Interventions and measurement instruments used for falls efficacy in community-dwelling older adults: A systematic review

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Abstract

Falls efficacy has been defined as perceived self-belief in the prevention and management of falls. In the case of community-dwelling older adults, it is essential that interventions should address the different aspects of falls efficacy in terms of balance confidence, balance recovery confidence, safe landing confidence and post-fall recovery confidence to improve their agency to deal with falls. This review aims to provide the current landscape of falls efficacy interventions and measurement instruments. A literature search of five electronic databases was conducted to extract relevant trials from January 2010 to September 2021, and the CASP tool for critical appraisal was applied to assess the quality and applicability of the studies. Eligibility criteria included randomised controlled trials evaluating falls efficacy as a primary or secondary outcome for community-dwelling older adults. A total of 302 full texts were reviewed, with 47 selected for inclusion involving 7,259 participants across 14 countries. A total of 63 interventions were identified, using exercise and other components to target different aspects of falls efficacy. The novel contribution of this article is to highlight that those interventions were applied to address the different fall-related self-efficacies across pre-fall, near-fall, fall landing and completed fall stages. Appropriate measurement instruments need to be used to support empirical evidence of clinical effectiveness.

Keywords: Falls efficacy, Interventions, Older adults, Outcome measures, Systematic review

Introduction

Falls are a significant concern for many older adults1. To facilitate greater resilience against falls, their agency to prevent and manage falls should be adequately addressed. According to Bandura2, the key factor of agency is the belief in personal efficacy. Perceived self-efficacy is not a global trait but a differentiated set of self-beliefs linked to distinct realms of functioning2. Viewing it as a single domain of functional capability risks overlooking its potential effectiveness in particular aspects of perceived capabilities. Falls efficacy has been equated with balance confidence4, but this could foreground one domain of the perceived capacity to cope with falls (the ability to perform activities without losing balance) at the expense of others, such as the perceived ability to manage a fall if one occurs. Falls efficacy has been recently posited as a series of perceived capabilities needed to overcome varying fall-related demands across different domains of a fall (pre-fall, near-fall, fall-landing and completed fall)5. Consideration of a person’s abilities to act in prospective fall-related situations would facilitate planning and tailoring of empowering interventions for older adults.

It has been proposed that falls efficacy encompasses a

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A series of perceived falls-related abilities: Balance confidence (perceived ability to perform activities without losing balance); Balance recovery confidence (perceived ability to recover balance in response to destabilising perturbations); Safe landing confidence (perceived ability to protect oneself upon falling); and Post-fall recovery confidence (perceived ability to get up or get help after a fall). Self-belief in relation to the capability to prevent and manage falls has been conceptualised through corresponding falls-related domains: Pre-fall domain – the individual to perform activities steadily without falling; Near-fall domain – the individual to arrest a fall following a trip, slip or loss of balance from volitional movements; Fall-landing domain – the individual to land safely on the ground if a fall cannot be arrested; and Completed fall domain – the individual to get up or help from the ground after a fall. Different modes of interventions designed to address respective aspects of falls efficacy could potentially help older adults to overcome their concerns about falls more comprehensively. For example, balance and strength training for balance control, perturbations-based training for reactive balance control, safe landing strategies to reduce their landing force impact and floor-rise training to improve their ability to get up from floor. The use of targeted interventions can help to improve older adults’ agency to cope with falls holistically.

This study aims to understand the different types of interventions used to address the various types of falls-related self-efficacy vis-à-vis the choice of measurement instruments. These fall-related self-efficacies refer to the balance confidence, balance recovery confidence, safe landing confidence, and post-fall recovery confidence that surrounds the agency to deal with a fall at the pre-fall, near-fall, fall-landing and post-fall stages (Figure 1). Falls efficacy and fear of falling have often been treated as similar constructs. However, it is important to distinguish between them as interventions could be designed differently to address the specific construct of interest. Further, different interventions need to apply appropriate measurement instruments. Falls efficacy, rooted in Bandura’s self-efficacy theory, is a cognitive mechanism that mediates between thoughts/emotions and actions. The measurement of self-efficacy concerns the belief in capabilities to perform in a given domain of functioning. The sources influencing self-efficacy have been identified as including performance accomplishments, vicarious experience and verbal persuasion. Self-efficacy beliefs can be strengthened by building physical strength, reducing anxiety and correcting the misreading of physical and emotional states. In contrast, fear of falling has been identified to lack theoretical underpinning and self-efficacy theory has been drawn upon to facilitate its understanding. While falls efficacy was once recognised to be a suitable measure for fear of falling, research now suggests it can be better evaluated through consideration of behavioural, emotional, cognitive and physiological elements. Since 2011, the understanding of falls efficacy, balance confidence and fear of falling has been reconceptualised. A review of interventions and measurement instruments could clarify understanding of contemporary approaches to addressing different aspects of falls efficacy.

Figure 1. Falls-related self-efficacy model (adapted from Soh et al., 2021).
Previous systematic reviews on interventions targeting falls efficacy have focused on balance confidence. Büla et al. reported that balance confidence could be addressed using multicomponent behavioural group interventions; Rand et al. suggested Tai Chi interventions were most beneficial to improve perceived balance self-efficacy. The characteristics of interventions targeting other aspects of falls efficacy such as balance recovery confidence, safe-landing confidence, and post-fall recovery confidence remain unaddressed. A recent systematic review conducted by Krusinski et al. reported that characteristics of interventions to reduce fear of falling incorporate mediation, holistic exercises and body awareness. The nature of fear-mediating interventions may or may not be similar to those that target falls efficacy, and therefore they warrant further investigations. It is, however, noted that the review on fear of falling interventions incorporated falls efficacy-type measures (interpreted to measure cognitive-based fear of falling construct) and fear of falling-type measures (interpreted to measure affect-based fear of falling construct). The measures for behavioural-based fear of falling construct were not included in the review.

The selection of appropriate measurement instruments is critical to investigate the efficacy of interventions for the construct of interest. A poor choice of measurement instruments risks presenting an incomplete picture of the intervention's clinical effectiveness. For example, a trial using perturbation-based training was reported to have brought no significant changes in falls efficacy despite a significant improvement in voluntary stepping times and balance control. While such findings provided evidence that perturbation-based training might not be clinically useful to improve balance confidence, its efficacy for reactive balance recovery confidence remains unclear. Reactive balance recovery confidence – another domain of falls efficacy – warrants attention since perturbation-based training is designed to prevent falls by training reactive balance control through the use of unexpected destabilising perturbations.

A new global initiative has been set up with a view to developing a worldwide falls prevention and management guideline. It is a timely move to energise conventional perspectives and inject bold ideas towards improving older adults’ resiliency against falls. The proper planning of interventions and use of measurement instruments will be paramount in this process. This study will be useful to inform the endeavour.

**Study aims and objectives**

This paper aims to systematically review interventions for falls efficacy in community-dwelling older adults. The study focuses on trials’ aims, intervention principles and choice of falls efficacy-type instruments. The objectives are to:

1. Report the characteristics of trials with primary or secondary outcomes of falls efficacy.
2. Present the empirical evidence of interventions targeting specific domains of falls efficacy categorised by the different fall-related domains (pre-fall, near-fall, fall-landing, and post-fall).
3. Highlight the types of falls efficacy measurement instruments used by the interventions.

**Materials and Methods**

The review protocol was registered with PROSPERO (CRD42021260225) and the review was guided by the PRISMA guidelines (available at https://osf.io/7ut9n/).

**Data sources and search strategy**

A comprehensive language-unrestricted search was conducted between 1 January 1990 and 11 September 2021 using MEDLINE via Web of Knowledge, Web of Science Core Collection, PubMed, Cochrane Central Register of Controlled Trials, Scopus, and PsychINFO (EBSCOhost) databases. A systematic search strategy on interventions that potentially target falls efficacy in community-dwelling older adults was conducted using appropriate Boolean operators. The list of studies was then filtered to exclude studies before 2010 taking into account Hadjistavropoulos et al.’s article published in 2011 advocating the need to distinguish fear of falling and falls efficacy as well as to present current landscape of interventions and falls efficacy measurement instruments used. The reference list of the included studies related to the scope of this review were also searched.

**Eligibility criteria**

A study was included if it involved: (1) a randomised and controlled design, (2) research with older adults living independently in the community, (3) experimental interventions that were compared with no intervention, sham control, wait-list control, usual care, or active control using another experimental intervention, (4) interventions targeting falls efficacy, and (5) use of falls-related self-efficacy measurement instruments as a primary or secondary outcome. The list of different types of falls efficacy measurement instruments aligned to that presented in a falls efficacy-related paper, including the Falls Efficacy Scale, Activities-specific Balance Confidence Scale and Perceived Control Over Falling Scale. Studies were excluded if they: (1) measure different falls-related psychological concerns, such as fear, anxiety, depression or self-efficacy for exercise, (2) use fear of falling measures, such as the Falls Efficacy Scale-International, Geriatric Fear of Falling Measure or Survey of Activities and Fear of Falling in the Elderly. (3) focus on older adults with specific medical conditions, such as stroke or Parkinson’s, (4) report on falls-related efficacy value only at baseline, (5) involve a sample size of 30 or less, (6) are not published in peer-reviewed journals, and (7) are dated before 2010.
### Table 1. Search strategy.

| Database                                   | Search Strategy                                                                 |
|--------------------------------------------|---------------------------------------------------------------------------------|
| **Medline via Web of Knowledge (691 articles)** | 1. TS=(self efficacy OR confidence) AND TI=fall* AND TI=(randomised controlled trial OR controlled clinical trial) AND TS=(elder* OR senior OR old* OR aged) (1221 articles) <br> 2. TS=(self efficacy OR confidence) AND TI=balanc* AND TI=(randomised controlled trial OR controlled clinical trial) AND TS=(elder* OR senior OR old* OR aged) (120 articles) |
Interventions for falls efficacy

Efficacy Scale-International\(^\text{25}\) is conceptually different to the Falls Efficacy Scale\(^\text{16}\). The developers of the Falls Efficacy Scale-International reported that the term ‘Falls Efficacy’ was retained as the instrument’s name to acknowledge the historical development of the scale\(^\text{25}\).

**Trials selection**

Two independent reviewers (AL, MM) interrogated database-derived titles and abstracts for eligibility and, subsequently, full texts for potential inclusion. A consensus was sought, with disagreements resolved by a third reviewer (SS).

**Data extraction**

Three reviewers were paired (AL, SS; MM, SS) to conduct data extraction. Any disagreements were resolved via consensus or a separate reviewer (JL or CW) when required. The following information was extracted from every trial: year and country, participant age, intervention and control type, choice of fall efficacy-related measure, main findings, and potential domain of falls efficacy that could be targeted in the trial. Two reviewers (JL, CW) randomly selected 25% of the total list to verify the accuracy of the data.

**Quality assessment**

Three reviewers were paired (AL, SS; MM, SS) to evaluate the quality of included studies. The Critical Appraisal Skills Program (CASP) randomised controlled trials checklist tool\(^\text{28}\) was applied to evaluate each trial categorised in respective domains of falls efficacy (available at https://osf.io/xmt59/). The tool has 11 questions evaluating four sections: 1) Is the basic study design valid for a randomised controlled trial? 2) Was the study methodologically sound? 3) What are the results? 4) Will the results help locally? A modified scoring system\(^\text{29}\) was applied to evaluate the clinical applicability for the purposes of this review. Each question was scored as follows: ‘yes’=1, ‘no’=0, ‘can’t tell’=0.5, with a maximum score total of 11. Studies were rated as “highly clinically applicable” for a total score of \(\geq 8\), “potentially clinically applicable” for a total score of 4 to 7, and “less clinically applicable” for a total score of <4. Two reviewers (JL, CW) reviewed and verified the recommendations. Any disagreements were resolved via consensus within the team.

**Data synthesis and analysis**

The Template for Intervention Description and Replication (TIDieR) checklist\(^\text{30}\) was referenced to guide our reporting. Trials were categorised under different fall-related stages (pre-fall, near-fall, fall-landing and completed fall) based on the intervention content and principles to fit the training for respective aspects of falls efficacy: balance confidence; balance recovery confidence; safe-landing confidence; and post-fall recovery confidence. For example, interventions targeting balance confidence, such as strengthening...
### Table 2. Summary of the interventions and characteristics of the 47 selected trials.

| Authors/Year | Country | Sample | Intervention | Intervention type | Control | Choice of measure | Potential domain |
|--------------|---------|--------|--------------|-------------------|---------|-------------------|-----------------|
| 1 Aibar-Almazan et al., 2019<sup>1</sup> | Spain | Experimental: n = 55; mean ± SD age, 69.98 ± 7.83. Control: n = 52; mean ± SD age, 66.79 ± 10.14. | Pilates program. 60-minute session x 2 times per week x 12 weeks. | Exercise. | Guidelines fostering physical activity. | ABC-S-16. | Pre-fall |
| 2 Anson et al., 2018<sup>11</sup> | United States | Experimental: n = 20; mean ± SD age, 75.7 ± 5.3. Control: n = 20, mean ± SD age, 75.8 ± 6.5. | Treadmill walking with trunk motion visual feedback (VFB). 30-minute session x 3 times per week x 4 weeks. | Exercise. | Treadmill walking with no VFB. | ABC-16. | Pre-fall |
| 3 Arghavani et al., 2020<sup>46</sup> | Iran | Experimental: n = 18; mean ± SD age, 70.4 ± 3.21. Control: n = 15, mean ± SD age, 69.6 ± 3.09. | Perturbation training (PT). 60-minute session x 3 times per week x 8 weeks. | Exercise. | No intervention. | ABC-16. | Near-fall |
| 4 Arghavani et al., 2020<sup>46</sup> | Iran | Experimental: n = 16; mean ± SD age, 68.9 ± 2.29. Control: n = 15, mean ± SD age, 69.6 ± 3.09. | Balance training (BT). 60-minute session x 3 times per week x 8 weeks. | Exercise. | No intervention. | ABC-16. | Pre-fall |
| 5 Okuyan and Bilgili, 2017<sup>25</sup> | Turkey | Total participants: n = 44. | Tai Chi Chuan exercise. 40-minute session x 2 times per week x 12 weeks. | Exercise. | Usual care exercises. | MFES-14. | Pre-fall |
| 6 Chen et al., 2012<sup>23</sup> | Taiwan | Experimental: n = 20; mean ± SD age, 76.41 ± 7.35. Control: n = 20, mean ± SD age, 76.39 ± 4.45. | Video game-based training. 30-minute session x 2 times per week x 6 weeks. | Exercise. | Sit to stand exercises. | MFES-14. | Pre-fall, Near-fall |
| 7 Chewning et al., 2020<sup>26</sup> | United States | Experimental: n = 94; mean ± SD age, 75.0 ± 7.4. Control: n = 103; mean ± SD age, 72.8 ± 7.0. | Tai Chi Prime. 90-minute session x 2 times per week x 6 weeks. | Exercise. | No intervention. | ABC-16. | Pre-fall |
| 8 Clemson et al., 2012<sup>20</sup> | Australia | Experimental: n = 212 Control: n = 105; mean ± SD age, 83.47 ± 3.81. | A lifestyle integrated approach. Five sessions with two booster sessions and two follow-up phone calls over a six-month period. | Multicomponent. | Flexibility exercises. | ABC-16. | Pre-fall |
| 9 Covill et al., 2017<sup>43</sup> | United States | Experimental: n = 15; mean ± SD age, 72.2 ± 7.0. Control: n = 17, mean ± SD age, 75.1 ± 5.8. | Tai Chi program incorporated water-based exercises. 30 to 40-minute session. | Multicomponent. | Impairment based aquatic therapy. | ABC-16. | Pre-fall |
| 10 Freiberger et al., 2012<sup>44</sup> | Germany | Experimental (total): n = 63; mean ± SD age, 76.4 ± 4.1. Control: n = 80; mean ± SD age, 76.8 ± 4.1. | Strength and balance exercise. 60-minute session x 2 times per week x 16 weeks. | Exercise. | No intervention. | ABC-16. | Pre-fall |
| 11 Freiberger et al., 2012<sup>44</sup> | Germany | Experimental (total): n = 64; mean ± SD age, 75.3 ± 3.6. Control: n = 80; mean ± SD age, 76.8 ± 4.1. | Strength, balance and endurance training. 60-minute session x 2 times per week x 16 weeks. | Exercise. | No intervention. | ABC-16. | Pre-fall |
| 12 Freiberger et al., 2012<sup>44</sup> | Germany | Experimental (total): n = 73; mean ± SD age, 75.6 ± 4.3. Control: n = 80; mean ± SD age, 76.8 ± 4.1. | Strength, balance and fall risk education. 60-minute session x 2 times per week x 16 weeks. | Multicomponent. | No intervention. | ABC-16. | Pre-fall |
| 13 Gallo et al., 2018<sup>45</sup> | United States | Experimental: n = 13; mean ± SD (female) age, 77.3 ± 8.5. Control: n = 22; mean ± SD (female) age, 80.4 ± 6.2. | Home-exercise program. 30 to 60-minute session x 1 to 2 times per week x 10 to 32 total sessions. | Exercise. | Usual care. | ABC-16. | Pre-fall |
| 14 Gine-Garriga et al., 2013<sup>46</sup> | Spain | Experimental: n = 22; mean ± SD age, 83.9 ± 2.8. Control: n = 19, mean ± SD age, 84.1 ± 3. | Functional circuit training. 2 times per week x 12 weeks. | Exercise. | Usual care and social meeting. | ABC-16. | Pre-fall |
| 15 Hale et al., 2020<sup>20</sup> | New Zealand | Experimental: n = 23, mean ± SD age, 73.6 ± 1.5. Control: n = 16, mean ± SD age, 75.7 ± 1.1. | Water-based exercise. 20 to 60-minute session x 2 times per week x 12 weeks. | Exercise. | Computer training. | ABC-16. | Pre-fall, Near-fall |
| 16 Hamrick et al., 2017<sup>44</sup> | United States | Experimental: n = 19, mean (min-max): 69.8 (60-88). Control: n = 19, mean (min-max): 70.0 (61-81). | Yoga. 60-minute session x 2 times per week x 8 weeks. | Exercise. | Home relaxation. | ABC-16. | Pre-fall |
| 17 Whyatt et al., 2015<sup>27</sup> | United Kingdom | Experimental: n = 40; mean ± SD age, 77.18 ± 6.59. Control: n = 42; mean ± SD age, 76.62 ± 7.28. | Wii Balance board exercise. 30-minute session x 2 times per week x 10 sessions over 5 weeks. | Exercise. | No intervention. | ABC-16. | Pre-fall |
| 18 Wu et al., 2010<sup>27</sup> | United States | Experimental (Tele-ex): n = 22; mean ± SD age, 76.1 ± 7.9. (Home-ex): n = 22, mean ± SD age, 75.9 ± 6.3. | Tele-ex Tai Chi Chuan. 1-hour session x 3 times per week x 15 weeks. | Exercise. | Home exercises. | ABC-16. | Pre-fall |
Table 2. (Cont. from previous page).

| Authors/Year | Country | Sample | Intervention | Intervention type | Control | Choice of measure* | Potential domain |
|--------------|---------|--------|--------------|-------------------|---------|-------------------|-----------------|
| 19 Wu et al., 2010<sup>37</sup> | United States | Experimental (Comm-ex): n = 20; mean ± SD age, 74.1 ± 6.9. (Home-ex): n = 22; mean ± SD age, 75.9 ± 6.3. | Comm-ex Tai Chi Chuan. 1-hour session x 3 times per week x 15 weeks. | Exercise. | Home exercises. | ABC-16. | Pre-fall |
| 20 Zhang et al., 2014<sup>46</sup> | China | Experimental: n = 19; mean ± SD age, 85.8 ± 3.58. Control: n = 18; mean ± SD age, 84.67 ± 3.68. | Whole-body vibration. 4 to 5-minute x 3 to 5 times per week x 8 weeks. | Modality. | Physical modalities. | ABC-16. | Pre-fall |
| 21 Zijlstra et al., 2011<sup>47</sup> | Netherlands | Experimental: n = 280; mean ± SD age, 77.82 ± 4.6. Control: n = 260; mean ± SD age, 77.97 ± 5.0. | A cognitive behavioural intervention. 2-hour session x 1 time per week x 8 weeks. | Cognitive behavioural therapy. | No intervention. | PCOF. | Pre-fall, Completed fall |
| 22 Headley & Payne, 2014<sup>43</sup> | United States | Experimental: n = 26 (age > 65). Control: n = 24 (age > 65). | Fall prevention program. 50-minute session x 2 times per week x 6 weeks. | Exercise. | Education. | BES-18. | Pre-fall |
| 23 Huang et al., 2011<sup>38</sup> | Taiwan | Experimental: n = 62. Control: n = 62, age ≥ 60 | Cognitive behavioural therapy with Tai Chi. 10-16 lessons, 5 times per week x 8 weeks. | Multicomponent. | No intervention. | FES-10. | Pre-fall, Fall-landing, Completed fall |
| 24 Huang et al., 2011<sup>38</sup> | Taiwan | Experimental: n = 62. Control: n = 62, age ≥ 60 | Cognitive behavioural therapy. 60-90 minutes x 8 sessions. | Multicomponent. | No intervention. | FES-10. | Pre-fall, Fall-landing, Completed fall |
| 25 Iliffe et al., 2015<sup>45</sup> | United Kingdom | Experimental: n = 410. mean ± SD age, 72.8 ± 5.8. Control: n = 457. mean ± SD age, 73.1 ± 6.2. | Otago Exercise Program. 3 times per week x 24 weeks. | Exercise. | Usual care. | CONFbal. | Pre-fall |
| 26 Iliffe et al., 2015<sup>45</sup> | United Kingdom | Experimental: n = 387. mean ± SD age, 72.9 ± 6.1. Control: n = 457. mean ± SD age, 73.1 ± 6.2. | Falls Management Exercise. Group exercise: 1x per week; Home exercise: 2 times per week over 24 weeks. | Exercise. | Usual care. | CONFbal. | Pre-fall, Near-fall |
| 27 Jeon et al., 2014<sup>45</sup> | South Korea | Experimental: n = 35. mean ± SD age, 69.32 ± 4.46. Control: n = 35. mean ± SD age, 69.16 ± 4.05. | Fall prevention program. | Multicomponent. | No intervention. | FES-10. | Pre-fall, Completed fall |
| 28 Jiménez-García et al., 2019<sup>54</sup> | Spain | Experimental: n = 50. Control: n = 23. mean ± SD age, 68.52 ± 6.33. | High-intensity interval training and moderate-intensity interval training. 45-minute session x 2 times per week x 12 weeks. | Exercise. | Health education. | ABC-16. | Pre-fall, Near-fall |
| 29 Johnson et al., 2021<sup>44</sup> | Sweden | Experimental: n = 58. mean ± SD age, 83.7 ± 4.1. Control: n = 56. mean ± SD age, 82.3 ± 4.7. | Otago exercise program with motivational interview. | Exercise. | General safety recommendation booklet. | FES-S-13. | Pre-fall |
| 30 Johnson et al., 2021<sup>44</sup> | Sweden | Experimental: n = 61. mean ± SD age, 83.4 ± 5.0. Control: n = 56. mean ± SD age, 82.3 ± 4.7. | Otago exercise program. | Exercise. | General safety recommendation booklet. | FES-S-13. | Pre-fall |
| 31 Kurz et al., 2016<sup>7</sup> | Israel | Experimental: n = 27. mean ± SD age, 78.2 ± 5.6. Control: n = 26. mean ± SD age, 81.4 ± 4.3. | Unexpected perturbation training. 20-minute session x 2 times a week x 12 weeks. | Exercise. | Treadmill walking | FES-10. | Near-fall |
| 32 Lastayo et al., 2017<sup>58</sup> | United States | Experimental: n = 68. mean ± SD age, 76.59 ± 7.39. Control: n = 66. mean ± SD age, 75.59 ± 6.98. | Resistance exercises. 60-minute session x 3 times per week x 3 months. | Exercise. | Traditional resistance exercise. | ABC-16. | Pre-fall |
| 33 Li et al., 2019<sup>59</sup> | United States | Experimental: n = 224. Control: n = 223. | Tai Ji Quan. 60-minute session x 2 times per week x 24 weeks. | Exercise. | Stretching group. | ABC-16. | Pre-fall |
| 34 Li et al., 2019<sup>59</sup> | United States | Experimental: n = 223. Control: n = 223. | Multimodal exercise. 60-minute session x 2 times per week x 24 weeks. | Exercise. | Stretching group. | ABC-16. | Pre-fall |
Table 2. (Cont. from previous page).

| Authors/Year     | Country     | Sample                                                                 | Intervention                                                                                                 | Intervention type       | Control                     | Choice of measure* | Potential domain |
|------------------|-------------|------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|-------------------------|----------------------------|--------------------|-------------------|
| 35 Lurie et al., 2020 | United States | Experimental: n = 93; mean ± SD age, 75.9 ± 9.1. Control: n = 87; mean ± SD age, 74.6 ± 8.6. | Tai Chi. Group tai chi exercise: 2 times per week x 52 weeks. Home practice: 20-minute session x 3 times per week x 52 weeks. | Exercise.             | Health education. | ABC-16.             | Pre-fall          |
| 36 Liu et al., 2021 | United States | Experimental: n = 114; mean ± SD age, 75.8 ± 7.5. Control: n = 119; mean ± SD age, 74.6 ± 7.0. | A multicomponent intervention.                                                                                   | Multicomponent.         | Home visits       | FES-10.            | Pre-fall, Completed fall |
| 37 Liu et al., 2021 | Canada       | Experimental: n = 47; mean ± SD age, 69.5 ± 2.6. Control: n = 42; mean ± SD age, 69.9 ± 3.0. | Resistance training. Conducted once a week (1x/wk).                                                              | Exercise.             | Resistance exercises | ABC-16.            | Pre-fall          |
| 38 Liu et al., 2021 | Canada       | Experimental: n = 46; mean ± SD age, 69.4 ± 3.0. Control: n = 42; mean ± SD age, 69.9 ± 3.0. | Resistance training. Conducted twice a week (2x/wk).                                                             | Exercise.             | Resistance exercises | ABC-16.            | Pre-fall          |
| 39 Ma et al., 2014 | Hong Kong    | Experimental: n = 17; mean ± SD age, 67.5 ± 6.3. Control: n = 16; mean ± SD age, 72.1 ± 10.3. | Ving Tsun. 1-hour session x 2 times per week x 3 months.                                                            | Exercise.             | Usual care       | ABC-C-16.           | Pre-fall, Near-fall |
| 40 Oh et al., 2012 | South Korea  | Experimental: n = 36; mean ± SD age, 66.2 ± 3.2. Control: n = 29; mean ± SD age, 68.7 ± 5.4. | A multicomponent intervention. 120-minute session x 3 times per week x 12 weeks.                                  | Multicomponent.        | No intervention.  | ABC-K-16.           | Pre-fall          |
| 41 Nick et al., 2016 | Iran         | Experimental: n = 20; mean ± SD age, 68 ± 4.87. Control: n = 19; mean ± SD age, 68.79 ± 4.81. | Hatha yoga. 1-hour session x 2 times per week x 8 weeks.                                                         | Exercise.             | No intervention.  | MFES-14.            | Pre-fall          |
| 42 Rendon et al., 2012 | United States | Experimental: n = 16; mean ± SD age, 85.7 ± 4.3. Control: n = 18; mean ± SD age, 83.3 ± 6.2. | Virtual reality gaming. 35 to 45-minute session x 3 times per week x 6 weeks.                                     | Exercise.             | No intervention.  | ABC-16.             | Pre-fall          |
| 43 Roller et al., 2018 | United States | Experimental: n = 27; mean ± SD age, 78.52 ± 7.57. Control: n = 28; mean ± SD age, 76.68 ± 6.79. | Pilates reformer exercises. 45-minute session x 1 time per week x 10 weeks.                                       | Exercise.             | No intervention.  | ABC-16.             | Pre-fall          |
| 44 Smulders et al., 2010 | Netherlands | Experimental: n = 50; mean ± SD age, 70.5 ± 5.0. Control: n = 46; mean ± SD age, 71.6 ± 4.4. | The Nijmegen Fall Prevention Program. 11 sessions conducted over 5.5 weeks.                                      | Multicomponent.        | No intervention.  | SABC-D.            | Pre-fall, Near-fall, Fall-landing, Completed fall |
| 45 Tousignant et al., 2012 | Canada       | Experimental: n = 76; mean ± SD age, 79.1 ± 6.4. Control: n = 76; mean ± SD age, 80.7 ± 6.0. | Tai Chi Chuan. 60-minute session x 2 times per week x 15 weeks.                                                 | Exercise.             | Balance rehabilitation. | GSES-10.            | Pre-fall          |
| 46 Ullmann et al., 2010 | United States | Experimental: n = 25; mean ± SD age, 74 ± 7.5. Control: n = 22; mean ± SD age, 77 ± 7.1. | Feldenkrais Method. 1-hour session x 3 times per week x 5 weeks.                                                  | Exercise.             | No intervention.  | FES-10, ABC-16.     | Pre-fall          |
| 47 Lurie et al., 2020 | United States | Experimental: n = 253, mean (mean-max), 78 (65-96). Control: n = 253, mean (min-max), 78 (65-95). | Surface perturbation training. 45-minute session x 2 to 3 times per week x 4 to 6 weeks.                        | Exercise.             | Gait/balance intervention | ABC-16.             | Near-fall         |

*ABC-S-16: Activities-specific Balance Confidence Scale-Spanish-16 items; ABC-16: Activities-specific Balance Confidence Scale-16 items; MFES-14: Modified Falls Efficacy Scale-14 items; PCOF: Perceived control over falling; BES-18: Balance Efficacy Scale-18 items; FES-10: Falls Efficacy Scale- 10 items; CONFbal: CONFbal scale-10 items; FES-S-13: Falls Efficacy Scale-Swedish-13 items; ABC-C-16: Activities-specific Balance Confidence Scale - Chinese ABC-C-16 items; ABC-K-16: Activities-specific Balance Confidence Scale-Korean-16 items; SABC-D: Short Activities-specific Balance Confidence Scale-Dutch-6 items; GSES-10: General self-efficacy scale-10 items.
exercises, were classified in the pre-fall domain. Interventions targeting balance recovery confidence by eliciting a reactive response through stimulating a loss of balance, such as the use of perturbation, were identified under the near-fall domain. Interventions that incorporated principles of teaching older adults to fall safely or to recover from a fall were classified under the fall-landing and completed fall domains, respectively.

Within each category of fall-related domain, interventions were further identified for their nature based on the content and principles of the intervention. For example, exercise modalities, such as resistance training, Pilates or Tai Chi, were reported as an exercise intervention. Programmes that incorporated more than one strategy, such as exercise and educational talk(s), were reported as multicomponent interventions. Self-management interventions promoting individual self-confidence to address relevant falls-management issues were reported as cognitive behavioural therapy. Therapeutic modality interventions were reported as modality.

Meta-analysis of the trials' results was not conducted in this review, given that there was considerable heterogeneity among the included studies. The review is exploratory in nature, and therefore a narrative review is provided. To provide some indicators of the level of effectiveness of interventions and how they could influence the various categories of perceived self-efficacy, the effect size was calculated for each study. The means, standard deviation (SDs), and number of participants of the intervention and control groups were used to estimate the standardised mean difference (SMD). Where data were unavailable, the Cochrane handbook\textsuperscript{31} was used to guide the calculation, for example, standard errors or 95% confidence interval were used to calculate standard deviation. The SMD was interpreted as follows: 0.2 is a small effect, 0.5 is a moderate effect, and 0.8 is a large effect\textsuperscript{32}.

Results

Electronic searches identified 6673 records. Manual searches added two records. After removing duplicates, 3620 titles and abstracts were screened leading to 304 full texts being reviewed (Figure 2). A summary list of the 47 selected trials was presented with their characteristics (Table 2). This review included 7259 participants from 14 countries, the most common being the United States (17 trials). The mean age of participants ranged from 66.79±10.14 years to 85.84±3.58 years. All trials were identified to be highly clinical applicable or potentially clinically applicable to address the different domains of falls efficacy in community-dwelling older adults (available at https://osf.io/e3xn6/).

On interventions for the different aspects of falls efficacy

Among 63 interventions identified, 44 (70%) of them were identified to address balance confidence. These interventions incorporated either exercise (33 trials) or multicomponent elements (9 trials). The exercise interventions mainly targeted strength and balance control, namely Pilates\textsuperscript{33,34}, Tai Chi\textsuperscript{35-41}, Yoga\textsuperscript{42,43}, Otago exercises\textsuperscript{44,45} or Fall Management Exercise programme (FAME)\textsuperscript{46}. Two other interventions designed for balance confidence used modality\textsuperscript{46} and cognitive-behavioural therapy\textsuperscript{37}. Ten (15%) interventions that assessed balance recovery confidence were identified. There were either exercises (9 trials) or multicomponent (1 trial). The exercises categorised for balance recovery confidence were designed to be challenging\textsuperscript{46-51}. Some of the training interventions used intentional and controlled destabilisation perturbations to elicit reactive balance recovery\textsuperscript{7,8}. For safe-landing confidence, three (5%) interventions were identified and found to be multicomponent. Education was used to teach participants how to fall safely among other fall prevention strategies\textsuperscript{38,52}. Six (10%) interventions were identified to address post-fall recovery confidence. They were multicomponent (5 trials) and cognitive-behavioural therapy (1 trial). Similarly to interventions for safe-landing confidence, the teaching of post-fall recovery strategies were conducted as part of falls management.

On the efficacy of measurement instruments and related interventions

The most common measurement instruments used among the 47 trials were the original and modified versions of the Activities-specific Balance Confidence scale (67%), followed by the original and modified versions of the Falls Efficacy Scale (23%). The remaining instruments used were the CONFbal scale of balance confidence (4%), Balance Efficacy Scale (2%), General Self-efficacy Scale (2%) and Perceived Control over Falling Scale (2%). There were no measurement instruments identified as purposefully developed to measure different domains of falls efficacy, such as balance recovery confidence, safe-landing confidence, post-fall recovery confidence. Through the existing versions used either for the intended construct of interest or as proxy measures for another aspect of falls efficacy, the effect sizes of interventions across different domains were generally varied. Forty-four interventions targeting balance confidence under pre-fall stage indicated the effects ranged between negligible and large (Figure 3a). Ten interventions for balance recovery confidence under near-fall stage indicated small to large effects (Figure 3b). Three interventions targeting safe-landing confidence under fall-landing stage had small to large effects (Figure 3c). Six interventions for post-fall recovery confidence under completed fall stage indicated small to large effects (Figure 3d).

Discussion

This study presents the current landscape of trials, interventions and choice of measurement instruments used to address various aspects of falls efficacy across the different fall-related stages (pre-fall, near-fall, fall-landing and completed fall) in community-dwelling older adults.
adults. The evidence from the published trials shows that several interventions strategies could be adopted to address older adults’ beliefs in their own efficacy to prevent and manage falls.

At the pre-fall stage, strategies based on exercises and education were commonly used to help older adults build their confidence to avoid a fall. This finding supports previous reviews highlighting similar characteristics of interventions aiming to improve balance confidence. This review reiterated several interventions designed either as
single- or multi-component interventions showed promising results to address balance confidence. At the near-fall stage, the interventions tended to focus on agility-based and skill-based training to help older adults address their perceived reactive ability to recover balance. Some examples of agility exercises were: obstacle training\textsuperscript{52}; Chinese martial arts training\textsuperscript{51}; dynamic balance work\textsuperscript{45,48,53}; water-based exercises\textsuperscript{50}; and high-intensity training\textsuperscript{49,54}. For skill-based training, controlled destabilising perturbations\textsuperscript{7,8} were used to train balance recovery abilities. At the fall-landing and completed fall stages - to help older adults address their perceived ability to fall safely and to get up from a fall, interventions strategies were commonly delivered through cognitive-behaviour therapy\textsuperscript{38,47,55}. The Nijmegen Falls Prevention Program\textsuperscript{52} stood out for its training of fall techniques. The different interventions applied to target balance recovery confidence, safe-landing confidence, and post-fall recovery confidence had small to large effects to influence falls efficacy in community-dwelling older adults. The use of appropriate measurement instruments in future trials can provide a greater understanding of the contribution to which interventions content can play to address the different fall-related self-efficacies. Overall, this review identifies that existing interventions have employed various strategies, such as the building of physical capacity and the use of enactive mastery to address the different beliefs to prevent and manage falls which include balance confidence, balance recovery confidence, safe-landing confidence and post-fall recovery confidence. Falls prevention and management interventions can help community-dwelling older adults gain a greater level of control to overcome the threats of a fall.

**Figure 3b.** Forest plot of the different interventions categorised under different fall-stages. Presentation of 10 interventions categorised under near-fall stage.

**Figure 3c.** Forest plot of the different interventions categorised under different fall-stages. Presentation of three interventions categorised under fall-landing stage.
A disproportionate attention of interventions addressed balance confidence. More than 90% of the trials focused on falls efficacy by attending to the perceived ability among older adults to deal with the risk of a fall by improving their perceived ability to perform activities without losing balance. Approximately 10% of the interventions covered strategies to address balance recovery confidence, safe-landing confidence and post-fall recovery confidence. It is important to give broader attention to the perceived abilities that older adults need to cope with a fall if it does occur. From a pragmatic perspective, the various external and internal perturbations that challenge balance in daily life pose the risk of a fall56. Older adults have reported common experiences of near-fall57,58. It is therefore important to address the perceived ability to arrest a fall and, if a fall occurs, the perceived ability to fall safely or to get up or be helped up after a fall. Older adults have reported various concerns surrounding falls, such as ‘falling as a part of life’ and ‘fearing the consequences’1. Applying a comprehensive approach towards influencing the self-belief in relation to different fall-related capabilities could improve a person’s control of potential fall-events that could detrimentally affect their lives.

To the best of our knowledge, there had been no previous review examining interventions to address specific domains of falls efficacy. This article presents interventions that may be suitably categorised to target the different aspects of falls-efficacy. A significant emphasis on balance confidence was observed and this may have contributed by the interpretation of falls efficacy as balance confidence4. According to Bandura2, people make causal contributions to their own psychosocial functioning through mechanisms of personal agency and efficacy belief is a major basis of action. A holistic approach towards falls efficacy would be useful to regulate a person’s motivation, though processes, affective states, and actions that may include changing environmental conditions, depending on what the person seeks to achieve to overcome the fall threats. The proper use of measurement instruments to interpret the efficacy of interventions on the construct of interest is important59. Applying conventional measurement instruments as surrogate measures for different domains of falls efficacy could limit understanding of interventions’ effectiveness. While a recent systematic review on the methodological quality of content development and validity studies of falls efficacy-related measurement instruments suggested more work is needed to present their quality evidence60, a list of measurement instruments for the different aspects of falls efficacy has been made available in another article5 for the planning of future trials. Moving forward, a more complete picture is needed to illustrate the characteristics of various interventions to address the different aspects of falls efficacy informed by the use of the most appropriate measurement instruments.

**Limitation of this review**

The limitation of our review relates to trials not being explicit about specific domains of falls efficacy. Categorisation and clinical applicability of interventions were inferred by the reviewers based on the content description, principles of interventions, and main findings. Steps were taken to moderate bias through consultations and discussions among reviewers; however, a degree of subjectivity cannot be excluded.

**Conclusion**

A new perspective for interventions targeting falls efficacy encourages future trials to be clear about their intentions by being explicit about specific aspects of falls efficacy – balance confidence, balance recovery confidence, safe-landing confidence and post-fall recovery confidence. Existing interventions have incorporated varying strategies to address personal beliefs in the ability to prevent and manage falls. Measurement instruments must be appropriately selected to provide the most accurate interpretation of

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**Figure 3d.** Forest plot of the different interventions categorised under different fall-stages. Presentation of six interventions categorised under completed fall stage.
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the potential of individual interventions to improve specific perceived self-efficacy of capabilities to address fall issues.

References

1. Gustavsson J, Jernbro C, Nilson F. There is more to life than risk avoidance - elderly people’s experiences of falls, fall-injuries and compliant flooring. Int J Qual Stud Health Well-being 2018;13(1):1479586.
2. Bandura A. Self-efficacy: the exercise of control. New York: W.H. Freeman and Company, 1997.
3. Bandura A. Guide for constructing self-efficacy scales. In: Urdan T, Pajares F, eds. Self-Efficacy Beliefs of Adolescents. Connecticut: Information Age Publishing 2006:307-337.
4. Hadjistavropoulos T, Delbaere K, Fitzgerald TD. Reconceptualizing the role of fear of falling and balance confidence in fall risk. J Aging Health 2011;23(1):3-23.
5. Soh SJH, Tan CW, Thomas JL, et al. Falls efficacy: extending the understanding of self-efficacy in older adults towards managing falls. J Frailty Sarcopenia Falls 2021;6(3):131-138.
6. Sherrington C, Fairhall NJ, Wallbank GK, et al. Exercise for preventing falls in older people living in the community. Cochrane Database Syst Rev 2019;1(1):CD012424.
7. Kurz I, Gimmon Y, Shapiro A, Debi R, Snir Y, Melzer I. Unexpected perturbations training improves balance control and voluntary stepping times in older adults - a double blind randomized control trial. BMC Geriatr 2016;16:58.
8. Lune JD, Zagaria AB, Ellis L, et al. Surface perturbation training to prevent falls in older adults: a highly pragmatic, randomized controlled trial. Phys Ther 2020;100:1153-1162.
9. Moon Y, Sosnoff JJ. Safe Landing Strategies During a Fall: Systematic Review and Meta-Analysis. Arch Phys Med Rehabil 2017;98(4):783-794.
10. Hofmeyer MR, Alexander NB, Medell JL, Koreshi A, Nyquist LV. Floor-rise strategy training in older adults. J Am Geriatr Soc 2002;50:1702-1706.
11. Moore DS, Ellis R. Measurement of fall-related psychological constructs among independent-living older adults: a review of the research literature. Aging Ment Health 2008;12(6):684-699.
12. McKenna SP, Heaney A, Wilburn J. Measurement of patient-reported outcomes. 2: Are current measures failing us? J Med Econ 2020;23(1):1479586.
13. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psychological Review 1977;84(2):191-215.
14. Bandura A. On the functional properties of perceived self-efficacy revisited. J Manage 2012;38(1):9-44.
15. Hughes CC, Kneebone II, Jones F, Brady B. A theoretical and empirical review of psychological factors associated with falls-related psychological concerns in community-dwelling older people. Int Psychogeriatr 2015;27(7):1071-87.
16. Litinetti ME, Richman D, Powell L. Falls efficacy as a measure of fear of falling. J Gerontol B Psychol Sci Soc Sci 1990;45(6):239-243.
17. Rand D, Miller WC, Yiu J, Eng J. Interventions for addressing low balance confidence in older adults: a systematic review and meta-analysis. Age Ageing 2011;40(3):297-306.
18. Bula CJ, Monod S, Hoskovec C, Rochat S. Interventions aiming at balance confidence improvement in older adults: an updated review. Gerontology 2011;57(3):276-86.
19. Kruisbrink M, Rutzen R, Kempen G, et al. Disentangling interventions to reduce fear of falling in community-dwelling older people: a systematic review and meta-analysis of intervention components. Disabil Rehabil 2021;1:1-11.
20. Mansfield AJW, Bryce J, et al. Does perturbation-based balance training prevent falls? Systematic review and meta-analysis of preliminary randomized controlled trials. Phys Ther 2015;95:700-709.
21. Montero-Odasso M, van der Veide N, Alexander NB, et al. New horizons in falls prevention and management for older adults: a global initiative. Age Ageing 2021;50(5):1499-1507.
22. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71.
23. Powell LE, Myers AM. The Activities-specific Balance Confidence (ABC) scale. J Gerontol A Biol Sci Med Sci 1995;50A:M28-M34.
24. Tennstedt S, Howland J, Lachman M, Peterson E, Kasten L, Jette A. Randomized, controlled trial of a group intervention to reduce fear of falling and associated activity restriction in older adults. J Gerontol B Psychol Sci Soc Sci 1998;53B(1):P43-P50.
25. Yardley L, Beyer N, Hauer K, Kempen G, Plotz-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). Age Ageing 2005;34(6):14-9.
26. Huang TT. Geriatric fear of falling measure development and psychometric testing. Int J Nurs Stud 2006;43(3):357-65.
27. Lachman ME, Howland J, Tennstedt S, Jette A, Assmann S, Peterson EW. Fear of falling and activity restriction: the survey of activities and fear of falling in the elderly (SAFE). J Gerontol B Psychol Sci Soc Sci 1998;53B(1):P43-P50.
28. CASP. Randomised Controlled Trial Checklist. Oxford: Critical Appraisal Skills Programme, 2018 [cited 2021 19 February]. Available from: https://casp-uk.net/wp-content/uploads/2018/03/CASP-Randomised-Controlled-Trial-Checklist-2018_fillable_form.pdf.
29. Crandon S, Elbaz MSM, Westenberg J, van der Geest RJ, Plein S, Garg P. Clinical applications of intra-cardiac four-dimensional flow cardiovascular magnetic resonance: a systematic review. Int J Cardiol 2017;249:486-493.
30. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. BMJ 2014;348:g1687.
31. Higgins JPT, Li T, Deeks JJ. Chapter 6: Choosing effect measures and synthesising the evidence. In: Higgins J, Altman D, Newcombe R, et al., eds. Cochrane Handbook for Systematic Reviews of Interventions. 2nd ed. Chichester, UK: Wiley, 2011.
32. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.
33. Albar-Almazan A, Martinez-Annat A, Cruz-Diaz D, et al. Effects of Pilates on fall risk factors in community-dwelling elderly women: a randomized, controlled trial. European Journal of Sport Science 2019;19(10):1386-1394.
34. Rollner M, Kachingwe A, Beling J, Ikdes DM, Cabot A, Shnir G. Pilates reformer exercises for falls risk reduction in older adults: a randomized controlled trial. J Body Mov Ther 2018;22(4):983-998.
35. Okuyan CB, Bilgili N. Effect of Tai Chi Chuan on fear of falling, balance and physical self-perception in elderly: A randomised controlled trial. Turk J Geriatr Derg 2017;20:3:232-241.
36. Cheenwong B, Hallisy KM, Mahoney JE, Wilson D, Sangasubana N, Gannon R. Disseminating Tai Chi in the community: Promoting home practice and improving balance. Gerontologist 2020;60(4):700-709.
37. Wu G, Keyses L, Callas P, Ren X, Bookchin B. Comparison of telecommunication, community, and home-based Tai Chi exercise programs on compliance and effectiveness in elders at risk for falls. Arch Phys Med Rehabil 2010;91(6):849-56.
38. Huang TT, Yang LH, Liu CY. Reducing the fear of falling among community-dwelling elderly people through cognitive-behavioural strategies and intense Tai Chi exercise: a randomized controlled trial.
39. Li F, Harmer P, Chou LS. Dual-task walking capacity mediates Tai Ji Quan's impact on physical and cognitive function. Med Sci Sports Exerc. 2019;51(11):2318-2324.

40. Lipsitz LA, Macklin EA, Travison TG, et al. A cluster randomized trial of Tai Chi vs health education in subsidized housing: The MiWiSH study. J Am Geriatr Soc. 2019;67(9):1812-1819.

41. Toussignant M, Corniveau H, Roy PM, et al. The effect of supervised Tai Chi intervention compared to a physiotherapy program on fall-related clinical outcomes: a randomized clinical trial Disabil Rehabil. 2012;34(3):196-201. DOI: 10.3109/09638288.2011.591891.

42. Nick N, Petramfar P, Ghodsi F, Keshavarzi S, Jahanbin I. The effect of yoga on balance and fear of falling in older adults. PM R 2016;8(2):145-51.

43. Hannick I, Mross P, Christopher N, Smith PD. Yoga’s effect on falls in rural older adults. Complement Ther Med 2017;35:57-63.

44. Johnson ST, Anens E, Johansson AC, Hellstrom K. The Otago exercise program with or without motivational interviewing for community-dwelling older adults: a 12-month follow-up of a randomized, controlled trial J Appl Gerontol 2021;40(3):289-299.

45. Iliffe S, Kendrick D, Morris R, et al. Promoting physical activity in older people in general practice: ProAct65+ cluster randomised controlled trial. Br J Gen Pract 2015;65(640):e73-1 8.

46. Zhang L, Weng C, Liu M, Wang O, Liu L, He Y. Effect of whole-body vibration exercise on mobility, balance ability and general health status in frail elderly patients: a pilot randomized controlled trial. Clin Rehabil 2014;28(1):59-68.

47. Zijlstra GA, van Haastregt JC, van Eijk JT, de Witte LP, Ambergen T, Kempen GI. Mediating effects of psychosocial factors on concerns about falling and daily activity in a multidisciplinary cognitive behavioral group intervention. Aginq Ment Health 2011;15(1):68-77.

48. Arghavani H, Zolaktafi V, Lenjannejadian S. Comparing the effects of anticipatory postural adjustments focused training and balance training on postural preparation, balance confidence and quality of life in elderly with history of a fall. Aging Clin Exp Res 2020;32(9):1757-1765.

49. Chen PY, Wei SH, Hsieh WL, Hsieh JR, Chen LK, Kao CL. Lower limb power rehabilitation (LLPR) using interactive video game for improvement of balance function in older people. Arch Gerontol Geriatr 2012;55(3):677-82.

50. Hale LA, Waters D, Herbison P. A randomized controlled trial to investigate the effects of water-based exercise to improve falls risk and physical function in older adults with lower-extremity osteoarthritis. Arch Phys Med Rehabil 2012;93(1):27-34.

51. Ma AWW, Wang HK, Chen DR, et al. Chinese martial art training failed to improve balance or inhibit falls in older adults. Percept Mot Skills 2019;128(3):389-409.

52. Smulders E, Weerdesteyn V, Groen BE, et al. Efficacy of a short multidisciplinary falls prevention program for elderly persons with osteoporosis and a fall history: a randomized controlled trial. Arch Phys Med Rehabil 2012;93(1):1705-11.

53. Headley CM, Payne L. Examination of a fall prevention program on leisure and leisure-based fear of falling of older adults. Int J Disabil Dev Educ 2014;13(1):149-154.

54. Jimenez-Garcia JD, Hita-Contreras F, de la Torre-Cruz M, et al. Risk of falls in healthy older adults: benefits of high-intensity interval training using lower body suspension exercises. J Aging Phys Act 2019;27(3):325-333.

55. Jeon MY, Jeong H, Petrofsky J, Lee H, Yimm J. Effects of a randomized controlled recurrent fall prevention program on risk factors for falls in frail elderly living at home in rural communities. Med Sci Monit 2014;20:2283-91.

56. Toker D, Grimmer M, Sefarth A. Review of balance recovery in response to external perturbations during daily activities. Hum Mov Sci 2020;69:102546.