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Review Article

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 significant concern to many older adults[1]. To facilitate greater resilience against falls, their agency to prevent and manage falls should be adequately addressed. According to Bandura[2], 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 functioning[3]. 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 confidence[4], 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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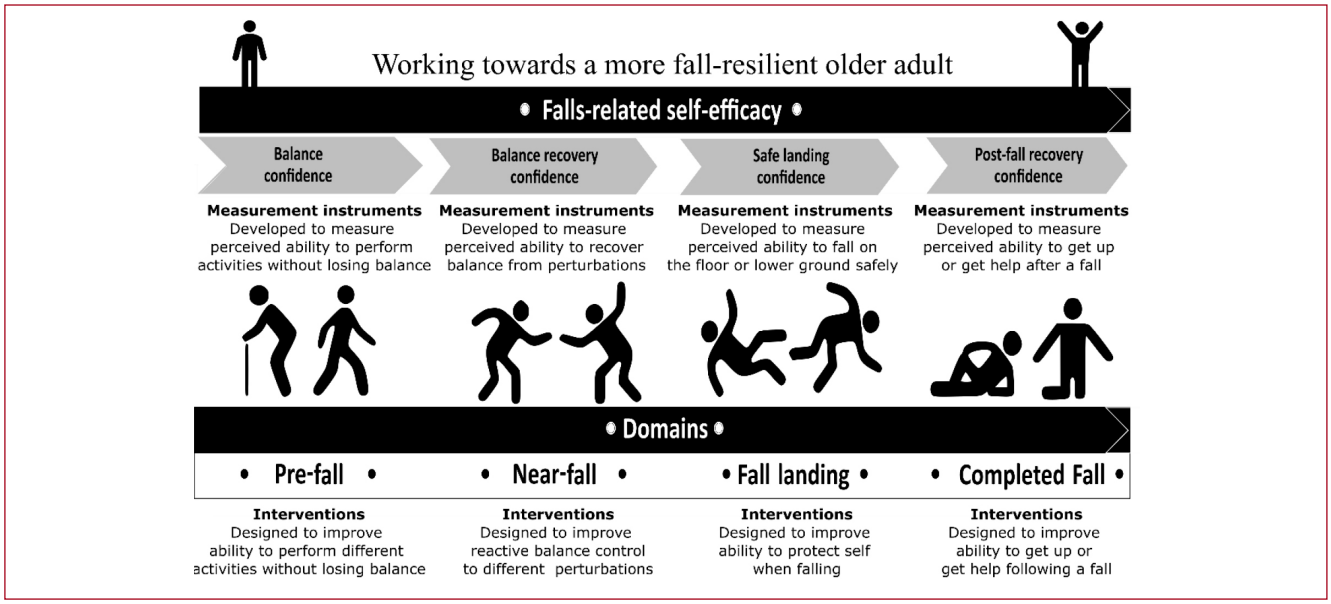

Figure 1. Falls-related self-efficacy model (adapted from Soh et al., 2021[5]).

series of perceived falls-related abilities[5]: 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 be helped up 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[6], perturbations-based training for reactive balance control[7,8], safe landing strategies to reduce their landing force impact[9] and floor-rise training to improve their ability to get up from floor[10]. 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[11]. 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[12]. Falls efficacy, rooted in Bandura's self-efficacy theory[13], 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[14]. The sources influencing self-efficacy have been identified as including performance accomplishments, vicarious experience and verbal persuasion[13]. Self-efficacy beliefs can be strengthened by building physical strength, reducing anxiety and correcting the misreading of physical and emotional states[14]. In contrast, fear of falling has been identified to lack theoretical underpinning and self-efficacy theory has been drawn upon to facilitate its understanding[15]. While falls efficacy was once recognised to be a suitable measure for fear of falling[16], research now suggests it can be better evaluated through consideration of behavioural, emotional, cognitive and physiological elements[4,15]. Since 2011, the understanding of falls efficacy, balance confidence and fear of falling has been reconceptualised[4]. A review of interventions and measurement instruments could clarify understanding of contemporary approaches to addressing different aspects of falls efficacy.

Previous systematic reviews on interventions targeting falls efficacy have focused on balance confidence[17,18]. Büla et al[18] reported that balance confidence could be addressed using multicomponent behavioural group interventions; Rand et al[17] 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 Kruisbrink et al.[19] 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[12]. 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[7]. 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[20].

A new global initiative has been set up with a view to developing a worldwide falls prevention and management guideline[21]. 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[22] (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 (Table 1). The list of studies was then filtered to exclude studies before 2010 taking into account Hadjistavropoulos and colleagues' article[4] 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[5], including the Falls Efficacy Scale[16], Activities-specific Balance Confidence Scale[23] and Perceived Control Over Falling Scale[24]. 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[25], Geriatric Fear of Falling Measure[26] or Survey of Activities and Fear of Falling in the Elderly[27], (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. Studies using versions of the Falls Efficacy Scale-International were excluded as these measurement instruments assess fear or concerns about falling. The construct measured by the Falls

Table 1. Search strategy.

Medline via Web of Knowledge (691 articles)	
For falls efficacy, balance confidence, and balance recovery confidence (257 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) (153 articles) 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) (84 articles) 3. TS=(self efficacy OR confidence) AND TI=postur* AND TI=(randomised controlled trial OR controlled clinical trial) AND TS=(elder* OR senior OR old* OR aged) (20 articles)
For safe land confidence (94 articles)	TI=(fall*) AND TS=(fracture*) AND TS=(training* OR strategy) AND TS=(randomized controlled trial OR controlled clinical trial) AND TS=(elder* OR senior OR old* OR aged) (94 articles)
For post fall recovery confidence (340 articles)	TS=("get up" OR "floor rise" OR lying) AND TI=(randomised controlled trial OR controlled clinical trial) AND TS=(elder* OR senior OR aged OR old*) Timespan: 1990-2021 (340 articles)
Web of Science Core Collection (585 articles)	
For falls efficacy, balance confidence, and balance recovery confidence (230 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) (144 articles) 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) (72 articles) 3. TS=(self efficacy OR confidence) AND TI=postur* AND TI=(randomised controlled trial OR controlled clinical trial) AND TS=(elder* OR senior OR old* OR aged) (14 articles)
For safe land confidence (129 articles)	TI=(fall*) AND TS=(fracture*) AND TS=(training* OR strategy) AND TS=(randomised controlled trial OR controlled clinical trial) AND TS=(elder* OR senior OR old* OR aged) (129 articles)
For post fall recovery confidence (226 articles)	TS=("get up" OR "floor rise" OR lying) AND TI=(randomised controlled trial OR controlled clinical trial) AND TS=(elder* OR senior OR aged OR old*) (226 articles)
Pubmed (3524 articles)	
For falls efficacy, balance confidence, and balance recovery confidence (3208 articles)	1. (((self efficacy OR confidence) AND (fall*)) AND (randomized controlled trial OR controlled clinical trial)) AND (elder* OR senior OR old* OR aged) (1221 articles) 2. (((self efficacy OR confidence) AND (balanc*)) AND (randomized controlled trial OR controlled clinical trial)) AND (elder* OR senior OR old* OR aged) (1429 articles) 3. (((self efficacy OR confidence) AND (postur*)) AND (randomized controlled trial OR controlled clinical trial)) AND (elder* OR senior OR old* OR aged) (558 articles)
For safe land confidence (190 articles)	(fall*) AND (fracture*) AND (training* OR strategy) AND (randomised controlled trial OR controlled clinical trial) AND (elder* OR senior OR old* OR aged) (190 articles)
For post fall recovery confidence (126 articles)	("get up"[Title/Abstract] OR "floor rise"[Title/Abstract] OR "lying"[Title/Abstract]) AND (randomized controlled trial OR controlled clinical trial) AND ("elder*"[Title/Abstract] OR "senior"[Title/Abstract] OR "aged"[Title/Abstract] OR "older"[Title/Abstract]) (126 articles)
Scopus (1474 articles)	
For falls efficacy, balance confidence, and balance recovery confidence (1118 articles)	1. TITLE-ABS-KEY ((self AND efficacy OR confidence) AND "fall*" AND ("randomized controlled trial" OR "controlled clinical trial") AND (elder* OR senior OR old* OR aged)) AND PUBYEAR > 1989 (428 articles retrieved) 2. TITLE-ABS-KEY ((self efficacy OR confidence) AND "balanc*" AND ("randomized controlled trial" OR "controlled clinical trial") AND (elder* OR senior OR old* or aged)) AND PUBYEAR > 1989 (502 articles) 3. TITLE-ABS-KEY ((self efficacy OR confidence) AND "postur*" AND ("randomized controlled trial" OR "controlled clinical trial") AND (elder* OR senior OR old* or aged)) AND PUBYEAR > 1989 (188 articles)
For safe land confidence (342 articles)	TITLE-ABS-KEY (fall* AND fracture*) AND TITLE-ABS-KEY (training* OR strategy) AND TITLE-ABS-KEY ("randomized controlled trial" OR "controlled clinical trial") AND (elder* OR senior OR old* or aged) AND PUBYEAR > 1989 (342 articles)
For post fall recovery confidence (14 articles)	TITLE-ABS-KEY ((get up OR floor rise OR lying) AND ("randomized controlled trial" OR "controlled clinical trial") AND (elder* OR senior OR old* or aged)) AND PUBYEAR > 1989 (14 articles)
PsychINFO (399 articles)	
For falls efficacy, balance confidence, and balance recovery confidence (364 articles)	1. ("self efficacy" OR "confidence") AND "fall*" AND ("randomized controlled trial" OR "controlled clinical trial)" AND ("elder*" OR "senior" OR "old*" OR "aged") (136 articles) 2. ("self efficacy" OR "confidence") AND "balanc*" AND ("randomized controlled trial" OR "controlled clinical trial)" AND ("elder*" OR "senior" OR "old*" OR "aged") (165 articles) 3. ("self efficacy" OR "confidence") AND "postur*" AND ("randomized controlled trial" OR "controlled clinical trial)" AND ("elder*" OR "senior" OR "old*" OR "aged") (63 articles)
For safe land confidence (12 articles)	(fall*) AND (fracture*) AND (training* OR strategy) AND (randomised controlled trial OR controlled clinical trial) AND (elder* OR senior OR old* OR aged) (12 articles)
For post fall recovery confidence (23 articles)	(get up OR floor rise OR lying) AND (randomised controlled trial OR controlled clinical trial) AND (elder* OR senior OR old* OR aged) (23 articles)

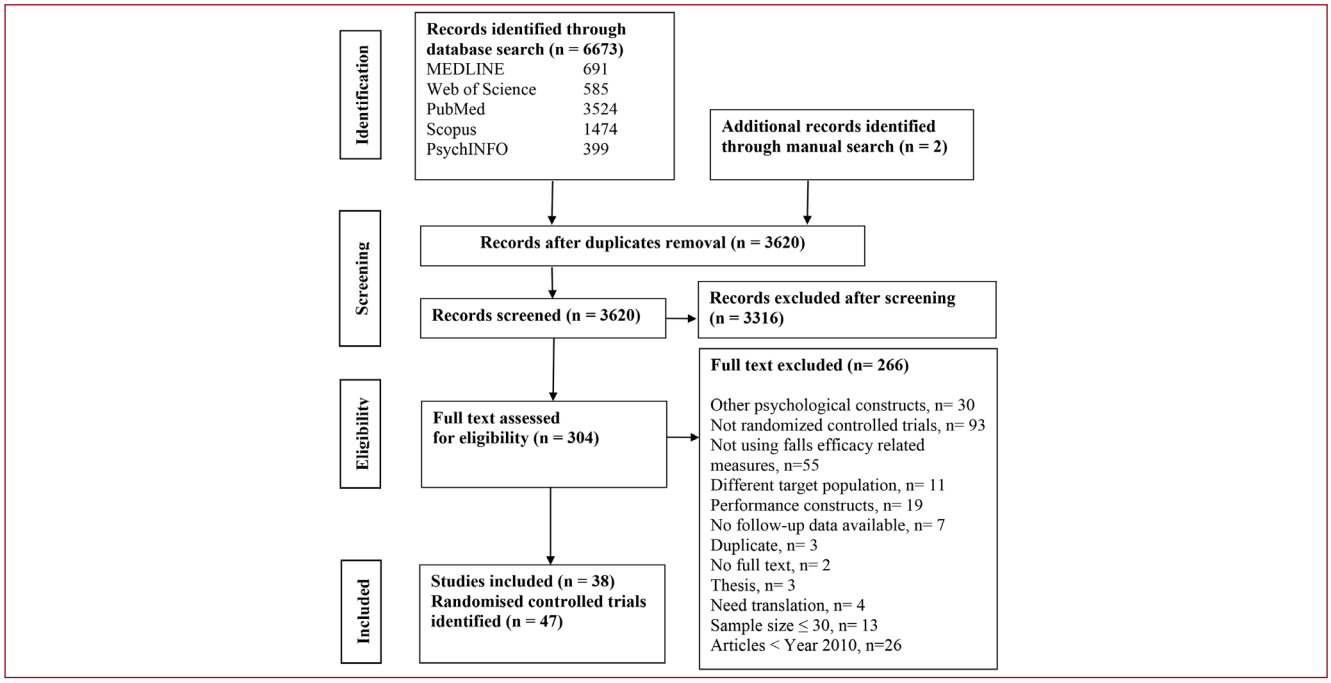

Figure 2. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram for study selection.

Efficacy Scale-International[25] is conceptually different to the Falls Efficacy Scale[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[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[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[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 ≥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[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[a]	Potential domain
1 Aibar-Almazan et al., 2019[33]	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[61]	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[48]	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[48]	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[35]	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[49]	Taiwan	Experimental: n = 20; mean ± SD age, 76.41 ± 7.35. Control: n = 20; mean ± SD age, 75.39 ± 8.45.	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[36]	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[62]	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[63]	United States	Experimental: n = 15; mean ± SD age, 72.2 ± 7.0. Control: n = 17; mean ± SD age, 75.1 ± 5.8.	Ai 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[64]	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[64]	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[64]	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[65]	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[66]	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., 2012[50]	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[43]	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[67]	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[37]	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[a]	Potential domain
19 Wu et al., 2010[37]	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[46]	China	Experimental: n = 19; mean ± SD age, 85.84 ± 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[47]	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[53]	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[38]	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[38]	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
25Iliffe et al., 2015[45]	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[45]	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[55]	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[54]	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[44]	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[44]	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[7]	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[68]	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[39]	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[39]	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[a]	Potential domain
35 Lipsitz et al., 2019[40]	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[69]	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-Ambrose et al., 2010[70]	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-Ambrose et al., 2010[70]	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., 2019[51]	Hong Kong	Experimental: n = 17; mean ± SD age, 67.5 ± 6.3.Control: n = 16; mean ± SD age, 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[71]	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[42]	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[72]	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[34]	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[52]	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[41]	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[73]	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[8]	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

[a]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[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[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 7,259 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[33,34], Tai Chi[35-41], Yoga[42,43], Otago exercises[44,45] or Fall Management Exercise programme (FaME)[45]. Two other interventions designed for balance confidence used modality[46] and cognitive-behavioural therapy[47]. 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[48-51]. Some of the training interventions used intentional and controlled destabilisation perturbations to elicit reactive balance recovery[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[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

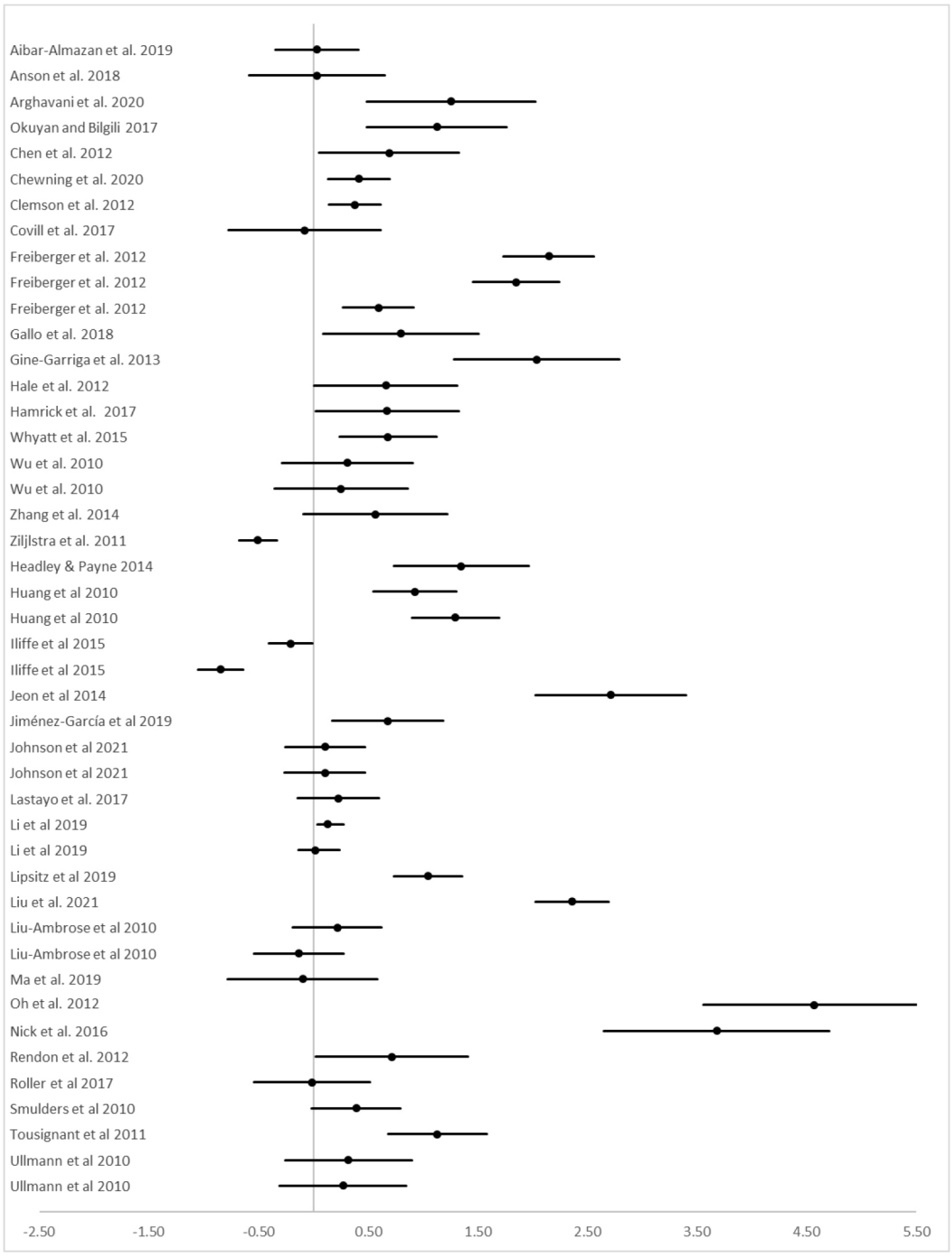

Figure 3a. Forest plot of the different interventions categorised under different fall-stages. Presentantion of 44 interventions categorised under pre-fall stage.

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[17,18] highlighting similar characteristics of interventions aiming to improve balance confidence. This review reiterated several interventions designed either as

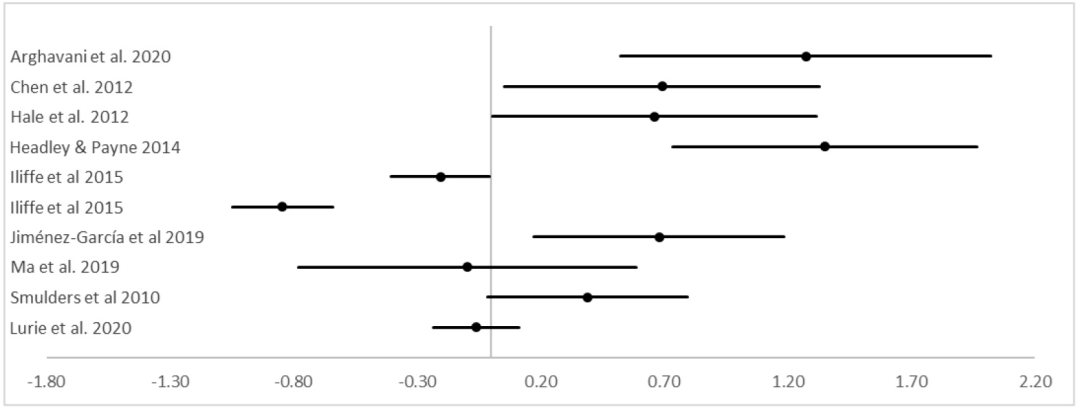

Figure 3b. Forest plot of the different interventions categorised under different fall-stages. Presentantion of 10 interventions categorised under near-fall stage.

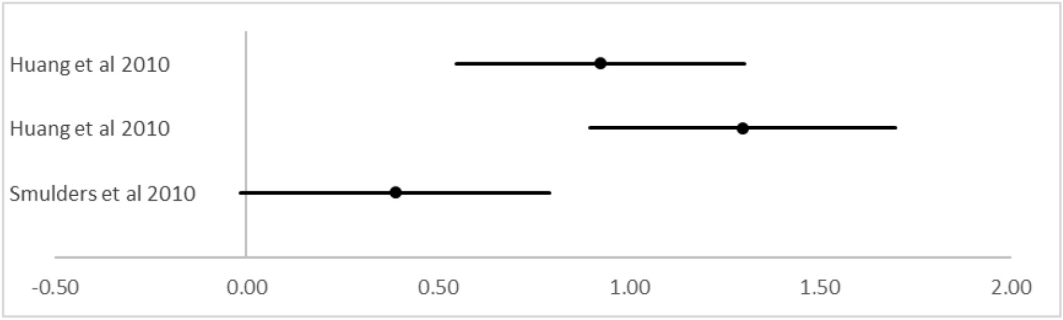

Figure 3c. Forest plot of the different interventions categorised under different fall-stages. Presentantion of three interventions categorised under fall-landing stage.

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[52]; Chinese martial arts training[51]; dynamic balance work[45,48,53]; water-based exercises[50]; and high-intensity training[49,54]. For skill-based training, controlled destabilising perturbations[7,8] were used to train balance recovery abilities. At the fall-landing and completed fall stages - to help older adults addressed their perceived ability to fall safely and to get up from a fall, interventions strategies were commonly delivered through cognitive-behaviour therapy[38,47,55]. The Nijmegan Falls Prevention Program[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.

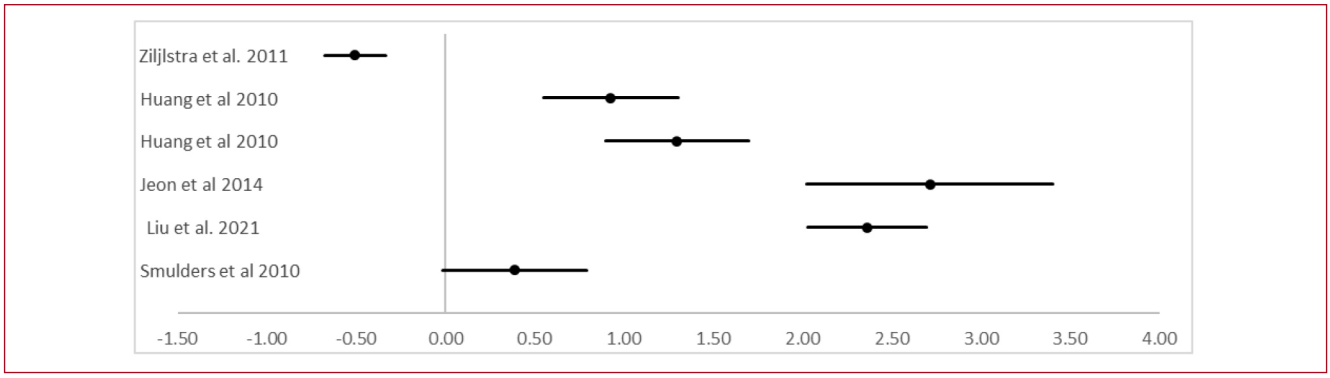

Figure 3d. Forest plot of the different interventions categorised under different fall-stages. Presentantion of six interventions categorised under completed fall stage.

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 challenges balance in daily life pose the risk of a fall[56]. Older adults have reported common experiences of near-fall[57,58]. 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 confidence[4]. According to Bandura[2], 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 important[59]. 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 evidence[60], a list of measurement instruments for the different aspects of falls efficacy has been made available in another article[5] 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

the potential of individual interventions to improve specific perceived self-efficacy of capabilities to address fall issues.

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