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Age does not limit virtual reality acceptance in subacute stroke rehabilitation – a secondary analysis

Věk nezabraňuje přijetí virtuální reality v rehabilitaci po subakutní cévní mozkové příhodě – sekundární analýza

Dear Editor,

The intersection of aging demographics and technological innovation in healthcare presents important challenges for rehabilitation medicine. As stroke incidence increases with age and virtual reality (VR) becomes a promising neurorehabilitation tool, concerns about digital literacy in seniors have raised doubts about its broader applicability [1]. To clarify this issue, we performed a secondary analysis examining whether age influences acceptance, satisfaction, and tolerance of VR rehabilitation among subacute ischemic stroke patients.

Our prospective pilot study (January–December 2024) evaluated 19 patients (mean age 67.7 ± 11.2 years, range 46–86 years) who completed VR rehabilitation using the MDR-certified VR Vitalis® Pro system (Ostrava, Czech Republic) at the University Hospital Ostrava [2]. Patient satisfaction was measured using the validated 30-point User Satisfaction Evaluation Questionnaire (USEQ), where higher scores indicate greater satisfaction. We performed a post-hoc analysis stratifying patients by age: < 70 years (N = 10, mean age 59.1 years) vs. ≥ 70 years (N = 9, mean age 77.3 years).

Patient selection followed a consecutive sampling approach. Out of 30 eligible patients screened, 11 were excluded: 6 due to cognitive impairment (Montreal Cognitive Assessment < 20), 2 due to visual impairment, 1 due to unstable cardiovascular status, and 2 declined participation. All patients meeting inclusion criteria were asked to participate, with no randomization of VR exposure.

The VR rehabilitation program included bilateral upper limb coordination tasks ("Hanging laundry"), reach-and-grasp activities ("Carrying mugs to shelves"), balance exercises, and cognitive-motor dual tasks. Sessions lasted 10–20 min with frequency individualized based on patient tolerance. All participants received concurrent conventional rehabilitation (mean 60 min per session).

Physiotherapist assessments utilized a structured 5-point Likert scale comparing VR outcomes to expected conventional therapy results (1 = significantly worse; 2 = slightly worse; 3 = similar; 4 = slightly better; 5 = significantly better). While not formally validated, similar comparative scales have been employed in VR rehabilitation studies. Physiotherapists were blinded to patient satisfaction scores during assessments.

Statistical analysis used the Shapiro-Wilk test to verify non-normal data distribution. The Mann-Whitney U test compared USEQ scores between age groups, and Fisher's exact test was applied for categorical variables. Statistical significance was set at $P < 0.05$.

Patient satisfaction assessed by USEQ showed a mean score of 25.0 ± 6.8 points (median: 27; IQR: 22–30; range: 7–30). Distribution: high satisfaction (≥ 25 points) in 13 patients (68.4%); medium satisfaction (15–24 points) in 5 patients (26.3%); and low satisfaction (< 15 points) in 1 patient (5.3%) (Tab. 1). Contrary to widespread assumptions about technology acceptance in older adults, patients aged ≥ 70 years demonstrated remarkably similar satisfaction scores to their younger counterparts (25.4 vs. 24.6 USEQ points, respectively; $P = 0.756$). This finding becomes even more compelling when examining individual cases: our oldest participant (86 years) achieved maximum USEQ satisfaction (30 points), while the lowest satisfaction score (7 points) occurred in a 68-year-old patient. This paradoxical finding directly challenges age-based assumptions about VR rehabilitation candidacy.

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Tab. 1. Individual USEQ question analysis.

Question	Mean ± SD	Median (IQR)	Range	Score 5 N (%)
Q1 (Enjoyment)	4.21 ± 1.40	5 (3–5)	1–5	13 (68.4%)
Q2 (Success)	3.84 ± 1.30	4 (3–5)	1–5	8 (42.1%)
Q3 (Control)	4.00 ± 1.49	5 (3–5)	1–5	11 (57.9%)
Q4 (Clarity)	4.63 ± 0.96	5 (5–5)	1–5	15 (78.9%)
Q5 (Discomfort)*	1.79 ± 1.27	1 (1–2)	1–5	–
Q6 (Benefit)	4.37 ± 1.12	5 (4–5)	1–5	13 (68.4%)

*lower scores indicate less discomfort; reverse-scored for total USEQ calculation
IQR – interquartile range; N – number; SD – standard deviation; USEQ – User Satisfaction Evaluation Questionnaire

Tab. 2. Summary of primary and secondary outcomes.

Outcome	Value	Statistical details
Age groups comparison		
< 70 years USEQ (N = 10)	24.6 ± 7.2	mean age: 59.1 years
≥ 70 years USEQ (N = 9)	25.4 ± 6.1	mean age: 77.3 years
between-group difference	P = 0.756	Mann-Whitney U test
Physiotherapist assessment		
better outcomes (scores 4–5)	31.6% (6/19)	95% CI: 12.6–56.6%
similar outcomes (score 3)	52.6% (10/19)	95% CI: 28.9–75.6%
worse outcomes (scores 1–2)	15.8% (3/19)	95% CI: 3.4–39.6%
Safety		
VR sessions per patient	4.2 ± 4.1	range: 1–13
serious adverse events	0/19 (0%)	–
treatment completion rate	19/19 (100%)	–

CI – confidence interval; N – number; USEQ – User Satisfaction Evaluation Questionnaire; VR – virtual reality

Clinical outcomes mirrored satisfaction patterns. Physiotherapist assessments using a 5-point scale compared VR outcomes to the expected conventional therapy results. Among older patients, 77.8% achieved similar or better outcomes than expected with conventional therapy alone, compared to 90% in the younger group – a clinically insignificant difference. Both groups demonstrated excellent VR session tolerance, with no age-related discontinuations, adverse events, or safety concerns reported across 80 total VR sessions (Tab. 2).

Sex distribution was balanced in both age groups (older: 44% female; younger: 60% female), eliminating sex as a confounding variable. VR session intensity (mean 4.2 ± 4.1 sessions per patient) showed no significant age-related differences, suggesting comparable treatment adherence across age groups.

These results correspond with the Technology Acceptance Model, which emphasizes perceived usefulness and ease of use over demographic factors [3]. VR rehabilitation tasks are structured, intuitive, and reinforced with clear visual feedback, which may help older adults engage effectively even if they have limited prior experience with digital devices. By focusing attention on meaningful therapeutic goals rather than technical complexity, VR may naturally support acceptance across all ages.

Clinically, our findings argue against age-based exclusion from VR rehabilitation. Relying on chronological age as a barrier could prevent older patients from accessing motivating, engaging, and potentially beneficial therapeutic options. Instead, clinicians should prioritize cognitive status, visual capacity, and motivation when selecting VR candidates. Given that adults aged ≥ 65 years represent the fastest growing stroke population, equitable access to digital rehabilitation technologies is increasingly important [4].

Our findings align well with international evidence. Roussou et al. demonstrated high VR acceptance in stroke patients using the Suitability Evaluation Questionnaire (median 61/65 points) [5], while Khan and colleagues have shown that VR yields outcomes comparable to conventional therapy [4]. Maier et al. further reported that specific VR interventions outperformed non-specific approaches (d = 0.45; 95% confidence interval [CI]: 0.17–0.73) [6]. In our cohort, 84.2% of patients achieved physiotherapist-rated outcomes similar or superior to expected results from conventional therapy, reinforcing the broader consensus that VR represents a valuable adjunct to rehabilitation.

However, limitations must be acknowledged. The sample size was small, reducing the ability to detect subtle differences. Being a single-center study, our findings may not generalize to different patient groups or healthcare systems. Volunteer bias may be present, as those willing to try VR may hold more positive attitudes toward technology. We did not evaluate education level, personality traits, or prior digital experience, all of which may influence technology acceptance. Furthermore, the absence of a formal control group limits conclusions about comparative efficacy. USEQ scores were collected immediately after therapy, preventing insight into long-term satisfaction or sustained engagement.

Future research should examine predictors of VR success beyond age, including cognitive profiles, motivation, and premorbid technology exposure. Developing validated screening tools to identify ideal VR candidates could improve clinical decision-making. Additionally, age-specific adaptations – such as simplified interfaces, adjustable visual settings, or longer familiarization periods – may enhance VR usability in older adults.

The high satisfaction and strong clinical results among individuals aged ≥ 70 years

challenge ageist assumptions. Our results support age-inclusive VR implementation and highlight the need for evidence-based, individualized selection to ensure equitable digital neurorehabilitation access for all. As healthcare systems increasingly integrate digital health technologies, our findings advocate for evidence-based rather than assumption-based patient selection criteria.

Ethical principles

The entire study was conducted in accordance with the Helsinki Declaration of 1975 (as revised in 2004 and 2008). Ethical approval for this study was obtained from the Ethics Committee of the University Hospital Ostrava, Ostrava, Czech Republic (Reference number: 766/2023; Date of approval: 26 October 2023).

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Conflict of interest

The authors declare they have no potential conflicts of interest concerning drugs, products, or services used in the study.

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