Review Article

Usability of Videoconferencing Technology to Deliver Physical Activity Interventions to Older People Living in the Community: A Systematic Review

Louise Robin[1,2]*, Benoit Borel[1]*, Stephane Mandigout[1], Charles Sebiyo Batcho[1-3] and Axelle Gélineau[1]

[1]*Center for Interdisciplinary Research in Rehabilitation and Social Integration (CIRRIS), Canada*
[2]*University of Limoges, Laboratoire HAVAE-UR20217, France*
[3]*Department of Rehabilitation, Laval University, Canada*

Abstract

Background: Videoconference combines the convenience of home exercise with the group interaction and supervision of exercise in the community, and appears useful for increasing physical activity (PA) level of older people.

Objective: To assess evidence on the usability of videoconferencing technologies as a medium for a PA intervention delivered synchronously to healthy older adults.

Methods: Four databases (Pubmed/Ovid Medline, Embase, Scopus, and CINHAL) were searched until November 2022 for articles on measures of usability, effectiveness, efficiency and satisfaction of technology, used to deliver the PA program in older adults. The Mixed Methods Appraisal Tool was used for quality assessment.

Results: A total of 8 studies was included. Our results showed that videoconferencing intervention strategies can be used to deliver a PA intervention, but that their effectiveness, efficiency, and satisfaction are variable depending on the technological medium used. Despite the significant use of videoconferencing with the elderly, we identified a small number of studies that evaluate usability. We found a lack of usability testing methods to evaluate technologies used to conduct remote PA interventions.

Conclusion: Measuring the usability of technologies used to deliver PA programs can help develop and evolve them to meet the needs and characteristics of older adults. This review has shown that measuring usability supports the conclusion that older adults can use a technology support to monitor an intervention. Further research, using standardized tools, is needed to help older adults engage in physical activity.

INTRODUCTION

Several research studies have shown that regular physical activity (PA) limit some of the effects of aging in order to preserve the quality of life and independence of seniors [1]. However, access to exercise programs among older adults is often low due to environmental barriers such as difficulty of access to infrastructure where these programs are delivered [2]. Another option for achieving regular PA practice is to exercise at home. In particular, multidirectional exercises (e.g., Pilates or OTAGO) have become popular for targeting balance impairments in older [3]. However, home-based exercise does not allow for supervision and social interaction in its original format (practicing alone at home, without supervision). Social isolation and lack of peer interaction among homebound older adults reduces their motivation to exercise [4].

Thus, an ideal form of exercise program for these older adults might be to combine the convenience of home exercise with the group interaction and supervision of exercise in the community. Video conferencing technologies allow a group of older adults and a clinician to "meet" from their homes and train together live and interactively [5-7]. These systems offer the potential for new strategies such as feedback, social support, coaching, and appear to be particularly useful for increasing PA [5]. Nevertheless, despite their potential benefits, integration of videoconferencing systems into daily practice remains rare.

To be used effectively, it is essential that the technology

⊘SciMedCentral

matches the user's needs (clients and clinicians) [8]. This consideration refers to the notion of usability. The International Organization for Standardization (ISO) described usability as, "the degree to which a product can be used, by identified users, to achieve defined goals with effectiveness, efficiency, and satisfaction, within a specified context of use" [9]. For older adults undergoing geriatric rehabilitation, usability is particularly crucial, as there are age-related barriers that can hinder eHealth use [10]. Therefore, it appears necessary to appraise evidence on the usability of videoconferencing solution for providing a PA intervention. The objective of this systematic review was to assess evidence on the usability of videoconferencing technologies as a medium for a PA intervention delivered synchronously to healthy older adults.

METHODS

Search strategy

This systematic review was structured according to the PRISMA guidelines [11]. The review was conducted by 2 independent reviewers (LR and BB) using the following four leading databases: PubMed/Ovid Medline, Embase, Scopus, and CINHAL. The following keywords were identified and combined to address the research questions: 1) The target population was healthy elderly people. The population was not to be studied because of a specific health characteristic (osteoarthritis, post-fall, motor or cognitive disorders...), 2) videoconference used as support of intervention, 3) program of PA as a type of intervention and 4) usability as the main purpose. Synonyms were used to maximize inclusion. Keyword and related subject heading searched using Boolean operators. Publications were included until November 2022. The Mesh terms and combinations used are listed in Table 1.

Eligibility Criteria

The selection of studies was conducted based on pre-specified PICOS [12]:

(1) Participants: older adults (≥65 years old) without health problems identified by the articles.

(2) Intervention: Physical exercises delivered via videoconferencing technologies. The Telerehabilitation (TR) Intervention should have been delivered at home or local community contexts.

(3) Comparison: A control group was not necessary for this research.

(4) Outcome: The ease of use, efficiency and effectiveness of videoconferencing technologies to deliver exercise interventions at a distance and the satisfaction or acceptance of older people. These criteria attest to the usability of the technology as a medium for remote interventions.

(5) Study design: we included Randomised Controlled Trials (RCT), non-randomised controlled trials (NRCT), non-controlled trials (NCT), crossover and pilot studies without control group.

Table 1: Research terms

	Terms MeSh	
	PubMed, CINHAL, Embase	Scopus
Population	((Aged people) OR (Aged adult*) OR (Aging) OR (older adult*) OR ("Older people") OR (Elder*) OR (Seniors))	(older adults OR "aged people" OR senior OR aging)
	NOT	AND NOT
	((Disease) OR (Child*) OR (Syndrome) OR (Young) OR (Chronic) OR (Fracture) OR (Pain) OR (Surgery) OR (Stroke) OR (Dysph*) OR (Parkinson) OR (Incontinence) OR (Obstruct*) OR (Sclerosis) OR (COPD) OR (Diabet*) OR (HIV) OR (Alzheimer) OR (Arthritis) OR (Dement*) OR (Heart) OR (Cancer) OR (Cardia*) OR (obesity))	(diabete OR cancer OR parkinson OR sclerosis OR chronic OR surgery OR demencia OR alzheimer OR disorders)
	AND	AND
Method of intervention	((web-based) OR (teleconferenc*) OR (Videoconferenc*) OR (Telehealth) OR (Telerehabilitation) OR (Tele-rehabilitation) OR (Teleexercise) OR (Tele-exercise))	(visioconference OR visioconferencing OR teleconferencing OR tele-rehabilitation OR telerehabilitation OR telehealth OR teleexercise)
	AND	AND
Type of intervention	((Physical exercise*) OR (Physical activit*) OR (Fitness exercise*) OR (Remedial exercise*) OR (Exercise therap*) OR (Rehabilitation) OR (Motor activity) OR (Physical fitness) OR (Exercise Movement Techniques))	("physical activity" OR "physical exercise" OR exercises)
	AND	AND
Outcomes	((Usability) OR ("ease-of-use") OR (efficiency) OR (satisfaction) OR (efficacy) OR (effectiveness))	(usability OR "ease-of-use" OR efficiency OR satisfaction OR efficacy OR effectiveness)

Non-peer reviewed conference and journal publications, review articles, and publications that took place in hospitals, rehabilitation centers or care settings were excluded.

Data collection and analysis

Selection of studies. Using Covidence software (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia), two authors (LR, BB) reviewed and pre-screened all titles and abstracts of studies identified by the search strategy for possible inclusion according to the selection criteria. The full text of the pre-selected articles was checked for eligibility. In case of disagreement, discussions were made in order to identify a collegiate response and if no consensus could be reached, the decision was made by a third author (CSB).

Data extraction. Two authors (LR, AG) extracted data from each study meeting the inclusion criteria, using a data collection form, with the other authors (BB, CSB, SM) performing a final check. We extracted authors' names, year of study, country, objectives, study design, population (i.e. sample size, age and place of residence), intervention modalities (e.g. technological support, group or individual sessions) and comparator (e.g. face-to-face intervention or simply counselling), results and conclusions on usability effectiveness, efficiency and satisfaction of the proposed techonlogies.

⊘SciMed Central

Quality assessment of studies and risk of bias

Critical appraisal of study quality was independently conducted by two reviewers (LR, AG) using the Mixed Methods Appraisal Tool (MMAT), a reliable and efficient instrument which is suitable for appraising quantitative, qualitative, and mixed methods research across multiple disciplines [13-15]. The MMAT allows for quality assessment by applying a different set of five criteria to diverse study designs, including qualitative, RCT, NRCT, observational descriptive and mixed methods.

RESULTS

The search strategy yielded 731 records, from which 515 abstracts were selected after eliminating duplicates. After title and abstract selection, 24 articles were retained for full text screening. After reading each publication, 16 publications were excluded: 7 publications were not related to an intervention delivered via videoconferencing, 5 were not pursuing the targeted study objective (no results to evaluate the usability of the technology), 3 were not related to our population of interest, and 1 was retracted. Finally, 8 full-text publications were included (Figure 1).

Included studies

The main characteristics of the studies are summarised in Table 2 (**Included in Supplementary data**).

Publication. None of the included publications were published before 2006, 1 study was published in 2006 [16] and 7 between 2016 and 2022 [7,17-22].

Population. Sample sizes varied across the studies, ranged from 7 up to 302 participants. Participants were on average aged 73.1 [69.6-81] years old.

Intervention. The interventions consisted of the application of a PA program inspired by pre-existing home-based activity programs, e.g., Gerofit [23], OTAGO [18,22] or yoga and tai chi techniques [16] or designed by physiotherapists [24]. Except one study [18], which lasted only 3 weeks, PA interventions duration ranged from 8 [7,24] to 12 weeks [16,17,22]. The interventions were all supervised by health professionals or certified trainers. Finally, two studies compared the group receiving a remote intervention with a group receiving a recorded remote intervention [17] or a control group receiving a traditional intervention [22].

Videoconferencing systems. Different terms were used by authors to describe the intervention medium: Teleconferencing [18], videoconferencing [16,24,25], tele-exercise [19], telehealth [22,26], web-based live intervention (17) and virtual-group exercise [21]. Similarly, various technological supports were used: computer [21,22], smartphone [18], TV screen [16], allowing access to various videoconferencing softwares such as Zoom® [17,19,24,26], Skype® [18], or Whats'app® [24].
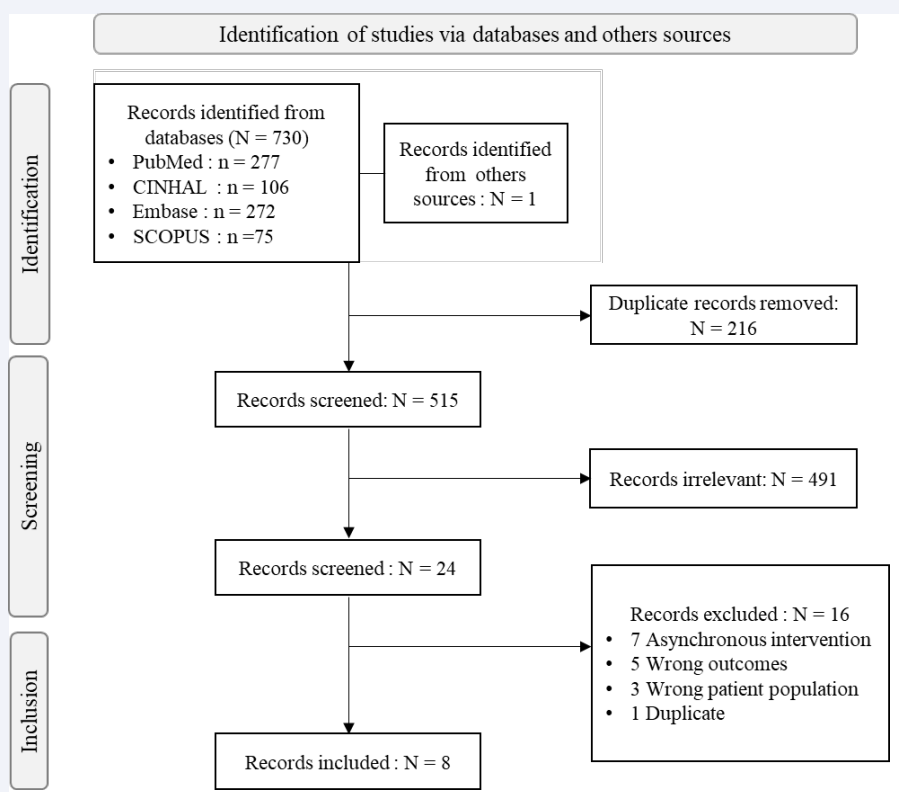

Figure 1 Flow chart.

Table 3: Critical appraisal of study quality

Author, year	Screening questions		1. Qualitative studies					2. Quantitative randomized controlled trials					3. Quantitative non-randomized studies					4. Quantitative descriptive studies					5. Mixed methods studies				
	S1	S2	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5
Granet et al., 2022								0	0	0	0	1															
Hawley-Hague et al., 2021	1	1	1	1	1	1	1																				
Ho et al., 2022	1	1																1	1	0	0	1					
Jennings et al., 2020	1	1											1	1	1	CT	0										
Schwartzt al., 2021	1	1	1	1	1	1	1						1	1	1	CT	1						CT	1	1	1	1
Tomita et al., 2016	1	1						0	1	1	0	1															
VanRavenstein et al., 2020	1	1	1	1	1	1	1						1	1	1	CT	1						1	1	1	1	1
Wu et Keyes, 2006	1	1																1	1	1	1	1					
Note: 1= yes; 0= No, CT = can't tell																											

Critical appraisal of study quality

For the only RCT identified and included in this systematic review, the randomization approach was poorly detailed. Blinded evaluation was not also specified. Nevertheless, the participants were representative of the study population and the authors reported good adherence to the intervention [17]. We included one quantitative descriptive study [19]. This study contains various biases raised by the authors. The pre-selected participants were not representative of the study population and only 14% of the intervention participants agreed to be interviewed [19]. We included one qualitative study [18], one non-randomized quantitative study [7] and one quantitative descriptive study [16] that were of good quality. Finally, 2 studies followed a mixed-model [20,22]. We note that these studies carried out 2 distinct designs to meet 2 different objectives. In this way, the methods do not always complement each other. Nevertheless, these studies are of good quality and a good adherence to the intervention is reported. The methodologies used in the mixed studies are consistent and the participants are representative of the populations studied. These results regarding study quality are summarized in (Table 3).

Usability of technological support

Effectiveness of technological support: All studies indicate that it is possible to deliver PA interventions synchronously via videoconferencing technology. Adherence and participation rates ranged from 50 to 100% [16,17,22,24]. Reasons given for continuing or not continuing exercise were independent of the technology used. There were individual characteristics, like lack of interest in the intervention or health problems [17]. The high attrition of participants in the studies testifies to the effectiveness of the technologies used. It appears possible for participants to join the interventions conducted remotely. The instructions and progression of the exercise were the same as face-to-face [21]. All the technological supports have been effective in delivering video conferencing intervention programmes.

Efficiency of technological support: Five studies evaluated the efficiency of the interventions offered by videoconferencing [16,18,19,24,26]. Their results address different issues: ease of use and ease of learning, user acceptability of the technology, technological reliability, safety and cost.

Ease of use and learn, Ho & Merchant (2022) report that, while 79% of respondents acknowledged having the knowledge to use the system, 57% (n=24) were apprehensive about using the technology. Forty one percent (n=17) disagreed or were neutral that the technology is easy to use. However a majority (60%, n=25) of respondents agreed with the affirmation "technology is easy to learn". Eighty-six percent (n=36) agreed that they could accomplish the task if someone showed them or through an instruction manual. The proper use of the tool required a learning period from the intervention sessions in 2 studies. These sessions were either two face-to-face sessions to learn about the technology and software [18] or a short 2.5 hours training session [16].

Acceptability of the technology, The initial concerns of the older people were about installing the equipment and using it (sometimes large screens in small spaces) [18]. Nevertheless, the majority managed to use the technology without major difficulties [16,18]. Where difficulties arose, the use of the technology was facilitated by the existence of associated services.

Reliability of the technology, these services could help with connection, audio (such as adjusting the volume of the microphone) or hardware problems (such as a faulty camera, microphone or videoconferencing device audio circuit) that could compromise clinician-participant interaction, well as hold the intervention [16,18,24]. The technology support chosen to be more or less effective depending on the group. Jennings et al. (2020) indicate that group size was influenced by the platform used. The Veteran affairs platform had limitations on the number of people observed simultaneously, while the Zoom platform did not.

Security, Hawley-Hague et al., reported that for health professionals, a display issue emerged: difficulty in seeing contrasts when the senior was dressed in black or if the room light was low. This was exacerbated in group sessions as the individual

image was smaller. While these difficulties were not a concern for the patients who felt safe to perform the exercises, it raises up increased safety concerns according to the professionals. Jennings et al., also reported that 95% of participants had reported feeling safe during exercise sessions.

Cost, finally, the financial situation of older adults must be considered. For 35% of the participants in the study of Ho & Merchant (2022), it limited technology use. Similarly, many participants were resistant to broadband installation because of the cost that would have to be borne once the study was completed [18]

Satisfaction: Some people were afraid to have the technology installed in their homes, finding it too intrusive [18]. However, as reported in many other studies, people were satisfied with the overall intervention, the proposed program and the technology [16-19,22,24]. They were willing to continue the interventions by visioconference if possible [16].

Various advantages of videoconferencing technologies were noted. The tool made it possible to limit external risks such as frozen roads [16], and was more interesting than telephone follow-up, particularly during the follow-up phase [18]. The group sessions enabled by the technology provided considerable value through the possible interaction between participants and the instructor. Schwartz et al., reported that for one person, the group activity allowed by videoconferencing helped alleviate feelings of loneliness and created a positive atmosphere. The instructor's remote presence via videoconferencing and professionalism were appreciated and reassuring [21,24]. Two studies reported that the technology delivered an intervention in which participants perceived benefits on physical and mental well-being [19,24].

DISCUSSION

The use of videoconferencing allows professionals to offer PA interventions to older adults despite their isolation. Nevertheless, it seemed important to evaluate the usability of the technological supports used to propose these interventions while encouraging the adherence of the older people. To our knowledge, this is the first systematic review to evaluate the usability of various technological supports for delivering PA programs to seniors via videoconferencing. Our results indicate that intervention strategies via videoconferencing are usable, but their usability is variable depending on the technological support used.

Usability of videoconferencing technologies

All of the studies included in this review demonstrated the effectiveness of technology-based supports in delivering live, remote PA interventions, with variable adherence rates (ranging from 57% to 100%), sometimes higher than adherence rates for exercise programs offered without video conferencing Geraedts et al,.Thus, technology was not a deterrent to exercise cessation.

While videoconferencing is effective in providing a live remote

PA intervention, our results indicate various points of caution. Firstly, variations in participants' adherence to the program could be influenced by user characteristics. It may be more difficult to use technology for adults inexperienced with technology [17] Our results showed that older people may require external assistance to use the technology [16,18,19]. These observations are consistent with the litterature. Kim et al, reported that cardiovascular rehabilitation can be adapted remotely for people who are disabled, isolated, or socioeconomically disadvantaged older people. Some factors hold back the use of technology by older adults users, the main are the cost of the technology, followed by its complexity to use technology [29,30]. This may justify the importance for obtaining environmental supports, i.e. financial support and training opportunities, as it appears essential to help older users to overcome technological barriers [31]. Secondly, variations in effectiveness technology effectiveness could be influenced by device characteristics and user satisfaction with the technology. According to our results, clinicians and older adults may encounter reliability issues with the technology that compromised the intervention and thus hindered user satisfaction and safety of older adults [16,22]. Some platforms appear to be less usable than others for large group interventions [7,18]. For videoconferencing systems, the required bandwidth, the security of the transmitted images and the importance of reliability are important factors to consider [32]. In the event of difficulties with technology, some solutions exist, for example [17] suggested that recorded sessions may be appropriate for participants who are temporarily unable to attend live, online group sessions.

Assessment of usability

Through this synthesis, we have identified different methods to assess the usability of videoconferencing technology to deliver PA programs to older people. Qualitative interviews, auto-questionnaires and observations were preferred to assess the efficiency of the technological support and the satisfaction of the users with the system and the proposed intervention. These self-reported collection methods provide relevant information about users' perceptions: if they report positive feelings or reactions to a technology, then they are likely to use or reuse it [33]. Some studies have also based their measures on theories like constructivist grounded theory [22]or the Technology Acceptance Model [18]. However, no study used existing usability scales such as the System Usability Scale [34] or the Quebec User Evaluation of Satisfaction with Assistive Technology [35]. While qualitative methods are essential to provide specific details that quantitative measures sometimes cannot capture, both qualitative and quantitative approaches should be applied to the design or improvement of technologies. Albert & Tullis emphasize the use of standardized tools as a mean of ensuring measurement quality because they are valid, reliable, available for comparison purposes.

We also note that no study had assessed all the usability attributes defined by the ISO (9) or Nielsen (1993). Most studies

assessed elements covering only part of the theoretical concept, with satisfaction and effectiveness being the most common attributes, while other important aspects such as ease of use or safety are left out. This observation is also shared by Sousa & Dunn Lopez (2017). The results of their review indicate that the questionnaires constructed and used to assess usability in studies only assess part of the usability construct. However, it is possible that some effectiveness studies did not include the assessment of efficiency and satisfaction, as these data could be assessed earlier in the intervention design process.

LIMITATIONS

The use of technology has become very popular in recent years, attracting much research interest. Yet, despite this popularity, quality studies evaluating the usability of technologies are rare. This raises questions about the reliability of the information disseminated and the importance of conducting rigorous scientific research. The level of evidence and the small number of included studies (n=8) are the main limitations of our search. We included pilot studies because videoconferencing interventions have not yet been widely evaluated in healthy older adults. We included pilot studies because videoconferencing interventions have not yet been widely evaluated in healthy older people. Pilot studies often act as a preliminary step for larger research projects [39]. These preliminary studies provide a lot of information about the feasibility of a targeted method. It aims to i) evaluate the methods of recruitment of the population; ii) evaluate the reliability of the technological equipment, iii) take into account adverse events (related to the technology and the intervention or inherent to the safety of the users) [40,41]. These pilot studies thus provide evidence that can be used to assess the usability of interventions delivered via videoconferencing. However, as revealed by our review, the limited number of included studies can be explained by the fact that usability testing is rarely mentioned in research with seniors. This observation is consistent with Meiland et al, who report that usability issues of intervention technologies for people with dementia are very poorly studied. Usability testing of remote intervention technologies appears to be an emerging field whose potential is accentuated during major events, such as the COVID-19 pandemic [43]. The democratization of remote intervention following the pandemic could lead to an increase in studies and publications on this topic. Future research could make usability assessment more comprehensive, for example through mixed methods promoting mixed models, using standardized tools to assess the usability of technologies used with older people. This review may be updated in the next few years.

Clinical perspectives

The COVID-19 pandemic has led to a significant shift in the trajectory of TR adoption to provide remote PA programs. Various studies have been able to find clinical efficacy of remotely delivered interventions [13,44]. However, isolation measures and COVID-19 restrictions are gradually being removed. Clinicians and older adults are no longer required to use remote practice models. They can return to their face-to-face practice [45]. In addition, clinicians have doubts about the usability of technology

to ensure the safety of participants and to provide accurate feedback [18]. As a result, therapists may stop offering remote PA programs. Nevertheless, some participants may prefer to perform these remote interventions [45]. PA programs delivered via videoconferencing through technology provide access to rehabilitation for older adults who do not have access to face-to-face interventions due to, for example, limited access to facilities, particularly in rural areas, and travel difficulties related to aging. Thus, continuing to offer TR allows clinicians to meet the diverse needs of older adults. The positive aspect of the pandemic may be a revision of care delivery models across the continuum, allowing for improved accessibility, adaptability. The prospect of further research into the usability of technologies is necessary [43].

CONCLUSION

Measuring the usability of technologies used to deliver PA programs synchronously to older adults can help to develop and evolve them according to the needs and characteristics of older adults. This review showed that the measurement of usability, efficiency, and effectiveness data concluded that older adults can use technology to deliver a PA intervention. Similarly, questionnaires and scales were the most used tools to measure subjective data of satisfaction and its related dimensions Our results showing that older adults consider their experience as positive, despite some difficulties (related to hardware or connection issues). Further research, using standardized tools, is needed to promote clinician and older people adherence to videoconferencing interventions supported by various technologies; and to ensure the clinical effectiveness of interventions.

REFERENCES

1. Cunningham C, O' Sullivan R, Caserotti P, Tully MA. Consequences of physical inactivity in older adults: A systematic review of reviews and meta-analyses. Scand J Med Sci Sports. 2020; 30: 816–827.

2. Cleland CL, Hunter RF, Kee F, Cupples ME, Sallis JF, Tully MA. Validity of the Global Physical Activity Questionnaire (GPAQ) in assessing levels and change in moderate-vigorous physical activity and sedentary behaviour. BMC Public Health. 2014: 10; 14:1255.

3. Sherrington C, Michaleff ZA, Fairhall N, Paul SS, Tiedemann A, Whitney J, et al. Exercise to prevent falls in older adults: an updated systematic review and meta-analysis. Br J Sports Med. 2017; 51: 1750–1800.

4. Biedenweg K, Meischke H, Bohl A, Hammerback K, Williams B, Poe P, et al. Understanding older adults' motivators and barriers to participating in organized programs supporting exercise behaviors. J Prim Prev. 2014: 35: 1–11.

5. Sullivan AN, Lachman ME. Behavior Change with Fitness Technology in Sedentary Adults: A Review of the Evidence for Increasing Physical Activity. Front Public Health. 2017; 4.

6. Hawley-Hague H, Tacconi C, Mellone S, Martinez E, Ford C, Chiari L, et al. Smartphone Apps to Support Falls Rehabilitation Exercise: App Development and Usability and Acceptability Study. JMIR MHealth UHealth. 2020; 8: e15460.

7. Jennings SC, Manning KM, Bettger JP, Hall KM, Pearson M, Mateas C, et al. Rapid Transition to Telehealth Group Exercise and Functional Assessments in Response to COVID-19. Gerontol Geriatr Med. 2020; 6: 2333721420980313.

8. Eichler S, Rabe S, Salzwedel A, Müller S, Stoll J, Tilgner N, et al. Effectiveness of an interactive telerehabilitation system with home-based exercise training in patients after total hip or knee replacement: study protocol for a multicenter, superiority, no-blinded randomized controlled trial. Trials. 2017; 18: 438.

9. ISO 9241-11:2018. Ergonomie de l'interaction homme-système — Partie 11: Utilisabilité — Définitions et concepts. [Internet]. 2018.

10. Broekhuis M, van Velsen L, ter Stal S, Weldink J, Tabak M. Why My Grandfather Finds Difficulty in using Ehealth: Differences in Usability Evaluations between Older Age Groups. 2019; 48.

11. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. J Clin Epidemiol. 2021; 134: 178–189.

12. Brown D. A Review of the PubMed PICO Tool: Using Evidence-Based Practice in Health Education. Health Promot Pract. 2020; 21: 496–498.

13. Hong QN, Gonzalez-Reyes A, Pluye P. Improving the usefulness of a tool for appraising the quality of qualitative, quantitative and mixed methods studies, the Mixed Methods Appraisal Tool (MMAT). J Eval Clin Pract. 2018; 24: 459–467.

14. Pace R, Pluye P, Bartlett G, Macaulay AC, Salsberg J, Jagosh J, et al. Testing the reliability and efficiency of the pilot Mixed Methods Appraisal Tool (MMAT) for systematic mixed studies review. Int J Nurs Stud. 2012; 49: 47–53.

15. Souto RQ, Khanassov V, Hong QN, Bush PL, Vedel I, Pluye P. Systematic mixed studies reviews: updating results on the reliability and efficiency of the Mixed Methods Appraisal Tool. Int J Nurs Stud. 2015; 52: 500–501.

16. Wu G, Keyes LM. Group tele-exercise for improving balance in elders. Telemed J E-Health Off J Am Telemed Assoc. 2006; 12: 561-570.

17. Granet J, Peyrusqué E, Ruiz F, Buckinx F, Abdelkader LB, Dang-Vu TT, et al. Web-based physical activity interventions are feasible and beneficial solutions to prevent physical and mental health declines in community-dwelling older adults during isolation periods. J Gerontol A Biol Sci Med Sci. 2023; glac127.

18. Hawley-Hague H, Tacconi C, Mellone S, Martinez E, Chiari L, Helbostad J, et al. One-to-One and Group-Based Teleconferencing for Falls Rehabilitation: Usability, Acceptability, and Feasibility Study. JMIR Rehabil Assist Technol. 2021; 8: e19690.

19. Ho V, Merchant RA. The Acceptability of Digital Technology and Tele-Exercise in the Age of COVID-19: Cross-sectional Study. JMIR Aging. 2022; 5: e33165.

20. Schwartz H, Har-Nir I, Wenhoda T, Halperin I. Staying physically active during the COVID-19 quarantine: exploring the feasibility of live, online, group training sessions among older adults. Transl Behav Med. 2021; 11: 314–322.

21. Tomita M, EdD N, Ramsey D, MNS K, Bierdeman L, Kocher L, et al. Effects of Virtual-Group Exercise at Home (V-GEAH) on Adherence and Fall Risks in Older Adults with a History of Falling. Gerontol Geriatr Res. 2016; 2.

22. VanRavenstein K, Brotherton S, Davis B. Investigating the Feasibility of Using Telemedicine to Deliver a Fall Prevention Program: A Pilot Study. J Allied Health. 2020; 49: 221–227.

23. Jennings SC, Manning KM, Bettger JP, Hall KM, Pearson M, Mateas C, et al. Rapid Transition to Telehealth Group Exercise and Functional Assessments in Response to COVID-19. Gerontol Geriatr Med. 2020; 6: 233372142098031.

24. Schwartz H, Har-Nir I, Wenhoda T, Halperin I. Staying physically active during the COVID-19 quarantine: exploring the feasibility of live, online, group training sessions among older adults. Transl Behav Med. 2021; 11: 314-322.

25. Savard J, Labossière S, Cardinal D, Pinet B, Borris C. Évaluation de Marche vers le futur, un programme novateur de prévention des chutes offert par videoconference. Can J Aging. 2018; 37: 363–376.

26. Jennings SC, Manning KM, Bettger JP, Hall KM, Pearson M, Mateas C, et al. Rapid Transition to Telehealth Group Exercise and Functional Assessments in Response to COVID-19. Gerontol Geriatr Med. 2020; 6: 2333721420980313.

27. Geraedts H, Zijlstra A, Bulstra SK, Stevens M, Zijlstra W. Effects of remote feedback in home-based physical activity interventions for older adults: A systematic review. Patient Educ Couns. 2013; 91: 14-24.

28. Kim SY, Daley K, Pruski AD, AlFarra T, Azola A, Gonzalez Fernandez M, et al. Implementation of a Framework for Telerehabilitation in Clinical Care Across the Continuum During COVID-19 and Beyond. Am J Phys Med Rehabil. 2022; 101: 53-60.

29. Marzano G, Lubkina V. A Review of Telerehabilitation Solutions for Balance Disorders. ICTE 2016 Riga Tech Univ Latv. 2017; 104: 250–277.

30. Moore K, O'Shea E, Kenny L, Barton J, Tedesco S, Sica M, et al. Older Adults' Experiences With Using Wearable Devices: Qualitative Systematic Review and Meta-synthesis. JMIR MHealth UHealth. 2021; 9: e23832.

31. Chen K, Chan AHS. Predictors of gerontechnology acceptance by older Hong Kong Chinese. Technovation. 2014; 34: 126-35.

32. Pramuka M, van Roosmalen L. Telerehabilitation Technologies: Accessibility and Usability. Int J Telerehabilitation. 2009; 1: 85-98.

33. Albert WB, Tullis TS. Chapter 8 - Measuring Emotion. In: Measuring the User Experience (Third Edition). Third. Morgan Kaufmann; 2022; 195-216.

34. Bangor A, Kortum PT, Miller JT. An Empirical Evaluation of the System Usability Scale. Int J Human–Computer Interact. 2008; 24: 574-594.

35. Demers L, Weiss-Lambrou R, Ska B. Development of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). Assist Technol Off J RESNA. 1996; 8: 3-13.

36. Albert B, Tullis T. Chapter 5 - Self-Reported Metrics. In: Measuring the User Experience (Third Edition). Morgan Kaufmann; 2022; 109-51. (Interactive Technologies).

37. Nielsen J. Usability Inspection Methods: Book by Jakob Nielsen. Nielsen Norman Group. 1993. Available from: https://www.nngroup.com/books/usability-inspection-methods/

38. Sousa VEC, Dunn Lopez K. Towards Usable E-Health. A Systematic Review of Usability Questionnaires. Appl Clin Inform. 2017; 8: 470-490.

39. Bell ML, Whitehead AL, Julious SA. Guidance for using pilot studies to inform the design of intervention trials with continuous outcomes. Clin Epidemiol. 2018; 10: 153-157.

40. Feeley N, Cossette S, Côté J, Héon M, Stremler R, Martorella G, et al. The importance of piloting an RCT intervention. Can J Nurs Res Rev Can Rech En Sci Infirm. 2009; 41.

41. Leon AC, Davis LL, Kraemer HC. The role and interpretation of pilot studies in clinical research. J Psychiatr Res. 2011; 45: 626-629.

42. Meiland F, Innes A, Mountain G, Robinson L, van der Roest H, García-Casal JA, et al. Technologies to Support Community-Dwelling Persons With Dementia: A Position Paper on Issues Regarding Development, Usability, Effectiveness and Cost-Effectiveness, Deployment, and Ethics. JMIR Rehabil Assist Technol. 2017; 4: e1.

43. Hill JR, Brown JC, Campbell NL, Holden RJ. Usability-In-Place—Remote Usability Testing Methods for Homebound Older Adults: Rapid Literature Review. JMIR Form Res. 2021; 5: e26181.

44. Kuldavletova O, Pasquier F, Bigot L, Langeard A, Gauthier A, Quarck G. Videoconference-Based Adapted Physical Exercise Training Is a Good and Safe Option for Seniors. Int J Environ Res Public Health. 2021; 18: 9439.

45. Lord Ferguson S. Is the End of the Pandemic the End of Telerehabilitation? Phys Ther. 2022; 102: pzac004.