10.36803/indojpmr.v14i2.487

ORIGINAL ARTICLE

Acceptability & Tolerability of Virtual Reality Sessions in Acute Geriatric Ward

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ABSTRACT

Introduction: Virtual Reality (VR) could improve mental and physical condition. However, limited studies have been conducted on VR utilization for the elderly in acute wards. This study aimed to evaluate the acceptability and tolerability of a VR Prototype called VRAGMENT in the acute geriatric ward, as well as the acceptance correlation with cognitive function.

Methods: In this cross-sectional study, thirty-two subjects were recruited consecutively. Their satisfaction and complaints during and after a single VRAGMENT session were recorded using a questionnaire that elaborates the Technology Acceptance Model. VRAGMENT is a VR game programmed based on Instrumental Activities of Daily Living, designed by Universitas Indonesia.

Result: No falls or near falls were reported. No subject reported nausea, boredom, sleepiness, or oculomotor impairments such as dry or red eye, eye strain, blur, or difficulty focusing. Few subjects complained of general discomfort (19%), fatigue (6%), headache (9%), and dizziness (16%). All subjects declared that they were satisfied, enjoyed, and impressed. Most of them (97%) stated that VRAGMENT met their expectations and needs, and would like to recommend it to others. The overall acceptance and perceived ease of learning were significantly correlated with cognitive function.

Conclusion: This study proved that despite their age, cognitive impairment, and acute clinical condition, most subjects could accept and tolerate VRAGMENT sessions. This could be achieved through since VRAGMENT specifically designed for the elderly with cognitive impairment, as well as game protocol adaptation. Following study about the effect on patient outcomes needs to be conducted.

Keywords: Virtual Reality, VRAGMENT, Geriatric, Cognitive, Acute Ward

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INTRODUCTION

The aging population is happening globally. In most countries, including Indonesia, the elderly population is growing rapidly, bringing up some medical and economic challenges, such as Hospital-acquired disability (HAD). HAD has become a very serious problem in the aging population.[1–3] HAD was defined as the loss of independence in Activities of Daily Living (ADL) due to a complex sequence of physiological changes that can impact numerous systems of elderly patients. It appeared because of prolonged or complex hospitalization that caused a reduction in muscle mass and a considerable decline in their ability to function. HAD appears in 25–50% of the elderly who are admitted to hospitals. It causes more comorbidities and complications, which lengthen hospital stays and increase medical costs.[4] The United States spent billions on healthcare in 2019, which accounted for about 8.3% of all medical expenses in that year, related to HAD.[3] To overcome HAD, elderly patients need to be managed by the integrated team during hospitalization.[5,6] Considering the urgency, the Indonesian government set the policy to emphasize the need for an integrated geriatric team in each hospital.[7]

HAD is measured with the Barthel Index, in order to know how much patients are dependent on performing daily activities.[1] Patient's dependency level becomes variable, which is measured to evaluate the effect of HAD management. Interdisciplinary management in the acute geriatric ward gives a chance for more patients to be less dependent and reduce their disability level.[2] Although it was proved to be effective, interdisciplinary management needed more resources. Dealing with limited resources and medical complexity, innovation in rehabilitation services in the geriatric acute ward is a must.

The innovation of virtual reality (VR) usage in acute clinical settings was proven to be effective and satisfying.[8] Studies have proven that VR could improve both patients' physical and mental conditions during hospitalization.[8,9] Its effects during hospitalization also included reduced pain, cost-saving, and reduced length of stay.[10] It was given as part of pain management, COVID-19, and also for delirium.[10–12] However, no VR was designed specifically for the elderly in Indonesia and adjusted to be applicable in acute geriatric ward settings.

Designing VR for the elderly was challenging. Studies of VR that are specifically designed for the elderly focused on developing VR for mobility and balance improvement,[13–15] which all implemented in a home-based and outpatient setting. Those researchers used games that already existed on the VR market. However, most of those games were made not in Bahasa or Indonesian settings, nor were they commonly designed for the elderly. For example, the VR that was used in the balance study was a skiing game, which is obviously not suitable for tropical countries such as Indonesia.[16] This motivated Universitas Indonesia to develop a gamification VR based on Instrumental Activities of Daily Living (IADL) - making phone calls, grocery shopping, and money management - called VRAGMENT.

As mentioned previously, VR for the elderly was mostly designed not for an acute setting. In acute settings, subjects had lower cognitive, physical, and even psychological capacities due to their acute diseases and geriatric giants that might have already happened before hospital admission. Those could make them less likely to accept and tolerate VRAGMENT. This study aimed to evaluate the acceptability and tolerability of VRAGMENT in the acute geriatric ward.Methods

Participants and setting

This pilot study was conducted from March to June 2024 in a tertiary hospital, the National Referral Centre, Dr. Cipto Mangunkusumo Hospital (CMH). In this hospital, the core of the integrated geriatric team was internists, physiatrists, and psychiatrists who had a sub-speciality in geriatric medicine. CMH had an acute geriatric ward with 30 beds. It was provided for ≥60-year-old patients who had multi-pathological acute conditions. The integrated geriatric team didn't just work in the acute geriatric ward. Another inpatient team frequently consulted them to do interdisciplinary management of geriatric syndromes.

The study was approved by the Health Research Ethics Committee, Faculty of Medicine, Universitas Indonesia – Dr. Cipto Mangunkusumo Hospital. Number of ethical approval letter was KET-288/UN2.FI/ETIK/PPM.00.02/2024. Written informed consent from each subject or eligible family proxy was obtained.

The sample size was calculated for the bivariate correlation between cognitive function and acceptance. For the variables of total acceptance, perceived enjoyment, perceived usefulness, perceived ease of use, and perceived ease of learning, we set the level of significance at 0.05, power at 0.80, and a medium effect size at 0.5. Thus, a total of 32 subjects were needed in the study.

Study design

A cross-sectional study was conducted on geriatric patients during hospitalization. Single VR session was held in order to give experience to all subjects. Subjects were recruited using consecutive sampling.

Inclusion and exclusion criteria

We included all geriatric patients if they could follow instructions and orders, sit upright, and raise their arms against gravity. We excluded clinically unstable patients.

Previous studies had shown that even severe dementia could still give reliable responses in completing a self-administered questionnaire with or without help.[17] Nevertheless, cognitive impairment is one of the geriatric giants that need to be anticipated while giving intervention in geriatric acute wards. Some communication techniques had to be made to improve engagement between subjects and study investigators and reliability, especially in administering the acceptance questionnaire and confirming subjective complaints related to VR sessions. Communication strategies included language and non-language-based skills, as well as environmental modification strategies.[18] Indeed, subjects would be excluded if they were unable to complete the interview regarding acceptance and tolerability after the VR session.

VR Software and Equipment

A virtual game that was used in this study is VRAGMENT. VRAGMENT is an acronym for VR Daily Activity for Ageing and Dementia People. It is a semi-immersive VR game module based on instrumental activities of daily living, such as making phone calls, grocery shopping, and money management. This software was designed by researchers of Universitas Indonesia, in a collaboration between the Indonesian Medical Education and Research Institute (IMERI) - Faculty of Medicine, the Physical Medicine & Rehabilitation (PM&R) Department - Faculty of Medicine, and the Industrial Engineering Department - Faculty of Engineering.

For VR hardware, we selected Oculus Meta Quest 2®, developed by Reality Labs, because of its popularity in Indonesia. Besides headsets, touch controllers were also used during VR sessions.

Procedures

VRAGMENT operator gave familiarization to subjects by showing them how to wear and use the equipment. The operator also showed virtual shop recorders that would be seen in VRAGMENT. Administration of VRAGMENT was performed in an upright position. Subjects were encouraged to play in a standing position, if not possible, might be in a sitting position or else leaning back if necessary. In this case, we needed to adjust the VRAGMENT original module, which used to be played in the standing position, to be alternatively played in the sitting position. The sitting position needed to be as specific as the bed height so that a proper playing area could be achieved.

The vital sign was measured before and after the session. VR sessions would be terminated if there were subjective or objective signs before, during, or after the session that were categorized as contraindications in doing exercise or physical activity according to CMH clinical practice guidelines.[19]

VRAGMENT simulates a grocery shopping activity, which in the beginning allows the subject to receive a virtual phone call that provides a shopping list. Subjects must reach virtual shelves and use the touch controller to pick groceries as per the list given. Subsequently, they need to make virtual payments according to the groceries spent by combining Indonesian virtual money. The virtual reality environment in the Oculus Quest was projected, wired, to the laptop screen to be seen by family and operators. Subjects are allowed to have verbal direction, guidance, and encouragement from his/her family and operators in completing the game. This wired connection was chosen to overcome an unstable internet connection that might disturb or delay the projection.

After completing the VR session, subjects completed a survey that incorporated the Technology Acceptance Model (TAM), which had been used and validated, including in the Indonesia version [20–22].Four aspects were reviewed: perceived usefulness, enjoyment, ease of use and learning. Subjects graded their impression using the Likert scale, with a 6-level score. Scores 4-5-6 indicated agreement, with gradation weak – moderate - strong. Score 1-2-3 indicated disagreement, with gradation strong – moderate - weak.

For tolerability, the subject was asked about their complaints during and after a single

VRAGMENT session. Cognitive function was evaluated using the Indonesian version of the Montreal Cognitive Assessment (MoCA-Ina).[23,24] Chief diagnostics were categorized according to ICD-10 version 2019, for example, coronary arterial disease and myocardial infarction were categorized as diseases of the circulatory systems.[25]

Data analysis

Study data analyses were performed using SPSS version 24. Descriptive statistics were presented using mean and standard deviation for continuous variables and proportion for categorical variables. A correlation statistical analysis was carried out to check the correlation between cognitive and enjoyment rates. Spearman correlation was used since normality testing showed abnormal data distribution. A correlation analysis between cognitive function and enjoyment rate was conducted based on a previous VRAGMENT study.[2,26]

RESULTS

This study recruited 32 elderly subjects: 16 women and 16 men. Their mean age was 67.38 (SD 5.51). All had no experience using any VR device. Most subjects were hospitalized because of diseases of the digestive system (43.8%). Almost all subjects had cognitive impairment (90.7%). The mean average playing time was around 8 minutes, with the median acceptance score categorized as moderate (see Table 1 for details).

Table 1. Baseline Characteristic of Subjects undergoing VR session

Variables	Subjects (n=32)
Age in years ($\bar{x}$(SD))	67.38 (5.51)
Sex, n (%)	
Female	16 (50%)
Diagnosis, n (%)	
Neoplasms	6 (18.8%)
Diseases of the digestive system	14 (43.8%)
Diseases of the circulatory system	3 (9.4%)
Diseases of the genitourinary system	1 (3.1%)
Diseases of the respiratory system	4 (12.5%)
Diseases of the skin and subcutaneous tissue	1 (3.1%)
Endocrine, nutritional, and metabolic diseases	3 (9.4%)
Cognitive Function, n (%)	
Normal	3 (9.4%)
Mild-moderate impairment	14 (43.8%)
Severe impairment	15 (46.9%)
VR session duration (minute), ($\bar{x}$(SD))	8.3 (3)
Technology Acceptance, median(min-max)	
Perceived enjoyment	5.5 (3.7-6)
Perceived usefulness	5.2 (4-5.8)
Perceived ease of use	4.8 (3.7-5.7)
Perceived ease of learning	5 (3-5.75)

Acceptability

Most of the subjects (96.9%) perceived that VRAGMENT was enjoyable & useful. They testified that VRAGMENT was easy to use & to learn (90.6%). Details of each domain of acceptance are described in **Figure 1**.

Subjects were asked whether VRAGMENT was easy to learn and use, useful, also enjoyable. The answer was scored as 1-2-3 indicating disagreement, with gradation strong – moderate - weak. Otherwise, scores 4-5-6 indicated agreement, with gradation weak – moderate - strong. Blue shows the proportion of those who agreed, and orange shows those who disagreed.

Tolerability

No falls or near falls were reported. No subject reported nausea, boredom, sleepiness, or oculomotor impairments such as dry or red eye, eye

strain, blur, or difficulty focusing. Few subjects complained of general discomfort (19%), fatigue (6%), headache (9%), and dizziness (16%). All subjects declared that they were satisfied, enjoyed, and impressed. Most of them (97%) stated that VRAGMENT met their expectation and needs, and they also would like to recommend it to others, as described in **Figure 2**.

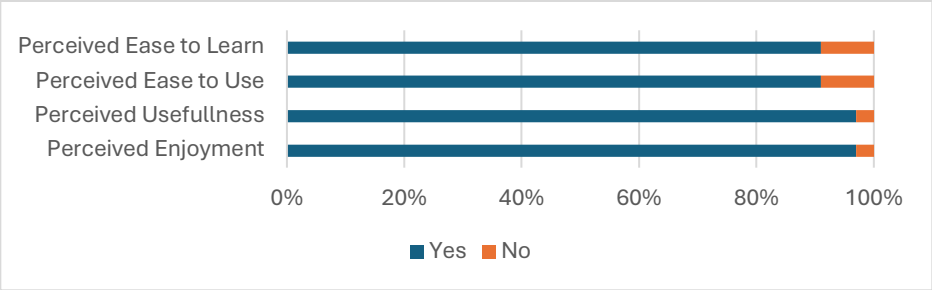

Figure 1. Technology Acceptance Model (TAM) survey.

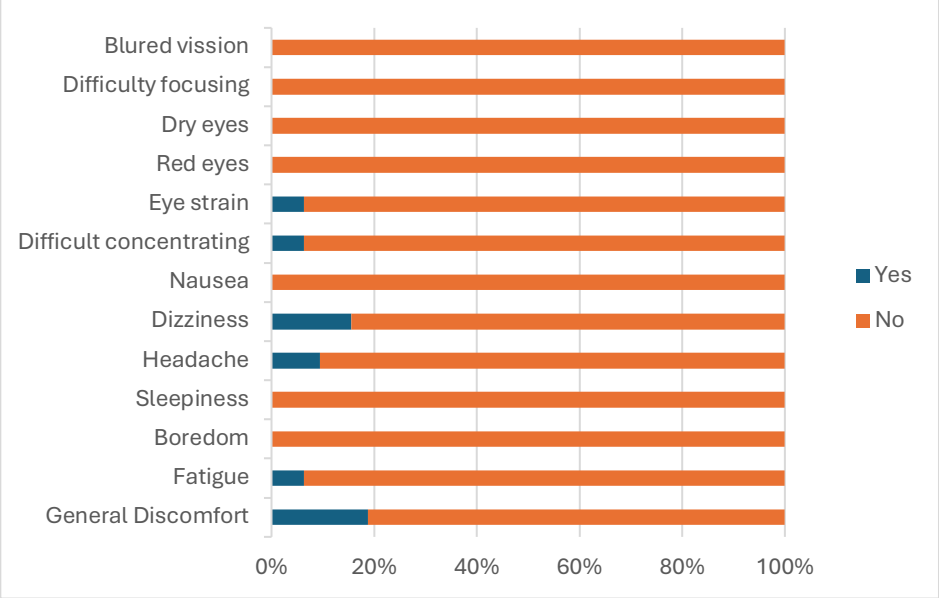

Figure 2. VR Tolerability proportion.

Subjects were asked whether they had VR sickness symptoms during and after VRAGMENT session. Blue shows the proportion of those who had VR sickness, and orange shows those with no VR sickness.

Correlation of Cognitive Function and Fun

Cognitive function had a positive correlation with overall acceptance (r^2 = 0.434, p = 0.015). Cognitive function specifically had a positive correlation with perceived ease of learning (r^2 = 0.387, p = 0.032), Table 2. The sub-section of MoCA-Ina scores are described in Table 3. It showed most cognitive domains were impaired except for abstraction and orientation. The median of abstraction and orientation was at the maximum score.

Table 2. Cognitive Correlation with Technology Acceptance

Technology Acceptance	Cognitive Function	
	r	p
Perceived Enjoyment	0.264	0.145
Perceived Usefulness	0.349	0.055
Perceived Ease of Use	0.330	0.070
Perceived Ease of Learning	0.387*	0.032
Overall Acceptance	0.434*	0.015

Spearman, significance p<0.05

Table 3. MoCA Ina Subsections Median (Min-Max) and Maximum Value

	Median (Min-Max)	Maximum Score
Visuospatial	3 (0-5)	5
Naming	3 (0-3)	3
Attention	4 (0-6)	6
Language	2 (0-3)	3
Abstraction	2 (0-2)	2
Delayed Recall	1 (0-5)	5
Orientation	6 (2-6)	6

DISCUSSION

In this study, overall, 97% of subjects had good acceptance and tolerability. Previous studies have shown that older chronological age predicted lower technology acceptance.[27] This stereotypical concept of ageism led the elderly to have a negative attitude towards the intention to use digital technology (DT). These led them to have low experience and acceptance of DT.[28] To empower the elderly and also increase the use and adoption of DT by the elderly, the development of technology that is tailor-made for them [28], as VRAGMENT, is needed.

Developing VR for the geriatric population, especially those with cognitive impairment, was challenging. As in this study, most subjects had cognitive impairment. Cognitive impairment is one of the geriatric giants that might become a barrier in accepting technology, such as VR.[27] Thus, we decided to choose daily activity as the main content since it might already become an engram, which would not easily be forgotten.

Despite ageism and cognitive capacity, the most important aspect of adopting technology in the elderly is how they perceive themselves. Those who perceived usefulness, perceived ease of use, and perceived enjoyment of play would have positive acceptance.[29]

Critical illness might lead to cognitive impairment. Memory is the most frequently impaired, followed by executive function and attention deficit [30]. As in this study, the median of delayed recall, one of the memory functions, remained very low (1/5). Encourage & verbal guidance during the VRAGMENT session were delivered to support subjects in overcoming self-ageism and memory impairment, so they got the experience and had good acceptance.[28]

Even though cognitive function became the core in designing VRAGMENT, still, a better cognitive function leads to better overall acceptance, especially for the perceived ease of learning aspect. The visuospatial function is one of the important keys in directing human cognitive processes, together with mental function. Visuospatial workload remained to increase in virtual reality environments.[31] As in this study, the median of the visuospatial score was lower than the maximum score. It would increase the difficulty in playing VRAGMENT. Verbal guidance could reduce cognitive load, especially visuospatial activity [31], which made the game easier.

VR sickness was defined as side effects or symptoms from virtual environment usage.[32] The most common VR sickness reported was nausea, followed by oculomotor and disorientation. Factors that influence VR sickness are content, visual stimulation, locomotion, and exposure time.[33] Content that might cause VR sickness was gaming and 360^0 videos. Visual stimulation is described as the amount of visual movement within the content, regardless of user-directed movement. Visual stimulation was graded

low as visual changes remained slow. High visual stimulation had more risk of causing VR sickness. Locomotion was how users moved and navigated in the virtual environment. It was classified as stationary, controller-based movement, or physical walking. Stationary and physical walking had less risk of causing VR sickness. Exposure time of more than 10 minutes would increase VR sickness.[33]

VRAGMENT had designs that might prevent VR sickness. VRAGMENT is a grocery simulation game, but the visual stimulation remained low since no passing by or moving objects throughout the game. VRAGMENT users would have some directional panoramic, but not 360^0. The locomotion function could be adjusted either by physical walking or controller-based movement. In this study, the mean (SD) of VRAGMENT exposure time was 8.3(3) minutes. Few VRAGMENT sessions in this study might slightly exceed the recommended exposure time, but overall, in this study, VR sickness percentages were low. Certainly, no VRAGMENT sessions were terminated by VR sickness.

Regarding subjects who had mild to severe cognitive impairment, a question might arise as to whether the subjects' responses were valid and reliable. Communication competence is the harmonization between cognitive, emotional, and physical functions. It involves not only verbal but also non-verbal language. Non-verbal language involves social cognition; face and emotion perception, attribution, and empathy.[34] These were not measured specifically by MoCA-Ina, but became crucial in the inclusion criteria that subjects must be able to follow instructions and orders.

Communication skills that were applied during this study were needed to enhance communication and reliability among subjects with cognitive impairment.[18] This was a common intervention in the middle to late stages of cognitive impairment, such as dementia. The key components for language-based skills included reducing sentence length and structure, also the complexity of vocabulary. Non-language-based communication skills included management of voice tone, time allowed for turn-taking, eye contact, gesturing, and positive reinforcement. For environmental modification strategies, the cores were enforcing minimal distraction and choosing the best time of day for conversation. Using those skills, the completeness of the subjects' responses could be achieved.

Strengths and Limitations

Overall, this study finds the potential of VRAGMENT to be used in acute geriatric ward patients. It proved that VRAGMENT module adjustment to ward setting, wired connection between headset and laptop, and also verbal guidance through the session could make high acceptance and tolerability. The limitation of the research was bias in sampling since we used a non-random selection. Also, CMH, as a tertiary and National referral hospital, had patients with very complex clinical conditions, so the subjects might have some different characteristics from elderly patients in other hospitals or even in the community. In one aspect, it becomes a study limitation. But, on the other hand, this leads to the hypothesis that VRAGMENT had been accepted by the hospitalized elderly with very complex conditions, moreover, those with better clinical conditions.

CONCLUSION

Geriatric patients could accept and tolerate VRAGMENT sessions during hospitalization in the acute geriatric ward. Some modifications in the VRAGMENT module and playing protocol resulted in moderate perceived enjoyment, usefulness, ease of use, and ease of learning. Next, a study about the effect on patient outcomes needs to be conducted.

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