R.M.; Waycott, J.; Carrasco, R.; Hoang, T.; Batchelor, F.; Ozanne, E.; Dow, B.; Warburton, J.; Vetere, F. Interrogating Social Virtual Reality as a Communication Medium for Older Adults. *Proc. ACM Hum. Comput. Interact.* **2019**, *3*, 1–24. [CrossRef]
82. Lu, F.; Yu, D.; Liang, H.-N.; Chen, W.; Papangelis, K.; Ali, N.M. Evaluating Engagement Level and Analytical Support of Interactive Visualizations in Virtual Reality Environments. In Proceedings of the 2018 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), Munich, Germany, 16–20 October 2018; pp. 143–152.
83. Neri, S.G.; Cardoso, J.R.; Cruz, L.; Lima, R.M.; De Oliveira, R.J.; Iversen, M.D.; Carregaro, R.L. Do Virtual Reality Games Improve Mobility Skills and Balance Measurements in Community-Dwelling Older Adults? Systematic Review and Meta-Analysis. *Clin. Rehabil.* **2017**, *31*, 1292–1304. [CrossRef]
84. Corriveau Lecavalier, N.; Ouellet, É.; Boller, B.; Belleville, S. Use of Immersive Virtual Reality to Assess Episodic Memory: A Validation Study in Older Adults. *Neuropsychol. Rehabil.* **2020**, *30*, 462–480. [CrossRef]
85. Phu, S.; Vogrin, S.; Al Saedi, A.; Duque, G. Balance Training Using Virtual Reality Improves Balance and Physical Performance in Older Adults at High Risk of Falls. *CIA* **2019**, *14*, 1567–1577. [CrossRef]
86. Hsieh, C.-C.; Lin, P.-S.; Hsu, W.-C.; Wang, J.-S.; Huang, Y.-C.; Lim, A.-Y.; Hsu, Y.-C. The Effectiveness of a Virtual Reality-Based Tai Chi Exercise on Cognitive and Physical Function in Older Adults with Cognitive Impairment. *Dement. Geriatr. Cogn. Disord.* **2019**, *46*, 358–370. [CrossRef] [PubMed]
87. Benham, S.; Kang, M.; Grampurohit, N. Immersive Virtual Reality for the Management of Pain in Community-Dwelling Older Adults. *OTJR Occup. Part. Health* **2019**, *39*, 90–96. [CrossRef]
88. Micarelli, A.; Viziano, A.; Micarelli, B.; Augimeri, I.; Alessandrini, M. Vestibular Rehabilitation in Older Adults with and without Mild Cognitive Impairment: Effects of Virtual Reality Using a Head-Mounted Display. *Arch. Gerontol. Geriatr.* **2019**, *83*, 246–256. [CrossRef]
89. Yeşilyaprak, S.S.; Yildirim, M.S.; Tomruk, M.; Ertekin, O.; Algun, Z.C. Comparison of the Effects of Virtual Reality-Based Balance Exercises and Conventional Exercises on Balance and Fall Risk in Older Adults Living in Nursing Homes in Turkey. *Physiother. Theory Pract.* **2016**, *32*, 191–201. [CrossRef]
90. Huang, K.-T. Exergaming Executive Functions: An Immersive Virtual Reality-Based Cognitive Training for Adults Aged 50 and Older. *Cyberpsychol. Behav. Soc. Netw.* **2020**, *23*, 143–149. [CrossRef]
91. Zhu, S.; Sui, Y.; Shen, Y.; Zhu, Y.; Ali, N.; Guo, C.; Wang, T. Effects of Virtual Reality Intervention on Cognition and Motor Function in Older Adults with Mild Cognitive Impairment or Dementia: A Systematic Review and Meta-Analysis. *Front. Aging Neurosci.* **2021**, *13*, 586999. [CrossRef] [PubMed]
92. Lin, C.X.; Lee, C.; Lally, D.; Coughlin, J.F. Impact of Virtual Reality (VR) Experience on Older Adults' Well-Being. In *Human Aspects of IT for the Aged Population. Applications in Health, Assistance, and Entertainment*; Zhou, J., Salvendy, G., Eds.; Lecture Notes in Computer Science; Springer International Publishing: Cham, Switzerland, 2018; Volume 10927, pp. 89–100, ISBN 978-3-319-92036-8.
93. Mostajeran, F.; Steinicke, F.; Nunez, O.J.A.; Gatsios, D.; Fotiadis, D. Augmented Reality for Older Adults: Exploring Acceptability of Virtual Coaches for Home-Based Balance Training in an Aging Population. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (CHI'20), Honolulu, HI, USA, 25–30 April 2020; Association Computing Machinery: New York, NY, USA, 2020; p. 438.
94. Park, J.-S.; Jung, Y.-J.; Lee, G. Virtual Reality-Based Cognitive–Motor Rehabilitation in Older Adults with Mild Cognitive Impairment: A Randomized Controlled Study on Motivation and Cognitive Function. *Healthcare* **2020**, *8*, 335. [CrossRef] [PubMed]
95. Chen, J.; Or, C. Assessing the Use of Immersive Virtual Reality, Mouse and Touchscreen in Pointing and Dragging-and-Dropping Tasks among Young, Middle-Aged and Older Adults. *Appl. Ergon.* **2017**, *65*, 437–448. [CrossRef] [PubMed]

96. Zając-Lamparska, L.; Wiłkość-Dębczyńska, M.; Wojciechowski, A.; Podhorecka, M.; Polak-Szabela, A.; Warchoł, Ł.; Kędziora-Kornatowska, K.; Araszkiewicz, A.; Izdebski, P. Effects of Virtual Reality-Based Cognitive Training in Older Adults Living without and with Mild Dementia: A Pretest-Posttest Design Pilot Study. *BMC Res. Notes* **2019**, *12*, 776. [CrossRef] [PubMed]
97. Lee, Y.; Choi, W.; Lee, K.; Song, C.; Lee, S. Virtual Reality Training with Three-Dimensional Video Games Improves Postural Balance and Lower Extremity Strength in Community-Dwelling Older Adults. *J. Aging Phys. Act.* **2017**, *25*, 621–627. [CrossRef]
98. Monteiro-Junior, R.S.; Figueiredo, L.F.D.S.; Maciel-Pinheiro, P.D.T.; Abud, E.L.R.; Engedal, K.; Barca, M.L.; Nascimento, O.J.M.; Laks, J.; Deslandes, A.C. Virtual Reality–Based Physical Exercise with Exergames (PhysEx) Improves Mental and Physical Health of Institutionalized Older Adults. *J. Am. Med. Dir. Assoc.* **2017**, *18*, 454.e1–454.e9. [CrossRef]
99. Høeg, E.R.; Povlsen, T.M.; Bruun-Pedersen, J.R.; Lange, B.; Nilsson, N.C.; Haugaard, K.B.; Faber, S.M.; Hansen, S.W.; Kimby, C.K.; Serafin, S. System Immersion in Virtual Reality-Based Rehabilitation of Motor Function in Older Adults: A Systematic Review and Meta-Analysis. *Front. Virtual Real.* **2021**, *2*, 647993. [CrossRef]
100. De Vries, A.W.; Van Dieën, J.H.; Van Den Abeele, V.; Verschueren, S.M.P. Understanding Motivations and Player Experiences of Older Adults in Virtual Reality Training. *Games Health J.* **2018**, *7*, 369–376. [CrossRef]
101. Torpil, B.; Azahin, S.; Pekçetin, S.; Uyanlk, M. The Effectiveness of a Virtual Reality-Based Intervention on Cognitive Functions in Older Adults with Mild Cognitive Impairment: A Single-Blind, Randomized Controlled Trial. *Games Health J.* **2021**, *10*, 109–114. [CrossRef] [PubMed]
102. Atkins, A.S.; Khan, A.; Ulshen, D.; Vaughan, A.; Balentin, D.; Dickerson, H.; Liharska, L.E.; Plassman, B.; Welsh-Bohmer, K.; Keefe, R.S.E. Assessment of Instrumental Activities of Daily Living in Older Adults with Subjective Cognitive Decline Using the Virtual Reality Functional Capacity Assessment Tool (VRFCAT). *J. Prev. Alzheimers Dis.* **2018**, *5*, 216–234. [CrossRef]
103. Kalantari, S.; Bill Xu, T.; Mostafavi, A.; Lee, A.; Barankevich, R.; Boot, W.R.; Czaja, S.J. Using a Nature-Based Virtual Reality Environment for Improving Mood States and Cognitive Engagement in Older Adults: A Mixed-Method Feasibility Study. *Innov. Aging* **2022**, *6*, igac015. [CrossRef] [PubMed]
104. Skurla, M.D.; Rahman, A.T.; Salcone, S.; Mathias, L.; Shah, B.; Forester, B.P.; Vahia, I.V. Virtual Reality and Mental Health in Older Adults: A Systematic Review. *Int. Psychogeriatr.* **2022**, *34*, 143–155. [CrossRef]
105. Baragash, R.S.; Aldowah, H.; Ghazal, S. Virtual and Augmented Reality Applications to Improve Older Adults' Quality of Life: A Systematic Mapping Review and Future Directions. *Digit. Health* **2022**, *8*, 205520762211320. [CrossRef] [PubMed]
106. Korsgaard, D.; Bjøner, T.; Nilsson, N.C. Where Would You like to Eat? A Formative Evaluation of Mixed-Reality Solitary Meals in Virtual Environments for Older Adults with Mobility Impairments Who Live Alone. *Food Res. Int.* **2019**, *117*, 30–39. [CrossRef]
107. Wais, P.E.; Arioli, M.; Anguera-Singla, R.; Gazzaley, A. Virtual Reality Video Game Improves High-Fidelity Memory in Older Adults. *Sci. Rep.* **2021**, *11*, 2552. [CrossRef]
108. Kruse, L.; Karaosmanoglu, S.; Rings, S.; Ellinger, B.; Steinicke, F. Enabling Immersive Exercise Activities for Older Adults: A Comparison of Virtual Reality Exergames and Traditional Video Exercises. *Societies* **2021**, *11*, 134. [CrossRef]
109. Carroll, J.; Hopper, L.; Farrelly, A.M.; Lombard-Vance, R.; Bamidis, P.D.; Konstantinidis, E.I. A Scoping Review of Augmented/Virtual Reality Health and Wellbeing Interventions for Older Adults: Redefining Immersive Virtual Reality. *Front. Virtual Real.* **2021**, *2*, 655338. [CrossRef]
110. Li, X.; Niksirat, K.S.; Chen, S.; Weng, D.; Sarcar, S.; Ren, X. The Impact of a Multitasking-Based Virtual Reality Motion Video Game on the Cognitive and Physical Abilities of Older Adults. *Sustainability* **2020**, *12*, 9106. [CrossRef]
111. Chan, J.Y.C.; Chan, T.K.; Wong, M.P.F.; Cheung, R.S.M.; Yiu, K.K.L.; Tsoi, K.K.F. Effects of Virtual Reality on Moods in Community Older Adults. A Multicenter Randomized Controlled Trial. *Int. J. Geriatr. Psychiatry* **2020**, *35*, 926–933. [CrossRef]
112. Oliveira, C.R.; Lopes Filho, B.J.P.; Sugarman, M.A.; Esteves, C.S.; Lima, M.M.B.M.P.; Moret-Tatay, C.; Irigaray, T.Q.; Argimon, I.I.L. Development and Feasibility of a Virtual Reality Task for the Cognitive Assessment of Older Adults: The ECO-VR. *Span. J. Psychol.* **2016**, *19*, E95. [CrossRef]
113. Lee, M.; Son, J.; Kim, J.; Pyun, S.-B.; Eun, S.-D.; Yoon, B. Comparison of Individualized Virtual Reality- and Group-Based Rehabilitation in Older Adults with Chronic Stroke in Community Settings: A Pilot Randomized Controlled Trial. *Eur. J. Integr. Med.* **2016**, *8*, 738–746. [CrossRef]
114. Lima Rebêlo, F.; de Souza Silva, L.F.; Doná, F.; Sales Barreto, A.; de Souza Siqueira Quintans, J. Immersive Virtual Reality Is Effective in the Rehabilitation of Older Adults with Balance Disorders: A Randomized Clinical Trial. *Exp. Gerontol.* **2021**, *149*, 111308. [CrossRef] [PubMed]
115. Tsang, W.W.; Fu, A.S. Virtual Reality Exercise to Improve Balance Control in Older Adults at Risk of Falling. *Hong Kong Med. J.* **2016**, *22*, S19–S22. [CrossRef] [PubMed]
116. Stamm, O.; Dahms, R.; Müller-Werdan, U. Virtual Reality in Pain Therapy: A Requirements Analysis for Older Adults with Chronic Back Pain. *J. NeuroEng. Rehabil.* **2020**, *17*, 129. [CrossRef] [PubMed]
117. Cheng, V.Y.-W.; Huang, C.-M.; Liao, J.-Y.; Hsu, H.-P.; Wang, S.-W.; Huang, S.-F.; Guo, J.-L. Combination of 3-Dimensional Virtual Reality and Hands-on Aromatherapy in Improving Institutionalized Older Adults' Psychological Health: Quasi-Experimental Study. *J. Med. Internet Res.* **2020**, *22*, e17096. [CrossRef]
118. De Vries, A.W.; Willaert, J.; Jonkers, I.; Van DIeën, J.H.; Verschueren, S.M.P. Virtual Reality Balance Games Provide Little Muscular Challenge to Prevent Muscle Weakness in Healthy Older Adults. *Games Health J.* **2020**, *9*, 227–236. [CrossRef]

119. Afifi, T.; Collins, N.; Rand, K.; Otmar, C.; Mazur, A.; Dunbar, N.E.; Fujiwara, K.; Harrison, K.; Logsdon, R. Using Virtual Reality to Improve the Quality of Life of Older Adults with Cognitive Impairments and Their Family Members Who Live at a Distance. *Health Commun.* **2023**, *38*, 1904–1915. [CrossRef]
120. Stamm, O.; Dahms, R.; Reithinger, N.; Ruß, A.; Müller-Werdan, U. Virtual Reality Exergame for Supplementing Multimodal Pain Therapy in Older Adults with Chronic Back Pain: A Randomized Controlled Pilot Study. *Virtual Real.* **2022**, *26*, 1291–1305. [CrossRef]
121. Park, J.-H. Effects of Virtual Reality-Based Spatial Cognitive Training on Hippocampal Function of Older Adults with Mild Cognitive Impairment. *Int. Psychogeriatr.* **2020**, *34*, 157–163. [CrossRef]
122. Riaz, W.; Khan, Z.Y.; Jawaid, A.; Shahid, S. Virtual Reality (VR)-Based Environmental Enrichment in Older Adults with Mild Cognitive Impairment (MCI) and Mild Dementia. *Brain Sci.* **2021**, *11*, 1103. [CrossRef]
123. Ren, Y.; Lin, C.; Zhou, Q.; Yingyuan, Z.; Wang, G.; Lu, A. Effectiveness of Virtual Reality Games in Improving Physical Function, Balance and Reducing Falls in Balance-Impaired Older Adults: A Systematic Review and Meta-Analysis. *Arch. Gerontol. Geriatr.* **2023**, *108*, 104924. [CrossRef] [PubMed]
124. Zhu, K.Y.; Zhang, Q.Y.; He, B.W.; Huang, M.Z.; Lin, R.; Li, H. Immersive Virtual Reality-Based Cognitive Intervention for the Improvement of Cognitive Function, Depression, and Perceived Stress in Older Adults with Mild Cognitive Impairment and Mild Dementia: Pilot Pre-Post Study. *JMIR Serious Games* **2022**, *10*, e32117. [CrossRef] [PubMed]
125. Yang, J.-G.; Thapa, N.; Park, H.-J.; Bae, S.; Park, K.W.; Park, J.-H.; Park, H. Virtual Reality and Exercise Training Enhance Brain, Cognitive, and Physical Health in Older Adults with Mild Cognitive Impairment. *Int. J. Environ. Res. Public Health* **2022**, *19*, 13300. [CrossRef]
126. Campo-Prieto, P.; Cancela-Carral, J.M.; Rodríguez-Fuentes, G. Feasibility and Effects of an Immersive Virtual Reality Exergame Program on Physical Functions in Institutionalized Older Adults: A Randomized Clinical Trial. *Sensors* **2022**, *22*, 6742. [CrossRef]
127. Lee, N.; Choi, W.; Lee, S. Development of an 360-Degree Virtual Reality Video-Based Immersive Cycle Training System for Physical Enhancement in Older Adults: A Feasibility Study: Development of Immersive Virtual Cycle for Older Adults. *BMC Geriatr.* **2021**, *21*, 325. [CrossRef]
128. Lieze, M.; Jelle, V.C.; Benedicte, D.; Nico, V.D.W.; Mario, M.; Van Dyck, D. Using Virtual Reality to Investigate Physical Environmental Factors Related to Cycling in Older Adults: A Comparison between Two Methodologies. *J. Transp. Health* **2020**, *19*, 100921. [CrossRef]
129. Yeh, T.-M.; Pai, F.-Y.; Jeng, M.-Y. The Factors Affecting Older Adults' Intention toward Ongoing Participation in Virtual Reality Leisure Activities. *Int. J. Environ. Res. Public Health* **2019**, *16*, 333. [CrossRef]
130. Drazich, B.F.; McPherson, R.; Gorman, E.F.; Chan, T.; Teleb, J.; Galik, E.; Resnick, B. In Too Deep? A Systematic Literature Review of Fully-Immersive Virtual Reality and Cybersickness among Older Adults. *J. Am. Geriatr. Soc.* **2023**, *71*, 3906–3915. [CrossRef] [PubMed]
131. Masoumzadeh, S.; Moussavi, Z. Does Practicing with a Virtual Reality Driving Simulator Improve Spatial Cognition in Older Adults? A Pilot Study. *Neurosci. Insights* **2020**, *15*, 286–291. [CrossRef]
132. Yu, D.; Li, X.; Lai, F.H.-Y. The Effect of Virtual Reality on Executive Function in Older Adults with Mild Cognitive Impairment: A Systematic Review and Meta-Analysis. *Aging Ment. Health* **2023**, *27*, 663–673. [CrossRef]
133. Kim, S.-H.; Cho, S.-H. Benefits of Virtual Reality Program and Motor Imagery Training on Balance and Fall Efficacy in Isolated Older Adults: A Randomized Controlled Trial. *Medicina* **2022**, *58*, 1545. [CrossRef] [PubMed]
134. Davis, R.L.; Weisbeck, C. Search Strategies Used by Older Adults in a Virtual Reality Place Learning Task. *Gerontologist* **2015**, *55*, S118–S127. [CrossRef] [PubMed]
135. Delgado, F.; Der Ananian, C. The Use of Virtual Reality through Head-Mounted Display on Balance and Gait in Older Adults: A Scoping Review. *Games Health J.* **2021**, *10*, 2–12. [CrossRef] [PubMed]
136. Afifi, T.; Collins, N.L.; Rand, K.; Fujiwara, K.; Mazur, A.; Otmar, C.; Dunbar, N.E.; Harrison, K.; Logsdon, R. Testing the Feasibility of Virtual Reality with Older Adults with Cognitive Impairments and Their Family Members Who Live at a Distance. *Innov. Aging* **2021**, *5*, igab014. [CrossRef] [PubMed]
137. Mehrabi, S.; Muñoz, J.E.; Basharat, A.; Boger, J.; Cao, S.; Barnett-Cowan, M.; Middleton, L.E. Immersive Virtual Reality Exergames to Promote the Well-Being of Community-Dwelling Older Adults: Protocol for a Mixed Methods Pilot Study. *JMIR Res. Protoc.* **2022**, *11*, e32955. [CrossRef]
138. Elhusseiny, A.M.; Bishop, K.; Staffa, S.J.; Zurakowski, D.; Hunter, D.G.; Mantagos, I.S. Virtual Reality Prototype for Binocular Therapy in Older Children and Adults with Amblyopia. *J. AAPOS* **2021**, *25*, e1–e217. [CrossRef]
139. Boller, B.; Ouellet, É.; Belleville, S. Using Virtual Reality to Assess and Promote Transfer of Memory Training in Older Adults with Memory Complaints: A Randomized Controlled Trial. *Front. Psychol.* **2021**, *12*, 627242. [CrossRef]
140. Huang, C.-M.; Liao, J.-Y.; Lin, T.-Y.; Hsu, H.-P.; Charles Lee, T.-C.; Guo, J.-L. Effects of User Experiences on Continuance Intention of Using Immersive Three-Dimensional Virtual Reality among Institutionalized Older Adults. *J. Adv. Nurs.* **2021**, *77*, 3784–3796. [CrossRef]
141. Yan, M.; Zhao, Y.; Meng, Q.; Wang, S.; Ding, Y.; Liu, Q.; Yin, H.; Chen, L. Effects of Virtual Reality Combined Cognitive and Physical Interventions on Cognitive Function in Older Adults with Mild Cognitive Impairment: A Systematic Review and Meta-Analysis. *Ageing Res. Rev.* **2022**, *81*, 101708. [CrossRef]

142. Dobrowolski, P.; Skorko, M.; Pochwatko, G.; Myśliwiec, M.; Grabowski, A. Immersive Virtual Reality and Complex Skill Learning: Transfer Effects After Training in Younger and Older Adults. *Front. Virtual Real.* **2021**, *1*, 604008. [CrossRef]
143. Rings, S.; Steinicke, F.; Picker, T.; Prasuhn, C. Memory Journalist: Creating Virtual Reality Exergames for the Treatment of Older Adults with Dementia. In Proceedings of the 2020 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW), Atlanta, GA, USA, 22–26 March 2020; Institute of Electrical and Electronics Engineers Inc.: New York, NY, USA, 2020; pp. 687–688.
144. Sarkar, T.D.; Edwards, R.R.; Baker, N. The Feasibility and Effectiveness of Virtual Reality Meditation on Reducing Chronic Pain for Older Adults with Knee Osteoarthritis. *Pain Pract.* **2022**, *22*, 631–641. [CrossRef] [PubMed]
145. Flynn, A.; Healy, D.; Barry, M.; Brennan, A.; Redfern, S.; Houghton, C.; Casey, D. Key Stakeholders' Experiences and Perceptions of Virtual Reality for Older Adults Living with Dementia: Systematic Review and Thematic Synthesis. *JMIR Serious Games* **2022**, *10*, e37228. [CrossRef] [PubMed]
146. Da Costa, R.Q.M.; Pompeu, J.E.; Moretto, E.; Silva, J.M.; Dos Santos, M.D.; Nitrini, R.; Brucki, S.M.D. Two Immersive Virtual Reality Tasks for the Assessment of Spatial Orientation in Older Adults with and without Cognitive Impairment: Concurrent Validity, Group Comparison, and Accuracy Results. *J. Int. Neuropsychol. Soc.* **2022**, *28*, 460–472. [CrossRef] [PubMed]
147. Baker, S.; Waycott, J.; Vetere, F.; Hoang, T. The Technology Explorers: Partnering with Older Adults to Engage with Virtual Reality and Virtual Avatars. In *Ageing and Digital Technology: Designing and Evaluating Emerg. Technologies for Older Adults*; Springer: Singapore, 2019; pp. 231–246, ISBN 978-981133693-5.
148. Thangavelu, K.; Hayward, J.A.; Pachana, N.A.; Byrne, G.J.; Mitchell, L.K.; Wallis, G.M.; Au, T.R.; Dissanayaka, N.N. Designing Virtual Reality Assisted Psychotherapy for Anxiety in Older Adults Living with Parkinson's Disease: Integrating Literature for Scoping. *Clin. Gerontol.* **2022**, *45*, 235–251. [CrossRef] [PubMed]
149. Jeng, M.-Y.; Yeh, T.-M.; Pai, F.-Y. The Continuous Intention of Older Adult in Virtual Reality Leisure Activities: Combining Sports Commitment Model and Theory of Planned Behavior. *Appl. Sci.* **2020**, *10*, 7509. [CrossRef]
150. Davis, R. The Feasibility of Using Virtual Reality and Eye Tracking in Research with Older Adults with and without Alzheimer's Disease. *Front. Aging Neurosci.* **2021**, *13*, 607219. [CrossRef]
151. Hwang, N.-K.; Choi, J.-B.; Choi, D.-K.; Park, J.-M.; Hong, C.-W.; Park, J.-S.; Yoon, T.-H. Effects of Semi-Immersive Virtual Reality-Based Cognitive Training Combined with Locomotor Activity on Cognitive Function and Gait Ability in Community-Dwelling Older Adults. *Healthcare* **2021**, *9*, 814. [CrossRef]
152. Yu, K.; Wen, S.; Xu, W.; Caon, M.; Baghaei, N.; Liang, H.-N. Cheer for Me: Effect of Non-Player Character Audience Feedback on Older Adult Users of Virtual Reality Exergames. *Virtual Real.* **2023**, *27*, 1887–1903. [CrossRef]