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# From learning to enjoyment: Virtual reality walking experiences for older adults in long-term care[☆]

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ABSTRACT

*Background and objectives:* Virtual reality (VR) technologies are increasingly being explored in long-term care (LTC) settings as tools to promote engagement and well-being among older adults, including those with cognitive impairments. However, the usability and accessibility of such technologies remain some critical concerns. This study aimed to examine how older adults in Slovenia adapted to using VR equipment for virtual walking experiences, focusing on their ability to operate the technology and their subjective evaluation of the experience.
*Method:* The study involved 31 older adults from two LTC homes in Slovenia who participated in virtual walking sessions using Google Street View, accessed through VR glasses and controlled via a joystick. Researchers observed participants' ability to use the equipment, assessed their cognitive and general health, and collected feedback on their experience via a structured questionnaire.
*Results:* Unlike prior studies that focus on VR exposure, our study quantifies learning time and links it to cognitive profiles, proposing a framework for adaptive VR interventions. The results showed that cognitive abilities significantly influenced how quickly participants could navigate the virtual environment, with those possessing higher cognitive abilities adapting more quickly. Although some participants found the navigation challenging, particularly those with dementia, this did not affect their overall enjoyment. Nearly all participants (97%) rated the experience as pleasant, and 74% expressed a desire to repeat it.
*Discussion and implications:* The study highlights the strong potential of VR to enhance residents' well-being in LTC homes. However, to ensure accessibility and maximise benefits, varying levels of support and customised technological solutions should be provided based on each resident's health status and cognitive abilities.

## 1. Introduction

Older adults, particularly those living in long-term care (LTC) homes, are the most inactive and sedentary group in society. They are also more prone to isolation and loneliness, and face greater challenges in accessing spaces for physical activity and social engagement (Zapata-Restrepo et al., 2023). Due to their reduced mobility, which sometimes results in confinement indoors and isolation, symptoms of depression, anxiety, loneliness, and apathy can appear (Appel et al., 2020). In Slovenia, the share of people older than 65 years is currently 22.5% (data from June 2026) (*Število in Sestava Prebivalstva*, n.d.). This percentage is slowly increasing; for example, in 2018, 19.6% of people were aged 65 or older (Lovrečič et al., 2020). Worldwide, people aged 80 and over are the fastest-growing age group and are projected to double by 2050 (Jiang et al., 2025). The old-age dependency ratio, as a measure of population ageing, in 13 EU member states is projected to exceed 50.0% by 2050, meaning there will be fewer than two working-age persons for each person aged 65 and over (Mihajlovi and Miladinov, 2024). In the U.S., employment of home health aides and personal care aides is projected to grow by 34% between 2019 and 2029, much faster than the average for all other occupations (Shih et al., 2022).

In LTC homes in Slovenia, some years ago, the main problem was long waiting lists due to limited capacity. Today, the situation is different: although some LTC homes have vacant places, staff shortages prevent them from admitting new residents (Horozović, 2023). Due to population ageing and increased life expectancy, we can also expect an increase in the number of people with dementia over the next 10 years (Lovrečič et al., 2020). Dementia, primarily caused by

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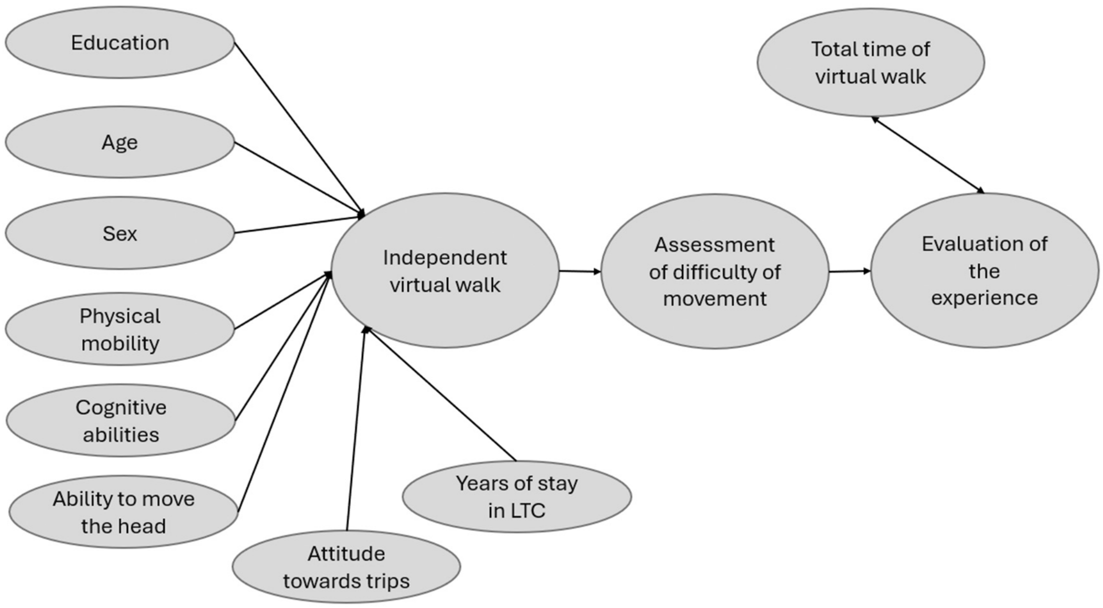


**Fig. 1.** Research proposal.

neurodegenerative diseases in older adults, significantly impacts patients, caregivers, and healthcare systems (Angioni et al., 2024) – with no known cure despite persistent efforts to find a solution (Raza et al., 2024). It is a growing public health concern with significant personal and societal impacts, particularly due to cognitive decline and impaired communication (Gerbaudo-González et al., 2024). This will increase the demand for specialised care in the coming years. So, on the one hand, we have many elderly people, many of whom will require special care, and on the other hand, a lack of people to care for them. One of the key challenges we will need to address in the future is how to prevent LTC homes from becoming mere waiting places for the end of life. It is crucial to ensure a high-quality living environment for the elderly while also attracting and retaining more people willing to work in these homes.

In this study, we explore the potential of virtual reality (VR) technology, if introduced in LTC homes, to enhance residents' quality of life by addressing key challenges such as cognitive decline and limited physical mobility. We examine whether VR can create a more dynamic and fulfilling living environment in LTC homes. By evaluating residents' responses and identifying any barriers to implementation, we aim to assess the feasibility and impact of integrating VR technology into elderly care.

### *1.1. Previous research and definition of the research problem*

The focus of society today is on maintaining older people's well-being; hence the need to develop innovative approaches to address the isolation of ageing people and tackle psychosocial factors (Restout et al., 2023). Studies have already shown that residents of LTC facilities find it exciting to explore virtual environments via VR. One study found that participants wore the VR glasses longer than anticipated and none experienced cybersickness (Mühlegger, 2018). VR also shows potential to improve physical function and balance, minimise falls among the elderly (Ren et al., 2023), and enhance the physical, emotional, cognitive, and social well-being of older adults living in LTC homes, including those with cognitive impairment (Chaze et al., 2022). Acceptance of VR games among 20 older adults living in LTC facilities was also tested, and participants perceived the technology as helpful and easy to use, with no heightened gaming-related anxiety (Hosseini, 2023). In a Canadian study, older adults experienced 3 to 20 min of 360°-video footage of nature scenes displayed on Samsung Gear VR HMD, and all participants completed the study with no negative side effects reported (such as dizziness, disorientation, interference with hearing aids) (Appel et al., 2020). However, in a study from Portugal, where people with dementia used VR headsets to view 360° videos with personal relevance, researchers also reported a few cases of minor increases in eyestrain, head fullness, anxiety, irritability, and agitation (Coelho et al., 2020). A pilot study on seven participants examined the effects of VR tourism exposure on indices of psycho-social well-being among older adults in LTC also suggests that VR tourism may be a viable program for older adults in residential care; however, VR headsets caused slight discomfort for some of the participants who wore glasses and did not decrease depression (Fiocco et al., 2021). A study of 17 participants in residential care, which tested whether VR using head-mounted displays (HMDs) could be successfully used in exposure- and distraction-based therapies, discovered that participants enjoyed the experience, but 35% (6/17) of participants experienced temporary side effects (Saredakis et al., 2020).

In their literature review, Dermody et al. (2020) conclude that interventions to improve health outcomes through VR have demonstrated potential; however, synthesising findings by primary outcome for the older adult population is not possible, and important questions remain regarding how physical frailty, functional limitations, usability of VR systems, and user acceptance influence the effectiveness of VR interventions in older adults. 2023 review of studies on VR using 360° videos to manage well-being in older adults also reports that most of the previous research was pilot studies; the material and content of VR were diversified, and the results were positive or mixed (Restout et al., 2023). Moreover, even in the case of interactive computer games, Bleakley et al. claim that although there was preliminary evidence that such games are a safe and effective exercise intervention for older adults, the dearth of high-quality evidence limits this finding (Bleakley et al., 2015). Further studies are thus required to establish more robust evidence on the efficiency of VR interventions for older adults, particularly focusing on short and long-term positive and negative outcomes and the specific characteristics of VR content that contribute to its effectiveness. Additionally, there is a need to explore the role of personalised and adaptive VR experiences tailored to individual preferences and health conditions, which could potentially enhance both well-being and therapeutic benefits. Future research should also consider larger sample sizes to improve the generalizability of findings.

Our study aims to address this research gap. Our research question is: Does the use of VR, including applications such as Google Maps and VR headsets with the controller, have the potential to enhance the daily

**Fig. 2.** Meta Quest 2 and Meta Quest 3.
Source: *Amazon.com: Meta Quest 2—Advanced All-In-One Virtual Reality Headset—128 GB*, n.d., *Meta Quest 3 512 GB VR očala*, n.d.

lives and living experiences of residents in LTC facilities? Specifically, how does the experience of a "virtual walk" (using Google Street View) impact individuals with various health conditions, such as mild dementia or mobility impairments, and what technological adaptations might be necessary to accommodate these different health conditions?

A research proposal is presented in Fig. 1. We would like to investigate how independent variables such as age, attained education, cognitive abilities, and physical mobility affect the participant's ability to initiate independent movement (i.e., without support staff) around the virtual location using the joystick. Further, we assume that the time spent on learning to move influences the participant's assessment of the difficulty of this operation (those who spend more time learning will probably argue that virtual walking is very challenging). Ultimately, this can affect how they rate the experience. We predict that those who took longer to learn will find the experience less pleasant than those who mastered the joystick immediately. By this, we want to better understand the relationship between the learning curve for using VR technology and the overall user experience among older adults. Specifically, we aim to examine whether factors such as age, education level, cognitive abilities, and physical mobility not only influence the ease with which participants learn to navigate with a controller but also shape their perceptions of the virtual experience. Our goal is to assess whether prolonged learning periods correlate with lower enjoyment and satisfaction, which could have implications for the design and implementation of VR interventions in this population. Ultimately, this research will help in tailoring VR experiences to be more accessible and enjoyable for older adults, ensuring that the technology is both user-friendly and beneficial to their well-being.

## 2. Methods

### 2.1. Pilot study

Prior to the main study, a pilot study was conducted on July 30th 2024, at the Novo mesto LTC home in Slovenia, involving six residents and some staff members. During this pilot, participants tested the Google Street View application using VR glasses. The focus was on measuring how long it took participants to independently control the controller (joystick) and initiate movement within the virtual environment. Participants were interviewed to gather feedback on their experience after the virtual walk. This pilot study provided critical insights that informed the design and refinement of the questionnaire used in the main study, ensuring it was well-suited to the target population.

### 2.2. Main study

The main study was conducted from August 6th to August 8th 2024, at two locations: the LTC home Novo mesto (DSO Novo mesto) and the Centre for the blind, visually impaired, and elderly in Škofja Loka (CSS Škofja Loka). A total of 31 elderly residents participated in the experiment. Eligibility criteria: Participants were included based on their willingness to participate. However, they were excluded if they had vision impairment severe enough to prevent them from seeing the Google Maps environment and if they were unable to provide informed consent.

The involvement of LTC home staff was essential for organising the event and providing detailed insights into the participants' health conditions, which were integral to the study.

### 2.3. Pre-intervention data collection

The data collection process began with the participants or the LTC staff responding to questions designed to gather basic demographic and health-related information. Participants were then asked to choose a location for their virtual walk, explain their reasons for selecting it, and share their previous travel experiences (e.g., whether they liked travelling and trips when they were younger).

Most variables were measured on a 5-point Likert scale.

### 2.4. During-intervention data collection

Participants were then fitted with Meta Quest 2 and Meta Quest 3 VR headsets (Fig. 2), standalone VR headsets that allow users to perceive three-dimensional environments through stereoscopic displays and head tracking. Each device includes two handheld controllers for navigation and interaction, with the Quest 3 offering improved resolution, a wider field of view, and enhanced mixed-reality capabilities compared to the Quest 2. Participants were assigned to the available devices rather than according to any demographic, cognitive, or health-related characteristics. Both headset models used the same Google Street View application, the same controller-based interaction, and the same navigation procedure. As the primary outcomes of this study focused on learning controller-based navigation, perceived navigation difficulty, and user experience rather than visual performance, the influence of the headset model on the reported results was expected to be minimal.

Detailed instructions on how to use the joystick controller were provided, and the time taken for each participant to independently use the VR headset and navigate through the Google Street View application was recorded. Any noteworthy observations, including unexpected reactions or difficulties encountered during the VR experience, were documented. Additionally, the total duration of each participant's virtual walk was recorded.

### 2.5. Post-intervention data collection

Following the virtual walk, participants were asked to evaluate their experience and share their perceptions. This feedback was crucial in assessing the usability and enjoyment of the VR experience.

### 2.6. Data analysis

All responses from participants and staff, collected before, during, and after the virtual walk, were systematically recorded in an online survey tool (1KA), ensuring a comprehensive and organised data set.

The collected data was analysed using JASP, an open-source statistical analysis software. This analysis included both descriptive and inferential statistics to identify trends, correlations, and potential causal relationships. MS Excel was used to create visual representations of the

**Table 1**
Demographics and health status of participants.

| | Age | Years of stay in LTC | Education [1-Unfinished primary school; 2-Primary school; 3-Vocational or secondary school; 4-Higher education; 5-Specialisation, master's degree, doctorate] | Body mobility [1-Fully mobile; 2-Partially mobile (can sit, arms/fingers mobile); 3-Immobile (bedridden) with mobile fingers] | Neck mobility [1-Person can turn head normally; 2-Neck range of motion is limited; 3-Neck range of motion is very weak; 4-Person cannot move head] | Cognitive abilities [From 1 - No cognitive impairment to 5 - Severe dementia] | Self-assessment of health [From 1 – Excellent to 5 – Bad] |
|---|---|---|---|---|---|---|---|
| Number of valid answers | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| Missing | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Median | 87 | 2 | 3 | 1 | 1 | 1 | 3 |
| Mean | 84.45 | 3.50 | | | | 1.87 | 3.16 |
| Std. Deviation | 10.62 | 4.17 | | | | 1.12 | 1.00 |
| Minimum | 53 | 0.00 | 1 | 1 | 1 | 1 | 1 |
| Maximum | 97 | 15.00 | 4 | 3 | 2 | 4 | 5 |

**Table 2**
Destinations of virtual walk.

| Variable: destination | | | |
|---|---|---|---|
| Level | Counts | Total | Proportion |
| Paris | 5 | 31 | 0.161 |
| Rome | 3 | 31 | 0.097 |
| Berlin | 2 | 31 | 0.065 |
| Logarska valley | 2 | 31 | 0.065 |
| München | 2 | 31 | 0.065 |
| Amsterdam | 1 | 31 | 0.032 |
| Barcelona | 1 | 31 | 0.032 |
| Brezje | 1 | 31 | 0.032 |
| Burghausen | 1 | 31 | 0.032 |
| Gornja Brezovica | 1 | 31 | 0.032 |
| Ljubljana | 1 | 31 | 0.032 |
| Melbourne | 1 | 31 | 0.032 |
| New York | 1 | 31 | 0.032 |
| Ninh Binh | 1 | 31 | 0.032 |
| Novo mesto | 1 | 31 | 0.032 |
| Novo mesto - Main square | 1 | 31 | 0.032 |
| Otočec | 1 | 31 | 0.032 |
| Srebrniče | 1 | 31 | 0.032 |
| Vinica | 1 | 31 | 0.032 |
| Windsor Canada | 1 | 31 | 0.032 |
| Škocjan | 1 | 31 | 0.032 |
| Železniki | 1 | 31 | 0.032 |

data.

### 2.7. Ethical considerations

Throughout the study, ethical considerations were given high priority. Informed consent was obtained from all participants, and efforts were made to ensure that the VR experience was accessible and comfortable for individuals with varying levels of physical and cognitive abilities. The anonymity and confidentiality of participants' data were strictly maintained throughout the research process.

## 3. Results

### 3.1. Descriptive statistics

From DSO Novo mesto, 15 participants participated, while from CSS Škofja Loka, 16. Among them, 23 were women, and only 8 were men. Such a ratio was expected and reflects population proportions since women live longer in Slovenia.

The average age of the participants in the experiment was 84.5 years, the youngest was 53, and the oldest was 97 (Table 1). On average, they have been housed in the LTC home for three and a half years. The most common level of education attained was vocational or high school. None of the participants completed a specialisation, master's degree or doctorate.

**Table 3**
Time to independent execution of movement and time of virtual walk.

| | Time to independent execution of movement with the controller [s] | Duration of virtual walk [s] |
|---|---|---|
| Valid | 31 | 31 |
| Missing | 0 | 0 |
| Mean | 191.45 | 397.58 |
| Std. Deviation | 136.45 | 116.87 |
| Minimum | 20.00 | 200.00 |
| Maximum | 600.00 | 664.00 |

Most of the participants did not have any serious mobility problems (16), 13 of them are only partially mobile, which means they cannot walk, but they can sit and move their hands and fingers, and completely immobile, so they are tied to a bed or a wheelchair, there were only two. The vast majority of participants had no problems turning their heads (27), only four could turn their heads to a limited extent. But no one had a serious limitation, or even a complete inability, to turn the head.

Regarding cognitive abilities, the LTC staff evaluated them using the following scale: 1 - No cognitive impairment, 2 - Mild cognitive impairment, 3 - Incipient dementia, 4 - Moderate dementia, 5 - Severe dementia. About half of the participants (16) had no cognitive impairment. As expected, there was no one with severe dementia, as they probably would not have been able to participate.

We also asked the participants to self-assess their health on a scale: 1 – Excellent, 2 – Very good, 3 – Good, 4 – Not so good, 5 – Bad. Most participants rated their health as good, but the average rating would still be slightly more negative, i.e., between “Good” and “Not so good”.

#### 3.1.1. Where do participants want to go on a virtual walk, and have they enjoyed travelling in the past?

As shown in Table 2 below, the participants chose very different locations, but Paris (5 participants) stands out, probably because of the Olympic Games, which took place just at the time of the experiment, followed by Rome, Berlin, Logarska valley, München, and Novo mesto.

When they were asked why they want to see this location, most participants answered that because of the memories (15), followed by the answer that they always wanted to travel there, but they never did (12), while four participants gave other reasons, namely: “my daughter is currently in this city”, “relatives live there”, “my sister lives there” and that “it is very nice there”.

When asked whether they liked to travel and go on trips in the past, 22 answered positively, and nine answered negatively.

**Fig. 3.** Older adult participant learning controller-based navigation in the virtual walking intervention with assistance from a researcher.

**Fig. 4.** Older adult participant navigating the Google Street View virtual environment using a Meta Quest VR headset and handheld controller after receiving instructions from the researcher.

*3.1.2. How quickly did the participants learn to use the controller, and how long did the VR walk take?*

On average, it took participants a little more than 3 min (192 s) to learn to operate the controller without the help of a present assistant and to move independently (Table 3). The fastest time was 20 s – this record was achieved by an 89-year-old man with a high or higher level of education, a chemist by profession, and without any movement barriers or cognitive disorders.

Four people were not able to operate the controller independently during the test. As researchers reported, the reasons were different: either they had difficulties understanding the instructions or deliberately chose not to listen.

The walk itself lasted an average of nearly 7 min (398 s); the minimum time was 3 min and 20 s, but in this case, it is recorded that the experiment was interrupted because the battery in the glasses ran out. The participant would likely still be interested in continuing. The record holder for length (11 min and 4 s) was an 81-year-old man, a miner by profession, who expressed great enthusiasm for the place he visited, including memories of the past.

In the pictures below (Figs. 3 to 6), we see some participants and researchers who assisted them in virtual walking.

*3.1.3. Descriptions of experiences*

After the virtual walk, we asked the participants to rate their experience. First, we asked them how pleasant they found it, to which they were able to answer with: 1 – Very pleasant, 2 – Pleasant, 3 – Unpleasant, 4 – Very unpleasant.

For the vast majority (21 people), the experience was very pleasant, and only one person found it unpleasant (Fig. 7). The experience was not "very unpleasant" for anyone. The person who rated the experience as unpleasant was a 90-year-old man with some mobility problems and moderate dementia. He completed the walk relatively quickly, after 5 min, but, interestingly, he also learned to move on his own extremely quickly – after only 29 s, which is one of the fastest rates. He rated moving around the location as very easy, but he would not repeat the virtual walk again – the exact reasons are unfortunately not evidenced.

When participants were asked how difficult it was to move around the location, they could answer on a scale of 1–4: 1- Very easy, 2- Fairly easy with minor problems, 3- Difficult, 4- Very difficult (Fig. 8).

Most participants found the movement easy or fairly easy (24), but seven rated it as difficult or very difficult.

Then we asked them whether they would like to repeat the virtual walk (Fig. 9).

The vast majority (23) of participants answered YES, six answered NO, and two did not know.

When asked if they saw something that made them happy or brought back good memories, the majority of participants (22) also answered YES. If we look at the specific responses that pleased the participants, we can see that they were quite diverse, although three participants were particularly excited to see the Eiffel Tower. Otherwise, they were happy to see their home, hometown or place from their childhood, to remember how they were in the mountain hut with their partner, they relived the memory of the way to their job, they saw their brother's house or simply beautiful nature, flowers, architecture, mansions and statues.

When asked whether anything disturbed, angered, or saddened the participants, we received only one answer. The participant was sad to see a car on a road otherwise closed to traffic.

Participants were also asked if they had any suggestions for improving the virtual walk. Responses from three participants were recorded: to add some more locations, to be able to walk to a particular river waterfall, and to record a person's house, which apparently could not be seen.

**Fig. 5.** Participant actively using a VR headset while researchers prepare or assist other participants.

**Fig. 6.** Overview of the experimental setup during the VR virtual walking sessions in a LTC facility.

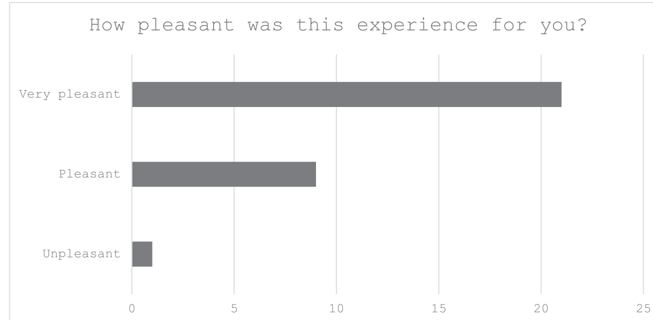


**Fig. 7.** Assessment of the experience.

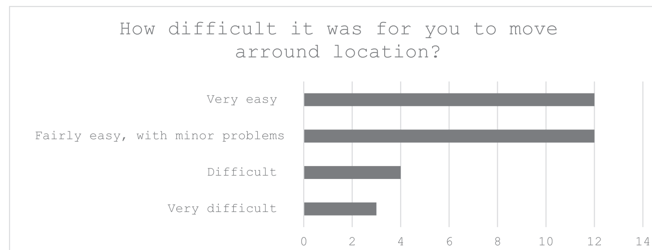


**Fig. 8.** Assessment of the difficulty of movement.

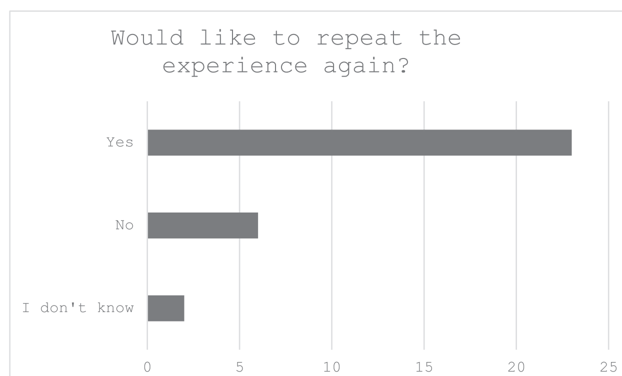


**Fig. 9.** Desire to repeat the experience.

**Table 4**
Model summary - time to independent execution of movement with the controller (learning time).

| Model | R | $R^2$ | Adjusted $R^2$ | RMSE |
|---|---|---|---|---|
| $H_0$ | 0.000 | 0.000 | 0.000 | 136.452 |
| $H_1$ | 0.789 | 0.622 | 0.460 | 100.266 |

### 3.2. Exploring variable relationships

Using a multiple linear regression analysis, we examined whether different independent variables predicted the dependent variable Time

**Table 5**
ANOVA.

| Model | | Sum of squares | df | Mean square | F | p |
|---|---|---|---|---|---|---|
| $H_1$ | Regression | 347,454.412 | 9 | 38,606.046 | 3.840 | 0.005 |
| | Residual | 211,119.266 | 21 | 10,053.298 | | |
| | Total | 558,573.677 | 30 | | | |

**Table 6**
Coefficients.

| Model | | Unstandardized | Standard error | Standardized[a] | t | p |
|---|---|---|---|---|---|---|
| $H_0$ | (Intercept) | 191.452 | 24.507 | | 7.216 | <0.001 |
| $H_1$ | (Intercept) | −244.804 | 189.515 | | −1.377 | 0.210 |
| | Education | 8.895 | 20.359 | 0.068 | 0.489 | 0.667 |
| | Body mobility | −33.191 | 36.916 | −0.152 | −0.906 | 0.379 |
| | **Cognitive abilities** | **71.347** | **19.610** | **0.584** | **3.644** | **0.002** |
| | Self-assessment of health | 37.582 | 24.491 | 0.276 | 1.493 | 0.140 |
| | Age | 1.411 | 2.191 | 0.110 | 0.654 | 0.527 |
| | Years of stay in LTC | 10.082 | 5.289 | 0.308 | 1.849 | 0.070 |
| | Sex (2) | 60.450 | 62.506 | | 0.996 | 0.344 |
| | Did you like to travel and go on trips in the past? (2) | 91.028 | 54.121 | | 1.597 | 0.107 |
| | Neck mobility (2) | −107.429 | 71.471 | | −1.458 | 0.148 |

**Note:** Bold values in the table indicate statistically significant predictors ($p < 0.05$).
[a] Standardised coefficients can only be computed for continuous predictors.

**Table 7**
Spearman's correlations.

| Variable | | Time to independent execution of movement with the controller | Duration of virtual walk | How pleasant was this experience for you? | How difficult was it to move around the location? | Cognitive abilities | Age |
|---|---|---|---|---|---|---|---|
| Time to independent execution of movement with the controller | Spearman's rho | – | | | | | |
| | p-Value | – | | | | | |
| Duration of virtual walk | Spearman's rho | 0.184 | – | | | | |
| | p-Value | 0.323 | – | | | | |
| How pleasant was this experience for you? | Spearman's rho | −0.239 | 0.016 | – | | | |
| | p-Value | 0.196 | 0.932 | – | | | |
| How difficult it was to move around the location? | Spearman's rho | **0.513** | 0.008 | −0.175 | – | | |
| | p-Value | 0.003 | 0.966 | 0.346 | – | | |
| Cognitive abilities | Spearman's rho | **0.509** | −0.224 | 0.023 | **0.478** | – | |
| | p-Value | 0.003 | 0.225 | 0.903 | 0.007 | – | |
| Age | Spearman's rho | **0.458** | −0.216 | −0.183 | **0.389** | 0.328 | – |
| | p-Value | 0.010 | 0.244 | 0.324 | 0.030 | 0.072 | – |

**Note:** Values shown in bold indicate statistically significant correlations ($p < 0.05$).

to independent execution of movement with the controller (learning time) (Tables 4 to 6).

We can conclude that our model is of sufficient quality, as the coefficient of determination is 0.622, which means that our model explains as much as 62% of the variability of the data (38% must be attributed to factors we do not know and are not included in the model - these could be, e.g. depression level, motivation, apathy, etc.).

The *p-value* is less than 0.05, indicating that our model is statistically significant (Table 5).

However, a detailed examination of the influence of individual variables shows that only Cognitive abilities have a statistically significant effect on our dependent variable ($p < 0.05$). A higher level of dementia impacts how long it will take for an individual to move around the location independently (the higher the level of dementia, the longer learning). Other factors, such as age, education, gender, years of stay in LTC, body mobility, neck mobility, self-assessment of health status, and past travel experience, do not have a statistically significant influence, indicating that we cannot claim they are not the result of chance within our sample.

The relationship between some variables and participants' opinions about the virtual walk was assessed using the Spearman correlation coefficient (since half of the variables included were measured on an ordinal scale – otherwise we would use the Pearson correlation coefficient). The correlation matrix is presented in Table 7 below.

Firstly, there is a strong positive correlation between the time to perform independent movement around the location and the assessment of how difficult it was to move. As expected, those who studied joystick control for a longer time also rated the process as more difficult.

Secondly, Spearman's correlation confirmed the findings of the regression analysis, showing a strong positive association between cognitive abilities and the time required to achieve independent movement within the virtual environment. This analysis confirms that there is also a moderately strong positive correlation between the assessment of the difficulty of movement and cognitive abilities. As dementia severity increases, the participant's assessment of the difficulty of moving around the location also increases.

Thirdly, there is also a statistically significant, moderately strong correlation between age and the time to independent movement with the controller (which was not confirmed by the regression analysis), as well as between age and assessment of the difficulty of movement. Older participants are more likely to report difficulties with moving.

Fourthly, the variable "How pleasant was this experience…" does not significantly correlate with any other variable. Therefore, the experience was pleasant for most participants, regardless of their age, cognitive abilities and difficulties they might have with learning to move virtually.

## 4. Discussion and conclusion

31 older adults living in two LTC homes in Slovenia participated in our experiment, which tested how quickly they can adapt to a virtual walk using VR glasses and a joystick and how they evaluate this experience.

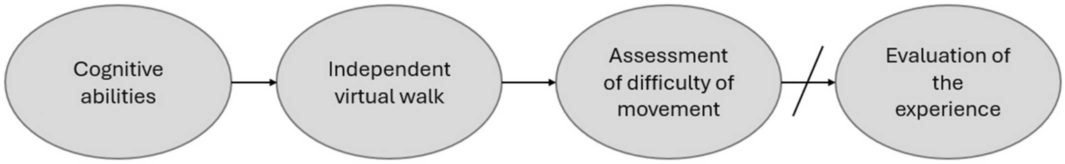


**Fig. 10.** Confirmed connections between variables.

**Table 8**
Mobility - dementia matrix.

| | No dementia | Mild cognitive impairment | Early-stage dementia | Moderate dementia | Severe dementia |
|---|---|---|---|---|---|
| Fully mobile | Independent VR exploration, virtual walks, interactive games | Same as left, but add larger text/icons, simplified menus | Guided VR walks, shorter sessions, reduce complexity | VR possible only with caregiver assistance, limited to simple, calming experiences | Independent VR not feasible; only passive sensory content (music, nature videos) |
| Partially mobile (can sit, arms/ fingers mobile) | VR with joystick/hand controllers; seated virtual walk or interactive games | Same as left, but with clearer instructions and multimodal cues (pictures + audio) | VR walks with joystick or trackball, shorter guided sessions | Caregiver-guided passive VR (e.g., virtual tours with narration) | Passive VR only (e.g., VR meditation, 360° relaxing videos), external facilitation |
| Immobile (bedridden) | VR via eye-tracking; interactive seated experiences possible | Simplified VR menus, eye-tracking navigation with larger visual cues | Guided VR (e.g., virtual walk via eye-tracking), limited autonomy | Only pre-recorded VR experiences with external assistance | Passive sensory input only: soothing VR, music, nature sounds, full facilitator support |

According to the results, the following can be established unequivocally: cognitive abilities strongly influence how quickly a person adapts to the joystick and begins walking around the virtual environment independently of external assistance. This finding is consistent with expectations, as people with better cognitive abilities are more flexible and master new technologies faster. Further, the time spent learning was positively correlated with how difficult participants perceived navigation within the virtual environment to be. According to some of our analyses, the participant's age was also associated with this. The elderly and those with a higher level of dementia would therefore need more help.

However, this does not mean that the use of VR glasses for virtual walks is not suitable for them, since the difficulty of navigating the location was not associated with their level of satisfaction with the experience (Fig. 10). According to our analyses, no significant association was found between advanced age and the degree of dementia and satisfaction with the experience and the desire to repeat it. It should be noted that all but one participant rated the experience as very pleasant or pleasant (97%), and that 23 participants (74%) would like to repeat it.

This indicates that we can answer our basic research question positively, i.e. whether VR has the potential to contribute to the well-being of residents in the LTC homes. However, we suggest different implementations as older adults are a diverse cohort, though they are often viewed as one homogenous group with the same needs (Gates and Wilson-Menzfeld, 2022). The results of our study suggest that the implementation of VR in LTC homes should be tailored not only to residents' cognitive abilities but also to their physical mobility. While preparing presentations and implementation guidelines for additional LTC facilities interested in adopting VR technology from April to August 2025, we explored different scenarios based on combinations of mobility and cognitive status (Table 8).

Individuals who are bedridden and unable to move their arms may benefit from passive VR experiences, such as guided meditation, nature videos, or other pre-recorded content. Alternatively, eye-tracking technology may enable participation in virtual walks without the need for handheld controllers. Residents who can move their arms but not their legs may use seated VR experiences with joystick- or trackball-based navigation, whereas fully mobile individuals may be able to participate in more independent and interactive VR activities.

Our findings indicate that cognitive abilities represent an even greater challenge than physical limitations. Participants with more advanced dementia required substantially more time to learn controller-based navigation and were more likely to need assistance. Therefore, in addition to mobility status (fully mobile, partially mobile, immobile), levels of cognitive impairment should also be considered when planning VR interventions. Combining these two dimensions results in 15 potential user profiles, each requiring a different degree of technological adaptation and staff support. Based on these considerations, we propose the mobility–dementia matrix presented in Table 8 as a practical framework for selecting appropriate VR interventions in LTC settings.

Younger residents and those with better cognitive abilities could use VR equipment independently, e.g. in their room without the assistance of LTC staff. In contrast, those with lower cognitive abilities would require supervised use involving staff assistance. It is also very important how instructions to move in the virtual environment are provided to them. As Sharit and Czaja explain (Sharit and Czaja, 2020), since older adults generally possess less attentional capacity, it is especially important during the early stages of instruction to emphasise material that should be the focus of attention while minimising distracting information. As we saw in our experiment, some participants did not want to listen to the instructions or did not pay sufficient attention to them. Such LTC residents will probably always need some assistance. However, there are not many of them; in our sample, only four people or 13%.

Besides the need to adapt VR experience to the LTC resident's mobility and cognitive conditions, we could also consider a technical simplification of the controller, perhaps in the form of a ball (trackball) rather than a joystick. In our case, one participant also reported difficulties with low-vision glasses that did not fit completely with the VR glasses due to their size. Such discomfort was also reported in the study of Fiocco et al. (2021). Producers of VR glasses should therefore consider more adaptable designs that could better fit people with low vision.

In the future, new research should expand the sample and examine whether adjustment problems, despite the limited cognitive abilities of some LTC residents, improve over time and with repeated use of VR applications and equipment. Moreover, interdisciplinary approaches that combine insights from gerontology, psychology, and technology development could offer more comprehensive solutions for integrating VR into older adults' care routines.

Finally, it should be noted that, despite their limitations, our research results provide some valuable insight into the potential benefits of VR technology for older people, especially those who struggle with cognitive challenges. Thus, VR applications and equipment appear to be a promising technology for improving quality of life and may offer new forms of therapy and recreation in the future. With this, our study contributes to other studies which also confirm the beneficial effects of

VR technology on older adults (Appel et al., 2020; Chaze et al., 2022; Hosseini et al., 2023; Ren et al., 2023). Our findings complement the review by Anton et al. (2020), which highlights the benefits of behavioural interventions incorporating complex walking tasks for improving mobility. Specifically, our results demonstrate that VR-based interventions can be adapted to individual cognitive and functional profiles, thereby enhancing accessibility, engagement, and potentially both mobility and overall well-being. Our research provides empirical evidence that VR-based virtual walking can serve as a scalable, adaptive, and enjoyable intervention to support mobility, cognitive engagement, and well-being in older adults.

However, although our and the past studies clearly demonstrated the various benefits that VR might offer to older adults, including physical and cognitive therapies, diagnostic tools and opportunities for social connection and interaction, there is little evidence that this success has translated into the widespread uptake of VR as a beneficial tool or activity for older adults (Wilding et al., 2024). We hope that this will change in the near future.

## CRediT authorship contribution statement

**Ana Hafner:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Krištof Debeljak:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Investigation, Conceptualization. **Nika Brili:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Funding acquisition, Conceptualization.

## Declaration of competing interest

The authors report there are no competing interests to declare.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.exger.2026.113237.

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