# Engaging Older Adults in Community Health Exercise Programs through VR and Exergaming

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## Abstract

Virtual reality (VR) and exergame technologies are being used to promote physical activity among older adults, but research on their effectiveness for physical activity programs is spread across disciplines so there is limited understanding of the overall body of evidence. To address this gap, we conducted a scoping review. A search of the ACM Digital Library, PubMed, Science Direct, and Elsevier's Scopus found 15 relevant studies. Analysing these studies, we found that VR improves balance, muscle strength, and exercise learning in older adults. Challenges include technological barriers, concerns about simulator sickness, support for social interactions, differing motivations, and health conditions that limit capacity to use VR. We argue that future implementations of VR exercise programs for older adults should: be personalised to cater to individual needs, involve simplified interactions for improved usability, be designed to enhance social interactions, and include organizational support, through staff training and community engagement.

## CCS Concepts

• **Human-centered computing**; • **Interaction design**; • **Interaction design process and methods**; • **User centered design**;

## Keywords

virtual reality, exercise program, older adults, community, healthcare

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## 1 INTRODUCTION

We are living in an ageing society, with more people living for longer than in previous generations. Overall, this is a positive trend, but people can experience health challenges as they age and may have fewer opportunities to engage in physical activity due to decreased mobility and other challenges [1, 2]. Researchers have previously investigated the use of movement-based technologies, including video gaming and Virtual Reality (VR), to encourage exercise among older adults [3-5]. Studies indicate that many older adults enjoy playing video games and learning new technologies, suggesting that these mediums could be utilized to increase engagement in physical activity [3, 4].

In particular, immersive VR can be used to improve "exergaming", which is defined as playing games that require physical exertion or movement that targets improvement in physical health such as strength, balance, and flexibility [6]. VR supports sensorimotor contingency, which can elicit feelings of presence [7]. Research has shown that older adults are generally positive about VR [8], including when used for exercise programs. [5]

However, there remains a need for further research to better understand the balance between the benefits of VR for physical activity and the challenges VR may present. For instance, while gaming in a social setting can be empowering for some older adults, it may also pose vulnerabilities for those with impairments [3]. This highlights the importance of investigating the nuances of technology-based interventions in promoting exercise and healthcare among older populations. Additionally, research on the effectiveness of using VR to support older adults' physical activity is spread across disciplines, including human-computer interaction, physiotherapy, and other health sciences. The research evidence about opportunities and challenges of using VR in exercise programs for older adults has not been comprehensively collated. Furthermore, while much of the existing research has focused on the use of VR in institutional care and hospital settings [9-11], there is limited knowledge of the specific opportunities and challenges associated with using VR for physical exercise programs in community settings. In this paper, "community settings" refers to settings in which older adults live independently. We focus on community organizations that provide health and care services outside of institutional or hospital-based care. For example, neighbourhood or community centres where people gather for group and social activities often provide facilitated exercise programs.

This research aims to address this gap by investigating the benefits, challenges, and design considerations of incorporating VR into exercise programs for older adults in community settings, with a specific emphasis on fostering sustained engagement and improving long-term health outcomes. The research questions are as follows:

1. What are the benefits and challenges of using VR for physical activity with older adults, according to current evidence?


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2. What needs to be considered when designing VR exercise programs in promoting sustained engagement among older adults in community settings?
3. What are the best practices for the successful implementation of VR exercise programs for older adults in community settings?

# 2 Methodology

## 2.1 Rationale and Search Strategy

Due to the broad and exploratory nature of the research questions, we conducted a scoping review. Scoping reviews "aim to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available." [12]. They are used to summarize and disseminate research findings and to identify research gaps in the existing literature [13].

In this study, we followed the PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines [14]. We searched the following databases: ACM Digital Library, PubMed, Science Direct, and Elsevier's Scopus, which were selected due to their focus on computing, technology and biomedical science. Search terms included: ("virtual reality" OR "immersive technology") AND ("exercise program*" OR "physical activit*") AND ("older adults" OR elderly) AND (community OR healthcare). These search terms were used consistently across the four databases and were searched in abstracts, keywords, and title.

## 2.2 Inclusion& Exclusion Criteria

Articles were reviewed to determine eligibility based on the following inclusion criteria.

**(a) Participants**: Individuals aged 65 or above, in line with the Australian government's eligibility criteria for aged care services [15].

**(b) Technologies**: Studies involving Virtual Reality or related technology such as Augmented Reality (AR), which allows the person to see the real world, but it is overlaid with digital content in real time [19], and motion tracking.

**(c) Research Focus**: Research focusing on physical activity, including exergaming.

**(d) Publication period**: Articles published in English within the last 10 years, reflecting significant developments in VR technology post-2013.

**(e) Empirical Evidence**: Only articles that include empirical findings, either qualitative or quantitative, to ensure data is based on actual experiments or evaluations.

We excluded studies that contained the following:

**(a) Participants**: Research involving hospitalized individuals or older adults living in a long-term care facility, residential aged care center, nursing home etc.

**(b) Research Focus**: Studies primarily examining technology for social enrichment, rather than physical activities.

## 2.3 Selection Process

Initially, titles and abstracts were screened to identify studies that met the inclusion criteria. After the initial screening, a full-text review was conducted to ensure the articles met the inclusion criteria. This resulted in a final set of 15 articles, as shown in Figure 1.

## 2.4 Data Extraction

The PRISMA flow diagram of the database search strategy is illustrated in Figure 1. Initially, 777 studies were identified across four databases, with 61 duplicates removed. After screening titles and abstracts, 76 studies were brought forward for a full-text review. The primary reasons for excluding studies included participants residing in home care institutions, or studies not focusing on physical activity. Subsequently, 15 studies met the inclusion criteria and were selected for qualitative synthesis.

Data such as study objectives, methodologies, settings, participant characteristics, and details of interventions were extracted and categorized in Table 1 in the Supplementary Material. The findings were analysed to identify common themes related to the use of VR for physical activity in older adults, addressing the research questions on benefits, challenges, and design and implementation considerations for VR exercise programs in community settings.

# 3 RESULTS

## 3.1 Overview of studies

*3.1.1 Study Focus & Setting.* The fifteen studies took place in Australia, Brazil, Canada, Germany, Greece, Hong Kong, Malaysia, South Korea, Spain, and Taiwan. Eight studies focused on the impact of VR on different components of physical health in older adults [17-24], four on the feasibility and user experience of utilizing VR in exercise programs or exergames [3, 7, 19, 25], six compared the differences between traditional and VR exercise programs [17, 20, 24, 26-28], and one investigated the design requirements for an AR and VR exercise program [29]. Five studies took place at local independent living centres [17, 18, 21, 24, 26], one at a community center [19], one at home [3], two at a university lab [20, 25], and the remaining six did not specify their locations [7, 22, 23, 27-29].

*3.1.2 Study Design.* Two studies had a sample size of only 4 [3, 25]. Five studies had a sample size of greater than 50 but less than 100 [20, 21, 23, 24, 28]. Eight studies had a sample size of less than 50 [7, 17-19, 22, 26, 27, 29]. Around half of the studies utilized immersive head-mounted display (HMDs), all published within the last three years –possibly due to the Oculus Quest 2's release in 2020 and the subsequent rise in VR popularity [32]. The other half of the studies made use of motion-tracking devices and projectors, such as Microsoft's Kinect for Xbox 360 and the Nintendo Wii-U console. The studies included randomized controlled trials [17, 19-21, 23, 24, 27, 28], non-randomized controlled trials [22], and experimental designs supplemented by interviews or semi-structured focus groups [3, 7, 18, 25, 26, 29].

*3.1.3 Exercise Program/ Exergame Design.* The studies targeted various physical health aspects, including cardiorespiratory fitness, muscle strength, balance, functional mobility, agility, and flexibility. More than half utilized commercially available games or exercise programs [17, 20, 22, 23, 25, 27, 28]. Two were based on the American College of Sport Medicine (ACSM) guidelines for flexibility, muscle strength, cardiorespiratory fitness, balance, and agility training [22, 24]. Two focused on balance and lower extremity training for older adults [22, 30]. Six other studies developed their own games and exercise programs [10, 18, 19, 25, 29] , with two involving end users and healthcare experts in focus groups during

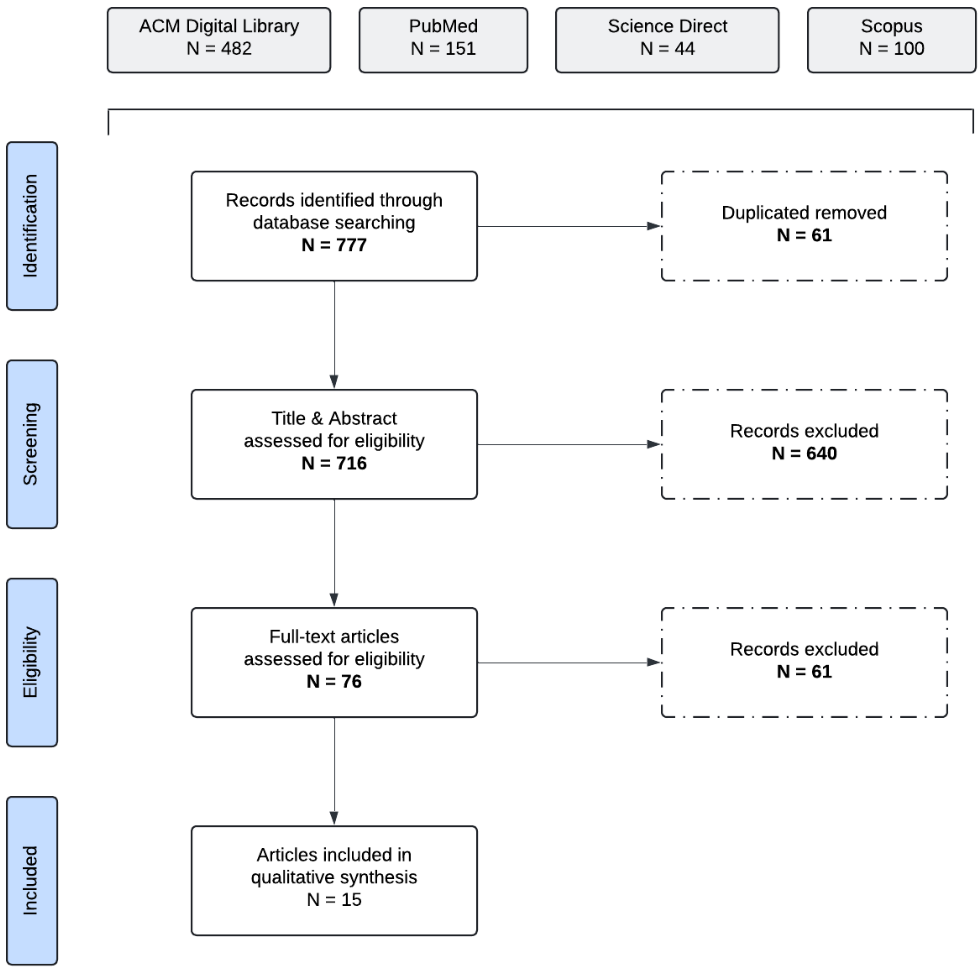


**Figure 1: The PRISMA flow diagram**

the design phase [18, 26]. One study featured a 30-minute virtual exercise class led by a real instructor represented as an avatar [3], and one study did not specify the details of their exercise program design [21].

*3.1.4 Program Details.* Ten studies focused on exergaming [7, 17-19, 22, 24-28], where participants engaged in exercise through interactive gameplay. The remaining five studies focused on structured exercise programs that did not incorporate gaming elements [3, 20, 21, 23, 29]

In the exergaming category, two studies utilized the Nintendo Wii-U console to simulate sports activities like soccer and snowboarding slalom [17, 27]. Six studies employed immersive head-mounted display (HMDs) for diverse activities: boxing in a virtual gym [25], performing farming tasks like seeding and fertilizing a field [18], performing the role of a musical conductor [26], performing daily living tasks such as grocery shopping and flipping eggs [19], slicing spheres with a sword [7], and hunting [24]. Two studies utilized Microsoft's Kinect for Xbox 360 for motion-tracking in games like dance battles [22] and goalkeeper challenges [28].

Traditional exercise programs included participants represented as avatars and following movements led by a virtual instructor [3, 20, 29]. One study implemented a VR kayak program simulating water training using a stool and a footrest on a springboard, with images of kayaks and a lake displayed via a 3D beam projector [21]. Another study utilized three projectors to display exercises like boxing and aerobic dance [23].

The table below summarizes the key findings from the reviewed studies. They will be elaborated further in the subsequent sections.

## 3.2 Benefits of using VR and exergaming

*3.2.1 Improved Balance.* Six papers demonstrated significant improvements in balance among participants [17, 20, 21, 23, 27, 28]. These included studies that incorporated exercises specifically designed to enhance lower body balance, such as using the snowboard/ski slalom and table tilt from the Wii Fit games [17, 27]. The

**Table 1: Summary of study findings in terms of benefits, challenges, and other relevant considerations**

| Category | Findings |
|---|---|
| Benefits of using VR | 1. Improved Balance<br>2. Improved Muscle Strength<br>3. Improved Cognitive Function<br>4. Enhanced exercise learning effect |
| Challenges of using VR | 1. Usability Challenges<br>Difficulties with operation of VR system, multiple controllers<br>Feeling of insecurity<br>2. Simulator Sickness |
| Other Considerations | 1. Social interaction<br>Impacted by the format and size of exercise groups<br>2. Motivation<br>Impacted by exercise feedback provided by the VR system, topics related to fitness and health and group-based format |
| Older adults with specific health conditions | 1. Cognitive Frailty<br>VR simultaneous motor-cognitive training is feasible with good adherence, successful learning outcome, and minimal adverse effects<br>2. Mild Cognitive Impairment (MCI)<br>The sense of presence during VR experiences can enhance cognitive health<br>3. Hypertension (High blood pressure)<br>Competitive thoughts should be avoided |

study that involved VR kayaking required participants to perform large motions with the upper limbs for paddling, activating trunk muscles and improving balance [21]. Three other studies indicated that their exercises targeted balance, but did not explain in detail how they achieved this [20, 23, 28]. For example, they stated that the exercise program included boxing, aerobic dance, and the motions were based on tai chi that focused on balance.

*3.2.2 Improved Muscle Strength.* Multiple studies showed improvements in both upper and lower body muscle strength. A tai chi-based program enhanced lower body strength as indicated by better performance on the 30-Second Chair Stand Test [20]. Another study involved VR balance training targeting lower body balance, which showed improvements in isokinetic quadriceps and hamstrings strength, measured by the Biodex Isokinetic Dynamometer [28]. Significant improvements in eccentric hamstring peak torque, measured by a Biodex System 4, were observed among community-dwelling older women after a 12-week dance exergame program [22]. In this program, participants engaged in approximately 40-minute sessions of pop dance exergaming, following the music and game avatar. The VR kayak training program, which involved repetitive paddling motions, significantly increased upper body and grip length, suggesting overall improvements in upper extremity functions [21]. Finally, exercises like boxing and aerobic dance enhanced upper body muscle strength, which was reflected in the improvements in the arm curl test [23].

*3.2.3 Enhanced learning effect.* Three studies [20, 23, 27] concluded that the instant visual and auditory feedback in VR exercise programs improved participants' movement precision, enhancing the exercise learning effect. For example, in a study that used individualized feedback-based virtual reality (IFVR) exercises, participants received real-time scores for the accuracy of their movements and saw their total scores after the exercises [20]. Another study using the immersive VR exergame, Maestro Game, tracked participants' movements, calibration, and progress through various parameters, allowing for a later evaluation [26]. These studies demonstrate how VR and exergaming technologies might provide tools and techniques that are not available through traditional exercise programs.

## 3.3 Challenges of using VR and exergaming

*3.3.1 Usability Challenges.* Some participants struggled to use the VR system independently [3, 18, 25] or felt uncertain about using the technology [26]. The authors of one study argued that participants had a low level of familiarity with technology [25]. Feedback from questionnaires in two studies indicated that participants required technical support to operate the devices [18, 25] and experienced difficulties and frustration when logging into the system [3]. Using multiple controllers also posed difficulties, impacting the ease of use of the new technology [25]. In a study that implemented a VR exergame where players were situated in a 3D concert hall, playing the role of a conductor, the game was originally planned to be played in standing position [26]. However, due to feeling of insecurity after wearing the VR headset, two first-time VR users requested to sit down.

*3.3.2 Simulator Sickness.* A minority of participants in each study reported undesirable effects after using the VR system, with simulator sickness and exhaustion being the most commonly reported undesirable effects [18, 19, 21, 26]. One study reported no cases of simulator sickness among participants with cognitive frailty, suggesting that the content of a program could significantly affect the severity of simulator sickness symptoms [19]. Cognitive frailty is the co-occurrence of physical frailty and cognitive impairment in older adults [19]. In another comparative study involving nine older and nine younger adults playing an exergame that involved slicing spheres, stronger symptoms were reported by the younger group [7]. It was hypothesized that this was because older adults tend to move more slowly and interact less frantically than younger participants.

## 3.4 Other considerations

*3.4.1 Social Interaction.* The size of the training group and exercise format significantly influenced social interaction. In one exergame-based program, no increases were observed in the social subscale scores of the Motives for Physical Activity Measure-Revised (MPAM-R), which is used to assess the strength of motives for participating in physical activities, for any of the training groups, likely due to small group sessions (4-5 people), and a short 6-week training period [17]. Conversely, another study that compared individualized feedback-based virtual reality (IFVR) exercises with group-based exercises found a greater increase in social functioning scores on the Short-Form Health Survey (SF-36), which measures health-related quality of life, among participants in group-based exercises. The survey includes items assessing perceptions of physical health and pain, and well-being, which helps to reveal the health benefits of the exercise programs. Group-based exercise with 28 participants showed greater social functioning improvements, compared to the IFVR exercise where individualized feedback requires single participant involvement without interaction from others [20].

*3.4.2 Motivation.* Studies found that older adults were motivated by exercise feedback provided by the VR system, topics related to fitness and health, and a group-based format. Two studies concluded that detailed and abundant visual feedback facilitates the learning of correct movements, resulting in increased motivation [23, 29]. In one exergame-based program, a significant improvement in the MPAM-R Fitness-Health subscale score demonstrated that older adults are motivated by fitness and health-related subjects, such as the desire to maintain their physical strength [17]. Additionally, the group-based exercise format helps keep participants motivated to stay in the program because they enjoy meeting new people and socializing, which they find more enjoyable than exercising alone [29].

## 3.5 Specific Health Condition

*3.5.1 Older adults with Cognitive Frailty.* A study focusing on older adults with cognitive frailty, which refers to the coexistence of physical frailty and cognitive impairment, found that VR simultaneous motor-cognitive training is feasible with good adherence, successful learning outcome, and minimal adverse effects [19]. The training involved daily living tasks like navigation and recalling items while grocery shopping, targeting older adults' orientation, calculation, memory, reaction time, and attention. Motor training was provided through cycling on an ergometer. The study provides preliminary evidence that this simultaneous motor-cognitive training could produce a synergistic response on global cognitive function, demonstrating its effectiveness in enhancing cognitive function in this population. Results also showed that simulator sickness was not a concern for many older adults with cognitive frailty.

*3.5.2 Older adults with Mild Cognitive Impairment (MCI)..* MCI is defined as a decline in cognitive function higher than that expected for an individual's age [31]. This condition is often seen as an early phase of dementia, and prior research suggests that digital games can help maintain cognitive skills for those experiencing MCI [33]. One study we reviewed demonstrated that VR-based cognitive training can improve cognitive and brain function in MCI patients more effectively than traditional exercise programs [24]. The sense of presence during VR experiences has helped activate certain types of brain activity that are usually high in people with MCI, leading to improved brain function. This improvement in brain activity has been linked to better scores on the Mini-Mental-State Examination test that measures global cognitive function, showing that VR can enhance cognitive health.

*3.5.3 Older adults with Essential Hypertension (High blood pressure).* For older adults with essential hypertension, or high blood pressure, competitive thoughts should be minimized to avoid stress and injury risks [29]. Exergame design for this group should focus on alleviating high blood pressure symptoms through controlled physical activities and heart rate monitoring.

# 4 DISCUSSION

This scoping review explored the benefits, challenges, and design considerations of integrating VR and motion technologies into exercise programs for older adults within community settings. The findings indicate that VR-based exercises and exergaming can improve physical attributes like balance and muscle strength depending on the design and focus of the programs. Moreover, the instant visual and auditory feedback provided by VR exercise programs facilitates more precise movements, thereby enhancing the learning effects of these exercises.

However, the review also highlighted significant challenges in using VR and exergaming for physical activity. These included difficulties participant had using the systems independently, handling multiple controllers, and navigating within VR environments. Health-related concerns were noted, suggesting the design of the equipment and intensity of activities may not be suitable for all older adults. Issues such as simulator sickness and exhaustion were reported in some participants.

Thus, designing effective VR programs requires careful consideration at individual, technological, and organizational levels to promote sustained engagement and successful implementation in community settings.

## 4.1 Individual Level

*4.1.1 Personalization.* Personalization within VR exercise programs is essential for accommodating the diverse fitness levels, progress, and health conditions of older adults, ensuring sustained engagement and effectiveness. The reviewed studies demonstrated that feedback not only guides participants toward more precise movements [20, 23] but also enhances the learning effect of the exercises [20, 27] and thus increases motivation [23, 29]. Therefore, we recommend offering adjustable difficulty levels, and providing instant personalized feedback (visual, auditory, or haptic) during workouts, especially to those with limited physical activity experience, to achieve accurate movements while reducing injury risk. By engaging in VR exercises tailored to individual needs, older adults can stay committed and benefit more effectively from the programs. In addition, although not directly addressed in the studies we reviewed, personalization could extend to offering games that align with program participants' interests. Exergames for older adults can sometimes be perceived as childish, suggesting a need for program facilitators to choose games carefully [33]. Prior work on the use of VR for social enrichment in aged care has shown that to ensure the VR program is effective, it is crucial that program facilitators choose experiences that respond to people's interests [34]. VR for exergaming may require a similar attention to personal interests in order to motivate people to participate.

*4.1.2 Intrinsic Motivation & Sustained Engagement.* While VR exercises yield positive outcomes, they do not automatically ensure motivation among older adults. Studies show that exercise adherence is highest when individuals are intrinsically motivated by pleasure and satisfaction [35, 36]. Detailed and abundant visual feedback facilitates the learning of correct movements, resulting in increased motivation [25, 31]. Components such as matching the task to the participant's skill level, setting clear activity goals, and providing feedback on progress can lead to enjoyment during an experience [37]. Therefore, various game design elements should be incorporated into VR exercise programs to meet these requirements and intrinsically motivate older adults to join and maintain engagement in the program.

Incorporating progress tracking and goal setting is essential. Studies have found a positive relationship between self-monitoring components and physical activity [38], and that using an activity tracker increases users' self-awareness of their activity levels, thus enhancing task motivation [39]. However, the use of a tracker can be discouraging when individuals do not meet their activity goals [40]. Therefore, default recommended goals should be carefully planned and users should be provided with varying levels of complexity and a personalized goal setting option to ensure the skill level matches the player.

Second, competitive modes can be integrated in the exercise program since competition is one of the basic components of intrinsically motivating activities [41]. Competition provides users with feedback on performance and encourages them to continue training to remain competitive [37]. However, competition should be cautiously implemented, particularly for older adults with conditions like hypertension, to avoid stress and potential injuries [31]. Therefore, the program should be carefully structured to accommodate different conditions among older adults.

## 4.2 Technological Level

*4.2.1 Simplified User Interaction.* The user interface design should be optimized for simplicity and intuitive interaction. The reviewed studies suggested participants experienced difficulties in using multiple controllers and required technical assistance to operate the VR system [3, 18, 25]. To enhance accessibility, VR exercise programs should involve minimal buttons and controls, offering simpler navigation. Introducing step-by-step tutorials for first-time users could also improve interaction efficiency. By simplifying and reducing the complexity of the interactions, the VR exercise program could become more accessible for older adults, potentially increasing engagement as they can use the system more efficiently and independently.

*4.2.2 Stakeholder Engagement.* Most studies reviewed utilized commercially available games or exercise programs that were not specifically designed for older adults. Only two studies involving end users and healthcare experts in the design phase [18, 26], raising concerns about whether the content of these exercise programs is truly optimized for older adults' health needs. Careful consideration of program details is critical when implementing VR exercise programs within community settings, as they can significantly impact the health and well-being of participants.

To tailor VR exercise programs effectively, both older adults and healthcare professionals should be actively involved in the design process. Older adults can offer valuable feedback to engineers designing user-centered technology, while health professionals ensure the technology is suitable for practical use [40]. Participatory design workshops have proven effective for gaining direct insights into design needs and creating products that truly meet user requirements [43]. Employing this co-design approach could better address user needs and enhance the relevance and effectiveness of the program.

Furthermore, adherence to specific physical activity guidelines is also crucial. For instance, the World Health Organization recommends that "older adults should engage in varied multicomponent physical activity that emphasizes functional balance and strength training at moderate or greater intensity, on 3 or more days a week, to enhance functional capacity and prevent falls" [44]. The reviewed studies suggest that combing VR exercise with traditional exercise improves strength, balance, and functional mobility, more effectively than either alone [30]. Therefore, healthcare professionals could consider designing VR exercises that focus on balance and functional mobility, complementing them with other physical activities outside VR. Following these guidelines can help structure VR exercise programs to maximize health benefits for older adults.

*4.2.3 Program Structure.* The reviewed studies showed that larger group-based exercise formats fostered social interactions [17, 20], which motivated participants to stay engaged [29]. Other research has also highlighted the importance of social connections for individual wellbeing in older adults [45, 46], and noted that many community-dwelling older adults feel motivated by being part of a group exercise program, which provides a sense of belonging [47-49].

Therefore, it is advisable to design exercise programs with larger, group-based sessions where feasible. Given that the nature of immersive VR exercises in a head-mounted display tends to be individualistic, creating opportunities for social interaction before or after exercises could potentially enhance motivation by fostering a sense of community among older adults.

Additionally, research has found that "collective efficacy and empowerment through social engagement were beneficial to members as individuals and as a group, and contributed to well-being through a general sense of accomplishment and pride." [50]. Therefore, integrating features that encourage cooperation and communication within VR settings can further enhance the social benefits of the exercise program. For example, incorporating team challenges or group goals in the games or exercise programs can motivate participants to communicate and work together, improving their collective efficacy and collective achievement, thus enhancing well-being.

## 4.3 Organizational Level

*4.3.1 Staff training and support.* The difficulties study participants faced with VR systems, including challenges in independent use [3, 18, 25] and issues like simulator sickness and exhaustion [18, 19, 21, 26], highlight the importance of comprehensive staff training and support in VR exercise programs. Experienced and well-trained facilitators at community centres are crucial for helping older adults navigate through technology-based activities and ensuring safety, particularly for those with conditions like hypertension [29]. Novel technologies like VR, typically require facilitators to familiarize themselves with the system in advance and be fully aware of all the potential situations that may occur during the activities [51]. Facilitators should be vigilant in monitoring ongoing activities and must be trained to recognize and respond to the early signs of simulator sickness, such as nausea and dizziness [52].

Guidelines for staff training in the healthcare sector have highlighted the need for demonstrations, dry runs, and early planning for any new IT implementation [53]. Many online resources offer guidelines and tips for facilitators preparing to run a VR session [54, 55], and specialized VR training programs are available for healthcare professionals to manage behavioural emergencies in older adults [56, 57]. Facilitators' competency can then be assessed by simulating possible situations using the Kirkpatrick Four-Level Training Evaluation Model, a globally recognized method for evaluating the outcomes of training and learning programs [58].

# 5 CONCLUSION AND FUTURE RESEARCH

This scoping review synthesized 15 studies focusing on VR and exergame applications in physical activities for older adults aged 65 and above. The reviewed studies show high user acceptance of VR and exergaming technology among older adults [3, 18, 25, 26, 28], indicating readiness for VR exercise programs in community settings. However, a limitation of the studies we reviewed is that they only identified short-term benefits of VR and exergaming with this population. Future research should focus on evaluating the long-term effects, sustainability, and practical implementation of VR exercise programs for older adults. This involves assessing the lasting health outcomes, understanding the adherence rates by systematically monitoring how consistently older adults engage with these programs, and exploring operational logistics of integrating such technologies into regular community health practices. These efforts will help identify the most effective strategies to ensure that VR interventions are effective not only in the short term but also deliver sustained health benefits and remain practical and accessible for the community.

Moreover, studies should employ larger and more diverse samples, focusing on the most common chronic diseases in community-dwelling older adults to better represent the health conditions in the community settings. Comparative studies should also determine the most effective VR technologies and assess the psychological and social impacts of these programs to refine program design and maximize benefits for older adults. In addition, given the sensitive setting in which this research takes place, it is crucial that researchers identify any ethical challenges that need to be addressed when implementing VR and exergame programs for older adults [59].

The global ageing problem represents an urgent need for innovative approaches to support the well-being of older adults. Research on the effectiveness of using VR and other motion-based technologies to support older adults' physical activity is spread across disciplines, and there remains limited understanding of the specific opportunities and challenges associated with using VR for physical activities in community settings. The key contribution of this study lies in its comprehensive analysis of the benefits and challenges of using VR and the formulation of detailed design and implementation considerations of VR exercise programs for older adults in community settings in the future.

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