JHeS (Journal of Health Studies)
Vol. 9, No. 1 (2025), pp.108-123
e-ISSN 2549-3353
p-ISSN 2549-3345
https://doi.org/10.31101/jhes.4168

Literature Review

Remote health information systems for falls prevention in older adults at home: a scoping review

Dian Rizki Ramadhani, Alfiana Maulida Rahmah*, Decky Nurhadi Sopyan, Novi Rohmawati, Putri Ramadhanti, Sali Zakiah Muslim
Master of Nursing, Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia
alfianamaulidar@gmail.com

Submitted: June 10, 2025 Revised: August 7, 2025 Accepted: August 23, 2025

Abstract
This review is to describe the remote health information system related to falls in the elderly used at home. We conducted a literature review using the Population Content Context (PCC) method. The databases used include EBSCOHost, Cochrane, and Scopus. The keywords used are (telehealth OR telemedicine OR telenursing OR m-health OR e-health) AND (elderly OR geriatric) AND falls AND home. The article selection process was done with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol. As a result, 2.587 publications were identified and screened using the inclusion criteria. The assessment of article quality is conducted through assessment by design and manual assessment. The final result was 18 articles. The results of the article identification discussed the risk of falls, falls prevention, fall events, fear of falls, and response to falls with elderly respondents aged ≥ 55 years. So, there are various types of technologies used, namely sensor-based, phone calls, video conferencing, web, applications, force plates (style plates), tablet computers, smartphones, Artificial Intelligence (AI), and Virtual Reality (VR). The remote health information system has been proven to provide many benefits related to falls on the elderly at home.

Keywords: elderly; falls; home; information; technology

1. Introduction

Patient safety refers to minimizing preventable harm to patients at an acceptable level. It involves a system of culture, processes, behaviors, technology, and environment in healthcare that reduces risks, prevents avoidable injuries, and minimizes the impact of errors (WHO, 2023). Common threats to patient safety include medication errors, surgical errors, healthcare-associated infections, sepsis, diagnostic errors, thromboembolism, pressure ulcers, unsafe transfusion or injection practice, misidentification, and patient falls (WHO, 2023).

Falls are the second leading cause of accidental injury-related deaths worldwide, with an estimated 684.000 deaths annually. More than 80% occur in low- and middle-income countries, and adults over 60 experience the highest rates (WHO, 2021). In Indonesia, data show falls-related injuries among older adults are common 7,7% in the 55-64 age group, 8,1% in those aged 65-74, and 9,2% in those 75 and older (Kemenkes RI, 2018). Risk increases with age due to vision decline, muscle loss, reduced mobility, and delayed responses to hazards such as tripping or slipping (Julianto et al., 2022).

International Patient Safety Goals (IPSG) emphasize preventing falls across healthcare services (The Joint Commission, 2015). Recommended strategies include education, exercise, environmental modifications, and policy development (WHO, 2021). Research has shown that well-designed exercise programs can reduce falls among community-dwelling older adults by approximately 23% (Sherrington et al., 2019).

Integrated intervention involving professionals, nurses, and patients is essential. These include raising awareness, identifying risks, implementing prevention, and providing treatment and rehabilitation for those who have fallen or are at high risk (Matchar et al., 2017). Information and communication technology (ICT) supports these efforts by enabling communication, decision-making, training, and education. Digital technologies can deliver exercise programs effectively at low cost and with high accessibility, thereby improving motivation and compliance (Valenzuela et al., 2018). Based on this, in reducing the risk and occurrence of falls, the elderly can use information technology, for example, telehealth, telemedicine, telenursing, and so on.

Telehealth, which uses ICT to deliver health services remotely, has shown benefits such as improved access, timeliness, and efficiency, including for older adults in remote areas (Elbaz et al., 2021). However, based on our review, we found that no previous scoping review specifically explores remote health information systems related to falls in older adults at home. Therefore, this study aims to describe the use of remote health information systems in falls prevention and management among older adults living at home.

2. Research Methods

The reference of this scoping review uses three databases, namely EBSCOHost, Cochrane, and Scopus. The search was conducted on September 6, 2023, limiting the publication year to between 2018-2023.

The strategy used to search for articles is the Population Content Context (PCC) framework, where the population (P) is the elderly; the concept (C) is a falls-related remote health information system; and context (C) is used at home. The complete search strategy for each database is presented in Table 1.

Database	Keywords
EBSCOHost	Informatic tools OR telehealth AND elderly AND falls AND home
Cochrane	Informatic tools OR m-health AND “elderly” AND falls AND home
Scopus	(telehealth OR telemedicine OR telenursing OR m-health OR e-health) AND (elderly OR geriatric) AND falls AND home”.

The article selection process in this study uses the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol.

Inclusion criteria: (1) published in 2018-2023; (2) is a full-text article; (3) article published in English; (4) the research subjects are the elderly; (5) explaining remote information systems in health services; (6) home use; (7) It is a primary research article (other than an abstract, poster, narrative review, literature review, scoping review, systematic review, book chapter, proceedings, guidelines, conference and consensus).

The assessment of article quality is conducted through both design-based evaluation and manual evaluation, which considers factors such as currency, relevance, authority, accuracy, and purpose. The final result was obtained from 18 articles used in the scoping review. The selection of study articles can be illustrated in the following PRISMA diagram (Figure 1).

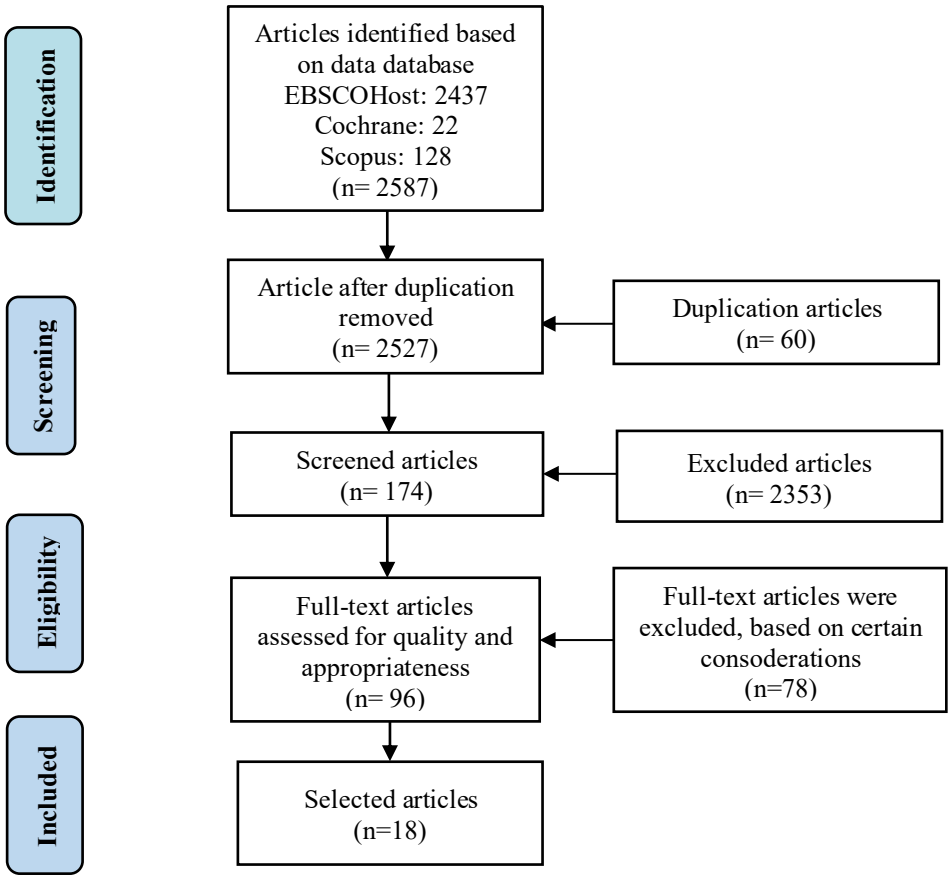

Figure 1. PRISMA Diagram for the Article Screening Process.

3. Results and Discussion

3.1.Results

Based on the results of the literature search, 18 articles were found explaining falls, consisting of 9 articles discussing the risk of falls, 5 articles discussing falls prevention, 2 articles discussing the occurrence of falls, 1 article discussing the fear of falls, and 1 article discussing responses to falls. The articles used come from 12 countries from the European continent, 3 countries from the Asian continent, 2 countries from the American continent, and 1 country from the Australian continent. The elderly who were the respondents to the study were those ≥ 55 years old, but the majority of studies included the age of ≥ 65 years as an inclusion criterion.

The health information system contained in the 18 articles uses various types of technology, including sensor-based (Greene et al., 2021; Pedrero-Sánchez et al., 2023; Qiu et al., 2018; Watson et al., 2021), phone calls (Bernocchi et al., 2019; Pettersson et al., 2019; Pfeiffer et al., 2020), video conference (Bernocchi et al., 2019; Li et al., 2021; Sari et al., 2023; Tomita et al., 2019), Web (Gaspar & Lapão, 2022; Hamm et al., 2019), application (Hamm et al., 2019; Mansson et al., 2020), force plate (Gallamini et al., 2021; Sadura-Sieklucka et al., 2023), tablet computer (Delbaere et al., 2021), smartphone (Yi & Yim, 2021), Artificial Intelligence (AI) (Buisseret et al., 2020), and Virtual Reality (VR) (Sadura-Sieklucka et al., 2023). The entire health information system is applied to the elderly at home, and there is a remote data exchange.

Of the 18 articles about remote health information systems related to falls in the elderly used at home, all have positive effects, including can be used to assess the risk of falls, reduce the risk of falls, be useful for falls prevention, reduce the incidence of falls, reduce the fear of falls, and accelerate the response of helpers to falls experienced by the elderly at home.

Table 1. Article Review Table

No.	Author and Year	Research Location	Level of Evidence	Information Systems	Data Outcome	Research Results	Strengths/Limitations
1	(Qiu et al., 2018)	South Korea	III (Quasi-experimental)	Inertial sensors (Five body points)	Risk of falling	Accurately distinguish between falling and not falling retrospectively, with an overall accuracy of 89.4% (sensitivity of 92.7% and specificity of 84.9%). Thus, this tool is an innovative method for multifactorial fall risk assessment in the elderly.	Limitations: only focused on the major intrinsic factors for fall risk assessment, used retrospective falls.
2	(Bernocchi et al., 2019)	Italian	II (RCT)	Home-TeleHealth (phone calls, video conferences, and home visits)	Falls events	The Home-TeleHealth program is effective in reducing the incidence of falls and the fear of falling at home for 6 months of use.	Strengths: prospective design, large sample size (n=283), 6-month follow-up, feasibel and safety (the absence of side effects, patient compliance and satisfaction). Limitations: was not blind patients and health care personnel to the group allocation (assessors and data analysts were blinded), single-center study, falls were self-reported
3	(Tomita et al., 2019)	USA	II (RCT)	Virtual-Group Exercise at Home (V-GEAH) Program via video conference	Risk of falling	The V-GEAH program during 3 months of use is effective in reducing the risk of falls in the elderly.	Limitation: the adherences of this follow-up study was low compared to the adherences level of the VGEAH intention study, which was very high.
4	(Pettersson et al., 2019)	Swedish	II (Qualitative)	Mobile phone-based physical exercise application	Falls Prevention	Mobile phone-based physical exercise applications improve physical fitness, balance, and confidence to prevent falls.	Strengths: relatively large and varied sample, including participants from different recruitment settings (richness of data) and variety of researchers which may have enhanced credibility in the process of triangulation. Limitation: one of the interviewers had met

No.	Author and Year	Research Location	Level of Evidence	Information Systems	Data Outcome	Research Results	Strengths/Limitations
							some of the participants during the introduction- and follow-up meeting.
5	(Hamm et al., 2019)	English	III (Mixed methods)	Guidetomeasure-3D, a web-based 3D mobile application	Risk of falling	The Guidetomeasure-3D application has proven to be more accurate and consistent in assisting the elderly in carrying out self-assessment measurement tasks as part of the fall risk assessment process at home compared to using a booklet.	Strength: comprehensively explored and discussed the generalisability and transferability of The Guidetomeasure-3D application and how it may influence and contribute to healthcare practice more generally.
6	(Mansson et al., 2020)	Swedish	II (RCT)	Safe Step v1 digital falls prevention exercise application	Falls Prevention	Respondents who used digital programs with the Safe Step v1 application had a higher level of exercise compliance compared to those who used booklets. Respondents also reported high levels of satisfaction and felt supported by the app.	Strengths: RCT design, focus on vulnerable elderly groups. Limitations: limited sample size (n=25), short study duration.
7	(Pfeiffer et al., 2020)	German	II (RCT)	"Step by Step", four phone calls and one home visit program	Fear of falling	The "Step by Step" intervention has a significant effect in reducing the fear of falling and improving physical activity and physical performance in the short term in the elderly. However, the effect on the duration of daily walking is not significant.	Strengths: RCT study design, the cross-sectoral design of the programme and the accompanying monitoring for quality assurance. Limitations: the exclusion of about one-third of eligible patients due to cognitive impairment and missing data on medication and comorbidities.
8	(Buisseret et al., 2020)	Belgium	III (Cohort)	A combination of the Timed Up and Go (TUG) test, a Six-Minute Walking test using an Inertial Measurement	Risk of falling	The use of a combination of Timed Up and Go (TUG) tests, Six-Minute Walking tests using Inertial Measurement Units (IMUs) and Artificial Intelligence (AI) increases the accuracy of	Strengths: innovative and relevant for measuring fall risk in the elderly, focus on a six-month prediction rather than on real-time detection.

No.	Author and Year	Research Location	Level of Evidence	Information Systems	Data Outcome	Research Results	Strengths/Limitations
				Unit (IMU), and Artificial Intelligence (AI)		predicting the risk of falls in the elderly. The AI algorithm achieved 75% accuracy, specificity, and sensitivity in predicting falls risk.	Limitations: AI classification in this study, based on a convolutional neural network
9	(Delbaere et al., 2021)	Australia	II (RCT)	The tablet computer-based "Standing Tall Balance Exercise"	Falls events	The Standing Tall Balance Exercise program has a significant effect on the reduction of falls rates and injury rates after 24 months.	Strengths: large sample size, broad inclusion criteria and use of methods designed to reduce the risk of bias such as concealed random allocation to groups, blinded outcome assessment, intention-totreat analyses, and preregistered statistical analysis plan. Limitations: the reliance on self-reported falls, participant masking was not possiblen (risk of bias by expectation), the subsequent multiple testing of the results could introduce error, the results might not generalise to usage in more rural or less affluent areas, the weekly education fact sheets have induced a behaviour change in control group that might reduce statistical power.
10	(Yi & Yim, 2021)	South Korea	II (RCT)	Remote Home-Based Exercise Program based on wifi connected	Falls Prevention	The Remote Home-Based Exercise Program has a significant effect on improving physical and psychological function and balance (which important factor in falls prevention). The experimental group experienced a decrease in Geriatric Depression Scale	Limitations: participants were recruited from 2 organizations on a volunteer basis, which might restrict the generalizability to the wider population.

No.	Author and Year	Research Location	Level of Evidence	Information Systems	Data Outcome	Research Results	Strengths/Limitations
						(GDS) scores, an increase in hand grip strength and Four Square Step Test (FTSS) scores, and an increase in static balance compared to the control group.	
11	(Li et al., 2021)	USA	II (RCT, feasibility)	Tai Ji Quan (Balance Exercise via Online/Zoom)	Falls Prevention	The Tai Ji Quan program at home, virtually and interactively, delivered in real-time, as a balance training and potential falls prevention intervention for the elderly.	Limitations: falls data via self-reports (risk of recall bias), did not consider enrolling older adults at high risk of falling (ie, persons with multiple falls or impaired gait or balance).
12	(Watson et al., 2021)	English	II (Qualitative descriptive)	Rapid response alarm technology (combination of self-activated and automatic sensors i.e. falls sensors, smoke detectors, extreme temperature sensors, pressure sensors) and telecare services	Response to Falls	Rapid response alarm technology and telecare services encourage elderly independence, make seniors and caregivers feel safe, delay or prevent seniors from moving to nursing homes, and reduce stress and anxiety reported by caregivers	Limitations: limited scope and demographics.
13	(Greene et al., 2021)	Irish	III (Study Report)	Inertial sensors embedded in smartphones	Risk of falling	The use of smartphone applications with inertial sensors can be used to measure the risk of falls and balance disturbances in the elderly	Strengths: the largest study conducting research on the use of smartphones for fall prevention. Limitations: self-reported data particularly using retrospective falls history, can be unreliable and under-report the incidence of falls.
14	(Gallamini et al., 2021)	Italian	III (Cohort)	ArgoplusMK1, a balance exercise using a force plate to assess balance and postural control in individuals.	Risk of falling	ArgoplusMK1 can identify balance deficits in the elderly as a cost-effective and non-invasive screening tool to identify individuals at risk of falls.	Strengths: uses advanced detection equipment. Limitations: non-representative population, and limited

No.	Author and Year	Research Location	Level of Evidence	Information Systems	Data Outcome	Research Results	Strengths/Limitations
							empirical evidence support.
15	(Gaspar & Lapão, 2022)	Portugal	III (Explanatory sequential mixed methods)	"BALANCE" digital service implemented and integrated with METHIS (web service for remote monitoring)	Risk of falling	The BALANCE digital service is very helpful in the rehabilitation process of patients with balance disorders who have a risk of falling	Limitations: sampling method was intentional, and the focus groups were conducted remotely via Zoom due to SARS-CoV-2 pandemic limitations, short follow-up time period (three months).
16	(Pedrero-Sánchez et al., 2023)	Spanish	III (Quasi-experimental)	Smartphone-based 3D inertial sensor, data is recorded at 100 Hz by the sensor. The smartphone is attached with a fastener around the participant's waist	Risk of falling	The use of fast smartphone-based 3D inertial sensors allows for accurate classification of falls risk in the elderly and can be a useful screening tool in clinical settings. The tool is also easy to use	Strengths: high accuracy and reliability, simple, easy to use, and cost-effective. Limitations: limited sample size and diversity.
17	(Sadura-Sieklucka et al., 2023)	Polish	II (RCT)	Force plates balance exercise combined with Virtual Reality (VR)	Risk of falling	e-Health with Virtual Reality is influential in reducing the vulnerability of falls in the elderly	Limitation: limited population.
18	(Sari et al., 2023)	Indonesian	III (Pre-experiment)	Telehealth video conference program	Falls Prevention	Telehealth through video conferencing for 12 weeks guided by a physiotherapist and supervised by a nurse affects improving physical activity levels and quality of life as well as preventing disability	Strength: first study to provide evidence on feasibility of telehealth home-based exercise programs for older people in Indonesia. Limitations: no randomization, the same physiotherapist performed the online assessments with the participant and carer as the physiotherapist supervising the exercise program, and self-reported assessment conducted online.

3.2.Discussion

The elderly have a high risk of falling. The incidence rate of falls among the elderly is 30% for those over 65 years old, and it will double for those over 80 years old. Falls are the leading cause of

disability among the elderly and can potentially result in mortality (Pedrero-Sánchez et al., 2023). The experience of falling causes fear and trauma in the elderly, which can disrupt daily activities and potentially lead to social isolation (Mansson et al., 2020).

To reduce the risk of falls in the elderly, currently health information systems have been developed using various modern information and communication technologies. The rapid expansion and confluence of digital technologies has a significant impact on daily life. These technologies have begun to play an important role in health care, and their potential to improve public health is a source of great interest (Falzon et al., 2023).

Telemedicine is defined as the use of telecommunications and information technology to provide healthcare data and services to patients living far away. It involves the transfer of data through electronic signals and includes the use of electronic medical records (EMR) to facilitate access to patient information. Telemedicine encompasses various applications, including remote clinical consultations, diagnostic tests, and patient guidance, which improve communication between healthcare providers and patients across geographical boundaries (Sachdeva & Ali, 2022). Telemedicine provides various benefits, including cost savings, convenience, and enhanced access to healthcare for individuals with mobility restrictions or living in rural areas (Das et al., 2024).

Teleconferencing services, such as video conferencing through Zoom, are widely used for long-distance communication. Teleconferencing enables health professionals to work with the elderly to develop exercise programs that increase their physical activity and quality of life (Sari et al., 2023). The study found that a 12-week intermittent telehealth-based exercise program delivered via video conferencing improved physical activity levels, several aspects of function (lower extremity domain) and disability (total frequency dimension and personal role domain), health-related sports benefits, exercise enjoyment, and quality of life for the elderly with dementia living in Indonesian communities (Sari et al., 2023). The Virtual-Group Exercise at Home (V-GEAH) program, which is an exercise program conducted at least twice a week for three months, can significantly reduce the risk of falls in the elderly who have a history of falls, especially for those who follow the program (Tomita et al., 2019).

The Remote Home-Based Exercise Program, which includes training videos and is monitored remotely by a therapist who contacts patients twice a week, significantly improves physical and psychological function, improves balance, and prevents falls in the elderly (Yi & Yim, 2021). Another study suggests that exercise programs for fall prevention can increase muscle strength, which is directly related to improved physical function in the elderly (Lacroix et al., 2016). By designing the right exercise program and using media that can be used by the elderly will be very helpful in the rehabilitation programs of older individuals at risk of falling (Gaspar & Lapão, 2022).

Some of the benefits of digital health services for patient rehabilitation include increased comfort, doctor-patient interaction (feeling close), potential motivation, and patient involvement in self-care. Furthermore, the availability of video tutorials with balancing exercises is seen to be a good effect, since it helps patients recall exercises and motivates them to exercise, including outdoors (Wynn et al., 2020). These videos also allow caregivers to understand the recommended exercises (Van Vugt et al., 2019). The experience of using a mobile phone-based exercise application for falls prevention has a positive response. Some respondents said that the program supplied is simple to use, motivates them, and allows them to exercise by adjusting their abilities and the training environment they like (Hamm et al., 2019). Applications used and managed by the elderly themselves in their communities have proven to be very effective in reducing the risk of falling among the elderly (Delbaere et al., 2021). The use of the application has also proven to be more accurate and consistent than using media such as booklets or other manual faults (Hamm et al., 2019).

The Timed Up and Go (TUG) test is a reliable predictor of fall risk, with studies showing significant correlations between TUG performance and fall incidents (Oliveira-Zmuda et al., 2022). The TUG test is not only used to assess fall risk, but it also measures gait, motor speed, and physical function, making it a useful tool in geriatric care (Brucki, 2015).

The use of a custom-made sensor, the ultralow-cost wearable wearable inertial sensor (DYSKIMOT), serves to capture locomotor movements during a six-minute running test, which enhances the predictive power of the TUG test regarding fall risk among elderly individuals in nursing homes, regardless of whether they have previously fallen, across two sets of measurements taken at six-month intervals (TUG+ test) (Buisseret et al., 2020). The position of the inertia of the sensor in the lumbar area is relevant because it is close to the center of body mass (Buisseret et al., 2020). Other studies show that this position is best for distinguishing between those who fall and those who don't (Howcroft et al., 2016). This study also presents kinematic data analysis based on variability assessment and Artificial Intelligence (AI) techniques. The role of AI is to analyze data collected from wearable sensors and predict the risk of falls in nursing home residents (Buisseret et al., 2020). According to Avron Barr and Edward E. Feigenbaum (1982) in Tjahyanti et al., (2022). Artificial Intelligence (AI) is a part of computer science that studies (in the sense of designing) intelligent computer systems, i.e. systems that have human-like thinking characteristics.

Another study found that a rapid smartphone-based 3D inertial sensor can accurately classify the risk of falls in the elderly and could be a useful screening tool in clinical settings. This tool is also easy to use because it is only installed around the elderly's waist (Pedrero-Sánchez et al., 2023). The use of inertial sensor devices includes elements of all these assessments that are embedded in functional tests (i.e., modified TUGs). The use of this technology can allow clinicians to conduct evaluations in an average of 105 seconds, including one minute of initial explanation, making it 38 minutes shorter than the PPA protocol (which takes 40 minutes) (Pedrero-Sánchez et al., 2023). This is in line with research in South Korea which states that inertial sensors can accurately distinguish between the elderly with a history of falls and those with an accuracy of 89.4% when inertial sensors are used in assessing the risk of falls in the elderly (Qiu et al., 2018). In addition to being installed on the body, this inertial sensor device can also be embedded in a smartphone and linked to an application that records important data such as falls history, polypharmacy, and mobility problems (Greene et al., 2021).

Balance exercises using force plates combined with Virtual Reality (VR) technology are effective in reducing the susceptibility of falls in the elderly (Sadura-Sieklucka et al., 2023). Virtual Reality (VR) is a technology that allows users to enter and interact within a virtual world, as it combines special input and output devices to enable deep interaction with the virtual environment, making it feel as if they are in the real world (Musril et al., 2020). The main advantage of VR is an experience that makes users feel the sensation of the real world in the virtual world (Wardhana et al., 2019). VR transports us to another dimension where the depiction of the state resembles the original shape of the object, when in reality we are still in the same place (Musril et al., 2020). These results are in line with the research of Gallamini et al. (2021) who examined the ArgoplusMK1, a balance exercise using a force plate to assess balance and postural control in individuals. The study's findings revealed that ArgoplusMK1 was able to identify balance deficits in the elderly as a cost-effective and non-invasive screening tool to identify individuals at risk of falling (Gallamini et al., 2021).

Force plate-based exercises provide an effective method for teaching patients to control their physical exertion, allowing them to precisely adjust the position of their center of gravity without generating excessive inertial forces. These excessive forces are often a direct cause of falls because they can shift the center of pressure (COP) outside the area of the foot. Visual-motor feedback (biofeedback) in posturographs consists of relating the images observed by the person standing on the force plate to his motor activity. Over the years, VR devices have become increasingly popular and affordable. This

makes it a good way to continue the patient's self-improvement at home, as well as to monitor their progress (Bevilacqua et al., 2019). Training using VR technology can be more effective in improving mental condition, mobility, and overall quality of life in older people (Maranesi et al., 2022). In the context of a digital approach to preventing falls, the use of technology for patient-led data capture, such as balance and falls risk assessment, is critical to enabling personalized interventions to encourage users to adopt strength and balance training routines (Hughes et al., 2019; McGarrigle et al., 2020). Patient-led data collection supports a customized rehabilitation program at home, which helps determine physiotherapist-assisted exercise protocols (Palestra et al., 2018) and monitor the progress of the exercise (Uzor & Baillie, 2019). Strength training, which focusses primarily on improving lower limb strength, and classical balance exercises, which should be progressive in difficulty: reducing the field of support, reducing base stability, limiting eye control, and so on.

However, the success of this exercise is also influenced by the level of patient compliance in participating in a predetermined exercise program. Compliance with reporting training results in real-time is very useful in determining the next training program to reduce the risk of falling (Li et al., 2021). Overall, families or caregivers can supervise and encourage people with dementia to participate in a home exercise program with intermittent physiotherapist guidance through regular online visits, however it is more difficult to encourage them to participate when physiotherapist supervision stops. Previous study has found that caregivers support is critical to the success of sports programs for adults with cognitive impairments/disabilities and dementia (Suttanon et al., 2013). Other research states that the involvement of patients, caregiver, and healthcare workers is one of the key points for the success of digital interactive solutions (Goldsack & Zanetti, 2020; Tossaint-Schoenmakers et al., 2021).

Despite the numerous benefits of using technology, there are several barriers to the use of digital devices in clinical settings, including the elderly's limitations in accessing and using technology, a lack of digital training, and caregiver support (Heponiemi et al., 2020; Jun, 2020; Orton et al., 2018; Ricciardi et al., 2019; Trenerry et al., 2021). Therefore, in the development of digitalization in healthcare, it is important to listen and engage with patients, family members, caregivers, healthcare professionals, and policymakers to improve the implementation of digital solutions in clinical settings (Kim et al., 2021; Tossaint-Schoenmakers et al., 2021).

4. Conclusion

Remote health information systems currently use various types of technology, including sensor-based, phone calls, video conferencing, web, applications, force plates (style plates), tablet computers, smartphones, Artificial Intelligence (AI), and Virtual Reality (VR The various benefits of using these technologies include assessing the risk of falls, reducing the risk of falls, being useful for preventing falls, reducing the incidence of falls, reducing the fear of falls, and accelerating the response of rescuers to falls experienced by the elderly at home. All of these benefits can help the elderly get the health services they need at home without having to always come to a hospital or certain health facilities.

The success of a remote health information system is also influenced by the compliance and support of various parties involved in implementing fall-related interventions in older adults, such as neighborhood associations, elderly cadres, community health centers, and local governments.Therefore, the role of family and caregivers for the elderly is crucial. In addition, the ease of use of technology also needs to be considered due to various limitations in the functions of the elderly. This scoping review identified several limitations, including the varying designs, information systems, and outcomes of the journal articles used. Therefore, the study results cannot be generalized across situations, and it cannot be determined which technology is most effective. Therefore, future researchers can conduct experimental studies on older adults using different information systems to compare outcomes, which can then be applied to healthcare facilities and local government services.

Acknowledgements

The authors thank the institutions for their support of this study. The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Bernocchi, P., Giordano, A., Pintavalle, G., Galli, T., Ballini Spoglia, E., Baratti, D., & Scalvini, S. (2019). Feasibility and Clinical Efficacy of a Multidisciplinary Home-Telehealth Program to Prevent Falls in Older Adults: A Randomized Controlled Trial. *Journal of the American Medical Directors Association*, *20*(3), 340–346. https://doi.org/10.1016/j.jamda.2018.09.003

Bevilacqua, R., Maranesi, E., Riccardi, G. R., Di Donna, V., Pelliccioni, P., Luzi, R., Lattanzio, F., & Pelliccioni, G. (2019). Non-immersive virtual reality for rehabilitation of the older people: A systematic review into efficacy and effectiveness. *Journal of Clinical Medicine*, *8*(11), 1–14. https://doi.org/10.3390/jcm8111882

Buisseret, F., Catinus, L., Grenard, R., Jojczyk, L., Fievez, D., Barvaux, V., & Dierick, F. (2020). Timed up and go and six-minute walking tests with wearable inertial sensor: One step further for the prediction of the risk of fall in elderly nursing home people. *Sensors (Switzerland)*, *20*(11), 1–15. https://doi.org/10.3390/s20113207

Brucki, S. M. D. (2015). Timed Up and Go test: a simple test gives important information in elderly. Arquivos De Neuro-psiquiatria (Academia Brasileira de Neurologia (ABNEURO)), 73(3), 185-186. https://doi.org/10.1590/0004-282X20140243

Das, J., Kutum, T., Deori, C., & Deori, R. (2024). TELEHEALTH TECHNOLOGY AND HEALTHCARE. Futuristic Trends in Biotechnology, Volume 3, Book 10, Part 2, Chapter 7. https://doi.org/10.58532/v3bfbt10p2ch7

Delbaere, K., Valenzuela, T., Lord, S. R., Clemson, L., Zijlstra, G. A. R., Close, J. C. T., Lung, T., Woodbury, A., Chow, J., McInerney, G., Miles, L., Toson, B., Briggs, N., & Van Schooten, K. S. (2021). E-health StandingTall balance exercise for fall prevention in older people: Results of a two year randomised controlled trial. *The BMJ*, *373*. https://doi.org/10.1136/bmj.n740

Elbaz, S., Cinalioglu, K., Sekhon, K., Gruber, J., Rigas, C., Bodenstein, K., Naghi, K., Lavin, P., Greenway, K. T., Vahia, I., Rej, S., & Sekhon, H. (2021). A Systematic Review of Telemedicine for Older Adults With Dementia During COVID-19: An Alternative to In-person Health Services? *Frontiers in Neurology*, *12*(December). https://doi.org/10.3389/fneur.2021.761965

Falzon, D., Temesgen, Z., & Story, A. (2023). Digital Technology for Global Health. In Sustainable Development Goals Series (pp. 383-387). Springer International Publishing. https://doi.org/10.1007/978-3-031-33851-9_58

Gallamini, M., Piastra, G., Lucarini, S., Porzio, D., Ronchi, M., Pirino, A., Scoppa, F., Masiero, S., & Tognolo, L. (2021). Revisiting the instrumented romberg test: Can today's technology offer a risk-of-fall screening device for senior citizens? an experience-based approach. *Life*, *11*(2), 1–20. https://doi.org/10.3390/life11020161

Gaspar, A. G. M., & Lapão, L. V. (2022). A Digital Health Service for Elderly People with Balance Disorders and Risk of Falling: A Design Science Approach. *International Journal of Environmental Research and Public Health*, *19*(3). https://doi.org/10.3390/ijerph19031855

Goldsack, J. C., & Zanetti, C. A. (2020). Defining and Developing the Workforce Needed for Success in the Digital Era of Medicine. *Digital Biomarkers*, *4*(suppl 1), 136–142. https://doi.org/10.1159/000512382

Greene, B. R., McManus, K., Ader, L. G. M., & Caulfield, B. (2021). Article unsupervised assessment of balance and falls risk using a smartphone and machine learning. *Sensors*, *21*(14), 4770.

https://doi.org/10.3390/s21144770

Hamm, J., Money, A. G., & Atwal, A. (2019). Enabling older adults to carry out paperless falls-risk self-assessments using guidetomeasure-3D: A mixed methods study. *Journal of Biomedical Informatics*, *92*. https://doi.org/10.1016/j.jbi.2019.103135

Heponiemi, T., Jormanainen, V., Leemann, L., Manderbacka, K., Aalto, A. M., & Hyppönen, H. (2020). Digital divide in perceived benefits of online health care and social welfare services: National cross-sectional survey study. *Journal of Medical Internet Research*, *22*(7). https://doi.org/10.2196/17616

Howcroft, J., Lemaire, E. D., & Kofman, J. (2016). Wearable-sensor-based classification models of faller status in older adults. *PLoS ONE*, *11*(4), 1–16. https://doi.org/10.1371/journal.pone.0153240

Hughes, K. J., Salmon, N., Galvin, R., Casey, B., & Clifford, A. M. (2019). Interventions to improve adherence to exercise therapy for falls prevention in community-dwelling older adults: Systematic review and meta-analysis. *Age and Ageing*, *48*(2), 185–195. https://doi.org/10.1093/ageing/afy164

Julianto, E. K., Mufidah, A., & Adha, E. A. H. (2022). Hubungan Tingkat Aktivitas Sehari Hari dengan Resiko Jatuh pada Lansia di Desa Tulung Rejo Kecamatan Trucuk Kabupaten Bojonegoro. *Jurnal Ilmu Kesehatan MAKIA*, *12*(2), 135–139.

Jun, W. (2020). A study on the current status and improvement of the digital divide among older people in Korea. *International Journal of Environmental Research and Public Health*, *17*(11), 1–13. https://doi.org/10.3390/ijerph17113917

Kim, H. S., Kwon, I. H., & Cha, W. C. (2021). Future and development direction of digital healthcare. *Healthcare Informatics Research*, *27*(2), 95–101. https://doi.org/10.4258/HIR.2021.27.2.95

Lacroix, A., Kressig, R. W., Muehlbauer, T., Gschwind, Y. J., Pfenninger, B., Bruegger, O., & Granacher, U. (2016). Effects of a supervised versus an unsupervised combined balance and strength training program on balance and muscle power in healthy older adults: A randomized controlled trial. *Gerontology*, *62*(3), 275–288. https://doi.org/10.1159/000442087

Li, F., Harmer, P., Voit, J., & Chou, L.-S. (2021). Implementing an online virtual falls prevention intervention during a public health pandemic for older adults with mild cognitive impairment: A feasibility trial. *Clinical Interventions in Aging*, *16*, 973 – 983. https://doi.org/10.2147/CIA.S306431

Mansson, L., Lundin-Olsson, L., Skelton, D. A., Janols, R., Lindgren, H., Rosendahl, E., & Sandlund, M. (2020). Older adults' preferences for, adherence to and experiences of two self-management falls prevention home exercise programmes: A comparison between a digital programme and a paper booklet. *BMC Geriatrics*, *20*(1). https://doi.org/10.1186/s12877-020-01592-x

Maranesi, E., Casoni, E., Baldoni, R., Barboni, I., Rinaldi, N., Tramontana, B., Amabili, G., Benadduci, M., Barbarossa, F., Luzi, R., Di Donna, V., Scendoni, P., Pelliccioni, G., Lattanzio, F., Riccardi, G. R., & Bevilacqua, R. (2022). The Effect of Non-Immersive Virtual Reality Exergames versus Traditional Physiotherapy in Parkinson's Disease Older Patients: Preliminary Results from a Randomized-Controlled Trial. *International Journal of Environmental Research and Public Health*, *19*(22). https://doi.org/10.3390/ijerph192214818

Matchar, D. B., Duncan, P. W., Lien, C. T., Ong, M. E. H., Lee, M., Gao, F., Sim, R., & Eom, K. (2017). Randomized Controlled Trial of Screening, Risk Modification, and Physical Therapy to Prevent Falls Among the Elderly Recently Discharged From the Emergency Department to the Community: The Steps to Avoid Falls in the Elderly Study. *Archives of Physical Medicine and Rehabilitation*, *98*(6), 1086–1096. https://doi.org/10.1016/j.apmr.2017.01.014

McGarrigle, L., Boulton, E., & Todd, C. (2020). Map the apps: a rapid review of digital approaches to

support the engagement of older adults in strength and balance exercises. *BMC Geriatrics*, *20*(1), 1–11. https://doi.org/10.1186/s12877-020-01880-6

Musril, H. A., Jasmienti, J., & Hurrahman, M. (2020). Implementasi Teknologi Virtual Reality Pada Media Pembelajaran Perakitan Komputer. *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, *9*(1), 83. https://doi.org/10.23887/janapati.v9i1.23215

Oliveira-Zmuda, G. G., Soldera, C. L. C., Jovanov, E., & Bós, Â. J. G. (2022). Timed Up and Go test phases as predictors of future falls in community-dwelling older adults. SciELO journals. https://doi.org/https://doi.org/10.6084/m9.figshare.21383151.v1

Orton, M., Agarwal, S., Muhoza, P., Vasudevan, L., & Vu, A. (2018). Strengthening delivery of health services using digital devices. *Global Health Science and Practice*, *6*, S61–S71. https://doi.org/10.9745/GHSP-D-18-00229

Palestra, G., Rebiai, M., Courtial, E., & Koutsouris, D. (2018). Evaluation of a rehabilitation system for the elderly in a day care center. *Information (Switzerland)*, *10*(1), 1–14. https://doi.org/10.3390/info10010003

Pedrero-Sánchez, J. F., De-Rosario-Martínez, H., Medina-Ripoll, E., Garrido-Jaén, D., Serra-Añó, P., Mollà-Casanova, S., & López-Pascual, J. (2023). The Reliability and Accuracy of a Fall Risk Assessment Procedure Using Mobile Smartphone Sensors Compared with a Physiological Profile Assessment. *Sensors*, *23*(14). https://doi.org/10.3390/s23146567

Pettersson, B., Wiklund, M., Janols, R., Lindgren, H., Lundin-Olsson, L., Skelton, D. A., & Sandlund, M. (2019). 'Managing pieces of a personal puzzle'-Older people's experiences of self-management falls prevention exercise guided by a digital program or a booklet. *BMC Geriatrics*, *19*(1). https://doi.org/10.1186/s12877-019-1063-9

Pfeiffer, K., Kampe, K., Klenk, J., Rapp, K., Kohler, M., Albrecht, D., Büchele, G., Hautzinger, M., Taraldsen, K., & Becker, C. (2020). Effects of an intervention to reduce fear of falling and increase physical activity during hip and pelvic fracture rehabilitation. *Age and Ageing*, *49*(5), 771 – 778. https://doi.org/10.1093/ageing/afaa050

Qiu, H., Rehman, R. Z. U., Yu, X., & Xiong, S. (2018). Application of Wearable Inertial Sensors and A New Test Battery for Distinguishing Retrospective Fallers from Non-fallers among Community-dwelling Older People. *Scientific Reports*, *8*(1), 1. https://doi.org/10.1038/s41598-018-34671-6

Ricciardi, W., Pita Barros, P., Bourek, A., Brouwer, W., Kelsey, T., Lehtonen, L., Anastasy, C., Barry, M., De Maeseneer, J., Kringos, D., McKee, M., Murauskiene, L., Nuti, S., Siciliani, L., & Wild, C. (2019). How to govern the digital transformation of health services. *European Journal of Public Health*, *29*, 7–12. https://doi.org/10.1093/eurpub/ckz165

Sachdeva, S., & Ali, A. (2022). Rise of Telemedicine in Healthcare Systems Using Machine Learning: A Key Discussion. In K. Sharma, Y. Gigras, V. Sharma, D. J. Hemanth, & R. C. Poonia (Eds.), Internet of Healthcare Things: Machine Learning for Security and Privacy (pp. 113-130). https://doi.org/https://doi.org/10.1002/9781119792468.ch6

Sadura-Sieklucka, T., Czerwosz, L. T., Kądalska, E., Kożuchowski, M., Księżopolska-Orłowska, K., & Targowski, T. (2023). Is Balance Training Using Biofeedback Effective in the Prophylaxis of Falls in Women over the Age of 65? *Brain Sciences*, *13*(4). https://doi.org/10.3390/brainsci13040629

Sari, Y. M., Burton, E., Lee, D.-C. A., & Hill, K. D. (2023). A Telehealth Home-Based Exercise Program for Community-Dwelling Older People with Dementia in Indonesia: A Feasibility Study. *International Journal of Environmental Research and Public Health*, *20*(4). https://doi.org/10.3390/ijerph20043397

Sherrington, C., Fairhall, N. J., Wallbank, G. K., Tiedemann, A., Michaleff, Z. A., Howard, K.,

Clemson, L., Hopewell, S., & Lamb, S. E. (2019). Exercise for preventing falls in older people living in the community. *Cochrane Database of Systematic Reviews*, *2019*(1). https://doi.org/10.1002/14651858.CD012424.pub2

Suttanon, P., Hill, K. D., Said, C. M., Williams, S. B., Byrne, K. N., Logiudice, D., Lautenschlager, N. T., & Dodd, K. J. (2013). Feasibility, safety and preliminary evidence of the effectiveness of a home-based exercise programme for older people with Alzheimer's disease: A pilot randomized controlled trial. *Clinical Rehabilitation*, *27*(5), 427–438. https://doi.org/10.1177/0269215512460877

The Joint Commission. (2015). *Preventing falls and fall-related injuries in health care facilities*.

Tjahyanti, L. P. A. S., Saputra, P. S., & Gitakarma, M. S. (2022). Peran artificial intelligence (AI) untuk mendukung pembelajaran di masa pandemi covid-19 [The role of artificial intelligence (AI) to support learning during the covid-19 pandemic]. *Jurnal Komputer Dan Teknologi Sains (KOMTEKS)*, *1*(1), 16–17.

Tomita, M. R., Fisher, N. M., Ramsey, D., Stanton, K., & Naughton, B. J. (2019). Follow-Up of a Virtual-Group-Exercise at Home Program to Reduce Fall Risks. *Journal of the American Geriatrics Society*, *67*(9), 1981–1983. https://doi.org/10.1111/jgs.15992

Tossaint-Schoenmakers, R., Versluis, A., Chavannes, N., Talboom-Kamp, E., & Kasteleyn, M. (2021). The challenge of integrating eHealth into health care: Systematic literature review of the donabedian model of structure, process, and outcome. *Journal of Medical Internet Research*, *23*(5). https://doi.org/10.2196/27180

Trenerry, B., Chng, S., Wang, Y., Suhaila, Z. S., Lim, S. S., Lu, H. Y., & Oh, P. H. (2021). Preparing Workplaces for Digital Transformation: An Integrative Review and Framework of Multi-Level Factors. *Frontiers in Psychology*, *12*(March), 1–24. https://doi.org/10.3389/fpsyg.2021.620766

Uzor, S., & Baillie, L. (2019). RECOv-R: Evaluation of a home-based tailored exergame system to reduce fall risk in seniors. *ACM Transactions on Computer-Human Interaction*, *26*(4). https://doi.org/10.1145/3325280

Valenzuela, T., Okubo, Y., Woodbury, A., Lord, S. R., & Delbaere, K. (2018). Adherence to Technology-Based Exercise Programs in Older Adults: A Systematic Review. *Journal of Geriatric Physical Therapy*, *41*(1), 49–61. https://doi.org/10.1519/JPT.0000000000000095

Van Vugt, V. A., Van Der Wouden, J. C., Essery, R., Yardley, L., Twisk, J. W. R., Van Der Horst, H. E., & Maarsingh, O. R. (2019). Internet based vestibular rehabilitation with and without physiotherapy support for adults aged 50 and older with a chronic vestibular syndrome in general practice: Three armed randomised controlled trial. *The BMJ*, *367*, 1–11. https://doi.org/10.1136/bmj.l5922

Wardhana, N. J., Arthana, I. K. R., & Divayana, D. G. H. (2019). Pengembangan Aplikasi Virtual Reality 3D Pengenalan Manusia Purba Bangsa Indonesia untuk SMA Kelas X (Studi Kasus SMA Negeri 2 Singaraja). *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, *8*(2), 109. https://doi.org/10.23887/janapati.v8i2.17714

Watson, P., Bearpark, T., & Ling, J. (2021). The impact of rapid response and telecare services on elderly and vulnerable residents. *Health and Social Care in the Community*, *29*(4), 897–904. https://doi.org/10.1111/hsc.13123

World Health Organization. (2021). *Falls*. https://www.who.int/news-room/fact-sheets/detail/falls

World Health Organization. (2023). *Patient safety*. https://www.who.int/news-room/fact-sheets/detail/patient-safety

Wynn, R., Gabarron, E., Johnsen, J. A. K., & Traver, V. (2020). Special issue on e-health services. *International Journal of Environmental Research and Public Health*, *17*(8). https://doi.org/10.3390/ijerph17082885

Yi, D., & Yim, J. (2021). Remote Home-Based Exercise Program to Improve the Mental State, Balance, and Physical Function and Prevent Falls in Adults Aged 65 Years and Older during the COVID-19 Pandemic in Seoul, Korea. *Medical Science Monitor*, *27*. https://doi.org/10.12659/MSM.935496