BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (http://bmjopen.bmj.com).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

Effects of exercise programmes delivered using video technology on physical performance and falls in people aged 60 years and over living in the community: A systematic review and meta-analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-092775
Article Type:	Original research
Date Submitted by the Author:	22-Aug-2024

Complete List of Authors:	Adliah, Fadhia; University of Exeter, Public Health and Sport Sciences; Hasanuddin University Hall, Abigail J.; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences Goodwin, Victoria; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences Lamb, Sarah; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences; University of Oxford, NDORMS

Keywords:	Digital Technology, Exercise, Aged

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Effects of exercise programmes delivered using video technology on physical performance and falls in people aged 60 years and over living in the community: A systematic review and meta-analysis

Fadhia Adliah[1,2]*, Abigail J Hall[1], Victoria A Goodwin[1], Sarah E Lamb[1]

[1] Public Health and Sport Sciences, Faculty of Health and Life Sciences, University of Exeter

[2] Physiotherapy, Faculty of Nursing, Hasanuddin University

Corresponding author:

Fadhia Adliah, Public Health and Sport Sciences, Faculty of Health and Life Sciences, University of Exeter, St Lukes Heavitree Road, Exeter EX1 2LP

Email: fa436@exeter.ac.uk

Abstract

Objectives: This systematic review and meta-analysis synthesised the evidence and evaluated the effect of exercise programmes delivered using instructional videos compared with control on physical performance and falls in community-dwelling older people aged 60 years and older.

Methods: We included all RCT designs. A search was conducted using MEDLINE, EMBASE, CINAHL, PsycINFO, The Cochrane Central Register of Controlled Trials, TRIP, and PEDro databases to identify randomised controlled trials evaluating video-delivered exercise programmes for community-dwelling older people aged ≥60 years. The primary outcome was physical performance including muscle strength, balance, and mobility. Secondary outcomes were number of falls, number of fallers, and fear of falling. We calculated treatment effects using random effects model, 95% CIs, mean differences (MD) and standardised mean differences (SMDs, Hedges' g) for data with the different measurement units. ROB2 was used to assess risk of bias in the included studies.

Results: We identified 13 articles that included 1706 participants. The meta-analysis revealed significant effects of video-delivered exercise programmes in lower extremity strength SMD=0.36, 95%CI 0.09 to 0.63; I^2=73.17%, p=0.01, moderate quality evidence GRADE), balance (SMD=0.45, 95%CI 0.07 to 0.83; I^2=85.07%, p=0.02, low quality evidence GRADE), mobility (MD=0.96, 95%CI 0.46 to 1.46; I^2=53.31%, p<0.001, moderate quality evidence GRADE), and physical performance SMD=0.36, 95%CI 0.17 to 0.56; I^2=13.49%, p<0.001, moderate quality evidence GRADE). No effect of video-delivered exercise programmes on fear of falling was found (SMD=0.61, 95%CI -0.46 to 1.69; I^2=96.39%, p=0.26, very low quality evidence GRADE). There was insufficient data for reporting falls.

Conclusion: Video-delivered exercise programmes improved physical performance particularly lower extremity strength, balance, and mobility, with moderate quality evidence. There is uncertainty about the effect of video-delivered exercise programmes on number of falls, number of fallers, and fear of falling.

PROSPERO registration number: CRD42023415530

Keywords: video exercise, falls, physical performance, older people

Strengths and limitations of this study

- This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and followed a prespecified protocol registered on PROSPERO.
- The methodological quality of the included reviews was assessed using standardised measures.
- The trials are open-label, meaning that participants and therapists are aware of the intervention assignment.
- A few of the outcomes are based on self-report and recall, particularly in fall outcomes.

Introduction

Regular exercise and physical activity in older people have been shown to have numerous benefits in preventing and managing age-associated diseases and conditions, as well as improved mobility, mental health, and quality of life.[1, 2] Exercise, either standalone or when combined with other interventions, is effective in reducing falls even in vulnerable older people.[3] Older people at risk of falling should be offered a tailored exercise programme comprising multicomponent exercises like a set of muscle strength and balance exercises that progress from moderate to high challenge.[3, 4] These exercises should be done regularly, with muscle strengthening exercise twice a week or more, and functional balance training supplemented with brisk walking activities at least three days a week.[3, 5] Despite the availability of best practice clinical guidelines to support exercise interventions aimed at improving function and preventing falls, there is often a low level of participation and adherence in older people.[6] Barriers to physical activity programmes include lack of motivation, boredom, fear of injury, and current health problems.[7-9] In addition, environmental factors and resources have emerged as major issues, such as poor access to exercise facilities and equipment, a shortage of transportation, safety concerns, weather, and cost.[10-13]

The integration of technology in physical activity programmes was initially created to provide enjoyable ways to exercise and improve programme adherence in people with acute or chronic illnesses who are undergoing rehabilitation.[14] Later on, technology-based exercise began to be provided to older people, either in a community or in a nursing facility, to promote physical activity.[15] The latest developments in computer, tablet and mobile phone technology have offered an affordable and easily accessible way of reaching out to more people and delivering exercise programmes. Utilising technology for providing exercise training to older people may provide more options for preferred exercise, greater convenience, and accessibility, and encourage a higher level of engagement.[15-18]

The use of video technology to provide a demonstration of exercise programmes has been reported in several trials.[18-20] In addition to verbal instructions and motivating background music, video can provide accurate visual information on how to perform the exercise movements.[21-23] Video demonstrations, as opposed to text, minimise the cognitive effort required to process information, resulting in improved comprehension, and being more engaging than text-delivered content.[24] Furthermore, internet and smartphone advancements have also made video-based exercise accessible anywhere and anytime at an affordable cost. Due to social barriers during the COVID-19 pandemic, video-based interventions were used extensively because they could be provided remotely via the Internet. [18, 20, 25] Although there are numerous published studies on the use of video technology in older people, this evidence has yet to be synthesised to determine its effectiveness. This systematic review and meta-analysis aimed to systematically review and synthesise evidence about the use of video demonstration to support exercise programmes for older adults and investigate its effectiveness on physical performance and falls compared with usual care or non-exercise interventions.

Method

This systematic review and meta-analysis has been reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[26] The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) under registration number: CRD42023415530.

Eligibility criteria

We included all randomised controlled trial designs that were published in English. We followed the PICO (Population, Intervention, Comparator, Outcomes) approach[27] to define the eligibility criteria and studies eligible for inclusion had to meet the following criteria.

Table 1. Population, intervention, comparator, and outcomes.

Population	• Community-dwelling older people (male and/or female) who were 60 years or older. • Studies were considered if the mean age of the sample was at least 60 years. • We excluded studies on hospitalised or institutional-based older people and studies that only included people with a specific disease or condition (e.g., Parkinson's disease, Stroke, etc).
Intervention	• Any type of exercise program that used pre-recorded instructional videos (online or offline) to provide demonstrations on how to perform exercises. • We excluded studies that used synchronous instructional videos such as live streaming, video calls, or video conferencing. Video-based exercise programmes could be supplemented with home visits or in-person interactions with practitioners.
Comparator	Either no exercise intervention or a control non-exercise intervention such as receiving leaflets, link to physical activity promotion websites or physical activity guidelines.
Outcomes	• Primary outcome was physical performance, defined as the observed ability to perform tasks related to transfer and mobility (e.g., sit-to-stand, walking, etc). Other terms were physical function, functional ability, or functional performance. • Secondary outcomes were fall-related variables including number of falls, number of fallers and fear of falling.

Data Source

Electronic databases were searched (MEDLINE, EMBASE, CINAHL, PsycINFO, The Cochrane Central Register of Controlled Trials, TRIP, and PEDro) from 2000 to May 2023. The search also included grey literature to identify unpublished research material that was not commercially available. Types of grey literature included theses and dissertations, accessed from Ethos and ProQuest. Reference lists of included studies were manually searched for any further eligible studies and citation tracking of included studies was searched backwards and forward using Google Scholar. Search terms included a combination of variants for the keywords older people, video-based exercise, and physical performance. The search strategy and full search terms are shown in the supplementary table.

Study selection

All retrieved papers during the search were first de-duplicated using EndNote 20 and then exported to RAYYAN[28] for manual screening. The screening was performed manually and independently by two reviewers (FA, AH). The first step was to screen the titles and abstracts of all references retrieved from selected databases, followed by full-text screening using the predetermined inclusion and exclusion criteria. Any disagreements were resolved by a third reviewer (VG). All studies that did not meet the eligibility requirements were excluded. Reasons for exclusion are given in the PRISMA flow diagram (Figure 1).

Data extraction

Data were extracted using an electronic data extraction form, and according to the PRISMA statement.[27] Study authors were contacted by email to provide further information regarding missing data. The following data were extracted by one reviewer (FA) and independently confirmed by another reviewer (AH): author, year of publication, country, sample characteristics (sample size, age, sex, health status), study design, recruitment sources, eligibility criteria, setting, exercise types and components, dose, mode of delivery, video characteristics (technology used, way of delivery), and adherence. Primary and secondary outcome data were extracted for preintervention and postintervention time points. If data was generated from more than one follow-up timepoint, we selected the data with the shortest timepoint. Any disagreement between the two authors was resolved by a third author (VG) through discussion.

Methodological quality assessment

The Cochrane Risk of Bias tool (RoB2) was used to assess the risk of bias in each included study.[29] Risk of bias is assessed across several domains as a judgement of low risk, high risk, or unclear.[30] To evaluate the overall quality of evidence, we used the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system. The GRADE was conducted via the GRADEPro website and guided by the Cochrane Handbook for Systematic Reviews.[31, 32] This is a subjective assessment of the evidence's quality categorised as high, moderate, low or very low based on the presence of the following factors: risk of bias, imprecision, indirectness, and inconsistency. For each factor observed, the quality was downgraded to one level lower if (1) most information was from studies at high risk of bias and sufficient to affect the interpretation of the results; (2) each outcome has less than 400 participants; (3) the evidence included in the review did not sufficiently direct to PICO; (4) high heterogeneity ($I^2>50\%$).[31, 32]

Data analysis

We performed a meta-analysis with STATA 18.0 software using the random effects models. The meta-analysis took place only when more than two studies were compared for each outcome. Considering the heterogeneity of the population, measurements, and interventions, the random effects model was chosen. We calculated treatment effects for the continuous variable with the same measurement units using mean differences and using standardised mean differences (SMDs, Hedges' g) for data with the different measurement units.[33] We calculated effect estimates from post-score mean and standard deviation (or its estimate) with 95% CIs for between groups in change scores based on available data. Some measurements indicated that the higher the score, the better physical performance, while some studies used a scale where a higher score means a lower physical performance. Therefore, in trials in which higher scores were indicative of lower physical performance, the scores were multiplied by -1 to ensure consistency in the interpretation of outcomes before entering data into the meta-analysis.[33]

We visually examined forest plots for evidence of heterogeneity among studies with consideration of the I^2. When the I^2 value was 50% or less, the pooled data was considered homogeneous; otherwise, if the I^2 value was greater than 50%, the pooled data were considered to have significant heterogeneity. P value <0.05 was considered to indicate statistical significance. SMD was calculated by taking the differences in means between groups and dividing it by the pooled standard deviation at the postintervention timepoint. SMD value of 0.20 indicates small effects, values of 0.50 indicate medium effects and values of 0.80 indicate large effects.[34] Funnel plots were visually examined to detect publication bias. A narrative synthesis was undertaken where there was insufficient data for meta-analysis.

Results

Search outcome

A total of 5700 records were retrieved from the databases and manual searches. Of those, 2323 duplicate records were removed using EndNote 20, and 3274 records were excluded after screening the titles and abstracts. Subsequently, 103 articles were selected for full-text screening. Among them, 12 articles satisfied the inclusion criteria and were then searched for references and citations manually. From forward citation tracking, we retrieved 1 additional article. The PRISMA flow diagram is illustrated in Figure 1. Three articles were produced from one study that had multiple follow-up timepoints. Therefore, this review contained 13 articles from 11 studies.

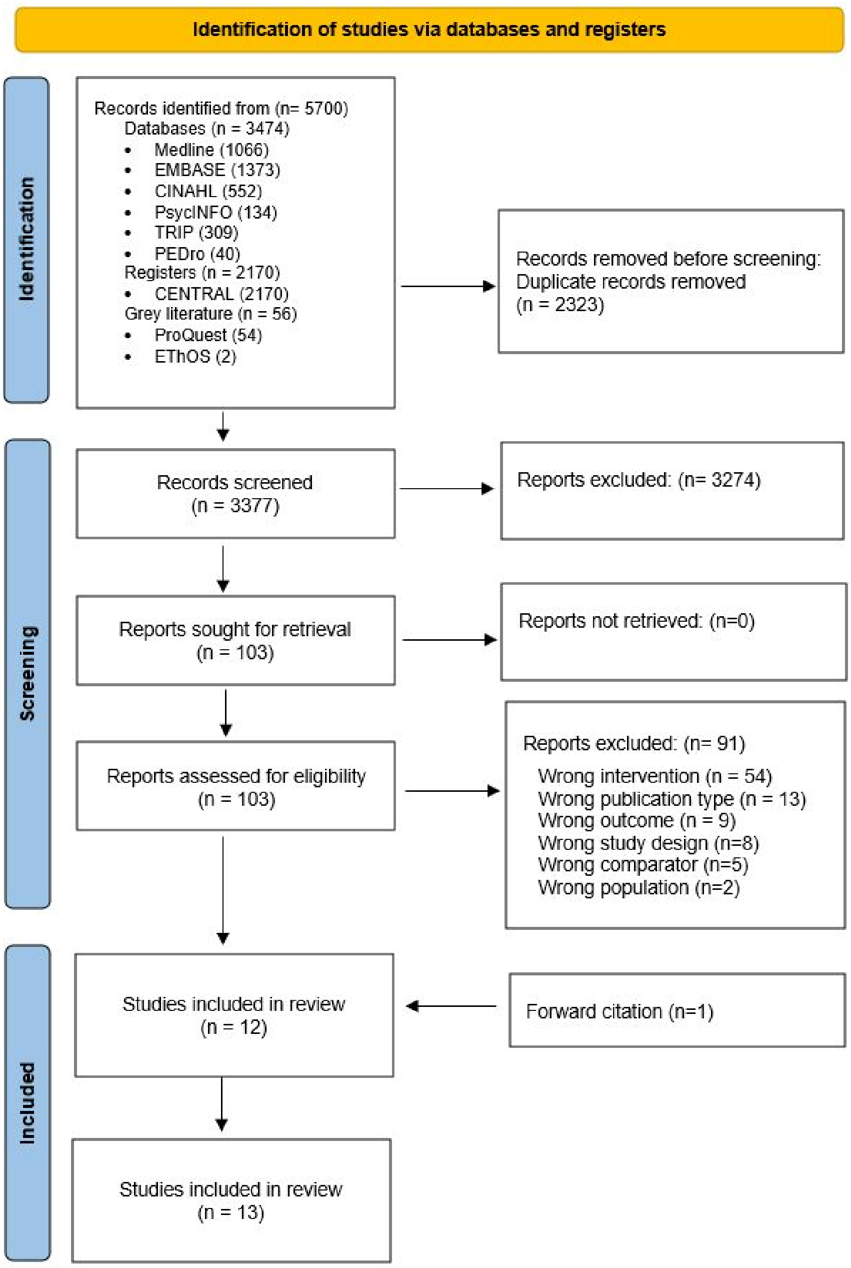


Figure 1. PRISMA flow diagram

Study characteristics

Fourteen articles published between 2007 and 2023 in English were included. These studies were conducted in the United Kingdom[35], Australia[22, 36], Spain[19], Greece[20], France[37], Denmark[23], Japan[38], Thailand[21], Taiwan[39] and one study from the United States that produced three reports[40-42]. The study characteristics are summarized in Table 2.

Participants

Studies included sample sizes ranging from 19 to 417 participants (n=1706). The mean age of participants from individual studies ranged from 67 to 90 years. All participants are older people living in the community with one study only included female participants,[23] whereas ten studies had both male and female participants, with a higher percentage of female participants.[19-22, 35-42] One study reported participants who had a history of falling[20] and another reported the risk of falling.[37]

Risk of bias

Three articles were linked to an overall low risk of bias,[19, 21, 39] four articles had overall some concerns,[20, 35, 38] and six articles had an overall high risk of bias.[22, 23, 36, 37, 40-42] Details on the risk of bias are presented in Figure 2.

Figure 2. Risk of Bias

Table 2. Summary of the characteristics of included trials

Study author; country	Sample (n); % female; mean age	Exercise components	Duration; session length; frequency	Setting; exercise mode	Comparator	Video exercise; media; device	Physical performance measurements	Fall-related outcomes and measurements
Boongird et al (2017); Thailand	417; 86.6%; 74.08	Lower extremity strengthening, stretching, and balance training.	6 months; 60 min; 2-3x wk	Home; individual; supervised	Non-exercise intervention	Entirely video; offline; Video Disk Recorder (VDR)	Strength (5-STS); Dynamic balance (TUG, BBS)	Fear of falling (Thai FES-I); Number of falls and fallers (self-recorded)
Caballer et al (2016); Spain	51; 69%; 69.1±4	Lower extremity strengthening, balance, mobility, flexibility, endurance.	4 months; 45 min; 3x wk	Centre; group; supervised	No intervention	Entirely video; offline; DVD player	Mobility (TUG); Functional balance (BBS); Balance (OLS); Aerobic endurance (6MWT); Lower limb function (SPPB); Lower extremity strength (5-STS)	Not assessed
Chang et al (2023); Taiwan	167; 70.1%; 67.6±7.86	Resistance, static balance, dynamic balance, speed-walking.	4 months; 60 min; 2-3x wk	Centre and home; both group and individual; supervised	Non-exercise intervention	Partially video (combined with face-to-face exercise); online; smartphone & chat application	Upper limb strength (Grip strength); SPPB; static balance ability (OLS); physical agility (TUG); dynamic balance ability (functional reach)	Not assessed
Fyfe et al (2022); Australia	19; 67%; 69.8±3	Lower extremity strengthening, balance, functional tasks	1 month; 9 min; 3x day	Home; individual; unsupervised	No intervention	Entirely video; online; smartphone/tablet & website platform	Physical function (5-STS and 30s CSTS)	Not assessed

Haines et al (2009); Australia	50; 60.4%; 80.9±6.5	Muscle strength, balance	2 months; 13 min	Home; individual; supervised	No intervention	Entirely video; offline; DVD player	Balance (BOOMER); Strength (15s sit-to-stand); Mobility (2-minute walk test)	Fear of falling (ABC Scale); Number of falls (self-recorded)
Liang et al (2020); United Kingdom	30; 67%; 71.1±3.6	Functional tasks, muscle strength, balance, tai chi	1 month; 2x day	Home; individual; unsupervised	Non-exercise intervention	Entirely video; online; smartphone/tablet and website platform	Physical function (5-STS, 60s sit-to-stand, leg standing balance)	Not assessed
Lytras et al (2022); Greece	150; 90.7%; 70	Lower extremity strengthening, balance, flexibility	6 months; 45 min; 5x wk	Centre and home; both group and individual; supervised	Non-exercise intervention	Partially video (combined with face-to-face exercise); offline; TV or computer	Functional mobility (TUG); Static balance (4-stage balance); Leg strength (30s CST); Balance (BBS)	Fear of falling (short FES-I); Number of falls (self-recorded)

Table 2. Continued

Study author; country	Sample (n); % female; mean age	Exercise components	Duration; session length; frequency	Setting; exercise mode	Comparator	Video exercise; media; device	Physical performance measurements	Fall-related outcomes and measurements
McAuley et al (2012); United States	260; 71.52%; 70.62±0.4	Muscle strength, balance, and flexibility.	6 months; 3x wk	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Meziere et al (2021); France	35; 83.3%; 90	Muscle strength, balance, functional	3 months; 2x wk	Home; individual; supervised	Non-exercise intervention	Partially video (combined with face-to-	Walking and balance ability (TUG)	Absence of falls requiring medical care

		tasks, joint mobilization exercises				face exercise); offline; tablet		
Roberts et al (2017); United States	153; 73.6%; 70+4.98	Muscle strength, balance, and flexibility.	24 months follow up; 3x wk	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Vestergaard et al (2007); Denmark	53; 100%; 81+3.3	Muscle strength, balance, flexibility, and endurance	5 months; 26 min; 3x wk	Home; individual; unsupervised	No intervention	Entirely video; offline; Video player	Functional ability (5-STS, 10-meter walking, standing balance test, PPT, Mob-T)	Not assessed
Wojcicki et al (2015); United States	237; 71.5%; 70.6+0.4	Muscle strength, balance, and flexibility.	12 months follow up; 3x wk	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Yamada et al (2011); Japan	84; 80.5%; 83+6.7	Muscle strength, balance, agility, and dual tasks.	6 months; 20 min; 2x wk	Centre; group; supervised	No intervention	Entirely video; offline; DVD player	Functional fitness (TUG, 5-STS)	Not assessed

Intervention

All included studies applied multicomponent exercises which contain strength and balance. Five studies added flexibility exercises to the training component[19-21, 23, 39, 40], three studies added functional tasks exercise[22, 35, 37], three studies added endurance exercise[19, 23, 39], and one study added joint mobilization exercises to the program.[37]

The duration of intervention follow-up ranged from one month to two years. Four studies reported multiple follow-up time points. Both Haines et al and Lytras et al had two follow-up timepoints (2 and 6 months) and (3 and 6 months), respectively.[20, 36] Boongird et al and McAuley et al had three follow-up timepoints (3, 6, 12 months) and (6, 12, 24 months), respectively.[21, 40-42]

Exercise programme doses were varied, with the frequency of two to three times per week being the most commonly prescribed[19, 23, 37-40], and 20-45 minutes being the most commonly used duration.[19, 20, 23, 37, 38] Some studies reported that training load was progressed by increasing the level of difficulty and using ankle cuff weights.[19-22, 36, 37, 40] Telephone calls, exercise diaries, and face-to-face visits were the most commonly used strategies for monitoring exercise progress. Three studies implemented the Otago Exercise Programme, which required at least four home visits.[19-21]

Two different methods were applied to deliver the pre-recorded exercise videos to older people. Eight studies (67%) relied on an offline method, such as providing pre-recorded videos on DVD or videotape, while three studies (33%) used online methods, such as sending videos over the Internet using smartphones, apps, or websites.[22, 35, 39] More recent studies (since 2020) used the online method, Chang et al utilised smartphone-based messaging applications to send pre-recorded videos for performing exercises to their participants.[39] Fyfe et al provided guidelines and instructional videos for exercise accessible via a website.[22] Liang et al sent the video demonstrations along with written instructions through emails.[35]

Six of eleven studies (54%) compared video-delivered exercise to non-exercise interventions such as providing educational materials about healthy lifestyles,[20, 35, 39, 40] fall prevention materials,[21] or a home helper without an exercise program[37], while the remainder (46%) compared with no intervention at all.[19, 22, 23, 36, 38]

Outcome Measures

Several studies assessed physical performance using a single measurement including the Short Physical Performance Battery[19, 39, 40] or Physical Performance Test[23]. However, some studies examine physical performance components (strength, balance, and mobility) individually.

Lower extremity strength was estimated through the Five times Sit-to-Stand test[19, 21-23, 35, 38, 39] and 30 seconds Chair Stand Test.[20] Balance was evaluated by the Berg Balance Scale (BBS),[19-21] one leg stand,[35, 39] semi tandem stand,[23] and the Balance Outcome Measure for Elder Rehabilitation (BOOMER).[36] Functional mobility was assessed using the Timed up and go test.[19-21, 38, 39] Fear of falling was assessed using Fall Efficacy Scale International (FES-I)[21], Short FES-I[20], or Activities-specific Balance Confidence (ABC) Scale.[36]

Effects of video-delivered exercise programmes on physical performance

The effects of video-delivered exercise programmes on strength, balance, mobility, and functional performance are illustrated in Figure 3. The pooled effect of video-delivered exercise programmes on lower extremity strength from eight trials (n=1041) indicates a small, statistically significant effect compared with control (SMD=0.36, 95%CI 0.09 to 0.63; I^2=73.17%, p=0.01). The pooled results provide moderate quality evidence (GRADE). Regarding the balance outcome, the pooled effect of video-delivered exercise programmes from seven trials (n=959) demonstrates there was a small to moderate, statistically significant effect compared with control (SMD=0.45, 95%CI 0.07 to 0.83; I^2=85.07%, p=0.02). This pooled result provides low quality evidence (GRADE).

The meta-analysis of video-delivered exercise on mobility from five trials (n=891) presented statistically significant effect (MD=0.96, 95%CI 0.46 to 1.46; I^2=53.31%, p<0.001), with moderate quality evidence (GRADE). Furthermore, four studies that assessed physical performance from four trials (n=531) also presented a small statistically significant effect compared with control (SMD=0.36, 95%CI 0.17 to 0.56; I^2=13.49%, p<0.001). The pooled results provide moderate quality evidence (GRADE). The summary of the quality of evidence can be seen in Table 3.

Effects of video-delivered exercise programmes on fall-related variables

Three studies reported fear of falling.[20, 21, 36] Haines et al[36] reported that there was no difference in fear of falling scores after two months of video-delivered exercise intervention versus control. Meanwhile, Boongird et al[21] and Lytras et al[20] found a statistically significant effect after six months of video-delivered exercise intervention compared to control. However, when the meta-analysis was performed, the pooled effect still indicated that there was no difference in fear of falling between video-delivered exercise programmes and control (SMD=0.61, 95%CI -0.46 to 1.69; I2=96.39%, p=0.26 n=636), with very low quality evidence.

This review included only two studies that reported on fall rate and number of fallers, which was insufficient to conduct a meta-analysis. Both studies observed a decrease in the rate of falls and the number of fallers in their trials. Boongird et al[21] observed that the intervention group had fewer falls than the control group over the one-year follow-up period, as did Haines et al[36] during the 6-month follow-up. However, the difference did not reach statistical significance.

Adverse events

Adverse events were reported in five studies (42%).[21, 22, 35, 36, 40] There were no major adverse events associated with the intervention among those reported. Reported adverse events including minor muscle pain, muscle discomfort, and knee joint pain.

Adherence to the video-delivered exercise programmes

Eight studies (67%) reported adherence to the exercise programmes using various indicators for evaluating adherence. The included studies defined adherence as; 1) the proportion of completed exercise sessions per person; 2) the proportion of people who attended the exercise session; 3) the average number of days exercise per week; or 4) the percentage of people who exercised for more than 120 minutes per week. Boongird et al demonstrated relatively low adherence compared to other included studies, with 29.6% of participants exercising $\geq$ 120 min per week in the first (3-month) follow-up.[21] Liang et al had the highest adherence data, with 90% of people completing the prescribed exercise intervention over four weeks.[21] There was still uncertainty about the overall adherence to video-delivered exercises due to heterogeneity in measurement and interpretation.

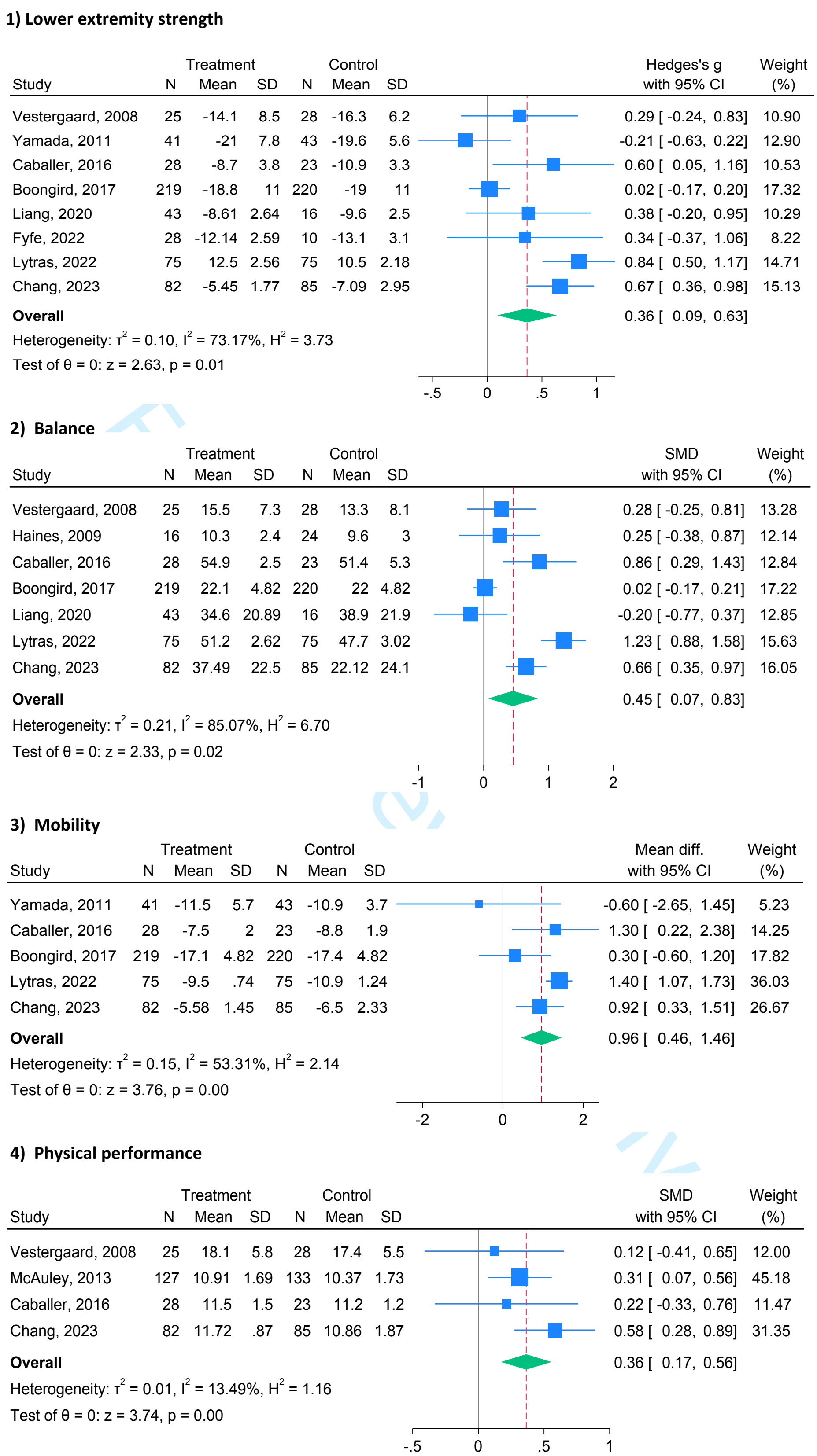


Figure 3. Effect size (95% CI) of video-delivered exercise programmes on lower extremity strength, balance, mobility, and physical performance versus control using SMD and random effects meta-analysis.

Table 3. Summary of the quality of evidence

Outcome	Number of trials	Risk of bias[a]	Inconsistency[b]	Imprecision[c]	Effect size [95%CI], I^2, p-value	Certainty
Lower extremity strength	9	-	↓	-	SMD=0.36 [0.09 to 0.63], I^2=73.17%, p=0.02	⊕⊕⊕ Moderate[d]
Balance	7	↓	↓	-	SMD=0.45 [0.07 to 0.83], I^2=85.07%, p=0.02	⊕⊕ Low[e]
Functional performance	4	↓	-	-	SMD=0.36 [0.17 to 0.56], I^2=13.49%, p<0.001	⊕⊕⊕ Moderate[f]
Mobility	6	-	↓	-	MD=0.96 [0.46 to 1.46], I^2=53.31%, p<0.001	⊕⊕⊕ Moderate[g]
Fear of falling	3	↓	↓↓	-	SMD=0.61 [-0.46 to 1.69], I^2=96.39%, p=0.26	⊕ Very low[h]

[a]we downgraded if >25% of included trials had a high risk of bias
[b]we downgraded if there was statistical heterogeneity or wide confidence interval
[c]we downgraded if there were <400 participants

[d,g] Reason for downgrade: statistical heterogeneity
[e]Reason for downgrade: statistical heterogeneity, >25% of included trials had a high risk of bias
[f]Reason for downgrade: >25% of included trials had a high risk of bias
[h]Reason for downgrade: statistical heterogeneity, wide confidence interval, >25% of included trials had a high risk of bias

Discussion

Our systematic review aimed to synthesize the effect of video-delivered exercises on physical performance and falls in community-dwelling older people. The quality of the evidence base varied with the outcomes being investigated. Considering the heterogeneity of the population, measurements, and interventions, the random effects model was chosen. Four meta-analyses showed differences in physical performance outcomes between participants who received video-delivered exercises. Although the measurement methods varied, process measures were favourable for video-delivered exercises, with a small effect size observed for physical performance with low to moderate-quality evidence. However, in some important outcomes including the number of falls, number of fallers, and fear of falling, the quality of literature was poor, and fewer studies reported those outcomes meaning it was not possible to draw robust conclusions.

Despite the uncertainty on fall outcomes, our results suggest that exercise programmes delivered using instructional videos improve physical performance in community-dwelling people aged 60 and older. Physical performance is associated with the risk of falls in older people, as lower physical performance is marked by reduced lower extremity strength and balance, both of which increase the likelihood of falling.[43] A Cochrane systematic review that included 108 studies of exercise, established that exercise that challenges balance has the greatest effect on both the rate of falls (24% reduction) and risk of falls (13% reduction) in community-dwelling older people.[3]

Our result demonstrated that video-delivered exercise had a positive effect on lower extremity strength and balance. Chair sit-to-stand, calf raises, hip abductor strength, hip and knee extensor strength, and hip and knee movement exercises with ankle weights, as used in the Otago exercise programme, were among the lower extremity strength exercises for older people identified in this review. Meanwhile, balance exercises such as one-leg stand, clock stepping, marching on the spot, tandem stand and walk, and side and backwards walking were typically demonstrated. Furthermore, we found that video-delivered exercise programmes slightly improved the mobility of community-dwelling older people. However, this increase was considerably smaller (0.96 seconds) than what would be expected based on the previous study's Minimal Clinically Important Difference (MCID). The MCID of the Timed-up-and-go (TUG) in older people that has ever been reported was 2.1 seconds.[44] This might be due to differences in the characteristics of the older people population (healthier and less healthy) and the measurements used. Even though TUG has been recognised as a measuring tool for assessing fall risk, research suggests that it may not be the most appropriate tool for healthy and higher-functioning older people, resulting in very small changes.[45]

With the advancement of technological devices and the internet, video-delivered interventions have become particularly useful for providing accurate remote instructions.[46] Video has become a popular medium because it can accurately display instructions and, in some cases, include background music to make them more enjoyable.[19, 23] This review demonstrates that providing video instruction using online and offline methods is equally appropriate. The offline method requires additional devices such as a DVD player and TV screen. A computer that includes an internal video player can be used in the absence of a DVD player. The online method emphasises the use of smartphones and the internet. Websites are ideally suited for distributing exercise videos.[22, 35] Additionally, smartphone chat applications with video-sharing features could be employed to provide video instructions to participants.[39]

The video quality may pose concerns for older people and affect their adherence. A high level of satisfaction with video quality contributed to a high adherence rate.[40-42] Video and descriptive instructions that lack clarity may be less motivating for older people, leading them to prefer face-to-face demonstrations.[35] The videos that were filmed with older actresses with whom participants could identify may have contributed to the high level of satisfaction.[37] Overall, video-delivered exercise has been shown to be beneficial, particularly during the COVID-19 pandemic, when community-based group exercise was not possible due to social restrictions.[18, 20, 25, 39]

Study limitations

Despite we believe this is the first systematic review and meta-analysis of RCT-based evidence for video-delivered exercise in community-dwelling older people, we acknowledge several limitations. The first limitation is the inclusion of a small number of studies published in English, we might have missed studies in which the authors did not explicitly mention using video-based exercises. The second limitation is most of the included studies are open-label, meaning that participants and therapists are aware of the intervention assignment. This is a very strong methodological limitation of all studies in this field. Another limitation is that quite a few of the results are based on self-report and recall, particularly in secondary outcomes. Given the positive trends in digital technology, future research should prioritise high-quality studies with recommended exercise regimens to stimulate strength and balance. There is also a need to examine the long-term impact of video-delivered exercise on falls and compare the effectiveness with traditional exercise programmes.

Conclusion

The finding of this review suggests that video-delivered exercise programmes improve physical performance including lower extremity strength, balance, and mobility in older people living in the community compared with control. What remains unknown is the impact of video-delivered exercise programmes on falls and the fear of falling in this population.

Contributors

FA, AH, SL and VG conceptualised and designed the review. FA and AH determined the search terms and conducted screening. FA extracted data and performed analysis under the supervision of AH and VG. The extracted data and its analysis were discussed with VG and SL. SL provided technical support. All authors reviewed, approved, and agreed to submit the final manuscript.

Funding

The author, Fadhia Adliah was funded by an Indonesian Education Scholarship, Beasiswa Pendidikan Indonesia (LPDP) for her PhD study.

VG is funded by the National Institute of Health and Care Research (NIHR) Applied Research Collaboration South West Peninsula (NIHR200167) and is an NIHR Senior Investigator. SL is funded by the NIHR Exeter Biomedical Research Centre (NIHR 203320). AH is funded by the National Institute for Health and Care Research (NIHR) School for Primary Care Research (119247). The views expressed in this publication are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

Competing interest

None declared

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Ethics approval

Not applicable

Data availability statement

All data relevant to the study are included in the article or uploaded as supplementary information.

Supplementary information

This content has been supplied by the author(s).

ORCHID IDs

Fadhia Adliah https://orcid.org/0009-0008-2559-2926

Abigail J Hall https://orcid.org/0000-0002-3453-5631

Victoria A Goodwin https://orcid.org/0000-0003-3860-9607

Sarah E Lamb https://orcid.org/0000-0003-4349-7195

Reference

1. Izquierdo M, Merchant RA, Morley JE, Anker SD, Aprahamian I, Arai H, et al. International Exercise Recommendations in Older Adults (ICFSR): Expert Consensus Guidelines. The Journal of nutrition, health and aging. 2021;25(7):824-53.
2. Nikitas C, Kikidis D, Bibas A, Pavlou M, Zachou Z, Bamiou DE. Recommendations for physical activity in the elderly population: A scoping review of guidelines. J Frailty Sarcopenia Falls. 2022;7(1):18-28.
3. Sherrington C, Fairhall NJ, Wallbank GK, Tiedemann A, Michaleff ZA, Howard K, et al. Exercise for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2019;1(1):Cd012424.
4. Montero-Odasso M, van der Velde N, Martin FC, Petrovic M, Tan MP, Ryg J, et al. World guidelines for falls prevention and management for older adults: a global initiative. Age and Ageing. 2022;51(9):afac205.
5. WHO guidelines on physical activity and sedentary behaviour. Geneva: World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO.
6. Di Lorito C, Long A, Byrne A, Harwood RH, Gladman JRF, Schneider S, et al. Exercise interventions for older adults: A systematic review of meta-analyses. J Sport Health Sci. 2021;10(1):29-47.
7. Kalavar JM, Kolt GS, Giles LC, Driver RPAIGLC, https://orcid.org O, Bandura ABJSBCEBFCJKBJACNKKGSGL, et al. Physical Activity in Older Asian Indians Living in the United States: Barriers and Motives. Activities, Adaptation & Aging. 2004;29(1):47-62.
8. Li Y, Du X, Zhang C, Wang S. Physical activity among the elderly in China: a qualitative study. Br J Community Nurs. 2013;18(7):340-passim.
9. Yoshigai M, Musumari PM, Hudson J, Kihara MO, Kihara M. Factors promoting and inhibiting exercise for older women in Kyoto, Japan. Health Promot Internation. 2023;38(3).
10. Horne M, Tierney S. What are the barriers and facilitators to exercise and physical activity uptake and adherence among South Asian older adults: a systematic review of qualitative studies. Preventive medicine. 2012;55(4):276-84.
11. Karunanayake AL, Senaratne CD, Stathi A. A descriptive cross sectional study comparing barriers and determinants of physical activity of Sri Lankan middle aged and older adults. PLOS ONE. 2020;15(5):e0232956.
12. Marthammuthu T, Hairi FM, Choo WY, Salleh NAM, Hairi NN. A Qualitative Investigation on the Roles of Social Support on Physical Activity Behaviour among the Rural-Dwelling Older Women in Malaysia. International journal of environmental research and public health. 2021;18(18).
13. Yi X, Pope Z, Gao Z, Wang S, Pan F, Yan J, et al. Associations between individual and environmental factors and habitual physical activity among older Chinese adults: A social-ecological perspective. Journal of sport and health science. 2016;5(3):315-21.
14. Valenzuela T, Okubo Y, Woodbury A, Lord SR, Delbaere K. Adherence to Technology-Based Exercise Programs in Older Adults: A Systematic Review. Journal of Geriatric Physical Therapy. 2018;41(1).
15. Muellmann S, Forberger S, Möllers T, Bröring E, Zeeb H, Pischke CR. Effectiveness of eHealth interventions for the promotion of physical activity in older adults: A systematic review. Preventive Medicine. 2018;108:93-110.
16. Delbaere K, Valenzuela T, Lord SR, Clemson L, Zijlstra GR, Close JC, et al. E-health StandingTall balance exercise for fall prevention in older people: results of a two year randomised controlled trial. bmj. 2021;373.
17. 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(9):e15460.
18. Kulkarni S, Nagarkar A. Effect of a video-assisted fall prevention program on fall incidence in community-dwelling older adults during COVID. Geriatric Nursing. 2023;50:31-7.

19. Benavent-Caballer V, Rosado-Calatayud P, Segura-Ortí E, Amer-Cuenca JJ, Lisón JF. The effectiveness of a video-supported group-based Otago exercise programme on physical performance in community-dwelling older adults: a preliminary study. Physiotherapy. 2016;102(3):280-6.
20. Lytras D, Sykaras E, Iakovidis P, Komisopoulos C, Chasapis G, Mouratidou C. Effects of a modified Otago exercise program delivered through outpatient physical therapy to community-dwelling older adult fallers in Greece during the COVID-19 pandemic: a controlled, randomized, multicenter trial. Eur Geriatr Med. 2022;13(4):893-906.
21. Boongird C, Keesukphan P, Phiphadthakusolkul S, Rattanasiri S, Thakkinstian A. Effects of a simple home-based exercise program on fall prevention in older adults: A 12-month primary care setting, randomized controlled trial. Geriatr Gerontol Int. 2017;17(11):2157-63.
22. Fyfe JJ, Dalla Via J, Jansons P, Scott D, Daly RM. Feasibility and acceptability of a remotely delivered, home-based, pragmatic resistance 'exercise snacking' intervention in community-dwelling older adults: a pilot randomised controlled trial. BMC Geriatr. 2022;22(1):521.
23. Vestergaard S, Kronborg C, Puggaard L. Home-based video exercise intervention for community-dwelling frail older women: A randomized controlled trial. Aging Clinical and Experimental Research. 2008;20(5):479-86.
24. McDonough DJ, Helgeson MA, Liu W, Gao Z. Effects of a remote, YouTube-delivered exercise intervention on young adults' physical activity, sedentary behavior, and sleep during the COVID-19 pandemic: Randomized controlled trial. Journal of Sport and Health Science. 2022;11(2):145-56.
25. Yi D, Yim J. 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. Med Sci Monit. 2021;27:e935496.
26. Matthew JP, Joanne EM, Patrick MB, Isabelle B, Tammy CH, Cynthia DM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
27. Alessandro L, Douglas GA, Jennifer T, Cynthia M, Peter CG, John PAI, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ. 2009;339:b2700.
28. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev. 2016;5(1):210.
29. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. Bmj. 2019;366:l4898.
30. Higgins JPT, Savović J, Page MJ, Elbers RG, Sterne JAC. Chapter 8: Assessing risk of bias in a randomized trial. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.4 (updated August 2023). Cochrane, 2023. Available from www.training.cochrane.org/handbook.
31. Ryan R, S H. How to GRADE the quality of the evidence. Cochrane Consumers and

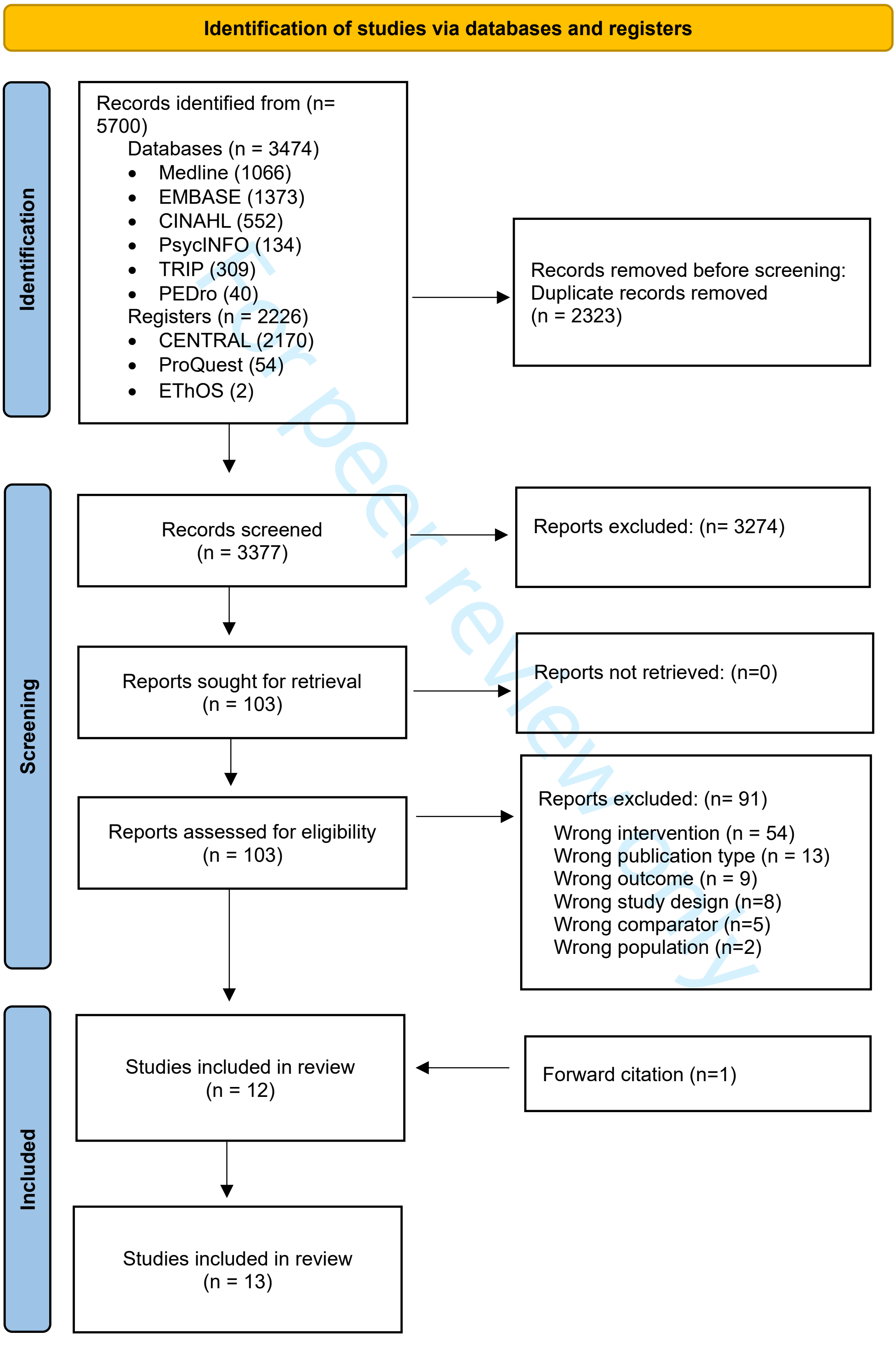
Communication Group, available at http://cccrg.cochrane.org/author-resources. Version 3.0 December 2016.
32. Schünemann H BJ, Guyatt G, Oxman A, editors. . GRADE handbook for grading quality of evidence and strength of recommendations. Updated October 2013. The GRADE Working Group, 2013. Available from guidelinedevelopment.org/handbook. .
33. Higgins JPT, Li T, (editors). DJ. Chapter 6: Choosing effect measures and computing estimates of effect. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.4 (updated August 2023). Cochrane, 2023. Available from www.training.cochrane.org/handbook.
34. Cohen J. Statistical power analysis for the behavioral sciences: Academic press; 2013.
35. Liang IJ, Perkin OJ, McGuigan PM, Thompson D, Western MJ. Feasibility and Acceptability of Home-Based Exercise Snacking and Tai Chi Snacking Delivered Remotely to Self-Isolating Older Adults During COVID-19. J Aging Phys Act. 2022;30(1):33-43.

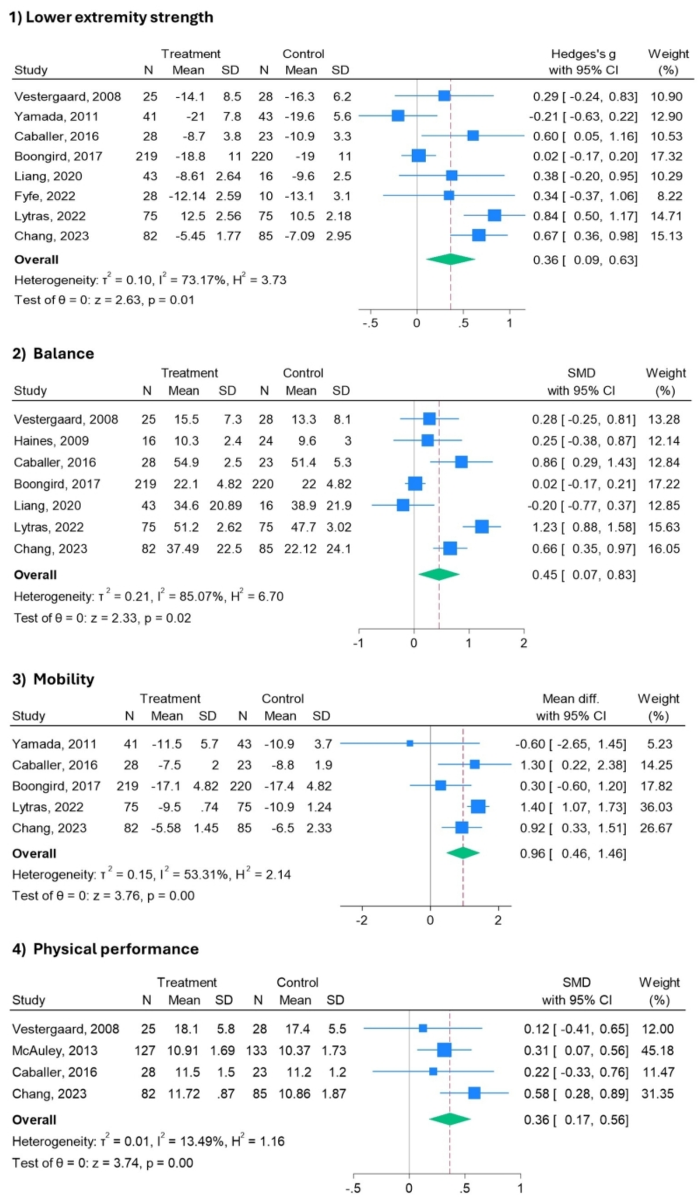
36. Haines TP, Russell T, Brauer SG, Erwin S, Lane P, Urry S, et al. Effectiveness of a video-based exercise programme to reduce falls and improve health-related quality of life among older adults discharged from hospital: a pilot randomized controlled trial. Clin Rehabil. 2009;23(11):973-85.
37. Mézière A, Oubaya N, Michel-Pellegrino V, Boudin B, Neau M, Robert H, et al. Exercise Interventions With Trained Home Helpers for Preventing Loss of Autonomy and Falls in Community-Dwelling Older Adults Receiving Home Heath Physical Therapy T4H: A Randomized Controlled Pilot Study. J Geriatr Phys Ther. 2021;44(3):E138-e49.
38. Yamada M, Aoyama T, Hikita Y, Takamura M, Tanaka Y, Kajiwara Y, et al. Effects of a DVD-based seated dual-task stepping exercise on the fall risk factors among community-dwelling elderly adults. Telemed J E Health. 2011;17(10):768-72.
39. Chang SH, Chiang CC, Chien NH. Efficacy of a multicomponent exercise training program intervention in community-dwelling older adults during the COVID-19 pandemic: A cluster randomized controlled trial. Geriatr Nurs. 2023;49:148-56.
40. McAuley E, Wójcicki TR, Gothe NP, Mailey EL, Szabo AN, Fanning J, et al. Effects of a DVD-delivered exercise intervention on physical function in older adults. J Gerontol A Biol Sci Med Sci. 2013;68(9):1076-82.
41. Roberts S, Awick E, Fanning JT, Ehlers D, Motl RW, McAuley E. Long-Term Maintenance of Physical Function in Older Adults Following a DVD-Delivered Exercise Intervention. J Aging Phys Act. 2017;25(1):27-31.
42. Wójcicki TR, Fanning J, Awick EA, Olson EA, Motl RW, McAuley E. Maintenance Effects of a DVD-Delivered Exercise Intervention on Physical Function in Older Adults. J Gerontol A Biol Sci Med Sci. 2015;70(6):785-9.
43. Orwoll ES, Fino NF, Gill TM, Cauley JA, Strotmeyer ES, Ensrud KE, et al. The Relationships Between Physical Performance, Activity Levels, and Falls in Older Men. J Gerontol A Biol Sci Med Sci. 2019;74(9):1475-83.
44. Maldaner N, Sosnova M, Ziga M, Zeitlberger AM, Bozinov O, Gautschi OP, et al. External Validation of the Minimum Clinically Important Difference in the Timed-up-and-go Test After Surgery for Lumbar Degenerative Disc Disease. Spine (Phila Pa 1976). 2022;47(4):337-42.
45. Schoene D, Wu SM-S, Mikolaizak AS, Menant JC, Smith ST, Delbaere K, et al. Discriminative Ability and Predictive Validity of the Timed Up and Go Test in Identifying Older People Who Fall: Systematic Review and Meta-Analysis. Journal of the American Geriatrics Society. 2013;61(2):202-8.
46. Martins AC, Santos C, Silva C, Baltazar D, Moreira J, Tavares N. Does modified Otago Exercise Program improves balance in older people? A systematic review. Prev Med Rep. 2018;11:231-9.

Search strategy

Keywords	Alternatives
Population (older adults)	Older adults OR older people OR older person OR older OR elderly OR geriatric OR senior OR aged 65 OR aged OR frail
Intervention (video-supported home exercise)	(Exercise OR training OR physical activity OR programme OR home OR home-based) AND (video OR taped OR DVD OR web-based OR website OR remote OR tablet OR ipad OR smartphone OR phone OR youtube OR computer OR television OR application OR ehealth OR mhealth)
Outcomes (physical performance and falls)	Physical performance OR physical function OR functional performance OR functional ability OR physical ability OR balance OR strength OR fall OR faller OR mobility
Study design	Randomised controlled trial

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only





Meta-analysis results

120x203mm (300 x 300 DPI)

BMJ Open

Effects of exercise programmes delivered using video technology on physical performance and falls in people aged 60 years and over living in the community: A systematic review and meta-analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-092775.R1
Article Type:	Original research
Date Submitted by the Author:	17-Dec-2024
Complete List of Authors:	Adliah, Fadhia; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences; Hasanuddin University, Faculty of Nursing, Physiotherapy Hall, Abigail J.; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences Goodwin, Victoria; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences Lamb, Sarah; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences
Primary Subject Heading:	Sports and exercise medicine
Secondary Subject Heading:	Sports and exercise medicine
Keywords:	Digital Technology, Exercise, Aged

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Effects of exercise programmes delivered using video technology on physical performance and falls in people aged 60 years and over living in the community: A systematic review and meta-analysis

Fadhia Adliah[1,2]*, Abigail J Hall[1], Victoria A Goodwin[1], Sarah E Lamb[1]

[1] Public Health and Sport Sciences, Faculty of Health and Life Sciences, University of Exeter

[2] Physiotherapy, Faculty of Nursing, Hasanuddin University

Corresponding author:

Fadhia Adliah, Public Health and Sport Sciences, Faculty of Health and Life Sciences, University of Exeter, St Lukes Heavitree Road, Exeter EX1 2LP

Email: fa436@exeter.ac.uk

Abstract

Objectives: This systematic review and meta-analysis synthesised the evidence and evaluated the effect of exercise programmes delivered using instructional videos compared with control on physical performance and falls in community-dwelling older people aged 60 years and older.

Methods: We included all RCT designs. A search followed PRISMA guidelines was conducted using MEDLINE, EMBASE, CINAHL, PsycINFO, The Cochrane Central Register of Controlled Trials, TRIP, and PEDro databases to identify randomised controlled trials evaluating video-delivered exercise programmes for community-dwelling older people aged $\geq$60 years. The primary outcome was physical performance including muscle strength, balance, and mobility. Secondary outcomes were number of falls, number of fallers, and fear of falling. We calculated treatment effects using random effects model, 95% CIs, mean differences (MD) and standardised mean differences (SMDs, Hedges' g) for data with the different measurement units. ROB2 was used to assess risk of bias in the included studies.

Results: We identified 13 studies that included 1706 participants. The meta-analysis of 10 studies revealed significant effects of video-delivered exercise programmes in lower extremity strength SMD=0.36, 95%CI 0.09 to 0.63; I^2=73.17%, p=0.01, moderate quality evidence GRADE), balance (SMD=0.45, 95%CI 0.07 to 0.83; I^2=85.07%, p=0.02, low quality evidence GRADE), mobility (MD=0.96, 95%CI 0.46 to 1.46; I^2=53.31%, p<0.001, moderate quality evidence GRADE), and physical performance SMD=0.36, 95%CI 0.17 to 0.56; I^2=13.49%, p<0.001, moderate quality evidence GRADE). No evidence of an effect of video-delivered exercise programmes on fear of falling was found (SMD=0.61, 95%CI -0.46 to 1.69; I^2=96.39%, p=0.26, very low quality evidence GRADE). There was insufficient data for reporting falls.

Conclusion: Video-delivered exercise programmes improved physical performance particularly lower extremity strength, balance, and mobility, with moderate quality evidence. There is uncertainty about the effect of video-delivered exercise programmes on number of falls, number of fallers, and fear of falling.

PROSPERO registration number: CRD42023415530

Keywords: video exercise, falls, physical performance, older people

Strengths and limitations of this study

- This is the first systematic review and meta-analysis of video-based exercise for older people and its impact on physical performance and falls.
- This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and followed a prespecified protocol registered on PROSPERO.
- The methodological quality of the included reviews was assessed using standardised measures.
- High heterogeneity exists due to varying of follow-up periods and measuring criteria.
- A few of the outcomes are based on self-report and recall, particularly in fall outcomes.

Introduction

Regular exercise and physical activity in older people have been shown to have numerous benefits in preventing and managing age-associated diseases and conditions, as well as improved mobility, mental health, and quality of life.[1, 2] Exercise, either standalone or when combined with other interventions, is effective in reducing falls even in vulnerable older people.[3] Older people at risk of falling should be offered a tailored exercise programme comprising multicomponent exercises like a set of muscle strength and balance exercises that progress from moderate to high challenge.[3, 4] These exercises should be done regularly, with muscle strengthening exercise twice a week or more, and functional balance training supplemented with brisk walking activities at least three days a week.[3, 5] Despite the availability of best practice clinical guidelines to support exercise interventions aimed at improving function and preventing falls, there is often a low level of participation and adherence in older people.[6] Barriers to physical activity programmes include lack of motivation, boredom, fear of injury, and current health problems.[7-9] In addition, environmental factors and resources have emerged as major issues, such as poor access to exercise facilities and equipment, a shortage of transportation, safety concerns, weather, and cost.[10-13]

The integration of technology in physical activity programmes was initially created to provide enjoyable ways to exercise and improve programme adherence in people with acute or chronic illnesses who are undergoing rehabilitation.[14] Later on, technology-based exercise began to be provided to older people, either in a community or in a nursing facility, to promote physical activity.[15] The latest developments in computer, tablet and mobile phone technology have offered an affordable and easily accessible way of reaching out to more people and delivering exercise programmes. Utilising technology for providing exercise training to older people may provide more options for preferred exercise, greater convenience, and accessibility, and encourage a higher level of engagement.[15-18]

The use of video technology to provide a demonstration of exercise programmes has been reported in several trials.[18-20] In addition to verbal instructions and motivating background music, video can provide accurate visual information on how to perform the exercise movements.[21-23] Video demonstrations, as opposed to text, minimise the cognitive effort required to process information, resulting in improved comprehension, and being more engaging than text-delivered content.[24] Furthermore, internet and smartphone advancements have also made video-based exercise accessible anywhere and anytime at an affordable cost. Due to social barriers during the COVID-19 pandemic, video-based interventions were used extensively because they could be provided remotely via the Internet. [18, 20, 25] Although there are numerous published studies on the use of video technology in older people, this evidence has yet to be synthesised to determine its effectiveness. This systematic review and meta-analysis aimed to systematically review and synthesise evidence about the use of video demonstration to support exercise programmes for older adults and investigate its effectiveness on physical performance and falls compared with usual care or non-exercise interventions.

Method

This systematic review and meta-analysis has been reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[26] The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) under registration number: CRD42023415530.

Eligibility criteria

We included all randomised controlled trial designs that were published in English. We followed the PICO (Population, Intervention, Comparator, Outcomes) approach[27] to define the eligibility criteria and studies eligible for inclusion had to meet the following criteria.

Population

Community-dwelling older people (male and/or female) who were 60 years or older. Studies were considered if the mean age of the sample was at least 60 years. We excluded studies on hospitalised or institutional-based older people and studies that only included people with a specific disease or condition (e.g., Parkinson's disease, Stroke, etc).

Intervention

Any type of exercise program that used pre-recorded instructional videos (online or offline) to provide demonstrations on how to perform exercises. We excluded studies that used synchronous instructional videos such as live streaming, video calls, or video conferencing. Video-based exercise programmes could be supplemented with home visits or in-person interactions with practitioners.

Comparator

Either no exercise intervention or a control non-exercise intervention such as receiving leaflets, link to physical activity promotion websites or physical activity guidelines.

Outcomes

Primary outcome was physical performance, defined as the observed ability to perform tasks related to transfer and mobility (e.g., sit-to-stand, walking, etc). Other terms were physical function, functional ability, or functional performance. Secondary outcomes were fall-related variables including number of falls, number of fallers and fear of falling.

Data Source

Electronic databases were searched (MEDLINE, EMBASE, CINAHL, PsycINFO, The Cochrane Central Register of Controlled Trials, TRIP, and PEDro) from 2000 to May 2023. The search also included grey literature to identify unpublished research material that was not commercially available. Types of grey literature included theses and dissertations, accessed from Ethos and ProQuest. Reference lists of included studies were manually searched for any further eligible studies and citation tracking of included studies was searched backwards and forward using Google Scholar. Search terms included a combination of variants for the keywords older people, video-based exercise, and physical performance. The search strategy and full search terms are shown in the supplementary table.

Study selection

All retrieved papers during the search were first de-duplicated using EndNote 20 and then exported to RAYYAN[28] for manual screening. The screening was performed manually and independently by two reviewers (FA, AH). The first step was to screen the titles and abstracts of all references retrieved from selected databases, followed by full-text screening using the predetermined inclusion and exclusion criteria. Any disagreements were resolved by a third reviewer (VG). All studies that did not meet the eligibility requirements were excluded. Reasons for exclusion are given in the PRISMA flow diagram (Figure 1).

Data extraction

Data were extracted using an electronic data extraction form, and according to the PRISMA statement.[27] Study authors were contacted by email to provide further information regarding missing data. The following data were extracted by one reviewer (FA) and independently confirmed by another reviewer (AH): author, year of publication, country, sample characteristics (sample size, age, sex, health status), study design, recruitment sources, eligibility criteria, setting, exercise types and components, dose, mode of delivery, video characteristics (technology used, way of delivery), and adherence. Primary and secondary outcome data were extracted for preintervention and postintervention time points. If data was generated from more than one follow-up timepoint, we selected the data with the shortest timepoint. Any disagreement between the two authors was resolved by a third author (VG) through discussion.

Methodological quality assessment

The Cochrane Risk of Bias tool (RoB2) was used to assess the risk of bias in each included study.[29] Risk of bias is assessed across several domains as a judgement of low risk, high risk, or some concerns.[30] To evaluate the overall quality of evidence, we used the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) system. The GRADE was conducted via the GRADEPro website and guided by the Cochrane Handbook for Systematic Reviews.[31, 32] This is a subjective assessment of the evidence's quality categorised as high, moderate, low or very low based on the presence of the following factors: risk of bias, imprecision, indirectness, and inconsistency. For each factor observed, the quality was downgraded to one level lower if (1) most information was from studies at high risk of bias and sufficient to affect the interpretation of the results; (2) each outcome has less than 400 participants; (3) the evidence included in the review did not sufficiently direct to PICO; (4) high heterogeneity (I^2>50%).[31, 32]

Data analysis

We performed a meta-analysis with STATA 18.0 software using the random effects models. The meta-analysis took place only when more than two studies were compared for each outcome. Considering the heterogeneity of the population, measurements, and interventions, the random effects model was chosen. We calculated treatment effects for the continuous variable with the same measurement units using mean differences and using standardised mean differences (SMDs, Hedges' g) for data with the different measurement units.[33] We calculated effect estimates from post-score mean and standard deviation (or its estimate) with 95% CIs for between groups in change scores based on available data. Some measurements indicated that the higher the score, the better physical performance, while some studies used a scale where a higher score means a lower physical performance. Therefore, in trials in which higher scores were indicative of lower physical performance, the scores were multiplied by -1 to ensure consistency in the interpretation of outcomes before entering data into the meta-analysis.[33]

We visually examined forest plots for evidence of heterogeneity among studies with consideration of the I^2. When the I^2 value was 50% or less, the pooled data was considered homogeneous; otherwise, if the I^2 value was greater than 50%, the pooled data were considered to have significant heterogeneity. P value <0.05 was considered to indicate statistical significance. SMD was calculated by taking the differences in means between groups and dividing it by the pooled standard deviation at the postintervention timepoint. SMD value of 0.20 indicates small effects, values of 0.50 indicate medium effects and values of 0.80 indicate large effects.[34] Funnel plots were visually examined to detect publication bias. A narrative synthesis was undertaken where there was insufficient data for meta-analysis.

Results

Search outcome

A total of 5700 records were retrieved from the databases and manual searches. Of those, 2323 duplicate records were removed using EndNote 20, and 3274 records were excluded after screening the titles and abstracts. Subsequently, 103 reports were selected for full-text screening. Among them, 12 studies satisfied the inclusion criteria and were then searched for references and citations manually. From forward citation tracking, we retrieved 1 additional study. Therefore, this review contained 13 studies. The PRISMA flow diagram is illustrated in Figure 1.

Study characteristics

Thirteen studies published between 2007 and 2023 in English were included. These studies were conducted in the United Kingdom[35], Australia[22, 36], Spain[19], Greece[20], France[37], Denmark[23], Japan[38], Thailand[21], Taiwan[39] and one study from the United States that produced three reports[40-42]. Table 1 summarises the study characteristics. Further details are also available in supplementary material.

Participants

Studies included sample sizes ranging from 19 to 417 participants (n=1706). The mean age of participants from individual studies ranged from 67 to 90 years. All participants are older people living in the community with one study only included female participants,[23] whereas ten studies had both male and female participants, with a higher percentage of female participants.[19-22, 35-42] One study reported participants who had a history of falling[20] and another reported the risk of falling.[37]

Risk of bias

Three studies were linked to an overall low risk of bias,[19, 21, 39] four studies had overall some concerns,[20, 35, 38] and six studies had an overall high risk of bias.[22, 23, 36, 37, 40-42] Details on the risk of bias are presented in Figure 2.

Table 1. Summary of the characteristics of included studies

Study	Sample (n); % female; mean age	Exercise components	Duration; session length; frequency	Setting; exercise mode	Video exercise; media; device
Boongird et al (2017)	417; 86.6%; 74.08	Lower extremity strengthening, stretching, and balance training.	6 months; 60 min; 2-3x wk	Home; individual; supervised	Entirely video; offline; Video Disk Recorder (VDR)
Caballer et al (2016)	51; 69%; 69.1±4	Lower extremity strengthening, balance, mobility, flexibility, endurance.	4 months; 45 min; 3x wk	Centre; group; supervised	Entirely video; offline; DVD player
Chang et al (2023)	167; 70.1%; 67.6±7.86	Resistance, static balance, dynamic balance, speed-walking.	4 months; 60 min; 2-3x wk	Centre and home; both group and individual; supervised	Partially video (combined with face-to-face exercise); online; smartphone & chat application
Fyfe et al (2022)	19; 67%; 69.8±3	Lower extremity strengthening, balance, functional tasks	1 month; 9 min; 3x day	Home; individual; unsupervised	Entirely video; online; smartphone/tablet & website platform
Haines et al (2009)	50; 60.4%; 80.9±6.5	Muscle strength, balance	2 months; 13 min	Home; individual; supervised	Entirely video; offline; DVD player
Liang et al (2020)	30; 67%; 71.1±3.6	Functional tasks, muscle strength, balance, tai chi	1 month; 2x day	Home; individual; unsupervised	Entirely video; online; smartphone/tablet and website platform
Lytras et al (2022)	150; 90.7%; 70	Lower extremity strengthening, balance, flexibility	6 months; 45 min; 5x wk	Centre and home; both group and individual; supervised	Partially video (combined with face-to-face exercise); offline; TV or computer
McAuley et al (2012)	260; 71.52%; 70.62±0.4	Muscle strength, balance, and flexibility.	6 months; 3x wk	Home; individual; unsupervised	Entirely video; offline; DVD player
Meziere et al (2021)	35; 83.3%; 90	Muscle strength, balance, functional tasks, joint mobilization exercises	3 months; 2x wk	Home; individual; supervised	Partially video (combined with face-to-face exercise); offline; tablet

Roberts et al (2017)	153; 73.6%; 70±4.98	Muscle strength, balance, and flexibility.	24 months follow up; 3x wk	Home; individual; unsupervised	Entirely video; offline; DVD player
Vestergaard et al (2007)	53; 100%; 81±3.3	Muscle strength, balance, flexibility, and endurance	5 months; 26 min; 3x wk	Home; individual; unsupervised	Entirely video; offline; Video player
Wojcicki et al (2015)	237; 71.5%; 70.6±0.4	Muscle strength, balance, and flexibility.	12 months follow up; 3x wk	Home; individual; unsupervised	Entirely video; offline; DVD player
Yamada et al (2011)	84; 80.5%; 83±6.7	Muscle strength, balance, agility, and dual tasks.	6 months; 20 min; 2x wk	Centre; group; supervised	Entirely video; offline; DVD player

Intervention

All included studies applied multicomponent exercises which contain strength and balance. Five studies added flexibility exercises to the training component[19-21, 23, 39, 40], three studies added functional tasks exercise[22, 35, 37], three studies added endurance exercise[19, 23, 39], and one study added joint mobilization exercises to the program.[37]

The duration of intervention follow-up ranged from one month to two years. Four studies reported multiple follow-up time points. Both Haines et al and Lytras et al had two follow-up timepoints (2 and 6 months) and (3 and 6 months), respectively.[20, 36] Boongird et al and McAuley et al had three follow-up timepoints (3, 6, 12 months) and (6, 12, 24 months), respectively.[21, 40-42]

Exercise programme doses were varied, with the frequency of two to three times per week being the most commonly prescribed[19, 23, 37-40], and 20-45 minutes being the most commonly used duration.[19, 20, 23, 37, 38] Some studies reported that training load was progressed by increasing the level of difficulty and using ankle cuff weights.[19-22, 36, 37, 40] Telephone calls, exercise diaries, and face-to-face visits were the most commonly used strategies for monitoring exercise progress. Three studies implemented the Otago Exercise Programme, which required at least four home visits.[19-21]

Two different methods were applied to deliver the pre-recorded exercise videos to older people. Eight studies (67%) relied on an offline method, such as providing pre-recorded videos on DVD or videotape, while three studies (33%) used online methods, such as sending videos over the Internet using smartphones, apps, or websites.[22, 35, 39] More recent studies (since 2020) used the online method, Chang et al utilised smartphone-based messaging applications to send pre-recorded videos for performing exercises to their participants.[39] Fyfe et al provided guidelines and instructional videos for exercise accessible via a website.[22] Liang et al sent the video demonstrations along with written instructions through emails.[35]

Six of eleven studies (54%) compared video-delivered exercise to non-exercise interventions such as providing educational materials about healthy lifestyles,[20, 35, 39, 40] fall prevention materials,[21] or a home helper without an exercise program[37], while the remainder (46%) compared with no intervention at all.[19, 22, 23, 36, 38]

Outcome Measures

Several studies assessed physical performance using a single measurement including the Short Physical Performance Battery[19, 39, 40] or Physical Performance Test[23]. However, some studies examine physical performance components (strength, balance, and mobility) individually.

Lower extremity strength was estimated through the Five times Sit-to-Stand test[19, 21-23, 35, 38, 39] and 30 seconds Chair Stand Test.[20] Balance was evaluated by the Berg Balance Scale (BBS),[19-21] one leg stand,[35, 39] semi tandem stand,[23] and the Balance Outcome Measure for Elder Rehabilitation (BOOMER).[36] Functional mobility was assessed using the Timed up and go test.[19-21, 38, 39] Fear of falling was assessed using Fall Efficacy Scale International (FES-I)[21], Short FES-I[20], or Activities-specific Balance Confidence (ABC) Scale.[36]

Effects of video-delivered exercise programmes on physical performance

The effects of video-delivered exercise programmes on strength, balance, mobility, and physical performance are illustrated in Figure 3-6. The pooled effect of video-delivered exercise programmes on lower extremity strength from eight trials (n=1041) indicates a small, statistically significant effect compared with control (SMD=0.36, 95%CI 0.09 to 0.63; I^2=73.17%, p=0.01). The pooled results provide moderate quality evidence (GRADE). Regarding the balance outcome, the pooled effect of video-delivered exercise programmes from seven trials (n=959) demonstrates there was a small to moderate, statistically significant effect compared with control (SMD=0.45, 95%CI 0.07 to 0.83; I^2=85.07%, p=0.02). This pooled result provides low quality evidence (GRADE).

The meta-analysis of video-delivered exercise on mobility from five trials (n=891) presented statistically significant effect (MD=0.96, 95%CI 0.46 to 1.46; I^2=53.31%, p<0.001), with moderate quality evidence (GRADE). Furthermore, four studies that assessed physical performance from four trials (n=531) also presented a small statistically significant effect compared with control (SMD=0.36, 95%CI 0.17 to 0.56; I^2=13.49%, p<0.001). The pooled results provide moderate quality evidence (GRADE). The summary of the quality of evidence can be seen in Table 2.

Effects of video-delivered exercise programmes on fall-related variables

Three studies reported fear of falling.[20, 21, 36] Haines et al[36] reported that there was no difference in fear of falling scores after two months of video-delivered exercise intervention versus control. Meanwhile, Boongird et al[21] and Lytras et al[20] found a statistically significant effect after six months of video-delivered exercise intervention compared to control. However, when the meta-analysis was performed, the pooled effect still indicated that there was no difference in fear of falling between video-delivered exercise programmes and control (SMD=0.61, 95%CI -0.46 to 1.69; I2=96.39%, p=0.26 n=636), with very low quality evidence.

This review included only two studies that reported on fall rate and number of fallers, which was insufficient to conduct a meta-analysis. Both studies observed a decrease in the rate of falls and the number of fallers in their trials. Boongird et al[21] observed that the intervention group had fewer falls than the control group over the one-year follow-up period, as did Haines et al[36] during the 6-month follow-up. However, the difference did not reach statistical significance.

Adverse events

Adverse events were reported in five studies (42%).[21, 22, 35, 36, 40] There were no major adverse events associated with the intervention among those reported. Reported adverse events including minor muscle pain, muscle discomfort, and knee joint pain.

Adherence to the video-delivered exercise programmes

Eight studies (67%) reported adherence to the exercise programmes using various indicators for evaluating adherence. The included studies defined adherence as; 1) the proportion of completed exercise sessions per person; 2) the proportion of people who attended the exercise session; 3) the average number of days exercise per week; or 4) the percentage of people who exercised for more than 120 minutes per week. Boongird et al demonstrated relatively low adherence compared to other included studies, with 29.6% of participants exercising $\geq$ 120 min per week in the first (3-month) follow-up.[21] Liang et al had the highest adherence data, with 90% of people completing the prescribed exercise intervention over four weeks.[21] There was still uncertainty about the overall adherence to video-delivered exercises due to heterogeneity in measurement and interpretation.

Table 2. Summary of the quality of evidence

Outcome	Number of trials	Risk of bias[a]	Inconsistency[b]	Imprecision[c]	Effect size [95%CI], I^2, p-value	Certainty
Lower extremity strength	9	-	↓	-	SMD=0.36 [0.09 to 0.63], I^2=73.17%, p=0.02	⊕⊕⊕ Moderate[d]
Balance	7	↓	↓	-	SMD=0.45 [0.07 to 0.83], I^2=85.07%, p=0.02	⊕⊕ Low[e]
Physical performance	4	↓	-	-	SMD=0.36 [0.17 to 0.56], I^2=13.49%, p<0.001	⊕⊕⊕ Moderate[f]
Mobility	6	-	↓	-	MD=0.96 [0.46 to 1.46], I^2=53.31%, p<0.001	⊕⊕⊕ Moderate[g]
Fear of falling	3	↓	↓↓	-	SMD=0.61 [-0.46 to 1.69], I^2=96.39%, p=0.26	⊕ Very low[h]

[a]we downgraded if >25% of included trials had a high risk of bias
[b]we downgraded if there was statistical heterogeneity or wide confidence interval
[c]we downgraded if there were <400 participants

[d,g] Reason for downgrade: statistical heterogeneity
[e]Reason for downgrade: statistical heterogeneity, >25% of included trials had a high risk of bias
[f]Reason for downgrade: >25% of included trials had a high risk of bias
[h]Reason for downgrade: statistical heterogeneity, wide confidence interval, >25% of included trials had a high risk of bias

Discussion

Our systematic review aimed to synthesize the effect of video-delivered exercises on physical performance and falls in community-dwelling older people. The quality of the evidence base varied with the outcomes being investigated. Considering the heterogeneity of the population, measurements, and interventions, the random effects model was chosen. Four meta-analyses showed differences in physical performance outcomes between participants who received video-delivered exercises. Although the measurement methods varied, process measures were favourable for video-delivered exercises, with a small effect size observed for physical performance with low to moderate-quality evidence. However, in some important outcomes including the number of falls, number of fallers, and fear of falling, the quality of literature was poor, and fewer studies reported those outcomes meaning it was not possible to draw robust conclusions.

Despite the uncertainty on fall outcomes, our results suggest that exercise programmes delivered using instructional videos improve physical performance in community-dwelling people aged 60 and older. Physical performance is associated with the risk of falls in older people, as lower physical performance is marked by reduced lower extremity strength and balance, both of which increase the likelihood of falling.[43] A Cochrane systematic review that included 108 studies of exercise, established that exercise that challenges balance has the greatest effect on both the rate of falls (24% reduction) and risk of falls (13% reduction) in community-dwelling older people.[3]

Our result demonstrated that video-delivered exercise had a positive effect on lower extremity strength and balance. Chair sit-to-stand, calf raises, hip abductor strength, hip and knee extensor strength, and hip and knee movement exercises with ankle weights, as used in the Otago exercise programme, were among the lower extremity strength exercises for older people identified in this review. Meanwhile, balance exercises such as one-leg stand, clock stepping, marching on the spot, tandem stand and walk, and side and backwards walking were typically demonstrated. Furthermore, we found that video-delivered exercise programmes slightly improved the mobility of community-dwelling older people. However, this increase was considerably smaller (0.96 seconds) than what would be expected based on the previous study's Minimal Clinically Important Difference (MCID), where it should have increased by 2.1 seconds to be clinically significant.[44] This might be due to differences in the characteristics of the older people population (healthier and less healthy) and the measurements used. Even though TUG has been recognised as a measuring tool for assessing fall risk, research suggests that it may not be the most appropriate tool for healthy and higher-functioning older people, resulting in very small changes.[45]

With the advancement of technological devices and the internet, video-delivered interventions have become particularly useful for providing accurate remote instructions.[46] Video has become a popular medium because it can accurately display instructions and, in some cases, include background music to make them more enjoyable.[19, 23] This review demonstrates that providing video instruction using online and offline methods is equally appropriate. The offline method requires additional devices such as a DVD player and TV screen. A computer that includes an internal video player can be used in the absence of a DVD player. The online method emphasises the use of smartphones and the internet. Websites are ideally suited for distributing exercise videos.[22, 35] Additionally, smartphone chat applications with video-sharing features could be employed to provide video instructions to participants.[39]

The video quality may pose concerns for older people and affect their adherence. A high level of satisfaction with video quality contributed to a high adherence rate.[40-42] Video and descriptive instructions that lack clarity may be less motivating for older people, leading them to prefer face-to-face demonstrations.[35] The videos that were filmed with older actresses with whom participants could identify may have contributed to the high level of satisfaction.[37] Overall, video-delivered exercise has been shown to be beneficial, particularly during the COVID-19 pandemic, when community-based group exercise was not possible due to social restrictions.[18, 20, 25, 39]

Study limitations

Despite we believe this is the first systematic review and meta-analysis of RCT-based evidence for video-delivered exercise in community-dwelling older people, we acknowledge several limitations. The first limitation is the inclusion of a small number of studies published in English, we might have missed studies in which the authors did not explicitly mention using video-based exercises. Furthermore, the number of studies included for fall outcomes was insufficient, which may have affected the certainty of conclusions about falls and fear of falling. The second is a high heterogeneity exists due to varying of follow-up periods and measuring criteria. Another limitation is that quite a few of the results are based on self-report and recall, particularly in secondary outcomes. Given the positive trends in digital technology, future research should prioritise high-quality randomised controlled trials with recommended exercise regimens to improve strength and balance. There is also a need to examine the long-term impact of video-delivered exercise on falls and compare the effectiveness with traditional exercise programmes.

Conclusion

The finding of this review suggests that video-delivered exercise programmes improve physical performance including lower extremity strength, balance, and mobility in older people living in the community compared with control. What remains unknown is the impact of video-delivered exercise programmes on falls and the fear of falling in this population.

Contributors

FA, AH, SL and VG conceptualised and designed the review. FA and AH determined the search terms and conducted screening. FA extracted data and performed analysis under the supervision of AH and VG. The extracted data and its analysis were discussed with VG and SL. SL provided technical support. All authors reviewed, approved, and agreed to submit the final manuscript. FA is responsible for the overall content as guarantor.

Funding

The author, Fadhia Adliah was funded by Lembaga Pengelola Dana Pendidikan (LPDP) and Kementerian Pendidikan, Kebudayaan, Riset dan Teknologi (Number: 202205080313).

VG is funded by the National Institute of Health and Care Research (NIHR) Applied Research Collaboration South West Peninsula (NIHR200167) and is an NIHR Senior Investigator. SL is funded by the NIHR Exeter Biomedical Research Centre (NIHR 203320). AH is funded by the National Institute for Health and Care Research (NIHR) School for Primary Care Research (119247). The views expressed in this publication are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

Competing interest

None declared

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Ethics approval

Not applicable

Data availability statement

All data relevant to the study are included in the article or uploaded as supplementary information.

Supplementary information

This content has been supplied by the author(s).

ORCHID IDs

Fadhia Adliah https://orcid.org/0009-0008-2559-2926

Abigail J Hall https://orcid.org/0000-0002-3453-5631

Victoria A Goodwin https://orcid.org/0000-0003-3860-9607

Sarah E Lamb https://orcid.org/0000-0003-4349-7195

Reference

1. Izquierdo M, Merchant RA, Morley JE, Anker SD, Aprahamian I, Arai H, et al. International Exercise Recommendations in Older Adults (ICFSR): Expert Consensus Guidelines. The Journal of nutrition, health and aging. 2021;25(7):824-53.
2. Nikitas C, Kikidis D, Bibas A, Pavlou M, Zachou Z, Bamiou DE. Recommendations for physical activity in the elderly population: A scoping review of guidelines. J Frailty Sarcopenia Falls. 2022;7(1):18-28.
3. Sherrington C, Fairhall NJ, Wallbank GK, Tiedemann A, Michaleff ZA, Howard K, et al. Exercise for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2019;1(1):Cd012424.
4. Montero-Odasso M, van der Velde N, Martin FC, Petrovic M, Tan MP, Ryg J, et al. World guidelines for falls prevention and management for older adults: a global initiative. Age and Ageing. 2022;51(9):afac205.
5. WHO guidelines on physical activity and sedentary behaviour. Geneva: World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO.
6. Di Lorito C, Long A, Byrne A, Harwood RH, Gladman JRF, Schneider S, et al. Exercise interventions for older adults: A systematic review of meta-analyses. J Sport Health Sci. 2021;10(1):29-47.
7. Kalavar JM, Kolt GS, Giles LC, Driver RPAIGLC, https://orcid.org O, Bandura ABJSBCEBFCJKBJACNKKGSGL, et al. Physical Activity in Older Asian Indians Living in the United States: Barriers and Motives. Activities, Adaptation & Aging. 2004;29(1):47-62.
8. Li Y, Du X, Zhang C, Wang S. Physical activity among the elderly in China: a qualitative study. Br J Community Nurs. 2013;18(7):340-passim.
9. Yoshigai M, Musumari PM, Hudson J, Kihara MO, Kihara M. Factors promoting and inhibiting exercise for older women in Kyoto, Japan. Health Promot International. 2023;38(3).
10. Horne M, Tierney S. What are the barriers and facilitators to exercise and physical activity uptake and adherence among South Asian older adults: a systematic review of qualitative studies. Preventive medicine. 2012;55(4):276-84.
11. Karunanayake AL, Senaratne CD, Stathi A. A descriptive cross sectional study comparing barriers and determinants of physical activity of Sri Lankan middle aged and older adults. PLOS ONE. 2020;15(5):e0232956.
12. Marthammuthu T, Hairi FM, Choo WY, Salleh NAM, Hairi NN. A Qualitative Investigation on the Roles of Social Support on Physical Activity Behaviour among the Rural-Dwelling Older Women in Malaysia. International journal of environmental research and public health. 2021;18(18).
13. Yi X, Pope Z, Gao Z, Wang S, Pan F, Yan J, et al. Associations between individual and environmental factors and habitual physical activity among older Chinese adults: A social-ecological perspective. Journal of sport and health science. 2016;5(3):315-21.
14. Valenzuela T, Okubo Y, Woodbury A, Lord SR, Delbaere K. Adherence to Technology-Based Exercise Programs in Older Adults: A Systematic Review. Journal of Geriatric Physical Therapy. 2018;41(1).
15. Muellmann S, Forberger S, Möllers T, Bröring E, Zeeb H, Pischke CR. Effectiveness of eHealth interventions for the promotion of physical activity in older adults: A systematic review. Preventive Medicine. 2018;108:93-110.
16. Delbaere K, Valenzuela T, Lord SR, Clemson L, Zijlstra GR, Close JC, et al. E-health StandingTall balance exercise for fall prevention in older people: results of a two year randomised controlled trial. bmj. 2021;373.
17. 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(9):e15460.
18. Kulkarni S, Nagarkar A. Effect of a video-assisted fall prevention program on fall incidence in community-dwelling older adults during COVID. Geriatric Nursing. 2023;50:31-7.

19. Benavent-Caballer V, Rosado-Calatayud P, Segura-Ortí E, Amer-Cuenca JJ, Lisón JF. The effectiveness of a video-supported group-based Otago exercise programme on physical performance in community-dwelling older adults: a preliminary study. Physiotherapy. 2016;102(3):280-6.
20. Lytras D, Sykaras E, Iakovidis P, Komisopoulos C, Chasapis G, Mouratidou C. Effects of a modified Otago exercise program delivered through outpatient physical therapy to community-dwelling older adult fallers in Greece during the COVID-19 pandemic: a controlled, randomized, multicenter trial. Eur Geriatr Med. 2022;13(4):893-906.
21. Boongird C, Keesukphan P, Phiphadthakusolkul S, Rattanasiri S, Thakkinstian A. Effects of a simple home-based exercise program on fall prevention in older adults: A 12-month primary care setting, randomized controlled trial. Geriatr Gerontol Int. 2017;17(11):2157-63.
22. Fyfe JJ, Dalla Via J, Jansons P, Scott D, Daly RM. Feasibility and acceptability of a remotely delivered, home-based, pragmatic resistance 'exercise snacking' intervention in community-dwelling older adults: a pilot randomised controlled trial. BMC Geriatr. 2022;22(1):521.
23. Vestergaard S, Kronborg C, Puggaard L. Home-based video exercise intervention for community-dwelling frail older women: A randomized controlled trial. Aging Clinical and Experimental Research. 2008;20(5):479-86.
24. McDonough DJ, Helgeson MA, Liu W, Gao Z. Effects of a remote, YouTube-delivered exercise intervention on young adults' physical activity, sedentary behavior, and sleep during the COVID-19 pandemic: Randomized controlled trial. Journal of Sport and Health Science. 2022;11(2):145-56.
25. Yi D, Yim J. 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. Med Sci Monit. 2021;27:e935496.
26. Matthew JP, Joanne EM, Patrick MB, Isabelle B, Tammy CH, Cynthia DM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.
27. Alessandro L, Douglas GA, Jennifer T, Cynthia M, Peter CG, John PAI, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. BMJ. 2009;339:b2700.
28. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev. 2016;5(1):210.
29. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. Bmj. 2019;366:l4898.
30. Higgins JPT, Savović J, Page MJ, Elbers RG, Sterne JAC. Chapter 8: Assessing risk of bias in a randomized trial. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.4 (updated August 2023). Cochrane, 2023. Available from www.training.cochrane.org/handbook.
31. Ryan R, S H. How to GRADE the quality of the evidence. Cochrane Consumers and Communication Group, available at http://cccrg.cochrane.org/author-resources. Version 3.0 December 2016.
32. Schünemann H BJ, Guyatt G, Oxman A, editors. . GRADE handbook for grading quality of evidence and strength of recommendations. Updated October 2013. The GRADE Working Group, 2013. Available from guidelinedevelopment.org/handbook. .
33. Higgins JPT, Li T, (editors). DJ. Chapter 6: Choosing effect measures and computing estimates of effect. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.4 (updated August 2023). Cochrane, 2023. Available from www.training.cochrane.org/handbook.
34. Cohen J. Statistical power analysis for the behavioral sciences: Academic press; 2013.
35. Liang IJ, Perkin OJ, McGuigan PM, Thompson D, Western MJ. Feasibility and Acceptability of Home-Based Exercise Snacking and Tai Chi Snacking Delivered Remotely to Self-Isolating Older Adults During COVID-19. J Aging Phys Act. 2022;30(1):33-43.

36. Haines TP, Russell T, Brauer SG, Erwin S, Lane P, Urry S, et al. Effectiveness of a video-based exercise programme to reduce falls and improve health-related quality of life among older adults discharged from hospital: a pilot randomized controlled trial. Clin Rehabil. 2009;23(11):973-85.
37. Mézière A, Oubaya N, Michel-Pellegrino V, Boudin B, Neau M, Robert H, et al. Exercise Interventions With Trained Home Helpers for Preventing Loss of Autonomy and Falls in Community-Dwelling Older Adults Receiving Home Heath Physical Therapy T4H: A Randomized Controlled Pilot Study. J Geriatr Phys Ther. 2021;44(3):E138-e49.
38. Yamada M, Aoyama T, Hikita Y, Takamura M, Tanaka Y, Kajiwara Y, et al. Effects of a DVD-based seated dual-task stepping exercise on the fall risk factors among community-dwelling elderly adults. Telemed J E Health. 2011;17(10):768-72.
39. Chang SH, Chiang CC, Chien NH. Efficacy of a multicomponent exercise training program intervention in community-dwelling older adults during the COVID-19 pandemic: A cluster randomized controlled trial. Geriatr Nurs. 2023;49:148-56.
40. McAuley E, Wójcicki TR, Gothe NP, Mailey EL, Szabo AN, Fanning J, et al. Effects of a DVD-delivered exercise intervention on physical function in older adults. J Gerontol A Biol Sci Med Sci. 2013;68(9):1076-82.
41. Roberts S, Awick E, Fanning JT, Ehlers D, Motl RW, McAuley E. Long-Term Maintenance of Physical Function in Older Adults Following a DVD-Delivered Exercise Intervention. J Aging Phys Act. 2017;25(1):27-31.
42. Wójcicki TR, Fanning J, Awick EA, Olson EA, Motl RW, McAuley E. Maintenance Effects of a DVD-Delivered Exercise Intervention on Physical Function in Older Adults. J Gerontol A Biol Sci Med Sci. 2015;70(6):785-9.
43. Orwoll ES, Fino NF, Gill TM, Cauley JA, Strotmeyer ES, Ensrud KE, et al. The Relationships Between Physical Performance, Activity Levels, and Falls in Older Men. J Gerontol A Biol Sci Med Sci. 2019;74(9):1475-83.
44. Maldaner N, Sosnova M, Ziga M, Zeitlberger AM, Bozinov O, Gautschi OP, et al. External Validation of the Minimum Clinically Important Difference in the Timed-up-and-go Test After Surgery for Lumbar Degenerative Disc Disease. Spine (Phila Pa 1976). 2022;47(4):337-42.
45. Schoene D, Wu SM-S, Mikolaizak AS, Menant JC, Smith ST, Delbaere K, et al. Discriminative Ability and Predictive Validity of the Timed Up and Go Test in Identifying Older People Who Fall: Systematic Review and Meta-Analysis. Journal of the American Geriatrics Society. 2013;61(2):202-8.
46. Martins AC, Santos C, Silva C, Baltazar D, Moreira J, Tavares N. Does modified Otago Exercise Program improves balance in older people? A systematic review. Prev Med Rep. 2018;11:231-9.

Figure legends

Figure 1. PRISMA flow diagram

Figure 2. Risk of bias of included studies

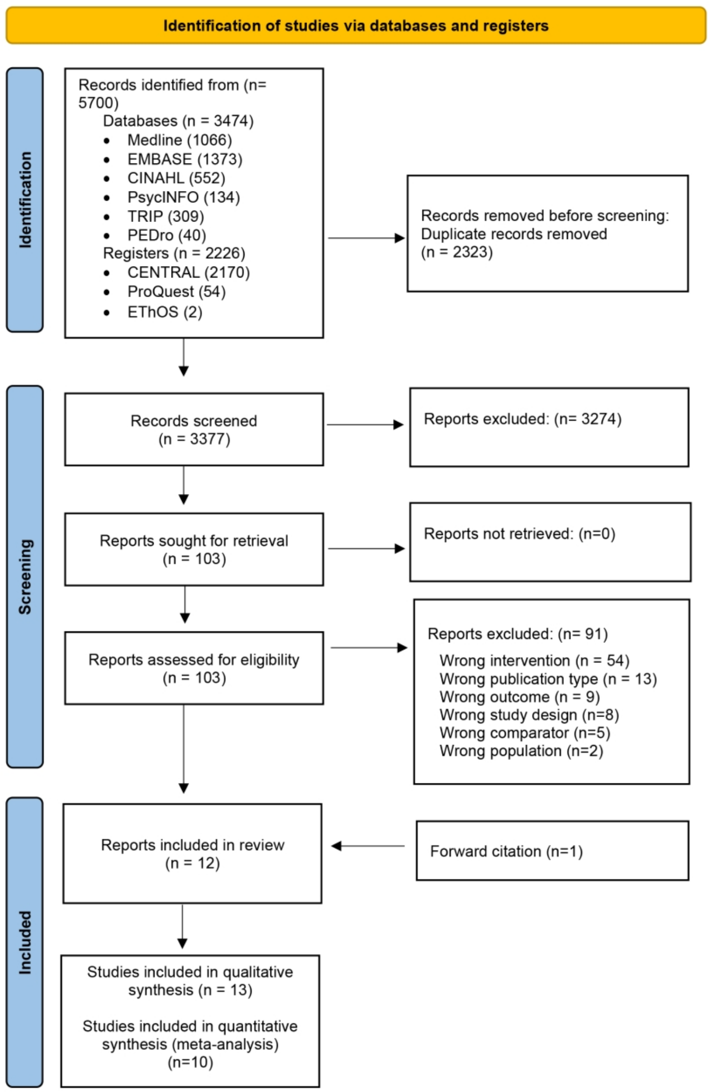
Figure 3. Forest plot of the effect of video-delivered exercise programs on lower extremity strength in older adults. Meta-analysis of eight studies shows Hedges' g effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Hedges' g = 0.36; 95% CI: 0.09 to 0.63). Heterogeneity is notable ($I^2 = 73.17\%$, $\tau^2 = 0.10$), and the overall effect is significant ($z = 2.63$, $p = 0.01$).

Figure 4. Forest plot of the effect of video-delivered exercise programs on balance in older adults. Meta-analysis of seven studies shows Hedges' g effect sizes with 95% CIs. Blue squares indicate individual effects (weighted by size), and the diamond represents the pooled effect (Hedges' g = 0.45; 95% CI: 0.07 to 0.83). Heterogeneity is high ($I^2 = 85.07\%$, $\tau^2 = 0.21$), and the overall effect is significant ($z = 2.33$, $p = 0.02$).

Figure 5. Forest plot of the effect of video-delivered exercise programs on mobility in older adults. Meta-analysis of five studies shows Mean Difference effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Mean Difference = 0.96; 95% CI: 0.46 to 1.46). Heterogeneity is moderate ($I^2 = 53.31\%$, $\tau^2 = 0.15$), and the overall effect is significant ($z = 3.76$, $p = 0.00$).

Figure 6. Forest plot of the effect of video-delivered exercise programs on physical performance in older adults. Meta-analysis of four studies shows Hedges' g effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Hedges' g = 0.36; 95% CI: 0.17 to 0.56). Heterogeneity is low ($I^2 = 13.49\%$, $\tau^2 = 0.01$), and the overall effect is significant ($z = 3.74$, $p = 0.00$).

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

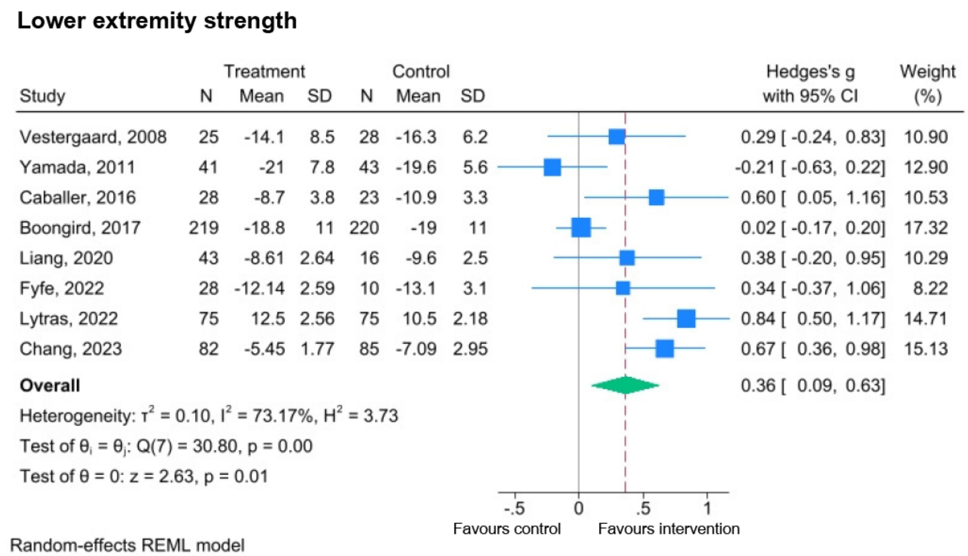


PRISMA flow diagram

166x243mm (300 x 300 DPI)

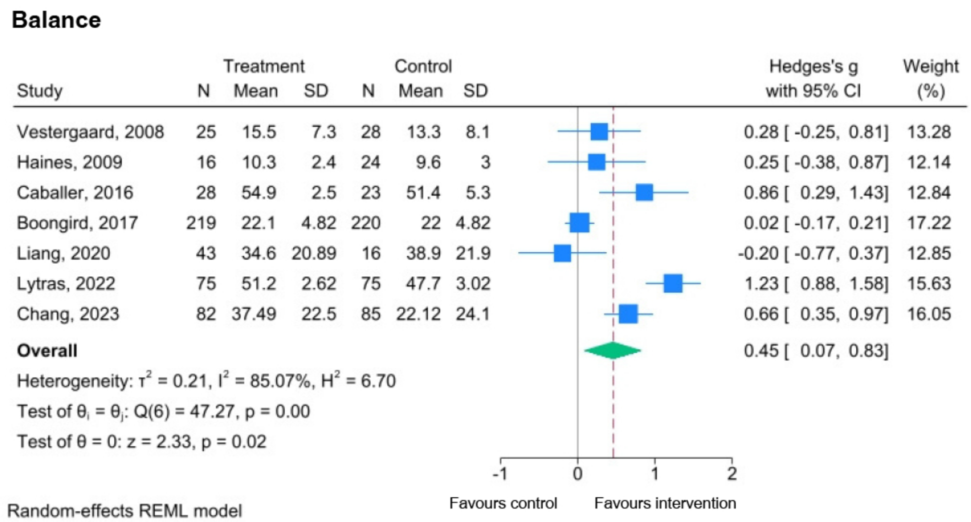
Risk of bias of included studies

136x131mm (300 x 300 DPI)



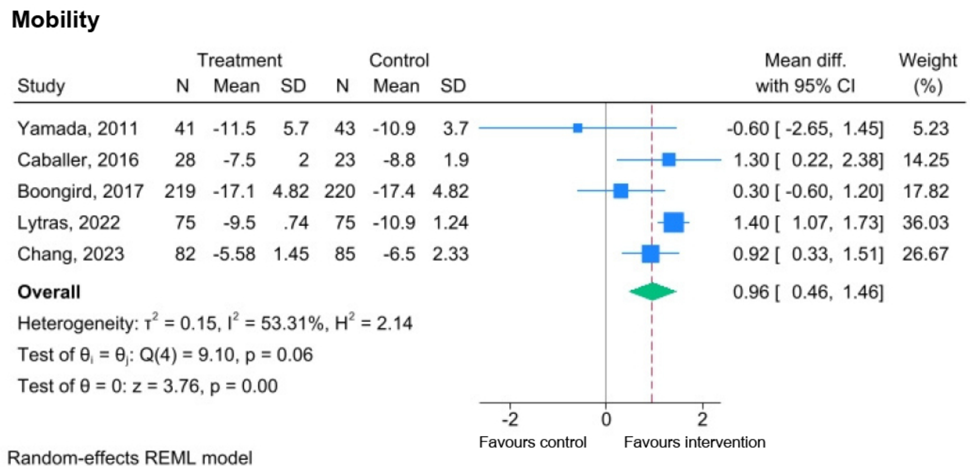
Forest plot of the effect of video-delivered exercise programs on lower extremity strength in older adults. Meta-analysis of eight studies shows Hedges' g effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Hedges' g = 0.36; 95% CI: 0.09 to 0.63). Heterogeneity is notable (I^2 = 73.17%, τ^2 = 0.10), and the overall effect is significant (z = 2.63, p = 0.01).

89x53mm (300 x 300 DPI)



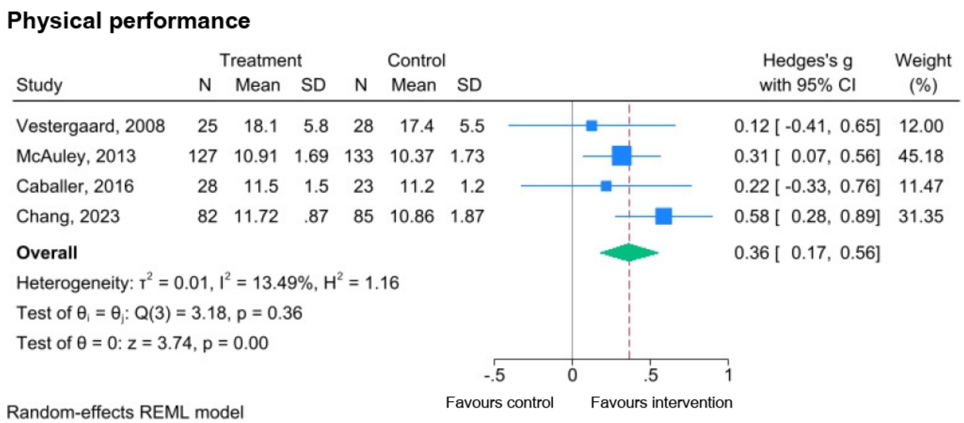
Forest plot of the effect of video-delivered exercise programs on balance in older adults. Meta-analysis of seven studies shows Hedges' g effect sizes with 95% CIs. Blue squares indicate individual effects (weighted by size), and the diamond represents the pooled effect (Hedges' g = 0.45; 95% CI: 0.07 to 0.83). Heterogeneity is high (I^2 = 85.07%, τ^2 = 0.21), and the overall effect is significant (z = 2.33, p = 0.02).

89x48mm (300 x 300 DPI)



Forest plot of the effect of video-delivered exercise programs on mobility in older adults. Meta-analysis of five studies shows Mean Difference effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Mean Difference = 0.96; 95% CI: 0.46 to 1.46). Heterogeneity is moderate ($I^2 = 53.31\%$, $\tau^2 = 0.15$), and the overall effect is significant ($z = 3.76$, $p = 0.00$).

89x44mm (300 x 300 DPI)



Forest plot of the effect of video-delivered exercise programs on physical performance in older adults. Meta-analysis of four studies shows Hedges' g effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Hedges' g = 0.36; 95% CI: 0.17 to 0.56). Heterogeneity is low (I^2 = 13.49%, τ^2 = 0.01), and the overall effect is significant (z = 3.74, p = 0.00).

89x42mm (300 x 300 DPI)

SEARCH STRATEGY

Keywords	Alternatives
Population (older adults)	Older adults OR older people OR older person OR older OR elderly OR geriatric OR senior OR aged 65 OR aged OR frail
Intervention (video-supported home exercise)	(Exercise OR training OR physical activity OR programme OR home OR home-based) AND (video OR taped OR DVD OR web-based OR website OR remote OR tablet OR ipad OR smartphone OR phone OR youtube OR computer OR television OR application OR ehealth OR mhealth)
Outcomes (physical performance and falls)	Physical performance OR physical function OR functional performance OR functional ability OR physical ability OR balance OR strength OR fall OR faller OR mobility
Study design	Randomised controlled trial

MEDLINE, EMBASE, PsycINFO (Ovid)

1	aged/ or "aged, 80 and over"/ or frail elderly/
2	"older adult*".ab,ti.
3	"elder*".ab,ti.
4	"senior*".ab,ti.
5	"geriatric*".ab,ti.
6	older people.ab,ti.
7	older.ab,ti.
8	aged 65.ab,ti.
9	older person.ab,ti.
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9
11	"exercise*".ab,ti.
12	"training*".ab,ti.
13	"home*".ab,ti.
14	physical activity.ab,ti.
15	"program*".ab,ti.
16	11 or 12 or 13 or 14 or 15
17	"video*".ab,ti.
18	taped.ab,ti.
19	"DVD*".ab,ti.
20	"website*".ab,ti.
21	web-based.ab,ti.
22	remote.ab,ti.
23	"tablet*".ab,ti.
24	"ipad*".ab,ti.
25	"smartphone*".ab,ti.
26	"phone*".ab,ti.
27	"youtube*".ab,ti.
28	"computer*".ab,ti.
29	"television*".ab,ti.
30	"application*".ab,ti.
31	ehealth.ab,ti.

32	mhealth.ab,ti.
33	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32
34	"physical perform*".ab,ti.
35	"physical function*".ab,ti.
36	"functional perform*".ab,ti.
37	"functional abilit*".ab,ti.
38	balance.ab,ti.
39	strength.ab,ti.
40	"fall*".ab,ti.
41	"mobilit*".ab,ti.
42	"physical abilit*".ab,ti.
43	34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42
44	10 and 16 and 33 and 43
45	"random*".ab,ti.
46	44 and 45
47	limit 46 to yr="2000 -Current"

CINAHL

Searching on abstract and title:
Older adults OR older people OR older person OR (older women or aging women or elderly women) OR (older men or older males or elderly men) OR elderly OR senior OR geriatric OR aged 65 OR aged OR (frailty or frail elderly) AND
Exercise OR training OR home OR physical activity OR program* AND
Video* OR taped OR DVD* OR website* OR web-based OR remote OR tablet* OR computer* OR ipad* OR phone* OR television OR TV or smartphone* or youtube* or application or ehealth or mhealth or digital health AND
Physical perform* OR physical function OR functional perform* OR functional ability* OR balance OR strength OR fall OR mobilit* OR physical ability* AND
Random*

Limiters - Published Date: 20000101-20231231
Expanders - Apply equivalent subjects
Search modes - Boolean/Phrase

CENTRAL

#1	Older adult* OR older person OR older people OR elderly OR geriatric OR senior* OR aged 65
#2	Exercise* OR training OR home OR physical activity OR program*
#3	Video* OR taped OR DVD* OR website OR web-based OR remote OR tablet* OR ipad* OR smartphone* OR phone* OR youtube* OR computer* OR television* OR application* OR ehealth OR mhealth OR digital health
#4	Balance OR strength OR fall* OR mobilit* OR physical perform* OR physical function* OR physical ability* OR functional perform* OR functional abilit*
#5	Random*
#6	#1 AND #2 AND #3 AND #4 AND #5 With publication year from 2000 to 2023, in Trials

TRIP

(Older adult* OR older person OR older people OR elder OR geriatric OR senior* OR aged 65) AND (Exercise* OR training OR home OR physical activity OR program*) AND (Video* OR taped OR DVD* OR website OR web-based OR remote OR tablet* OR ipad* OR smartphone* OR phone* OR youtube* OR computer* OR television* OR application* OR ehealth OR mhealth OR digital health) AND (Random*)

PEDRO

Title and abstract: Video-based exercise
Subdicipline: gerontology
Method: clinical trial
Published since: 2000

PROQUEST

abstract(Older adult* OR older person OR older people OR elder OR geriatric OR senior* OR aged 65) AND abstract(Exercise* OR training OR home OR physical activity OR program*) AND abstract(Video* OR taped OR DVD* OR website OR web-based OR remote OR tablet* OR ipad* OR smartphone* OR phone* OR youtube* OR computer* OR television* OR application* OR ehealth OR mhealth OR digital health) AND abstract(Balance OR strength OR fall* OR mobilit* OR physical perform* OR physical function* OR physical ability* OR functional perform* OR functional abilit*) AND abstract(random*)

Limiters: full text, dissertation & thesis, English language, published since 2000

EThOS

Older adult* AND video AND exercise

Summary of the characteristics of included trials

Study author; country	Sample (n); % female; mean age	Exercise components	Duration; session length; frequency	Setting; exercise mode	Comparator	Video exercise; media; device	Physical performance measurements	Fall-related outcomes and measurements
Boongird et al (2017); Thailand	417; 86.6%; 74.08	Lower extremity strengthening, stretching, and balance training.	6 months; 60 min; 2-3x wk	Home; individual; supervised	Non-exercise intervention	Entirely video; offline; Video Disk Recorder (VDR)	Strength (5-STS); Dynamic balance (TUG, BBS)	Fear of falling (Thai FES-I); Number of falls and fallers (self-recorded)
Caballer et al (2016); Spain	51; 69%; 69.1±4	Lower extremity strengthening, balance, mobility, flexibility, endurance.	4 months; 45 min; 3x wk	Centre; group; supervised	No intervention	Entirely video; offline; DVD player	Mobility (TUG); Functional balance (BBS); Balance (OLS); Aerobic endurance (6MWT); Lower limb function (SPPB); Lower extremity strength (5-STS)	Not assessed
Chang et al (2023); Taiwan	167; 70.1%; 67.6±7.86	Resistance, static balance, dynamic balance, speed-walking.	4 months; 60 min; 2-3x wk	Centre and home; both group and individual; supervised	Non-exercise intervention	Partially video (combined with face-to-face exercise); online; smartphone & chat application	Upper limb strength (Grip strength); SPPB; static balance ability (OLS); physical agility (TUG); dynamic balance ability (functional reach)	Not assessed
Fyfe et al (2022); Australia	19; 67%; 69.8±3	Lower extremity strengthening, balance, functional tasks	1 month; 9 min; 3x day	Home; individual; unsupervised	No intervention	Entirely video; online; smartphone/tablet & website platform	Physical function (5-STS and 30s CST)	Not assessed
Haines et al (2009); Australia	50; 60.4%; 80.9±6.5	Muscle strength, balance	2 months; 13 min	Home; individual; supervised	No intervention	Entirely video; offline; DVD player	Balance (BOOMER); Strength (15s sit-to-stand); Mobility (2-minute walk test)	Fear of falling (ABC Scale); Number of falls (self-recorded)
Liang et al (2020); United Kingdom	30; 67%; 71.1±3.6	Functional tasks, muscle strength, balance, tai chi	1 month; 2x day	Home; individual; unsupervised	Non-exercise intervention	Entirely video; online; smartphone/tablet and website platform	Physical function (5-STS, 60s sit-to-stand, Leg standing balance)	Not assessed
Lytras et al (2022); Greece	150; 90.7%; 70	Lower extremity strengthening, balance, flexibility	6 months; 45 min; 5x wk	Centre and home; both group and individual; supervised	Non-exercise intervention	Partially video (combined with face-to-face exercise); offline; TV or computer	Functional mobility (TUG); Static balance (4-stage balance); Leg strength (30s CST); Balance (BBS)	Fear of falling (short FES-I); Number of falls (self-recorded)

Continued

Study author; country	Sample (n); % female; mean age	Exercise components	Duration; session length; frequency	Setting; exercise mode	Comparator	Video exercise; media; device	Physical performance measurements	Fall-related outcomes and measurements
McAuley et al (2012); United States	260; 71.52%; 70.62±0.4	Muscle strength, balance, and flexibility.	6 months; 3x wk	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Meziere et al (2021); France	35; 83.3%; 90	Muscle strength, balance, functional tasks, joint mobilization exercises	3 months; 2x wk	Home; individual; supervised	Non-exercise intervention	Partially video (combined with face-to-face exercise); offline; tablet	Walking and balance ability (TUG)	Absence of falls requiring medical care
Roberts et al (2017); United States	153; 73.6%; 70±4.98	Muscle strength, balance, and flexibility.	24 months follow up; 3x wk	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Vestergaard et al (2007); Denmark	53; 100%; 81±3.3	Muscle strength, balance, flexibility, and endurance	5 months; 26 min; 3x wk	Home; individual; unsupervised	No intervention	Entirely video; offline; Video player	Functional ability (5-STS, 10-meter walking, standing balance test, PPT, Mob-T)	Not assessed
Wojcicki et al (2015); United States	237; 71.5%; 70.6±0.4	Muscle strength, balance, and flexibility.	12 months follow up; 3x wk	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Yamada et al (2011); Japan	84; 80.5%; 83±6.7	Muscle strength, balance, agility, and dual tasks.	6 months; 20 min; 2x wk	Centre; group; supervised	No intervention	Entirely video; offline; DVD player	Functional fitness (TUG, 5-STS)	Not assessed

PRISMA 2020 for Abstracts Checklist

Section and Topic	Item #	Checklist item	Reported (Yes/No)
TITLE			
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	Yes
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	Yes
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	Yes
Interpretation	10	Provide a general interpretation of the results and important implications.	Yes
OTHER			
Funding	11	Specify the primary source of funding for the review.	No
Registration	12	Provide the register name and registration number.	Yes

From: 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. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 1 & 2
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 2
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 3
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 3
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 3 & supplementary file
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 3 & 4
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 3 & 4
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 3
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 3
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 4
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 4
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 4
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 4
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 4
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 4
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Page 4

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Page 4
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 5
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Page 5
Study characteristics	17	Cite each included study and present its characteristics.	Page 5 & 6
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 7
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Page 8 - 9
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 9 – 11
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Page 9 – 12
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Page 13
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 13
	23b	Discuss any limitations of the evidence included in the review.	Page 14
	23c	Discuss any limitations of the review processes used.	Page 14
	23d	Discuss implications of the results for practice, policy, and future research.	Page 13 & 14
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 15
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 15
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 15
Competing interests	26	Declare any competing interests of review authors.	Page 15
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 15

PRISMA 2020 Checklist

From: 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. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

BMJ Open

Effects of exercise programmes delivered using video technology on physical performance and falls in people aged 60 years and over living in the community: A systematic review and meta-analysis

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2024-092775.R2
Article Type:	Original research
Date Submitted by the Author:	28-Mar-2025

Complete List of Authors:	Adliah, Fadhia; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences; Hasanuddin University, Faculty of Nursing, Physiotherapy Hall, Abigail J.; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences Goodwin, Victoria; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences Lamb, Sarah; University of Exeter Faculty of Health and Life Sciences, Public Health and Sport Sciences

Primary Subject Heading:	Sports and exercise medicine
Secondary Subject Heading:	Sports and exercise medicine
Keywords:	Digital Technology, Exercise, Aged

I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our licence.

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which Creative Commons licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

Effects of exercise programmes delivered using video technology on physical performance and falls in people aged 60 years and over living in the community: A systematic review and meta-analysis

Fadhia Adliah[1,2]*, Abigail J Hall[1], Victoria A Goodwin[1], Sarah E Lamb[1]

[1] Public Health and Sport Sciences, Faculty of Health and Life Sciences, University of Exeter

[2] Physiotherapy, Faculty of Nursing, Hasanuddin University

Corresponding author:

Fadhia Adliah, Public Health and Sport Sciences, Faculty of Health and Life Sciences, University of Exeter, St Lukes Heavitree Road, Exeter EX1 2LP

Email: fa436@exeter.ac.uk

Abstract

Objectives: This systematic review and meta-analysis synthesised the evidence and evaluated the effect of exercise programmes delivered using instructional videos compared with control on physical performance and falls in community-dwelling older people aged 60 years and older.

Design: A systematic review and meta-analysis conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.

Data sources: MEDLINE, EMBASE, CINAHL, PsycINFO, The Cochrane Central Register of Controlled Trials, TRIP, and PEDro. Grey literature sources included theses and dissertations from Ethos and ProQuest.

Eligibility criteria: Studies were included if they involved community-dwelling older people (aged $\geq$60 years) participating in exercise programmes delivered through instructional videos.

Data extraction and synthesis: Treatment effects were estimated using a random-effects model, reporting 95% confidence intervals (CIs), mean differences (MD), and standardized mean differences (SMD, Hedges' g) for outcomes measured in different units. The risk of bias was assessed using ROB2, and the certainty of evidence was evaluated using the GRADE approach.

Results: A total of 7487 records were screened, with 16 studies (n=1910) meeting the inclusion criteria. Meta-analysis of 11 studies revealed significant effects of video-delivered exercise programmes in lower extremity strength (SMD=0.35, 95%CI 0.11 to 0.59; I^2=70.35%, p<0.001, GRADE moderate quality), balance (SMD=0.45, 95%CI 0.07 to 0.83; I^2=85.07%, p=0.02, GRADE low quality), mobility (MD=0.96, 95%CI 0.46 to 1.46; I^2=53.31%, p<0.001, GRADE moderate quality), and physical performance SMD=0.36, 95%CI 0.17 to 0.56; I^2=13.49%, p<0.001, GRADE moderate quality). No evidence of an effect of video-delivered exercise programmes on fear of falling was found (SMD=0.5, 95%CI -0.30 to 1.29; I^2=95.48%, p=0.22, GRADE very low quality). There was insufficient data for reporting falls.

Conclusions: Video-delivered exercise programmes improved physical performance, particularly lower extremity strength, balance, and mobility, with low to moderate quality evidence. There is uncertainty about the effect of video-delivered exercise programmes on number of falls, number of fallers, and fear of falling.

PROSPERO registration number: CRD42023415530

Keywords: video exercise, falls, physical performance, older people

Strengths and limitations of this study

- This is the first systematic review and meta-analysis specifically examining the role of video demonstrations in supporting exercise programmes.
- Conducted according to the PRISMA guidelines and a prespecified PROSPERO-registered protocol. The methodological quality of the included reviews was assessed using standardised measures.
- The findings provide valuable insights for future digital or remote-based interventions.
- Potential limitations include the availability and heterogeneity of the existing evidence and variations in methodological quality.

Introduction

Regular exercise and physical activity offer numerous benefits for older adults, including the prevention and management of age-related conditions, improved mobility, enhanced mental well-being, and a better quality of life.[1, 2] In particular, exercise has been shown to effectively reduce falls, even in vulnerable older populations, either alone or in combination with other interventions.[3]

To minimise fall risk, older adults should engage in tailored exercise programmes that incorporate multicomponent exercises, including muscle strengthening and balance training.[3, 4] These programmes should progressively increase in challenge and be performed regularly including muscle-strengthening activities at least twice a week, along with functional balance training supplemented by brisk walking at least three days per week.[3-5]

Despite the availability of best-practice clinical guidelines for exercise-based fall prevention, participation and adherence among older adults remain low.[6] Barriers include personal factors such as lack of motivation, boredom, fear of injury, and pre-existing health conditions.[7-9] Additionally, environmental and logistical challenges such as poor access to exercise facilities, limited transportation options, safety concerns, weather conditions, and cost, further hinder participation.[10-13]

To address these barriers, technology has been increasingly integrated into physical activity programmes to enhance engagement and adherence, particularly in rehabilitation settings.[14, 15] Over time, technology-based exercise interventions have expanded to community and residential settings, offering accessible and affordable ways to promote physical activity in older adults.[16] Advances in digital technology, including computers, tablets, and smartphones, now provide convenient and flexible options for delivering exercise programmes.[16-18]

Among these technological advancements, video-based exercise demonstrations have gained popularity as an option to guide older adults through exercise routines. Compared to text-based instructions, videos provide clear visual demonstrations, verbal instructions, and often motivating background music, which can enhance comprehension, engagement, and adherence.[19-22] The accessibility of video-based exercises has further improved with the widespread availability of the Internet and smartphones, allowing for remote participation at a relatively low cost. This became particularly relevant during the COVID-19 pandemic when video-based interventions enabled the continuation of exercise programmes despite social restrictions.[23, 24]

A recent systematic review and meta-analysis by Lee et al.[25] examined the effects of fall prevention interventions using information and communication technology (ICT), including telehealth, computerised balance training, exergaming, mobile applications, virtual reality, and cognitive-behavioural training. Their findings demonstrated that ICT-based interventions, particularly telehealth and exergames, improved balance, reduced fall risk, and enhanced physical function in older adults. However, the review encompassed a broad range of ICT-based interventions and did not specifically evaluate the effectiveness of video-based exercise demonstrations.

Given the increasing adoption of video technology for exercise training, there remains a need to systematically review and synthesise the evidence on its effectiveness in improving physical performance and reducing falls in older adults. Therefore, this systematic review and meta-analysis aim to address this gap by focusing specifically on the role of video demonstrations in supporting exercise programmes. The objective is to evaluate the effectiveness of video-based exercises compared with usual care or non-exercise intervention in enhancing physical performance and reducing falls.

Method

This systematic review and meta-analysis have been reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[26] The PRISMA checklist can be found in supplemental material 3-4. The protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) under registration number CRD42023415530. Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Eligibility criteria

We included all randomised controlled trials published in English to ensure accurate data extraction and interpretation while minimising the risk of translation errors. Eligibility criteria were defined using the PICO (Population, Intervention, Comparator, Outcomes) framework,[26] and studies had to meet the following criteria for inclusion.

Population

Community-dwelling older adults (male and/or female) aged 60 years or older. Studies were eligible if the sample's mean age was at least 60 years. Studies focusing on hospitalised or institutionalised older adults, as well as those exclusively involving individuals with specific diseases or conditions (e.g., Parkinson’s disease, stroke), were excluded.

Intervention

Exercise programmes utilising pre-recorded instructional videos (online or offline) to demonstrate exercises. Studies using synchronous instructional videos, such as live streaming, video calls, or video conferencing, were excluded. Video-based exercise programs could be supplemented with home visits or in-person interactions with practitioners.

Comparator

No exercise intervention or a non-exercise control intervention, such as receiving leaflets, links to physical activity promotion websites, or physical activity guidelines.

Outcomes

The primary outcome was physical performance, defined as the observed ability to perform tasks related to transfer and mobility (e.g., sit-to-stand, walking). Other related terms included physical function, functional ability, or functional performance. Secondary outcomes included fall-related variables such as the number of falls, number of fallers, and fear of falling.

Data Source

We systematically searched MEDLINE, EMBASE, CINAHL, PsycINFO, the Cochrane Central Register of Controlled Trials, TRIP, and PEDro for articles published between 2000 and 2025. The initial search on 17 May 2023 covered studies from 2000 to 2023, and an update on 17 March 2025 using the same search strategy included recent studies from 2023 to 2025.

The search also included grey literature to identify unpublished research material, specifically theses and dissertations accessed through Ethos and ProQuest. Additionally, reference lists of included studies were manually searched for further eligible studies, and citation tracking (both backward and forward) was conducted using Google Scholar.

The search strategy employed Boolean operators (AND, OR, NOT), filters (date range), and other relevant limits. A full, detailed search strategy, including precise search terms, Boolean logic, filters, and limits applied for each database and register, as well as the date of each database search, is provided in supplemental material 1.

Study selection

All retrieved papers were first de-duplicated using EndNote 20 and then exported to RAYYAN[27] for manual screening. Two reviewers (FA, AH) independently conducted the screening process. Initially, tittles and abstracts from the selected databases were screened, followed by full-text screening based on the predetermined inclusion and exclusion criteria. A third reviewer (VG) resolved any disagreements. Studies that did not meet the eligibility criteria were excluded, with reasons for exclusion documented in the PRISMA flow diagram[26] (Figure 1).

Data extraction

Data were extracted using an electronic data extraction form. Study authors were contacted via email for additional information on missing data. One reviewer (FA) extracted the data, and another (AH) independently verified it. Extracted data included the following: author, year of publication, country, participant characteristics (sample size, age, sex, health status), study design, recruitment sources, eligibility criteria, setting, exercise type and components, dose, mode of delivery, video characteristics (technology used, method of delivery), and adherence. Primary and secondary outcome data were collected for pre-intervention and post-intervention time points. If multiple follow-up time points were reported, the earliest was selected. Any disagreements between the two reviewers were resolved through discussion with a third author (VG).

Methodological quality assessment

We used the Cochrane Risk of Bias tool (RoB2) to assess bias in each included study, categorising it as low risk, high risk, or some concerns.[28] To evaluate overall evidence quality, we applied the GRADE system via the GRADEPro website, following the Cochrane Handbook for Systematic Reviews.[29, 30] GRADE rates evidence as high, moderate, low, or very low based on the risk of bias, imprecision, indirectness, and inconsistency. Quality was downgraded if (1) most data came from high-risk studies, (2) outcomes had fewer than 400 participants, (3) evidence did not directly address PICO, or (4) heterogeneity was high (I^2 >50%). The first author conducted the risk of bias and quality assessment, which was then reviewed by the team. Discrepancies were resolved through discussion until a consensus was reached.

Data analysis

Meta-analysis was conducted using STATA 18.0 software with random-effects models. This approach was chosen due to the heterogeneity of the population, measurements, and interventions. Meta-analysis was performed only when at least three studies were available for comparison per outcome.

For continuous variables measured in the same units, treatment effects were calculated using mean differences. When different measurement units were used, standardized mean differences (SMDs, Hedges' g) were applied.[31] Effect estimates were derived from post-score means and standard deviations (or their estimates), with 95% confidence intervals (CIs) for between-group change scores. Because some measurements indicated that higher scores reflected better physical performance, while others indicated the opposite, scores from studies where higher values represented worse physical performance were multiplied by -1 to ensure consistency before inclusion in the meta-analysis.[31]

Heterogeneity among studies was visually assessed using forest plots and quantified with the I^2 statistic. An I^2 value of 50% or lower indicated homogeneity, while values above 50% suggested substantial heterogeneity. Statistical significance was set at $p < 0.05$. SMDs were calculated by dividing the difference in means between groups by the pooled standard deviation at the post-intervention time point. SMD values of 0.20, 0.50, and 0.80 were interpreted as small, medium, and large effects, respectively.37 Publication bias was assessed visually using funnel plots. When insufficient data were available for meta-analysis, a narrative synthesis was conducted.

Ethics

This study involved the secondary analysis of data from previously published studies. Since all data were obtained from existing literature, ethical approval was not required.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Results

Search outcome

The initial search was conducted on 17 May 2023 and updated on 17 March 2025. A total of 7,487 records were identified through database and manual searches. After removing 2,823 duplicates and excluding 4,504 records based on title and abstract screening, 160 reports underwent full-text review. Of these, 15 studies met the inclusion criteria, and an additional study was identified through forward citation tracking, bringing the total to 16 studies. The PRISMA flow diagram (Figure 1) illustrates this process.

Study characteristics

Sixteen studies published between 2007 and 2025 in English were included. These studies were conducted in the United Kingdom[32], Australia[22, 33], Spain[19], Greece[20], France[34], Italy[35], Denmark[36], Japan[37, 38], Thailand[21], Taiwan[39], and China.[40] Additionally, one study from the United States generated three reports[41-43]. Table 1 provides a summary of the study characteristics, with further details available in supplemental material 2.

Participants

The included studies had sample sizes ranging from 15 to 417 participants, with a total of 1910. The mean age of participants ranged from 67 to 90 years, and all were older adults living in the community.

One study included only female participants[36] while 15 studies included both males and females, though two had fewer female participants.[38, 40]

Risk of bias

Three studies had a low risk of bias, six had some concerns, and seven had a high risk of bias. Further details are shown in Figure 2.

Table 1. Summary of the characteristics of included studies

Study	Sample (n); % female; mean age	Exercise components	Duration; session length; frequency	Setting; exercise mode	Video exercise; media; device
Vestergaard et al (2007)[36]	53; 100%; 81+3.3	Muscle strength, balance, flexibility, and endurance	5 months; 26 min; 3x wk	Home; individual; unsupervised	Entirely video; offline; Video player
Haines et al (2009)[33]	50; 60.4%; 80.9+6.5	Muscle strength, balance	2 months; 13 min	Home; individual; supervised	Entirely video; offline; DVD player
Yamada et al (2011)[37]	84; 80.5%; 83+6.7	Muscle strength, balance, agility, and dual tasks.	6 months; 20 min; 2x wk	Centre; group; supervised	Entirely video; offline; DVD player
McAuley et al (2012)[41]	260; 71.52%; 70.62+0.4	Muscle strength, balance, and flexibility.	6 months; 3x wk	Home; individual; unsupervised	Entirely video; offline; DVD player
Wojcicki et al (2015)[43]	237; 71.5%; 70.6+0.4	Muscle strength, balance, and flexibility.	12 months follow up; 3x wk	Home; individual; unsupervised	Entirely video; offline; DVD player
Caballer et al (2016)[19]	51; 69%; 69.1+4	Lower extremity strengthening, balance, mobility, flexibility, endurance.	4 months; 45 min; 3x wk	Centre; group; supervised	Entirely video; offline; DVD player
Boongird et al (2017)[21]	417; 86.6%; 74.08	Lower extremity strengthening, stretching, and balance training.	6 months; 60 min; 2-3x wk	Home; individual; supervised	Entirely video; offline; Video Disk Recorder (VDR)
Roberts et al (2017)[42]	153; 73.6%; 70+4.98	Muscle strength, balance, and flexibility.	24 months follow up; 3x wk	Home; individual; unsupervised	Entirely video; offline; DVD player
Liang et al (2020)[32]	30; 67%; 71.1+3.6	Functional tasks, muscle strength, balance, tai chi	1 month; 2x day	Home; individual; unsupervised	Entirely video; online; smartphone/tablet and website platform
Meziere et al (2021)[34]	35; 83.3%; 90	Muscle strength, balance, functional tasks, joint	3 months; 2x wk	Home; individual; supervised	Partially video (combined with face-to-face exercise); offline; tablet

		mobilization exercises			
Lytras et al (2022)[20]	150; 90.7%; 70	Lower extremity strengthening, balance, flexibility	6 months; 45 min; 5x wk	Centre and home; both group and individual; supervised	Partially video (combined with face-to-face exercise); offline; TV or computer
Fyfe et al. (2022)[22]	19; 67%; 69.8±3	Lower extremity strengthening, balance, functional tasks	1 month; 9 min; 3x day	Home; individual; unsupervised	Entirely video; online; smartphone/tablet & website platform
Chang et al (2023)[39]	167; 70.1%; 67.6±7.86	Resistance, static balance, dynamic balance, speed-walking.	4 months; 60 min; 2-3x wk	Centre and home; both group and individual; supervised	Partially video (combined with face-to-face exercise); online; smartphone & LINE chat application
Suzuki et al (2024)[38]	15; 33.3%	Slow squats, one-legged stance	3 months; 15 min; daily	Home; individual; supervised	Entirely video; online; smartphone & YouTube application
Ferrari et al (2024)[35]	73; 49%; 66.89±5.93	Muscle strength and balance	6 months; 30 min; 3x wk	Home; individual; supervised	Entirely video; online; tablet & website platform
Zhou et al (2025)[40]	116; 25%; 84.4±3.2	Muscle strength and balance	12 months; 30 min; 3x wk	Home; individual; supervised	Entirely video; online; smartphone & WeChat application

Intervention

All included studies implemented multicomponent exercises incorporating both strength and balance. Five studies added flexibility exercises to the training component[19-21, 36, 39, 41], three studies added functional tasks exercise[22, 32, 34], three added endurance exercise[19, 36, 39]and one added joint mobilization exercises.[34]

The duration of intervention follow-up ranged from one month to two years. Four studies reported multiple follow-up time points: Haines et al. and Lytras et al. measure outcomes at two time points (2 and 6 months, and 3 and 6 months, respectively),[20, 33] while Boongird et al. and McAuley et al. had three follow-up assessments (3, 6, and 12 months, and 6, 12, and 24 months, respectively).[21, 41-43]

Exercise programme doses were varied, with a frequency of two to three times per week being the most commonly prescribed[19, 34-37, 39-41], and 20-45 minutes being the most commonly used duration.[19, 20, 34-37, 40] Some studies reported progressive training loads by increasing difficulty levels and using ankle cuff weights. [19-22, 33, 34, 41] Monitoring strategies included telephone calls, exercise diaries, and face-to-face visits. Three studies implemented the Otago Exercise Programmes, which required at least four home visits.[19-21]

Two delivery methods were used for pre-recorded exercise videos. Ten studies (62.5%) provided offline access through DVDs or videotapes,[19-21, 33, 34, 36, 37, 41-43] while the remaining six (37.5%) used online delivery via smartphones, apps, or websites.[22, 32, 35, 38-40] More recent studies (since 2020) favoured online methods: Chang et al.[39], Zhou et al.[40] used smartphone-based messaging apps to send exercise videos. Fyfe et al.[22] and Ferrari et al.[35] provided videos and guidelines via a website platform.

Eight studies (50%) compared video-delivered exercise to non-exercise interventions, such as providing educational materials on healthy lifestyles, fall prevention resources, or a home helper without an exercise programme.[20, 21, 32, 34, 39, 41-43] The remaining studies (50%) compared to no intervention at all.[19, 22, 33, 35-38, 40]

Outcome Measures

Several studies assessed physical performance using a single measurement, such as the Short Physical Performance Battery[19, 39, 41] or Physical Performance Test[36]. However, some studies evaluated individual components of physical performance, including strength, balance, and mobility.

Lower extremity strength was assessed using the Five Times Sit-to-Stand test[19, 21, 22, 32, 36, 37, 39, 40] and the 30-second Chair Stand Test.[20] Balance was measured using the Berg Balance Scale (BBS),[19-21] one leg stand,[32, 39] semi tandem stand,[36] and the Balance Outcome Measure for Elder Rehabilitation (BOOMER).[33] Functional mobility was assessed using the Timed up and go test.[19-21, 37, 39] Fear of falling was assessed using the Fall Efficacy Scale International (FES-I)[21], Short FES-I[20], or Activities-specific Balance Confidence (ABC) Scale.[33]

Effects of video-delivered exercise programmes on physical performance

Physical performance, as we define it, is a broad category encompassing strength, balance, and mobility. While not all included studies use the same definition, they assess components that align with ours. The effects of video-delivered exercise programs on these aspects of physical performance are illustrated in Figures 3–6.

The pooled analysis of nine trials (n=1165) assessing lower extremity strength indicates a small but statistically significant improvement compared to the control group (SMD=0.35, 95% CI 0.11 to 0.59; I^2=70.35%, p<0.001). This finding is supported by moderate-quality evidence (GRADE).

For balance, a pooled analysis of seven trials (n=959) shows a small to moderate, statistically significant effect in favour of video-delivered exercise programs compared to control (SMD=0.45, 95% CI 0.07 to 0.83; I^2=85.07%, p=0.02). However, this result is supported by low-quality evidence (GRADE).

The meta-analysis of five trials (n=891) evaluating the effects of video-delivered exercise on mobility found a statistically significant improvement compared to the control group (MD=0.96, 95% CI 0.46 to 1.46; I^2=53.31%, p<0.001), supported by moderate-quality evidence (GRADE).

Additionally, four trials (n=531) assessing overall physical performance reported a small but statistically significant effect in favour of video-delivered exercise (SMD=0.36, 95% CI 0.17 to 0.56; I^2=13.49%, p<0.001). These pooled results are also supported by moderate-quality evidence (GRADE).

A summary of the quality of evidence is provided in Table 2.

Effects of video-delivered exercise programmes on fall-related variables

Four studies reported fear of falling.[20, 21, 33] Haines et al[33] and Zhou et al[40] reported that there was no difference in fear of falling scores of video-delivered exercise intervention versus control. Meanwhile, Boongird et al[21] and Lytras et al[20] found a statistically significant effect after six months of video-delivered exercise intervention compared to control. However, when the meta-analysis was performed, the pooled effect still indicated that there was no difference in fear of falling between video-delivered exercise programmes and control (SMD=0.5, 95%CI -0.3 to 1.29; I2= 95.48%, p=0.22, n=760), with very low-quality evidence.

This review included only three studies that reported on fall rate and number of fallers, which was insufficient for a meta-analysis. All three studies observed a reduction in falls and the number of fallers in their intervention groups compared to controls. Boongird et al.[21] and Zhou et al.[40] reported fewer falls in the intervention group over a one-year follow-up, while Haines et al.[33] observed a similar trend over six months. However, these differences did not reach statistical significance.

Adverse events

Adverse events were reported in six studies (37.5%).[21, 22, 32, 33, 40, 41] No major adverse events were associated with the intervention. Reported minor adverse events included muscle pain, muscle discomfort, and knee joint pain.

Adherence to the video-delivered exercise programmes

Eleven studies (68.7%) reported adherence to exercise programmes using various indicators to evaluate adherence. The included studies defined adherence as; 1) the proportion of completed exercise sessions per person; 2) the proportion of participants who attended the exercise session; 3) the average number of exercise days per week; 4) the percentage of participants exercising for more than 120 minutes per week; or 5) the total of video playbacks. Boongird et al reported relatively low adherence, with only 29.6% of participants exercising for more than 120 minutes per week in the first (3-month) follow-up.[21] In contrast, Liang et al. recorded the highest adherence, with 90% of participants completing the prescribed exercise intervention over four weeks.[21] However, overall adherence to video-delivered exercise programmes remains uncertain due to heterogeneity in measurement methods and interpretation.

Table 2. Summary of the quality of evidence

Outcome	Number of trials	Risk of bias[a]	Inconsistency[b]	Imprecision[c]	Effect size [95%CI], I^2, p-value	Certainty
Lower extremity strength	9	-	↓	-	SMD=0.35 [0.11 to 0.59]; I^2=70.35%, p<0.001	⊕⊕⊕ Moderate[d]
Balance	7	↓	↓	-	SMD=0.45 [0.07 to 0.83], I^2=85.07%, p=0.02	⊕⊕ Low[e]
Physical performance	4	↓	-	-	SMD=0.36 [0.17 to 0.56], I^2=13.49%, p<0.001	⊕⊕⊕ Moderate[f]
Mobility	6	-	↓	-	MD=0.96 [0.46 to 1.46], I^2=53.31%, p<0.001	⊕⊕⊕ Moderate[g]
Fear of falling	3	↓	↓↓	-	SMD=0.5 [-0.30 to 1.29], I^2=95.48%, p=0.22	⊕ Very low[h]

[a]we downgraded if >25% of included trials had a high risk of bias
[b]we downgraded if there was statistical heterogeneity or wide confidence interval
[c]we downgraded if there were <400 participants

[d,g] Reason for downgrade: statistical heterogeneity
[e]Reason for downgrade: statistical heterogeneity, >25% of included trials had a high risk of bias
[f]Reason for downgrade: >25% of included trials had a high risk of bias
[h]Reason for downgrade: statistical heterogeneity, wide confidence interval, >25% of included trials had a high risk of bias

Discussion

This systematic review evaluated the effects of video-delivered exercises on physical performance and falls in community-dwelling older adults. The quality of evidence varied across outcomes. While several studies had a strong randomisation process, some raised concerns regarding sequence generation and allocation concealment. Additionally, one study[22] showed a significant difference in baseline characteristics, with the control group having more comorbidities. However, the absence of a p-value for these differences led to a high risk of bias assessment.

Considering the heterogeneity of the population, measurements, and interventions, the random effects model was chosen. Four meta-analyses showed differences in physical performance outcomes between participants who received video-delivered exercises. Although the measurement methods varied, process measures were favourable for video-delivered exercises, with a small effect size observed for physical performance with low to moderate-quality evidence. However, in some important outcomes including the number of falls, number of fallers, and fear of falling, the quality of literature was poor, and fewer studies reported those outcomes, making it difficult to draw robust conclusions.

Despite the uncertainty surrounding fall-related outcomes, our findings indicate that video-delivered exercises positively influence lower extremity strength, balance, mobility and overall physical performance. Strength-focused exercises included chair sit-to-stand, calf raises, hip abductor strength exercises, and resistance-based hip and knee movements, as seen in the Otago exercise program. Balance exercises frequently demonstrated in the video included one-leg stands, clock stepping, marching on the spot, tandem walking, and multidirectional walking (side and backwards).

While these improvements reached statistical significance, their clinical relevance remains uncertain. The observed effect sizes were small, particularly for balance (SMD=0.45, 95% CI 0.07 to 0.83). Lower extremity strength improvements (SMD=0.35, 95%CI 0.11 to 0.59) were supported by moderate-quality evidence, providing greater confidence in this result. In contrast, balance outcomes were supported by low-quality evidence, reducing the certainty of their impact. Improvements in mobility (MD=0.96 seconds, 95% CI 0.46 to 1.46) were statistically significant and supported by moderate-quality evidence, yet they fell below the Minimal Clinically Important Difference (MCID) threshold of 2.1 seconds established in previous research.[44] This suggests that while improvements were measurable, they may not translate into meaningful functional benefits for older adults. The discrepancy may stem from differences in participant health status (e.g., healthier vs. frailer individuals) and the measurement tools used. Although the Timed Up and Go (TUG) test is widely utilised for fall risk assessment, it may not be sensitive enough to detect changes in highly functional older adults, resulting in limited observed effects.[45]

Overall physical performance also showed a small but statistically significant improvement (SMD=0.36, 95% CI 0.17 to 0.56), supported by moderate-quality evidence, indicating that video-delivered exercises can enhance multiple aspects of physical function. However, the small effect size suggests that while beneficial, the real-world impact may be limited. Future research should explore the clinical implications of these findings, particularly regarding their role in fall prevention.

With advances in technology, video-based interventions have emerged as a practical tool for delivering structured exercise programmes to older adults. Video instruction offers clear visual demonstrations and, in some cases, background music to enhance engagement.[19, 36, 46] This review found that both online and offline delivery methods were viable. Offline methods require additional devices such as DVD players and television screens, though computers with internal video players can serve as an alternative. Online methods, by contrast, rely on internet-based platforms such as websites, video-sharing applications, and smartphone chat apps for accessibility and distribution.

Adherence to video-delivered exercise programs may be influenced by video quality and presentation style.[41, 42] High levels of satisfaction with video clarity and instruction have been linked to better adherence. Conversely, unclear instructions or poor-quality visuals may discourage engagement, leading some older adults to prefer face-to-face demonstrations.[32] Additionally, videos featuring older adults as demonstrators may enhance relatability and motivation, thereby improving adherence rates.[34]

Despite some limitations, our findings suggest that video-delivered exercise programmes are a feasible, accessible, and beneficial approach to improving physical performance in community-dwelling older adults. The convenience of remote exercise delivery may be particularly valuable for individuals with mobility limitations or those living in areas with limited access to in-person exercise programmes. The value of video-based exercise was further emphasised during the COVID-19 pandemic when restrictions on community-based activities highlighted the need for alternative, home-based solutions.

Study limitations

While we believe this is the first systematic review and meta-analysis of RCT-based evidence on video-delivered exercise for community-dwelling older people, several limitations should be acknowledged. First, limiting the included articles to those published in English may have resulted in a smaller number of studies and the potential exclusion of relevant research published in other languages or studies that did not explicitly mention video-based exercise. Second, the number of studies reporting fall-related outcomes was insufficient, which may have affected the certainty of conclusions regarding falls and fear of falling. Third, substantial heterogeneity was observed due to variations in follow-up periods and measurement criteria. However, because of the small number of included studies, we were unable to conduct meaningful subgroup analyses, limiting our ability to explore potential variations in effect sizes.

Conclusion

This review suggests that video-delivered exercise programmes can effectively improve physical performance, including lower extremity strength, balance, and mobility, in community-dwelling older adults. These findings highlight the potential of video-based interventions as an alternative to traditional in-person exercise programmes, particularly for individuals with mobility limitations or those in remote areas. However, the impact of video-delivered exercise on falls and the fear of falling remains uncertain due to the limited number of studies reporting these outcomes. Given the positive trends in digital technology, future research should prioritise high-quality trials examining fall-related outcomes, long-term adherence, and optimal delivery methods to maximise both engagement and clinical effectiveness.

Contributors

FA, AH, SL and VG conceptualised and designed the review. FA and AH determined the search terms and conducted screening. FA extracted data and performed analysis under the supervision of AH and VG. The extracted data and its analysis were discussed with VG and SL. SL provided technical support.

All authors reviewed, approved, and agreed to submit the final manuscript. FA is responsible for the overall content as guarantor.

Funding

The author, Fadhia Adliah was funded by Kementerian Pendidikan, Kebudayaan, Riset, dan Teknologi (Ministry of Education, Culture, Research, and Technology), Award Number: 202205080313 and Lembaga Pengelola Dana Pendidikan (Education Fund Management Institute, Indonesia Endowment Fund for Education, LPDP).

VG is funded by the National Institute of Health and Care Research (NIHR) Applied Research Collaboration South West Peninsula (NIHR200167) and is an NIHR Senior Investigator. SL is funded by the NIHR Exeter Biomedical Research Centre (NIHR 203320). AH is funded by the National Institute for Health and Care Research (NIHR) School for Primary Care Research (119247). The views expressed in this publication are those of the author(s) and not necessarily those of the NIHR or the Department of Health and Social Care.

Competing interest

None declared

Ethics approval

Not applicable

Data availability statement

All data relevant to the study are included in the article or uploaded as supplementary information.

Supplementary information

This content has been supplied by the author(s).

ORCHID IDs

Fadhia Adliah https://orcid.org/0009-0008-2559-2926

Abigail J Hall https://orcid.org/0000-0002-3453-5631

Victoria A Goodwin https://orcid.org/0000-0003-3860-9607

Sarah E Lamb https://orcid.org/0000-0003-4349-7195

Reference

1. Izquierdo M, Merchant RA, Morley JE, Anker SD, Aprahamian I, Arai H, et al. International Exercise Recommendations in Older Adults (ICFSR): Expert Consensus Guidelines. The Journal of nutrition, health and aging. 2021;25(7):824-53.
2. Nikitas C, Kikidis D, Bibas A, Pavlou M, Zachou Z, Bamiou DE. Recommendations for physical activity in the elderly population: A scoping review of guidelines. J Frailty Sarcopenia Falls. 2022;7(1):18-28.
3. Sherrington C, Fairhall NJ, Wallbank GK, Tiedemann A, Michaleff ZA, Howard K, et al. Exercise for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2019;1(1):Cd012424.
4. Montero-Odasso M, van der Velde N, Martin FC, Petrovic M, Tan MP, Ryg J, et al. World guidelines for falls prevention and management for older adults: a global initiative. Age and Ageing. 2022;51(9):afac205.
5. WHO guidelines on physical activity and sedentary behaviour. Geneva: World Health Organization; 2020. Licence: CC BY-NC-SA 3.0 IGO.
6. Di Lorito C, Long A, Byrne A, Harwood RH, Gladman JRF, Schneider S, et al. Exercise interventions for older adults: A systematic review of meta-analyses. J Sport Health Sci. 2021;10(1):29-47.
7. Kalavar JM, Kolt GS, Giles LC, Driver RPAIGLC, https://orcid.org O, Bandura ABJSBCEBFCJKBJACNKKGSGL, et al. Physical Activity in Older Asian Indians Living in the United States: Barriers and Motives. Activities, Adaptation & Aging. 2004;29(1):47-62.
8. Li Y, Du X, Zhang C, Wang S. Physical activity among the elderly in China: a qualitative study. Br J Community Nurs. 2013;18(7):340-passim.
9. Yoshigai M, Musumari PM, Hudson J, Kihara MO, Kihara M. Factors promoting and inhibiting exercise for older women in Kyoto, Japan. Health Promot Internation. 2023;38(3).
10. Horne M, Tierney S. What are the barriers and facilitators to exercise and physical activity uptake and adherence among South Asian older adults: a systematic review of qualitative studies. Preventive medicine. 2012;55(4):276-84.
11. Karunanayake AL, Senaratne CD, Stathi A. A descriptive cross sectional study comparing barriers and determinants of physical activity of Sri Lankan middle aged and older adults. PloS one. 2020;15(5):e0232956.
12. Marthammuthu T, Hairi FM, Choo WY, Salleh NAM, Hairi NN. A Qualitative Investigation on the Roles of Social Support on Physical Activity Behaviour among the Rural-Dwelling Older Women in Malaysia. International journal of environmental research and public health. 2021;18(18).
13. Yi X, Pope Z, Gao Z, Wang S, Pan F, Yan J, et al. Associations between individual and environmental factors and habitual physical activity among older Chinese adults: A social-ecological perspective. Journal of sport and health science. 2016;5(3):315-21.
14. Valenzuela T, Okubo Y, Woodbury A, Lord SR, Delbaere K. Adherence to Technology-Based Exercise Programs in Older Adults: A Systematic Review. J Geriatr Phys Ther. 2018;41(1):49-61.
15. De Vitis A, Battaglino A, Sinatti P, Sánchez Romero EA, Bissolotti L, Cotella D, et al. Effects of Telemedicine for Postural Instability in Independent Patients With Parkinson's Disease: A Literature Review. Topics in Geriatric Rehabilitation. 2023;39(4):294-306.
16. Muellmann S, Forberger S, Möllers T, Bröring E, Zeeb H, Pischke CR. Effectiveness of eHealth interventions for the promotion of physical activity in older adults: A systematic review. Preventive Medicine. 2018;108:93-110.
17. Delbaere K, Valenzuela T, Lord SR, Clemson L, Zijlstra GR, Close JC, et al. E-health StandingTall balance exercise for fall prevention in older people: results of a two year randomised controlled trial. bmj. 2021;373.
18. 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(9):e15460.

19. Benavent-Caballer V, Rosado-Calatayud P, Segura-Ortí E, Amer-Cuenca JJ, Lisón JF. The effectiveness of a video-supported group-based Otago exercise programme on physical performance in community-dwelling older adults: a preliminary study. Physiotherapy. 2016;102(3):280-6.

20. Lytras D, Sykaras E, Iakovidis P, Komisopoulos C, Chasapis G, Mouratidou C. Effects of a modified Otago exercise program delivered through outpatient physical therapy to community-dwelling older adult fallers in Greece during the COVID-19 pandemic: a controlled, randomized, multicenter trial. Eur Geriatr Med. 2022;13(4):893-906.

21. Boongird C, Keesukphan P, Phiphadthakusolkul S, Rattanasiri S, Thakkinstian A. Effects of a simple home-based exercise program on fall prevention in older adults: A 12-month primary care setting, randomized controlled trial. Geriatr Gerontol Int. 2017;17(11):2157-63.

22. Fyfe JJ, Dalla Via J, Jansons P, Scott D, Daly RM. Feasibility and acceptability of a remotely delivered, home-based, pragmatic resistance 'exercise snacking' intervention in community-dwelling older adults: a pilot randomised controlled trial. BMC Geriatr. 2022;22(1):521.

23. Yi D, Yim J. 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. Med Sci Monit. 2021;27:e935496.

24. Kulkarni S, Nagarkar A. Effect of a video-assisted fall prevention program on fall incidence in community-dwelling older adults during COVID. Geriatric Nursing. 2023;50:31-7.

25. Lee K, Yi J, Lee S-H. Effects of community-based fall prevention interventions for older adults using information and communication technology: A systematic review and meta-analysis. Health Informatics Journal. 2024;30(2):14604582241259324.

26. Matthew JP, Joanne EM, Patrick MB, Isabelle B, Tammy CH, Cynthia DM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.

27. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan-a web and mobile app for systematic reviews. Syst Rev. 2016;5(1):210.

28. Sterne JAC, Savović J, Page MJ, Elbers RG, Blencowe NS, Boutron I, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. Bmj. 2019;366:l4898.

29. Ryan R, S H. How to GRADE the quality of the evidence. Cochrane Consumers and Communication Group, available at http://cccrg.cochrane.org/author-resources. Version 3.0 December 2016.

30. Schünemann H BJ, Guyatt G, Oxman A, editors. . GRADE handbook for grading quality of evidence and strength of recommendations. Updated October 2013. The GRADE Working Group, 2013. Available from guidelinedevelopment.org/handbook. .

31. Higgins JPT, Li T, (editors). DJ. Chapter 6: Choosing effect measures and computing estimates of effect. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.4 (updated August 2023). Cochrane, 2023. Available from www.training.cochrane.org/handbook.

32. Liang IJ, Perkin OJ, McGuigan PM, Thompson D, Western MJ. Feasibility and Acceptability of Home-Based Exercise Snacking and Tai Chi Snacking Delivered Remotely to Self-Isolating Older Adults During COVID-19. J Aging Phys Act. 2022;30(1):33-43.

33. Haines TP, Russell T, Brauer SG, Erwin S, Lane P, Urry S, et al. Effectiveness of a video-based exercise programme to reduce falls and improve health-related quality of life among older adults discharged from hospital: a pilot randomized controlled trial. Clin Rehabil. 2009;23(11):973-85.

34. Mézière A, Oubaya N, Michel-Pellegrino V, Boudin B, Neau M, Robert H, et al. Exercise Interventions With Trained Home Helpers for Preventing Loss of Autonomy and Falls in Community-Dwelling Older Adults Receiving Home Heath Physical Therapy T4H: A Randomized Controlled Pilot Study. J Geriatr Phys Ther. 2021;44(3):E138-e49.

35. Ferrari L, Bochicchio G, Bottari A, Scarton A, Cavedon V, Milanese C, et al. Feasibility and effectiveness of a 6-month, home-based, resistance exercise delivered by a remote technological solution in healthy older adults. Archives of Gerontology and Geriatrics. 2024;127:105559.

36. Vestergaard S, Kronborg C, Puggaard L. Home-based video exercise intervention for community-dwelling frail older women: A randomized controlled trial. Aging Clinical and Experimental Research. 2008;20(5):479-86.
37. Yamada M, Aoyama T, Hikita Y, Takamura M, Tanaka Y, Kajiwara Y, et al. Effects of a DVD-based seated dual-task stepping exercise on the fall risk factors among community-dwelling elderly adults. Telemed J E Health. 2011;17(10):768-72.
38. Suzuki Y, Shimizu Y, Soma Y, Matsuda T, Hada Y, Koda M. Effectiveness of a Remote Monitoring-Based Home Training System for Preventing Frailty in Older Adults in Japan: A Preliminary Randomized Controlled Trial. Geriatrics. 2024;9(1):20.
39. Chang SH, Chiang CC, Chien NH. Efficacy of a multicomponent exercise training program intervention in community-dwelling older adults during the COVID-19 pandemic: A cluster randomized controlled trial. Geriatr Nurs. 2023;49:148-56.
40. Zhou J, Bo L, Jian-fang X, Fu-bai-hui W, Hui Y, Jin-Ping D, et al. Home-based strength and balance exercises for fall prevention among older individuals of advanced age: a randomized controlled single-blind study. Annals of Medicine. 2025;57(1):2459818.
41. McAuley E, Wójcicki TR, Gothe NP, Mailey EL, Szabo AN, Fanning J, et al. Effects of a DVD-delivered exercise intervention on physical function in older adults. J Gerontol A Biol Sci Med Sci. 2013;68(9):1076-82.
42. Roberts S, Awick E, Fanning JT, Ehlers D, Motl RW, McAuley E. Long-Term Maintenance of Physical Function in Older Adults Following a DVD-Delivered Exercise Intervention. J Aging Phys Act. 2017;25(1):27-31.
43. Wójcicki TR, Fanning J, Awick EA, Olson EA, Motl RW, McAuley E. Maintenance Effects of a DVD-Delivered Exercise Intervention on Physical Function in Older Adults. J Gerontol A Biol Sci Med Sci. 2015;70(6):785-9.
44. Maldaner N, Sosnova M, Ziga M, Zeitlberger AM, Bozinov O, Gautschi OP, et al. External Validation of the Minimum Clinically Important Difference in the Timed-up-and-go Test After Surgery for Lumbar Degenerative Disc Disease. Spine (Phila Pa 1976). 2022;47(4):337-42.
45. Schoene D, Wu SM-S, Mikolaizak AS, Menant JC, Smith ST, Delbaere K, et al. Discriminative Ability and Predictive Validity of the Timed Up and Go Test in Identifying Older People Who Fall: Systematic Review and Meta-Analysis. Journal of the American Geriatrics Society. 2013;61(2):202-8.
46. Martins AC, Santos C, Silva C, Baltazar D, Moreira J, Tavares N. Does modified Otago Exercise Program improves balance in older people? A systematic review. Prev Med Rep. 2018;11:231-9.

Figure 1. PRISMA flow diagram

Figure 2. Risk of bias of included studies

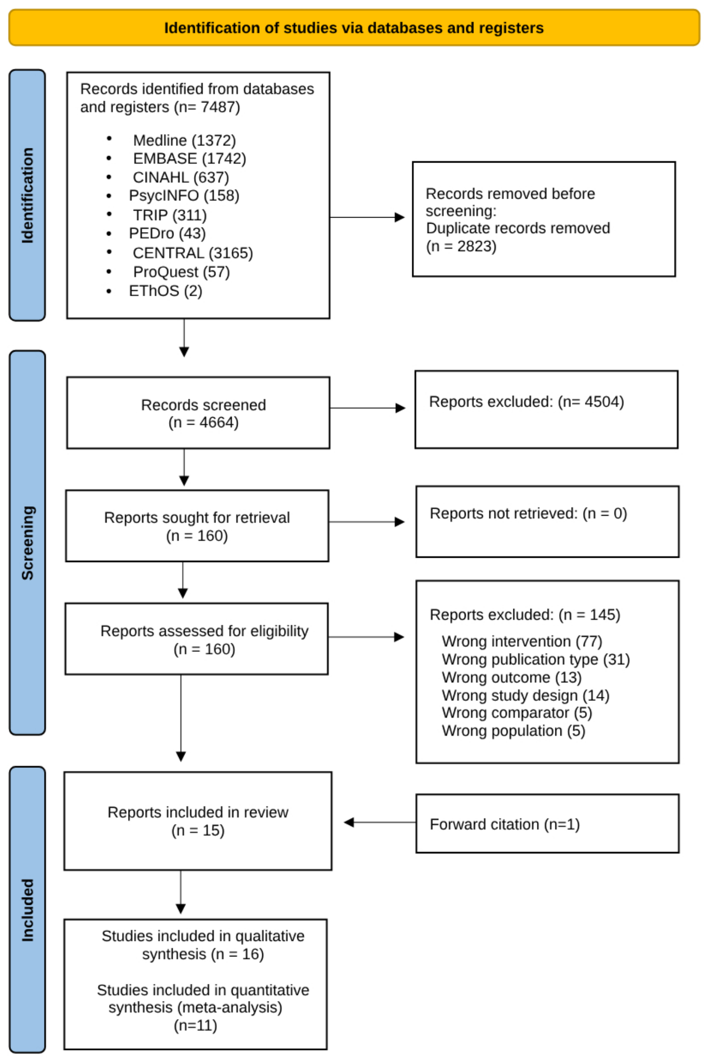
Figure 3. Forest plot of the effect of video-delivered exercise programs on lower extremity strength in older adults. Meta-analysis of eight studies shows Hedges' g effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Hedges' g = 0.35; 95% CI: 0.11 to 0.59). Heterogeneity is notable ($I^2 = 70.35\%$, $\tau^2 = 0.09$), and the overall effect is significant ($z = 2.89$, $p < 0.001$).

Figure 4. Forest plot of the effect of video-delivered exercise programs on balance in older adults. Meta-analysis of seven studies shows Hedges' g effect sizes with 95% CIs. Blue squares indicate individual effects (weighted by size), and the diamond represents the pooled effect (Hedges' g = 0.45; 95% CI: 0.07 to 0.83). Heterogeneity is high ($I^2 = 85.07\%$, $\tau^2 = 0.21$), and the overall effect is significant ($z = 2.33$, $p = 0.02$).

Figure 5. Forest plot of the effect of video-delivered exercise programs on mobility in older adults. Meta-analysis of five studies shows Mean Difference effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Mean Difference = 0.96; 95% CI: 0.46 to 1.46). Heterogeneity is moderate ($I^2 = 53.31\%$, $\tau^2 = 0.15$), and the overall effect is significant ($z = 3.76$, $p = 0.00$).

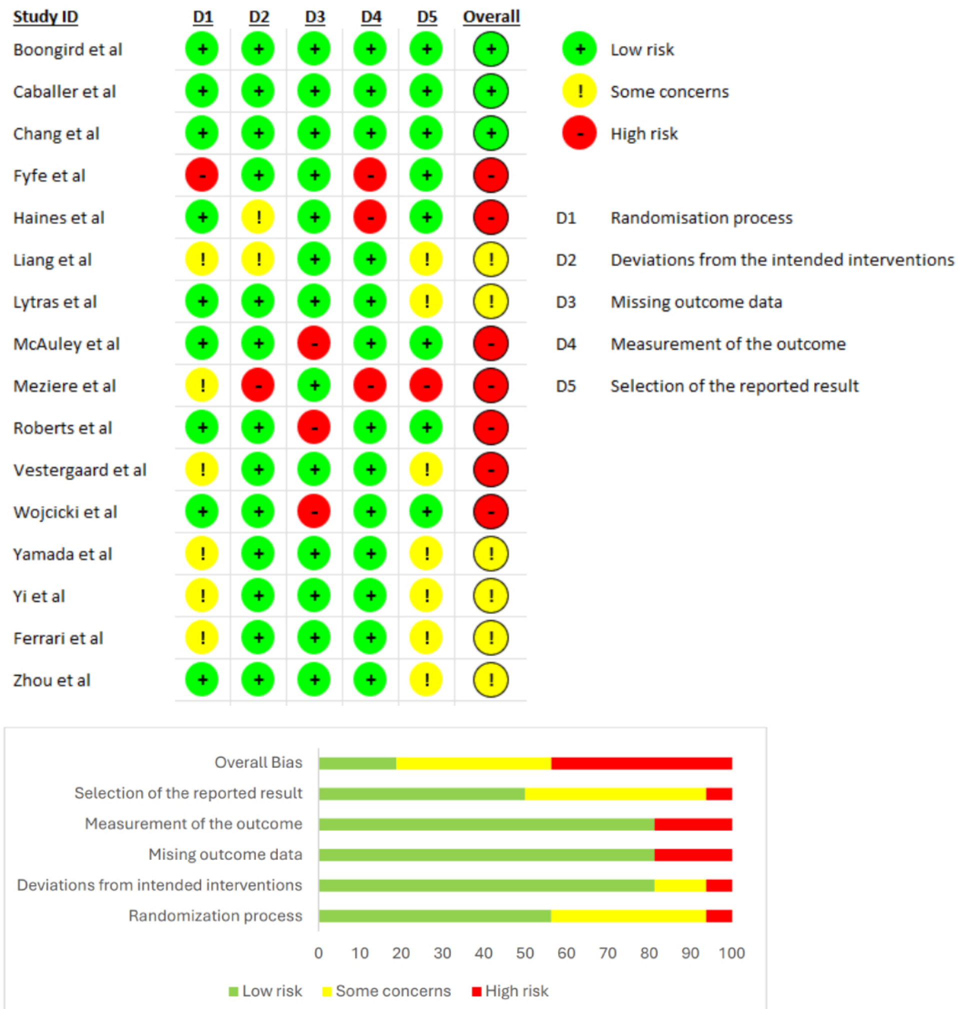
Figure 6. Forest plot of the effect of video-delivered exercise programs on physical performance in older adults. Meta-analysis of four studies shows Hedges' g effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Hedges' g = 0.36; 95% CI: 0.17 to 0.56). Heterogeneity is low ($I^2 = 13.49\%$, $\tau^2 = 0.01$), and the overall effect is significant ($z = 3.74$, $p = 0.00$).

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only



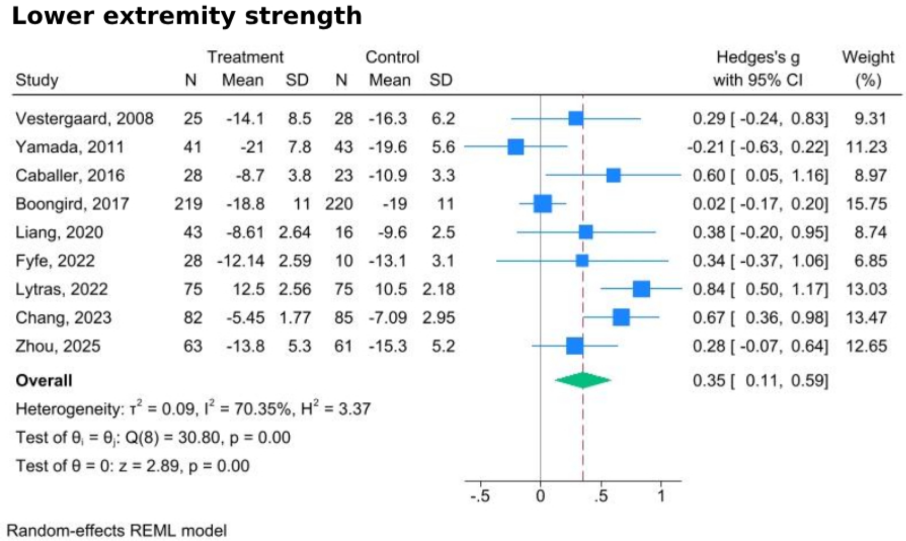
PRISMA flow diagram

81x118mm (300 x 300 DPI)



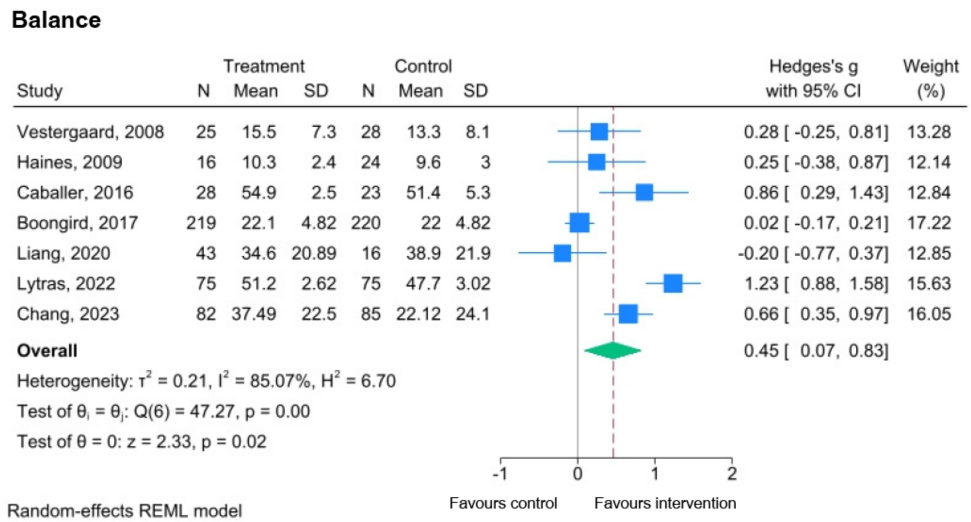
Risk of bias of included studies

92x100mm (300 x 300 DPI)



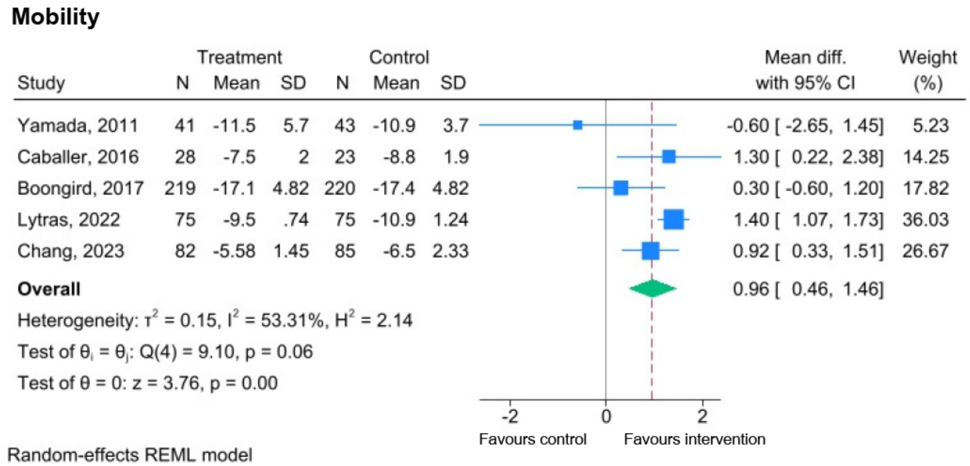
Forest plot of the effect of video-delivered exercise programs on lower extremity strength in older adults. Meta-analysis of eight studies shows Hedges' g effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Hedges' g = 0.35; 95% CI: 0.11 to 0.59). Heterogeneity is notable (I^2 = 70.35%, τ^2 = 0.09), and the overall effect is significant (z = 2.89, $p < 0.001$).

83x48mm (300 x 300 DPI)



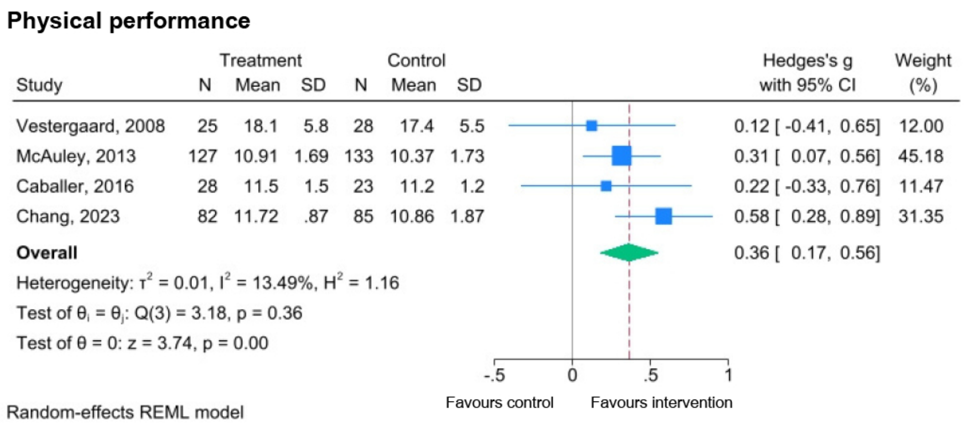
Forest plot of the effect of video-delivered exercise programs on balance in older adults. Meta-analysis of seven studies shows Hedges' g effect sizes with 95% CIs. Blue squares indicate individual effects (weighted by size), and the diamond represents the pooled effect (Hedges' g = 0.45; 95% CI: 0.07 to 0.83). Heterogeneity is high (I^2 = 85.07%, τ^2 = 0.21), and the overall effect is significant (z = 2.33, p = 0.02).

89x48mm (300 x 300 DPI)



Forest plot of the effect of video-delivered exercise programs on mobility in older adults. Meta-analysis of five studies shows Mean Difference effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Mean Difference = 0.96; 95% CI: 0.46 to 1.46). Heterogeneity is moderate ($I^2 = 53.31\%$, $\tau^2 = 0.15$), and the overall effect is significant ($z = 3.76$, $p = 0.00$).

89x44mm (300 x 300 DPI)



Forest plot of the effect of video-delivered exercise programs on physical performance in older adults. Meta-analysis of four studies shows Hedges' g effect sizes with 95% CIs. Blue squares represent individual effects (weighted by size), and the diamond indicates the pooled effect (Hedges' g = 0.36; 95% CI: 0.17 to 0.56). Heterogeneity is low ($I^2 = 13.49\%$, $\tau^2 = 0.01$), and the overall effect is significant ($z = 3.74$, $p = 0.00$).

89x42mm (300 x 300 DPI)

Full search strategies

This supplementary file outlines our full list of search strategies used throughout the review across multiple databases and time points. These are outlined below.

PICOS	Criteria
Population (older adults)	Participants are community-dwelling older adults (male or female) who are 60 years or older. Studies will be considered if the mean age is at least 60 years. Exclusion criteria : (1) Hospitalised or institutional-based older adults (2) Study that only includes people with a specific disease or condition (e.g., Parkinson's disease, stroke)
Intervention (video-supported home exercise)	The intervention is a home-based exercise programme delivered using pre-recorded instructional videos. The videos can be accessed online (e.g., websites, apps) or offline (e.g., CD, DVD, flash disc) and played at home using a television, CD/DVD player, computer, laptop, tablet, or mobile phone/smartphone. Exercise programmes may be supplemented with home visits or in-person interactions with practitioners. Exclusion criteria: (1) virtual reality video; (2) video game-based exercise; or (3) synchronous video-based exercise (e.g., videoconferencing, video call)
Comparator (no intervention or non-exercise intervention)	There is at least one control group or comparator that: (1) Receive no intervention. No intervention means participants were told to continue with their everyday routines and received no intervention at all; or (2) Receive non-exercise or non-physical therapy interventions. This can be verbal or written educational intervention (e.g., a leaflet, books, a link to physical activity promotion web, or physical activity guidelines). Exclusion criteria: The study without a control group will be excluded.
Outcomes (physical performance, fear of falling, number of falls, number of fallers)	The primary outcome is physical performance (other terms may be physical function, functional ability, or functional performance) Secondary outcomes are fall-related variables including fear of falling, number of falls, and number of people who fall.
Study design	All randomised controlled trials (RCTs) including randomised pilot and randomised feasibility-controlled trials, randomised crossover trials, and cluster randomised controlled trials.

List of searches

1. MEDLINE (via Ovid)
2. EMBASE (via Ovid)
3. CINAHL
4. PsycINFO (via OVID)
5. The Cochrane Central Register of Controlled Trials (Cochrane Library)
6. TRIP
7. PEDro
8. Ethos
9. ProQuest

1. **MEDLINE (via Ovid)**
The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Search 1
Date searched: 17 May 2023
Records downloaded: 1066

1	aged/ or "aged, 80 and over"/ or frail elderly/	3,444,504
2	"older adult*".ab,ti.	114,285
3	"elder*".ab,ti.	298,577
4	"senior*".ab,ti.	50,564
5	"geriatric*".ab,ti.	57,438
6	older people.ab,ti.	36,506
7	older.ab,ti.	543,259
8	aged 65.ab,ti.	32,633
9	older person.ab,ti.	1,601
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9	3,820,835
11	"exercise*".ab,ti.	343,939
12	"training*".ab,ti.	533,080
13	"home*".ab,ti.	612,932
14	physical activity.ab,ti.	140,586
15	"program*".ab,ti.	1,057,679
16	11 or 12 or 13 or 14 or 15	2,326,382
17	"video*".ab,ti.	163,929
18	taped.ab,ti.	3,515
19	"DVD*".ab,ti.	2,068
20	"website*".ab,ti.	38,399
21	web-based.ab,ti.	41,882
22	remote.ab,ti.	93,258
23	"tablet*".ab,ti.	62,039
24	"ipad*".ab,ti.	1,861
25	"smartphone*".ab,ti.	21,307
26	"phone*".ab,ti.	48,030
27	"youtube*".ab,ti.	3,602
28	"computer*".ab,ti.	336,450
29	"television*".ab,ti.	15,595
30	"application*".ab,ti.	1,558,716
31	ehealth.ab,ti.	4,108
32	mhealth.ab,ti.	5,340
33	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32	2,264,013
34	"physical perform*".ab,ti.	13,033
35	"physical function*".ab,ti.	31,894
36	"functional perform*".ab,ti.	5,447
37	"functional abilit*".ab,ti.	8,024
38	balance.ab,ti.	266,181
39	strength.ab,ti.	366,969

40	"fall*".ab,ti.	243,741
41	"mobilit*".ab,ti.	176,655
42	"physical abilit*".ab,ti.	1,841
43	34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42	1,052,376
44	10 and 16 and 33 and 43	3,439
45	"random*".ab,ti.	1,408,604
46	44 and 45	1,090
47	limit 46 to yr="2000 -Current"	1,066

Updating the search

Before publication, the search was updated to reflect more recent literature, building upon the initial search conducted in 2023. The same strategy and keywords were used, but the publication date was restricted to articles published between 1 January 2023, and 12 March 2025, to capture any additional relevant studies.

Date searched: 17 March 2025

Additional records downloaded: 306

2. **EMBASE (via Ovid)**

The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Search 1

Date searched: 17 May 2023

Records downloaded: 1373

1	aged/ or "aged, 80 and over"/ or frail elderly/	3,567,609
2	"older adult*".ab,ti.	146,669
3	"elder*".ab,ti.	426,746
4	"senior*".ab,ti.	72,230
5	"geriatric*".ab,ti.	91,835
6	older people.ab,ti.	45,369
7	older.ab,ti.	768,725
8	aged 65.ab,ti.	46,552
9	older person.ab,ti.	2,164
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9	4,142,389
11	"exercise*".ab,ti.	466,485
12	"training*".ab,ti.	714,978
13	"home*".ab,ti.	831,106
14	physical activity.ab,ti.	191,545
15	"program*".ab,ti.	1,412,611
16	11 or 12 or 13 or 14 or 15	3,099,891
17	"video*".ab,ti.	236,696
18	taped.ab,ti.	5,069
19	"DVD*".ab,ti.	3,618
20	"website*".ab,ti.	57,567
21	web-based.ab,ti.	58,419
22	remote.ab,ti.	115,703
23	"tablet*".ab,ti.	104,620

24	"ipad*".ab,ti.	3,852
25	"smartphone*".ab,ti.	27,682
26	"phone*".ab,ti.	74,374
27	"youtube*".ab,ti.	4,784
28	"computer*".ab,ti.	417,759
29	"television*".ab,ti.	17,241
30	"application*".ab,ti.	1,786,674
31	ehealth.ab,ti.	4,704
32	mhealth.ab,ti.	5,640
33	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32	2,739,416
34	"physical perform*".ab,ti.	17,789
35	"physical function*".ab,ti.	50,470
36	"functional perform*".ab,ti.	7,337
37	"functional abilit*".ab,ti.	11,817
38	balance.ab,ti.	340,192
39	strength.ab,ti.	425,307
40	"fall*".ab,ti.	318,485
41	"mobilit*".ab,ti.	207,407
42	"physical abilit*".ab,ti.	2,707
43	34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42	1,293,496
44	10 and 16 and 33 and 43	4,890
45	"random*".ab,ti.	1,954,348
46	44 and 45	1,396
47	limit 46 to yr="2000 -Current"	1,373

Search 2

Before publication, the search was updated to reflect more recent literature, building upon the initial search conducted in 2023. The same strategy and keywords were used, but the publication date was restricted to articles published between 1 January 2023, and 14 March 2025, to capture any additional relevant studies.

Date searched: 17 March 2025

Additional records downloaded: 369

3. **CINAHL**

The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Date searched: 17 May 2023

Records downloaded: 552

Searching on abstract and title using these keywords:
Older adults OR older people OR older person OR (older women or aging women or elderly women) OR (older men or older males or elderly men) OR elderly OR senior OR geriatric OR aged 65 OR aged OR (frailty or frail elderly) AND Exercise OR training OR home OR physical activity OR program* AND Video* OR taped OR DVD* OR website* OR web-based OR remote OR tablet* OR computer* OR ipad* OR phone* OR television OR TV or smartphone* or youtube* or application or ehealth or mhealth or digital health AND

Physical perform* OR physical function OR functional perform* OR functional ability* OR balance OR strength OR fall OR mobilit* OR physical ability* AND Random*
Limiters - Published Date: 20000101-20231231 Expanders - Apply equivalent subjects Search modes - Boolean/Phrase

Before publication, the search was updated to reflect more recent literature, building upon the initial search conducted in 2023. The same strategy and keywords were used, but the publication date was restricted to articles published between 1 January 2023, and 17 March 2025, to capture any additional relevant studies.
Date searched: 17 March 2025
Additional records downloaded: 85

4. PsycINFO (via Ovid)

The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Search 1

Date searched: 17 May 2023
Records downloaded: 134

1	aged/ or "aged, 80 and over"/ or frail elderly/	1828
2	"older adult*".ab,ti.	60768
3	"elder*".ab,ti.	71222
4	"senior*".ab,ti.	30650
5	"geriatric*".ab,ti.	17345
6	older people.ab,ti.	16145
7	older.ab,ti.	179499
8	aged 65.ab,ti.	10047
9	older person.ab,ti.	1014
10	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9	264256
11	"exercise*".ab,ti.	73941
12	"training*".ab,ti.	293168
13	"home*".ab,ti.	180821
14	physical activity.ab,ti.	40601
15	"program*".ab,ti.	443385
16	11 or 12 or 13 or 14 or 15	876444
17	"video*".ab,ti.	74306
18	taped.ab,ti.	3879
19	"DVD*".ab,ti.	1324
20	"website*".ab,ti.	15143
21	web-based.ab,ti.	15612
22	remote.ab,ti.	14398
23	"tablet*".ab,ti.	5896
24	"ipad*".ab,ti.	1316
25	"smartphone*".ab,ti.	6585
26	"phone*".ab,ti.	30920

27	"youtube*".ab,ti.	1659
28	"computer*".ab,ti.	97864
29	"television*".ab,ti.	16366
30	"application*".ab,ti.	189872
31	ehealth.ab,ti.	1013
32	mhealth.ab,ti.	1133
33	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32	432307
34	"physical perform*".ab,ti.	1978
35	"physical function*".ab,ti.	7483
36	"functional perform*".ab,ti.	1118
37	"functional abilit*".ab,ti.	2761
38	balance.ab,ti.	49858
39	strength.ab,ti.	68472
40	"fall*".ab,ti.	55423
41	"mobilit*".ab,ti.	22426
42	"physical abilit*".ab,ti.	1041
43	34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42	199402
44	10 and 16 and 33 and 43	618
45	"random*".ab,ti.	236116
46	44 and 45	137
47	limit 46 to yr="2000 -Current"	134

Search 2

Before publication, the search was updated to reflect more recent literature, building upon the initial search conducted in 2023. The same strategy and keywords were used, but the publication date was restricted to articles published between January 2023, and 17 March 2025, to capture any additional relevant studies.

Date searched: 17 March 2025

Additional records downloaded: 24

5. **CENTRAL (Cochrane Library)**

The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Search 1

Date searched: 17 May 2023

Records downloaded: 2170

#1	Older adult* OR older person OR older people OR elderly OR geriatric OR senior* OR aged 65	146512
#2	Exercise* OR training OR home OR physical activity OR program*	342321
#3	Video* OR taped OR DVD* OR website OR web-based OR remote OR tablet* OR ipad* OR smartphone* OR phone* OR youtube* OR computer* OR television* OR application* OR ehealth OR mhealth OR digital health	239200

#4	Balance OR strength OR fall* OR mobilit* OR physical perform* OR physical function* OR physical ability* OR functional perform* OR functional abilit*	186206
#5	Random*	1220919
#6	#1 AND #2 AND #3 AND #4 AND #5 With publication year from 2000 to 2023, in Trials	2170

Search 2

Before publication, the search was updated to reflect more recent literature, building upon the initial search conducted in 2023. The same strategy and keywords were used, but the publication date was restricted to articles published between January 2023, and December 2025, to capture any additional relevant studies.

Date searched: 17 March 2025

Additional records downloaded: 995

6. **PEDro**

The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Date searched: 17 May 2023

Records downloaded: 40

Search strategy:
Title and abstract: Video-based exercise Subdiscipline: Gerontology Method: clinical trial Published since: 2000

The search was updated on 17 March 2025 using the same strategy and keywords. The publication date was limited to articles published from 1 January 2023 to 3 March 2025.

Additional records downloaded: 3

7. **TRIP**

The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Date searched: 17 May 2023

Records downloaded: 309

Search strategy:
(Older adult* OR older person OR older people OR elder OR geriatric OR senior* OR aged 65) AND (Exercise* OR training OR home OR physical activity OR program*) AND (Video* OR taped OR DVD* OR website OR web-based OR remote OR tablet* OR ipad* OR smartphone* OR phone* OR youtube* OR computer* OR television* OR application* OR ehealth OR mhealth OR digital health) AND (Random*) In controlled trials published from 2000 to 2023

The search was updated on 17 March 2025 using the same strategy and keywords. The publication date was limited to articles published from 2023 to 2025.

Additional records downloaded: 2

8. Ethos

The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Date searched: 17 May 2023

Records downloaded: 2

Search strategy:
Older adult* AND video AND exercise

The search was updated on 17 March 2025 using the same strategy and keywords. The publication date was limited to articles published from 2023 to 2025.

Additional records downloaded: 0

9. ProQuest Thesis and Dissertation

The search was conducted on 17 May 2023 and was updated on 17 March 2025.

Date searched: 17 May 2023

Records downloaded: 54

Search strategy:
abstract(Older adult* OR older person OR older people OR elder OR geriatric OR senior* OR aged 65) AND abstract(Exercise* OR training OR home OR physical activity OR program*) AND abstract(Video* OR taped OR DVD* OR website OR web-based OR remote OR tablet* OR ipad* OR smartphone* OR phone* OR youtube* OR computer* OR television* OR application* OR ehealth OR mhealth OR digital health) AND abstract(Balance OR strength OR fall* OR mobilit* OR physical perform* OR physical function* OR physical ability* OR functional perform* OR functional abilit*) AND abstract(random*) Limiters: full text, dissertation & thesis, English language, published since 2000

The search was updated on 17 March 2025 using the same strategy and keywords. The publication date was limited to articles published from 2023 to 2025.

Additional records downloaded: 3

Summary of the characteristics of included trials

Study author; country	Sample (n); % female; mean age	Exercise components	Duration; session length; frequency	Setting; exercise mode	Comparator	Video exercise; media; device	Physical performance measurements	Fall-related outcomes and measurements
Boongird et al (2017); Thailand	417; 86.6%; 74.08	Lower extremity strengthening, stretching, and balance training.	6 months; 60 min; 2-3x week	Home; individual; supervised	Non-exercise intervention	Entirely video; offline; Video Disk Recorder (VDR)	Strength (5-STS); Dynamic balance (TUG, BBS)	Fear of falling (Thai FES-I); Number of falls and fallers (self-recorded)
Caballer et al (2016); Spain	51; 69%; 69.1±4	Lower extremity strengthening, balance, mobility, flexibility, endurance.	4 months; 45 min; 3x week	Centre; group; supervised	No intervention	Entirely video; offline; DVD player	Mobility (TUG); Functional balance (BBS); Balance (OLS); Aerobic endurance (6MWT); Lower limb function (SPPB); Lower extremity strength (5-STS)	Not assessed
Chang et al (2023); Taiwan	167; 70.1%; 67.6±7.86	Resistance, static balance, dynamic balance, speed-walking.	4 months; 60 min; 2-3x week	Centre and home; both group and individual; supervised	Non-exercise intervention	Partially video (combined with face-to-face exercise); online; smartphone & LINE chat application	Upper limb strength (Grip strength); SPPB; static balance ability (OLS); physical agility (TUG); dynamic balance ability (functional reach)	Not assessed
Fyfe et al (2022); Australia	19; 67%; 69.8±3	Lower extremity strengthening, balance, functional tasks	1 month; 9 min; 3x day	Home; individual; unsupervised	No intervention	Entirely video; online; smartphone/tablet & website platform	Physical function (5-STS and 30s CST)	Not assessed
Haines et al (2009); Australia	50; 60.4%; 80.9±6.5	Muscle strength, balance	2 months; 13 min	Home; individual; supervised	No intervention	Entirely video; offline; DVD player	Balance (BOOMER); Strength (15s sit-to-stand); Mobility (2-minute walk test)	Fear of falling (ABC Scale); Number of falls (self-recorded)
Liang et al (2020); United Kingdom	30; 67%; 71.1±3.6	Functional tasks, muscle strength, balance, tai chi	1 month; 2x day	Home; individual; unsupervised	Non-exercise intervention	Entirely video; online; smartphone/tablet and website platform	Physical function (5-STS, 60s sit-to-stand, Leg standing balance)	Not assessed
Lytras et al (2022); Greece	150; 90.7%; 70	Lower extremity strengthening, balance, flexibility	6 months; 45 min; 5x week	Centre and home; both group and individual; supervised	Non-exercise intervention	Partially video (combined with face-to-face exercise); offline; TV or computer	Functional mobility (TUG); Static balance (4-stage balance); Leg strength (30s CST); Balance (BBS)	Fear of falling (short FES-I); Number of falls (self-recorded)

Continued

Study author; country	Sample (n); % female; mean age	Exercise components	Duration; session length; frequency	Setting; exercise mode	Comparator	Video exercise; media; device	Physical performance measurements	Fall-related outcomes and measurements
McAuley et al (2012); United States	260; 71.52%; 70.62±0.4	Muscle strength, balance, and flexibility.	6 months; 3x week	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Meziere et al (2021); France	35; 83.3%; 90	Muscle strength, balance, functional tasks, joint mobilization exercises	3 months; 2x week	Home; individual; supervised	Non-exercise intervention	Partially video (combined with face-to-face exercise); offline; tablet	Walk and balance ability (TUG)	Absence of falls requiring medical care
Roberts et al (2017); United States	153; 73.6%; 70±4.98	Muscle strength, balance, and flexibility.	24 months follow up; 3x week	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Vestergaard et al (2007); Denmark	53; 100%; 81±3.3	Muscle strength, balance, flexibility, and endurance	5 months; 26 min; 3x week	Home; individual; unsupervised	No intervention	Entirely video; offline; Video player	Functional ability (5-STS, 10-meter walking, standing balance test, PPT, Mob-T)	Not assessed
Wojcicki et al (2015); United States	237; 71.5%; 70.6±0.4	Muscle strength, balance, and flexibility.	12 months follow up; 3x week	Home; individual; unsupervised	Non-exercise intervention	Entirely video; offline; DVD player	Functional performance (SPPB)	Not assessed
Yamada et al (2011); Japan	84; 80.5%; 83±6.7	Muscle strength, balance, agility, and dual tasks.	6 months; 20 min; 2x week	Centre; group; supervised	No intervention	Entirely video; offline; DVD player	Functional fitness (TUG, 5-STS)	Not assessed
Suzuki et al (2024); Japan	15; 33.3%	Slow squats, one-legged stance	3 months; 15 min; daily	Home; individual; supervised	No intervention	Entirely video; online; smartphone & YouTube application	Muscle strength (Grip strength, knee extension strength); Balance capability (One-leg standing time with eyes open and with eyes closed)	Not assessed
Ferrari et al (2024); Italy	73; 49%; 66.89±5.9	Muscle strength and balance	6 months; 30 min; 3x week	Home; individual; supervised	No intervention	Entirely video; online; tablet & website platform	Balance (semi-tandem); Gait (10-meter walking)	Not assessed
Zhou et al (2025); China	116; 25%; 84.4±3.2	Muscle strength and balance	12 months; 30 min; 3x week	Home; individual; supervised	No intervention	Entirely video; online; smartphone & WeChat application	Grip strength; Usual gait speed; 5-STS; TUG	Rate of new falls: Fear of falling (FES-I)

PRISMA 2020 for Abstracts Checklist

Section and Topic	Item #	Checklist item	Reported (Yes/No)
TITLE			
Title	1	Identify the report as a systematic review.	Yes
BACKGROUND			
Objectives	2	Provide an explicit statement of the main objective(s) or question(s) the review addresses.	Yes
METHODS			
Eligibility criteria	3	Specify the inclusion and exclusion criteria for the review.	Yes
Information sources	4	Specify the information sources (e.g. databases, registers) used to identify studies and the date when each was last searched.	Yes
Risk of bias	5	Specify the methods used to assess risk of bias in the included studies.	Yes
Synthesis of results	6	Specify the methods used to present and synthesise results.	Yes
RESULTS			
Included studies	7	Give the total number of included studies and participants and summarise relevant characteristics of studies.	Yes
Synthesis of results	8	Present results for main outcomes, preferably indicating the number of included studies and participants for each. If meta-analysis was done, report the summary estimate and confidence/credible interval. If comparing groups, indicate the direction of the effect (i.e. which group is favoured).	Yes
DISCUSSION			
Limitations of evidence	9	Provide a brief summary of the limitations of the evidence included in the review (e.g. study risk of bias, inconsistency and imprecision).	Yes
Interpretation	10	Provide a general interpretation of the results and important implications.	Yes
OTHER			
Funding	11	Specify the primary source of funding for the review.	No
Registration	12	Provide the register name and registration number.	Yes

From: 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. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Page 1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 2
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 2
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 3
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 3-4
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Supplementary
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 4
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 4
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 4
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 4
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 4
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 4-5
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 4
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Page 4
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Page 4
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 4
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	NA
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Page 4
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Page 4

PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Page 5
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Page 5
Study characteristics	17	Cite each included study and present its characteristics.	Page 5-6
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Page 5
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Page 6
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Page 7-8
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Page 7-8
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	NA
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Page 9
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 9-10
	23b	Discuss any limitations of the evidence included in the review.	Page 9-10
	23c	Discuss any limitations of the review processes used.	Page 9-10
	23d	Discuss implications of the results for practice, policy, and future research.	Page 10-11
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 1
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 1
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 11
Competing interests	26	Declare any competing interests of review authors.	Page 11
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 11

From: 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. BMJ 2021;372:n71. doi: 10.1136/bmj.n71