

Effectiveness and Feasibility of Lifestyle-integrated Functional Exercise (LiFE)- Based Interventions for Falls Prevention Among Community-based Older Adults - A Mixed-Methods Systematic Review

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Abstract

Background

Falls impose a substantial burden on healthcare systems and considerable morbidity and mortality. The Lifestyle-integrated Functional Exercise (LiFE) and its modified versions integrate exercise into daily activities offering greater flexibility for fall prevention. This systematic review aims to summarise evidence on effectiveness and feasibility of LiFE-based interventions for fall prevention among community-based older adults.

Methods

Systematic search of six databases was conducted from inception to August 2025. Quantitative and qualitative studies were included. We included studies using quantitative, qualitative, or mixed-methods designs that evaluated LiFE-based interventions in community-dwelling older adults and reporting effectiveness, acceptability, or feasibility (English or Chinese). Study quality was assessed using the Cochrane Risk of Bias, Joanna Briggs Institute, and Mixed Methods Appraisal tools. Quantitative data were synthesised using meta-analysis where appropriate, with narrative synthesis applied to non-pooled quantitative and qualitative data.

Results

Eleven studies were included. Risk of bias ranged from low to some concerns, and GRADE ranged from low to moderate. Meta-analysis showed that LiFE-based interventions significantly reduced fall rates (Rate Ratio = 0.68, 95% CI 0.47 to 0.97; $p = 0.04$), particularly among older adults at high risk of falls. Pooled analyses also suggested reductions in the proportion of participants reporting one fall (Rate Ratio = 0.74, 95% CI 0.50 to 1.09; $p = 0.13$) and two or more falls (RR = 0.74, 95% CI 0.50 to 1.11; $p = 0.14$), although these findings were not statistically significant. Improvements were observed across falls-related proxy outcomes, including balance, strength, gait, mobility and function, quality-of-life, and self-efficacy, though statistical significance was inconsistent. LiFE-based interventions demonstrated high retention rates comparable to controls. Qualitative findings indicated high acceptability, although paperwork burden was identified as a potential challenge.

Conclusions

This systematic review provides preliminary evidence that LiFE-based interventions may reduce fall rates and improve selected proxy outcomes among community dwelling older adults. However, the current evidence base remains limited and heterogeneous. Future research should prioritise standardised reporting of falls outcomes, longer follow-up periods, and evaluation across more diverse older adult populations.

BACKGROUND

From 2015 to 2050, the number of people aged 60 and above is expected to almost double, going from 12% to 22% of the world's population [1]. Age represents a primary risk factor for falls, with approximately one-third of community-dwelling older adults aged 65 years and above experiencing at least one fall per year [2–4]. Falls among older adults are increasingly recognised as a critical public health issue globally, ranking as the second

leading cause of injury-related deaths worldwide, accounting for over 38 million disability-adjusted life years annually [5].

Strength and balance exercise interventions have been shown to reduce the incidence of falls over time [6], with studies reporting a notable 23% reduction in fall rates [7]. However, adherence to exercise interventions tends to decline over time [8]. Various factors contribute to decreased adherence among older adults, including living alone, poor health status, reduced physical ability [8], time constraints, limited access to facilities, transportation issues, and the cost of exercise [9].

The Lifestyle-integrated Functional Exercise (LiFE) programme was designed for fall prevention among community-dwelling older adults aged ≥ 70 and performed individually [10, 11]. It incorporates four balance strategies and seven strength strategies, personalised to individual needs. Balance training emphasises progressive mastery of challenging activities, including reducing the base of support, moving to the limits of sway, shifting weight from foot to foot, and stepping over objects. Activities aimed at reducing the base of support are emphasised. Strength training strategies involve bending your knees, on your toes, on your heels, up the stairs, sitting to stand, moving sideways, and tightening muscles. LiFE programme requires no specialised facilities and no specific time to be allocated as exercises can be done whenever the participant wants during their day, thereby has higher chance to enhance individuals' adherence to long-term exercise goals for falls prevention [12, 13]. Previous reviews have mainly focused on the feasibility of LiFE as a concept [13] or provided narrative syntheses of LiFE-based interventions [14]. However, their effectiveness for falls prevention remains less clearly synthesised. This review therefore aims to evaluate the effectiveness of LiFE-based interventions for falls prevention compared with non-LiFE approaches, and to examine their feasibility among community-dwelling older adults.

METHODS

This systematic review with meta-analysis was conducted following the Cochrane Handbook for Systematic Review of Interventions [15] and is reported according to PRISMA guidelines [16]. The review protocol is registered in PROSPERO (registration number: CRD42023453730).

Eligibility criteria

We included quantitative, qualitative, and mixed-methods studies evaluating LiFE-based interventions. Studies were included if they: (1) recruited community-dwelling older adults (mean age ≥ 60 years); (2) the LiFE-based exercise programme was the intervention; (3) comparators included usual care, no intervention, written exercise advice, and other control conditions; (4) included falls related outcomes [17] (such as number of falls, rate of falls, number of fallers, and fall rate per person year), proxy outcomes (such as balance, strength, mobility and function, concerns about falling, or risk of falls), secondary outcomes (such as quality-of-life), explored feasibility outcomes (such as adherence, retention rate), and perspectives of related partners on LiFE-based programmes, including healthcare professionals and researchers with experiences of working with or conducting research involving Chinese older adults in the UK.

We excluded review or discussion papers, incomplete studies such as study protocols or ongoing studies, those not published in English or Chinese, and those that did not provide sufficient information about the measurement of the outcome of interest. Studies were also excluded if they were: (1) conducted in hospital or residential care settings; (2) involved participants with cognitive or physical impairments (e.g. severe cognitive impairment, Parkinson's disease, stroke with severe residual disability); (3) included LiFE-based interventions as one component

of a broader multifactorial intervention; or (4) used LiFE-based interventions in the control group, as these comparisons did not allow a clear assessment of the effectiveness of LiFE-based interventions relative to non-LiFE comparators.

Search strategies

Five databases (PubMed (Ovid), Embase (Ovid), APA PsycINFO (Ovid), CINAHL Plus (EBSCOhost), and Chinese Biology Medicine (CMB)) were searched from inception to August 2025. Search terms were adapted from a previous systematic review of interventions integrating functional exercises into everyday life [13]. Search strategies for all databases were developed based on the PubMed strategy (See Appendix 1). Reference lists of included studies and relevant reviews were searched to identify additional articles. Any disagreements about inclusion were resolved through discussion to reach a consensus.

Study selection process

Search records were imported into Rayyan [18], and duplicate records were removed. Three reviewers (L.H, Y.Y, and Y.M) independently screened titles and abstracts, followed by full-text assessment of potentially eligible studies. Disagreements were resolved through discussion with a third reviewer (H.H-H).

Risk of bias assessment

The Cochrane RoB-2 tool [19] was used for RCTs, the Joanna Briggs Institute (JBI) Critical Appraisal checklists [20, 21] were used for quasi-experimental studies and qualitative studies, and the Mixed Methods Appraisal Tool (MMAT) [22] was used for mixed-methods studies. As the included studies comprised single-group pre–post designs or qualitative components embedded within mixed-methods studies, the JBI checklists were adapted by retaining only items applicable to these designs and removing non-applicable items. Three reviewers (L.H, Y.Y, and Y.M) independently rated risk of bias, and discrepancies were resolved through discussion with a co-author (H.H-H). The Robvis tool was used to generate risk-of-bias plots [23].

Data extraction

Data extraction was performed independently by two reviewers (L.H and Y.Y) with Microsoft

Excel. It included: title, author, year of publication, study design, country of study, aim, LiFE versions, control group, sample size, mean age, follow-up time period, and main findings. LiFE versions were classified based on the intervention name and description reported by the study authors. Falls related outcomes include rate of falls (Relative Risk and Incidence rate ratio), adherence rates, balance and strength measures, and number of adverse events, as well as qualitative data covering stakeholders' experiences and feedback. For studies reporting multiple follow-up time points, effect estimates were extracted separately and categorised as short-term (≤ 3 months), medium-term (> 3 –6 months), or long-term (> 6 –12 months).

Data synthesis

Data synthesis was conducted using RevMan Web [18]. Meta-analyses were conducted for RCTs only; and non-RCTs were not statistically combined with because of differences in study design and potential sources of bias. For continuous outcomes, treatment effects were estimated using (95% confidence intervals (CIs)). Where means or standard deviations (SD) were not reported, values were calculated or derived using Cochrane-recommended methods [15, 24]. For dichotomous outcomes, Rate Ratio were calculated using the Mantel–Haenszel method with a random-effects model. Clinical and methodological heterogeneity were assessed by comparing outcome measures and follow-up time points profiles before pooling. Statistical heterogeneity was assessed using the I^2 statistic, interpreted alongside the magnitude and direction of effects and the overlap of confidence intervals. Heterogeneity was considered considerable when I^2 exceeded 75% [25]. Where multiple measures of the same outcome domain were reported at the same time point, only one measure was selected for each meta-analysis to avoid double-counting participants; preference was given to the most clinically interpretable measure [15]. For non-RCTs quantitative study, forest plots were generated for visual interpretation of trends only, and pooled effect estimates were not calculated. Qualitative studies were synthesised narratively.

Grading of recommendations, assessment, development and evaluation (GRADE)

The certainty of the evidence was assessed by L.H and Y.Y with the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach [26]. It is used to assess the certainty or quality of the evidence for each outcome and rated as very low, low, moderate, and high. The following factors were considered in relation to assessing the evidence: (i) risk of bias, (ii) inconsistency, (iii) imprecision, (iv) indirectness and (v) publication bias.

RESULTS

Study characteristics

The selection procedure is outlined in Fig. 1. Characteristics of the 11 included papers are summarised in Table 1. The review included four RCTs [10, 11, 27, 28], one of which incorporated a focus group component [27]; five single-arm feasibility studies [29–33], three of which included follow-up interviews [30, 31, 33], and two qualitative studies [34, 35]. Except original LiFE [10, 11, 35] format, different modified LiFE-based intervention formats were identified, including: group-based LiFE (gLiFE) [32, 33, 35]; group-based LiFE delivered to a younger population [30]; adapted LiFE (aLiFE) [27, 29, 34]; enhanced LiFE (eLiFE) [27]; and LiFE delivered to diverse older populations (DO LiFE) [28, 31].

Publication dates ranged from 2010 [10] to 2023 [28]. A total of 442 participants were included in RCTs and 140 in non-RCT studies, while qualitative components involved six trainers and 93 participants. The mean age of participants ranged from 66.2 years [27] to 87.9 years [32], and the percentage of women from 47 [10] to 100% [29]. Age of trainers were not reported. The included studies were conducted in Australia [10, 11]; Germany, Norway, and the Netherlands [27, 29, 33–35]; the USA [28, 31, 32]; and Canada [30].

Table 1
Description of included papers

Author (Year)	Study design	Country of study	LiFE version of intervention vs. control group (if applicable)	Target population	Sample size (Women %)	Mean age ($\pm$ SD)	Follow-up
Clemson et al. (2010) [10]	RCT	Australia	LiFE vs. No-intervention	Older adults aged $\geq$ 70 years	N = 34 (47%) LiFE:16 CG: 18	81.5 $\pm$ 5.9	3m and 6m
Clemson et al. (2012) [11]	RCT	Australia	LiFE vs. Gentle exercise	Older adults aged $\geq$ 70 years	N = 212 (55%) LiFE:107 CG:105	83.4	6m and 12m
Hu et al. (2023) [28]	RCT	USA	DO LiFE vs. Gentle exercise	Older adults aged $\geq$ 70 years	N = 16 (75%) DO LiFE:8 CG:8	77.3 $\pm$ 5.9	12w
Taraldsen et al. (2020) [27]	Mixed-methods study: RCT+ Focus groups	Germany, Norway, Netherlands	eLiFE, aLiFE vs. Information-only	Older adults aged 60–70 years	N = 180 (52%) eLiFE:61 aLiFE:59 CG:60	eLiFE: 66.4 $\pm$ 2.3. aLiFE: 66.2 $\pm$ 2.3. CG: 66.4 $\pm$ 2.7	6m and 12m
Li et al. (2018) [32]	Single-group pre-post study	USA	gLiFE	Older adults aged $\geq$ 65 years	N = 16 (88%)	87.9 $\pm$ 4.75	26w
Schwenk et al. (2019) [29]	Single-group pre-post study	Germany, Norway, Netherlands	aLiFE	Older adults aged 60–70 years	N = 31 (65%)	66.4 $\pm$ 2.7	4w
Hu et al. (2020) [31]	Mixed-methods study: Pre-interviews + Single-group pre-post study	USA	DO LiFE	Older adults aged $\geq$ 65 years	N = 17 for interviews (65%) + 8 for pre-post study (50%)	66.4 $\pm$ 5.6	6m

Author (Year)	Study design	Country of study	LiFE version of intervention vs. control group (if applicable)	Target population	Sample size (Women %)	Mean age ($\pm$ SD)	Follow-up
Fleig et al. (2016) [30]	Mixed-methods study: Single-group pre-post study + interviews	Canada	Group LiFE with younger population	Women aged 55–70 years	N = 13 (100%) (10 for interviews)	66 $\pm$ 4	6m
Kramer et al. (2020) [33]	Mixed-methods study: Single-group pre-post study + Focus groups	Germany	gLiFE	Older adults aged $\geq$ 70 years	N = 6 (83%) (5 for focus groups)	72.8	7w
Boulton et al. (2019) [34]	Follow-up interviews	Germany, Norway, Netherlands	aLiFE	Older adults aged $\geq$ 70 years	N = 37 31 participants (65%) + 6 trainers	78.8 $\pm$ 6.6	NA
Reicherzer et al. (2021) [35]	Follow-up interviews	Germany	LiFE gLiFE	Older adults aged $\geq$ 70 years	N = 30 (73%) LiFE: 15 gLiFE: 15	Participants (66.4 $\pm$ 2.7) trainers (30.0 $\pm$ 6.2)	NA

Risk of bias in studies

Blinding of participants was not feasible in RCTs because of the nature of the intervention. This contributed to “some concerns” in the risk-of-bias assessment [10, 11, 28]. Two papers were considered as ‘some concerns’ due to the high dropout rate in follow-up assessment and sample was not representative of the target population [30, 33]. Aside from this, 75% of included studies were judged to be at low overall risk of bias (See Fig. 2).

Effectiveness in reducing of falls- RCTs

All RCT outcomes are present in Appendix 2. Two studies [10, 11] assessed comparable falls related outcomes, including 212 LiFE participants and 105 participants from control groups. The pooled analysis showed that the LiFE intervention significantly reduced the rate of falls by 32% compared with control groups (Rate Ratio = 0.68, 95% CI 0.47 to 0.97, $p = 0.04$; $I^2 = 0\%$, $p = 0.45$) [10, 11] (See Fig. 3). LiFE participants were also 26% less likely to reported one fall (Rate Ratio = 0.74, 95% CI 0.50 to 1.09, $p = 0.13$; $I^2 = 0\%$, $p = 0.97$) [10, 11] (See Fig. 4) and recurrent

falls (Rate Ratio = 0.74, 95% CI 0.50 to 1.11, $p = 0.14$; $I^2 = 9$, $p = 0.29$) (See Fig. 5) compared with control groups. However, these latter two outcomes were not statistically significant. The certainty of evidence for falls outcomes was rated as low, downgraded by two levels due to imprecision (rate of falls and recurrent falls) and the limited number of included studies.

Effectiveness in falls-related proxy outcomes- RCTs

Balance

Four studies reported comparable balance outcomes [10, 11, 27, 28], involving 251 participants receiving LiFE-based interventions (LiFE, aLiFE, eLiFE, and DO LiFE) and 191 participants allocated to control groups. In general, the certainty of evidence was rated as moderate, downgraded once due to inconsistency within outcome measurements.

Short-term (≤ 3 months)

One study [28] showed insignificant balance improvement of DO LiFE compared with controls (Berg Balance Scale: $Z = -0.7$; $r = -0.2$). Another study [10] reported a statistically significant improvement in tandem walk time ($p = 0.04$), whereas not statistically significant improvements in one-leg stand and tandem stand ($p = 0.37$ and $p = 0.20$).

Medium-term ($> 3-6$ months)

One study [11] reported a significant improvement in the eight-level balance hierarchy in LiFE intervention (mean (SD) from 3.97 (2.06) to 5.18 (1.99); $p < 0.0001$). Improvements were also observed in 3m tandem walk and five-level balance hierarchy, although p -values were not provided. Another study [27] found no significant improvement in the eight-level balance hierarchy among eLiFE participants ($p = 0.34$), whereas the aLiFE showed a statistically significant improvement ($p = 0.019$). In contrast, one study [10] reported no statistically significant differences between groups (3m tandem walk: $p = 0.19$; tandem stand: $p = 0.23$; one-leg stand: $p = 0.55$).

Long-term ($> 6-12$ months)

One study [11] demonstrated statistically significant improvements in the LiFE group compared to controls, with moderate-to-large effects observed on both the five-level ($p = 0.001$; effect size = 0.55) and eight-level balance hierarchies ($p < 0.001$; effect size = 0.63). The 3m tandem walk also favoured the LiFE group, showing a significant moderate effect ($p = 0.002$; effect size = 0.42). In contrast, another study [27] reported no statistically significant differences between either the eLiFE or aLiFE interventions and control groups on the eight-level balance hierarchy ($p = 0.148$ and 0.097).

Strength

Short-term (≤ 3 months)

Only one study presented data and this study showed a statistically significant improvement in left knee strength ($p = 0.02$) in the LiFE group compared with the controls [10]. Trends for right knee ($p = 0.09$), right ankle ($p = 0.38$), left ankle ($p = 0.3$), right hip ($p = 0.69$), and left hip strength ($p = 0.08$) are all favoured the LiFE group but did not reach statistical significance [10]. The certainty of evidence was rated as low, downgraded twice due to imprecision of outcomes and limited included study.

Medium-term ($> 3-6$ months)

The pooled analysis shows no statistically significant improvement with LiFE-based interventions (LiFE, eLiFE, and aLiFE) compared with controls (SMD = 0.18, 95% CI - 0.04 to 0.41, $p = 0.12$), with very low heterogeneity across studies ($I^2 = 0\%$, $p = 0.80$) [11, 27] (See Fig. 6). Similarly, one study [10] reported p -values only and therefore could not be included in meta-analysis, but found no statistically significant improvements in LiFE intervention across strength measurements (right knee ($p = 0.37$), left knee ($p = 0.08$), right ankle ($p = 0.37$), left ankle ($p = 0.08$), right hip ($p = 0.33$), and left hip strength ($p = 0.08$)). The certainty of evidence was rated as low, downgraded twice due to inconsistency of outcome measures and imprecision of outcomes.

Long-term (> 6–12 months)

The pooled result shows no statistically significant improvement in LiFE-based interventions (LiFE, eLiFE, and aLiFE) compared with controls (SMD = 0.15, 95% CI - 0.08 to 0.39, $p = 0.21$), with very low heterogeneity across studies ($I^2 = 2\%$, $p = 0.43$) [11, 27] (See Fig. 7). The certainty of evidence was rated as low, downgraded twice due to inconsistency of outcome measures and imprecision of outcomes.

Gait, Mobility and Function

One study [27] demonstrated no statistically significant improvement in gait observed between either the aLiFE ($p = 0.328$ – 0.76) or eLiFE ($p = 0.098$ – 0.951) and control during both medium and long-term follow-up periods. Two studies [27, 28] showed no significant differences between LiFE-based interventions (aLiFE, eLiFE, and DO LiFE) and controls for SPPB or Community Balance and Mobility Scale (CBMS) outcomes at any time point ($p = 0.17$ – 0.653). The certainty of evidence was rated as moderate, downgraded once due to imprecise outcome measurements and non-significant results.

Secondary outcome

Quality-of-life

Short-term (≤ 3 months)

One study [10] showed no statistically significant improvement in physical or mental health status (SF-36) for the LiFE intervention group compared with the control group at the 3-month follow-up ($p = 0.33$ – 0.69). The certainty of evidence was rated as moderate, downgraded once due to imprecision from non-significant within-group results based on a single small-sample study.

Medium-term (> 3–6 months)

The pooled results show a small, non-significant difference between LiFE-based interventions (LiFE, eLiFE, and aLiFE) and controls (MD = - 0.02, 95% CI - 0.05 to 0, $p = 0.1$); with substantial heterogeneity across studies ($I^2 = 72\%$, $p = 0.03$) (See Fig. 8). Other measurement tools such as EQ-5D VAS, SF-12, and SF-36 also suggest improvement within LiFE-based interventions, but no significant difference between groups [10, 11, 27]. The certainty of evidence was rated as moderate, downgraded once due to inconsistency of outcomes measurements.

Long-term (> 6–12 months)

Two studies [11, 27] showed no significant difference between LiFE-based interventions and control groups (MD = - 0.01, 95% CI - 0.04 to 0.02, $p = 0.52$), with very low heterogeneity within studies ($I^2 = 0$, $p = 1$) [11, 27] (See Fig. 9).

Similarly, other measurement tools reveal no significant differences between groups [10, 11, 22]. The certainty of evidence was rated as moderate, downgraded once due to inconsistency of outcomes measurements.

Self-efficacy

In the short term, one study [10] reported a significant improvement in MFES ($p = 0.02$) in the LiFE groups compared with control group, with no significant effects observed for the Marcus Exercise Self-Efficacy Scale ($p = 0.15$) or the ABC Scale ($p = 0.20$). Another study [28] found no short-term difference in balance confidence, with ABC scores showing a very small negative effect favouring control ($z = -0.3$, $r = -0.1$). One study [10] also reported limited medium-term effects in LiFE-based intervention (DO LiFE), with only the ABC Scale demonstrating significant improvement ($p = 0.04$), while MFES ($p = 0.06$) and Marcus Self-Efficacy ($p = 0.05$) remained non-significant. Overall, LiFE-based interventions showed modest and measure-specific changes in self-efficacy. The certainty of evidence was rated as low, downgraded twice due to imprecise outcome measurements and imprecision results.

Effect on rate of falls - non-RCTs

None of the non-RCT studies reported falls outcomes.

Effect on falls-related proxy outcomes- non-RCTs

One study [32] reported improvements in balance and strength following LiFE-based interventions at short-term follow-up, whereas another study [30] found no improvement in gait speed at medium-term follow-up. Forest plot visualisation suggested improvements in mobility and functional performance following LiFE-based interventions [29–32] (See Fig. 10). Additionally, one study [30] reported improvements in quality-of-life following LiFE-based intervention (See Table 4).

Notes: Higher scores indicate better performance. TUG scores were inverted prior to analysis to ensure consistent directionality.

Figure 10 Mobility and function

Table 4
non-RCTs data outcomes

	Authors (Year)	Outcome measurements	Follow-up time	Number of participants	Mean (SD)
Balance	Li et al. (2018) [32]	Functional	Baseline	16	8.5 (1.55)
		Reach Test (FRT)	26w	16	9.56 (1.46)
		One leg stand	Baseline	16	3.47 (4.63)
			26w	16	7.90 (13.73)
Strength	Li et al. (2018) [32]	30s Chair Stand Test	Baseline	16	7.31 (4.21)
			26w	16	10 (4.84)
Gait	Fleig et al. (2016) [30]	Gait speed	Baseline	13	1.1 (0.2)
			6m	10	1.1 (0.2)
Mobility and function	Fleig et al. (2016) [30]	Short Physical Performance Battery (SPPB)	Baseline	13	11.0 (1.0)
			6m	10	11.0 (1.8)
	Hu et al. (2020) [31]	Performance-Oriented Mobility Assessment (POMA)	Baseline	8	20.75(6.43)
			6m	8	23.75(4.68)
	Schwenk et al. (2019) [29]	Community Balance and Mobility Scale (CBMS)	Baseline	30	65.97(12.73)
			4w	30	70.41(13.06)
	Li et al. (2018) [32]	Timed Up and Go (TUG)	Baseline	16	18.95(4.23)
			26w	16	16.11 (3.86)
Quality-of-life	Fleig et al. (2016) [30]	EQ-5D-5L VAS	Baseline	13	86.1 (11.1)
			6m	10	89.1 (7.0)
		EQ-5D-5L	Baseline	13	0.8 (0.2)
			6m	10	0.9 (0.2)

Higher scores indicate better function. TUG scores were inverted prior to analysis.

Feasibility outcomes

Retention rate

Retention rate was defined as the percentage of participants who completed final follow-up assessment. In general, LiFE-based groups have higher retention rates than control groups [10, 11, 28], ranging from 81%-100%. However, lower retention rates were observed in one study [27] (aLiFE: 66%, eLiFE: 74% vs. CG: 78%). Across single arm pre-post studies, retention rates ranged from 84% [32] to 97% [29] (See Table 5). Health-related issues were the most commonly reported reason for withdrawal.

Table 5
Retention Rate

	Measure time point	Completed final follow-up assessment	
RCTs			
Clemson et al. (2010) [10]	6m	IG:17 (94%)	CG:12 (75%)
Clemson et al. (2012) [11]	12m	IG: 81 (76%)	CG: 80 (76%)
Taraldsen et al. (2020) [27]	12m	IG1: 46 (66%)	CG: 49 (78%)
		IG2: 43 (74%)	
Hu et al. (2023) [28]	12w	IG:8 (100%)	CG: 8 (100%)
Non- RCTs			
Li et al. (2018) [32]	26w	IG:16 (84%)	NA
Schwenk et al. (2019) [29]	4w	IG:30 (97%)	NA
Hu et al. (2020) [31]	6m	IG:8 (89%)	NA
Fleig et al. (2016) [30]	6m	IG:10 (77%)	NA
Kramer et al. (2020) [33]	7w	IG: 6 (86%)	NA

IG: Intervention group; CG: Control group; IG1: aLiFE; IG2: eLiFE

Adherence

Measures of adherence were highly heterogeneous across studies, including percentage of return weekly log [11], activity frequency [11, 28, 29], attendance at intervention sessions [33] [31], maintenance of engagement[32], and self-reported adherence scales [27]. Reported reasons for lower adherence included health-related issues such as pain, acute illness, and depression.

RCTs

In Clemson et al. (2010) [10], although the authors stated that adherence was monitored using weekly and monthly logs, details of the measurement methods and outcomes were not provided. In the Clemson et al. (2012) [11] study, adherence was measured by the percentage of returned weekly logs, and no between-group difference in adherence was observed during the first six months, with approximately 47% across intervention and control groups. However, at the 12-month follow-up, higher adherence was reported in the LiFE group, with participants performing activities on an average of 3.89 days per week. Detailed adherence data for the control group were not provided. In Hu et al. [28], the DO-LiFE group demonstrated a mean adherence rate of 67.4% across seven intervention sessions. Participants reported performing LiFE activities on average 5.7 days per week, although the specific activity types and frequency of individual activities were not fully described. Only 12.5% of participants reported using the activity planner. The DO LiFE group completed a higher number of activities than the control group (mean $13.0 \pm SD 4.5$ vs. $11.3 \pm SD 3.3$). However, adherence for the control group were not reported.

Taraldsen et al. [27] assessed adherence using both a monthly single question (summarized as full adherence, partial adherence, or non-adherence) [36] and the Exercise Adherence Rating Scale (EARS) [37]. Different with above studies, at six months, full adherence to aLiFE (21%) and eLiFE (30%) was lower than the control group (40%). The aLiFE group showed the highest proportion of partial adherence (60%) and also the highest rate of non-adherence (23%). During the unsupervised follow-up (6–12 months), EARS scores indicated slightly higher adherence in the eLiFE group (mean $12.20 \pm \text{SD } 2.29$) compared to aLiFE ($11.85 \pm \text{SD } 2.44$) and control groups ($11.61 \pm \text{SD } 2.07$).

non- RCTs

Kramer et al. [33] assessed the average number of participants per session, and reported that participants practised a median of 9.5 activities approximately 5.2 days per week, corresponding to implementation of around 75% of prescribed activities. Similarly, Schwenk et al. [29] assessed adherence based on the number of activities implemented during the intervention period, with a maximum of 16 activities (four per visit). An activity was considered implemented if participants reported performing it at least once per week. The overall adherence rate was 76%, with participants performing an average of 12.1 (SD 1.8) activities weekly. Hu et al. [31] reported a mean adherence rate of 81.27% based on session attendance. Similarly, Li et al. [32] reported that 83% of participants maintained engagement with the exercise programme, suggesting continued incorporation of prescribed activities into daily routines.

Habit formation and intervention acceptability

Habit formation was assessed using different self-report measures across studies. Hu et al. [28, 31] found moderate improvements in exercise habits using the Self-Reported Habit Index (r : 0.35 to 0.41) in the DO LiFE groups. In Taraldsen et al. study [27], habit strength (Self-Report Behavioural Automaticity Index (SRBAI)) remained stable between 6 and 12 months of follow-up. Fleig et al. observed an increase in self-report habit index scores from baseline to 6 months (2.4 to 5.2) [30].

Acceptability was quantitatively evaluated in two studies using rating scales [31, 33]. In Hu et al. study [31], DO-LiFE activities received a mean rating of 6.89 (SD 0.38) on a 7-point Likert scale, with follow-up interviews attributing high acceptability to the programme's flexibility, ease of integration, weekly support, and promotion of habit formation. In Kramer et al. study [33], participants consistently rated the gLiFE as "very safe" and "very good."

These findings were echoed in the qualitative data, which showed that most participants were able to understand the concept and identify opportunities to integrate exercises into their daily routines [27, 29, 31, 33–35], as well as reporting the LiFE-concept to be more flexible and personalised than structured exercise programmes [27, 35]. Some participants highlighted the importance of action planning and situational cues, which helped them remember to perform the activities [30, 33, 34].

LiFE-based interventions were generally perceived as beneficial for improving balance, strength, physical activity levels, and fear of falling [30, 34, 35]. Overall, participants reported high levels of motivation and satisfaction with trainer support [27, 30, 33–35]. The manual was valued as a helpful resource [27, 30, 33–35]; however, concerns were raised that overly wordy materials could reduce motivation [31, 34] and the lack of ethnic diversity [31] might reduce generalisability. Several barriers to engagement were also reported, including embarrassment when

performing the activities [34], busy lifestyles [30, 34], health-related limitations [30, 34], persistent concerns about falling [35], and the burden associated with completing daily activity records and activity planners [30, 33–35].

DISCUSSION

This systematic review synthesised current evidence on the effectiveness and feasibility of LiFE-based exercise programmes for falls prevention in community-dwelling older adults. Overall, the findings suggest that LiFE-based interventions may be beneficial; however, the evidence base remains limited in several important respects. Participants across the included studies were predominantly female and were mainly recruited from White-majority countries. Similar patterns have been found in previous reviews of exercise-based falls prevention interventions in older adults [7, 38]. This may limit the transferability of findings to more ethnically and culturally diverse populations. Further adaptation and evaluation of LiFE-based interventions in underrepresented groups are therefore warranted.

Only a small number of studies reported fall-rate outcomes, which restricted the number of trials eligible for meta-analysis and reduced confidence in the pooled estimate. The available evidence indicated that LiFE-based interventions may reduce fall rate by 32% compared with control groups [10, 11]. Although this appears greater than the 23% reduction reported in a previous review of general exercise interventions compared with control for falls prevention [7], such comparisons should be interpreted cautiously given differences in intervention type, participant characteristics and comparator conditions. Notably, one study [10] reported a particularly large reduction in falls (RR = 0.21, 95% CI 0.06 to 0.67). This may be explained by the inclusion of participants at high risk of falling and the use of a non-exercise comparator. While this finding should be interpreted cautiously, it may suggest that LiFE-based interventions are particularly relevant for those at elevated risk of falls.

Evidence on long-term effectiveness was also limited, as few studies included follow-up beyond 12 months. A recent review suggested that at least 51 weeks may be required to adequately assess sustained effects of exercise on falls prevention in older adults [39]. Further studies with longer follow-up are needed to determine whether benefits of LiFE-based interventions are maintained over time. At present, the evidence supports LiFE-based interventions as a promising approach, rather than demonstrating superiority over more structured exercise programmes.

Beyond fall rate outcomes, LiFE-based interventions also appeared to show beneficial effects across a range of falls-related proxy outcomes. Overall, LiFE-based interventions tended to improve most falls-related proxy outcomes relative to control conditions in the RCTs, although statistically significant effects were observed for only a limited number of outcomes. This may partly reflect ceiling effects, as many participants were relatively high functioning at baseline, leaving limited room for measurable improvement [40]. Similar patterns were also reported in non-RCT studies, in which proxy outcomes generally improved following LiFE-based interventions.

Interpretation of these findings is constrained by considerable heterogeneity in the selection, measurement and reporting of proxy outcomes across studies. Outcome data were often incompletely reported, with missing means and standard deviations in several cases, limiting the feasibility of quantitative synthesis. There was also evidence of inconsistency in outcome classification, such as the categorisation of the SPPB as a balance measure in Hu et al. [28], despite its broader assessment scope. Consequently, pooled analysis was not possible for several proxy outcomes, and conclusions relied largely on narrative synthesis. Future studies should adopt more consistent outcome selection and reporting to strengthen comparability across trials.

Retention rates in LiFE-based intervention groups were generally comparable to or higher than those observed in control groups across most included RCTs. An exception was reported in the study by Taraldsen et al. [27], where the digital intervention group demonstrated lower retention compared with control group. Although previous review have suggested that technology-assisted interventions may support improved retention in some contexts [38], this finding indicate that this effect may not be consistent in older populations. This could be the variation in digital literacy and confidence among older adults, which may influence willingness to engage with technology-supported delivery formats. In addition, allocation to a digital intervention format, rather than a preferred paper-based alternative, may have also contributed to dissatisfaction and subsequent dropout. These findings highlight the importance of considering participant preferences, technological readiness, and perceived intervention burden when designing and implementing falls prevention programmes for older adults. Similar considerations may apply to non-randomised single-arm studies, where intervention engagement and retention are likely to be influenced by delivery format and individual preferences. Future research should therefore explore strategies to tailor intervention delivery modes to participant needs in order to optimise retention.

Adherence findings varied across studies, largely due to differences in how adherence was defined and measured, as well as incomplete reporting of adherence data in several trials. In LiFE-based interventions, adherence was commonly assessed using indicators such as completion of planned activity days, number of activities performed, and attendance at intervention sessions. Overall, findings were inconsistent, with some trials reporting higher adherence in LiFE-based intervention groups, while others observed similar or lower adherence compared with structured control programmes. Inconsistent reporting and the reliance on self-reported adherence measures further limited comparability across studies. Although an existing review [41] has provided definitions of adherence, it mainly focused on exercise class rather than home-based interventions. Future research would benefit from adopting more standardised approaches to defining and measuring adherence in lifestyle-integrated exercise interventions. Notably, the paperwork burden associated with data collection methods should also be considered. The process of writing down the exercises daily may have discouraged some participants from documenting their efforts and the use of multiple recording forms may have increased the potential for recall bias and incomplete reporting. With regard to delivery format, evidence from digital exercise programmes suggests that technology-supported interventions may introduce disparities related to variation in digital literacy among older adults [38]. This is broadly consistent with findings from Taraldsen et al. [27], where adherence appeared higher in the digital intervention group compared with the paper-based and control groups in unsupervised period. Qualitative findings were supportive of the general trend of adherence rates across the trials, with participants expressing strong motivation to continue LiFE-based activities independently, even without supervision.

Limitations

Several limitations should be considered when interpreting the findings of this review. First, due to substantial heterogeneity was observed in reporting outcomes formats, missing data, and unsuccessful attempts to obtain additional information from study authors restricted the inclusion of all relevant outcomes in the meta-analysis. Furthermore, the small number of eligible RCTs limited the robustness and precision of pooled estimates.

Differences in control group design also represented a methodological limitation. While some studies used no-exercise controls, others provided exercise advice or educational materials. Due to the limited number of available studies, these control conditions were combined for analysis, which may have reduced the precision of comparative estimates. In addition, variability in the definition and measurement of adherence across programmes further limited cross-study comparability and precluded additional quantitative synthesis.

The generalisability of findings may also be constrained by participant characteristics. Most included studies recruited relatively high-functioning older adults and were predominantly from White female-majority populations. This limits the applicability of findings to more diverse real-world populations. Moreover, there remains limited published evidence evaluating their cultural adaptability across different ethnic groups. Future research should prioritise more diverse populations, longer follow-up periods, standardised measurement, and clearer reporting of fall-rate outcomes.

CONCLUSION

LiFE-based interventions show promise as a feasible approach to falls prevention in community-dwelling older adults, with evidence suggesting reductions in fall rates and improvements in selected proxy outcomes. However, conclusions remain limited by heterogeneity in outcome reporting, variability in adherence measurement, missing data, and the small number of high-quality trials. Future research should prioritise standardised falls outcome reporting, longer follow-up, and evaluation across more diverse older adult populations.

Abbreviations

LiFE	Lifestyle-integrated Functional Exercise
JB	Joanna Briggs Institute
MMAT	Mixed Methods Appraisal Tool
SMDs	Standardised mean differences
CIs	Confidence intervals
GRADE	Grading of Recommendations Assessment, Development and Evaluation
gLiFE	group-based LiFE
aLiFE	adapted LiFE
eLiFE	enhanced LiFE
DO LiFE	diverse older populations LiFE
NA	Not applicable
FRT	Functional Reach Test
SPPB	Short Physical Performance Battery
POMA	Performance-Oriented Mobility Assessment
CBMS	Community Balance and Mobility Scale
TUG	Timed Up and Go
EARS	Exercise Adherence Rating Scale

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

All authors read and approved the final manuscript.

Data availability

No datasets were generated or analysed during the current study.

Competing interests

The authors declare no competing interests.

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This research did not receive funding.

Authors' contributions

Writing the review protocol: LH, H.HH, CT; Literature search: LH, YY, YM, H.HH, CT; Study screening and data extraction: LH, YY, YM, H.HH, CT. Data analysis: LH, YY, H.HH, CT, CH; Writing—original draft: LH; Writing—review and editing: H.HH, CT, CH.

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Figures

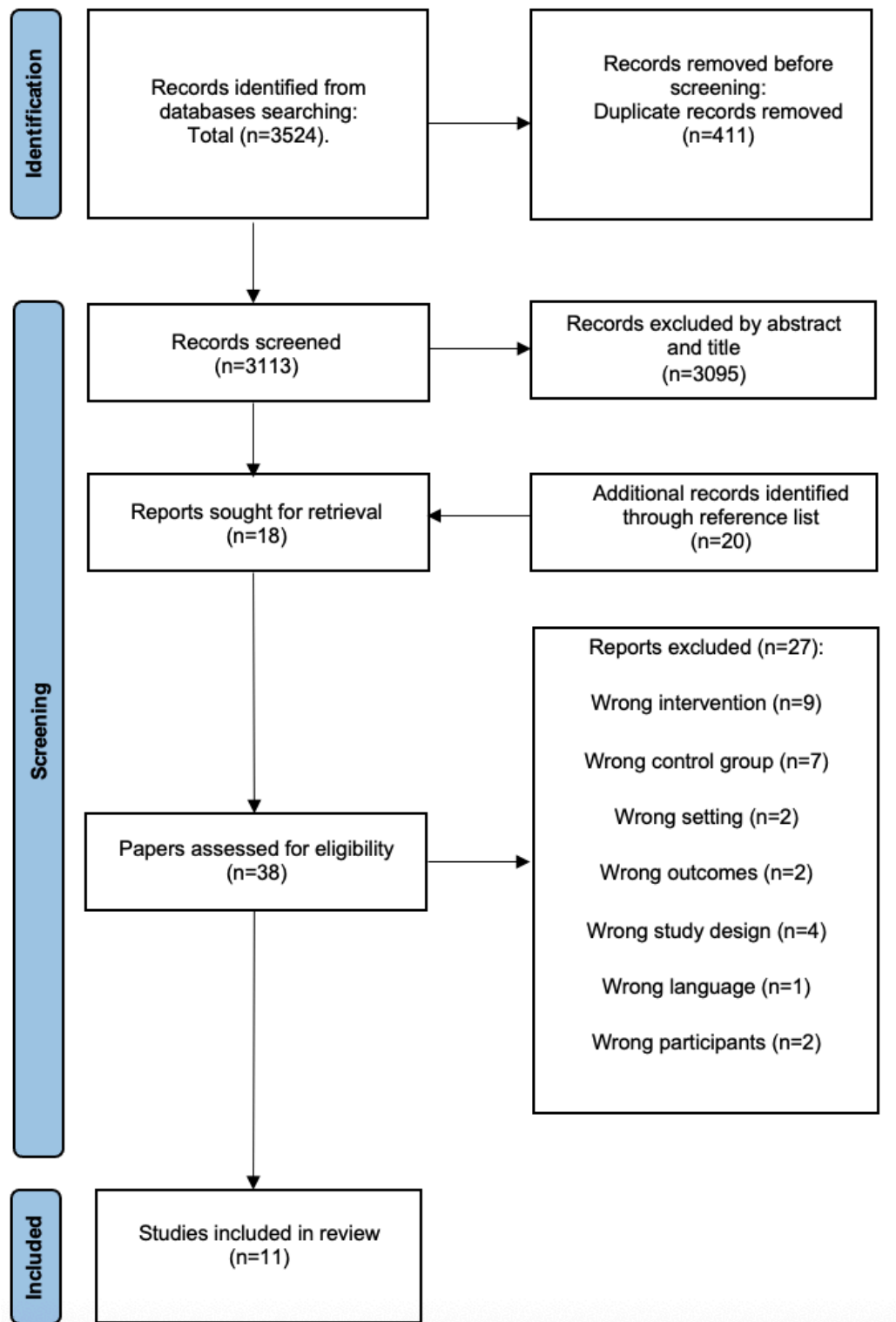


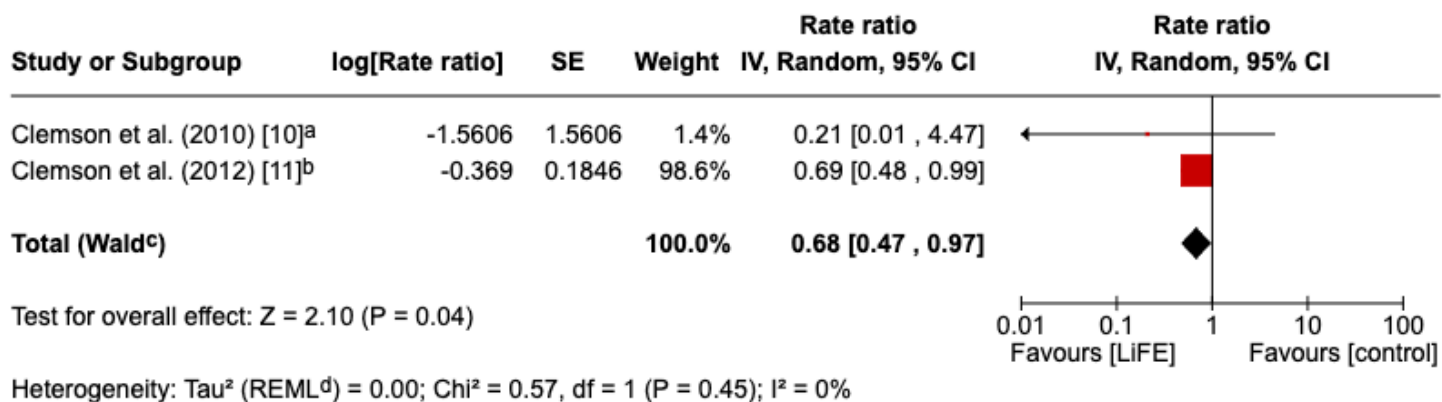
Figure 1

PRISMA Flow of study selection

Cochrane RoB-2 tool for RCTs						
	D1	D2	D3	D4	D5	Overall
Clemson et al. (2010) [10]	Low	Some concerns	Low	Low	Low	Some concerns
Clemson et al. (2012) [11]	Low	Some concerns	Low	Low	Low	Some concerns
Hu et al. (2023) [28]	Low	Some concerns	Low	Low	Low	Some concerns
Domain 1a: Risk of bias arising from the randomization process. Domain 2: Risk of bias due to deviations from the intended interventions (effect of assignment to intervention). Domain 3: Risk of bias due to missing outcome data. Domain 4: Risk of bias in measurement of the outcome. Domain 5: Risk of bias in selection of the reported result.						
JBI Critical Appraisal Tool for Quasi-experimental design studies						
Li et al. (2018) [32]	Low	Low	Low	Low	Low	Low
Schwenk et al. (2019) [29]	Low	Low	Low	Low	Low	Low
Domain 1: Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)? Domain 2: Were there multiple measurements of the outcome both pre and post the intervention/exposure? Domain 3: Were outcomes measured in a reliable way? Domain 4: Was follow-up complete and if not, were differences between groups in terms of their follow-up adequately described and analysed? Domain 5: Was appropriate statistical analysis used?						
JBI Critical Appraisal Tool for Qualitative Studies						
Boulton et al. (2019) [34]	Low	Low	Low	Low	NA	Low
Reicherzer et al. (2021) [35]	Low	Low	Low	Low	NA	Low
Domain 1: Is the influence of the researcher on the research, and vice-versa, addressed? Domain 2: Are participants, and their voices, adequately represented? Domain 3: Is the research ethical according to current criteria or for recent studies, and is there evidence of ethical approval by an appropriate body? Domain 4: Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?						
MMAT for Mixed Method Studies						
Hu et al. (2020) [31]	Low	Low	NA	Low	NA	Low
Fleig et al. (2016) [30]	Low	Low	NA	Low	NA	Low
Kramer et al. (2020) [33]	Low	Low	NA	Low	NA	Low
Taraldsen et al. (2020) [27]	Low	Low	Low	Low	NA	Low
Domain 1: Qualitative Domain 2: Quantitative nonrandomised Domain 3: Quantitative randomised controlled trials Domain 4: Mixed methods NA: Not applicable						

Figure 2

Critical appraisal for included studies



Footnotes

^aLiFE 6m

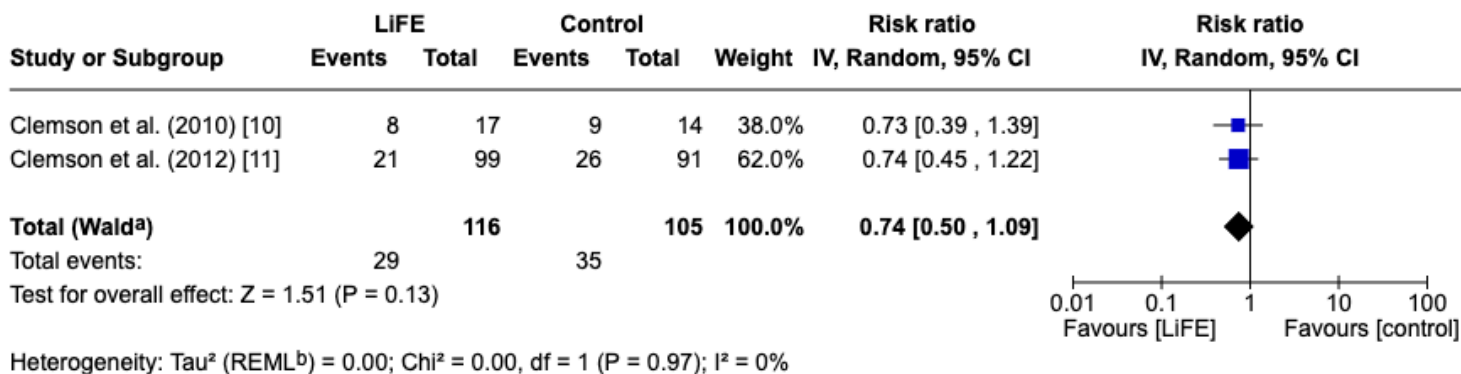
^bLiFE 12m

^cCI calculated by Wald-type method.

^d Tau^2 calculated by Restricted Maximum-Likelihood method.

Figure 3

Rate of falls



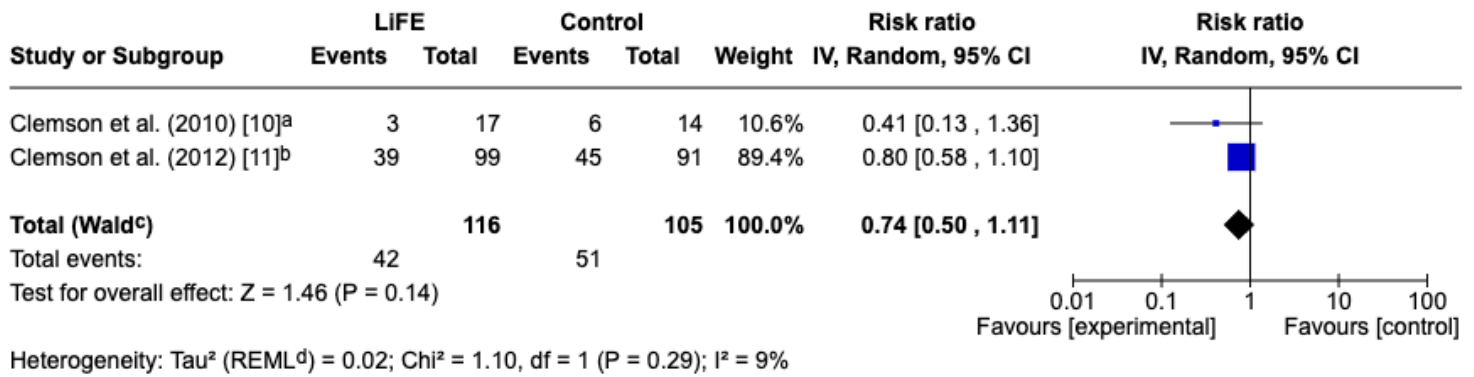
Footnotes

^aCI calculated by Wald-type method.

^b Tau^2 calculated by Restricted Maximum-Likelihood method.

Figure 4

Number of participants reported one fall



Footnotes

^aLiFE 6m

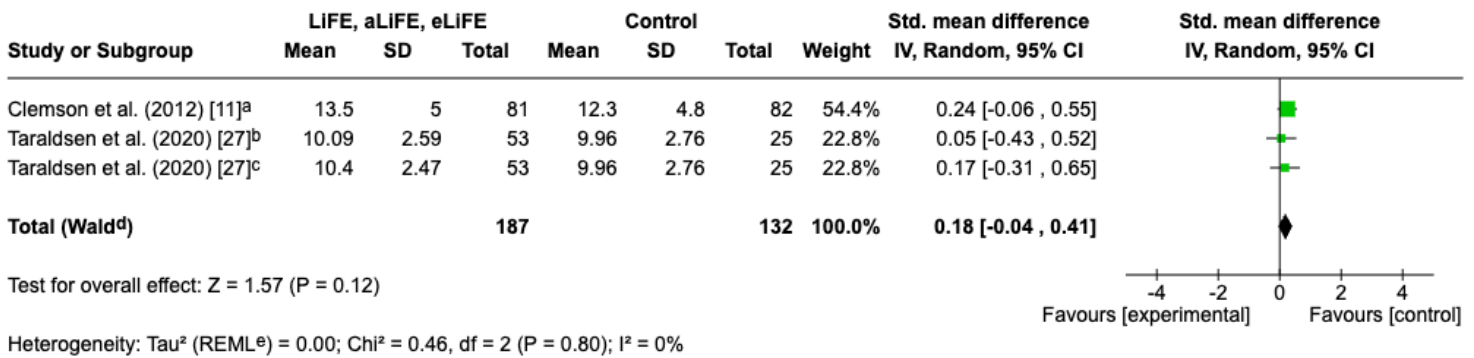
^bLiFE 12m

^cCI calculated by Wald-type method.

^dTau² calculated by Restricted Maximum-Likelihood method.

Figure 5

Number of participants reported two or more falls



Footnotes

^aRight ankle strength (LiFE 6m)

^bSit to stand (aLiFE 6m control halved)

^cSit to stand (eLiFE 6m control halved)

^dCI calculated by Wald-type method.

^eTau² calculated by Restricted Maximum-Likelihood method.

Figure 6

Strength – medium -term (SMD)

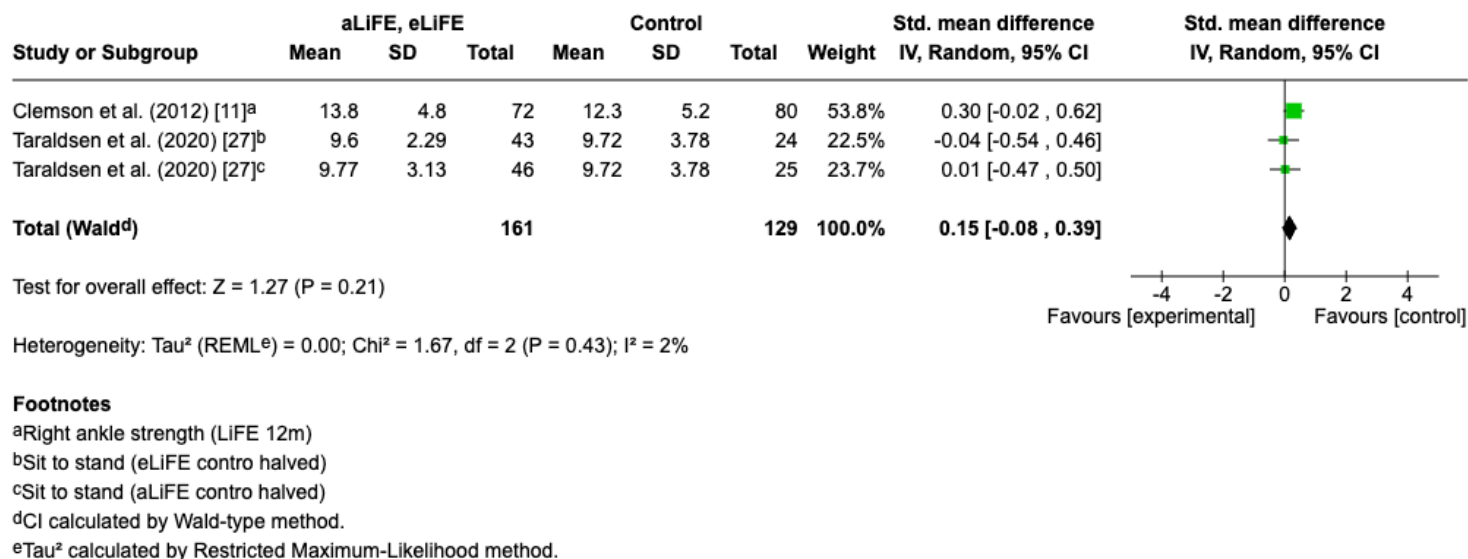


Figure 7

Strength – long -term (SMD)

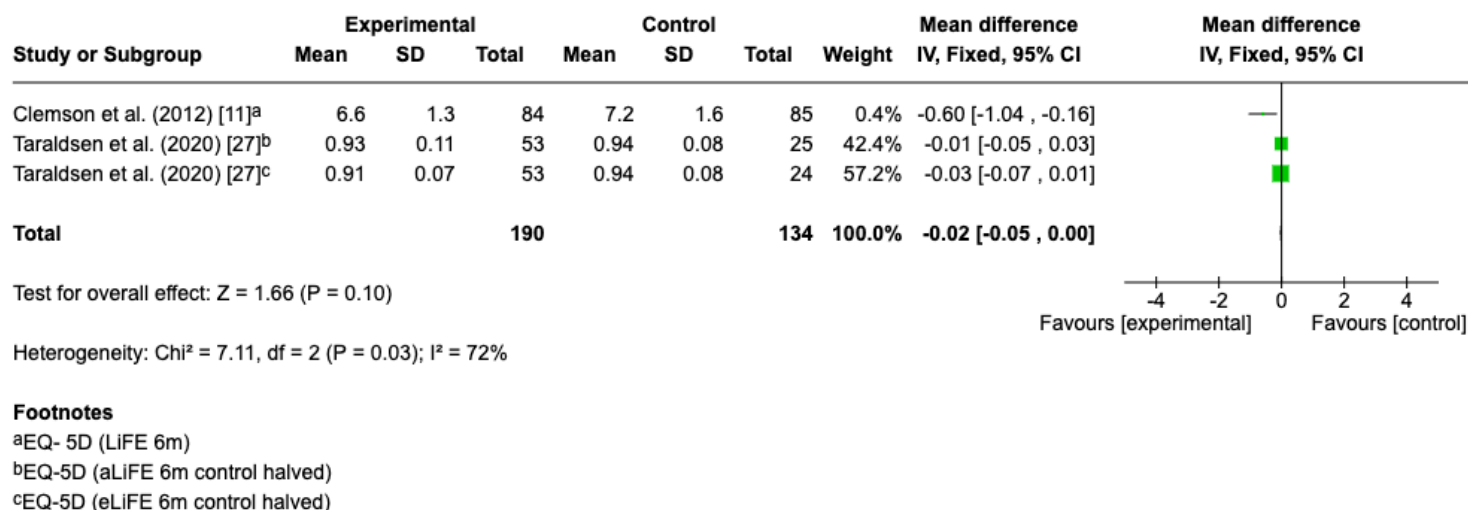


Figure 8

Quality-of-life- medium- term (SD)

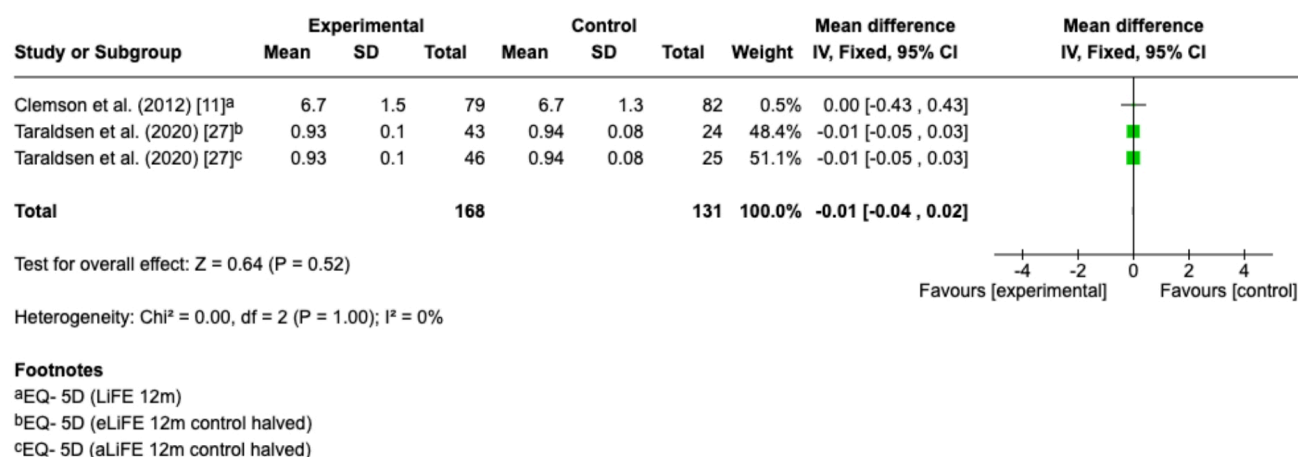


Figure 9

Quality-of-life- long-term (SD)

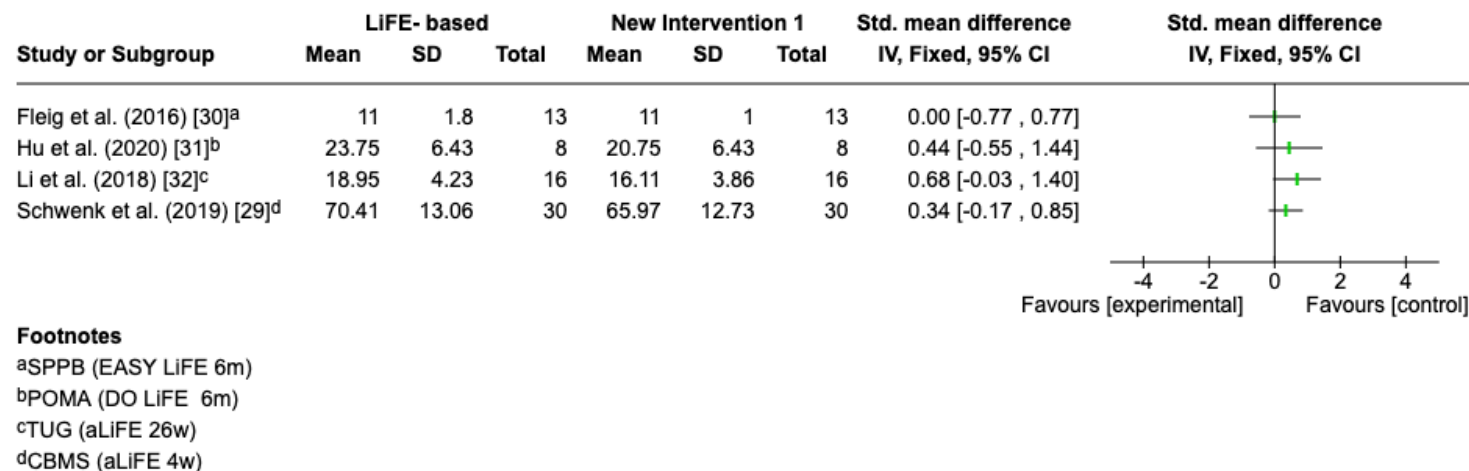


Figure 10

Mobility and function

Supplementary Files

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- [Reviewappendix1.xlsx](#)
- [ReviewAppendix2.xlsx](#)