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Immersive virtual reality in the promotion of health and well-being for people in residential aged care without cognitive impairment: A scoping review

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Abstract

Objective: Sustaining the health and well-being of older people living in residential aged care (RAC) requires new means of providing safe and stimulating recreational and therapeutic programs such as using virtual reality (VR). The aim of the scoping review was to investigate the utility of immersive VR interventions using head-mounted display technology to promote the health and well-being of people without cognitive impairment living in RAC.

Method: The following databases were searched from inception until January 2024: PubMed, PsycINFO, Scopus, Cochrane and CINAHL. The eligibility criteria were quantitative, qualitative or mixed methods studies published in English, conducted in RAC, using VR with head-mounted display with people without cognitive impairment.

Results: Of the 274 articles identified, 9 articles with a total of 310 residents and 50 staff met the inclusion criteria. Seven factors to either impede or enable the use of VR with head-mounted displays in RAC were: residents' agency; the nature of the VR experience; the content of the experience; the ease of use and comfort of the technology; the role of RAC staff; and the role of residents' family members.

Conclusion: Immersive VR has potential as a tool to promote the health and well-being of people without cognitive impairment living in RAC. Small sample sizes, variations in study design, and selection bias mean that generalisability of the results is limited. Further research is recommended to inform the design and implementation of immersive VR programs tailored specifically for this population.

Keywords

Virtual reality, cognitive impairment, nursing home, long term care, dementia, scoping review

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Introduction

The global population of older people is increasing as living standards and healthcare improve. Globally, the number of people aged 60 years and over is forecast to double from 1 billion in 2019 to 2.1 billion by 2050.[1] Various organisations that represent older people, communities, society, professionals and universities, and the private sector,[2] are investing in a variety of services to support older people to continue to live independently in the community, but

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longer life expectancies will result in more people with chronic health and disabling conditions living in residential aged care (RAC).[3–5] RAC provides 24-hour care for people with complex care needs who can no longer live independently.[6] Sustaining social connection, physical activity and mental stimulation in RAC is critical, and novel solutions are required to prolong the health, well-being and quality of life of this population.[5]

People living in RAC typically have complex needs, with over half having a record of dementia.[7–10] In Australian RAC in 2022, 37% of people required high care in activities of daily living, cognition and behaviour, and complex health care.[11] The physical, mental and social well-being of older people living in RAC is impacted by individual and environmental factors.[12,13] In recent years, the COVID-19 pandemic has and continues to, impact older people in RAC with residents' physical, mental and emotional well-being deteriorating because of increased social isolation. Social isolation is used as a strategy for preventing the spread of COVID-19 (and other infections) with limited empirical evidence.[5,6,14]

COVID-19 has added impetus to pursuing 'healthy ageing' and an independent, purposeful life.[14–16] One strategy that has been trialled in RAC is virtual reality (VR) or augmented reality (AR).[17] VR technology has been trialled in RAC organisations in multiple countries, including Australia, as an intervention to help improve socialisation, mental health and physical activity in both people with and without cognitive impairment.[17–22] VR creates the illusion of escape to novel virtual worlds and more naturalistic scenarios or historical sites that people living in RAC may no longer be able to visit in person.[23] It safely 'transports' the user to an alternate environment without the need for physical mobility.[21,24–26] Immersive VR technology with goggle-style head-mounted displays (HMD) which can be a helmet or set of goggles that attach to the head and present information into the eyes, allow users to shift perspective 360° by moving their head, and sensory gloves, joysticks or hand controllers providing a virtual sense of touch.[17,27,28] VR has been demonstrated to improve physical, mental and cognitive health.[20,25,29–31] Studies have reported success of VR's use in stroke rehabilitation,[29,32–34] managing Parkinson's Disease,[35] supporting emotional regulation,[36] reducing depression,[31] anxiety[37] and apathy[30]; in promoting balance[38,39] and physical activity[25,40–42] and reminiscence.[22,30] VR has also been found to promote social connection,[23,24] and to provide a non-pharmacological alternative to pain management.[43–46] A systematic review of the role of VR in improving health outcomes for older people concluded, however, that factors relating to usability and acceptability require further exploration.[29] This includes the consideration of the role of RAC staff in facilitating and promoting use of VR and its sustainability as a strategy in aged care.[26,47,48]

VR provides one avenue to meet the rising societal expectations for engaging and health-promoting activities for RAC residents that are cost-effective and allow for the utilisation of small group activities. Economic viability is important as, for example, more than 61% of Australia's RAC homes are currently operating at a loss.[49]

This scoping review focuses on the utility of immersive VR-based interventions to improve the health and well-being of older people living in RAC without cognitive impairment. A recent review investigated the effects of facilitators and barriers to reducing social isolation and loneliness by increasing the social engagement of all people in RAC through VR.[50] However, the population of older people in RAC without cognitive impairment merits specific consideration as a minority group that can feel isolated, experience unmet psychosocial and emotional needs, feel disengaged from routine recreation programs, and are often underreported in RAC.[24,51,52] Therefore, the aim of this review was to synthesise the evidence of benefits to health and well-being of using VR-based interventions in RAC for people without cognitive impairment. The objectives of the study were to identify the enablers and barriers, and to synthesise characteristics that foster utility for broader adoption as part of health promotion, lifestyle and recreational programs in RAC settings for people without cognitive impairment.

Method

This scoping review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) guidelines.[53] Given the diverse literature and study designs investigating the use of VR in RAC and the relatively unexplored effects, specifically on people without cognitive impairment, a scoping review methodology was accepted to scope the current literature and identify knowledge gaps. The scoping review was not preregistered.

Literature search and study selection

Five databases (PubMed, PsycINFO, Scopus, Cochrane and CINAHL) were searched between inception and May 2023 to identify relevant literature. Searches were re-ran in January 2024 to identify any potential new articles published. The search strategy was informed by the SPIDER (Sample, Phenomenon of interest, Design, Evaluation and Research) framework.[54] The following keywords were used to search 'all fields' in all databases except Scopus where title, abstract and keyword were searched ('Residential care' OR 'aged care' OR 'nursing homes' OR 'long?term care') AND ('Virtual reality' OR 'VR' OR 'immersive' OR 'augmented reality' OR 'exergaming') AND ('Observ*' OR 'survey' OR 'interview' OR 'trial' OR 'pilot' OR 'feasib*' OR 'question*' OR 'accept*' OR 'cost'). Search terms such as virtual, augmented and immersive were included as these are terms that are sometimes used interchangeably in describing virtual reality. The reference lists of relevant literature (articles and reviews) were also searched to identify additional relevant articles.

Eligibility criteria

Peer-reviewed articles that described primary research in English were included. Studies with samples limited to people living in RAC with a diagnosis of dementia and/or mild cognitive impairment were excluded, as were articles with phenomena of interest that did not include HMD VR technology. Articles including mixed populations were included and appraised even if they did not differentiate between whether the participants had a dementia diagnosis or cognitive impairment.

Data extraction

Articles identified during the database and reference list searches were imported into EndNote (Philadelphia, PA, USA) and duplicates were removed. Two authors (BC and HH) screened articles for inclusion based on titles and abstracts according to the eligibility criteria. A full text review was undertaken for articles where the title and abstract were unclear as to whether they met the eligibility criteria. Two authors (BC and HH) independently reviewed the full text of the remaining articles based on the eligibility criteria. Disagreements about eligibility were resolved by discussion with a third reviewer (NMD) to ensure consensus was reached. The corresponding authors of three articles were contacted to clarify methodology,[40,46,48] with two returning a response.[40,48]

Quality appraisal

The Mixed Methods Assessment Tool (MMAT) Version 2018 was selected to enable appraisal of the studies.[55] The rationale for using the MMAT tool was its suitability for appraising multiple different study designs and methodologies. A critical appraisal was performed to examine the methodological quality of the included studies. The articles were independently appraised by two authors (HH and SI) and discussed until consensus was reached or mediated by a third author (NMD). No studies were excluded based on the quality appraisal.

Synthesis of results

Data were grouped and synthesised by study design, participant characteristics and intervention characteristics. A narrative synthesis was then performed based on common themes of the included studies. Overall study characteristics, results, benefits/enablers and barriers/side effects were extracted and presented.

Results

Selection of sources of evidence

A flowchart depicting the selection process can be seen in Figure 1. In total, 382 articles were identified, and 274 remained after removing duplicates. Amongst these articles, 221 were excluded after title and abstract screening, leaving 53 for full-text review. A final library of 9 articles was included in the review from five countries following full-text screening. Table 1 presents the primary characteristics of these articles, which consisted of the following studies: mixed methods ($n = 3$),[25,43,46] a qualitative multi-method design ($n = 1$),[24] a randomised control multicentre pilot study ($n = 1$),[40] a cross-sectional explanatory study ($n = 1$),[26] a quasi-experimental case-control study ($n = 1$),[47] an observational qualitative study ($n = 1$)[48] and a qualitative comparison study ($n = 1$).[22] Three studies were pilot studies,[25,40,43] and two had a control group[40,47] which included assessment and usual recreational programs[40] and no exposure to either virtual or real horticulture.[47]

Participants

Interventions were conducted in between one[24,48] and six[46] RAC homes with the number of residents commencing the intervention ranging from 5[24] to 118.[47] The mean age of participants was reported in eight of the studies (80.7 ± 3.95; range 50–100 years). There were a total of 310 participants in the included studies, of which 88 were females, noting that Hayden et al. (2022) utilised the same population as Chaze et al. (2022). Hayden did not report gender in Phase 2 of the study.[43]

Participants were recruited using purposeful sampling, with staff of the RAC participating in recruitment by nominating suitable participants in five studies.[22,25,44,48] Other methods of recruitment included advertising within the RAC or staff promotion,[47] a presentation about the study to the residents[46] or advertisement through fliers and one-on-one discussions.[26] One study did not specify the method of recruitment.[40] Participants were selected based on the eligibility criteria which varied across the studies. Only four studies specifically identified criteria related to cognitive impairment or dementia,[22,26,47,48] or the ability to provide informed consent.[22,46] Lin et al. (2020) and Huang et al. (2021) excluded people with dementia but did not undertake a cognitive test with participants prior to the intervention. Lundstedt et al. (2021) excluded people with severe dementia, those with insufficient cognitive ability to perceive the virtual natural environment and to answer questions about their experience but did not undertake a cognitive test with the study participants prior to the intervention (confirmed by email contact with primary author). Webber et al. (2021) required participants to be able to give written consent and with no physical or cognitive impairments. They did not complete cognitive testing prior to the intervention but noted in their description that four of the seven participants showed signs of cognitive impairment.[22] Fiocco et al. (2021) eligibility criteria excluded people who could not provide informed consent. They determined people's eligibility to provide informed

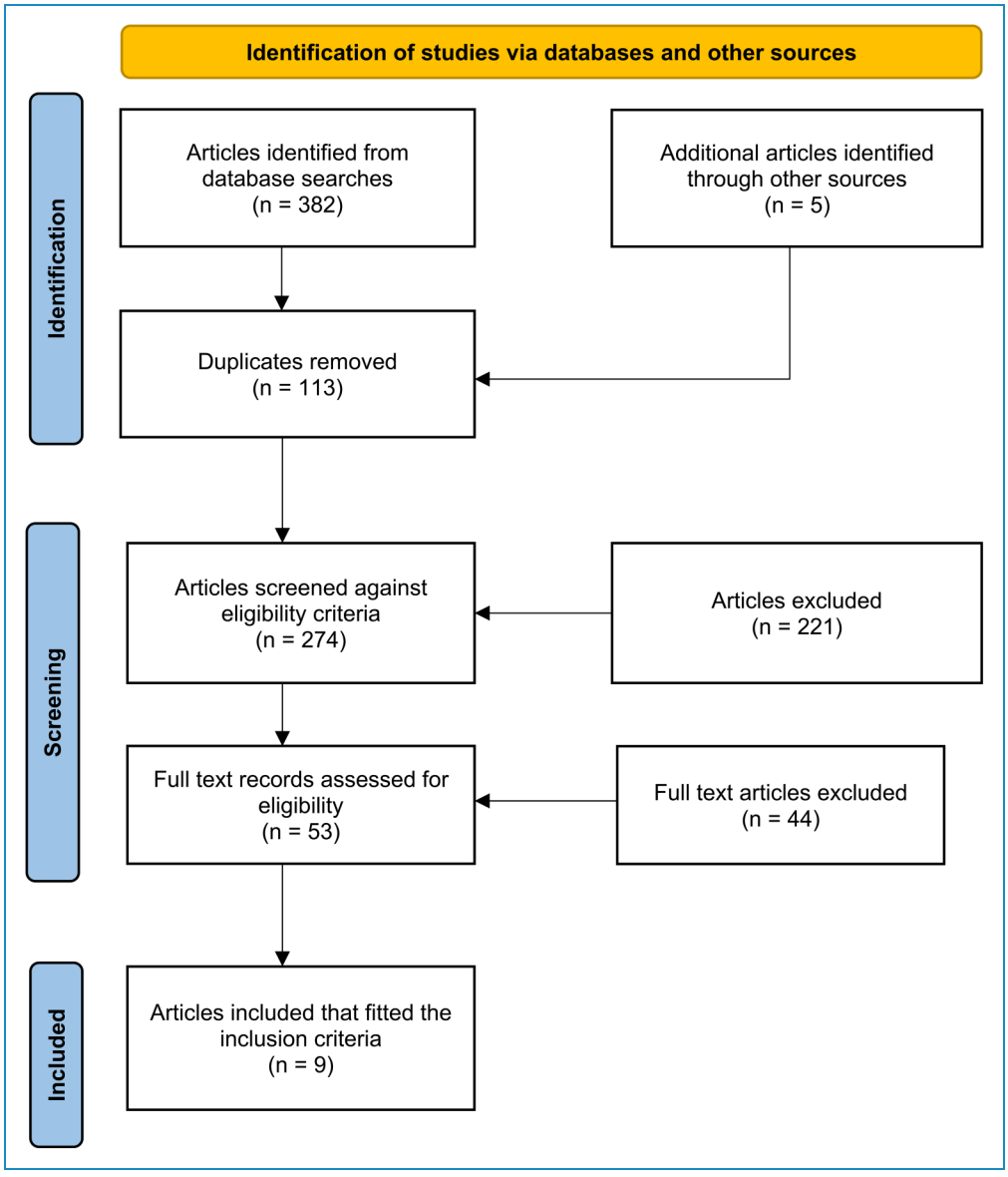

Figure 1. Flow of articles through the search process.

consent through the completion of a Mini-Mental State Exam (MMSE), with a score of >24 required (mean 27.75 (±1.7)).[46] One study did not state the presence of eligibility criteria.[40] The remaining eligibility criteria are listed in Supplemental Table S1.

Interventions

A variety of HMD VR systems were utilised across the nine studies: Oculus-Go VR headset ($n = 4$)[22,25,43,48] were the most popular, followed by the HTC VIVE HMD ($n = 2$),[47,48] Oculus Rift ($n = 1$),[24] Oculus Quest all-in-one headset ($n = 1$),[40] Samsung Odyssey HMD ($n = 1$),[48] Samsung Gear VR headset ($n = 1$)[46] and an unidentified brand of HMD and joystick.[26] Lundstedt et al. (2021) described three different types of HMD, the Oculus Go, the Samsung Odyssey and the HTC VIVE HMD.[48] The reason for using three different types of HMD was to pair the headset with specific audiovisual content.

Non-interactive content included 360° videos ($n = 3$),[40,46,48] YouTube 360° videos ($n = 2$)[25,43] and Google Earth ($n = 1$),[24] Google Maps Street View and Wander VR ($n = 1$)[23] and or developed content ($n = 2$).[25,26,43] Five studies utilised interactive VR software programs. One study utilised First Contact, Ocean Rift, Quill, Toybox and Power Solitaire.[24] Two studies created horticultural content,[26,47] one used different software available for VR,[24] and the other study utilised software such as the Blu and VR island.[48] Experiences including travel and tourism ($n = 5$),[22,24,25,43,46] reminiscence ($n = 3$),[22,24,46] horticulture ($n = 2$),[26,47] games ($n = 4$)[24] and

Table 1. Characteristics of included studies.

Author, year, country	Aim	Study design	Intervention	Participants	Benefits/enablers	Side effects/barriers	Quality appraisal
Baker et al., (2020), Australia.	To identify benefits/challenges of VR and to gather residents' views on potential uses of VR.	Qualitative multi-method design Data collection pre/post session individual interviews to assess experience and attitudes. Observation, video, and audio recording during VR sessions.	Oculus Rift. 2 tracking sensors, 2 hand controllers. Software – First Contact, Google Earth VR (all). Ocean Rift, Quill, Toybox, Power Solitaire (some). 'Intensive' 2- week evaluation. Up to four 1-hour individual sessions per resident. Virtual environments and interactive games.	1 RAC. 5 residents aged 74–88 (F = 2, M = 3) completed the intervention. 1 withdrawal. Purposeful sampling. Residents were nominated by RAC staff as being capable to participate. Five staff, no prior VR use ($n = 5$).	Immersive = engrossing. Tailored = engaging. Selecting experience = sense of agency. Potential for social interaction within and beyond RAC. Journey to former street of residence = mixed emotions.	1 of 5 reported feeling sick in the stomach and sad at making mistakes. Staff fear – bruising, abrasion from impact with wheelchair armrests. Researchers' fear – wheelchair tipping in reaching for virtual objects. Hand controllers added complexity.	Qualitative study *****
Chaze et al., (2022), Canada *Note:* This article reports the same intervention as Hayden et al., (2022).	To describe VR's potential in developing recreational programs to support well-being.	Mixed-methods pilot implementation project. Data Collection -PAINAD, Interact Short tool. Staff observation of residents' attention, focus, interaction, and emotions. Post-session resident interviews re. Pain (RAC staff). Staff interviews (research team). Research team completed a technological implementation observation guide pre & post.	Oculus-Go VR headset. Phase 1: 10 immersive video-clips were developed. Phase 2: Trial of VR video clips in community. Phase 3: 4 RAC, Staff – 60 minutes training session. Residents – 102 sessions by 32 residents in. 1–6 sessions of 8–10 minutes each over 2 weeks implemented by staff either formally within the recreation calendar or ad hoc. 10 unique VR video experiences of being in, standing and/or moving along an iconic Canadian location. VR content included music and narration to orientate user and invite engagement. Study was intended to permit residents' experiences to be simultaneously cast onto staff tablet, but RAC WiFi restrictions prevented this. 1 RAC supplemented pilot videos with YouTube 360 videos.	Phase 1 (6 months) – focus group to inform VR content development: 5 RAC; purposeful sample of 38 residents, 18 staff (recreation team). Phase 2 (4 months) – feedback on content created: 3 non-RAC residents with dementia. Phase 3 (5 months) –VR intervention: 4 RAC, 26 staff. 32 residents (F = 15, M = 17) aged 50–100. Mean age 77. 14 without self-self-reported cognitive impairment. Residents were selected via purposive sampling with advice from staff on who might benefit. There was overlap between participants of phase 1 and 3 groups. Total 102 VR experiences. 26 of 32 residents had multiple experiences. Average 4.9 sessions.	7 of 7 participants with daily pain, reported no pain during VR experience. Of 102 VR viewing experiences, participants were relaxed ($n = 67$), enjoying themselves ($n = 67$), happy ($n = 71$) and interacting with others ($n = 88$). Positive verbal responses ($n = 84$). Attentive ($n = 79$). VR changed the experience of people with persistent daily pain with 12 of the 13 participants experiencing no pain during the VR. 25 of the 102 residents self-initiated movement all of the time during the experience and 28 residents some of the time. Social interaction observed in 88 of 102 residents.	PAINAD data: laboured breathing ($n = 5$), noisy/laboured breathing ($n = 1$), occasional moans or groans ($n = 4$), sad or frightened facial expressions ($n = 3$), tense ($n = 8$) or rigid body language ($n = 1$). One resident was restless and did not complete the experience.	Mixed Methods Study Qualitative*** Quantitative**** Mixed methods** Overall score**
Hayden et al., (2022), Canada. Note: This article reports the same intervention as Chaze et al., (2022).	To examine the implementation of authors' HDM VR system in long-term care homes through the lens of RE-AIM. To make recommendations for improving VR implementation in RAC.	Mixed methods pilot study. Phase 1: online staff survey (8 of 18) and focus groups with staff and residents ($n = 39$). Development of VR experiences. Phase 2: Views of older people with dementia attending a community day program. Trial of 3 prototype experiences. Phase 3: PAINAD; Interact Short for observations of resident reactions; RE-AIM evaluation framework for residents' reactions; questionnaire on residents' perceptions.	Oculus Go VR headset. Phase 3. RAC pilot sites.1 site pilot test of VR manual due to COVID outbreak. 4 RAC sites, Residents ($n = 32$), Staff ($n = 26$), two-week pilot of VR programs with HMD.	Phase 1 (1–6 months): focus group to inform VR content development: 5 RAC (with one site being excluded due to COVID outbreak). 39 residents (purposeful sample); 18 staff (recreation team), only 8 completed the onboarding survey. Phase 2: Adult day centre for people with dementia. 3 clients. Phase 3: 4 RAC, 32 residents, aged 50–100 years of age), 16 staff.	Phase 3 results: VR incorporated into recreation programs increased reach. Content – some liked relaxing experiences others invigorating. Pain – scores low but varied. Would residents repeat VR experience? Yes 72.7% ($n = 16$) Maybe 18.2% ($n = 4$) No 9.1% ($n = 2$).	Requested headset be removed ($n = 2$); couldn't see anything. ($n = 2$); content scary ($n = 3$); content boring ($n = 1$). Staff said headset and content inappropriate for people living with dementia or cognitive impairment.	Mixed Methods Study Qualitative *** Quantitative **** Mixed Methods **** Overall Score ***

(continued)

Table 1. Continued.

Author, year, country	Aim	Study design	Intervention	Participants	Benefits/enablers	Side effects/barriers	Quality appraisal
Fiocco et al., (2021), Canada.	To examine the effects of VR tourism on psychosocial well-being. To examine the immediate and long-term benefits associated with VR tourism.	Mixed methods study. MMSE conducted prior to consenting. Pre/post psychosocial assessment. OPQOL-35 questionnaire, Social Engagement Scale, Geriatric Depression Scale, Visual Analogue Scale (unhappy/happy, bored/ engaged, anxious/ relaxed), and modified. Simulator Sickness Questionnaire. Qualitative - semi structured one-on-one interviews post VR experience.	Samsung Gear VR headset, with Samsung Galaxy Note 7 mobile phones and Sony headphones. 3 × 6–10-minute sessions per week for 6 weeks. 18 by 360-degree videos of travel destinations and activities plus the International Space Station. Sessions facilitated by researchers.	25 residents from 6 RACs. Exclusions - migraines and motion sickness. 18 residents completed program (F = 7, M = 11). Mean age 83.6. Withdrawals: HDM ($n = 1$) disappointed with content ($n = 1$) medical reasons ($n = 5$).	Decreased fatigue. Significant decrease anxiety. Significant increase in QoL. Increased social engagement. Long-term benefits unclear. Happiness and anticipation reported. Distraction from pain ($n = 1$).	Sadness at inability to travel. ($n = 2$) Minimal cybersickness. HDM was uncomfortable for residents' wearing glasses.	Mixed Methods Study Qualitative ***** Quantitative ***** Mixed Methods ***** Overall Score *****
Gruber et al., (2022), Germany.	To analyse the effect of 360° videos of different categories on the state of mind and if it lingers. To evaluate the usability for RAC staff and the experience of residents including that of varying video content and durations.	A randomised control multicentre pilot study. Health data including mobility, medication, motion sickness. State of mind, attitude to technology and VR experience. Interviews of RAC staff about usability.	Oculus Quest all-in-one headset. 10× 360° videos of varying lengths. Videos randomly assigned. No interactive component. Pilot conducted over 2 days with VR between second and third assessment interviews for the test group. facilitated by trained RAC staff. 360-degree videos of varying but unreported duration. Content: nature, city, animals, people, relaxation, action, and training. 1 VR experience each.	3 RACs - 2 had used previously used HMD. 2 groups test and control participants allocated by block randomisation. Test group- usual routine plus VR; control usual routine. Test group: 8 (7 without dementia), F = Mean age 85.25. Control group: 9 (6 without dementia.), f = 59 Mean age 83.44.	No statistical difference in happiness found but authors claim a 'tendency for a positive effect' and attributed it to VR. 'Happiness' effect was higher amongst women. Residents preferred content with people, animals, and action. Staff reported technology easy to use.	No discomfort from HMD or motion sickness symptoms reported. Residents in wheelchairs showed lower 'happiness' effect.	Quantitative randomised Control trial *
Huang et al., (2021), Taiwan. Note: This article reports the same intervention as Lin et al., (2020) with a different population.	To evaluate the acceptance of 3D- VR programs. To explore factors influencing acceptance (presence, involvement, interactivity) and ongoing use.	Cross-sectional explanatory study. 6-month data collection. Resident interviews based on a questionnaire developed by the research team. Structural equation modelling tested 10 hypotheses of causal relationships between program acceptance, presence, involvement, and interaction.	HMD and joysticks. Brand not specified. Animated experience. Avatars guided VR activities. Effort to achieve realism via visual and auditory environment, and action/ movement options. 9-week program of VR horticultural therapy. Undertaken with staff presence/ supervision. Virtual and actual rewards granted for achievement.	2 RACs. 91 residents consented. 71 completed the program. Average age 79.10 (SD 7.67). Inclusion criteria - able to use joystick, no 3D VR experience and without visual or hearing impairment, mental disorder, or dementia. 78.02% completed 9-week trial ($n = 71$, F = 23, M = 48). This exceeded required PLS-SEM sample size ($n = 65$).	Residents found activities 'plausible and interesting'. Statistically significant evidence that higher interactivity and immersion increased engagement and use and in turn lead to increased 'intention of continuous usage'.	No 'significant' cybersickness. Staff assistance and supervision required. VR experience complements, rather than replaces benefits of time spent in natural environment.	Quality appraisal Non-randomised quantitative *****
Lin et al., (2020), Taiwan. Note: This article trialled the same intervention as Huang et al.,	To explore the effects of a combination of 3D virtual reality and horticultural therapy on institutionalised older adults' physical and mental health.	Quasi-experimental case-control study. Chinese Health Questionnaire (CHQ-12) used to evaluate participants' health. Outcome measures: Chinese Health Scale,	HTC VIVE 3D VR 9-week intervention. 18 one-hour sessions with: pre/post-assessments and 2 months follow-up. Sessions facilitated by horticultural therapists, students,	118 residents aged over 65 from 2 RAC consented. Test group ($n = 59$); control group ($n = 59$). 106 completed the program. Dropout ($n = 12$) from control group for health reasons. Data recorded	Experimental group experienced significant improvements in health, meaning in life, perceived mattering, loneliness, and depression. Participants reported looking forward to	None reported.	Quantitative randomised controlled trial **

(continued)

Table 1. Continued.

Author, year, country	Aim	Study design	Intervention	Participants	Benefits/enablers	Side effects/barriers	Quality appraisal
(2021) with a different population.		and Geriatric Depression Scale (Chinese). Purpose in Life survey, General mattering Scale, UCLA Loneliness Scale were translated from English to Chinese with content validity (>0.8).	medical and RAC staff. VR 5–10 mines and combined with hands-on horticulture therapy. Control group received no horticultural therapy – real or virtual.	from test group ($n=59$, F = 11, M = 48) mean age 77.41 and control group ($n=47$, F = 22, M = 25), mean age 78.43. Differing gender proportion in analysis.	sessions for companionship, interaction, and to create products.		
Lundstedt et al., (2021), Sweden.	To understand how residents and staff use and experience different virtual natural environments to aid future design.	Observational qualitative study. Both groups participated in 2 'coffee sessions' of approx. 1 hour duration during which a resident spent 5–20 minutes undertaking 2 of the 3 VR options in ascending order of immersion and interactivity. Data collected involved the use of interviews and observations.	3 types of HMD paired with hand controllers and specific content: 1. 360° blue space videos with Oculus Go HMD. 2. the Blu – interactive under water environments with Samsung Odyssey HMD. 3. VR Island – an interactive explorable island designed by the authors with HTC Vive HMD and large screen TV. Collision detection was activated, and tracking controller attached to wheelchairs for Group B.	9 residents from 1 RAC self-selected from a pool developed with staff advice on abilities and health status. Split into 2 groups tested 3 weeks apart with modifications to VR Island gleaned from experience of Group A applied to Group B's experience. No testing of resident participants prior for Cognitive impairment. 7 of 9 participating residents attended both 'coffee sessions' (F = 4, M = 3). Aged 67 to 91. Median 88.	360° blue space videos on Oculus Go were most comfortable/flexible. The Blu experience prompted biggest and most positive reaction (joy, fascination).	Residents not overwhelmed/fatigued. Intensity of the Blu and VR Island experiences discomforting for some residents. Took residents longer than anticipated to get used to VR. Inability of facilitator to see resident's experience on Oculus Go was an impediment. VR Island and HTC Vive headset negative feedback: HDM heavy/ painful; hand controller difficult; steering in swivel chair was challenging and impossible for residents in wheelchairs; facilitator blocking signal disrupted experience. In Oculus Go HMD staff were required to remove the headset to adjust the graphical user interface.	Qualitative *****
Webber et al., 2020, Australia.	To examine the role virtual 'visits' might play in place-based reminiscence. To explore benefits/risks of virtual visits using digital mapping applications with either, tablet computers or HMD VR.	Qualitative comparison study. Residents: observation, questionnaires, and structured interviews. Family members: structured interviews. 2 individual reminiscence sessions of approx. 45 minutes each, facilitated/ guided by a researcher.	Tablet computer (iPad) and VR headset (Oculus Go VR) with digital mapping applications: Google Maps Street View on iPad and Wander VR on HMD VR. Oculus Go streaming capability was used through a smartphone, to enable researchers to see what the participant saw in the HMD. Each participant nominated up to 3 places of personal significance to visit.	2 RACs ($n=1$ and $n=6$). Purposive sampling by RAC staff. Residents ($n=7$, F = 4, M = 3) and their family members ($n=4$, F = 3, M = 1). Researchers assessed some residents ($n=4$) to have signs of cognitive impairment.	Technology: no noticeably different outcomes or preference. iPad better enabled facilitation and shared experience. Content: greater engagement with 'visits' to sites of community activity. Families hoped for an enriching experience and increased social interaction i.e., new family information, new topics of conversation.	Some were frustrated at being limited to Google Maps' 'street view'. HMD images 'blurry' ($n=1$). iPad buttons too small ($n=1$). Researchers found monitoring HMD experience via smartphone impractical and disruptive.	Qualitative Comparison Study Qualitative *****

active exploration ($n = 3$),[23,40,46] education ($n = 3$),[23,40,45] adventure ($n = 2$)[40,48] and relaxation activities ($n = 1$).[40] Two studies examined the same intervention[25,43] and examined one population's response to virtual experiences exploring iconic locations in Canada,[25,43] which may have been familiar to the participants. Two studies researched different populations' reactions to virtual horticulture[26,47] with one study following the virtual experience with actual hands-on therapy.[47] The data extracted is summarised in Table 1.

The VR intervention session time varied between studies. The number of VR sessions ranged from 1[40] to 18 conducted over 9 weeks.[47] Sessions lasted between 5 minutes[47,48] and 60 minutes.[24] Sessions were held on site at the RAC home in all studies. Only one study[46] specifically stated that the study was conducted in a quiet room at the aged care home, in a group and with participants seated. The study by Baker et al. (2020) stated that a storeroom was utilised, and all participants were in wheelchairs, but did not state how the sessions were conducted individually or in groups. However, photos within the article suggest that the VR sessions were conducted 1:1.[24] Analysis of the methods and results of the remaining articles suggest that group VR sessions were also used by three studies.[22,47,48] In four studies, these details are not stated.[25,26,40,43]

Two studies reported on the same intervention[25,43] and examined one population's responses to virtual experiences of exploring iconic locations in Canada.[26,47] Five articles reported one or more residents did not complete the intervention.[22,24,43,46,48] Reasons were detailed in only one article and were related to medical issues ($n = 5$), HMD discomfort ($n = 1$) and 'boring' content ($n = 1$).[43]

Quality appraisal

The results of the quality appraisal using the MMAT are available in Table 1. Five of the studies[22,24,26,46,48] received a score of five, four of the papers were identified with a score of four or below, with one paper with a score of one. Scores of four or below were due to the studies not meeting either the quantitative, qualitative or mixed methods criteria of the MMAT.[55] The article by Gruber et al. (2022) received the lowest score of one (20%) using the quantitative randomised control trial criteria available on the MMAT tool. It was unable to be determined if collected data addressed the research question if groups were comparable at baseline, the completeness of outcome data, as tables were reported in German and results presented as text. In addition, it was unclear if participants adhered to the assigned intervention or if the outcome assessors were blinded to the intervention.[40]

Narrative synthesis

Seven factors emerged as influential in promoting the health and well-being of older people utilising immersive VR: (a) the residents' sense of agency (sense of control or faith in ability to handle the task and its consequences); (b) the nature of the VR experience; c) the content; (d) ease of use; (e) comfort of the technology; (f) the role of RAC staff; and (g) the role of residents' family members.

Agency

VR experiences offer opportunities for a measure of control and independence (agency).[24,46] The VR programs studied offered residents three levels of agency, including input into the design of VR experiences[25,43] in choosing the content of the VR experience[22,24,46] such as the interactive ability to change the view, to move about and/or to manipulate objects with the use of a hand controller.[24,26,47,48]

Experience

VR experiences evoked varying emotional responses joy,[48] pleasure,[48] fascination,[48] happiness,[24,40] anticipation and enjoyment[46] and reminiscence.[23] Reminiscence experiences, for example, were polarising: some residents enjoyed or were excited to virtually revisit significant places;[25] others were saddened by remembering past visits,[22] or by being reminded of their inability to revisit these locations[46] or because they made mistakes whilst using the VR system.[24] Similarly, the content some residents found 'thrilling' was considered 'scary' by others.[43]

Interactivity was found to enable continued utility. Huang et al. (2021) found evidence that higher interactivity and immersion promoted engagement, use and likelihood of ongoing use. Residents 'looked forward to' VR programs in which they created something to show others,[47] learned or experienced something new they could relay to friends and family,[24] or could play games in real-time with other people.[24,25]

Content

Whilst some articles recommended developing individually tailored content,[22,23] or content designed purposively for people living in RAC,[47] many different content categories were well accepted by residents, and positively affected well-being, which was only measured by one study.[40] Nevertheless, the articles identified common characteristics that enhanced the utility of the VR content. These included appropriate background music and guiding narration.[25,43,46] The study by Huang et al. (2021) also found that virtual and real 'rewards' for completing activities supported ongoing participation and engagement.

Usability

Four articles reported on the resident's usability of the hardware (HMD and hand controllers) associated with the immersive VR systems, reporting the HMD and hand controllers were well received.[22,23,43,48] The comfort of the HMD

depended on the brand of VR system[48] and the length of the VR session.[24] Problems associated with the usability of the HMD included blurry visual display,[22,40,48] some residents finding the HMD to be uncomfortable or painful,[43,48] particularly if the resident also wore glasses,[46] and one resident complained of feeling 'closed in'.[24] Hand controllers also proved to be a problem with some residents in two studies.[22,48] Lundstedt et al. (2021) reported that in some scenarios, residents had trouble navigating through the scenario due to difficulty identifying the correct hand controller buttons. Similarly, mixed capabilities were reported amongst the residents to navigate complex scenarios using the hand controller, with one resident complaining that due to the size of their hands, they were unable to comfortably hold the controller, or another resident stating the controller felt awkward.[24]

In some instances, use of the VR equipment, posed potential risks to the participants' safety.[24] For residents in wheelchairs, the impact of their arms with wheelchair armrests posed risks of bruising or abrasion[24] and the threat of tipping whilst reaching during activity interactions with the software content.[24] Consideration was also given to the use of immersive VR and the different perspectives of people confined to bed.[40] Immersive VR caused motion or cybersickness in some residents,[24,26] and the technology's complexity was reported to make a resident sad because of his multiple mistakes.[24] Whilst a small number of residents reported these side effects, they are drawn from studies with small sample sizes and mixed populations.

Technology

Whilst VR technology enables experiences that are not 'limited by time and space',[26] there are factors that both enable and disrupt the immersive VR experience.[24] A technological adaption that proved enabling was the simultaneous 'streaming' or 'casting' of a resident's VR experience onto a screen. This enabled a facilitator to see the resident's perspective and correct malfunctions such as disrupted or blurred video.[48] Streaming also enabled a facilitator to encourage individual exploration[48] and for shared discovery as a group activity.[43] Streaming significantly enhanced VR's utility as a tool to promote social engagement[25] and address isolation.[22,24] Music that supported video content was also considered to enable enjoyment and the experience.[46] However, the experience of the resident was interrupted when staff or researchers were required to remove the HMD to make adjustments to the programming or the display or assist with navigating the content.[22,25,43] Reasons for removing the HMD included: where streaming or mirroring of VR content was not possible[40] or difficult because of technological issues (e.g. poor WiFi coverage)[25,43], and problems with the equipment, for example difficulty with using the hand controllers or the buttons on the hand controllers.[22,48]

Staffing

The articles reviewed underlined the importance of RAC staff in facilitating the use of VR programs. RAC staff were directly involved in eight of the nine articles[22,24 25,26,40,43,47,48] and their support emerged as essential to a resident's individual experience, resident safety and the sustainability of VR programs. Staff played central roles as facilitators, assistants, supervisors and promoters.[22,24–26,40,43,47,48] The study by Huang et al. (2021) concluded that residents using VR required 'continuous' assistance to ensure the success of VR. Training workshops and manuals were identified as important enablers of staff members' involvement in two studies.[25,43]

Family involvement

Two of the nine articles engaged families in the assessment of the VR technology.[22,24] Residents and family members enjoyed the efficacy of VR as an additional means of, or subject for interaction. Residents identified the opportunity for interactive gaming, and both residents and family members appreciated having new topics of conversation.[24] The articles did not assess families' capacity or interest in supporting or substituting for RAC staff as program facilitators.[22,24]

Recommendations from the studies

Recommendations made in the studies varied depending on the research focus, but studies suggested that immersive VR is a suitable activity for older people living in RAC. Additional recommendations included adjusting for people participating in immersive VR systems sitting in wheelchairs,[24] with cognitive impairment[24] or lying in bed.[40] Immersive VR can be an alternative option for residents not engaged in facility provided activities or other social activities.[23] Six articles suggest further research is required that considers expansion of VR content to include more variety such as the ability to include multiple players, games, longer videos, narration, music, more active experiences, integration of VR in regular activity programs, increased scenario variety and activities that allow immersion rather than just observation.[25,26,40,43,46,48] These modifications could promote further engagement.

In relation to the HMD, Hayden et al. (2022) recommend ensuring that HMD fit and comfort are correct, as this is critical to resident engagement, as is viewer focus. This was also the only study that made recommendations around the length of time for engagement in VR activities of 8 to 10 minutes.[43] Lundstedt et al. (2021) suggested a one button hand controller may also be of benefit and support easier use by the older person. Understanding user preferences and personal interests is considered important for choice of content.[24,48] RAC staff support during the experience was recommended by two studies[40,43] to assist with any troubleshooting, and to integrate VR programs into RAC. Webber et al. (2021) suggested

inclusion of family in the activity, may enhance the experience as they can nominate events or locations of interest.

Discussion

The included studies highlighted three main points when using immersive VR in RAC in people without cognitive impairment: (a) it is most useful when it allows for meaningful engagement and connection; (b) when the capabilities and preferences of the individual are considered; and (c) when the equipment, its function and resourcing (including internet connection) and staff skills and knowledge to facilitate, are considered. Limitations of the selected studies included the presence of selection bias, lack of cognitive assessment of participants and a lack of funding and resourcing analysis.

The results suggest immersive VR is most useful to people living in RAC homes when it provides opportunities for meaningful connection and engagement, not merely virtual escapism. For example, residents preferred immersive experiences that were active rather than passive;[43,46] encouraged reminiscence, socialisation and discussion;[24,40,47,49] and that explored natural environments no longer accessible to people living in RAC.[48] In a scoping review conducted by Restout et al. (2023) examining immersive VR using 360° video to manage well-being, they found that older people find VR to be a positive experience and nature scenes have the most positive effects on emotions.[28] Utilising personalised content, such as videos of familiar places, allowed older people the opportunity to reminisce, remember memories and improve socialisation.[28]

Careful consideration should be made before introducing immersive VR in relation to matching individual residents' preferences with the experience. In all included studies, the nature and operability of VR hardware influenced the resident's experience and along with program selection, determined its usability and the resident's engagement with the activity. What was evident is that people living in RAC are not a homogeneous group and to meet the different needs of individuals, RAC should offer programs that include person-centred experiences, a variety of content and different ways to interact with the system. This is particularly relevant in relation to the hand controller. This is supported by Finnegan and Campbell (2023), who point out that care should be taken when designing and implementing VR programs so that the equipment and the programs are appropriate for older persons to use.[56] Existing infrastructure and technology should be used, and online spaces facilitate more human–human interactive experiences like what would occur in the offline space, rather than solo experiences.[56]

The staffing and technological requirements of immersive VR should be carefully considered. Before using VR, residents should be well briefed about the technology, the requirements of using the hand controllers, and how to navigate through and select VR content. This would ensure that the experience is person-centred, enjoyable and constructive and has no ill effects on their psychological or emotional well-being.[22,24] It may also reduce the need for staff to intervene in the individual's experience to troubleshoot problems.[22] A recent scoping review by Hung et al. (2023) aligned with several of our findings. The review found that staff training, having personnel or champions as facilitators, and the organisational culture were key factors in using VR to decrease loneliness and improve social engagement in aged care settings.[50] In addition, the quality of the VR videos was found to be important in terms of how immersive the experiences are, and technology needed to be adaptable enough so that the HMD did not slip off and people with eyeglasses and hearing aids were able to use the VR comfortably.

Consideration should also be given to how sessions are to be conducted, whether the residents attend as an individual or as part of a group, the length of time of each session, and whether the content uses preexisting software or specifically designed video content. Fronemann et al. (2016) states that to improve the older person's relationship with technology and their desirability to use it, innovative ways of engaging need to be developed by including them in the co-design of VR technology (both equipment and programs), and the development of information on how to use VR to 'promote positive experiences in various contexts'.[57] The use of immersive VR requires labour-intensive and careful facilitation by RAC staff to ensure that resident safety is maintained physically and psychosocially and that they receive the full benefit of the experience. For example, adaptions are required for residents with mobility issues to address manoeuvrability challenges and safety if the older person is using a wheelchair.[22,24,48]

Limitations

Generalising the results is not possible due to the small sample sizes in the included studies, and the diverse methodologies and assessment tools used to assess the benefits to residents' health and well-being.[22,24–26,40,43,46,48,58] Most studies used a mixed population of residents with only one study undertaking a cognitive assessment prior to the intervention to clarify cognitive status.[40] These findings align with those in previous related reviews of VR and older people.[17,19,28,29]

As is common in a developing field of research involving technological change, the quality of evidence in the articles analysed in this review is of a lower methodological quality. Several biases and confounding factors are apparent. Selection bias may have occurred in articles in which RAC sites were nominated by management[48] or management-imposed limits on the trial.[24] Selection bias may have also occurred in articles where RAC staff nominated residents to participate,[22,25,43,48] and in studies where residents self-selected.[26,46,47] The sample sizes in most articles were very small; consequently, the results may not be generalisable. Further, results may have been confounded by residents responding to the novelty of a research project, rather than the VR experience itself[25,40] and by residents' relationships with RAC staff who collected qualitative data.[25,43]

A lack of reporting of participants' cognitive status in some studies impeded this review.[25,40,43] It was unclear in

the methodology and findings if there was a confirmed diagnosis of dementia, or participant selection based on cognitive abilities was the opinion of staff or family members, or self-identification. The lack of clarity complicated study selection may have introduced a selection bias.

A further limitation of this review is that none of the articles addressed resourcing issues of purchasing, maintaining, or upgrading the technology or equipment. All studies provided the technology and additional staff at no cost to the RAC homes or residents, which may have confounded conclusions relating to VR programs' viability for ongoing use. In addition, none of the articles reported interviewing staff about the viability, opportunity or cost of time spent on training, setting up or implementing immersive VR programs and troubleshooting issues with the immersive VR hardware, software or programs. This is a limitation of the articles in assessing the utility of VR in RAC, as activity programs involving staff participation ought to be considered within RAC due to the 'particularly acute' workforce challenges facing RAC.[59]

Recommendations for future research

The findings of this scoping review underline the need for further, higher-quality research to test the applicability of VR-based interventions for people without cognitive impairment in RAC settings. Further research is also needed to inform the design and implementation of immersive VR programs tailored specifically for the population. The studies in the scoping review identified a range of recommendations, including the evaluation of VR experiences that are more engaging and immersive than currently available technology and with greater optionality. The development of VR technology that is adaptable to the wide range of people living in RAC and their preferences and personalities should be prioritised. For example, people in wheelchairs, who are bed-bound, and those who wear glasses or use hearing devices, need HMD that are comfortable and easy to use. Further research is also required into financial and resource feasibility. There needs to be adequate staff employed to facilitate VR experiences, and if different VR-related interventions are used for people in RAC with and without cognitive impairment, this could require more of a time commitment from staff who may already be time-poor. As such, future research could focus on using volunteers to facilitate the long-term use of immersive VR experiences or evaluate the cost-effectiveness of a dedicated VR expert at each RAC home. To benefit all people in RAC, including those without cognitive impairment, research into VR and other technological solutions should incorporate co-design with end users and partnership with industry to maximise the health and well-being of the target population.

Conclusion

The articles examined in this review support the utility of immersive VR to promote the health and well-being of older people living in RAC whilst identifying a range of practical features to implement and impediments to remedy in the design and delivery of future interventions. The interventions reported were targeted but were not tailored for residents without cognitive impairment. The scoping review identified seven factors which impact on whether VR can promote health and well-being of people without cognitive impairment who live in RAC. These included ensuring agency in the choice of the nature and content of the VR experience; ease of use and suitability of the technology; and the role of RAC staff in facilitation. Further higher-quality research is recommended to assess the utility of immersive VR interventions tailored specifically for this minority population, which is potentially restricted or disengaged from social and therapeutic activities in RAC settings that cater to a majority with more complex needs. Future research in this specific area should include the use of cognitive testing prior to consent.

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