Evidence Synthesis
Number 236

Interventions to Prevent Falls in Older Adults: Updated Systematic Review for the U.S. Preventive Services Task Force

Prepared for:
Agency for Healthcare Research and Quality
U.S. Department of Health and Human Services
5600 Fishers Lane
Rockville, MD 20857
www.ahrq.gov

Contract No. HHSA75Q80120D00004, Task Order 75Q80121F32004

Prepared by:
Kaiser Permanente Evidence-based Practice Center
Kaiser Permanente Center for Health Research
Portland, OR

Investigators:
Janelle M. Guirguis-Blake, MD
Leslie A. Perdue, MPH
Erin L. Coppola, MPH
Sarah I. Bean, MPH

AHRQ Publication No. 23-05309-EF-1
December 2023

This report is based on research conducted by the Kaiser Permanente Research Affiliates Evidence-based Practice Center (EPC) under contract to the Agency for Healthcare Research and Quality (AHRQ), Rockville, MD (Contract No. HHSA75Q80120D00004, Task Order 75Q80121F32004). The findings and conclusions in this document are those of the authors, who are responsible for its contents; the findings and conclusions do not necessarily represent the views of AHRQ. Therefore, no statement in this report should be construed as an official position of AHRQ or of the U.S. Department of Health and Human Services.

The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of health care services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information (i.e., in the context of available resources and circumstances presented by individual patients).

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Acknowledgments

The authors gratefully acknowledge the following individuals for their contributions to this project: Howard Tracer, MD, at the Agency for Healthcare Research and Quality; current and former members of the U.S. Preventive Services Task Force who contributed to topic deliberations; National Institute on Aging, National Institute on Minority Health and Health Disparities, National Institute of Child Health and Human Development, and the Office of Research on Women’s Heath for providing federal partner review of the draft report; David Ganz, MD, PhD, Manuel Montero-Odasso, MD, PhD, AGSF, FGSA, FRCPC, and Elizabeth Phelan, MD, MS, who provided expert review of the draft report; Melinda Davies, MAIS, and Jill Pope, BS, for technical and editorial assistance at the Center for Health Research.

Structured Abstract

Background: Falls are the leading cause of injury-related morbidity and mortality among older adults in the United States.

Purpose: To systematically review evidence on the effectiveness of interventions to prevent falls in community-dwelling older adults.

Data Sources: We searched MEDLINE, Cumulative Index for Nursing and Allied Health Literature, and Cochrane Central Register of Controlled Clinical Trials for relevant English-language literature published between January 1, 2016, and May 8, 2023. Additionally, we re-evaluated all studies included in the 2018 review. We supplemented our searches with suggestions from experts and articles identified through news and table-of-contents alerts. We conducted ongoing surveillance through July 21, 2023 to identify any major studies published in the interim.

Study Selection: Two investigators independently reviewed identified abstracts and full text articles against a set of a priori inclusion and quality criteria.

Data Analysis: One investigator abstracted data into an evidence table and a second investigator checked these data. When we had an adequate number of studies, we conducted random effects meta-analyses with a Knapp-Hartung adjustment to estimate the effect of fall prevention interventions on falls, falls-related morbidity, and all-cause mortality.

Results: We included 83 fair- to good-quality randomized controlled trials (RCTs) (n=48,839) examining the effectiveness of fall prevention interventions in older adults. Most of the included studies examined the effectiveness of multifactorial (k=28, n=27,784) and exercise (k=37, n=16,117) interventions. The remaining studies examined environment (k=6, n=4,162), exercise plus environment (k=3, n=935), exercise plus education (k=4, n=1,047), medication review/modification (k=4, n=1,052), psychological (k=3, n=9279), and education interventions (k=1, n=310). Based on a pooled analysis of 20 trials, multifactorial interventions were associated with a statistically significant reduction in the number of falls (IRR, 0.84 [95% CI, 0.74 to 0.95]; I^2=85.0%), but not a statistically significant reduction in the number of people with a fall (RR, 0.96 [95% CI, 0.91 to 1.02]; I^2=48.2%; k=26). Multifactorial interventions also showed no statistically significant association with the number of falls resulting in injury and the people with a fall resulting in injury. Exercise interventions were associated with statistically significant reductions in the number of falls (IRR, 0.85 [95% CI, 0.75 to 0.96]; I^2=82.7%), the number of people with a fall (RR, 0.92 [95% CI, 0.87 to 0.98]; I^2=24.3%), the number of falls resulting in injury (IRR, 0.84 [95% CI, 0.74 to 0.95]; I^2=14.6%), but not the number of people with a fall resulting in injury (RR, 0.90 [95% CI, 0.79 to 1.02]; I^2=26.7%). Environment interventions were not statistically significantly associated with the number of falls and the number of people with a fall. Results from the other interventions did not show a consistent beneficial relationship with falls or fall-related morbidity. No interventions had a statistically significant association with all-cause mortality. Harms were poorly reported, but were usually rare, minor, and associated with exercise components of the interventions.

Limitations: The precision and generalizability of the body of literature for any single intervention type is limited by the marked heterogeneity of population characteristics including baseline falls risk and wide variation in intervention protocols. No specific effective exercise or multifactorial protocol has been widely replicated in larger population trials. Limited literature exists for falls prevention interventions in those community dwelling individuals with mild dementia. There are limited trials examining multifactorial and exercise interventions' effectiveness on outcomes beyond falls and falls injuries like hospitalizations, institutionalizations and mortality or the overall effectiveness of environmental interventions, medication review, and psychological interventions.

Conclusions:
The current evidence base demonstrates that exercise is associated with fewer falls, fewer people with a fall, and a reduced number of injurious falls in average- and increased-risk community dwelling older adults. Multifactorial interventions appear to reduce falls but not people with a fall or injuries; trials are clinically and statistically heterogeneous. Other single falls prevention interventions including environmental modification, medication review/modification, education, and psychological interventions as well as falls interventions with multiple components like exercise plus education and exercise plus environment have either few trials showing no statistically significant effect or a few trials reporting inconclusive results.

Table of Contents

Figures

Tables

Appendixes

Chapter 1. Introduction

Purpose

The Agency for Healthcare Research and Quality (AHRQ) has requested an updated evidence report on interventions to prevent falls in older adults. This report will be used by the U.S. Preventive Services Task Force (USPSTF) to update its 2018 recommendation.[1]

Prevalence and Burden

People aged 65 years and older constitute the fastest-growing segment of the U.S. population. The U.S. Census Bureau projects that the number of people aged 65 years and older will be 95 million in 2060, almost double the estimated population of 49 million in 2016.[2] The number of people aged 85 years old and older is expected to increase from 6.5 million in 2016 to 11.8 million in 2035, and nearly triple to 19 million by 2060.[2]

Falls—unexpected events in which a person comes to rest on the ground, floor, or lower level—are the leading cause of injury-related morbidity and mortality among older adults in the U.S. In 2018, 27.5 percent of community-dwelling people aged 65 years or older reported at least one fall in the past year (714 falls per 1,000 older adults) and 10.2 percent reported a fall-related injury (170 fall-related injuries per 1,000 older adults).[3] The Centers for Disease Control and Prevention (CDC) estimates that, in 2018, there were 3 million emergency department (ED) visits and 950,000 hospitalizations or transfers to another facility due to falls. Further, between 1999 and 2020, 478,214 deaths from falls occurred among adults aged 65 years or older, increasing from 10,097 in 1999 to 36,508 in 2020.[4] The risk of falling or experiencing a fall-related injury increases with age. In 2018, 25.9 percent of older adults aged 65 to 74 years old reported falling and 9.3 percent reported fall-related injuries. Among adults aged 85 years or older, 33.8 percent reported falling and 13.9 percent reported fall-related injuries.[3] Since 2001, the age-adjusted fall-related death rate has been steadily increasing for older adults, increasing by 41 percent in the most recent 10 years (55.3/100,000 in 2012 to 78.0/100,000 in 2021). Most fall-related deaths occur in those aged 85 years or older—this group also has the fastest growing death rate (**Figure 1**).[5]

Disparities in falls exist by sex, race, and ethnicity (terminology used for race and ethnicity in this report described in the **Methods** chapter), and geographic location. Women are more likely to experience nonfatal falls and fall-related injuries than men (29.1% of women versus 25.5% of men report a fall; 11.9% of women versus 7.9% men experience a fall-related injury).[3] However, after adjustment for age, men have a higher rate of fall-related deaths than women (73.2 per 100,000 men versus 54 per 100,000 women).[6] In 2018, American Indian/Alaska Native older adults reported more falls (32.2%) compared to White (28.3%), Black (22.5%), Hispanic/Latino (28.1%), Asian/Pacific Islander (15.6%), and multiracial or other race (29.6%) older adults. In addition, American Indian/Alaska Native older adults aged 65 years or older had a higher percentage of fall-related injuries (15.2%) compared to White older adults aged 65 years or older (10.2%).[3] Some hypotheses to explain these racial differences have been postulated related to cultural differences, home support, and engagement in outdoor activity.[3] In the same year, older adults living in rural areas reported a higher percentage of falls compared to those living in urban areas (29.5% versus 27.0%, respectively). However, when stratified by age group, this was only true for persons aged 65 to 74 years.[3]

Falls predict quality of life, disability, admission to long-term care facilities, and death. Between 20 and 30 percent of those who fall incur moderate to severe injuries, such as fractures, lacerations, and head trauma (including traumatic brain injury), that result in decreased mobility and potentially reduced independence.[7] In a 2017 analysis[8] conducted in the United Kingdom of 6,800 non-spinal fractures, the most common fall-related fractures among adults aged 60 to 90 years or older included the upper arm, forearm, hip, and ankle. Among the very elderly (i.e., 90 years or older), 50 percent of fall-related fractures occurred in the hip.[8] For people who are admitted to a hospital after a fall, the length of stay is longer and referral to long-term care facilities is significantly higher among older adults aged 65 years or older than younger people. Moreover, older adults aged 65 years or older with hip fractures are three to four times more likely to die within one year after surgery than the general population.[9, 10] Between 25 and 75 percent of older adults aged 65 years or older who lived independently before their hip fracture do not recover their pre-injury functional status.[11, 12]

Falls represent a significant economic burden on the U.S. health care system. A 2018 analysis[13] estimated that the combined medical costs of fatal and nonfatal falls in 2015 was approximately $50 billion. Overall medical spending for fatal falls was estimated to be $754 million, and more than $49.5 billion for medically treated, nonfatal fall-related injuries.[13] In 2017, an average of $9,389 was spent per fall for fall-related injuries among U.S. Medicare beneficiaries.[14]

Etiology and Natural History

Falls are caused by complex interactions among multiple risk factors, including long-term or short-term predisposing factors. Interactions between these factors may be modified by age, disease, and environment. A single fall may have multiple causes or contributors, and repeated falls are typically due to multiple (intrisic and extrinsic) contributors.

Risk Factors

Risk factors for falls can be classified as intrinsic (within an individual) or extrinsic (external to an individual). Intrinsic (i.e., patient-related) risk factors include age, cognitive, and sensory deficits; gait, strength, and balance deficits; acute and chronic conditions; and behaviors. Extrinsic factors include environmental hazards or hazardous activities, medications, footwear, assistive devices, home or neighborhood features, alcohol and drugs, and physical support provided by caregivers. Certain risk factors may be modifiable through interventions: gait, strength, balance, and sensory deficits; behaviors; medications; footwear; assistive devices; home environment; alcohol or drug use; and physical support provided by caregivers.

A person's functional capacity may decrease with aging because of physical and cognitive alterations that lead to impairments in balance, gait, and strength. A 2021 systematic review and meta-analysis[15] of 22 studies concluded that older adults with markers of frailty in balance and mobility were associated with a 33 percent increased risk of recurrent falls (95 % CI:1.11, 1.60;

$p = 0.007$). In addition to balance and mobility, medication (RR:1.53; 95 % CI: 1.11, 2.10), psychological (RR:1.35; 95 % CI: 1.03, 1.78), and sensory and neuromuscular (RR:1.51; 95 % CI: 1.18, 1.92) risk factor domains were the greatest predictors of recurrent falls.[15]

As people age, they may also develop more than one risk factor. Appreciating the interaction and probable synergism among multiple risk factors is important in making a clinical assessment. The risk for injuries that results from falling increases dramatically as the number of risk factors increases.

Fall Risk Screening Tools Feasible for Primary Care

Fall risk screening tools and fall risk assessment tools are important in identifying older adults at risk of falling and implementing appropriate interventions to prevent falls. Fall risk screening tools are standardized tools that are designed to quickly identify individuals at risk of falling and may be used to identify individuals who may benefit from a comprehensive fall risk assessment, which may include a one- to three-item fall-risk questionnaire (e.g., history of falls, feeling unsteady, and/or worry about falling or balance) to discriminate those at increased risk for falls from those at average risk. Older adults with positive screening questionnaires may or may not then complete a brief physical function assessment of strength, gait, and balance prior to referral to a single fall-prevention intervention or multiple interventions, as needed. Alternatively, both a questionnaire and an assessment of physical function could be administered to all older adults; results indicating a high risk of falls would trigger interventions aimed at reducing this risk. Again, these risk reduction interventions may include immediate advice and referrals or may involve an in-depth multifactorial risk assessment with subsequent individualized advice and referrals.

Several fall risk screening tools are available for use in primary care settings (**Table 1**). Risk tools that are feasible for primary care need to account for time, space, and personnel limitations. Ideally, fall risk tools would take less than 5 minutes to complete with no requirement for expensive equipment, much space beyond a clinic room or hallway, or additional training for implementation. Physical function tests feasible for use in primary care focus on assessing lower extremity strength, endurance, balance, and/or mobility. These tests vary in their ability to predict future falls, and many were originally intended for research purposes rather than primary care practice.

A 2021 systematic review (k=27, N=8,660)[16] examined the performance of fall risk screening tools for predicting falls in community-dwelling adults. Seven primary care feasible tools with performance outcomes were identified: Timed Up and Go (TUG) test, Gait Speed test, Berg Balance Scale, Performance Oriented Mobility Assessment-Balance (POMA-B), Performance Oriented Mobility Assessment-Gait (POMA-G), Functional Reach test, and falls history. Most of the identified studies captured falls risk among older adults over a period of 12 months (mean duration of followup = 15 months; range of followup = 6 months to 9 years). Results showed that none of the tools performed adequately; however, falls history performed equally to or better than any other tool. (**Table 1**) The reported area under the curve (AUC) for all tools included prospective falls ascertainment 6 months to 108 months after the tool's administration. The AUCs typically ranged from 0.5 to 0.7 and were considered inadequate for discrimination.[16]

More specifically, for the TUG, which provides a quick assessment of an individual's strength, mobility capacity and dynamic balance, 12 studies (N=5,240) reported an AUC that ranged from 0.46 to 0.89; sensitivity and specificity (k=8, N=1,433) ranged from 10 percent to 83.3 percent and 28.4 percent to 96.6 percent, respectively. For the Gait Speed Test, which measures the time it takes an individual to walk a set distance at their usual pace, one study (N=541) reported AUCs ranging from 0.54 to 0.68 for various followup periods; sensitivity and specificity (k=2, N=118) ranged from 38.4 percent to 100 percent and 23.9 to 84.7 percent, respectively. For the Berg Balance Scale, which provides a standardized assessment of balance, one study (N=187) reported an AUC of 0.59 while another study (N=98) reported an AUC of 0.47; sensitivity and specificity were reported in two studies (N=312) at various cut-off scores and varied widely. For the Tinetti POMA-B, which measures nine different movements to assess balance, four studies (N=442) reported sensitivities of 7.6 percent to 64 percent and specificities of 66.1 percent to 91 percent for cut-offs ranging from $\leq$8 to $\leq$10. For the Tinetti POMA-G, which measures six different movements to assess gait, two studies (N=252) reported sensitivities of 21 percent and 64 percent and specificities of 62.5 percent and 95 percent for cut-off score of 9. For the Functional Reach test, which assesses balance and mobility, two studies (N=1,544) reported AUCs of 0.509 and 0.60; one study (N=50) reported a sensitivity of 73 percent and a specificity of 88 percent. For falls history, which assesses fall risk by asking older adults if they had fallen in the previous year, two studies (N=811) reported AUCs of 0.64 and 0.71; sensitivity and specificity were reported in three studies (N=1,411) and ranged from 39 percent to 69 percent and 63 percent to 82 percent, respectively. The lack of conclusive evidence to identify falls risk assessment tools with adequate predictive performance and accuracy are consistent with other systematic reviews.[16-18] Additional attempts to examine other screening tools or develop new risk screening tools have had similar results.[19, 20] One large trial that included a mailed questionnaire including history and number of falls in the past 12 months, problems with balance while walking, and difficulty with ADLs reported an AUC of 0.66 (95% CI, 0.64 to 0.68) for a single falls, 0.72 (95% CI, 0.69 to 0.74) for repeat falls, and 0.60 (95% CI, 0.55 to 0.64) for fracture.[21] Researchers have argued that future studies should focus on the effectiveness of fall risk assessment tools in the reduction of falls and injuries using a randomized trial design rather than on prognostic accuracy.[19]

While current literature shows that all prognostic tools have inadequate discrimination, some experts have recommended an expert-guided approach to risk assessment.[22] However, research is limited. For example, the CDC's Stopping Elderly Accidents, Deaths, and Injuries (STEADI) initiative provides healthcare professionals with a standardized falls risk screening protocol (i.e., a 12-question screening tool and comprehensive fall risk assessment) and a comprehensive list of recommended interventions based on individualized risk factors. A 2022 systematic review[23] synthesized findings from three prospective studies (N=4,025) on the STEADI in predicting falls in the next 6 to 12 months. The three identified studies were small and only one study (N=77) reported the sensitivity and specificity for predicting falls in the next 6 months (68.4% and 44.9%, respectively).[23] An additional small study (N=95) reported AUCs of 0.87 to 0.91 when only two to three questions from the STEADI tool were administered.[24] While results showed fair predictive ability, large-scale studies are needed to further examine the effectiveness of the STEADI in clinical settings.

Treatment Approaches

Interventions to prevent falls in older adults are varied and complex, with multiple components involving multidisciplinary teams in different implementation settings. Interventions can be delivered alone, in combination, or as part of an individualized multifactorial assessment and intervention. Depending on the risk factors identified, patients may need to receive interventions for multiple risk factors, and this is often referred to as a multifactorial assessment and intervention. Interventions to reduce falls may include exercise (including physical therapy), reduction or alteration of medications to reduce fall risk, occupational therapy to assist with identifying home hazards, referrals to specialists for visual impairment or podiatric issues, and treatment of comorbidities, including conditions like osteoporosis which increases fracture risk after falls.[25]

Current Clinical Practice in the United States and Recent Recommendations

There are many reported barriers to implementation of fall-prevention interventions in current U.S. clinical practice, including competing demands, clinician education, and logistical issues (limitations in patient transportation, mobility). Furthermore, fewer than half of patients who experience a fall mention it to their doctor.[26] A 2018 survey of primary care providers found that 87 percent believed fall risk assessments could be effective in reducing fall risk among their older patients; ninety-six percent believed that older adults should be assessed for fall risk. However, only 52 percent of providers felt they had the expertise to conduct risk assessment for falls.[27]

After an initial risk assessment in the context of a primary care visit or an annual prevention or wellness visit, primary care clinicians may elect to refer all patients identified as being at high risk of falls to individual or multiple services for further risk assessment and tailored intervention or interventions (e.g., home health, physical therapy, occupational therapy). Alternatively, where available, clinicians can refer a patient at high risk of falls to a “falls clinic.” These clinics are not widely available in the United States and vary substantially in personnel staffing, content of the visit, and duration of the intervention. A falls clinic may have a single or multiple specialties staffed by advanced registered-nurse practitioners, physical therapists, occupational therapists, and/or a variety of physician specialists (e.g., geriatrician, physical medicine and rehabilitation physician, ophthalmologist, otolaryngologist, neurologist, orthopedist). The clinic can provide multicomponent risk assessments in a patient encounter lasting between 30 minutes to 3 hours and generate tailored referrals. It may also provide ongoing interventions to prevent falls.

The Centers for Medicare and Medicaid Services (CMS) sponsors the Initial Preventive Physical Examination (IPPE, known as the “Welcome to Medicare Preventive Visit”), a one-time benefit for all new Medicare beneficiaries within the first 12 months of their first Medicare Part B coverage period, along with the Annual Wellness Visit. As part of these visits, health care providers collect the plan member’s medical history, including risk factors for depression and other mood disorders, and review the beneficiary’s functional ability and level of safety. Appropriate screening questions and standardized questionnaires are used to review functional elements, including the risk of falls, hearing impairment, activities of daily living, and home safety.

To help incentivize primary care physicians to perform fall-risk assessment and intervention, CMS also provides a five-star quality rating to insurance plans that measure the percentage of plan members with a risk of falling who discussed this risk with their physicians and received a fall-prevention intervention.[28, 29] Despite efforts, implementation and utilization of annual wellness visits are suboptimal. A 2018 analysis[30] of Medicare claims data from 2008 to 2015 concluded that roughly half of primary care practices offer annual wellness visits and less than 20 percent of eligible Medicare beneficiaries receive them. Results also highlighted disparities among demographic and geographic characteristics. For example, annual wellness visit rates in rural practices were lower compared to metropolitan practices (8.1% versus 24.4%, respectively). Further, Black, Asian, "Hispanic," "North American Native" or other race individuals, patients with dual enrollment in Medicare and Medicaid, and patients with higher medical risk were less likely to receive an annual wellness visit compared to other patients (i.e., White individuals, low medical risk) in the same practice.

Health care providers can also use the CDC Stopping Elderly Accidents, Deaths, and Injuries (STEADI) toolkit, which was designed to help providers incorporate fall risk assessments and individualized fall interventions into current clinical practice.[31] The Royal Australian College of General Practitioners recommends assessment of risk for falls in older adults and, if indicated, a complete physical examination, medical history, and cognitive and functional assessments. Recommended first-line interventions include: exercise programs, medication review, and other multicomponent lifestyle modifications.[32] The U.S. Department of Health and Human Services' activity guidelines recommend that older adults get at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic physical activity per week, as well as muscle-strengthening activities twice per week.[33] Balance training three or more days per week for older adults at risk of falls due to a recent fall or difficulty walking is also recommended.[33] The National Institute on Aging outlines several interventions for falls: exercise for strength and balance, monitoring for environmental hazards, regular medical care to ensure optimized hearing and vision, and medication management.[34]

Recommendations from other professional societies or organizations are listed in **Table 2**. While all endorse interventions to prevent falls among older adults, the recommended interventions vary.

Previous USPSTF Recommendation

- The USPSTF recommends exercise interventions to prevent falls in community-dwelling adults 65 years or older who are at increased risk for falls (**B recommendation**).
- The USPSTF recommends that clinicians selectively offer multifactorial interventions to prevent falls to community-dwelling adults 65 years or older who are at increased risk for falls. Existing evidence indicates that the overall net benefit of routinely offering multifactorial interventions to prevent falls is small. When determining whether this service is appropriate for an individual, patients and clinicians should consider the balance of benefits and harms based on the circumstances of prior falls, presence of

comorbid medical conditions, and the patient's values and preferences. (**C recommendation**).

- The USPSTF recommends against vitamin D supplementation to prevent falls in community-dwelling adults 65 years or older (**D recommendation**).

Chapter 2. Methods

Scope and Purpose

This current review is an update of the 2018 review[35, 36] that supported the 2018 USPSTF recommendation[1] to prevent falls among older adults. The USPSTF will use this report to update its recommendation. While no substantive changes were made to the key questions (KQs) and analytic framework, compared to the 2018 review, this update excludes interventions of vitamin D supplementation and allows for the inclusion of participants with mild dementia, osteoporosis, osteoarthritis, and sarcopenia.

Key Questions and Analytic Framework

With input from the USPSTF, we developed an Analytic Framework (**Figure 2**) and two KQs to guide the literature search, data abstraction, and data synthesis.

Key Questions

1. Do interventions to prevent falls in unselected- or increased-risk community-dwelling older adults reduce falls, falls-related morbidity, or mortality?
    a. How is "increased risk" defined in the included trials?
2. Do interventions to prevent falls in unselected- or increased-risk community dwelling older adults result in any adverse effects?

Data Sources and Searches

In addition to re-evaluating all studies included in the 2018 review,[35, 36] we searched the following databases for relevant English-language literature published between January 1, 2016, and May 8, 2023: MEDLINE, Cumulative Index for Nursing and Allied Health Literature, and Cochrane Central Register of Controlled Clinical Trials. A research librarian developed and executed the search, which was peer reviewed by a second research librarian (**Appendix A**). We supplemented our searches with suggestions from experts and articles identified through news and table-of-contents alerts. We also searched ClinicalTrials.gov for ongoing trials and have conducted ongoing surveillance for relevant literature for all bodies of evidence through July 21, 2023. We imported the literature from these sources directly into EndNote® X9 (Thomson Reuters, New York, NY).

Study Selection

We developed specific criteria to guide our study selection (**Appendix A Table 1**). Two independent reviewers independently screened all records in the updated searches based on the titles and abstracts, using the inclusion and exclusion criteria as a guide. Subsequently, at least two reviewers assessed the full text of potentially relevant studies, including all the previously included studies. Disagreements were resolved through discussion and consensus. We kept detailed records of all included and excluded studies, including the reason for exclusion.

Population

We included trials of community-dwelling older adults aged 65 years or older. Participants could be unselected for their risk of falling or selected due to their increased risk of falling. We excluded trials recruiting populations living in specialized settings, such as people living in long-term care facilities. We further excluded older adults with moderate to severe dementia (or major neurocognitive disorder) but did include trials recruiting those with mild dementia or mild cognitive impairment. If we were unable to determine the severity of cognitive impairment among participants, the study was excluded. We also included trials that recruited participants with osteopenia/osteoporosis, osteoarthritis, or sarcopenia.

Interventions and Comparators

We included interventions that were feasible to conduct in or refer from primary care. Specifically, we included the following categories of interventions, delivered alone or in combination:

- Multifactorial assessment and intervention (hereafter referred to as multifactorial intervention)
- Exercise (supervised or unsupervised, individual or group)
- Environmental assessment/modification
- Medication review/modification
- Psychological (individual or group)
- Education

We excluded interventions in social marketing and policy (out of scope for the USPSTF); surgery (e.g., cataract extraction, pacemaker placement, podiatry surgery) fluid or nutrition therapy, management of urinary incontinence, and assistive technology (these interventions are performed as treatment of medical conditions); and vitamin D or other supplements (vitamin D has been included in another USPSTF evidence review[37]). We also excluded interventions that are considered disease management, such as osteoporosis pharmacotherapy, joint replacement, and cognitive function interventions. Trials of multifactorial interventions that incorporated any of the excluded intervention categories as one part of their assessment, referral, or treatment components were included; trials of multiple interventions (where all participants received all interventions) where an excluded intervention was a major category of intervention were excluded.

We captured the components of exercise interventions according to taxonomy developed by ProFaNE.[38] These categories included: gait, balance, and functional training; strength/resistance; flexibility; 3D (e.g., Tai Chi or dance); general physical activity; and endurance.

We required a minimal control or usual care comparison group. Any study with an active comparison group or a relatively intense comparison group was excluded.

Outcomes

Trials were required to report at least one fall or a fall-related injury outcome. We abstracted the following outcomes: falls, people with a fall, mortality, fall-related injuries (mild injuries, serious injuries, injuries resulting in medical care), people with fall-related injuries (people with mild injuries, serious injuries, or injuries resulting in medical care), hospitalizations or ED visits (falls-related hospitalizations/ED visits were preferentially abstracted when available otherwise all hospitalizations/ED visits were abstracted), people with hospitalizations or ED visits, fractures, people with fractures, institutionalizations, people institutionalized, instrumental activities of daily living, quality of life, and any harms outcomes as reported in the trials. We did not include basic activities of daily living as community-dwelling older adults are typically still functional in their basic activities of daily living and we would not expect to see an improvement in this outcome over a relatively short intervention duration.

We allowed any instrument measuring IADL. For QOL, we required overall or component scores (e.g., SF-36 mental component score). Falls and fall injuries could be measured using a falls diary, recall under 6 months, or via the use of administrative records. We required a minimum followup of 6 months. All outcomes had to capture the outcome starting at baseline; we excluded trials that reported only a segment of followup (e.g., only 12 to 24 months post-baseline).

Study Design

We included randomized controlled trials (RCTs) and cluster RCTs. All intervention harms were restricted to trials included for KQ1. Trials were required to have a primary or secondary aim of preventing falls or an aim related to fall prevention (e.g., fear of falling) and falls measured as a primary or secondary outcome.

Quality Assessment

We quality rated all studies for potential risks of bias that may impact the reported effects and assigned each study a quality rating of “good,” “fair,” or “poor.” We applied signaling questions from the Cochrane Risk of Bias (RoB 2)[39] tool along with the USPSTF-design specific criteria. **Appendix A Table 2** lists the criteria applied. We quality rated the trials with a focus on the falls outcomes (**Appendix A Figures 1–3**) and because the preferred measurement method is to use self-reported falls diaries, blinding of the outcome assessor was not possible. Therefore, we did not use that signaling question. For new evidence, two independent reviewers rated each study. For the previously included studies. one investigator reviewed the previous risk of bias assessments and assigned domain ratings to those studies. If needed, domains were reassessed. Discordant quality ratings were reviewed and discussed; a third reviewer adjudicated as needed.

Good-quality studies were those that met nearly all specified quality criteria. We rated a study as good quality if comparable groups were assembled initially and maintained throughout the study, reliable and valid measurement instruments were used and applied equally to the groups, procedures for maintaining fidelity to the intervention were in place, followup was adequate (i.e.,

≥80% retention overall) and not differential between groups, data were complete, and there was no evidence of selective reporting. Fair-quality studies did not meet these criteria but did not have serious threats to their internal validity related to the design, execution, or reporting of the study.

Studies rated as poor-quality had several important risks of potential bias or one critical flaw and were excluded from this review. Potential risk of bias for intervention trials resulting in poor-quality ratings included very high risk of bias due to confounding and imbalances in baseline characteristics between groups, high or differential rates of attrition between groups, or no information on the number of participants with complete data or reasons for missing data, falls outcome ascertainment validity concerns (i.e., recall > 6 months) and evidence of possible selective reporting.

Data Abstraction

One reviewer extracted key elements for each included study into standardized abstraction forms in DistillerSR. A second reviewer checked the data for accuracy.

We abstracted general characteristics of the study (e.g., study design, country), clinical and demographic characteristics of the sample and setting (e.g., recruitment strategy and setting, age, race and ethnicity, baseline clinical characteristics), intervention details (e.g., type, provider, frequency, duration), methods to collect information on falls, and relevant outcomes. A study in which participants prospectively collected information (e.g., onto calendars, postcards, or diaries) about their falls and sent the information to the research team was referred to as “diary” collection. When multiple intervention and/or control groups were available, we abstracted the most intense and comprehensive intervention group and the control group most similar to no intervention or usual care.

Data Synthesis and Analysis

We synthesized data separately for each KQ. Many outcomes did not allow for quantitative pooling due to the limited number of contributing studies (k<5), so those data are summarized narratively. For outcomes with enough contributing studies, we ran random-effects meta-analyses with a Knapp-Hartung adjustment[40] to calculate the pooled relative risks. When available, we favored the author-reported relative risks or incidence rate ratios over those we calculated for the analysis and data tables. When authors did not report relative risks or incidence rate ratios, we calculated a crude effect estimate and this unadjusted effect is presented in figures and tables. Within each study, we selected the longest followup available for pooled analyses and figures. Data from other followup times are presented in tables. As noted above, only one intervention and one control arm for each intervention category were abstracted and included in the analysis.

We grouped our outcomes as follows: number of falls, number of falls resulting in injury or medical care (also referred to as injurious falls), number of fall-related fractures, number of hospitalizations or ED visits, people with a fall, people with a fall resulting in injury or medical care (also referred to as people with an injurious fall), people with a fracture, people with a hospitalization or ED visit, people transitioning to institutionalized care, people hospitalized, mortality, quality of life, and IADL.

All fall and fall-related injury outcomes were reported either as an incident event (where a person could contribute more than one event to the analysis, e.g., falls, fractures) or the number of persons experiencing the event (where a person could contribute only once to an analysis, regardless of the number of times the event occurred, e.g., people experiencing a fall, people experiencing an injurious fall). For injurious fall outcomes, we included minor or severe injuries resulting from a fall, falls resulting in medical care, or any fall-related outcome the author categorized as injurious. The most inclusive outcome was used in meta-analysis if multiple outcomes in that injury category were reported (e.g., fall-related injuries instead of fall-related hospital admissions). For studies that did not report a composite injury outcome, we used the most prevalent outcome (e.g., falls leading to an ED visit was selected over falls leading to hospital admission). The number of injurious falls analyzed in the forest plots included both the number of fall-related injuries and the number of falls resulting in injury as reported in the trials. For fracture outcomes, we first selected fall-related fractures, but if that outcome was not available, we included data on hip fractures and overall fractures, even if the study may not have reported if the fracture was associated with a fall.

In cases where a cluster RCT was used but the authors did not account for the nested nature of the data, we adjusted for the clustering effect by applying a design effect, which was based on an estimated average cluster size (i.e., the total number of randomized participants divided by the total number of clusters) and multiplied by an estimated intraclass correlation. We estimated the intraclass correlation to be 0.05.

We examined statistical heterogeneity among the pooled studies by applying standard χ^2 tests and estimated the proportion of total variability in point estimates by using the I^2 statistic.[41] We applied the Cochrane Collaboration's rules of thumb for interpreting heterogeneity[42]: less than 40 percent likely represents unimportant heterogeneity; 30 to 65 percent, moderate heterogeneity; 50 to 90 percent, substantial heterogeneity; and more than 75 percent, considerable heterogeneity. In addition, we generated funnel plots to evaluate small-study effects (a possible indication of publication bias) and ran the Egger test to assess the statistical significance of imbalance in study size and findings that suggest a pattern.[43]

We investigated whether the heterogeneity among the main results (the outcome of falls and the outcome of people with 1 or more fall) was associated with any prespecified population or intervention characteristics of the studies. First, we used visual displays and tables grouped or sorted by these potentially important characteristics. For visual displays that suggested a difference between groups or a pattern in sorted results, we conducted meta regression. Specifically, we examined the publication year, study quality, recruitment setting, duration of followup, mean age, percentage female, recruitment for increased fall risk, and fall rate or the percent falling in the control group as they related to the effect estimates. For exercise interventions, we also examined the presence of a behavior change component, presence of cognitive task exercises, individual exercise components (e.g., balance, flexibility, strength), and format (group, individual, or both). We used Stata version 13.1 (Stata Corp LP, College Station, TX) for all quantitative analyses. All significance testing was two-sided. Results were considered statistically significant if the p-value was 0.05 or less.

Grading the Strength of the Body of Evidence

We graded the strength of the overall body of evidence for each KQ to reflect our confidence in the findings. We adapted the Evidence-based Practice Center approach,[44] which is based on a system developed by the Grading of Recommendations Assessment, Development, and Evaluation Working Group.[45] Our method explicitly addresses four of the five Evidence-based Practice Center-required domains: consistency (similarity of effect direction and size), precision (degree of certainty around an estimate), reporting bias, and study limitations. We did not address the fifth required domain—directness—as it is implied in the structure of the KQs (i.e., whether the evidence links the interventions directly to a health outcome).

Consistency was rated as consistent, inconsistent, or not applicable (e.g., single study). Precision was rated as precise, imprecise, or not applicable (e.g., no evidence). The body of evidence limitations field highlights important restrictions in answering the overall KQ (e.g., suspected reporting bias, lack of replication of interventions, nonreporting of outcomes).

We graded the overall strength of evidence as high, moderate, low, or insufficient.[44] These grades reflect our level of confidence in the estimate of effect (direction and magnitude) for benefit or harm – equating to our judgement as to how much the evidence reflects a true effect and our assessment of the level of deficiencies in the body of evidence and our belief in the stability of the findings. The strength of evidence grade does not reflect the actual magnitude of the effect (e.g., a "small" effect, "low" sensitivity).

"High" indicates high confidence that the evidence reflects the true effect, and that further research is very unlikely to change our confidence in the estimate of effect. "Moderate" suggests moderate confidence that the evidence reflects the true effect, and that further research may change our confidence in the estimate of effect and may change the estimate. "Low" indicates low confidence that the evidence reflects the true effect, and that further research is likely to change our confidence in the estimate of effect and is likely to change the estimate. A grade of "insufficient" indicates that evidence is either unavailable or does not permit estimate of an effect. We developed our overall strength of evidence grade based on consensus discussion involving at least two reviewers.

Race and/or Ethnicity Terminology

For consistency, in this report we use the following default terminology:

1. Black and White (in capitals) as descriptors for populations rather than nouns
2. Black persons as opposed to African Americans
3. Hispanic/Latino persons as opposed to Hispanic, Latine or Latinx persons

We realize there are no perfect or universally preferred terms for many of these categorizations and concepts; however, we have tried to stay away from terms that are inaccurate or perceived as marginalizing. In select instances, when using nonpreferred terms referenced by the source material, we note this using quotation marks (e.g., “diverse populations”).

Contextual Questions

In addition to the systematically reviewed questions (KQs 1 and 2), we also addressed a contextual question to aid with the broader interpretation of the evidence. Contextual questions are important considerations that may not be readily answerable from the KQ evidence or RCT literature. One CQ was prespecified in our Research Plan:

1. What is the prognostic accuracy of falls risk assessment tools that are feasible for administration in primary care?

The CQ was not systematically reviewed. Evidence for the CQ was identified based on literature retrieved for the systematic search for KQs as well as targeted searches and scanning bibliographies of relevant articles. A best evidence approach was used to identify the most recent, applicable, and robust evidence. The CQ is addressed in the Introduction and in **Table 1**.

Expert Review and Public Comment

The draft Research Plan was posted from April 21 to May 19, 2022. In response to public comment, fall prevention trials recruiting older adults with osteopenia/osteoporosis, osteoarthritis, and sarcopenia were included. The population designation “average-risk” was also replaced with “unselected-risk.” The intervention name “medication management” was also changed to “medication modification/review” to better reflect our intended inclusion criteria.

USPSTF and AHRQ Involvement

We worked with USPSTF members at key points throughout this review, particularly when determining the scope and methods and developing the Analytic Framework and KQs. The USPSTF members approved the final Analytic Framework, KQs, and inclusion and exclusion criteria after revisions reflecting the public comment period. AHRQ staff provided oversight for the project, coordinated systematic review, reviewed the draft report, and assisted in an external review of the draft evidence synthesis.

Chapter 3. Results

KQ 1. Do Interventions to Prevent Falls in Unselected or Increased-Risk Community-Dwelling Older Adults Reduce Falls, Falls-Related Morbidity, or Mortality?

KQ1a. How Is "Increased Risk" Defined in the Included Trials?

KQ 2. Do Interventions to Prevent Falls in Unselected or Increased-Risk Community Dwelling Older Adults Result in Any Adverse Effects?

We reviewed 5,142 abstracts and 403 full text articles for KQ 1 and KQ 2 (**Appendix B Figure 1**). Overall, we included 83 trials (reported in 145 publications); 32 were newly identified trials and 51 were carried forward from the previous review. Lists of included and excluded studies (with the reasons for exclusion) are available in **Appendix C** and **Appendix D**, respectively.

Most of our included studies investigated the effectiveness of multifactorial (k=28) and exercise (k=37) interventions. The remaining studies examined interventions including exercise with the addition of an education component (k=4), exercise with the addition of an environment assessment (k=3), environment assessments with or without modifications (k=6), medication review with or without modification (k=4), psychological interventions (k=3), and education interventions (k=1). An evidence map with total number of studies by intervention group is shown in **Figures 3 and 4**.

The most robust results with consistent associations across falls-related outcomes were found for exercise interventions, with statistically significant effects favoring the intervention for the number of falls, the number of falls resulting in injury or medical care, and persons with 1 or more falls. For multifactorial interventions, only the number of falls was statistically significantly reduced for the intervention group when compared with the control group. The findings from the remaining interventions did not demonstrate a consistent relationship with falls, falls-related morbidity, or mortality—the small number of studies per intervention grouping often precluded any meta-analyses. Harms for all intervention types were scantly reported but generally mild in severity and associated with any exercise components of interventions.

Multifactorial Interventions

Summary of Results

We identified 28 trials (n=27,784) of multifactorial interventions to prevent falls in community-dwelling older adults (**Figure 5**). Each trial examined direct interventions and referrals customized to participants based on an initial risk assessment, although the specific assessment and intervention components varied. Most of the trials recruited participants determined to be at high risk for falls; history of falls was the most common risk factor used for trial recruitment. Pooled results from 20 trials (n=22,115) demonstrated that multifactorial interventions were associated with a lower risk of falling at the longest followup (6–28 months) with substantial heterogeneity in the effect size (IRR, 0.84 [95% CI, 0.74 to 0.95]; I^2=85.0%). However, pooled results from 26 trials (n=23,626) demonstrated no association of multifactorial interventions with the risk of people experiencing a fall at the longest followup (6–28 months) (RR, 0.96 [95% CI, 0.91 to 1.02]; I^2=48.2%). Multifactorial interventions were not associated with mortality at longest followup (6 to 42 months) in the multifactorial group compared to the control group (k=24; n=21,596; RR, 1.01 [95% CI, 0.88 to 1.17]; I^2=0%). Qualitative analyses demonstrated multifactorial interventions were not associated with a change in hospitalization, institutionalization, IADL, or QOL, but these outcomes are reported in just a small proportion of studies. There is sparse evidence on the harms of multifactorial interventions, and when reported, they were rare, minor, and associated with the exercise components of multifactorial interventions.

Characteristics of Included Studies

We included 28 trials (in 45 articles) of multifactorial assessments and interventions (n=27,784).[21, 46-89] Of the 28 trials, 25 were included in the previous review[52-58, 61, 62, 68-70, 72-74, 76, 77, 79, 81, 83-86, 88, 89] and three were newly identified.[46, 48, 71] One trial[90] from the previous review was excluded due to a high risk of bias for their falls ascertainment.

Study Characteristics

We identified nine good-quality[46, 48, 55, 61, 73, 74, 83, 85, 88] and 19 fair-quality[52-54, 56-58, 62, 68-72, 76, 77, 79, 81, 84] trials with a primary or secondary aim of examining the effectiveness of multifactorial interventions on falls and/or fall-related injuries (**Table 3; Appendix E Table 1**). Most of the trials were conducted outside of the United States, with only four taking place in the United States,[46, 54, 85, 89] 18 in Europe, [48, 53, 55-57, 62, 68, 70-73, 76, 77, 79, 83, 84, 86, 88] four in Australia or New Zealand,[58, 61, 74, 81] and two in Canada.[52, 69] The size of the trials (intervention plus control groups randomized for our analysis) ranged from 153[76] to 6,524[48] participants. One very large trial[48] was unusual in that the trial tested the effectiveness of screening and multifactorial assessment and intervention: all those in the intervention group received a screening assessment and only those assessed at intermediate or high risk for falls actually were assigned to receive the multifactorial assessment and interventions.

Population Characteristics

Most trials recruited participants ≥65 years[53, 56, 57, 68, 69, 71, 72, 76, 83, 84, 88, 89] or ≥70 years[46, 48, 55, 61, 77, 79, 85, 86] of age but two trials recruited participants from the oldest old age groups (≥80[70] or ≥85[62] years) (**Table 3; Appendix E Tables 1 and 2**). Mean age ranged from 72 years[52] to 85 years.[62] The proportion of women in the trials ranged from 53 percent[48] to 94 percent.[52] Race and ethnicity were rarely reported (k=5). In three trials,[46, 48, 89] 91 to 99 percent of participants were White. One trial[46] additionally reported that 5 percent of participants were Black and 8 percent were Hispanic/Latino. One trial[52] from Canada identified 6 percent of participants as being from "Aboriginal origin" and a trial[58] from New Zealand reported 3 percent of participants classified themselves as “Maori or Pacific.” Measures of socioeconomic status, such as education or income level, varied widely. Nearly all trials solely recruited older adults living in the community. Fifteen trials recruited at least some proportion of participants from clinics,[46, 48, 52, 55, 57, 58, 61, 62, 70, 71, 76, 77, 79, 83, 84, 86] and six trials exclusively recruited from the ED[53, 56, 68, 72, 81, 88]. Three U.S. trials recruited patients from health maintenance organizations or health insurance databases.[54, 85, 89] An additional trial recruited patients in Australia from health insurance member databases.[74]

Sixteen trials excluded patients with cognitive impairment or dementia; many of these trials provided different MMSE cutoff scores for inclusion.[46, 53, 56-58, 61, 68, 70, 71, 74, 76, 81, 83-85, 88] An additional eight trials excluded those who could not understand instructions or provide their own informed consent.[55, 57, 58, 70, 72, 73, 77, 79] None of the trials specifically recruited those with cognitive impairment, but one trial removed their initial exclusion of those with cognitive impairment in order to recruit enough generalizable participants,[81] and one trial allowed participants with cognitive impairment with proxy consent[46].

Seven trials recruited patients unselected for their risk of falling (with the exception of their age). Among those unselected participants reporting percent at risk, 19 to 44 percent of those recruited were at increased risk for falls.[48, 54, 62, 70, 74, 79, 89] Twenty-one trials[46, 52, 53, 55-58, 61, 68, 69, 71-73, 76, 77, 81, 83-86, 88] solely recruited patients at increased risk for falls according to various definitions (**Figure 6; Appendix E Table 2**). Nearly half of the trials (13 of 28) defined high risk as having a history of falling as the sole risk criterion.[54, 58, 69, 70, 79, 83, 84, 89] The remainder of the trials recruited participants who fulfilled one or more risk factor criteria from a list of possible risk factors. Of the trials using multiple risk factors to define fall risk, the most common risk factors included a hospitalization or ED visit,[52, 53, 56, 57, 68, 72, 73, 76, 81, 88] physical function testing,[48, 52, 55, 77, 85, 86] and a history of one or more falls.[46, 48, 55, 77, 86] Three trials explicitly required participants to have the ability to walk independently without assistance from a device.[55, 80, 81, 85]

Trials reporting some measure of ADL function generally reported fairly independent ADLs,[54, 57, 62] although there were a few exceptions, such as the trial by Moller et al.,[76] which required participants to need assistance with at least two ADLs, and the trial by Russell et al.,[81] in which a third of participants needed some assistance with ADLs. Sixteen trials reported a measure of medication use; mean number of medications ranged from 5.0 to 15.5 and the proportion of people taking more than 4 medications ranged from 41 to 65 percent. Seven trials[46, 57, 58, 61, 68, 77, 81] reported mean number of medical comorbidities ranging from 1[57] to 7.[61] One trial specifically recruited a high proportion of individuals with stroke (15%) and Parkinson’s Disease (19%).[71]

Intervention Details

The 28 multifactorial trial publications described a heterogeneous group of complex assessment and intervention components (**Figures 7–9; Appendix E Table 3**). All trials administered an initial assessment which included several components such as medical history, medication review, clinical and laboratory tests, and patient questioning to assess and plan for fall risk mitigation (**Figure 7**). Most trials (24 of 28) provided outside referrals (**Figure 8**) and administered some research team-delivered intervention components (**Figure 9**). The referrals and study-delivered treatment interventions were largely individualized and based on the risk factors identified in the initial assessment. They generally targeted multiple intervention components, such as exercise (unsupervised or supervised, group or individual), psychological (cognitive behavioral therapy), nutrition therapy, education (e.g., via DVDs, lectures, pamphlets), medication management, urinary incontinence management, environment (e.g., assistive technology or dwelling recommendations), and referral to physical or occupational therapy, social or community services, and specialists (e.g., ophthalmologist, neurologist, cardiologist). Nineteen trials included one or more home visits for the initial assessment, environment interventions, and/or physical therapy/exercises.[52-54, 56, 58, 61, 68-73, 76, 77, 79, 81, 83, 85, 86] The vast majority of interventions in the trials, however, occurred in the outpatient setting. All interventions were in-person with some trials additionally including some telephone coaching.[46, 54, 70, 76, 89]

Initial assessment. All 28 trials administered an initial assessment of modifiable fall risk factors in order to customize the intervention for each participant (**Figure 7; Appendix E Table 3**). This initial assessment could include a multidisciplinary comprehensive geriatric assessment or an assessment of falls risk factors with any number of the following assessment components: balance, gait, vision, cardiovascular health (e.g., postural blood pressure or pulse, carotid sinus stimulation), medication, environment/home hazard), cognition, and psychological health. The vast majority of the trials' initial assessments included an environmental assessment, functional assessment, medication review, and vision screening. The other assessment components varied. All trials assessed falls risk factors, most (k=24) including functional assessments(s) (i.e., TUG, SPPB)[46, 48, 52-58, 61, 62, 68-72, 74, 76, 77, 83-86, 88], an environmental assessment (k=24)[46, 48, 52-58, 61, 62, 68, 69, 71-73, 76, 77, 79, 83-86, 89], or a medication review (k=22)[46, 48, 52-57, 61, 62, 68, 71-73, 76, 77, 83-86, 88, 89], but only three trials[71, 74, 81] administered a validated/formal falls risk assessment tool (FROP-Com, BPP). Of the 24 trials that provided an environmental assessment, 17 were conducted in participants' homes.[52-54, 56, 58, 61, 68, 69, 71-73, 76, 77, 79, 83, 85, 86] Twenty trials assessed participants vision[46, 48, 53, 56-58, 62, 68-72, 74, 77, 81, 83-85, 88, 89], eleven trials assessed cognitive function[53, 58, 62, 68, 70-72, 77, 84, 86, 88]; nine trials assessed medical diagnoses[55-58, 61, 68, 70, 85, 88]; nine trials assessed mental health[53, 61, 68, 70, 77, 81, 83, 85, 88]; nine trials assessed orthostatic blood pressure[46, 48, 52, 55-57, 69, 81, 84]; eight trials assessed cardiovascular health[56, 58, 68, 71, 72, 77, 84, 88]; six trials assessed hearing[62, 68, 70, 72, 85, 89]; six trials assessed ADLs[52, 53, 62, 77, 85, 86]; five trials assessed foot health[46, 48, 71, 72, 84]; and three trials administered a physical exam.[55, 57, 68] The initial assessment occurred in a clinical setting and/or the participant's home. The assessment was completed by nursing professionals (18 trials), physicians (12 trials), physical therapists (11 trials) and/or occupational therapists (6 trials).

Individualized services. Based on the results of the initial assessment, a variety of services or referrals for a service were described in the included trials (**Figure 8; Appendix E Table 3**). Eighteen trials referred some or all of the participants to an individual (such as one administered by a physical therapist) or group exercise intervention.[46, 48, 52, 56-58, 61, 62, 69, 71, 74, 76, 77, 81, 84, 85, 88, 89] Fourteen trials performed or referred participants to a medication review.[46, 48, 52, 53, 61, 71-73, 77, 83-85, 88, 89] Thirteen trials referred participants to vision and/or hearing specialists.[46, 48, 56-58, 62, 69, 71, 72, 74, 84, 88, 89] Seven trials referred participants to occupational therapy.[48, 52, 58, 61, 76, 81, 84] Nine trials referred participants back to their PCPs with risk assessment information and recommendations,[46, 48, 54, 57, 58, 68, 71, 81, 89] and eleven trials communicated with PCPs specifically regarding medication assessment results.[46, 48, 52, 53, 61, 72, 73, 83-85, 89] Of the trials that provided an environmental assessment, 17 provided additional recommendations or referrals for modifications with or without modification implementation, if indicated by the initial assessment.[46, 48, 53-58, 62, 68, 69, 71, 79, 84-86, 89]

Intervention components delivered to all participants in the intervention group. All trials delivered individualized falls prevention advice and recommendations based on the multifactorial risk assessment. Additionally, several trials provided intervention components to all participants regardless of the results of the risk assessment (**Figure 9; Appendix E Table 3**). Eleven trials provided environmental assessments which were generally home visits with specific recommendations for modifications with or without modification implementation.[53, 58, 62, 68, 71-73, 76, 77, 83, 86] Eight trials[52, 54, 55, 58, 62, 71, 79, 83] provided educational materials related to falls prevention (e.g., printed materials) while five[55, 71, 73, 79, 83] delivered falls-specific group education sessions. Six of the trials[54, 58, 71, 77, 79, 83] delivered a physical activity intervention (exercise or physical therapy) to all participants and three trials[46, 54, 70] delivered counseling/behavior modification coaching interventions focused on risk factor mitigation.

Intervention intensity and format. We could not quantify the intensity of the multifactorial interventions because total contact time was rarely reported, especially for the trials that included referrals to outside specialist care. In the studies that included an exercise intervention component, the frequency of exercise sessions was generally one to three times per week, while the duration of the exercise interventions ranged widely, from 6 weeks[73] to 12 months[58, 74, 76, 83, 86]. Due to the nature of multifactorial interventions having potentially several types of referrals based on initial assessment risks, the total duration of the interventions beyond the initial assessment were rarely reported. When the intervention duration was reported, it reflected intervention components beyond the assessment and referral part of the intervention, such as periodic check-ins from a health care coordinator or continuing exercise and education classes. The vast majority of trials had interventions delivered individually. In a few cases, there was a group format for education or exercise sessions in addition to the individually directed intervention.[71, 73, 79, 83, 89]

Intervention adherence. In general, most trials reported, in various degrees of detail, the percentage of participants who were referred to specialty services based on the initial falls risk assessment. Seventeen trials reported that 20% to 99% of participants attended the recommended referrals and/or implemented changes recommended by the referrals.[48, 55, 58, 61, 62, 68, 69, 74, 76, 77, 79, 81, 83, 85, 86, 88, 89] Most commonly, the adherence in trials to recommendations was in the 60-70 percent range for any individual recommendation or referral. In one large multifactorial trial, however, adherence to some interventions including medication review and environmental referrals were generally low: 3.2 percent of those eligible for environmental assessment actually received a home safety assessment and 4.3 percent of those who qualified completed a visit with pharmacist for medication review.[46, 65] In the other large multifactorial trial, researchers found documented evidence of action for 36% of all treatments recommended in the multifactorial falls prevention intervention (e.g. referral to, or outcome of attendance at, other referrals).[48, 50] In the multifactorial trials that included an exercise referral for some or all participants, 23% to 74% attended some or all exercise classes or sessions.[48, 58, 62, 79, 83]

Control groups. The majority (19 of 28) of trial control groups received no intervention or usual care.[52, 53, 55-58, 61, 62, 68, 70-74, 76, 81, 84, 86, 88, 89] The remaining nine trials compared their intervention to a control group that received usual care plus minimal or attention control (pamphlet, social visit, brief fall-risk advice, letter).[46, 48, 54, 69, 71, 77, 79, 83, 85]

Study Quality

Of the 28 trials, nine were rated good quality with low risk of bias in all domains (**Appendix A Figure 1**).[46, 48, 55, 61, 73, 74, 83, 85, 88] Eighteen fair-quality trials[52, 53, 56-58, 62, 68-72, 76, 77, 79, 81, 84, 86, 89] had moderate risk of bias in one or two domains and one trial[54] had moderate risk of bias in three domains. Five trials had moderate risk of bias for insufficient reporting of randomization or baseline confounding[54, 58, 72, 84, 89]; five trials had moderate risk of bias for intervention deviations[54, 57, 58, 68, 81]; seven trials had moderate risk of bias for outcome measurement issues, typically recall of the falls outcome at >1 month.[52, 70, 72, 76, 77, 79, 89] Seven trials had high and/or differential attrition and missing data.[53, 54, 62, 69, 71, 76, 86] The multifaceted and customized nature of these multifactorial interventions precluded analysis of intervention adherence rates. Nearly all trials used intention-to-treat analysis where all randomized participants were included in the analysis regardless of their participation at the conclusion of the study. To ascertain falls, most trials (21 of 28 trials)[46, 48, 52, 55-58, 61, 62, 68, 69, 71-74, 81, 83-86, 88] had the patient prospectively record falls on a calendar or in a diary, with or without additional confirmation (e.g., medical records or 3–6 month recall phone calls). Six trials recorded falls by the patient's recall every 1 to 6 months,[53, 54, 70, 76, 77, 79] and one study[89] recorded falls by the patient's recall at >6 months and in hospital discharge summaries—however we did not include the people with falls outcomes from this trial and only used their hospital documented falls-related injuries outcome.

Detailed Results

Falls

Meta-analysis of 20 multifactorial trials[46, 48, 53-56, 58, 59, 62, 69, 71-73, 76, 77, 81, 83, 85, 88] (n=22,115) demonstrated a statistically significantly lower rate of falls in the multifactorial group versus the control group at the longest followup (6–28 months), although with substantial statistical heterogeneity (IRR, 0.84 [95% CI, 0.74 to 0.95]; I^2=85.0%) (**Figure 10; Appendix E Table 4**). Absolute differences ranged from -6.77 falls per person-year (lower fall rate in the intervention group) to 1.31 falls per person-year (higher fall rate in the intervention group). In the control group, the rate of falls per person-year ranged from 0.38 to 7.68 events per person-year at the longest followup. Individual trials reported substantial variation in effect size, with wide CIs and IRR point estimates ranging from 0.39 (95% CI, 0.24 to 0.63)[53] to 1.13 (95% CI, 0.98 to 1.30).[48] Two trials particularly notable for much greater beneficial effect sizes were conducted by Close et al.[53] and Logan et al.,[73] with IRR point estimates of 0.39 and 0.45, respectively. These trials recruited participants from the emergency department[53] or an ambulance[73] following a fall; one had specific intervention protocols outlined in the publication,[53] and the other included intensive interventions (6 physical therapy sessions, 12 group sessions of supervised exercise or education on preventing falls, and up to 12 home sessions)[73].

We explored heterogeneity by examining the number of falls by country, date of publication, recruitment setting, fall rate of the control group, recruitment inclusion criteria of unselected or increased risk of falls, mean age, followup period, and study quality (**Appendix E Table 5**). We were unable to explain the high heterogeneity by any single variable. Visual examination of the funnel plot for the 20 pooled trials (not included in this report) did not suggest a publication bias, and the Egger's test was not statistically significant (p=0.17).

People With a Fall and People With Recurrent Falls

Meta-analysis of the 26 multifactorial trials[46, 48, 52-58, 61, 62, 68, 69, 71-74, 76, 77, 79, 81, 83-86, 88] (n=23,626) reporting the number of people with a fall demonstrated no statistically significant difference at the longest followup (6–28 months) in the multifactorial group compared to the control group (RR, 0.96 [95% CI, 0.91 to 1.02]; I^2=48.2%) (**Figure 11; Appendix E Table 6**). Three trials[53, 73, 77] reported a statistically significant modest reduction in people experiencing a fall (range of RR, 0.62 to 0.84). The remaining 23 trials[46, 48, 52, 54-58, 61, 62, 68, 69, 71, 72, 74, 76, 79, 81, 83-86, 88] showed no statistically significant difference in the number of people experiencing a fall, with one outlier study by Ciaschini et al.[52] reporting a nonsignificant increased risk of experiencing a fall among intervention participants versus the control (RR 1.51 [95% CI, 0.88 to 2.60]). This trial enrolled the youngest population (mean age 71.9 years), which was recruited from the emergency department after a fall. Approximately 40 percent of the trials (10 of 26) showed point estimates greater than 1.0, indicating that the control group had fewer people experiencing a fall, although none of the point estimates were statistically significant.[52, 58, 61, 62, 74, 76, 81, 83, 86, 88] The percentage of people experiencing a fall in the control group ranged from 17.0 to 94.1 percent.

Similar to people with 1+ falls, pooled analysis of people with 2+ falls demonstrated no statistically significant difference between the multifactorial and control groups at 12 to 28 months (RR 0.99 [95% CI, 0.94 to 1.04]; I^2=0%; k=11; n=14,471) (**Figures 11 and 12; Appendix E Table 6**).

Falls Resulting in Injury or Medical Care and Fall-Related Fractures

The association of multifactorial interventions with the risk of injurious falls and fall-related fractures was inconsistent among trials. Approximately 40 percent (k=12; n=10,563) of the 28 multifactorial trials reported falls resulting in injuries or resulting in medical care at 6 to 44 months (**Figure 13; Appendix E Table 7**).[46, 58, 61, 71, 72, 74, 76, 83, 85, 88] The definition of 'injuries' varied among trials, with some capturing only serious injuries (e.g., fractures, lacerations requiring sutures, head injuries requiring hospitalization) or injuries requiring medical care, and others including minor injuries as well (e.g., soft tissue bruises). Pooled results of these 12 trials showed no statistically significant association between multifactorial interventions and the number of injurious falls (IRR 0.92 [95% CI, 0.84 to 1.01], I^2=21.8%). The IRRs in these eleven trials ranged from 0.51 (95% CI, 0.13 to 2.05) to 1.09 (95% CI, 0.87 to 1.35). Seven trials reported number of fall-related fractures (n=15,211) showing no statistically significant association between multifactorial interventions and fall-related fractures (IRR, 1.03 [95% CI, 0.82 to 1.30]). Individual IRRs ranged from 0.76 (95% CI, 0.35 to 1.64) to 1.50 (95% CI, 0.80 to 2.82) (**Figure 14; Appendix E Table 8**). Three trials[48, 61, 88] reported a non-significant increase in fracture risk in the intervention group.

People With a Fall Resulting in Injury or Medical Care and Fall-Related Fracture

Meta-analysis of 13 trials[46, 53-55, 68, 70, 74, 76, 81, 85, 88, 89] (n=13,460) showed no difference in people with an injurious fall in the multifactorial group compared to the control group at the longest followup (9–28 months) (RR, 0.92 [95% CI, 0.82 to 1.03]; I^2=42.9%) (**Figure 15; Appendix E Table 9**). Seven trials[46, 48, 52, 56, 79, 81, 84] (n=13,912) reported the number of people with a fall-related fracture or any fracture at 6 to 44 months of followup (control group prevalence range, 0.7% to 22%). Overall, there was no statistically significant difference between the multifactorial and control groups and people with a fracture (RR 0.85 [95% CI, 0.57 to 1.26]; I^2=42.8%) (**Figure 16; Appendix E Table 10**). RR point estimates ranged from 0.52 to 1.02 in the five trials with relatively few events, which made estimates unstable.[52, 56, 79, 81, 84]

Mortality

Pooled analysis of 24 trials [46, 48, 52, 53, 55, 56, 58, 62, 68-70, 72-74, 76, 77, 79, 81, 83-86, 88, 89] (n=21,596) showed no difference in all-cause mortality at 6 to 42 months in the multifactorial group compared to the control group (RR, 1.01 [95% CI, 0.88 to 1.17]; I^2=0%) (**Figure 17**). Individual study results varied widely, with RRs ranging from 0.6 to 8.3 and wide CIs reflecting a relatively uncommon outcome with few events in most trials (**Appendix E Table 11**); not surprisingly, none of the relative comparisons were statistically significant as the trials were not intended nor powered to affect mortality outcomes.

Other Outcomes

Qualitative analysis demonstrates no effect on hospitalization, institutionalization, IADL, or QOL, but these outcomes were reported in just a small proportion of multifactorial trials. (**Appendix E Tables 12-14**)

Harms

In general, adverse events were sparsely reported. When reported, they were rare, minor, and associated with the exercise components of the multifactorial interventions. Five trials (n=4,199) reported harms associated with multifactorial interventions (**Appendix E Table 15**).[48, 61, 68, 83, 85] One trial[68] reported no adverse events in the intervention or control groups. Four trials[48, 61, 83, 85] reported adverse events in the intervention groups but did not provide data from the control group for comparison. One of these trials[83] reported three falls without injuries during the exercise sessions of the interventions, one reported back pain that either restricted ADLs for two or more days or resulted in medical attention in two intervention participants,[61], one reported musculoskeletal complaints in 10 intervention participants,[85] and the other reported no adverse events in the intervention group.[48]

Exercise Interventions

Summary of Results

We identified 37 trials (n=16,117) of exercise interventions to prevent falls in community-dwelling older adults (**Figure 5**). The trials generally included multiple exercise components, and the exercise interventions were primarily conducted in a supervised group setting. Fifty-eight percent of participants in these trials were determined to be at high risk for falls; fall history and hospital or ED admissions were the most common risk factor (alone or in combination) used for trial recruitment. Pooled analysis from 29 trials (n=14,475) demonstrated that exercise interventions were associated with a significant reduction in the rate of incident falls at the longest followup (6–24 months) (IRR, 0.85 [95% CI, 0.75 to 0.96]; I^2=82.7%). Meta-analysis of 25 exercise RCTs (n=13,384) demonstrated that exercise is associated with a significantly reduced risk of people falling at the longest followup (6 to 24 months) (RR, 0.92 [95% CI, 0.87 to 0.98]; I^2=24.3%). Exercise interventions were also associated with a reduction in the number of injurious falls and, but people with an injurious fall and fall-related fractures did not show a statistically significant association. Pooled analysis of 15 RCTs (n=10,461) showed no significant association between exercise and all-cause mortality at longest followup (12 to 85 months) (RR, 0.87 [95% CI, 0.71 to 1.06]; I^2=0.0%). Qualitative analysis demonstrates no effect on people with a hospitalization or ED visit (k=1), people institutionalized (k=3), IADL (k=6), or QOL (k=13) but the outcomes are reported in a small proportion of the exercise trials. Conclusions about the harms of exercise interventions are limited by only half of the trials reporting harms (k=19; n=11,087), incomplete reporting of adverse events, and rare event rates. Seven trials reported no differences in serious harms. Harms, including musculoskeletal complaints associated with exercise, were generally minor.

Characteristics of Included Studies

We included 37 trials (in 70 articles) of exercise interventions (n= 16,117).[21, 48-50, 63, 91-155] One trial from the previous review was excluded because the control group was considered too intense[156] and two trials were excluded [157, 158] because falls were not cumulatively measured (e.g., only from 12 to 24 months, rather than from baseline to 24 months).

Study Characteristics

We identified 32 fair-quality[95, 97, 100-102, 106-108, 112, 114, 117-119, 121-128, 132, 133, 135-137, 139, 141, 145, 147, 148, 154] and 5 good-quality[48, 105, 116, 150, 152] RCTs with a primary or secondary aim of examining the effectiveness of exercise on reducing falls and/or fall-related injuries at 6 to 85 months of followup (**Table 3; Appendix F Table 1**). Trials were primarily conducted outside of the US, with only five trials taking place in the United States,[97, 102, 119, 125, 145] twenty in Europe,[48, 106, 108, 112, 114, 116-118, 121, 122, 124, 127, 132, 135, 137, 139, 141, 147, 148, 150] eleven in Australia or New Zealand,[95, 100, 101, 105, 107, 123, 128, 133, 136, 152, 154]) and one in Singapore.[126] Trial sizes varied widely, ranging from 35[135] to 6,502[48] (participants randomized to exercise and control arms for our analysis). One very large trial was unusual in that it tested screening and exercise intervention: of those randomized into the active exercise arm, only those who screened as intermediate or high risk for falls actually received the exercise intervention.[48]

Population Characteristics

The most common target population ages for inclusion were ≥60 years[100, 116, 117, 119, 125, 128, 136, 145, 152] or ≥65 years,[95, 102, 108, 124, 126, 127, 135, 137, 139, 141, 147, 154] although two trials did recruit participants from the oldest old age groups (≥80[101] or ≥85[122] years) (**Table 3; Appendix F Tables 1-2**). The mean age ranged from 68 years[116] to 88 years.[122] Ten of the trials were conducted exclusively with women,[101, 102, 106, 112, 114, 116, 117, 124, 132, 150] while in only three trials less than half of the participants were female.[108, 118, 127] The majority of participants in the remaining trials were women.[48, 95, 97, 100, 105, 107, 119, 121-123, 125, 126, 128, 133, 135-137, 139, 141, 145, 147, 148, 152, 154] Only seven trials reported race/ethnicity; and in all but one of these trials,[119] participants were almost exclusively White.[48, 100, 108, 118, 139] Eighteen trials reported a measure of socioeconomic status—primarily education.[48, 97, 100, 105, 106, 108, 118, 119, 121, 126, 127, 135, 139, 145, 147, 148, 152, 154] Trials reported socioeconomic status differently, making it difficult to summarize this measure, but most participants who reported socioeconomic status had achieved at least a high school or equivalent education. All trials recruited community-dwelling adults. Nineteen trials recruited from a community or population based setting only[102, 105-107, 112, 114, 116, 119, 122, 126, 128, 132, 135, 141, 145, 147, 150, 152, 154] (e.g., population-based registries), thirteen trials recruited from a clinic setting (with or without additionally using community-based recruitment),[48, 95, 100, 101, 108, 118, 121, 124, 125, 133, 137, 139, 148] two trials from a hospital or ED only,[117, 136] two trials recruited from insurance registries,[97, 127] and one trial recruited from a retirement village.[123]

Three trials recruited participants with mild to moderate cognitive impairment[100, 108, 118], and one trial was limited to participants with an established Alzheimer's disease[127]. Eighteen trials excluded participants with mild to severe cognitive impairment.[100, 102, 105, 114, 119, 123, 126, 128, 132, 135, 136, 139, 141, 145, 148, 150, 152, 154] Nine trials excluded participants who were not ambulatory without the use of an assistive device.[102, 105, 114, 117, 119, 124, 125, 141, 147, 152, 154]

Twenty trials required all participants to be at increased risk for falls.[95, 102, 106, 114, 117, 121, 122, 124-127, 135-137, 139, 141, 145, 147, 148, 150] Fifteen trials[48, 97, 100, 101, 105, 107, 116, 118, 119, 123, 128, 132, 133, 152, 154] included populations with 6-59% of participants at increased risk for falls. The definitions of increased risk for falls varied amongst the trials (**Figure 18; Appendix F Table 2**). Most of the trials (22 of 37 trials) included history of falls as either the sole criteria[107, 118, 119, 123, 128, 133, 150, 152, 154] or one of several risk factors.[48, 97, 100, 101, 105, 116, 121, 122, 124, 127, 135, 137, 147] Other common risk factors for falls included a hospital or ED visit,[125, 136, 145] physical function testing thresholds,[48, 95, 106, 121, 122, 127, 135, 137, 139, 147] osteopenia or osteoporosis,[102, 114, 117, 124, 132] and frailty.[126, 127, 141, 147] The baseline measures of health or functional status reported in the trials varied. The measures included living alone, experiencing a fall in the past year, physical function, ADL or IADL baseline score, QOL or self-reported health rating, number of medications, and other factors. Overall, at baseline about 38 percent of participants in the included trials reported falling in the past year (k=12 reported people with 1 or more falls in the previous 12 months).

Intervention Details

The 37 exercise interventions varied along several dimensions: supervision, individual versus group exercise, duration, frequency, and exercise components (**Figures 19-20; Appendix F Table 3**).

Supervision. Most of the intervention groups attended supervised group classes with an additional unsupervised individual component. Three trials,[100, 105, 154] exceptionally, only utilized independent and unsupervised exercise sessions. Participants in the remaining 34 exercise trials were supervised during all or part of the intervention either in group classes,[95, 97, 102, 106, 107, 112, 114, 116-119, 121-123, 125, 126, 135, 137, 139, 145, 147, 150, 152] individual sessions,[48, 101, 108, 124, 133, 136, 141, 148] or both.[127, 132] Supervision was conducted by a specialized exercise instructor,[48, 95, 102, 106, 112, 118, 119, 121, 123, 132, 137, 139, 147, 152] physical or occupational therapist,[48, 101, 107, 108, 114, 116-118, 122, 124, 125, 127, 128, 132, 135-137, 141, 148, 150] health professional,[126, 133, 145] or unspecified supervisor.[97] Participants in the unsupervised trial were self-directed using a written program. One trial had entirely independently performed exercise programs with coaching via telephone followup.[154]

Format. Twenty-four interventions included group exercise alone or in combination with home-based exercise.[95, 97, 102, 106, 107, 112, 114, 116-119, 121-123, 125-127, 135, 137, 139, 145, 147, 150, 152] Seven interventions included only supervised individual-based exercise.[48, 101, 108, 124, 133, 141, 148] One trial's exercise interventions (group and individual sessions) took place in a gym setting.[132]

Duration. Exercise programs ranged from 2 months[125] to 30 months.[114] The most common duration was 12 months in fifteen trials.[95, 101, 108, 112, 118, 119, 123, 124, 127, 133, 136, 139, 141, 148, 154]

Frequency. Supervised exercise sessions were typically scheduled once to three times per week. The most common frequency was twice per week[116-119, 121, 123, 126, 127, 132, 139, 141, 150] or three times per week.[97, 102, 112, 124, 125, 135, 145].

Exercise components. Most trials utilized multiple exercise components, including: gait, balance, and functional training; strength and resistance; flexibility; tai chi/3-D training; general physical activity; and endurance (**Figure 20; Appendix F Table 3**). Nearly all exercise interventions included gait, balance and functional training (30 of 37 trials). Two-thirds of the trials[48, 95, 97, 100, 101, 107, 108, 112, 114, 116-118, 124-127, 132, 133, 136, 137, 139, 141, 145, 148, 150] (25 of 37 trials) additionally included a strength and resistance training component and approximately one-fifth[101, 106, 107, 116, 122, 125, 135, 141] (8 of 37 trials) additionally included flexibility training. Thirteen trials[48, 97, 101, 108, 118, 122, 124, 128, 133, 137, 141, 148, 154] included a general physical activity component. Six trials[95, 97, 101, 118, 127, 141] included an endurance component. Six trials[102, 119, 121, 123, 132, 152] included 3-D exercise like dance or tai-chi. Thirteen[48, 97, 101, 108, 118, 122, 124, 128, 133, 137, 141, 148, 154] of the trials employed general physical activity alone or in combination with another exercise component. Nine trials[101, 108, 118, 128, 136, 137, 139, 148, 154] included lifestyle behavioral counseling including coaching and/or motivational interviewing.

Intervention adherence. In general, most of the participants were adherent to the exercise interventions. Thirty-five trials reported a measure of adherence or compliance with the exercise intervention, but the measures used to report adherence varied.[48, 95, 97, 100-102, 105, 106, 108, 112, 114, 116-119, 121-128, 132, 133, 135-137, 139, 141, 145, 147, 148, 150, 152] Twelve trials reported 56 to 95 percent of sessions were attended. Three trials reported the mean number of sessions attended. The remaining 20 trials reported 42 to 94 percent were adherent based on varying definitions, such as the proportion attending all sessions, the proportion attending at least 50 percent of sessions, or those still exercising at 12 months.

Control groups. Control groups in the trials were instructed to maintain usual activity levels and/or received usual care, no intervention, minimal written information or other minimal education about health or preventing falls, or a social visit.

Study Quality

Of the 37 trials, five were rated good quality with low risk of bias in all domains (**Appendix A Figure 2**).[48, 105, 116, 150, 152] Thirty-two fair-quality trials had moderate risk of bias in one or two domains and three trials[101, 108, 122] had moderate risk of bias in three domains. Twenty-one trials[95, 97, 101, 106-108, 112, 114, 117, 123-125, 127, 128, 132, 133, 135-137, 145, 148] had moderate risk of bias due to insufficient reporting of randomization procedures or baseline characteristics differences. Two trials[101, 122] had moderate risk of bias for intervention deviations. Eight trials[102, 108, 118, 122, 126, 135, 139, 141] had moderate risk of bias for outcome measurement issues, typically recall of the falls outcome at >1 month. Eighteen trials[95, 97, 100, 101, 106, 108, 114, 119, 121, 122, 125, 133, 137, 139, 145, 147, 148, 154] had high attrition, differential attrition, or missing data. To ascertain falls, most trials (24 of 36 trials)[48, 97, 101, 105-108, 116, 121, 123-125, 127, 128, 132, 133, 136, 137, 145, 147, 148, 150, 152, 154] had the patient prospectively record falls on a calendar or in a diary or phone text messaging, with or without additional confirmation (e.g., medical records or 3–6 month recall phone calls). Twelve trials recorded falls by patient's recall every 1 to 6 months,[95, 100, 102, 114, 117-119, 122, 126, 135, 139, 141] and two study[112, 132] recorded falls resulting in injuries or fractures from administrative or hospital discharge records.

Detailed Results

Falls

Meta-analysis of 29 exercise trials (n=14,475) reporting the outcome of falls demonstrated a significant reduction in the rate of incident falls at the longest followup (6–24 months) in the exercise group compared to the control group, with substantial statistical heterogeneity (IRR, 0.85 [95% CI, 0.75 to 0.96]; I^2=82.7%) (**Figure 21; Appendix F Table 4**).[48, 95, 101, 102, 105-108, 114, 117-119, 121, 123, 124, 127, 128, 133, 135-137, 139, 141, 145, 148, 152, 154] The baseline fall rate of control groups varied widely, from 0.26 per person-year[119] to 5.0 per person-year.[102] Individual trials reported substantial variation in effect and effect size, with IRR point estimates ranging from 0.47 in favor of the intervention group[101] to 1.83 in favor of the control group.[148]

Two trials[136, 148] were notable for the statistically significantly higher fall rate in the exercise group compared with the control (IRR, 1.43 [95% CI, 1.06 to 1.92] and IRR 1.83 [95% CI, 1.23 to 2.74]). The first study[136] recruited patients discharged from geriatric care, rehabilitation, and orthopedic wards at any of four public hospitals in Sydney, Australia. Participants had a mean age of 81 years, and the authors note that their recruited population was less healthy than those of other trials reporting a beneficial effect of exercise on falls. The intervention was an individually based program designed to improve balance; participants received instruction from a physical therapist and were asked to do the exercises at home six times a week. At 12 months, 57 percent were participating in exercise sessions and 29 percent were no longer exercising. The second trial[148] was set in Sweden where recruitment required all participants to use walking aids and/or home help services; participants had a mean age of 83 years and the control group falls rate was low relative to the other trials. The intervention was a 12-month independent home-based Otago Exercise Program with home visits and phone support incorporating behavior change. The authors note that long winters could have affected the ability of older adults to take outdoor walks (only 52% of intervention participants were walking outdoors twice per week) and lessened the impact of the intervention. They also note their recruited population may have been more frail than other trials reporting a beneficial effect of the Otago Exercise Program on falls.

We explored heterogeneity by examining country where the trial took place, publication year, study quality, recruitment setting, selective recruitment for increased fall risk, control group event rate, mean age, duration of followup, specific exercise components (e.g., strength/resistance training), presence of a behavior change component as part of the intervention, presence of cognitive task exercises as part of the intervention, group versus individual exercise sessions, and intervention duration (**Appendix F Table 5**). However, we were unable to explain the high heterogeneity by any single variable after adjusting for multiple comparisons. Visual examination of the funnel plot for the 29 pooled trials (not included in this report) did not suggest a publication bias, and the Egger's test was not statistically significant (p=0.68).

People With a Fall and People With Recurrent Falls

Meta-analysis of 25 exercise trials (n=13,384) reporting the number of people with a fall demonstrated a reduced risk of falling at the longest followup (6–24 months) in the exercise group compared to the control group (RR, 0.92 [95% CI, 0.87 to 0.98]; I^2=24.3%) (**Figure 22; Appendix F Table 6**).[48, 95, 97, 100, 101, 105-107, 116, 118, 119, 121, 122, 124-126, 128, 136, 137, 147, 148, 152, 154] Individual trials reported substantial variation in effect and effect size, with wide and overlapping CIs and RR point estimates ranging from 0.40[116] to 1.66.[119] The results from two trials were consistent with a statistically significant reduction in the number of people with a fall in the exercise group compared to the control group (14 to 60 percent reduced risk).[106, 116] One trial[136] reported a statistically significant increase in the number of people with a fall in the exercise group compared with the control group (RR, 1.38 [95% CI, 1.11 to 1.72]) and two reported a nonstatistically significant association between exercise and people with a fall.[100, 119] The remaining trials showed a nonsignificant benefit in terms of fewer people with a fall in the exercise group than in the control group.[48, 95, 97, 101, 105, 107, 118, 121, 122, 124-126, 132, 137, 147, 148, 152, 154]

Nine trials (n=8,502) reporting people with recurrent falls (2 or more falls) showed no statistically significant association between exercise interventions and the number of people experiencing recurrent falls (2 or more falls) (RR, 0.77 [95% CI, 0.57 to 1.04]; I^2=45.0%) (**Figure 23; Appendix F Table 6**).

We explored heterogeneity by examining the country where the trial took place, publication year, study quality, recruitment setting, selective recruitment for increased fall risk, proportion of CG with a fall, mean age, duration of followup, specific exercise components (e.g., strength/resistance training), presence of a behavior change component as part of the intervention, presence of cognitive task exercises as part of the intervention, group versus unsupervised individual exercise sessions, and intervention duration (**Appendix F Table 7**). However, we were unable to explain the high heterogeneity by any single variable. Visual examination of the funnel plot for the 25 pooled trials (not included in this report) did not suggest a publication bias, and the Egger's test was not statistically significant (p=0.12).

Falls Resulting in Injury or Medical Care and Fall-Related Fractures

Meta-analysis of 12 exercise trials (n=3,984) reporting the outcome of injurious falls demonstrated a significant reduction in the rate of injurious falls at the longest followup (6 to 60 months) in the exercise group compared to the control (IRR, 0.84 [95% CI, 0.74 to 0.95]; I^2=14.6%) (**Figure 24; Appendix F Table 8**).[95, 105-107, 112, 128, 133, 136, 137, 148] Specific definitions for fall-related injury outcomes were reported as falls resulting in injuries,[95, 105, 107, 112, 128, 133, 150] fall-related injuries,[132, 137, 148] falls resulting in serious injuries,[106] and falls resulting in medical care.[136] Four of the trials reported statistically significantly reduced rates of fall-related injuries,[105, 112, 137] with significant effects ranging from 0.46 [150]to 0.80.[112] Two trials[136, 148] reported a nonstatistically significant increase in the rate of injuries among the intervention group compared to the control group (IRRs, 1.14 [95% CI, 0.76 to 1.72] and 1.35 [95% CI, 0.76 to 2.42]).

Eight trials (n=8,537) reporting fall-related fractures show no statistically significant difference between the intervention and control groups (IRR, 0.81 [95% CI, 0.57 to 1.15]; I^2=39.1%) (**Figure 25; Appendix F Table 9**).[48, 112, 114, 117, 118, 127, 136]

People With a Fall Resulting in Injury or Medical Care and Fall-Related Fracture

Pooled results from nine trials (n=3,672) showed no statistically significant association between exercise interventions and a reduction in people experiencing an injurious fall at 6 to 60 months followup (RR, 0.90 [95% CI, 0.79 to 1.02]; I^2=0.0%) (**Figure 26; Appendix F Table 10**). Relative risks among the exercise group ranged from 0.61[112] to 1.22.[148]

Four trials (n=7,080) showed mixed results for people with fall-related fractures with two trials reporting nonsignificant increased risk (RRs 1.13 [95% CI, 0.84 to 1.51] and 1.95 [95% CI, 0.22 to 17.28]),[48, 118] one trial reporting a nonstatistically significant decreased risk (RR 0.62 [95% CI, 0.38 to 1.01])[132], and one trial reporting statistically significant decreased risk (RR, 0.36 [95% CI, 0.15 to 0.89])[114] at 6-30 months followup (**Appendix F Table 11**).

Mortality

Pooled analysis of 15 trials (n=10,461) showed no significant association with all-cause mortality at longest followup (12–85 months) in the exercise group compared to the control group (RR, 0.87 [95% CI, 0.71 to 1.06]; I^2=0.0%) (**Figure 27; Appendix F Table 13**). Individual study results showed no statistically significant differences, and RRs varied widely (0.16[95, 133] to 1.30,[118] with wide CIs. The few deaths in most trials made estimates unstable.

Other Outcomes

Qualitative analysis demonstrates no effect on people with a hospitalization or ED visit (k=1), people institutionalized (k=3), IADL (k=6) or QOL (k=13). Of the 13 trials reporting QOL,[48, 102, 105, 108, 118, 119, 123, 128, 136, 139, 148, 150, 154] five measured QOL using the SF-12 or SF-36,[48, 102, 119, 123, 136] six measured QOL using the EQ-5D VAS or EQ-5D-3L,[105, 108, 118, 128, 139, 148] and two measured QOL using different scales (Liepad QOL[150] and Australian QOL[154]). These trials demonstrated no association between exercise interventions and mean differences in quality of life. The remaining outcomes were reported in a small proportion of the exercise trials and results are shown in the appendix (**Appendix F Tables 14–16**).

Harms

Half of the trials reported harms (19 of 37), with generally minor musculoskeletal side effects being most common; serious side effects were generally very rare. Overall, the description of harms ascertainment was sparse; measurement varied from capturing spontaneous, self-reported comments to repeated questionnaires asking about harms. Nineteen trials[48, 100, 105, 106, 112, 118, 119, 123, 124, 126, 128, 132, 136, 137, 139, 141, 147, 148, 150] (n=6,985) reported on harms in the intervention groups at 6 to 24 months (**Appendix F Table 17**). Five of these trials[118, 119, 139, 147, 150] also reported harms in the control group for comparison.

Seventeen trials[48, 100, 105, 106, 112, 118, 123, 124, 126, 128, 132, 136, 137, 141, 147, 148, 150] reported any adverse events (AEs) occurring during the exercise intervention sessions, ranging from 0 percent[48, 123, 124, [137, 147] to 58 percent[141]. These AEs directly related to the exercise intervention were largely musculoskeletal discomfort and pain symptoms, particularly in the trial reporting high rates of AEs (one trial[141] reporting 58% in the IG and no AE reporting in CG). Zero percent[148] to 11 percent[141] reported falls during the intervention exercise program. Serious adverse events related to the exercise intervention were measured in seven trials,[48, 100, 106, 118, 132, 139, 150] with half of these trials[48, 100, 132, 150] reporting zero serious adverse events related to the intervention and one trial[118] reporting <1% serious adverse events related to the exercise (2/281). One trial[106] reported a fall-related wrist fracture (1/352). One trial reported angina pectoris-like chest pain (2/457) and pre-scyncopal symptoms (2/457) during the intervention.[132] Another trial[139] reported overall AEs as 18 percent in the intervention group and 12 percent in the control group; however only one adverse event (1/334), a hip fracture, was attributed to the exercise session.

Exercise + Education Interventions

Summary of Results

The evidence examining the effectiveness of exercise in combination with education interventions to prevent falls consists of four trials (n=1047). In three of four trials, 100 percent of the participants were at increased risk for falling; in the fourth trial 27 percent were at increased risk. Two trials recruited only participants with osteoporosis or osteopenia and the other two trials used fall[159] or fracture history to determine risk. Qualitative analysis showed overall no effect on falls (IRR range 0.61 [95% CI, 0.40 to 0.94] to 1.08 [95% CI, 0.70 to 1.67]), people with a fall (RR range 0.87 [95% CI, 0.57 to 1.34] to 1.07 [95% CI, 0.57 to 2.00]), falls resulting in injury or medical care (IRR range 0.58 [95% CI, 0.33 to 1.01] to 1.02 [0.61 to 1.69]). The evidence on mortality was scant (RRs 0.67 [95% CI, 0.11 to 3.97] and 1.0 [95% CI, 0.06 to 15.72]). Conclusions about the harms of exercise plus education interventions are limited by the lack of control group comparison. While musculoskeletal pain was common, serious adverse events were very rare. Overall, the evidence is limited by few trials, imprecision demonstrated by wide confidence intervals, and largely insufficient evidence.

Characteristics of Included Studies

We included four trials (in 4 articles) of exercise plus education interventions (n=1,047).[159-165] Of the four trials, one was included in the previous review[159] and three were newly identified.[160, 161, 165]

Study Characteristics

We identified one fair-quality[165] and three good-quality[159-161] RCTs (n=1,047) examining the effectiveness of exercise plus educational interventions on reducing falls and/or fall-related injuries at 12 to 18 months of followup (**Table 3; Appendix G Table 1**). One trial was conducted in the United States,[159] two in Australia,[160, 161] and one in the Netherlands.[165] Trial sizes ranged from 96[165] to 453[159] participants randomized to exercise plus education and control arms (for our analysis).

Population Characteristics

All trials recruited community-dwelling adults aged 60 to 65 years or older (**Table 3; Appendix G Tables 1 and 2**). The mean age ranged from 67 years[161] to 78 years.[160] The majority of the trials' participants were women, ranging from 73 percent[161] to 94 percent.[165] Only one trial reported race and ethnicity and participants were almost exclusively White.[159] The trials did not report measures of socioeconomic status. One trial recruited participants from hospitals[160]; two trials recruited from the community through advertisements[159, 161]; and one trial had multiple strategies to identify those with osteoporosis/osteopenia through rheumatology departments, the Osteoporosis Patient Council and local newspapers.[165]

Three of the four trials solely recruited participants at increased risk for falls with the risk factors being history of fracture and/or osteopenia/osteoporosis (**Figure 28, Appendix G Table 2**).[160, 161, 165] The fourth trial did not exclusively recruit based on fall-risk; however, 27% of the participants in that trial reported experiencing a fall in the previous 3 months.[159] The baseline measures of health or functional status reported in the trials demonstrated a wide variation. For example, the number of medications and comorbidities varied widely: the number of mean medications varied from 2.5[165] to 6.5.[160]

Intervention Details

The four exercise plus education interventions varied along several dimensions: supervision, individual versus group exercise, duration, frequency, exercise components, and inclusion of behavioral counseling (**Appendix G Table 3**). All included exercise plus education and two of these trials additionally included a behavioral counseling component with health coaching and/or motivational interviewing.[160, 161] One trial also communicated results with the participants' PCPs.[159]

Education intervention. The educational components of these programs typically included multiple sessions focused on fall prevention with or without education about osteoporosis. The educational components varied in intensity and included: a one-hour education class each month for 12 months[159]; three educational seminars over 18 months[161]; seven two-hour group education sessions over 12 months[160]; 11 sessions over 5.5 weeks.[165]

Exercise supervision/individual vs. group. Three of the trials[159, 161, 165] had supervised group sessions while one trial[160] had supervised individual sessions plus self-directed prescribed exercise. Supervision was conducted by a specialized exercise instructor,[159, 161] physical therapist,[160] or occupational therapist.[165]

Exercise frequency and duration. Supervised exercise sessions were scheduled two[165] to three[159, 161] times per week[159, 161] with durations ranging from one month[165] to 18 months.[161]

Exercise components. All trials included gait, balance, and functional training as well as strength/resistance training. Two of the trials additionally included flexibility[159, 161] and two trials included general physical activity.[159, 165]

Control groups. Control groups received usual care[160, 165] or a minimal intervention.[159, 161]

Study Quality

Three exercise plus education trials were good quality, with low risk of bias in all domains (**Appendix A Figure 3**).[159-161] One trial had a low risk of bias in all domains except was rated to have a moderate risk of bias in the randomization/confounders domain based on scant baseline characteristics reporting.[165] All four trials used calendar diaries for falls ascertainment.

Detailed Results

Falls

Only one of the trials—a one month intervention in participants with osteopenia/osteoporosis—showed a statistically significant association between the intervention and reduction in the number of falls (IRR, 0.61 [95% CI, 0.40 to 0.94]) (**Figure 29; Appendix G Table 4**).[165] The remaining three trials reported nonsignificant results with wide confidence intervals and IRRs ranging from 0.75 (95% CI, 0.52 to 1.09)[159] to 1.08 (95% CI, 0.70 to 1.67).[161]

People With a Fall and People With Recurrent Falls

None of the four trials reported a statistically significant association between the intervention and people with 1 or more falls. Confidence intervals were wide and point estimates for the RRs ranged from 0.87 (95% CI, 0.57 to 1.34)[165] to 1.07 (95% CI, 0.57 to 2.00) (**Figure 30; Appendix G Table 5**).[161]

Two trials reported people experiencing recurrent falls[160, 161] with no significant differences between the intervention and control groups (RRs 1.00 (95% CI, 0.65 to 1.53) and 1.59 (95% CI, 0.67 to 3.79). (**Figure 31; Appendix G Table 5**).

Falls Resulting in Injury or Medical Care and Fall-Related Fractures

Three trials reported falls resulting in injuries or medical care, showing no significant differences with IRRs ranging from0.58 [95% CI, 0.33 to 1.01] to 1.02 [95% CI, 0.61 to 1.69])[159, 160, 165] (**Figure 32; Appendix G Table 5**). Two trials[160, 165] reported fall-related fractures, also showing no significant differences between the intervention and control groups (IRRs 0.64 [95% CI, 0.30 to 1.35] and 0.32 [95% CI, 0.03 to 3.07]) (**Appendix G Table 6**).

People With a Fall Resulting in Injury or Medical Care and Fall-Related Fracture

No trials reported people with a fall resulting in injury, medical care, or fracture.

Mortality

Two of the trials[159, 161] reported no statistically significant differences in mortality, with RRs 0.67 (95% CI, 0.11 to 3.97) and 1.00 (95% CI, 0.06 to 15.72) with wide CIs. The few deaths in most trials made estimates imprecise (**Figure 33; Appendix G Table 7**).

Other Outcomes

One trial (N=336) reported no statistically significant effect of the exercise plus education trials on falls requiring hospitalizations.[160] IADLs, institutionalizations and QOL were not reported in any of these trials. (**Appendix G Table 8**)

Harms

All four trials (n=522 analyzed in the IG only) reported adverse events associated with the intervention but none reported adverse events in the control group for comparison.[159-161, 165] (**Appendix G Table 9**). Two trials reported no adverse events.[159, 165] The most common complaints in the other two trials were musculoskeletal[160, 161] (foot, knee, shoulder pain) and many were related to preexisting injuries.[161] A total of one compression fracture[160], one fracture complication[160], and one wrist fracture[161] were the most serious, yet rare, events that occurred.

Exercise + Environment Interventions

Summary of Results

We identified three trials (n=935) examining the effectiveness of interventions combining exercise and an environment assessment with or without modifications (i.e., a single home visit to reduce home hazards) in older adults of varying risk. There is limited evidence based on the three trials whether exercise plus environment interventions reduce falls and fallers, and meta-analysis was not possible. There appeared to be no statistically significant effect of the interventions on people with a fall (RR range 0.81 [95% CI, 0.60 to 1.08] to 0.99 [95% CI, 0.82 to 1.19]). The evidence was inconclusive for the number of falls (IRRs 0.73 [95% CI, 0.60 to 0.90] and 0.78 [95% CI, 0.57 to 1.07]), injurious falls or falls resulting in medical care (IRRs 0.88 [95% CI, 0.67 to 1.15] and 1.18 [95% CI, 0.76 to 1.83]), people with an injurious fall (RR, 0.63 [95% CI, 0.40 to 0.98]), people with fall-related fracture (RR, 1.08 [95% CI, 0.45 to 2.59]), people hospitalized or who visited the hospital/ED (RR, 1.46 [95% CI, 0.81 to 2.64]), mortality (RR 0.34 [95% CI, 0.09 to 1.23]), QOL, and harms. No trials reported the number of fall-related fractures, people transitioning to institutional care, or IADLs.

Characteristics of Included Studies

We included three trials (in 4 articles) of interventions combining exercise and an environment assessment with or without modifications (i.e., a single home visit to reduce home hazards).[104, 107, 166, 167] These interventions are hereafter described as exercise plus environment. Of the three included trials, one was included in the previous review,[107] and two were newly identified.[166, 167]

Study Characteristics

We identified one good-quality[166] and two fair-quality[107, 167] RCTs (n=935) with a primary or secondary aim of examining the effectiveness of exercise plus environment assessment interventions on falls, fall-related injuries, or both (**Table 3; Appendix H Table 1**). Two trials were conducted in Australia,[107, 167] and one in Singapore.[166] Trials were small, with the number of randomly allocated participants to relevant groups ranging from 272[167] to 354[166]. Followup time ranged from 6 to 18 months.

Population Characteristics

Two trials recruited participants aged 65 years and older[166, 167]; one trial recruited participants aged 70 and older (**Table 3; Appendix G Tables 1 and 2**).[107] The mean age ranged from 76 years[107] to 82 years.[167] The proportion of women ranged from 49[167] to 77[166] percent. Only one study conducted in Singapore reported race and ethnicity; 83 percent of participants were Chinese ethnicity.[166] Measures of socioeconomic status were reported in two trials.[166, 167] One study[167] excluded patients with severe cognitive impairment.

All three trials recruited community-dwelling adults. Trials recruited participants from a population-based register,[107] the emergency department,[166] or health-related services including elder care, memory and cognitive disorders clinics, and dementia-specific day centers.[167] All three trials recruited patients at increased risk for falls, as defined as either a history of falls (in the previous month or 12 months),[107, 167] or presentation to the ED for a fall or fall-related injury (**Figure 28; Appendix G Table 2**).[166] Measures of health or functional status at baseline in the trials varied and included comorbid conditions, number of medications, and cognitive impairment. Two trials reported mean number of medications as 3.4[107] and 5.6.[167] One trial[166] reported that nearly one-half (47%) of participants had multiple comorbidities and another trial[167] reported that the mean number of comorbidities was 3.5.

Intervention Details

All trials included an intervention combining an environmental assessment with an exercise component – which was delivered in a group, individual, or a combination format. (**Appendix H Table 3**) One trial included 15 weeks of group strength, balance and flexibility classes supervised by a physiotherapist.[107] Classes were supplemented by daily home exercises, and a home visit to modify hazards. Home hazard modifications were completed either by the participants or through a city program.[107] Another trial included 24 weeks of group strength and balance exercise classes twice per week for participants with adequate physical performance (i.e., Short Physical Performance Battery (SPPB)>6) and progressive home-based exercises (12 sessions 3 times per week for 3 months) led by a physical therapist for participants with lower physical performance (i.e., SPPB >7).[166] Physical therapists also assessed the participants' homes for environmental hazards and provided brief advice and educational materials on falls prevention. The third trial included an individually tailored, home-based strength and balance exercise program as well as home safety visits to modify hazards.[167] Occupational therapists assessed participants' homes and provided home safety recommendations and modifications (90- to 120-minute sessions).[167]

Intervention adherence. Adherence was variably reported among the three trials. Adherence to the exercise portion of the intervention ranged from 60 percent[107] (those attending at least half the sessions) to 98 percent[166] (participants completing the prescribed number of events). Adherence to the environment modifications were reported in two studies, with 55 percent fully completing home safety recommendations in one trial[167] and 76 percent receiving help to make modifications for home hazards in the second.[107].

Control group. In all three trials, the control groups received usual care from their health care providers.[107, 166, 167] In one trial,[107] the control group received a delayed intervention. In another trial, the control group received educational materials on falls prevention.[166]

Study Quality

One of the three trials was rated good quality, with low risk of bias across all assessed domains (**Appendix A Figure 3**).[107] The remaining two trials were rated fair quality, with moderate risk in at least one of the assessed domains.[166, 167] In one trial,[167] there was differential attrition between the intervention and control groups; this trial was rated to have moderate risk of bias due to missing data. The other fair quality trial did not report baseline characteristics by study group and was rated moderate risk due to confounding.[107] In all three trials, participants used diaries or calendars to record the outcomes of falls prospectively. Two trials also used phone calls to verify falls or followup with participants who failed to return their calendars.[166, 167]

Detailed Results

Falls

Two exercise plus environment intervention trials (n=581)[107, 167] showed inconclusive results in the reduction in number of falls at the longest followup (9-18 months) (**Figure 29; Appendix H Table 4**). One trial (n=272)[107] reported a statistically significant reduction in falls at the 18-month followup (IRR, 0.73 [95% CI, 0.60 to 0.90]). The other trial (n=309) also reported a reduction in the number of falls for the intervention compared with the control group at 12 months followup, but the relative effect was not statistically significant (IRR, 0.78 [95% CI, 0.57 to 1.07]).[167]

People With a Fall and People With Recurrent Falls

Three exercise plus environment trials (n=935)[107, 166, 167] reported the number of people with 1+ falls and showed no differences between the intervention groups and the control groups at the longest followup (9-18 months) (RR range, 0.81 [95% CI, 0.60 to 1.08] to 0.99 [95% CI, 0.82 to 1.19]) (**Figure 30; Appendix H Table 5**). Two trials (n=581)[107, 167] reported people experiencing two or more falls, but only one showed a statistically significant reduction at 12 months (RR, 0.73 [95% CI, 0.54 to 0.99]) (**Figure 31; Appendix H Table 5**).

Falls Resulting in Injury or Medical Care and Fall-Related Fractures

Two trials reported falls resulting in injuries or falls requiring medical attention at 12 and 18 monhts.[107, 167] One trial (n=272)[107] reported a nonstatistically significant reduction in falls resulting in injuries (IRR, 0.88 [95% CI: 0.67 to 1.15]), while the other trial[167] reported a nonstatistically significant increase in falls resulting in medical attention (IRR, 1.18 [95% CI, 0.76 to 1.83]) (**Figure 32; Appendix H Table 6**). No exercise plus environment trials reported fractures.

People With a Fall Resulting in Injury or Medical Care and Fall-Related Fracture

One trial (n=354)[166] reported a statistically significant reduction in people experiencing an injurious fall at 9 months (RR, 0.63 [95% CI, 0.40 to 0.98]). One trial (n=309)[167] reported people with a fall-related fracture but there was no difference between the intervention group and control groups at the 12-month followup (RR, 1.08 [95% CI, 0.45 to 2.59]) (**Appendix H Table 7**).

Mortality

One exercise plus environment trial (n=309)[167] reported mortality but there was no difference between the intervention group and control group at the 12-month followup (RR, 0.34 [95% CI, 0.09 to 1.23]) (**Figure 33; Appendix H Table 8**).

Other Outcomes

One trial (n=309)[167] reported people with a fall-related presentation or hospitalization but there was no difference between the intervention group and control group at 12 months (**Appendix H Table 7**). The same trial (n=309)[167] reported no difference in QOL at 12-month followup (**Appendix H Table 9**). No exercise plus environment trials reported on IADLS or people transitioning to institutional care.

Harms

One trial (IG n=153)[167] reported four falls attributed to the exercise plus environment intervention. One fall occurred while a participant was descending the stairs during an occupational therapy home assessment and three participants fell during an exercise session.[167] No significant injuries were associated with these falls.

Environment Assessment (With or Without Modifications) Interventions

Summary of Results

We identified six trials (n=4162) that examined the effect of an environment assessment with or without modifications (i.e., a single home visit to reduce home hazards) on falls in older adults. All but one study was conducted outside of the US. In pooled analysis, there was no statistically significant effect on falls (IRR 0.83 [95% CI, 0.59 to 1.18]; I^2= 82.2%) or people with a fall (RR 0.94 [95% CI, 0.83 to 1.07]; I^2=20.3%) The results were inconclusive for the remaining outcomes where only one or two trials reported the outcome: falls resulting in injury or medical care (IRRs 0.97 [95% CI, 0.75 to 1.26] and 1.06 [95% CI, 0.93 to 1.21]), mortality (RR, 1.87 [95% CI, 0.87 to 4.01]), falls resulting in hospitalization (IRR, 0.67 [95% CI, 0.38 to 1.21]), quality of life and IADLs. In the two trials reporting harms, there were no adverse events or serious adverse events.

Characteristics of Included Studies

We included six trials (in 10 articles) with a primary or secondary aim of examining the effectiveness of environment assessment with or without modification interventions on falls and/or fall-related injuries.[104, 107, 168-175] Three were included in the previous review[107, 172, 175] and three were newly identified.[168, 169, 173]

Study Characteristics

We identified three good-quality RCTs[169, 172, 173] and three fair-quality RCTs[107, 168, 175] that examined the effect of environment interventions on falls (n=4,162) (**Table 3; Appendix I Table 1**). One trial was conducted in the US,[173] while the remainder were conducted in Hong Kong (k=1)[168], Australia (k=2)[107, 175], and Great Britain (k=2)[169, 172] The size of the trials ranged from 165[172] to 1,879[175] randomly assigned participants. Followup time ranged from 6 to 18 months.

Population Characteristics

All trials recruited community-dwelling older adults aged at least 65 or 70 years (**Table 3; Appendix I Table 1**). The mean age ranged from 75[173] to 80[169] years. The majority of participants were women (ranging from 52[175] to 78[173] percent). Only one study reported race and ethnicity at baseline,[173] noting that 56 percent of participants were Black. Two trials reported level of education; for one study,[173] the mean level of education was 13.7 years while another study reported that 36 percent of participants had an education level of 6 years or less.[168] Baseline measures of health or functional status reported in the trials varied. The number of mean medications per day ranged from 3.4[107] to 7.5[173]. No trials reported frailty or comorbidities. Three trials required that all participants had fallen at least once in the past 12 months[169, 172, 173] and one trial required presentation to an ED primarily due to a fall (**Figure 28; Appendix I Table 2**).

Intervention Details

A nurse,[175] home-maintenance staff member,[107] or physical or occupational therapist[168, 169, 172, 173] conducted an assessment of the participant's home to identify environment hazards that could contribute to a fall and recommended modifications (**Appendix I Table 3**). When possible, modifications within the home were made during the assessment.[169, 172, 175] In two trials, modifications were made through a city program (which paid up to $100)[107] or a government-funded program for participants living in public housing.[168] In the latter trial, participants randomized to the intervention group and who resided in government funded housing had their home modifications paid for; however, those residing in private housing were required to pay for the modifications themselves.[168] For hazards not modified during the assessor's visit or for participants living in private housing, the participant was responsible for making changes or hiring someone to complete the work.[168, 172, 173]

Control groups. Participants in the control group in four trials were not given any intervention but could continue to receive usual care.[169, 172, 173, 175] One trial offered a delayed intervention,[107] and one trial received attention control.[168]

Intervention adherence. Participants' adherence to the intervention was variably reported. In one study, 76 percent received help to make the home modifications.[107] Approximately 50 percent[169] to 91 percent[173] of participants partially or fully adhered to the recommendations. One study reported that several hazards (e.g., unsafe steps, rugs, or mats; rooms with trailing cords; rooms with an unsafe favorite chair) were significantly reduced.[175]

Study Quality

Three studies were rated as good quality, with low risk of bias for all assessed domains (**Appendix A Figure 3**). [169, 172, 173] Three studies were rated as fair quality, with higher risk of bias in one or more domain.[107, 168, 175] All three of these trials had moderate risk of bias due to randomization procedures.[107, 168, 175] Five trials measured falls data by participants' diaries or calendars,[107, 169, 172, 173, 175] which were collected monthly. For one trial,[168] participants self-reported falls by phone every two weeks. All trials reported adequate retention of participants during followup with minor differences between the intervention and control groups in attrition.

Detailed Results

Falls

Six environment trials (n=3,956) demonstrated no difference in the rate of falls in the environment group compared to the control group at the longest followup (12 to 18 months) (IRR, 0.83 [95% CI, 0.59 to 1.18]; I^2=82.2%) (**Figure 29; Appendix I Table 4**).

People With a Fall and People With Recurrent Falls

Five trials (n=2,242)[107, 168, 169, 172, 173] showed no statistically significant difference in people with a fall at 12 to 18 months (RR, 0.94 [95% CI, 0.83 to 1.07], I^2=20.3%) (**Figure 30; Appendix I Table 4**). Four trials (n=2,077)[107, 168, 169, 173] reported people experiencing two or more falls and found similar nonstatistically significant results (RR range, 0.36 [95% CI, 0.07 to 1.75] to 1.04 [95% CI, 0.89 to 1.22]) (**Figure 31; Appendix I Table 5**).

Falls Resulting in Injury or Medical Care and Fall-Related Fractures

Two trials captured falls resulting in injury or medical care (n=1,580).[107, 169] There were no statistically significant differences in the environment group versus the control group at 12 to 18 months (IRRs 1.06 [95% CI, 0.93 to 1.21] and 0.97 [95% CI, 0.75 to 1.26]) (**Figure 32; Appendix I Table 6**). One trial additionally reported fractures,[169] but events were rare and there was no statistically significant difference at 12 months for hip fractures (IRR, 1.69 [95% CI, 0.45 to 6.30]) or fall-related fractures (IRR, 0.83 [95% CI, 0.46 to 1.47]) (**Appendix I Table 6**).

People With a Fall Resulting in Injury or Medical Care and Fall-Related Fracture

One trial (n=1,331)[169] reported people with a fall-related fracture. There was no significant difference between the intervention and control groups at the 12-month followup (RR, 0.88 [95% CI, 0.50 to 1.56]) (**Appendix I Table 7**).

Mortality

One trial (n=1,201)[169] reported mortality but there was no significant difference between the environment group and control group at the 12-month followup (RR, 1.87 [95% CI, 0.87 to 4.01]) (**Figure 33; Appendix I Table 8**).

Other Outcomes

One environment trial (n=1,580) reported no statistically significant difference between the intervention group and the control group in fall-related overnight hospitalizations at 12 months (IRR, 0.67 [95% CI, 0.38 to 1.21]) (**Appendix I Table 6**).[169] One trial (n=198)[168] reported no statistically significant difference in people with a fall-related hospitalization (RR, 0.72 [95% CI, 0.21 to 2.48]) and people with a fall-related ED visit at 12 months (RR, 0.70 [95% CI, 0.37 to 1.34]) (**Appendix I Table 7**). Qualitative analysis showed no effect on QOL outcomes in three trials[169, 172, 173] (using the EuroQol and SF-12) (**Appendix I Table 9**). One trial (n=198)[168] reported no significant difference from baseline to 12 months between the intervention and control groups in IADLs (**Appendix I Table 10**). No environment trials reported people transitioning to institutional care.

Harms

One trial[169] reported no serious adverse events were attributed to the intervention (IG n=430) and a second trial[173] noted that no adverse events were reported during the trial (n=275).

Medication Review/Modification Interventions

Summary of Results

Four RCTs were included (n=1,052) that examined the effectiveness of a medication review with or without modification in older adults, three of which were limited to older adults at increased risk of falls. Meta-analysis was not possible due to few trials. At 6-to-12-month followup, these trials reported no difference between the intervention and control groups in people with a fall (k=3; n=846; RR range, 1.02 [95% CI, 0.79 to 1.31] to 1.16 [95% CI, 0.55 to 2.41]. Evidence was limited for the remaining outcomes due to only one or two trials reporting each outcome: falls (IRR, 1.01 [95% CI, 0.81 to 1.26]), falls resulting in injury or medical care (IRR, 0.87 [95% CI, 0.62 to 1.24]), people with a fall resulting in injury or medical care (RR range, 0.67 [95% CI, 0.36 to 1.26] to 1.69 [95% CI, 1.00 to 2.85]), mortality (RRs 0.40 [95% CI, 0.10 to 1.55] and 1.50 [95% CI, 0.26 to 8.77]), and QOL. There were no trials that reported on harms of the intervention.

Characteristics of Included Studies

We included four trials (in 8 articles) of medication review with or without modification interventions (n=1,052).[176-183] Two trials were included in the previous review[176, 180] and two were newly identified.[177, 183]

Study Characteristics

We identified two fair-quality[176, 180] and two good-quality[177, 183] RCTs with a primary or secondary aim of examining the effectiveness of medication review interventions (n=1052) (**Table 3; Appendix J Table 1**). Three were conducted in the United States,[176, 180, 183] and one in the Netherlands.[177] Trial sizes (participants randomized to medication review and control arms for our analysis) varied, ranging from 80[180] to 612[177] participants.

Population Characteristics

Three RCTs recruited participants aged 65 and older, [176, 177, 180] while one had a slightly older requirement of 70 years and older (**Table 3; Appendix J Tables 1 and 2**).[183] Mean age ranged from 75 to 83 years of age, and the majority of participants were female across trials (ranged from 62% to 79%). Race and ethnicity were only reported in two trials where participants were predominantly White (ranging from 89% to 99%).[176, 180] Measures of socioeconomic status were variably reported. Two trials excluded people with moderate or severe dementia.[176, 183]

Recruitment setting varied across trials. From the US trials, one trial recruited participants from a community pharmacy chain's central electronic database,[176] one trial recruited participants from a fall-prevention workshop,[180] and one trial recruited from an emergency department.[177] All of these trials recruited people at high risk for falls based on fall history or combination of fall history and another criteria.[176, 177, 180] The other study recruited from a family physician's office and had no fall-risk criteria for inclusion eligibility.[183]

All participants were community-dwelling older adults, but two trials excluded participants with moderate/severe or significant dementia.[176, 183] Baseline cognitive impairment was reported in two trials, both reporting no significant cognitive impairment (mean MMSE: 27.0[177] and mean CDR: 2.4[183]) among participants. Comorbidities were variably reported across the trials. One study reported the mean number of high-risk conditions as 1.62;[176] another reported the mean Charlson Comorbidity Index score as 1.9,[177] and one study reported the mean cumulative illness rating scale summary score as 16.7.[183] The remaining study reported that approximately 88 percent of participants self-reported their overall health to be "good, very good, or excellent".

Measures of baseline medication usage at recruitment were reported in all trials. The mean number of drugs currently taken ranged from 6.4[177] to 9.8.[183] In one trial, the proportion of participants taking at least one fall-risk-increasing drug (FRID) was 35 percent.[180] Another trial reported the proportion of participants using three or more FRIDs as 71 percent.[177] One trial reported a mean of 14 high-risk medication prescriptions filled in the year prior to the study.[176]

Three of the four trials recruited participants at increased risk for falling (**Figure 28; Appendix J Table 2**). Criteria for increased risk always included a fall history component. Additionally, one trial's criteria also recruited participants who had a fear of falling;[180] another also required participants to present to the ED after a fall,[177] and the final also recruited participants who were taking four or more long-term prescription medications (of which one or more was a central nervous system medication (e.g., benzodiazepines, antidepressants, anticonvulsants, sedative-hypnotics, narcotic analgesics, antipsychotics, skeletal muscle relaxants)[176].

Intervention Details

All trials included a medication review or modification intervention that included an in-person assessment and consultation (**Appendix J Table 3**). Two of the trials were conducted in the pharmacy, with a face-to-face medication consultation. [176, 180] The pharmacist either contacted the prescriber to approve the medication changes[176] or developed an action plan with prescriber communication only when deemed necessary.[180] The other two trials were both conducted in a clinical setting by a geriatrician. One trial's intervention consisted of a systematic fall-related medication assessment combined with drug modification or withdrawal if it could be done safely.[177] Another trial provided a comprehensive geriatric assessment and medication review, followed by the assessing geriatrician consulting the participants' primary provider briefly to summarize findings and if needed, suggest changes to the drug regimen.[183]

Intervention adherence. Three of the trials reported adherence to the intervention. One trial reported that of the 1,940 prescriptions for high-risk medications filled in the following year, 50 percent of these refills were filled by the patients in the intervention group.[176] Another trial reported that of the six medication-related problems identified, each resulted in recommendations.[180] Of these, approximately 50 percent of the recommendations were communicated by the pharmacist to the patient in person, 31 percent were communicated by the patient to the prescribing physician, and 19 percent were faxed by the pharmacist directly to the prescribing physician.[180] The third trial found that a medication change was deemed not possible or unnecessary for 40 percent of all FRIDs identified.[177] Additionally, in the same trial, 35 percent of all attempted FRID withdrawals were unsuccessful.[177]

Control group. The control group for all included trials received usual care.[176, 177, 180, 183]

Study Quality

Of the four trials, two were rated good quality with low risk of bias in all domains (**Appendix A Figure 3**).[177, 183] The two remaining trials, which were previously included in the prior review, had moderate risk of bias in at least one domain, both with moderate risk due to missing data[176, 180] and one with additional risk due to randomization procedures[176]. All trials recorded falls by using calendars that were turned in monthly and by participating in telephone interviews every 1 to 3 months.[176, 177, 180, 183]

Detailed Results

Falls

One trial reported no difference in the rate of falls between the medication management group and the control group (IRR, 1.01 [95% CI, 0.81 to 1.26]) (**Figure 29; Appendix J Table 4**).[176]

People With a Fall and People With Recurrent Falls

Four trials[176, 177, 180, 183] reported the number of people with one or more falls at 6 to 12 months followup. Results were inconclusive and none of the individual study comparisons were statistically significant. Individual RRs ranged from 1.02 [95% CI, 0.79 to 1.31] to 1.16 [95% CI, 0.55 to 2.41] in three trials and one trial reported an OR of 0.75 (95% CI, 0.35 to 1.60). (**Figure**

30; Appendix J Table 5). Two trials[177, 180] also reported no difference in the number of people who fell more than twice at 6 and 12 months (RRs 1.16 [95% CI, 0.79 to 1.71] and 2.10 [95% CI, 0.56 to 7.83]) (**Figure 31; Appendix J Table 5**).

Falls Resulting in Injury or Medical Care and Fall-Related Fractures

One trial reported a nonstatistically significant reduction in injurious falls between the intervention and control groups at 12 months (IRR, 0.87 [95% CI, 0.62 to 1.24]) (**Figure 32; Appendix J Table 6**).[176] No trials reported fall-related fractures.

People With a Fall Resulting in Injury or Medical Care and Fall-Related Fracture

One trial reported no statistically significant difference in people with an injurious fall at 12 months (RR, 0.69 [95% CI 0.46 to 1.04]) (**Appendix J Table 7**).[177]

Mortality

Two trials[176, 183] (n=344) reported no statistically significant difference in mortality between the intervention and control groups (RRs 0.40 [95% CI, 0.10 to 1.55] and 1.50 [95% CI, 0.26 to 8.77]) (**Figure 33; Appendix J Table 8**).

Other Outcomes

One trial reported people with a hospitalization (RR, .69 [95% CI, 1.00 to 2.85]) and one trial reported people with an ED visit (RR, 0.67 [95% CI, 0.36 to 1.26]) (**Appendix J Table 7**). Two trials[177, 183] reported no statistically significant difference in QOL between the intervention and control groups at 6 to 12 months (**Appendix J Table 9**).

Harms

No study reported harms.

Psychological Interventions

Summary of Results

Three RCTs of cognitive behavioral interventions, which targeted community-dwelling older adults at high risk of falling, were included (n=979). Due to few trials, the evidence base is considered inconclusive for the effect of psychological interventions on falls and falls-related outcomes. Two trials showed nonstatistically significant reductions in falls at 12- and 14-month followup (IRRs 0.86 [95% CI, 0.65 to 1.13] and 0.86 [95% CI, 0.65 to 1.14]). Only one of the three trials showed a statistically significant reduction in people with a fall (RR 0.72 [95% CI 0.58 to 0.90], RR 0.96 [95% CI 0.80 to 1.15], OR 1.40 [95% CI 0.45 to 4.37]). Only one trial reported a statistically significant reduction in people with two or more falls (RRs 0.59 [95% CI, 0.43 to 0.81] and 0.89 [95% CI, 0.67 to 1.19]). Trial results for falls resulting in injury were not statistically significant in either trial (RRs 0.78 [95% CI, 0.45 to 1.35] and 1.42 [95% CI, 0.96 to 2.10]). No study reported fall-related fractures or people with a fall resulting in injury. Trial results showed no difference in mortality between the intervention and control groups (RRs 0.98

[95% CI, 0.77 to 1.25] and 1.01 [95% CI, 0.36 to 2.81]). No differences were found in IADL outcomes between the intervention and control group. One study reported no adverse events.

Characteristics of Included Studies

We identified three RCTs (reported in 6 articles) that used cognitive behavioral interventions for reducing fear of falling (n=929).[184-189] Two trials were included in the previous review[185, 189] and one trial was newly identified[188].

Study Characteristics

The three fair-quality RCTs (n=979) aimed to reduce fear of falling and activity avoidance or to address concerns about falls in community-dwelling older adults (**Table 3; Appendix K Table 1**).[185, 188, 189] Two trials were conducted in the Netherlands[185, 189], and one was conducted in Australia[188].

Population Characteristics

All included trials targeted community-dwelling older adults with concerns or fear of falling, and two trials also recruited community-dwelling older adults who perceived their general health as fair or poor[185] or who had poor confidence in their balance[188] (**Table 3; Appendix K Tables 1 and 2**). Two trials recruited participants over the age of 70[188, 189], while one trial recruited older adults over 65 years of age[185]. The mean age ranged from 74 to 78, the percent female ranged from 70 to 72 percent. In the previous 6 months prior to the trials starting, more than half of participants (61%) in one trial[185], one-third of participants (35%) in another trial[189] had fallen at least once, and 44 percent of participants in the remaining trial had experienced at least one fall in the previous year[188] (**Figure 28; Appendix K Table 2**). Race and ethnicity were not reported for any of the included trials and measures of socioeconomic status were minimal.[185, 189]

Intervention Details

The three included trials all used a cognitive behavioral intervention designed to reduce fear of falling. Two of the trials were delivered in-person and facilitated by a nursing professional[185, 189], while the remaining trial was delivered virtually with self-directed online modules[188] (**Appendix K Table 3**). One trial delivered the intervention in group format, and was comprised of eight weekly 2-hour sessions with the purpose of addressing misconceptions on fall risks, setting realistic goals for safe activity, reducing home hazards, and promoting physical exercise to increase strength and balance.[189] Six of the eight sessions included 15 minutes of low-intensity physical exercise.[189] The other in-person trial used an individual approach, with seven total sessions (three 60-75 minute home visits, four 35-minute telephone contacts) over 16 weeks, which aimed to address concerns about falls, thoughts about falling, physical exercise, asserting oneself, overcoming personal barriers, safe behavior, and managing concerns about falls.[185] The remaining trial delivered an intervention consisting of three modules from the myCompass program, which is a self-help online cognitive behavioral therapy program.[188] Participants were given access to three skill-building modules that were relevant to fear of falling (Managing Fear and Anxiety, Taking Charge of Worry, and Solving Problems) for six weeks and were completed using a mobile device or a home computer.[188]

Intervention adherence. All trials reported adherence to the psychological intervention. One trial reported 58 percent of participants attended 5 of the 8 sessions.[189] In another trial, participant use of the action plans decreased towards the end of the trial, starting at 70 percent in initial sessions and dropping to 51 percent in the latter sessions.[185] In the online program intervention, the study reported that all intervention participants completed two out of the three required modules.[188]

Control groups. The control group for the two trials delivering an in-person intervention received usual care.[185, 189] The remaining trial delivered a minimal intervention to the control group, which consisted of all participants receiving two general health education booklets.[188]

Study Quality

All trials were rated fair quality with moderate or high risk of bias in at least one domain (**Appendix A Figure 3**).[185, 188, 189] Randomization was adequate, with no concerns that the groups differed at baseline. Data on falls were measured by participants' diaries, which were collected monthly[185, 188] or every 3 months[189]. However, there was differential attrition between the intervention and control groups for all trials, which resulted in a higher risk of bias due to missing data.

Detailed Results

Falls

Both trials[185, 189] reported the same nonstatistically significant lower rates of falls compared with the control group at 12 to 14 months of followup (IRRs 0.86 [95% CI, 0.65 to 1.13] and 0.86 [95% CI, 0.65, 1.14]) (**Figure 29; Appendix K Table 4**).

People With a Fall and People With Recurrent Falls

Only one of the three trials found a statistically significant reduction in people with one or more falls (RR 0.96 [95% CI, 0.80 to 1.15][185], RR 0.72 [95% CI, 0.58 to 0.90][189], OR 1.40 [95% CI 0.45 to 4.37][188]) (**Figure 30; Appendix K Table 5**). This same trial also reported a statistically significant reduction in people with 2 or more falls (RRs 0.59 [95% CI, 0.43 to 0.81][189] and 0.89 [95% CI, 0.67 to 1.19][185]) (**Figure 31; Appendix K Table 5**).

Falls Resulting in Injury or Medical Care and Fall-Related Fractures

The trial results for falls resulting in injury or medical care were mixed. At 12–14 months, one trial showed a nonstatistically significant reduction in fall-related injuries resulting in medical care in the intervention group compared to the control (IRR, 0.78 [95% CI, 0.45 to 1.35[189]]), but the other trial showed a nonsignificant increase in fall-related injuries (IRR, 1.42 [95% CI, 0.96, 2.10])[185] (**Figure 32; Appendix K Table 6**). Neither trial reported fall-related fractures.

People With a Fall Resulting in Injury or Medical Care and Fall-Related Fracture

Neither trial reported these outcomes.

Mortality

There was no difference in the number of participants who died between the intervention and control groups in either trial at longest followup (RR, 0.98 [95% CI, 0.77 to 1.25] at 7 years; RR, 1.01 [95% CI, 0.36 to 2.81] at 12 months) (**Figure 33; Appendix K Table 7**).

Other Outcomes

Both trials found no differences in IADL between the intervention and control group over 12-14 months of followup (**Appendix K Table 8**).

Harms

One trial reported no adverse events or side effects in the trial,[189] while the other did not report these outcomes.[185]

Education Interventions

Summary of Results

One trial that examined the effectiveness of a group education intervention in older adults at high risk of falls was included. This trial showed a statistically significant reduction in falls in the intervention group at 14 months (IRR, 0.68 [95% CI, 0.57 to 0.83]). No statistically significant difference was found between groups for people with a fall, people with recurrent falls, and QOL. No other relevant outcomes were reported.

Characteristics of Included Studies

We identified one trial (in one article) with a primary or secondary aim of examining the effectiveness of an educational intervention on falls or fall-related outcomes (n=310).[190] This trial was previously included; no were no new trials identified.

Study Characteristics

We identified one fair-quality RCT (n=310) conducted in Australia that examined the effectiveness of a group education intervention to prevent falls in adults aged 70 or older at increased risk for falling (**Table 3; Appendix L Table 1**).[190]

Population Characteristics

This trial recruited community-dwelling adults aged 70 years and older (**Table 3; Appendix L Tables 1 and 2**).[190] The mean age was 78, and approximately three-quarters of participants were female (74%). All participants were at increased risk for falling, based on personal concerns related to falling or fall history. Those with cognitive impairment were excluded. Race and ethnicity and measures of socioeconomic status were not reported. Twenty percent of participants were currently using psychotropic drugs at the time of recruitment, and per inclusion criteria, all participants had a fall in the previous 12 months or reported concerns about falling (**Figure 28**).[190]

Intervention Details

The trial implemented the Stepping On program, which aimed to improve fall self-efficacy, encourage behavior change, and reduce falls (**Appendix L Table 3**).[190] This program offered a combination of group classes in community and a followup home visit. Facilitated by an occupational therapist, approximately 15.5 hours of education sessions were delivered. Content of the Stepping On program curriculum included covering such topics as balance and strength exercises, how to cope with vision loss, encouraging medication management, and recommendations for environmental and behavioral home safety, and community safety. Additionally, each session provided an opportunity for action planning and homework for the next week. The individual home visit aimed to support follow through of fall-prevention strategies and activities.[190]

Intervention adherence. At the end of the trial, 59 percent of intervention participants were still doing their exercise routinely, 72 percent of those who needed a vision assessment initiated one, and 70 percent of program participants adhered to at least half of the environment recommendations.

Control groups. This trial included an attention control for the comparison group.[190] Participants randomized to the control received up to two social visits from an OT student. Visits were conducted at the same time as the Stepping On intervention and students leading the social visits were instructed not to discuss falls or falls prevention with participants.[190]

Study Quality

The trial was rated fair quality, with low risk of bias in all but one domain (**Appendix A Figure 3**).[190] The trial was found to have moderate risk of bias due to randomization procedures and confounding as authors reported statistically significant baseline differences between the intervention and control groups. Despite being controlled for some of these differences in the analyses, this may overestimate any benefit from the intervention. Study participants used diaries to record falls prospectively.

Detailed Results

Falls

The included trial showed statistically significant reductions in falls in the intervention group compared with the control group (IRR, 0.68 [95% CI, 0.57 to 0.83]) (**Figure 29; Appendix L Table 4**).[190]

People With a Fall and People With Recurrent Falls

The trial showed no difference at 14 months of followup (RR, 0.90 [95% CI, 0.73 to 1.10]).[190] Additionally, the trial reported a nonstatistically significant reduction in the number of people who had had two or more falls (RR, 0.74 [95% CI, 0.52 to 1.04]) (**Figures 30 and 31; Appendix L Table 5**).[190]

Falls Resulting in Injury or Medical Care and Fall-Related Fractures

The trial did not report these outcomes.

People With a Fall Resulting in Injury or Medical Care and Fall-Related Fractures

The trial did not report these outcomes.

Mortality

The trial did not report mortality.

Other outcomes

The included trial (n=258) reported on QOL at 14 months using the SF-36 physical and mental health components.[190] No statistically significant mean differences between the intervention and control group were found (**Appendix L Table 6**).[190]

Harms

The trial did not report harms.

Chapter 4. Discussion

Summary of Evidence

We conducted a systematic review to support the USPSTF in updating its recommendation on falls prevention in older community dwelling adults. A summary of evidence for each intervention type appears in **Tables 4 and 5**. Of the 83 included trials, 32 were newly identified trials reporting falls, people with falls, or fall-related injuries in average- and increased-risk older adults: two new multifactorial, 19 new exercise, three new exercise plus education, two new exercise plus environmental, three new environmental, two new medication review, one new psychological, and no new education-only intervention trials. The largest bodies of literature evaluated within this review were multifactorial and exercise interventions, which included 28 trials (N=27,784) and 37 trials (N=16,117), respectively. Our findings suggest that there is a statistically significant reduction only in the number of falls with multifactorial interventions and a statistically significant reduction in multiple falls-related outcomes with exercise interventions. These overall conclusions are generally consistent with our previous review[36] with the addition of newly published trials as well as trials solely recruiting specific populations with mild dementia, osteoporosis, osteoarthritis and sarcopenia. In fact, there were few trials in these populations.[100, 102, 108, 117, 118, 124, 127, 161] Of note, this update did not include vitamin D interventions as another in-process review will address the effectiveness of vitamin D to prevent falls and fractures.[37] Our findings are likewise consistent with other reviews of exercise and multifactorial interventions in community dwelling older adults.[191-199]

For multifactorial interventions, similar to the previous review[36], only the number of falls outcome was statistically significant in the pooled analysis. There were two new good quality trials[46, 48] that were added to the evidence base for this update; however, these very large trials had null findings for their primary outcomes. One hypothesis for these results is that the contemporary standard of care may provide a level of risk modification in the control group (falls risk assessment, medication review, exercise referrals) that may diminish relative benefits seen in the intervention. Some of the trials included a universally recommended exercise component,[54, 58, 77, 79, 83] while others provided exercise referrals only to some participants based on the initial risk assessment.[46, 48, 52, 56-58, 61, 62, 69, 74, 76, 77, 81, 84, 85, 88, 89] Furthermore, the systematic multifactorial interventions in these trials were extensive in their assessment and referrals; there was adherence drop off at each step of the process which may have diminished potential effectiveness. The effectiveness of such multi-step interventions may require extensive monitoring and followup to ensure adherence.

Evidence is most consistent across multiple fall-related outcomes for the exercise trials. For exercise interventions, the included trials doubled in number compared to our previous review, and the conclusions are mostly similar.[36] There remains a statistically significant association with number of falls, people with a fall, and injurious falls. In contrast to the previous review, there is no longer a statistically significant association between exercise and people with an injurious fall. This change in conclusion for this one fall-related outcome and the discordance across falls-related outcomes cannot be readily explained as the clinical and statistical heterogeneity in this body of evidence are substantial. We explored heterogeneity by various study, population, and intervention characteristics and found no patterns that suggested that any of these variables altered treatment effectiveness. Furthermore, two exercise trials reported within-study subgroup analyses for falls and/or fracture reporting no interaction by age, sex, history of falls, frailty and/or cognitive impairment.[48, 105] In terms of exercise harms, theoretically, increasing physical activity could lead to more frequent falls and injuries, but the trial literature is too limited to confirm this idea. Some of the exercise intervention trials and multifactorial interventions with exercise components have reported largely minor adverse effects associated with exercise, including muscle soreness; injurious falls occurring during exercise sessions were rare.[48, 105, 119]

For all other interventions, conclusions were limited by few trials for each intervention type and the availability of new trials could alter effect direction and size considerably.

To determine the absolute benefit of multifactorial and exercise interventions, we estimated the number of falls and people with a fall that could be prevented based on the pooled relative effect sizes and confidence intervals from our review and both fall rates from the included trials and national falls data[3] (**Figure 34**). These estimates should be interpreted with caution as they may suggest a false precision given the heterogeneity of intervention protocols and population characteristics for any given program and clinical population. In a hypothetical population of 1,000 older adults, based on national fall rates, multifactorial interventions would be expected to prevent between 36 and 186 falls. Exercise interventions would be expected to prevent 29 to 179 falls and 6 to 36 people from experiencing a fall, 9 to 44 falls resulting in injury. These absolute benefits would be greater in populations at higher risk for falls. It is important to underscore that overall, the participants in the multifactorial and exercise trials were at higher risk for falls than the national average and absolute benefits will be greater in higher risk populations. Furthermore, the multifactorial trial populations were at even higher risk for falls compared to the exercise trial populations (falls: weighted mean 1.46 falls per person-year versus 1.16 falls per person-year, respectively; weighted mean percent of people with 1+ falls: 48.4% versus 41.4%, respectively).

Falls and Falls-Related Outcomes

Most trials were designed to be powered for falls. However, the authors often assumed a larger difference between the intervention and control groups than what we have found in our review. Both falls and people with a fall represent clinically meaningful outcomes. Since each fall could result in injury, an intervention that reduces the number of falls could provide an important public health benefit by reducing the number of injuries and thus overall morbidity. Likewise, reducing the number of people experiencing a fall may represent an important outcome to individuals seeking to prevent the first fall and subsequent injury, activity limitation, and functional decline.

For effective interventions, trials would ideally show that interventions lead to fewer falls, fewer people with a fall, and in turn, fewer fall-induced injuries. We attempted to increase our power to analyze the effect of interventions on injuries by creating a composite category of "falls resulting in injury or medical care" (defined as a trial-reported injurious fall, fall-induced injury, or fall with injury resulting in medical attention), although we recognized that the severity of injuries may vary widely even among falls that lead to visits to an emergency department. For exercise interventions, we found a reduction in the number of injurious falls and people with injurious falls. The available evidence on injurious falls or people with injurious falls for the remaining intervention categories is either too limited, or findings suggests no effect. However, concluding that interventions other than exercise have no effect on fall-related injuries would be premature given that so few of the trials were designed to have adequate power for preventing injury (or fracture). The uncertainty of the effect of all interventions except exercise on injuries remains.

Implementation Issues

There are some important implementation considerations in applying our findings to the U.S. health care system for the multifactorial and exercise interventions. First, identifying those at increased fall risk who would be candidates for interventions remains a challenge. Simplified self-administered questionnaires are ideal for efficiency and while history of falls predicts future falls as well as primary care feasible questionnaires/functional tests, the use of falls history alone precludes prevention of the first fall.

While the majority of exercise trials consisted of group exercise programs (24 of 36 trials), one quarter (9 of 36 trials) involved individual programs similar to what is available in the US in the form of physical therapy referral. Most exercise trials included an additional unsupervised physical activity component independent of the structured group or individual sessions. Most of the exercise trials included multiple exercise types, the most common included gait/balance/function and strength/resistance training. Exploration of heterogeneity did not reveal any treatment modification based on exercise format or components, suggesting that primary care referrals for group community exercise programs, as well as traditional office-based physical therapy, are effective. The types of exercise programs provided varied across the interventions; however, the most commonly cited program was the Otago Exercise Program, which was delivered fully or partially by six studies.[48, 58, 124, 141, 148, 167] The next most commonly cited exercise programs delivered were Tai Chi exercise programs (in 4 studies),[102, 119, 121, 152] the Weight-bearing exercise for Better Balance program (delivered fully or in part in 3 studies),[136, 160, 167] and the Standing Tall program (delivered in 2 trials)[100, 105]. In the multifactorial trials, the individual treatment intervention—including physician specialty referrals, physical therapy/exercise, and environment interventions—are largely reflective of what patients could receive piecemeal in primary care. However, given the time constraints in a busy primary care clinic, these referrals may or may not be delivered in such a comprehensive fashion in the current U.S. health care delivery system, despite the introduction of the Medicare Initial and Annual Preventive Visits.[200] Adherence with multiple referrals and recommendations provided in a single visit presents an implementation challenge and may require case management for follow through. The exercise/PT interventions included in the multifactorial trials are similar to what patients receive in the U.S. clinical setting in their design (physical therapist designed and individually developed program based on functional assessment and diagnoses), delivery (physical therapist delivered most of the interventions—some individually and some group), and components (balance, gait, strength).

Ongoing Trials

There are several other ongoing research trials addressing the effectiveness of in-person and digital exercise programs, educational programs, home visitation programs, medication review interventions, and multicomponent interventions. These ongoing trials are listed in **Appendix M Table 1**. Four of these trials are based in the US and the largest ongoing trial is the Electronic Strategies for Tailored Exercise to Prevent FallS (eSTEPS) study (jointly funded by Brigham and Women's Hospital and the National Institute on Aging of the National Institutes of Health).[201] This is a large-scale (n=8,353), pragmatic cluster-randomized controlled trial of a clinical decision support implemented tailored falls prevention exercise plan (eSTEPS) in community-dwelling older adults at risk for falls (based on the STEADI screening protocol). The trial will recruit participants from urban and rural primary care clinics in the US, and report falls and fall-related injuries. The scheduled completion date is March 2025.[201]

Limitations of the Literature and Future Research Needs

Future research addressing multifactorial risk assessment interventions should include detailed protocol descriptions of such interventions including the specific protocol for the risk assessment and referrals as well as the time and personnel required to administer the assessment. Such protocols should be tested in large pragmatic trials using streamlined protocols for multifactorial risk assessment and referrals that are feasible for use in primary care practices. Further, it would be helpful to have large trials of medication review in the clinical setting with seamless communications with PCPs who can assess appropriateness of medication changes. Likewise, large trials providing environmental recommendations using checklists as well as capacity to implement modifications may provide an intervention that limits financial and logistical barriers to modification implementation. It remains uncertain whether psychological or educational interventions are effective for falls prevention, so trials of these interventions are needed. Finally, to provide adequate evidence on potential harms, all future research studies need to monitor adverse effects more consistently in both the control and intervention groups. There are several implementation issues including equity issues surrounding best practices for implementing multifactorial and exercise interventions in historically marginalized and medically underserved communities and how to improve adherence in all populations in real world settings. Future trials should recruit diverse participants representative of the US population and report population characteristics. Additional trials are needed for multifactorial and exercise interventions in community dwelling adults with mild cognitive impairment and mild dementia, osteoporosis, osteoarthritis, and sarcopenia. Any future research for multifactorial and exercise interventions in mixed risk populations should report results stratified by risk category.

Limitations of Our Approach

There are several limitations to our review scope and approach that are important to note. We included trials only when the primary or secondary aim was to prevent falls among older adults and a falls outcome was reported, both to select interventions with biologic plausibility of reducing falls and for pragmatic purposes. Further, our inclusion criteria generally represented

community-dwelling older adults seen in primary care and there are many subgroups of older adults to which these results may not apply. While we expanded our criteria to include trials recruiting older adults with mild cognitive impairment or mild dementia, osteoporosis, osteoarthritis, and sarcopenia, we still excluded trials that specifically recruited participants with major neurologic diagnoses (e.g., moderate to severe dementia, Parkinson's disease, stroke) because those populations may require specialized approaches to preventing falls.
Our attempts to describe the recruitment setting may also have limitations. While we aimed to distinguish studies that recruited participants from primary care and the community as separate from those that identified participants through their use of the emergency department, mixed recruitment strategies at times meant we may have under or overestimated the applicability of the recruitment setting.

Further, we tried to consistently categorize and describe the interventions, but the intervention procedures were not always described in adequate detail. This likely resulted in imprecision and potentially some inaccuracies in our categorizations and descriptions of some of the included interventions. Similarly, we did not include comparative effectiveness trials and excluded any trial where the comparison group had an active control (e.g., stretching, walking). At times it was difficult to determine whether a comparator was too intense to be considered a minimal control. Our protocol prioritized health outcomes consistent with the USPSTF methodology—specifically falls, falls-related morbidity, and mortality—and did not include intermediate functional outcomes, such as changes in balance, endurance, or walking speed. It is possible that these interventions also have a beneficial impact on these intermediate functional outcomes, which may lead to a later decrease in falls. Additionally, while we recognize that falls efficacy scales and fear of falling are commonly reported in trials, we excluded these outcomes in favor of direct fall event outcomes. We also did not examine other non-fall-related health outcomes that may have a positive association with these interventions (e.g., the effect of exercise on cardiovascular or mental health outcomes).

Conclusion

The current evidence base demonstrates that exercise is associated with fewer falls, fewer people with a fall, and a reduced number of injurious falls in average- and increased-risk community dwelling older adults. Multifactorial interventions appear to reduce falls but not people with a fall or injuries; trials are clinically and statistically heterogeneous. Other single falls prevention interventions including environmental modification, medication management, education, and psychological interventions as well as falls interventions with multiple components like exercise plus education and exercise plus environment have either few trials showing no statistically significant effect or a few trials reporting mixed results.

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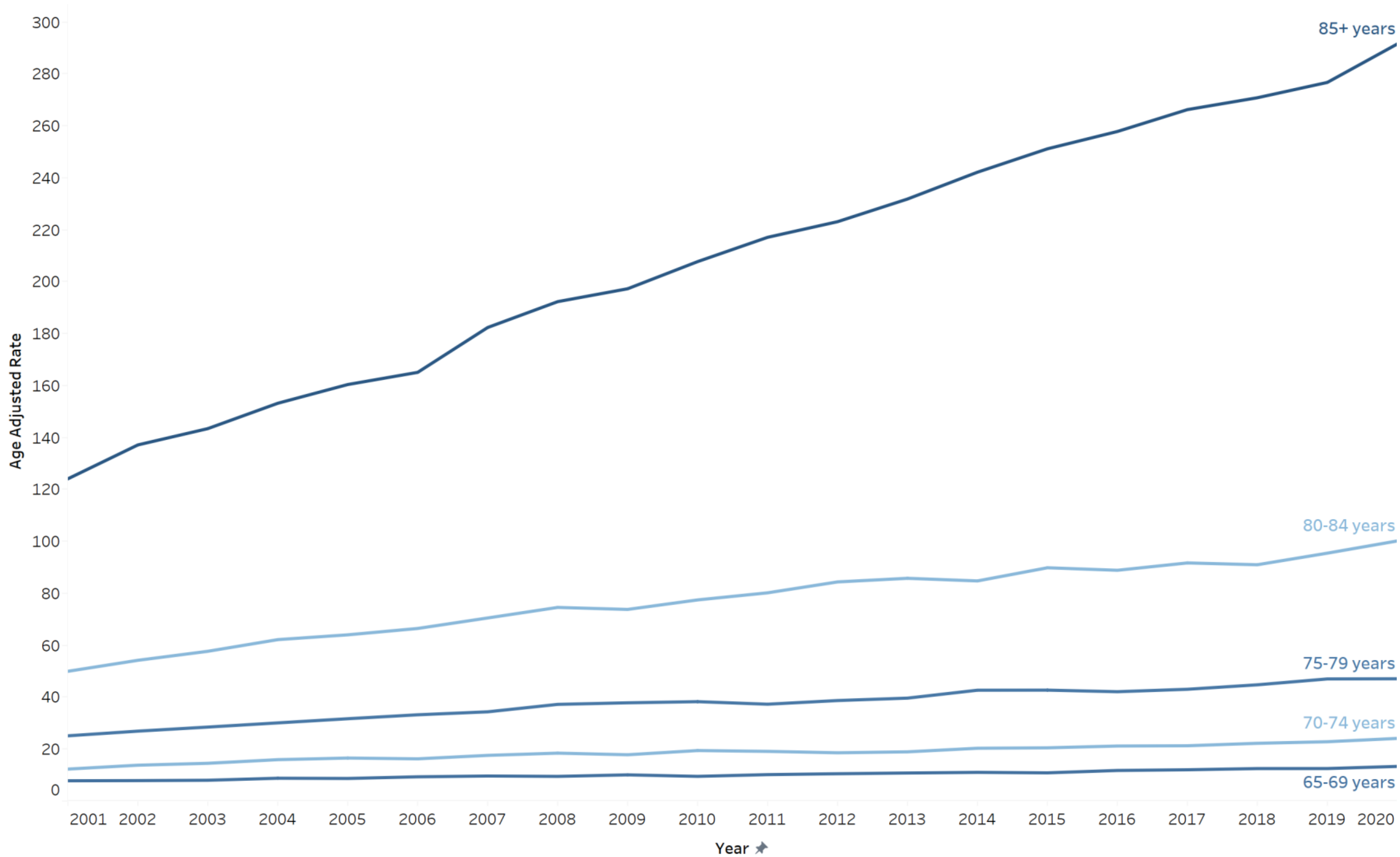
Figure 1. Unintentional Fall Death Rate From 2001 to 2020, by Age Group



Note: Data on unintentional fall deaths from the Centers for Disease Control and Prevention Web-based Injury Statistics Query and Reporting System. https://www.cdc.gov/injury/wisqars/index.html. Accessed 02.16.2023.

Figure 2. Analytic Framework

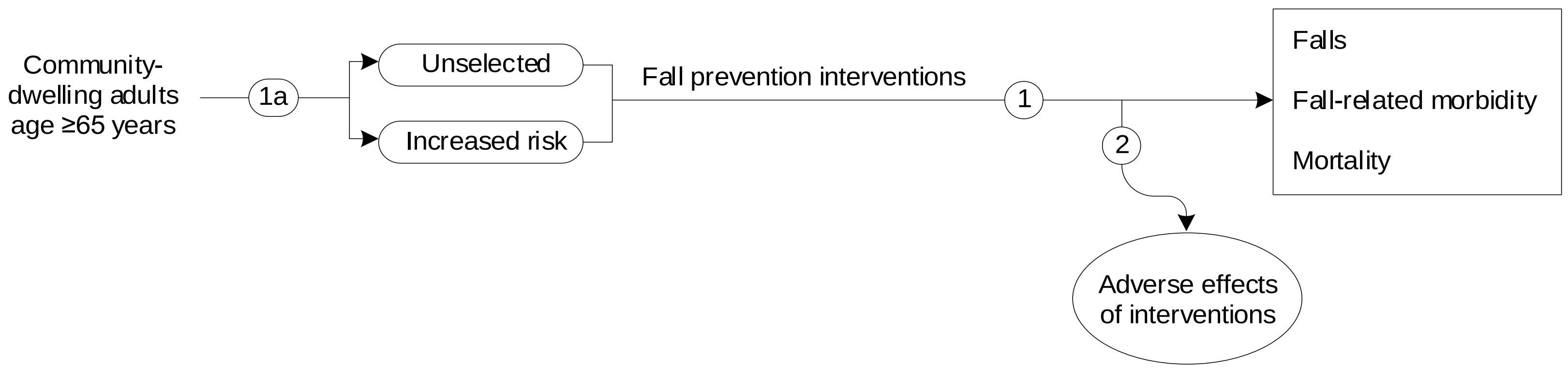
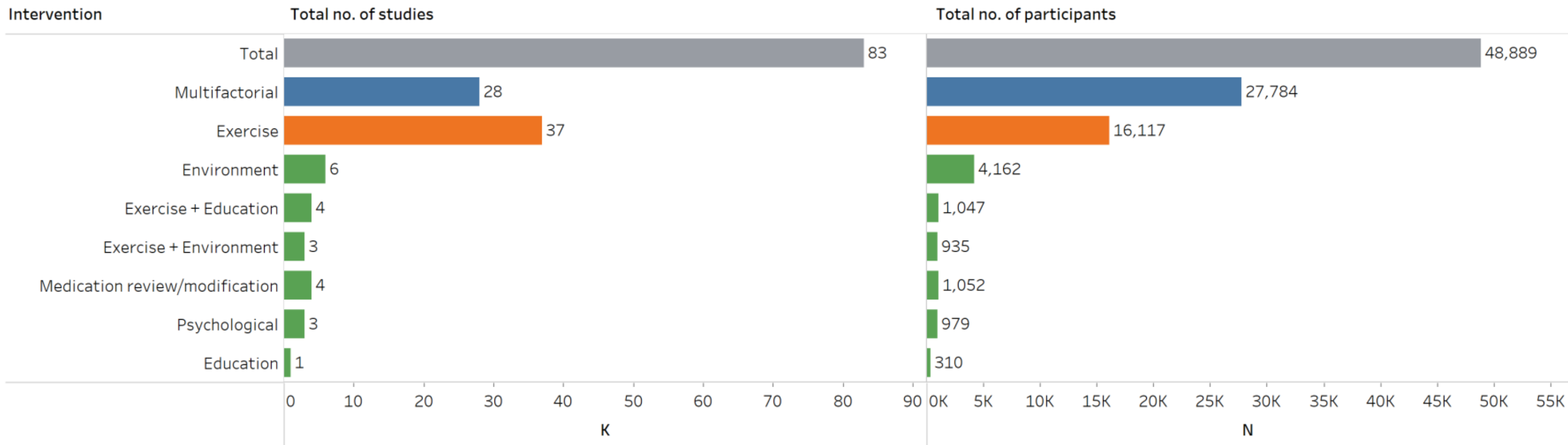


Figure 3. Total Number of Studies and Randomized Participants, by Intervention Group



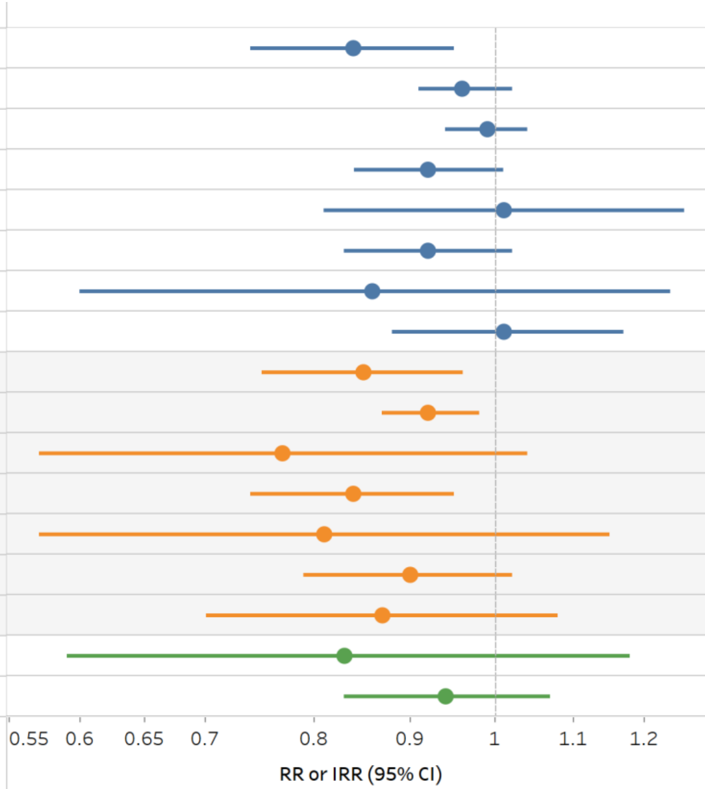
Abbreviations: k = number of studies, n = number of participants

Figure 4. Evidence Map by Intervention Type: Outcomes and Number of People Analyzed

	Outcome					
Intervention	No. of falls	No. of falls resulting in injury or medical care	Person with 1+ falls	Person with fall resulting in injury or medical care	Mortality	Harms
Multifactorial	22,115	10,563	23,626	13,460	21,596	4,199
Exercise	14,475	3,984	13,384	3,924	10,461	10,630
Exercise + Education	1,043	881	1,043		615	522
Exercise + Environment	581	581	935		309	309
Evironment	3,956	1,604	2,242		1,201	1,606
Medication review	186	186	846		344	
Psychological	886	886	936		928	540
Education	310		310			

Figure 5. Pooled Analyses for Multifactorial, Exercise, and Environment Interventions

Intervention	Outcome	K	N	RR or IRR (95% CI)
Multifactorial	No. of falls	20	22115	0.84 (0.74, 0.95)
	Person with 1+ falls	26	23626	0.96 (0.91, 1.02)
	Person with 2+ falls	11	14471	0.99 (0.94, 1.04)
	No. of falls resulting in injury or medical care	12	10563	0.92 (0.84, 1.01)
	No. of fall-related fractures	7	15211	1.01 (0.81, 1.26)
	Person with fall resulting in injury or medical care	13	13460	0.92 (0.83, 1.02)
	Person with fall-related fracture	7	13912	0.86 (0.60, 1.24)
	Mortality	24	21596	1.01 (0.88, 1.17)
Exercise	No. of falls	29	14475	0.85 (0.75, 0.96)
	Person with 1+ falls	25	13384	0.92 (0.87, 0.98)
	Person with 2+ falls	9	8502	0.77 (0.57, 1.04)
	No. of falls resulting in injury or medical care	12	3984	0.84 (0.74, 0.95)
	No. of fall-related fractures	8	8537	0.81 (0.57, 1.15)
	Person with fall resulting in injury or medical care	9	3924	0.90 (0.79, 1.02)
	Mortality	15	10461	0.87 (0.70, 1.08)
Evironment	No. of falls	6	3956	0.83 (0.59, 1.18)
	Person with 1+ falls	5	2242	0.94 (0.83, 1.07)



Abbreviations: CI = confidence interval; IRR = incidence rate ratio; k = number of studies; n = number of participants; RR = relative risk.

Figure 6. Baseline Fall Risk Ascertainment for Multifactorial Interventions

Author, year	% at increased risk	Fall history	Hospital/ED	Physical function	Osteoporosis/ osteopenia	Medications	Frailty	Fear of falling	Other	NR
Bhasin, 2020	100	X						X		
Ciaschini, 2009	100		X	X	X					
Close, 1999	100		X							
Conroy, 2010	100	X		X		X			X	
Davison, 2005	100		X							
de Vries, 2010	100		X							
Elley, 2008	100	X								
Fairhall, 2014	100						X			
Hendriks, 2008	100		X							
Hogan, 2001	100	X								
La Porta, 2022	100								X	
Lightbody, 2002	100		X							
Logan, 2010	100		X							
Moller, 2014	100		X						X	
Palvanen, 2014	100	X		X	X		X		X	
Russell, 2010	100		X							
Salminen, 2009	100	X								
Spice, 2009	100	X								
Tinetti, 1994	100			X		X			X	
van Haastregt, 2000	100	X		X						
Vind, 2009	100		X							
Cohen, 2015	19	X								
Perula, 2012	31	X								
Wagner, 1994	34	X								
Imhof, 2012	40	X								
Bruce, 2021	44	X		X						
Ferrer, 2014	NR									X
Lord, 2005	NR									X

Abbreviations: ED = emergency department; NR = not reported

Figure 7. Baseline Assessment Components for Multifactorial Interventions

Author Year	Environ	Fxn	Meds	Vision	Diag	Physical exam	Geriatric assess	ADL	Assist device	Bone health	Cog Fxn	CVD	Exercise	Fall history	Fall risk	Foot health	Hearing	Mental health	Nutr	Ortho hypo	EtOH/ drugs	Urinary incont
Bhasin, 2020	X	X	X	X						X						X				X		
Bruce, 2021	X	X	X	X										X		X				X		
Ciaschini, 2009	X	X	X					X												X		
Close, 1999	X	X	X	X			X	X			X							X				
Cohen, 2015	X	X	X											X								
Conroy, 2010	X	X	X		X	X														X		
Davison, 2005	X	X	X	X	X							X		X		X				X		
de Vries, 2010	X	X	X	X	X	X				X				X						X		
Elley, 2008	X	X		X	X					X	X	X		X								
Fairhall, 2014	X	X	X		X		X											X	X			X
Ferrer, 2014	X	X	X	X				X			X						X		X			
Hendriks, 2008	X	X	X	X	X	X					X	X		X			X	X				
Hogan, 2001	X	X		X																X	X	
Imhof, 2012		X		X	X		X				X						X	X				X
La Porta, 2022	X	X	X	X			X		X	X	X	X			X				X			
Lightbody, 2002	X	X	X	X							X	X				X	X					
Logan, 2010	X		X																			
Lord, 2005		X		X											X							
Moller, 2014	X	X	X																			
Palvanen, 2014	X	X	X	X				X	X		X	X	X	X				X	X		X	
Perula, 2012	X														X							
Russell, 2010				X											X			X	X	X		
Salminen, 2009	X	X	X	X						X								X	X			
Spice, 2009	X	X	X	X						X	X	X		X		X				X	X	
Tinetti, 1994	X	X	X	X	X			X						X			X	X				
van Haastregt, 2000	X	X	X					X			X											
Vind, 2009		X	X	X	X	X					X	X		X				X				
Wagner, 1994	X		X	X									X				X				X	

Abbreviations: assist device = assistive devices; cog fxn = cognitive function; CVD = cardiovascular disease; EtOH/drugs = alcohol and drug use; Diag = diagnosis; Environ = environment; exam = examination; fxn = function; incont = incontinence; meds = medications; nutr = nutrition; ortho hypo = orthostatic hypotension

Figure 8. Referrals/Recommendations as Indicated by the Assessment Results for Multifactorial Interventions

Author Year	Environ	Exer	Meds	Vision/Aud	PCP	OT	Assist devices	Pod	Nut	EtOH	CVD	Neuro	Osteo tx	Psych	Unspec
Bhasin, 2020	×	×	×	×	×			×					×		
Bruce, 2021	×	×	×	×	×	×		×							
Ciaschini, 2009		×	×			×									
Close, 1999	×		×												×
Cohen, 2015	×				×										
Conroy, 2010	×														×
Davison, 2005	×	×		×			×	×							
de Vries, 2010	×	×		×	×										×
Elley, 2008	×	×		×	×	×									×
Fairhall, 2014		×	×			×	×		×					×	×
Ferrer, 2014	×	×		×					×						×
Hendriks, 2008	×				×		×								
Hogan, 2001	×	×		×						×					×
Imhof, 2012															×
La Porta, 2022				×	×			×			×				×
Lightbody, 2002			×	×				×							×
Logan, 2010			×												
Lord, 2005		×		×											
Moller, 2014		×				×									×
Palvanen, 2014		×	×				×		×	×					×
Perula, 2012	×														
Russell, 2010		×			×	×	×	×	×						×
Salminen, 2009			×												
Spice, 2009	×	×	×	×		×									×
Tinetti, 1994	×	×	×												
van Haastregt, 2000	×														×
Vind, 2009		×	×	×							×	×			×
Wagner, 1994	×	×	×	×	×					×					

Abbreviations: environ = environment; exer = exercise; meds = medications; aud = auditory; PCP = primary care practitioner; OR = occupational therapist; assist devices = assistive devices; pod = podiatry; nut = nutrition; EtOH = alcohol; CVD = cardiovascular disease; neuro = neurology; psych = psychiatry; unspec = unspecified

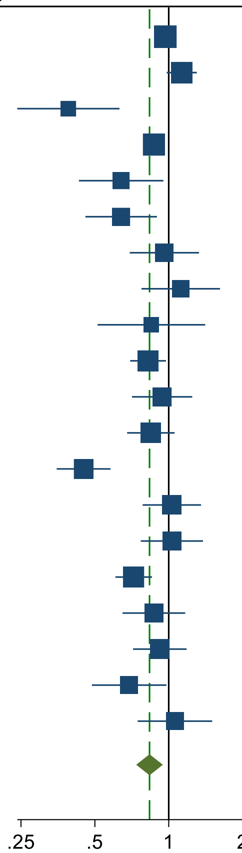
Figure 9. Components Delivered to All Intervention Participants for Multifactorial Interventions

Author Year	Advice	Environment	Educational materials	Exercise	Falls education	Counseling
Bhasin, 2020	×					×
Bruce, 2021	×					
Ciaschini, 2009	×		×			
Close, 1999	×	×				
Cohen, 2015	×		×	×		×
Conroy, 2010	×		×	×	×	
Davison, 2005	×					
de Vries, 2010	×					
Elley, 2008	×	×	×	×		
Fairhall, 2014	×					
Ferrer, 2014	×	×	×			
Hendriks, 2008	×	×				
Hogan, 2001	×					
Imhof, 2012	×					×
La Porta, 2022	×	×		×	×	
Lightbody, 2002	×	×				
Logan, 2010	×	×		×	×	
Lord, 2005	×					
Moller, 2014	×	×		×		
Palvanen, 2014	×	×		×		
Perula, 2012	×		×	×	×	
Russell, 2010	×					
Salminen, 2009	×	×	×	×	×	
Spice, 2009	×					
Tinetti, 1994	×					
van Haastregt, 2000	×	×				
Vind, 2009	×					
Wagner, 1994	×					

Figure 10. Key Question 1: Pooled Analysis of the Number of Falls at the Longest Followup for Multifactorial Interventions (k=20, n=22,115)

Study	Months followup	n Analyzed	IG event rate py	CG event rate py	IRR with 95% CI
Bhasin, 2020	28	5451	1.041	1.088	0.97 (0.94, 1.01)
Bruce, 2021	18	6524	1.272	1.056	1.13 (0.98, 1.30)
Close, 1999	12	397	.995	2.394	0.39 (0.24, 0.63)
Cohen, 2015	12	3301	.	.	0.87 (0.79, 0.96)
Conroy, 2010	12	344	1.7	2.7	0.64 (0.43, 0.95)
Davison, 2005	12	293	3.3	5.1	0.64 (0.46, 0.90)
Elley, 2008	12	312	1.91	2.01	0.96 (0.69, 1.33)
Fairhall, 2014	12	241	1.54	1.5	1.12 (0.77, 1.62)
Ferrer, 2014	12	328	.348	.378	0.85 (0.51, 1.41)
Hogan, 2001	12	163	3.051	3.702	0.82 (0.70, 0.97)
La Porta, 2022	12	403	1.66	1.765	0.94 (0.71, 1.25)
Lightbody, 2002	6	314	1.819	2.151	0.85 (0.68, 1.06)
Logan, 2010	12	204	3.46	7.68	0.45 (0.35, 0.58)
Lord, 2005	12	403	.906	.871	1.03 (0.78, 1.36)
Moller, 2014	12	153	1.2	1.164	1.03 (0.77, 1.38)
Palvanen, 2014	12	1314	.95	1.31	0.72 (0.61, 0.85)
Russell, 2010	12	698	2.77	4.24	0.87 (0.65, 1.17)
Salminen, 2009	12	589	.832	.912	0.92 (0.72, 1.18)
Tinetti, 1994	12	291	.624	.936	0.69 (0.49, 0.98)
Vind, 2009	12	392	2.153	2.031	1.06 (0.75, 1.50)
Overall					0.84 (0.74, 0.95)

Heterogeneity: $\tau^2 = 0.05$, $I^2 = 84.97\%$, $H^2 = 6.65$



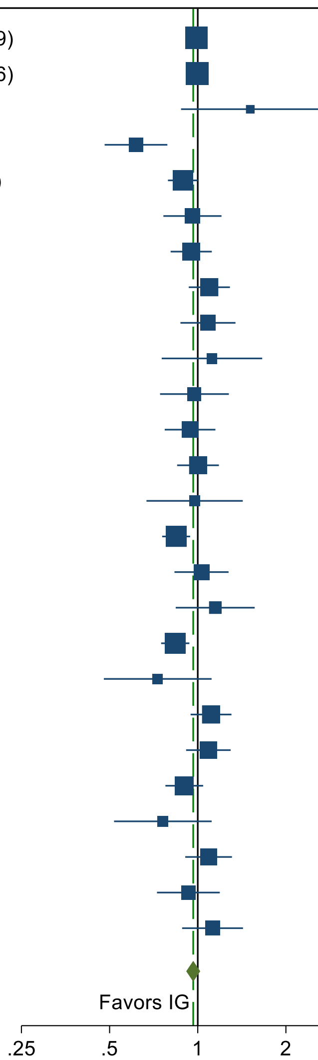
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CI = confidence interval; CG = control group; IG = intervention group; IRR = incidence rate ratio; p-y = person-year

Figure 11. Key Question 1: Pooled Analysis of People With 1 or More Falls at the Longest Followup for Multifactorial Interventions (k=26, n=23,626)

Study	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Bhasin, 2020	28	1833/2802 (65.4)	1798/2649 (67.9)	0.99 (0.91, 1.08)
Bruce, 2021	18	1301/3301 (39.4)	1276/3223 (39.6)	1.00 (0.93, 1.07)
Ciaschini, 2009	6	26/101 (25.7)	17/100 (17)	1.51 (0.88, 2.60)
Close, 1999	12	59/184 (32.1)	111/213 (52.1)	0.62 (0.48, 0.79)
Cohen, 2015	12	416/1586 (26.2)	504/1715 (29.4)	0.89 (0.79, 1.00)
Conroy, 2010	12	69/136 (50.7)	73/138 (52.9)	0.96 (0.76, 1.21)
Davison, 2005	12	94/144 (65.3)	102/149 (68.5)	0.95 (0.81, 1.12)
Elley, 2008	12	106/155 (68.4)	98/157 (62.4)	1.10 (0.93, 1.29)
Fairhall, 2014	12	72/120 (60)	67/121 (55.4)	1.08 (0.87, 1.35)
Ferrer, 2014	12	40/142 (28.2)	33/131 (25.2)	1.12 (0.75, 1.66)
Hendriks, 2008	12	55/124 (44.4)	61/134 (45.5)	0.97 (0.74, 1.28)
Hogan, 2001	12	54/79 (68.4)	61/84 (72.6)	0.94 (0.77, 1.15)
La Porta, 2022	12	119/203 (58.6)	117/200 (58.5)	1.00 (0.85, 1.18)
Lightbody, 2002	6	39/155 (25.2)	41/159 (25.8)	0.98 (0.67, 1.42)
Logan, 2010	12	81/102 (79.4)	96/102 (94.1)	0.84 (0.76, 0.94)
Lord, 2005	12	93/202 (46)	90/201 (44.8)	1.03 (0.83, 1.27)
Moller, 2014	12	44/80 (55)	35/73 (47.9)	1.15 (0.84, 1.56)
Palvanen, 2014	12	296/661 (44.8)	349/653 (53.4)	0.84 (0.75, 0.94)
Perula, 2012	12	23/133 (17.3)	64/271 (23.6)	0.73 (0.48, 1.12)
Russell, 2010	12	163/320 (50.9)	151/330 (45.8)	1.11 (0.95, 1.30)
Salminen, 2009	12	140/292 (47.9)	131/297 (44.1)	1.09 (0.91, 1.30)
Spice, 2009	12	158/210 (75.2)	133/159 (83.6)	0.90 (0.78, 1.04)
Tinetti, 1994	12	52/147 (35.4)	68/144 (47.2)	0.76 (0.52, 1.12)
Vind, 2009	12	110/196 (56.1)	101/196 (51.5)	1.09 (0.91, 1.31)
de Vries, 2010	12	55/106 (51.9)	62/111 (55.9)	0.93 (0.73, 1.19)
van Haastregt, 2000	18	68/120 (56.7)	58/115 (50.4)	1.12 (0.88, 1.43)
Overall				0.96 (0.91, 1.02)

Heterogeneity: $\tau^2 = 0.01$, $I^2 = 48.15\%$, $H^2 = 1.93$



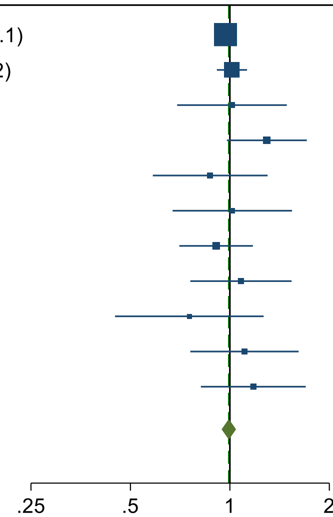
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 12. Key Question 1: Pooled Analysis of People With 2 or More Falls at the Longest Followup for Multifactorial Interventions (k=11, n=14,471)

Study	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Bhasin, 2020	28	1242/2802 (44.3)	1220/2649 (46.1)	0.97 (0.91, 1.04)
Bruce, 2021	18	743/3301 (22.5)	715/3223 (22.2)	1.01 (0.91, 1.13)
Conroy, 2010	12	38/136 (27.9)	38/138 (27.5)	1.01 (0.69, 1.49)
Elley, 2008	12	69/155 (44.5)	54/157 (34.4)	1.29 (0.98, 1.71)
Fairhall, 2014	12	32/120 (26.7)	37/121 (30.6)	0.87 (0.58, 1.30)
Hendriks, 2008	12	32/124 (25.8)	34/134 (25.4)	1.02 (0.67, 1.54)
La Porta, 2022	12	71/203 (35)	77/200 (38.5)	0.91 (0.70, 1.17)
Lord, 2005	12	49/202 (24.3)	45/201 (22.4)	1.08 (0.76, 1.54)
Moller, 2014	12	19/80 (23.8)	23/73 (31.5)	0.75 (0.45, 1.27)
de Vries, 2010	12	37/106 (34.9)	35/111 (31.5)	1.11 (0.76, 1.62)
van Haastregt, 2000	18	43/120 (35.8)	35/115 (30.4)	1.18 (0.82, 1.70)
Overall				0.99 (0.94, 1.04)

Heterogeneity: $\tau^2 = 0.00$, $I^2 = 0.00\%$, $H^2 = 1.00$



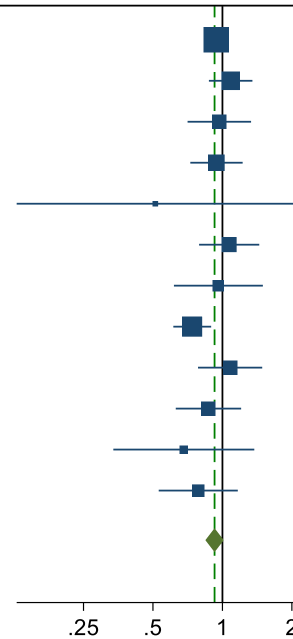
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk

Figure 13. Key Question 1: Pooled Analysis of the Number of Falls Resulting in Injury or Medical Care at the Longest Followup for Multifactorial Interventions (k=12, n=10,563)

Study	Outcome	Months followup	n Analyzed	IG event rate py	CG event rate py	IRR with 95% CI
Bhasin, 2020	Fall resulting in injuries	44	5451	.358	.38	0.94 (0.84, 1.06)
Elley, 2008	Fall resulting in injuries	12	312	1.14	1.05	1.09 (0.87, 1.35)
Fairhall, 2014	Fall resulting in injuries	12	241	.625	.645	0.97 (0.71, 1.33)
La Porta, 2022	Fall resulting in injuries	12	403	.542	.575	0.94 (0.73, 1.22)
Lightbody, 2002	Fall resulting in serious injuries	6	314	.039	.075	0.51 (0.13, 2.05)
Lord, 2005	Fall resulting in injuries	12	403	.589	.537	1.07 (0.79, 1.44)
Moller, 2014	Fall resulting in injuries	12	153	.5	.521	0.96 (0.62, 1.50)
Palvanen, 2014	Fall-related injuries	12	1314	.55	.75	0.74 (0.61, 0.89)
Russell, 2010	Fall-related injuries	12	698	1.07	1.01	1.08 (0.78, 1.49)
Salminen, 2009	Fall resulting in medical care	36	591	.141	.163	0.87 (0.63, 1.21)
Tinetti, 1994	Fall resulting in medical care	12	291	.17	.25	0.68 (0.34, 1.37)
Vind, 2009	Fall resulting in medical care	12	392	.224	.286	0.79 (0.53, 1.17)
Overall						0.92 (0.84, 1.01)

Heterogeneity: $\tau^2 = 0.01$, $I^2 = 21.79\%$, $H^2 = 1.28$



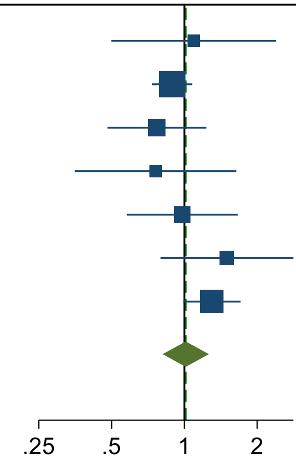
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CI = confidence interval; CG = control group; IG = intervention group; IRR = incidence rate ratio; n = number; p-y = person-year

Figure 14. Key Question 1: Pooled Analysis of the Number of Fall-Related Fractures at the Longest Followup for Multifactorial Interventions (k=7, n=15,211)

Study	Outcome	Months followup	n Analyzed	IG event rate py	CG event rate py	IRR with 95% CI
Fairhall, 2014	Fall resulting in fractures	12	241	.108	.099	1.09 (0.50, 2.39)
Bhasin, 2020	Fall-related fracture	44	5451	.021	.024	0.89 (0.74, 1.08)
Palvanen, 2014	Fall-related fracture	12	1314	.05	.07	0.77 (0.48, 1.23)
Russell, 2010	Fall-related fracture	12	698	.03	.05	0.76 (0.35, 1.64)
Salminen, 2009	Fall-related fracture	36	591	.031	.031	0.98 (0.58, 1.66)
Vind, 2009	Fall-related fracture	12	392	.122	.082	1.50 (0.80, 2.82)
Bruce, 2021	Fracture	18	6524	.035	.028	1.30 (0.99, 1.71)
Overall						1.01 (0.81, 1.26)

Heterogeneity: $\tau^2 = 0.02$, $I^2 = 34.05\%$, $H^2 = 1.52$



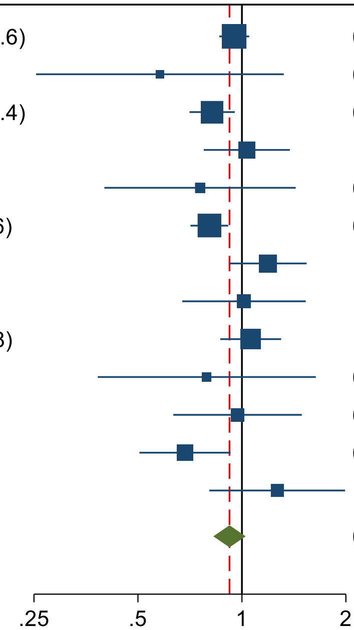
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CI = confidence interval; CG = control group; IG = intervention group; IRR = incidence rate ratio; n = number; p-y = person-year.

Figure 15. Key Question 1: Pooled Analysis of People With a Fall Resulting in Injury or Medical Care at the Longest Followup for Multifactorial Interventions (k=13, n=13,460)

Study	Outcome	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Bhasin, 2020	Person with fall resulting in medical care	28	772/2802 (27.6)	785/2649 (29.6)	0.95 (0.86, 1.05)
Close, 1999	Person with fall resulting in injury	12	8/184 (4.3)	16/213 (7.5)	0.58 (0.25, 1.32)
Cohen, 2015	Person with fall resulting in injury	12	254/1586 (16)	333/1715 (19.4)	0.82 (0.71, 0.95)
Conroy, 2010	Person with fall resulting in injury	12	56/136 (41.2)	55/138 (39.9)	1.03 (0.78, 1.38)
Hendriks, 2008	Person with fall resulting in injury	12	14/124 (11.3)	20/134 (14.9)	0.76 (0.40, 1.43)
Imhof, 2012	Person with fall resulting in injury	9	131/207 (63.3)	162/206 (78.6)	0.80 (0.71, 0.91)
Lord, 2005	Person with fall resulting in injury	12	80/202 (39.6)	67/201 (33.3)	1.19 (0.92, 1.54)
Moller, 2014	Person with fall resulting in injury	12	30/80 (37.5)	27/73 (37)	1.01 (0.67, 1.53)
Russell, 2010	Person with fall resulting in injury	12	118/320 (36.9)	115/330 (34.8)	1.06 (0.87, 1.30)
Tinetti, 1994	Person with fall resulting in medical care	12	21/147 (14.3)	26/144 (18.1)	0.79 (0.38, 1.64)
Vind, 2009	Person with fall resulting in injury	12	34/196 (17.3)	35/196 (17.9)	0.97 (0.63, 1.49)
Wagner, 1994	Person with fall resulting in injury	12	63/635 (9.9)	88/607 (14.5)	0.68 (0.51, 0.93)
van Haastregt, 2000	Person with fall resulting in injury	18	33/120 (27.5)	25/115 (21.7)	1.26 (0.80, 1.99)
Overall					0.92 (0.83, 1.02)

Heterogeneity: $\tau^2 = 0.01$, $I^2 = 47.26\%$, $H^2 = 1.90$



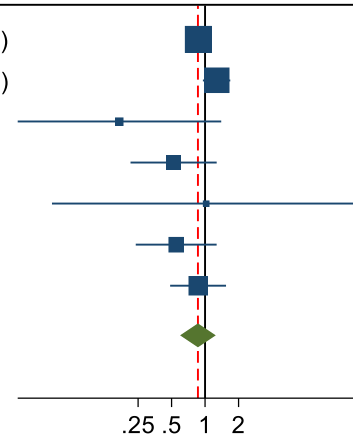
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 16. Key Question 1: Pooled Analysis of People With Fall-Related Fractures at the Longest Followup for Multifactorial Interventions (k=7, n=13,912)

Study	Outcome	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Bhasin, 2020	Person with fall-related fracture	44	184/2802 (6.6)	203/2649 (7.7)	0.87 (0.72, 1.05)
Bruce, 2021	Person with fracture	18	143/3301 (4.3)	110/3223 (3.4)	1.27 (0.96, 1.68)
Ciaschini, 2009	Person with fracture	6	1/101 (1)	6/100 (6)	0.17 (0.02, 1.40)
Davison, 2005	Person with fracture	12	7/159 (4.4)	13/154 (8.4)	0.52 (0.21, 1.27)
Perula, 2012	Person with fall-related fracture	12	1/133 (.8)	2/271 (.7)	1.02 (0.04, 24.73)
Russell, 2010	Person with fall-related fracture	12	8/320 (2.5)	15/330 (4.5)	0.55 (0.24, 1.27)
Spice, 2009	Person with fall-related fracture	12	40/210 (19)	35/159 (22)	0.87 (0.49, 1.54)
Overall					0.86 (0.60, 1.24)

Heterogeneity: $\tau^2 = 0.06$, $I^2 = 49.01\%$, $H^2 = 1.96$



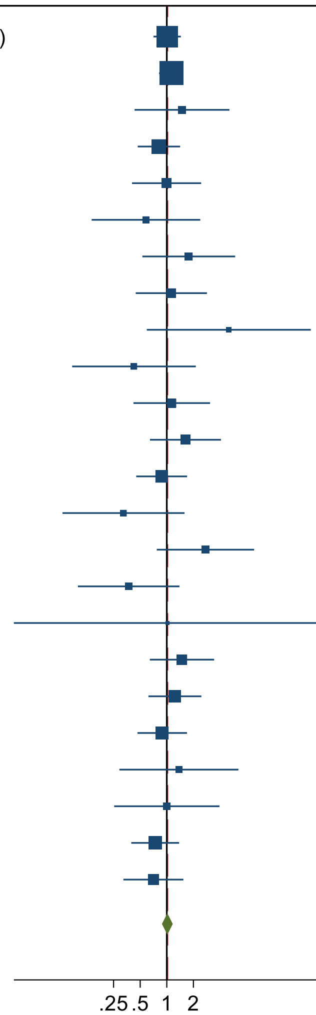
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 17. Key Question 1: Pooled Analysis of Mortality at the Longest Followup for Multifactorial Interventions (k=24, n=21,596)

Study	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Bhasin, 2020	42	235/2802 (8.4)	220/2649 (8.3)	1.01 (0.71, 1.44)
Bruce, 2021	18	107/3301 (3.2)	93/3223 (2.9)	1.12 (0.82, 1.54)
Ciaschini, 2009	6	6/101 (5.9)	4/100 (4)	1.49 (0.43, 5.10)
Close, 1999	12	19/184 (10.3)	27/213 (12.7)	0.81 (0.47, 1.42)
Conroy, 2010	12	9/182 (4.9)	9/181 (5)	0.99 (0.40, 2.45)
Davison, 2005	12	3/159 (1.9)	5/154 (3.2)	0.58 (0.14, 2.39)
Elley, 2008	12	7/155 (4.5)	4/157 (2.5)	1.77 (0.53, 5.93)
Ferrer, 2014	12	9/164 (5.5)	8/164 (4.9)	1.13 (0.44, 2.84)
Hendriks, 2008	12	5/166 (3)	1/167 (.6)	5.03 (0.59, 42.60)
Hogan, 2001	12	2/79 (2.5)	5/84 (6)	0.43 (0.08, 2.13)
Imhof, 2012	9	8/231 (3.5)	7/230 (3)	1.14 (0.42, 3.09)
Lightbody, 2002	6	11/171 (6.4)	7/177 (4)	1.63 (0.65, 4.10)
Logan, 2010	12	14/102 (13.7)	16/102 (15.7)	0.88 (0.45, 1.70)
Lord, 2005	12	2/210 (1)	6/204 (2.9)	0.32 (0.07, 1.59)
Moller, 2014	12	9/80 (11.3)	3/73 (4.1)	2.74 (0.77, 9.72)
Palvanen, 2014	12	3/661 (.5)	8/653 (1.2)	0.37 (0.10, 1.39)
Perula, 2012	12	1/133 (.8)	2/271 (.7)	1.02 (0.02, 55.72)
Russell, 2010	12	13/351 (3.7)	9/361 (2.5)	1.49 (0.64, 3.43)
Salminen, 2009	36	17/293 (5.8)	14/298 (4.7)	1.24 (0.62, 2.46)
Spice, 2009	12	34/210 (16.2)	29/159 (18.2)	0.89 (0.47, 1.69)
Tinetti, 1994	12	7/147 (4.8)	5/144 (3.5)	1.37 (0.29, 6.46)
Vind, 2009	12	4/196 (2)	4/196 (2)	1.00 (0.25, 3.94)
Wagner, 1994	24	17/635 (2.7)	22/607 (3.6)	0.74 (0.40, 1.38)
van Haastregt, 2000	18	10/159 (6.3)	14/157 (8.9)	0.71 (0.32, 1.54)
Overall				1.01 (0.88, 1.17)

Heterogeneity: $\tau^2 = 0.00$, $I^2 = 0.00\%$, $H^2 = 1.00$



Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 18. Baseline Fall Risk Ascertainment for Exercise Interventions

Author, year	% at increased risk	Fall history	Hospital/ED	Physical function	Osteoporosis/ osteopenia	Medications	Frailty	Fear of falling	Self-rated health	Other	NR
Barnett, 2003	100			X							
Chyu, 2010	100				X						
El-Khoury, 2015	100			X							
Korpelainen, 2006	100				X						
Kronhed, 2009	100				X						
Logghe, 2009	100	X		X		X				X	
Luukinen, 2007	100	X		X					X	X	
Miko, 2018	100	X			X					X	
Morgan, 2004	100		X							X	
Ng, 2015	100						X				
Ohman, 2016	100	X		X			X				
Rosado, 2021	100	X		X							
Sherrington, 2014	100		X								
Siegrist, 2016	100	X		X				X			
Stathi, 2022	100			X							
Suikkanen, 2021	100						X				
Tomita, 2016	100		X								
Trombetti, 2011	100	X		X			X				
Tuvemo Johnson, 2021	100									X	
Uusi-Rasi, 2015	100	X									
Campbell, 1997	51	X									
Lipsitz, 2019	48	X									
Bruce, 2021	44	X		X							
Delbaere 2021	38	X									
Kovacs, 2013	38	X									
Robertson, 2001	37	X									
Callisaya, 2021	36	X									
Voukelatos, 2007	33	X									
Lamb, 2018	30	X									
Merom, 2016	28	X									
Oliveira, 2019	28	X									
Buchner, 1997	25	X									
Voukelatos, 2015	22	X									
Fitzharris, 2010	6	X									
Goldberg 2019	NR										X
Karinkanta, 2015	NR										X
Rikkonen, 2023	NR										X

Abbreviations: ED = emergency department; NR = not reported.

Figure 19. Delivery Mode for Exercise Interventions

Author year	Supervised group classes	Supervised individual	Unsupervised individual
Barnett, 2003	×		×
Bruce, 2021		×	×
Buchner, 1997	×		×
Callisaya, 2021			×
Campbell, 1997		×	×
Chyu, 2010	×		
Delbaere 2021			×
El-Khoury, 2015	×		×
Fitzharris, 2010	×		×
Goldberg 2019		×	×
Karinkanta, 2015	×		
Korpelainen, 2006	×		×
Kovacs, 2013	×		
Kronhed, 2009	×		
Lamb, 2018	×		×
Lipsitz, 2019	×		×
Logghe, 2009	×		×
Luukinen, 2007	×		×
Merom, 2016	×		
Miko, 2018		×	×
Morgan, 2004	×		
Ng, 2015	×		×
Ohman, 2016	×	×	
Oliveira, 2019			×
Rikkonen, 2023	×	×	
Robertson, 2001		×	×
Rosado, 2021	×		
Sherrington, 2014		×	×
Siegrist, 2016	×		×
Stathi, 2022	×		
Suikkanen, 2021		×	×
Tomita, 2016	×		
Trombetti, 2011	×		
Tuvemo Johnson, 2021		×	×
Uusi-Rasi, 2015	×		×
Voukelatos, 2007	×		
Voukelatos, 2015			×

Figure 20. Components of Exercise Interventions

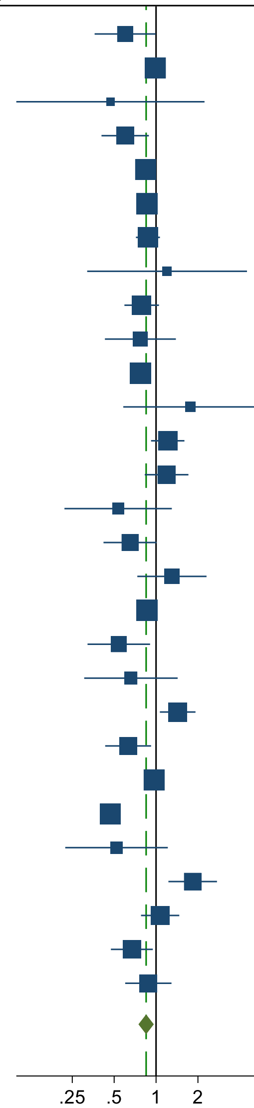
Author, year	Gait, balance, functional training	Strength/ resistance	General PA	Flexibility	Endurance	3D	Behavioral counseling	Cognitive task exercises
Barnett, 2003	×	×			×			
Bruce, 2021	×	×	×					
Buchner, 1997	×	×	×		×			
Callisaya, 2021	×	×						×
Campbell, 1997	×	×	×	×	×		×	
Chyu, 2010						×		
Delbaere 2021	×							
El-Khoury, 2015	×			×				
Fitzharris, 2010	×	×		×				
Goldberg 2019	×	×	×				×	×
Karinkanta, 2015	×	×						
Korpelainen, 2006	×	×						
Kovacs, 2013	×	×		×				
Kronhed, 2009	×	×						
Lamb, 2018	×	×	×		×		×	
Lipsitz, 2019						×		
Logghe, 2009						×		
Luukinen, 2007	×		×	×				
Merom, 2016						×		
Miko, 2018	×	×	×					
Morgan, 2004	×	×		×				
Ng, 2015	×	×						
Ohman, 2016	×	×			×			
Oliveira, 2019			×				×	
Rikkonen, 2023	×	×				×		
Robertson, 2001	×	×	×					
Rosado, 2021	×			×				×
Sherrington, 2014	×	×					×	
Siegrist, 2016	×	×	×				×	
Stathi, 2022	×	×					×	
Suikkanen, 2021	×	×	×	×	×			
Tomita, 2016	×	×						
Trombetti, 2011	×							
Tuvemo Johnson, 2021	×	×	×				×	
Uusi-Rasi, 2015	×	×						
Voukelatos, 2007						×		
Voukelatos, 2015			×				×	

Abbreviations: 3D = Tai Chi; PA = physical activity.

Figure 21. Key Question 1: Pooled Analysis of the Number of Falls at the Longest Followup for Exercise Interventions (k=29, n=14,475)

Study	Months followup	n Analyzed	IG event rate py	CG event rate py	IRR with 95% CI
Barnett, 2003	12	150	.605	.946	0.60 (0.36, 0.99)
Bruce, 2021	18	6502	1.044	1.056	0.99 (0.86, 1.14)
Campbell, 1997	12	233	.87	1.34	0.47 (0.10, 2.23)
Chyu, 2010	6	54	3	5	0.60 (0.41, 0.89)
Delbaere 2021	24	503	1.17	1.39	0.84 (0.72, 0.98)
El-Khoury, 2015	24	706	.79	.92	0.86 (0.77, 0.96)
Fitzharris, 2010	18	272	1.048	1.199	0.87 (0.72, 1.07)
Goldberg 2019	12	34	.	.	1.20 (0.32, 4.50)
Korpelainen, 2006	30	160	.419	.532	0.79 (0.59, 1.05)
Kronhed, 2009	12	65	.613	.794	0.77 (0.43, 1.39)
Lamb, 2018	12	418	2.352	3.044	0.77 (0.68, 0.87)
Lipsitz, 2019	6	144	.46	.26	1.76 (0.58, 5.33)
Logghe, 2009	12	269	.833	.687	1.21 (0.92, 1.60)
Merom, 2016	12	522	1.03	.8	1.19 (0.83, 1.71)
Miko, 2018	12	97	.143	.333	0.53 (0.22, 1.30)
Ohman, 2016	12	66	1.24	1.84	0.65 (0.42, 1.01)
Oliveira, 2019	6	109	.95	.8	1.30 (0.73, 2.30)
Rikkonen, 2023	24	914	.744	.865	0.86 (0.77, 0.96)
Robertson, 2001	12	240	.685	1.006	0.54 (0.32, 0.91)
Rosado, 2021	6	35	1.25	1.895	0.66 (0.30, 1.43)
Sherrington, 2014	12	340	1.035	.728	1.43 (1.06, 1.92)
Siegrist, 2016	24	356	1.219	2.042	0.63 (0.43, 0.92)
Stathi, 2022	12	630	1.288	1.33	0.97 (0.84, 1.11)
Suikkanen, 2021	12	260	1.4	3.1	0.47 (0.40, 0.55)
Tomita, 2016	6	51	.64	1.231	0.52 (0.22, 1.22)
Tuvemo Johnson, 2021	12	117	1.1	.6	1.83 (1.23, 2.74)
Uusi-Rasi, 2015	24	205	1.207	1.182	1.07 (0.78, 1.47)
Voukelatos, 2007	6	684	.496	.748	0.67 (0.47, 0.95)
Voukelatos, 2015	12	339	.	.	0.88 (0.60, 1.29)
Overall					0.85 (0.75, 0.96)

Heterogeneity: $\tau^2 = 0.07$, $I^2 = 82.73\%$, $H^2 = 5.79$



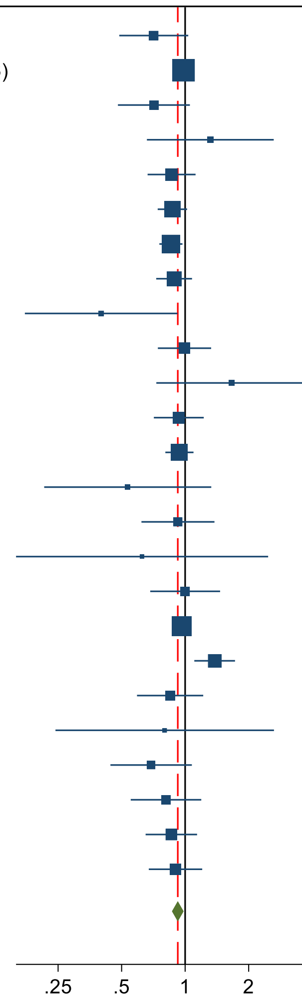
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CI = confidence interval; CG = control group; IG = intervention group; IRR = incidence rate ratio; n = number; p-y = person-year.

Figure 22. Key Question 1: Pooled Analysis of People With 1 or More Falls at the Longest Followup for Exercise Interventions (k=25, n=13,384)

Study	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Barnett, 2003	12	27/76 (35.5)	37/74 (50)	0.71 (0.49, 1.03)
Bruce, 2021	18	1277/3279 (38.9)	1276/3223 (39.6)	0.98 (0.92, 1.06)
Buchner, 1997	12	32/75 (42.7)	18/30 (60)	0.71 (0.48, 1.05)
Callisaya, 2021	6	13/44 (29.5)	11/49 (22.4)	1.32 (0.66, 2.63)
Campbell, 1997	12	53/116 (45.7)	62/117 (53)	0.86 (0.66, 1.12)
Delbaere 2021	24	./254 (.)	./249 (.)	0.87 (0.74, 1.02)
El-Khoury, 2015	24	189/352 (53.7)	222/354 (62.7)	0.86 (0.75, 0.97)
Fitzharris, 2010	18	76/135 (56.3)	87/137 (63.5)	0.89 (0.73, 1.08)
Kovacs, 2013	6	6/36 (16.7)	15/36 (41.7)	0.40 (0.17, 0.92)
Lamb, 2018	6	93/281 (33.1)	45/135 (33.3)	0.99 (0.74, 1.33)
Lipsitz, 2019	6	21/77 (27.3)	11/67 (16.4)	1.66 (0.73, 3.78)
Logghe, 2009	12	58/138 (42)	59/131 (45)	0.93 (0.71, 1.23)
Luukinen, 2007	16	126/217 (58.1)	136/220 (61.8)	0.94 (0.81, 1.10)
Miko, 2018	12	6/49 (12.2)	11/48 (22.9)	0.53 (0.21, 1.33)
Morgan, 2004	12	34/119 (28.6)	34/110 (30.9)	0.92 (0.62, 1.38)
Ng, 2015	12	3/48 (6.3)	5/50 (10)	0.63 (0.16, 2.47)
Oliveira, 2019	6	27/60 (45)	27/64 (42.2)	1.00 (0.68, 1.46)
Rikkonen, 2023	24	268/457 (58.6)	278/457 (60.8)	0.96 (0.87, 1.07)
Sherrington, 2014	12	98/171 (57.3)	70/169 (41.4)	1.38 (1.11, 1.72)
Siegrist, 2016	12	93/222 (41.9)	77/156 (49.4)	0.85 (0.59, 1.22)
Tomita, 2016	9	4/25 (16)	5/25 (20)	0.80 (0.24, 2.64)
Trombetti, 2011	6	19/66 (28.8)	32/68 (47.1)	0.69 (0.44, 1.08)
Tuvemo Johnson, 2021	24	21/44 (47.7)	30/51 (58.8)	0.81 (0.55, 1.19)
Voukelatos, 2007	6	71/347 (20.5)	81/337 (24)	0.86 (0.65, 1.14)
Voukelatos, 2015	12	54/159 (34)	68/180 (37.8)	0.90 (0.67, 1.20)
Overall				0.92 (0.87, 0.98)

Heterogeneity: $\tau^2 = 0.00$, $I^2 = 24.32\%$, $H^2 = 1.32$



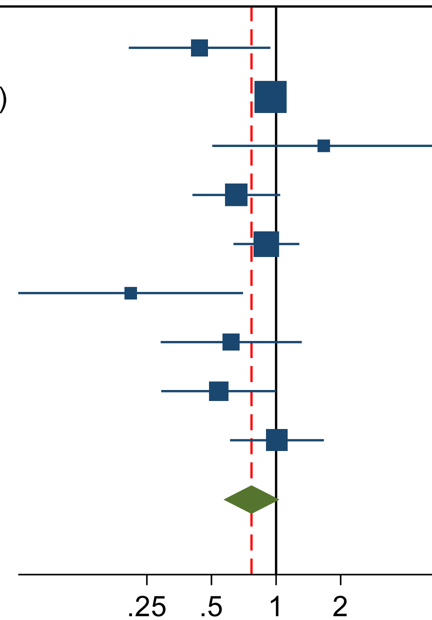
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 23. Key Question 1: Pooled Analysis of People With 2 or More Falls at the Longest Followup for Exercise Interventions (k=9, n=8,502)

Study	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Barnett, 2003	12	8/76 (10.5)	18/74 (24.3)	0.44 (0.21, 0.94)
Bruce, 2021	18	687/3279 (21)	715/3223 (22.2)	0.94 (0.85, 1.05)
Callisaya, 2021	6	6/44 (13.6)	4/49 (8.2)	1.67 (0.50, 5.53)
Campbell, 1997	12	22/116 (19)	34/117 (29.1)	0.65 (0.41, 1.05)
Fitzharris, 2010	18	40/135 (29.6)	45/137 (32.8)	0.90 (0.63, 1.28)
Trombetti, 2011	6	3/66 (4.5)	16/68 (23.5)	0.21 (0.06, 0.70)
Tuvemo Johnson, 2021	24	8/44 (18.2)	15/51 (29.4)	0.62 (0.29, 1.32)
Voukelatos, 2007	6	15/347 (4.3)	27/337 (8)	0.54 (0.29, 1.00)
Voukelatos, 2015	12	25/159 (15.7)	28/180 (15.6)	1.01 (0.61, 1.67)
Overall				0.77 (0.57, 1.04)

Heterogeneity: $\tau^2 = 0.04$, $I^2 = 44.99\%$, $H^2 = 1.82$



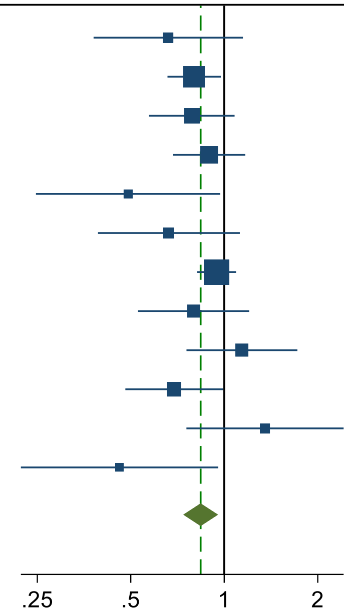
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 24. Key Question 1: Pooled Analysis of the Number of Falls Resulting in Injury or Medical Care at the Longest Followup for Exercise Interventions (k=12, n=3,984)

Study	Outcome	Months followup	IG event rate py	CG event rate py	IRR with 95% CI
Barnett, 2003	Fall resulting in injuries	12	.395	.541	0.66 (0.38, 1.15)
Delbaere 2021	Fall resulting in injuries	24	.71	.88	0.80 (0.66, 0.97)
El-Khoury, 2015	Fall resulting in serious injuries	24	.097	.123	0.79 (0.57, 1.08)
Fitzharris, 2010	Fall resulting in injuries	18	.585	.654	0.89 (0.68, 1.17)
Karinkanta, 2015	Fall resulting in injuries	60	.074	.122	0.49 (0.25, 0.97)
Oliveira, 2019	Fall resulting in injuries	6	.842	1.269	0.66 (0.39, 1.12)
Rikkonen, 2023	Fall-related injuries	24	.393	.416	0.94 (0.82, 1.09)
Robertson, 2001	Fall resulting in injuries	12	.36	.452	0.80 (0.53, 1.20)
Sherrington, 2014	Fall resulting in medical care	12	.357	.314	1.14 (0.76, 1.72)
Siegrist, 2016	Fall-related injuries	24	.443	.684	0.69 (0.48, 0.99)
Tuvemo Johnson, 2021	Fall-related injuries	12	.459	.339	1.35 (0.76, 2.42)
Uusi-Rasi, 2015	Fall resulting in injuries	24	.065	.132	0.46 (0.22, 0.96)
Overall					0.84 (0.74, 0.95)

Heterogeneity: $\tau^2 = 0.00$, $I^2 = 14.58\%$, $H^2 = 1.17$



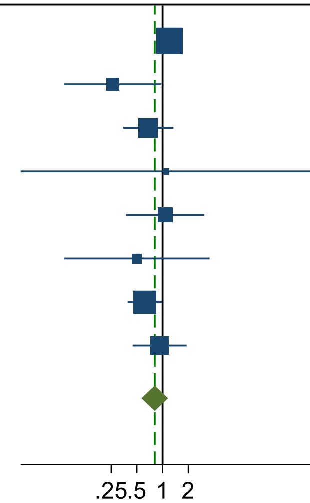
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CI = confidence interval; CG = control group; IG = intervention group; IRR = incidence rate ratio; n = number; p-y = person-year.

Figure 25: Key Question 1: Pooled Analysis of the Number of Fall-Related Fractures at the Longest Followup for Exercise Interventions (k=8, n=8,537)

Study	Outcome	Months followup	n Analyzed	IG event rate py	CG event rate py	IRR with 95% CI
Bruce, 2021	Fracture	18	6502	.031	.028	1.20 (0.91, 1.59)
Karinkanta, 2015	Fall-related fracture	60	72	.	.	0.26 (0.07, 0.97)
Korpelainen, 2006	Fall-related fracture	85	160	0	0	0.68 (0.35, 1.34)
Kronhed, 2009	Fall-related fracture	12	65	.016	.015	1.10 (0.02, 55.28)
Lamb, 2018	Fall-related fracture	12	418	.039	.036	1.07 (0.37, 3.09)
Ohman, 2016	Fall-related fracture	12	66	.045	.091	0.50 (0.07, 3.55)
Rikkonen, 2023	Fall-related fracture	24	914	.031	.049	0.62 (0.39, 0.99)
Sherrington, 2014	Fall-related fracture	12	340	.082	.089	0.92 (0.45, 1.91)
Overall						0.81 (0.57, 1.15)

Heterogeneity: $\tau^2 = 0.08$, $I^2 = 39.06\%$, $H^2 = 1.64$



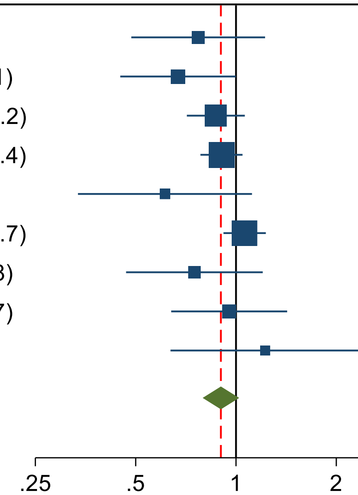
Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CI = confidence interval; CG = control group; IG = intervention group; IRR = incidence rate ratio; n = number; p-y = person-year.

Figure 26. Key Question 1: Pooled Analysis of People With a Fall Resulting in Injury or Medical Care at the Longest Followup for Exercise Interventions (k=9, n=3,924)

Study	Outcome	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Barnett, 2003	Person with fall resulting in injury	12	22/76 (28.9)	28/74 (37.8)	0.77 (0.48, 1.22)
Campbell, 1997	Person with fall resulting in injury	12	27/103 (26.2)	43/110 (39.1)	0.67 (0.45, 1.00)
Delbaere 2021	Person with fall resulting in injury	24	95/254 (37.4)	115/249 (46.2)	0.87 (0.71, 1.06)
El-Khoury, 2015	Person with fall resulting in injury	24	170/352 (48.3)	189/354 (53.4)	0.90 (0.78, 1.05)
Karinkanta, 2015	Person with fall resulting in injury	60	11/37 (29.7)	17/35 (48.6)	0.61 (0.34, 1.12)
Rikkonen, 2023	Person with fall resulting in injury	24	207/457 (45.3)	195/457 (42.7)	1.06 (0.92, 1.23)
Siegrist, 2016	Person with fall resulting in injury	12	63/222 (28.4)	59/156 (37.8)	0.75 (0.47, 1.20)
Stathi, 2022	Person with fall resulting in injury	6	43/328 (13.1)	40/291 (13.7)	0.95 (0.64, 1.42)
Tuvemo Johnson, 2021	Person with fall resulting in injury	12	16/61 (26.2)	12/56 (21.4)	1.22 (0.64, 2.36)
Overall					0.90 (0.79, 1.02)

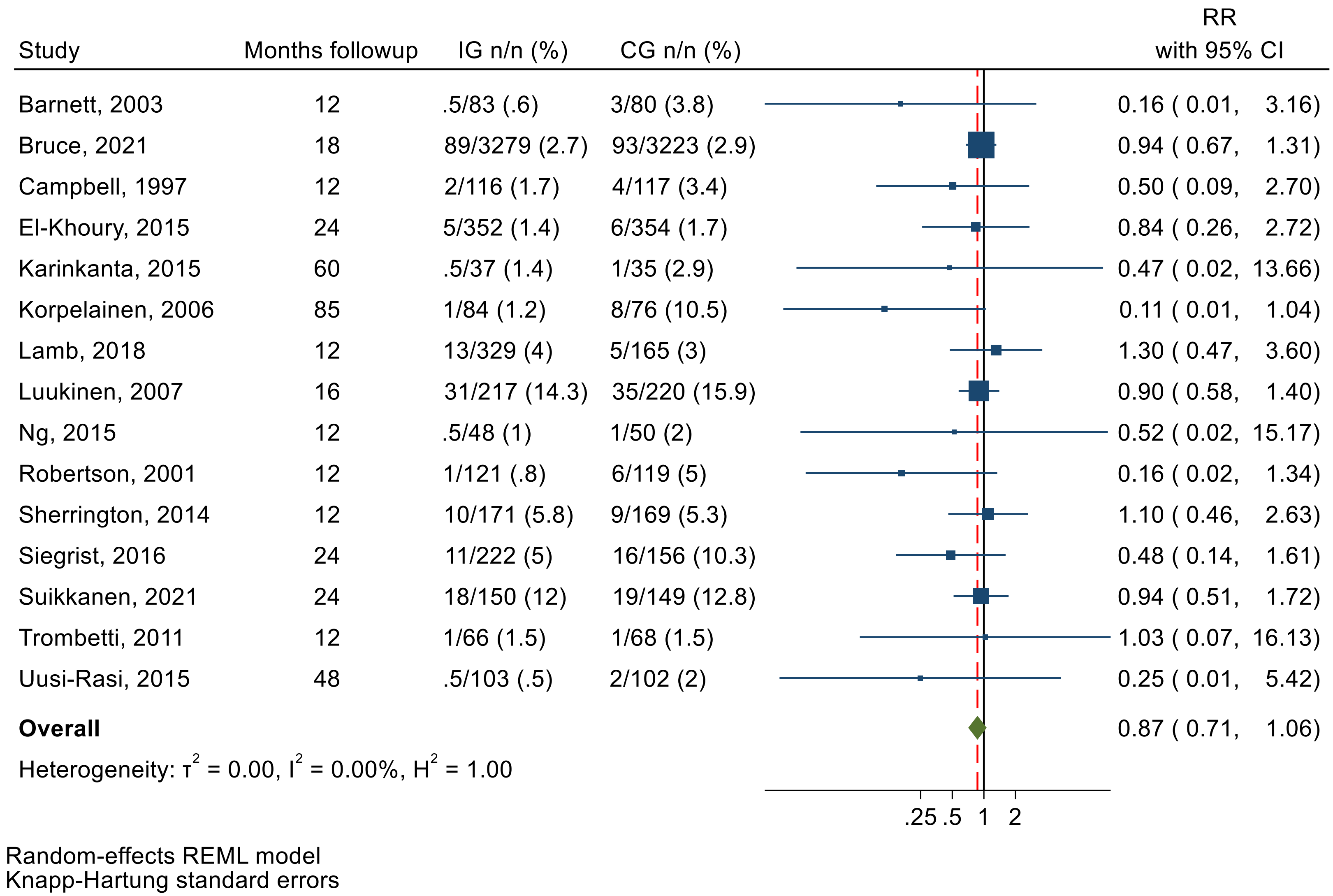
Heterogeneity: $\tau^2 = 0.01$, $I^2 = 26.66\%$, $H^2 = 1.36$



Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 27. Key Question 1: Pooled Analysis of Mortality at the Longest Followup for Exercise Interventions (k=15, n=10,461)



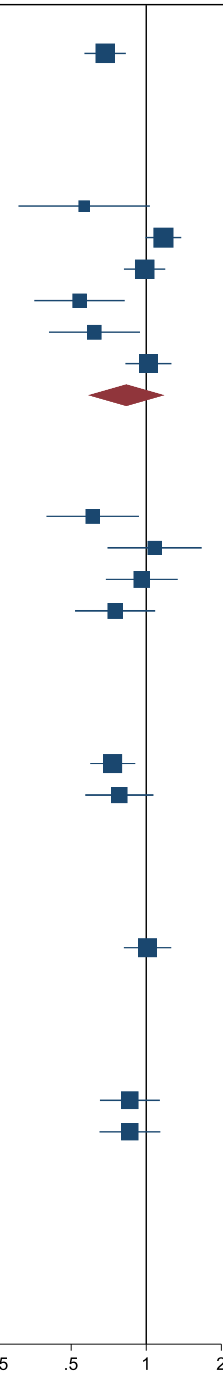
Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 28. Baseline Fall Risk Ascertainment for Other Intervention Groups

Intervention	Author, year	% at increased risk	Fall history	Hospital/ED	Physical function	Osteoporosis/ osteopenia	Medications	Fear of falling	Self-rated health	Other	NR
Exercise + Education + Other	Daly, 2020	100				X				X	
	Sherrington, 2020	100								X	
	Smulders, 2010	100	X			X					
	Shumway-Cook, 2007	27	X								
Exercise + Environment	Matchar, 2017	100		X							
	Taylor, 2021	52.8	X								
	Fitzharris, 2010	6	X								
Environment Assessment	Chu, 2017	100		X							
	Pighills, 2011	100	X								
	Stark, 2021	100	X					X			
	Stevens, 2001	27	X								
	Fitzharris, 2010	6	X								
	Cockayne, 2021	86	X		X						
Medication Review/Modification	Blalock, 2010	100	X				X				
	Boye, 2017	100		X							
	Mott, 2016	100	X								
	Romskaug, 2020	NR									X
Psychological	Dorresteijn, 2016	100						X	X		
	Lim, 2023	100			X			X			
	Zijlstra, 2009	100						X			
Education	Clemson, 2004	100	X								

Figure 29. Key Question 1: Pooled Analysis of the Number of Falls at the Longest Followup for Other Interventions

Study	Months followup	n Analyzed	IG event rate/py	CG event rate/py	IRR with 95% CI
Education					
Clemson, 2004	14	310	.977	1.429	0.68 (0.57, 0.83)
Environment					
Chu, 2017	12	198	16.8	29.8	0.56 (0.31, 1.03)
Cockayne, 2021	12	1308	1.967	1.615	1.17 (0.99, 1.38)
Fitzharris, 2010	18	273	1.181	1.199	0.98 (0.81, 1.19)
Pighills, 2011	12	165	2.011	3.718	0.54 (0.36, 0.82)
Stark, 2021	12	275	1.5	2.3	0.62 (0.41, 0.94)
Stevens, 2001	12	1737	.689	.723	1.02 (0.82, 1.26)
Heterogeneity: $\tau^2 = 0.08$, $I^2 = 82.16\%$, $H^2 = 5.61$					0.83 (0.59, 1.18)
Exercise + Edu ++					
Smulders, 2010	12	92	.72	1.18	0.61 (0.40, 0.94)
Daly, 2020	18	162	.005	.004	1.08 (0.70, 1.67)
Sherrington, 2020	12	336	.78	.768	0.96 (0.69, 1.34)
Shumway-Cook, 2007	12	453	1.33	1.77	0.75 (0.52, 1.09)
Exercise + Environment					
Fitzharris, 2010	18	272	.88	1.199	0.73 (0.60, 0.90)
Taylor, 2021	12	309	NR	NR	0.78 (0.57, 1.07)
Medication review/modification					
Blalock, 2010	12	186	2.157	2.131	1.01 (0.81, 1.26)
Psychological					
Dorresteijn, 2016	12	346	2.181	2.383	0.86 (0.65, 1.13)
Zijlstra, 2009	14	540	.924	1.256	0.86 (0.65, 1.14)

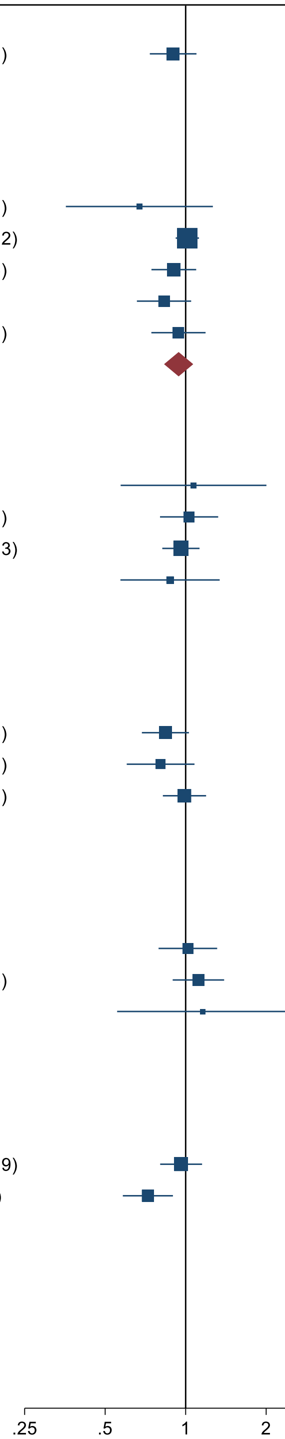


Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CI = confidence interval; CG = control group; Edu = education; IG = intervention group; IRR = incidence rate ratio; n = number; p-y = person-year.

Figure 30. Key Question 1: Pooled Analysis of People With 1 or More Falls at the Longest Followup for Other Interventions

Study	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Education				
Clemson, 2004	14	82/157 (52.2)	89/153 (58.2)	0.90 (0.73, 1.10)
Environment				
Chu, 2017	12	13/95 (13.7)	21/103 (20.4)	0.67 (0.36, 1.26)
Cockayne, 2021	12	245/430 (57)	506/901 (56.2)	1.01 (0.92, 1.12)
Fitzharris, 2010	18	78/136 (57.4)	87/137 (63.5)	0.90 (0.74, 1.10)
Pighills, 2011	12	50/87 (57.5)	54/78 (69.2)	0.83 (0.66, 1.05)
Stark, 2021	12	67/135 (49.6)	74/140 (52.9)	0.94 (0.74, 1.19)
Heterogeneity: τ^2 = 0.00, I^2 = 20.31%, H^2 = 1.25				0.94 (0.83, 1.07)
Exercise + Edu ++				
Daly, 2020	18	37/81 (45.7)	35/81 (43.2)	1.07 (0.57, 2.00)
Sherrington, 2020	12	72/168 (42.9)	70/168 (41.7)	1.03 (0.80, 1.32)
Shumway-Cook, 2007	12	124/226 (54.9)	130/227 (57.3)	0.96 (0.82, 1.13)
Smulders, 2010	12	21/47 (44.7)	23/45 (51.1)	0.87 (0.57, 1.34)
Exercise + Environment				
Fitzharris, 2010	18	72/135 (53.3)	87/137 (63.5)	0.84 (0.69, 1.03)
Matchar, 2017	9	54/177 (30.5)	67/177 (37.9)	0.81 (0.60, 1.08)
Taylor, 2021	12	94/153 (61.4)	87/156 (55.8)	0.99 (0.82, 1.19)
Medication review/modification				
Blalock, 2010	12	53/93 (57)	52/93 (55.9)	1.02 (0.79, 1.31)
Boye, 2017	12	115/308 (37.3)	91/272 (33.5)	1.12 (0.89, 1.39)
Mott, 2016	6	11/39 (28.2)	10/41 (24.4)	1.16 (0.55, 2.41)
Psychological				
Dorresteijn, 2016	12	94/166 (56.6)	106/180 (58.9)	0.96 (0.80, 1.15)
Zijlstra, 2009	14	91/280 (32.5)	117/260 (45)	0.72 (0.58, 0.90)

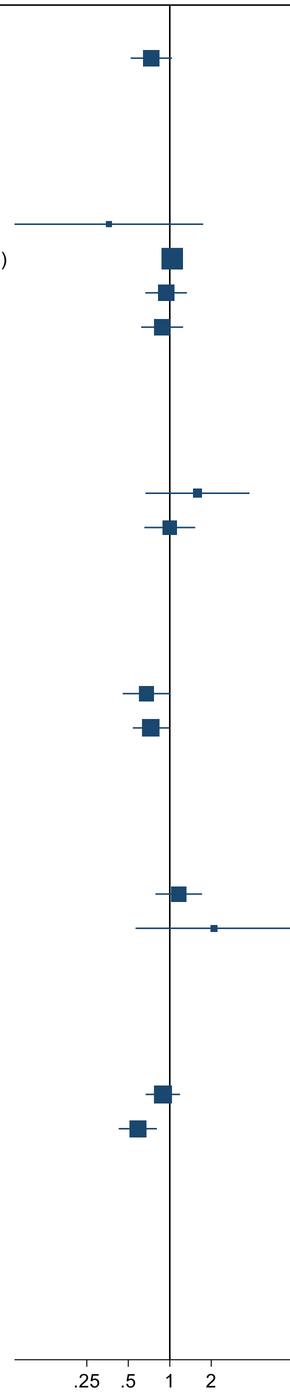


Random-effects REML model
Knapp-Hartung standard errors

Abbreviations: CG = control group; CI = confidence interval; Edu = education; IG = intervention group; n = number; RR = relative risk.

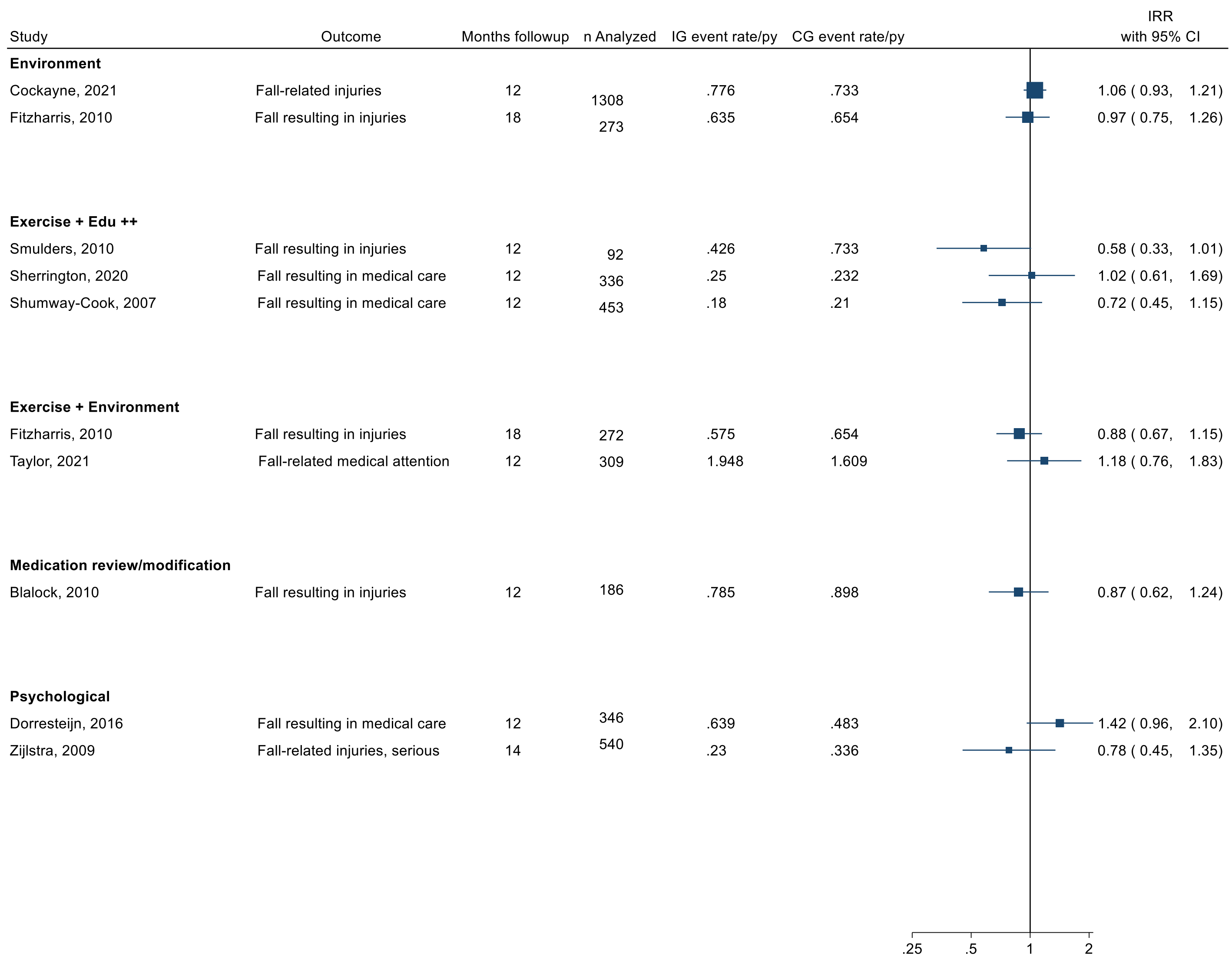
Figure 31. Key Question 1: Forest Plot of People With 2 or More Falls at the Longest Followup for Other Interventions

Study	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Education				
Clemson, 2004	14	40/157 (25.5)	53/153 (34.6)	0.74 (0.52, 1.04)
Environment				
Chu, 2017	12	2/95 (2.1)	6/103 (5.8)	0.36 (0.07, 1.75)
Cockayne, 2021	12	148/430 (34.4)	298/901 (33.1)	1.04 (0.89, 1.22)
Fitzharris, 2010	18	42/136 (30.9)	45/137 (32.8)	0.94 (0.66, 1.33)
Stark, 2021	12	39/135 (28.9)	46/140 (32.9)	0.88 (0.62, 1.25)
Exercise + Edu ++				
Daly, 2020	18	15/81 (18.5)	10/81 (12.3)	1.59 (0.67, 3.79)
Sherrington, 2020	12	34/168 (20.2)	34/168 (20.2)	1.00 (0.65, 1.53)
Exercise + Environment				
Fitzharris, 2010	18	30/135 (22.2)	45/137 (32.8)	0.68 (0.46, 1.01)
Taylor, 2021	12	49/153 (32)	58/156 (37.2)	0.73 (0.54, 0.99)
Medication review/modification				
Boye, 2017	12	50/308 (16.2)	38/272 (14)	1.16 (0.79, 1.71)
Mott, 2016	6	6/39 (15.4)	3/41 (7.3)	2.10 (0.56, 7.83)
Psychological				
Dorresteijn, 2016	12	55/166 (33.1)	67/180 (37.2)	0.89 (0.67, 1.19)
Zijlstra, 2009	14	48/280 (17.1)	76/260 (29.2)	0.59 (0.43, 0.81)



Abbreviations: CG = control group; CI = confidence interval; Edu = education; IG = intervention group; n = number; RR = relative risk.

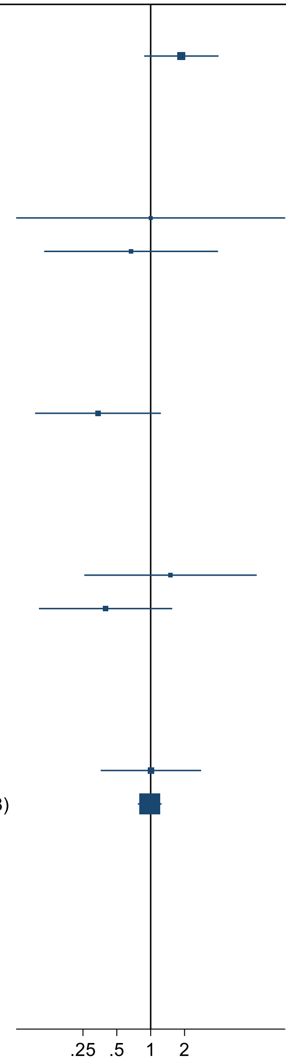
Figure 32. Key Question 1: Forest Plot of the Number of Falls Resulting in Injury or Medical Care at the Longest Followup for Other Interventions



Abbreviations: CI = confidence interval; CG = control group; IG = intervention group; IRR = incidence rate ratio; n = number; p-y = person-year.

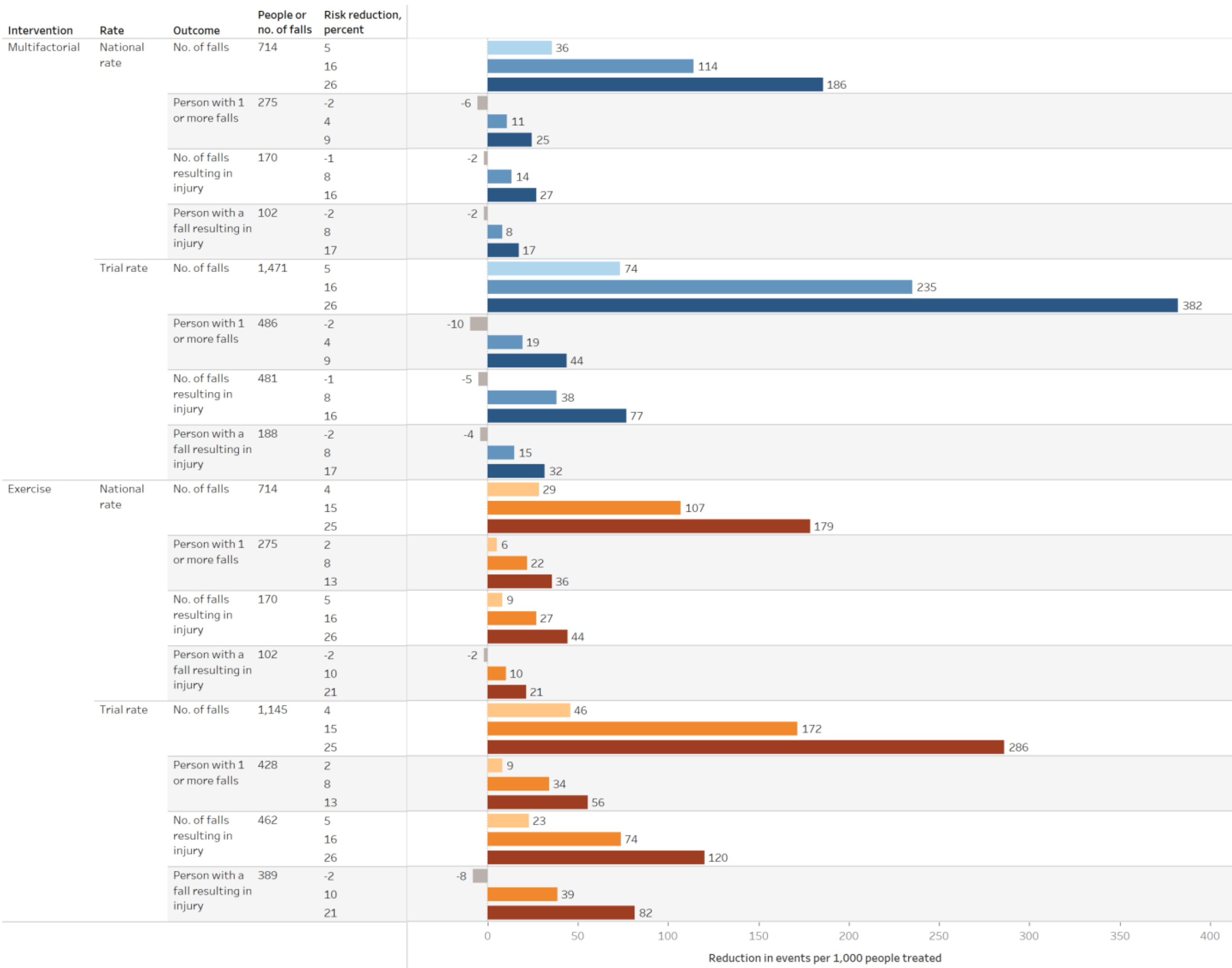
Figure 33. Key Question 1: Forest Plot of Mortality at the Longest Followup for Other Interventions

Study	Months followup	IG n/n (%)	CG n/n (%)	RR with 95% CI
Environment				
Cockayne, 2021	12	12/377 (3.2)	14/824 (1.7)	1.87 (0.87, 4.01)
Exercise + Edu ++				
Daly, 2020	18	1/81 (1.2)	1/81 (1.2)	1.00 (0.06, 15.72)
Shumway-Cook, 2007	12	2/226 (.9)	3/227 (1.3)	0.67 (0.11, 3.97)
Exercise + Environment				
Taylor, 2021	12	3/153 (2)	9/156 (5.8)	0.34 (0.09, 1.23)
Medication review/modification				
Blalock, 2010	12	3/93 (3.2)	2/93 (2.2)	1.50 (0.26, 8.77)
Romskaug, 2020	6	3/82 (3.7)	7/76 (9.2)	0.40 (0.10, 1.55)
Psychological				
Dorresteijn, 2016	12	7/194 (3.6)	7/195 (3.6)	1.01 (0.36, 2.81)
Zijlstra, 2009	84	90/280 (32.1)	85/259 (32.8)	0.98 (0.77, 1.25)



Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; n = number; RR = relative risk.

Figure 34. Absolute Reduction in Falls and Falls Resulting in Injury*



* In a hypothetical population of 1,000 older adults with a fall rate of 714 falls/1000 p-y, 27.5% older adults with a fall, fall injury rate of 170 fall injuries/1000 p-y, and 10.2% older adults with a fall injury (based on 2018 BRFSS data,[3]) and using the lower confidence interval, point estimate, and upper confidence interval from our pooled results, this figure estimates the reductions in the fall-related events/people.

Table 1. Fall Risk Screening Tools Feasible for Primary Care*

Screening tool	Brief description of screening tool	K	N	Cutoff score	AUC, range†	Sensitivity, range	Specificity, range
Timed Up and Go test (TUG)	Participants are asked to stand up from a chair, walk 3 meters, turn, walk 3 meters back and sit down again. The time taken to perform this task indicates high or low risk of falls.	12	5,240	Varied	0.46 to 0.89	0.10 to 0.833†	0.284 to 0.966‡
Gait Speed test (4 m)	Participants are asked to walk 4 meters at their usual pace. The time taken to complete the task is recorded, and Gait Speed is calculated (m/s).	1	541	NR	0.54 to 0.68	NR	NR
		2	118	0.67 m/s to ≥18 s	NR	0.384 to 1.00	0.239 to 0.847
Berg Balance Scale (BBS)	Participants are asked to perform a variety of sitting, transferring and standing positions.	1	187	≤52	0.47	NR	NR
		2	312	≤45 to ≤54	0.59 to 0.68	0.25 to 0.69	0.53 to 0.87
Performance Oriented Mobility Assessment – Balance (POMA-B)	Participants are asked to perform 9 different movements to assess balance.	4	442	<8 to 10	NR	0.23 to 0.89	0.47 to 0.913
Performance Oriented Mobility Assessment - Gait (POMA-G)	Participants are asked to perform six different movements to assess gait. It is recommended to conduct this test in a corridor.	2	252	9	NR	0.21 to 0.64	0.625 to 0.95
Functional Reach test (FR)	Participants are asked to hold their arms in front of them at an angle of 90 degrees, stretch forward as far as possible and return to the starting position. The distance between the starting position and the stretched position is used as an indicator of the risk of falling.	2	1,544	NR	0.509 to 0.60	NR	NR
		1	50	8 in	NR	0.73	0.88
Falls History	Definition varies. Most commonly, participants are asked if they have had one or more falls in the previous year.	4	1,603	≥1 fall in the previous year	0.71§	0.39 to 0.69	0.63 to 0.82
		1	449	History of multiple falls	0.64	NR	NR

* Adapted from Meeks, 2021[16]
† The reported area under the curve (AUC) for all tools included prospective falls ascertainment 6 months to 108 months after the tool's administration.
‡ Reported in 8 studies
§Reported in 1 study
Abbreviations: AUC = Area under the curve; M = Meter; NR = Not reported; S = Second

Table 2. Society and Professional Organization Recommendations on Falls Prevention in Community-Dwelling Older Adults

Society or Professional Organization	Year	Age, years	Recommendation
World Falls Guideline[202]	2022	NR	Recommends that all older adults should be advised on falls prevention and physical activity. Opportunistic case finding for falls risk is recommended for community-dwelling older adults. Those considered at high risk should be offered a comprehensive multifactorial falls risk assessment with a view to co-design and implement personalised multidomain interventions. Other recommendations cover details of assessment and intervention components and combinations, and recommendations for specific settings and populations.
Centers for Disease Control and Prevention[31]	2021	≥65	Recommends STEADI, a coordinated approach to implementing the AGS/BGS clinical practice guidelines for fall prevention that consists of 3 core elements: screen to identify fall risk, assess modifiable risk factors, and intervene using effective clinical and community strategies to reduce the identified risk. Clinical strategies include but are not limited to physical therapy and medication management. Community strategies include but are not limited to evidence-based exercise programs and home modification.
The Royal Australian College of General Practitioners[32]	2018	≥65	Recommend assessing risk of falls and if indicated by the screening questions, determine multifactorial fall risk and obtain relevant medical history, conduct a complete physical examination, and perform cognitive and functional assessments. Recommended interventions: exercise programs; medication review; vitamin D supplementation; podiatry intervention if indication; discuss dangers of bifocal and multifocal glasses when walking outdoors and recommend single lens glasses when outdoors; identify cataracts; occupational therapy home assessment (if history of recent falls)
U.S. Department of Health and Human Services[33]	2021	NR	Recommends that older adults get at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic physical activity per week, as well as muscle-strengthening activities twice per week. Recommend balance training three or more days per week for older adults at risk of falls due to a recent fall or difficulty walking.
The National Institute of Aging[34]	2017	NR	Outlines several interventions for falls: exercise for strength and balance, monitoring for environmental hazards, regular medical care to ensure optimized hearing and vision, and medication management.
National Institute for Health and Care Excellence[203]	2013	≥65	Older adults in contact with health professionals should be asked routinely whether they have fallen in the past year and asked about the frequency, context, and characteristics of the fall(s). Older people at risk of falling should be observed for balance and gait defects and considered for their ability to benefit from interventions to improve strength and balance. Older adults who present for medical attention because of a fall, or report recurrent falls in the past year, or demonstrate abnormalities of gait and/or balance should be offered a multifactorial falls risk assessment. Recommended interventions: Multifactorial interventions; strength and balance training; exercise in extended care settings; home hazard and safety intervention; psychotropic medication review; cardiac pacing.

Table 2. Society and Professional Organization Recommendations on Falls Prevention in Community-Dwelling Older Adults

Society or Professional Organization	Year	Age, years	Recommendation
American Geriatrics Society/British Geriatrics Society*[204]	2011	NR	Recommend a multifactorial fall risk assessment for all older adults who present with a fall or who have gait and balance problems. Also recommend a multifactorial falls risk assessment for individuals who simply report difficulties with gait or balance. A falls risk assessment is not considered necessary for older persons reporting only a single fall without reported or demonstrated difficulty or unsteadiness. Recommend that assessments include examination of the feet and footwear, functional assessment (assessment of activity of daily living skills, including use of adaptive equipment and mobility aids, as appropriate); assessment of the individual's perceived functional ability and fear related to falling; and environmental assessment, including home safety. Recommended components of multifactorial interventions: exercise, specifically programs that include balance, gait, and strength training, such as tai chi or physical therapy, in group programs or as individual programs at home; environmental adaptation or modification; medication reduction or withdrawal; assessment and treatment of postural hypotension; cataract surgery on the first eye should be expedited in older persons in which the surgery is indicated; dual-chamber cardiac pacing when indicated; and vitamin D supplementation.

*The AGS considers guidelines 5 years old and older to be no longer active. These inactive guidelines or recommendations have not been reviewed or updated by the AGS and the conclusions and recommendations in the guideline may not be current

Abbreviations: AGS = American Geriatric Society; BGS = British Geriatrics Society; NR = Not reported; STEADI = Stopping Elderly Accidents, Deaths, and Injuries

Table 3. Summary of Study and Participant Characteristics, All Interventions

Characteristic	No. of studies* for each intervention type							
	MF	Exercise	Exercise + Edu + Other	Exercise + Environ	Environ	Med Review/ Mod	Psych	Edu
Total studies	28	37	4	3	6	4	3	1
Newly identified	3	19	3	2	3	2	1	0
Previously identified	25	18	1	1	3	2	2	1
Quality rating	-	-	-	-	-	-	-	-
Good	9	5	3	1	3	2	0	0
Fair	19	32	1	2	3	2	3	1
Country	-	-	-	-	-	-	-	-
US	4	5	1	0	1	3	0	0
Europe	18	20	1	0	3	1	2	0
Other	6	12	2	3	2	0	1	1
Recruitment setting	-	-	-	-	-	-	-	-
Clinic (with or without community-based)	16	13	1	1	2	1	0	0
Community- or population-based only	0	19	1	1	3	1	3	1
ED or hospital only	7	2	0	1	1	1	0	0
Other	5	3	2	0	0	1	0	0
Baseline risk of falling	-	-	-	-	-	-	-	-
At increased risk	21	20	3	1	3	3	3	1
Unselected for risk	7	17	1	2	3	1	0	0
Falls data collection	-	-	-	-	-	-	-	-
Diary/calendar (+/- recall, administrative records)	21	24	4	3	5	3	3	1
Recall and administrative records	1	1	0	0	0	0	0	0
Recall only (1 to 6 months)	6	11	0	0	1	1	0	0
Administrative records only	0	1	0	0	0	0	0	0
Race/ethnicity	-	-	-	-	-	-	-	-
Majority White	3	7	1	0	0	2	--	--
Race/ethnicity not reported	23	30	3	2	5	2	3	1
Randomized sample size, range	153-6524	35-6502	96-453	272-354	165-1879	80-612	50-540	310
Age, weighted mean	79	77	75	79	77	77	78	78
Female, percent	62	68	78	63	60	66	71	74

* Value instead of number of studies when indicated

Abbreviations: ED = emergency department; Edu = education interventions; Environ = environmental interventions; MF = multifactorial interventions; No. = number; Psych = psychological interventions; US = United States

Table 4. Strength of Evidence: Multifactorial & Exercise Intervention Trials

Intervention	Number of included studies	Summary of findings	Consistency and precision	Other limitations	Strength of evidence*	Applicability
Multifactorial	k=28 n random= 27,784	*Falls:* IRR 0.84 (95% CI, 0.74 to 0.95); I^2=85.0% k=20, n analyzed=22,115	Consistent, precise	Heterogenous assessment interventions and referrals. Heterogeneous populations as reflected in wide variation in baseline falls risk; heterogeneous interventions; trials typically powered for falls and not other outcomes.	Moderate for benefit	Populations studied older community dwelling adults at both average and increased risk for falls. Most participants were at increased risk based on history of previous fall. Most studies took place outside the US but results are generalizable. Implementation of this multi-step, complex intervention would be challenging in any setting. Populations studied largely at high risk based on history of previous fall.
		People with 1+ fall: RR 0.96 (95% CI, 0.91 to 1.02); I^2=48.2% k=26, n analyzed=23,626	Inconsistent, imprecise		Low for no benefit	
		People with 2+ falls: RR 0.99 (95% CI, 0.94 to 1.04); I^2=0.0% k=11, n analyzed=14,471	Inconsistent, imprecise		Low for no benefit	
		Falls resulting in injury or medical care: IRR 0.92 (95% CI, 0.84 to 1.01); I^2=21.8% k=12, n analyzed=10,563	Inconsistent, imprecise		Low for no benefit	
		People with fall resulting in injury or medical care: RR 0.92 (95% CI, 0.83 to 1.02); I^2=47.3% k=13, n analyzed=13,460	Inconsistent, imprecise		Low for no benefit	
		Fall-related fractures: IRR 1.01 (95% CI, 0.81 to 1.26); I^2=34.0% k=7, n analyzed=15,211	Inconsistent, imprecise		Low for no benefit	
		People with fall-related fracture: RR 0.86 (95% CI, 0.60 to 1.24); I^2=49.0% k=7, n analyzed=13,912	Inconsistent, imprecise		Low for no benefit	
		Mortality: RR 1.01 (95% CI, 0.88 to 1.17); I^2=0% k=24, n analyzed=21,596	Inconsistent, imprecise		Low for no benefit	
		Harms: Rare, minor, and associated with the exercise components k=5, n analyzed=4,199	Inconsistent, imprecise	Harms sparsely reported and often only reported in intervention arm.	Insufficient	

Table 4. Strength of Evidence: Multifactorial & Exercise Intervention Trials

Intervention	Number of included studies	Summary of findings	Consistency and precision	Other limitations	Strength of evidence*	Applicability
Exercise	k=37 n random= 16,117	*Falls:* IRR 0.85 (95% CI, 0.75 to 0.96); I^2=82.7% k=29, n analyzed=14,475	Consistent, precise	Heterogeneous populations as reflected in wide variation in baseline falls risk; heterogeneous interventions; trials typically powered for falls and not other outcomes. Heterogeneous exercise interventions: individual vs group; multiple different exercise components administered; different program frequencies and durations.	Moderate for benefit	Applicable to older community dwelling populations at both average and increased risk for falls. Most participants in trials were at increased risk based on history of previous fall. Applicable to interventions (individual PT and exercise classes) that are typically available in the U.S. No single exercise/PT program protocol appears as a 'best' model. Nearly all programs
		People with 1+ fall: RR 0.92 (95% CI, 0.87 to 0.98); I^2=24.3% k=25, n analyzed=13,384	Consistent, precise		Moderate for benefit	
		People with 2+ falls: RR=0.77 (95% CI, 0.57 to 1.04); I^2=45.0% k=9, n analyzed=8,502	Consistent, imprecise		Low for no benefit	
		Falls resulting in injury or medical care: IRR 0.84 (95% CI, 0.74 to 0.95); I^2=14.6% k=12, n analyzed=3,984	Consistent, precise		Low for benefit	
		Fall-related fractures: IRR 0.81 (95% CI, 0.57 to 1.15); I^2= 39.1% k=8, n analyzed=8,537	Inconsistent, imprecise		Low for no benefit	
		People with fall resulting in injury or medical care: RR 0.90 (95% CI, 0.79 to 1.02); I^2=26.7% k=9, n analyzed=3,924	Consistent, imprecise		Low for no benefit	
		People with fall-related fracture: RR range 0.36 (95% CI, 0.15 to 0.89) to 1.95 (95% CI, 0.22 to 17.3) k=4, n analyzed=7994	Inconsistent, imprecise		Insufficient	
		Mortality: RR 0.87 (95% CI, 0.71 to 1.06); I^2=0.0% k=15, n analyzed=10,461	Consistent, imprecise		Low for no benefit	

Table 4. Strength of Evidence: Multifactorial & Exercise Intervention Trials

Intervention	Number of included studies	Summary of findings	Consistency and precision	Other limitations	Strength of evidence*	Applicability
		Harms Generally minor musculoskeletal side effects; serious side effects were generally very rare (<1%). k=18, n analyzed=6,528	Consistent, imprecise	Harms were sparsely reported and often only reported for the intervention arm.	Low for harm	include gait/balance/functional training and strength/resistance. Adherence to exercise classes may be variable in real world settings.

* For our review-of-reviews method, we adopted the strength of the overall body of evidence assigned within the primary systematic review. In most cases, these grades were based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) working group definitions which consider study limitations, consistency of effect, imprecision, indirectness and publication bias. Where strength of evidence grades were not available, we adapted the EPC approach to assign an overall strength of evidence grade based on consensus discussions involving at least two reviewers.

Abbreviations: CI = confidence interval; IRR = incidence rate ratio; k = number of studies; n = number of participants; PT = physical therapy; RR = relative risk; US = United States.

Table 5. Strength of Evidence: Other Interventions

Intervention	Number of included studies	Summary of findings	Consistency and precision	Other limitations	Strength of evidence*	Applicability
Exercise + Edu	k=4 n random= 1047	*Falls:* IRR range 0.61 (95% CI, 0.40, 0.94) to 1.08 (95% CI, 0.70 to 1.67) k=4, n analyzed=1,043	Consistent Imprecise	Few heterogenous trials with mixed results	Low for no benefit	Intervention relevant to older community dwelling populations at average and increased risk for falls however trials included only those at increased risk for falls. Exercise programs may be accessible in the US. Education programs variable.
		People with 1+ Fall: RR range 0.87 (95% CI, 0.57 to 1.34) to 1.07 (95% CI, 0.57 to 2.00) k=4, n analyzed=1,043	Inconsistent Imprecise		Low for no benefit	
		People with 2+ falls: RR 1.0 (95% CI, 0.65 to 1.53) and 1.59 (95% CI, 0.67 to 3.79) k=2, n analyzed=498	Inconsistent, imprecise		INSUFFICIENT	
		Falls resulting in injury or medical care: IRR range 0.58 (95% CI, 0.33 to 1.01) to 1.02 (0.61 to 1.69) k=3, n analyzed=881	Consistent Imprecise		Low for no benefit	
		Mortality: RRs 0.67 (95% CI, 0.11 to 3.97) and 1.0 (95% CI, 0.06 to 15.72) k=2, n analyzed=615	Inconsistent Imprecise		INSUFFICIENT	
		Harms Two trials reported no AEs reported in IG, two trials reported mostly musculoskeletal side effects associated with exercise intervention in IG k=4, n analyzed=522	Consistent, imprecise	Few trials, no trials ascertained AEs in the CG. Ascertainment measurements unclear for harms.	Low for harm	
Exercise + Environment	k=3 n random= 935	*Falls:* IRRs 0.73 (95% CI, 0.60 to 0.90) and 0.78 (95% CI, 0.57 to 1.07) k=2, n analyzed=581	Consistent Imprecise	Few heterogenous trials with mixed results.	INSUFFICIENT	Intervention relevant to older adult community-dwelling populations at average and increased risk for falls, however, trials only recruited participants at increased risk for falls.
		People with 1+ fall: RR range 0.81 (95% CI, 0.60 to 1.08) to 0.99 (95% CI, 0.82 to 1.19) k=3, n analyzed=935	Consistent, imprecise		Low for no benefit	
		People with 2+ falls: RRs 0.68 (95% CI, 0.46 to 1.01) and 0.73 (95% CI, 0.54 to 0.99) k=2, n analyzed=581	Consistent, imprecise		INSUFFICIENT	
		Falls resulting in injury:	Inconsistent		INSUFFICIENT	

Table 5. Strength of Evidence: Other Interventions

Intervention	Number of included studies	Summary of findings	Consistency and precision	Other limitations	Strength of evidence*	Applicability
		IRRs 0.88 (95% CI, 0.67 to 1.15) and IRR 1.18 (95% CI, 0.76 to 1.83) k=2, n analyzed=581	Imprecise			
		Mortality: RR 0.34 (95% CI, 0.09 to 1.23) k=1, n analyzed=309	Consistency NA, Imprecise		INSUFFICIENT	
		Harms: No trials reported on harms	NA	No trials	INSUFFICIENT	
Environment	k=6 n random= 4162	*Falls:* IRR 0.83 (95% CI, 0.59 to 1.18); I^2= 82.2% k=6, n analyzed=3,956	Inconsistent, Imprecise	Small number of trials. Some studies implemented modifications and others only made recommendations	Low for no benefit	Intervention relevant to older community dwelling populations at average and increased risk for falls.
		People with 1+ fall: RR 0.94 (95% CI, 0.83 to 1.07); I^2=20.3% k=5, n analyzed=2,242	Consistent, imprecise		Low for no benefit	
		People with 2+ falls: RR range 0.36 (95% CI, 0.07 to 1.75) to 1.04 (95% CI, 0.89 to 1.22) k=4, n analyzed=2077	Consistent, imprecise		Low for no benefit	
		Falls resulting in injury: IRRs 0.97 (95% CI, 0.75 to 1.26) and 1.06 (95% CI, 0.93 to 1.21) k=2, n analyzed=1604	Inconsistent Imprecise		INSUFFICIENT	
		Mortality: RR 1.87 (95% CI, 0.87 to 4.01) k=1, n analyzed=1201	Consistency NA, Imprecise		INSUFFICIENT	
		Harms: No serious AEs directly related to the IG (k=1, n=430) No AEs during the trial (k=1, n analyzed=175)	Consistent, imprecise		INSUFFICIENT	
Medication review/ modification	k=4 n random= 1052	*Falls:* IRR 1.01 (95% CI, 0.81 to 1.26) k=1, n analyzed=186	Consistency NA, Imprecise	Small number of trials. Outcomes reported variably across trials. All study IGs included at least a one-time medication assessment but	INSUFFICIENT	Intervention relevant to populations at average and increased risk for falls. Three of 4 trials were conducted in the US.
		People with 1+ fall: RR range 1.02 (95% CI, 0.79 to 1.31) to 1.16 (95% CI, 0.55 to 2.41) k=3, n analyzed=846 OR 0.75 (95% CI, 0.35 to 1.60) k=1, n analyzed=158	Inconsistent, imprecise		Low for no benefit	

Table 5. Strength of Evidence: Other Interventions

Intervention	Number of included studies	Summary of findings	Consistency and precision	Other limitations	Strength of evidence*	Applicability
		People with 2+ falls: RRs 1.16 (95% CI, 0.79 to 1.71) and 2.10 (95% CI, 0.56 to 7.83) k=2, n analyzed=660	Consistent, imprecise	follow up varied and may have additionally included time to PCP contact or modification implementation. Adherence was generally <50%.	INSUFFICIENT	Only 2 trials were conducted in clinical setting by geriatrician; the other 2 were conducted in pharmacy by pharmacist.
		Falls resulting in injury: IRR 0.87 (95% CI, 0.62 to 1.24) k=1, n analyzed=186	Consistency NA, Imprecise		INSUFFICIENT	
		Mortality: RRs 0.40 (95% CI, 0.10 to 1.55) and 1.50 (95% CI, 0.26 to 8.77) k=2, n analyzed=344	Inconsistent Imprecise		INSUFFICIENT	
		Harms: No trials reported on harms	NA		INSUFFICIENT	
Psychological	k=3 n random= 979	*Falls:* IRRs 95% CI, 0.65 to 1.13) and 0.86 (95% CI, 0.65 to 1.14) k=2, n analyzed=886	Consistent, imprecise	Small number of studies.	INSUFFICIENT	Intervention relevant to populations at average and increased risk for falls. Both non-US trials, with intervention facilitated by a nurse. Results applicable to US population.
		People with 1+ fall: RRs 0.72 (95% CI, 0.58 to 0.90) and 0.96 (95% CI, 0.80 to 1.15); OR 1.40 (95% CI, 0.45 to 4.37) k=3, n analyzed=936	Inconsistent, imprecise		INSUFFICIENT	
		People with 2+ falls: RRs 0.59 (95% CI, 0.43 to 0.81) and 0.89 (95% CI, 0.67 to 1.19) k=2, n analyzed=886	Consistent, imprecise		INSUFFICIENT	
		Falls resulting in injury: IRRs 0.78 (95% CI, 0.45 to 1.35) and 1.42 (95% CI, 0.96 to 2.10) k=2, n analyzed=886	Inconsistent, Imprecise		INSUFFICIENT	
		Mortality: RRs 0.98 (95% CI, 0.77 to 1.25) and 1.01 (95% CI, 0.36 to 2.81) k=2, n analyzed=928	Consistent, Imprecise		INSUFFICIENT	
		Harms: No adverse events or side effects reported k=1, n analyzed=540	NA		INSUFFICIENT	
Education	k=1 n random= 310	*No. of falls:* IRR 0.68 (95% CI, 0.57 to 0.83) k=1, n analyzed=310	Consistency NA, Imprecise	Single, small trial.	INSUFFICIENT	Standardized education protocol applied to adults

Table 5. Strength of Evidence: Other Interventions

Intervention	Number of included studies	Summary of findings	Consistency and precision	Other limitations	Strength of evidence*	Applicability
		People with 1+ fall: RR 0.90 (95% CI, 0.73 to 1.10) k=1, n analyzed=310	Consistency NA, Imprecise		INSUFFICIENT	at increased risk of falling. Conducted in Australia.
		People with 2+ falls: RR 0.74 (95% CI, 0.52 to 1.04) k=1, n analyzed=310	Consistency NA, Imprecise		INSUFFICIENT	
		No. of falls resulting in injury: k=0	NA		INSUFFICIENT	
		Mortality: k=0	NA		INSUFFICIENT	
		Harms: k=0	NA		INSUFFICIENT	

* For our review-of-reviews method, we adopted the strength of the overall body of evidence assigned within the primary systematic review. In most cases, these grades were based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) working group definitions which consider study limitations, consistency of effect, imprecision, indirectness and publication bias. Where strength of evidence grades were not available, we adapted the EPC approach to assign an overall strength of evidence grade based on consensus discussions involving at least two reviewers.

Abbreviations: CI = confidence interval; IRR = incidence rate ratio; k = number of studies; n = number of participants; NA = not applicable; RR = relative risk; US = United States.

Appendix A. Detailed Methods

Literature Search Strategies for Primary Literature

Bridge search – Date delivered 5/8/23
Original search – Date delivered 4/22/22

Sources Searched: database and platform 2016 to present
MEDLINE via Ovid
CINAHL via EBSCO
Cochrane Central Register of Controlled Clinical Trials via Wiley

Search filters used:
RCT filter:

- Chris Cooper, Jo Varley-Campbell and Patrice Carter, Established search filters may miss studies when identifying randomized controlled trials, Journal of Clinical Epidemiology, 2019-08-01, Volume 112, Pages 12-19
- Glanville JM, Lefebvre C, Miles JN, Camoso-Stefinovic J. How to identify randomized controlled trials in MEDLINE: ten years on. Journal of the Medical Library Association 2006; 94: 130-136. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1435857/
- Box 3.d Cochrane Highly Sensitive Search Strategy for identifying randomized trials in MEDLINE: sensitivity- and precision-maximizing version (2008 revision); Ovid format from: Lefebvre C, Glanville J, Briscoe S, Littlewood A, Marshall C, Metzendorf M-I, Noel-Storr A, Rader T, Shokraneh F, Thomas J, Wieland LS. Chapter 4: Searching for and selecting studies. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA (editors). Cochrane Handbook for Systematic Reviews of Interventions version 6.2 (updated February 2021). Cochrane, 2021. Available from www.training.cochrane.org/handbook
- Glanville et al, 2019, Development of a Search Filter to Identify Reports of Controlled Clinical Trials Within CINAHL Plus

Justification for Limits (what studies/papers):
"This search strategy was adopted from/adapted from/.. the strategy used by SEARCH CREATOR/S (year). The following changes were made..."

Key:
/ = MeSH subject heading
$ = truncation
ti = word in title
ab = word in abstract
pt = publication type
* = truncation
kw = keyword
kf = author attributed keyword
st = subset

MEDLINE
Database: Ovid MEDLINE(R) ALL <1946 to April 21, 2022>
Search Strategy:

Appendix A. Detailed Methods

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1 Accidental Falls/ (27337)
2 (falls or faller or fallers or fall injur$).ti,ab,kf. (53652)
3 (fall or falling).ti. (14131)
4 1 or 2 or 3 (72260)
5 aged/ or "aged, 80 and over"/ or frail elderly/ (3393862)
6 Geriatric Assessment/ (31036)
7 Geriatrics/ (31013)
8 Health Services for the Aged/ (18137)
9 geriatric$.ti,ab,kf. (72187)
10 older.ti,ab,kf. (503575)
11 senior$.ti,ab. (46894)
12 elder$.ti,ab,kf. (290222)
13 aged.ti,ab,kf. (663188)
14 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 (4137540)
15 4 and 14 (32442)
16 limit 15 to (english language and yr="2016 -Current") (12111)
17 (randomized controlled trial or controlled clinical trial).pt. or clinical trials as topic.sh. or exp Randomized Controlled Trials as Topic/ or (randomized or randomised or placebo or randomly or phase iii or phase 3).ti,ab,kf. or trial.ti. (1570961)
18 (RCT or sham or dummy or single blind$ or double blind$ or allocated or allocation or triple blind$ or treble blind$ or random$).ti,ab,kf. not medline.st. (208715)
19 17 or 18 (1648512)
20 16 and 19 (1796)

CINAHL via EBSCO

S10 S8 AND S9 Limiters - Published Date: 20160101-; English Language
Expanders - Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 2,723

S9 (MH randomized controlled trials) or (MH double-blind studies) or (MH single-blind studies) or (MH random assignment) or (MH pretest-posttest design) or (MH cluster sample) or (TI (randomised OR randomized)) or (AB (random*)) or (TI (trial)) or (MH (sample size) AND AB (assigned OR allocated OR control)) or (MH (placebos)) or (PT (randomized controlled trial)) or (AB (control W5 group)) or (MH (crossover design) OR MH (comparative studies)) or (AB (cluster W3 RCT)) Expanders - Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 949,992

S8 (S4 AND S7) Expanders - Also search within the full text of the articles; Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 25,638

S7 S5 OR S6 Expanders - Also search within the full text of the articles; Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases

Search Screen - Advanced Search
Database - CINAHL with Full Text 1,173,921
S6 TI (geriatric* or older or senior* or elder* or aged) OR AB (geriatric* or older or senior* or elder* or aged) Expanders - Also search within the full text of the articles; Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 503,910
S5 (MH "Frail Elderly") OR (MH "Aged") OR (MH "Aged, 80 and Over") Expanders - Also search within the full text of the articles; Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 911,333
S4 S1 OR S2 OR S3 Expanders - Also search within the full text of the articles; Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 57,328
S3 TI (fall or falling) Expanders - Also search within the full text of the articles; Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 19,265
S2 TI ((falls or faller or fallers or fall injur*)) OR AB ((falls or faller or fallers or fall injur*)) Expanders - Also search within the full text of the articles; Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 47,802
S1 mh "accidental falls" Expanders - Also search within the full text of the articles; Apply equivalent subjects
Search modes - Boolean/Phrase Interface - EBSCOhost Research Databases
Search Screen - Advanced Search
Database - CINAHL with Full Text 25,215

Cochrane Central Register of Controlled Clinical Trials (CENTRAL) via Wiley

Date Run: 22/04/2022 13:28:50

ID	Search	Hits
#1	**"accidental falls":ti,ab,kw**	**1815**
#2	**(falls or faller or fallers or "fall injur*"):ti,ab,kw**	**8316**
#3	**(fall or falling):ti**	**1535**
#4	**1-#3**	**8954**
#5	**(geriatric* OR older OR senior* OR elder* OR aged):ti,ab,kw**	**594397**
#6	**#4 and #5 with Publication Year from 2016 to present, in Trials**	**2786**

Appendix A Table 1. Inclusion and Exclusion Criteria

<table>
<tr><th>Category</th><th>Included</th><th>Excluded</th></tr>
<tr><td>Aim</td><td>Trials with the primary or secondary aim of reducing falls or falls-related injuries</td><td>Comparative effectiveness trials of fall interventions</td></tr>
<tr><td>Population</td><td>Community-dwelling, ambulatory adults age ≥65 years at unselected or increased risk for falls</td><td>Trials conducted exclusively in populations living in settings outside of the community (e.g., hospitals, nursing or care homes, rehabilitation centers, or other long-term care facilities)

Trials conducted exclusively in special populations (e.g., adults with neurocognitive disorders such as moderate to severe dementia or Parkinson’s disease) where interventions may be considered disease management

Trials conducted exclusively in a population with pre-existing social ties</td></tr>
<tr><td>Interventions</td><td>Interventions that are primary care feasible or referable

Categories of included interventions:
Exercise (supervised or unsupervised, individual or group)
Multifactorial assessment and intervention
Medication modification/review
Psychological (individual or group)
Environmental assessment and modification
Knowledge/Education
Interventions may be delivered alone or in combination</td><td>Categories of excluded interventions:
Social marketing
Policy
Surgery
Fluid or nutrition therapy
Management of urinary incontinence
Assistive technology
Vitamin D, supplements</td></tr>
<tr><td>Comparators</td><td>Placebo, minimal control (i.e., provision of education via written materials, video, lecture), usual care</td><td>Active comparators</td></tr>
<tr><td>Outcomes</td><td>KQ 1:
Falls
Mortality (all-cause and falls-related)
Fall-related morbidity, defined as:
Fall-related injuries and fractures
Disability (as measured by instrumental activities of daily life instruments)
Quality of life (validated instruments)
Hospitalizations for fall-related injuries
Emergency department visits for fall-related injuries
Institutionalizations (e.g., transition from community dwelling to nursing or care homes, or other long-term care facilities)
KQ 2: Harms outcomes as reported in studies</td><td>KQ 1:
Basic activities of daily living
Falls Efficacy Scale
Function measures (e.g., Performance-Oriented Mobility Assessment, Timed Get Up & Go Test, 6-meter timed walk, Functional Reach Test, and Berg Balance Scale)
KQ 2:

Minor adverse events that are reported using nonvalidated, nongeneralizable measures</td></tr>
<tr><td>Followup</td><td>Minimum 6 months followup</td><td></td></tr>
</table>

Appendix A Table 1. Inclusion and Exclusion Criteria

Category	Included	Excluded
Study Designs	Randomized controlled trials	Editorials, letters, systematic and nonsystematic reviews, opinions, non-randomized studies of interventions, convenience surveys, qualitative studies
Setting	Interventions conducted in primary care, referable from primary care	
Country	Countries categorized as “Very High” on the 2019 Human Development Index*	Countries that are not categorized as “Very High”
Language	English only	Non-English language publications
Quality	Fair or good, according to design-specific criteria	Poor, according to design-specific criteria

* As defined by the United Nations Development Programme. Human Development Report 2020. http://hdr.undp.org/sites/default/files/hdr2020.pdf Accessed 1/28/2022.
Abbreviations: KQ = Key question

Appendix A Table 2. Study-Design Quality Rating Criteria

Study Design	Adapted Quality Criteria
Randomized clinical trials*, adapted from U.S. Preventive Services Task Force Manual[2]	**Bias arising in the randomization process or due to confounding** • Valid random assignment/random sequence generation method used • Allocation concealed • Balance in baseline characteristics **Bias due to departures from intended interventions** • Fidelity to the intervention protocol • Low risk of contamination between groups • Participants were analyzed as originally allocated **Bias from missing data** • No, or minimal, post-randomization exclusions • Outcome data are reasonably complete and comparable between groups • Reasons for missing data are similar across groups • Missing data are unlikely to bias results **Bias in measurement of outcomes** • Outcomes are measured using consistent and appropriate procedures and instruments across treatment groups • No evidence of biased use of inferential statistics **Bias in reporting results selectively** No evidence that the measures, analyses, or subgroup analyses are selectively reported

*Good quality studies generally meet all quality criteria. Fair quality studies do not meet all the criteria but do not have critical limitations that could invalidate study findings. Poor quality studies have a single fatal flaw or multiple important limitations that could invalidate study findings. Critical appraisal of studies using *a priori* quality criteria are conducted independently by at least two reviewers. Disagreements in final quality assessment are resolved by consensus, and, if needed, consultation with a third independent reviewer.

Abbreviations: KQ = Key Question; U.S. = United States

Appendix A Figure 1. Risk of Bias in Multifactorial Intervention Trials, by Domain

Quality	Author	Domain: Randomization process/confounding	Domain: Intervention deviations	Domain: Outcome measurement	Domain: Missing data	Domain: Selective reporting
Good	Bhasin, 2020	✓	✓	✓	✓	✓
	Bruce, 2021	✓	✓	✓	✓	✓
	Conroy, 2010	✓	✓	✓	✓	✓
	Fairhall, 2014	✓	✓	✓	✓	✓
	Logan, 2010	✓	✓	✓	✓	✓
	Lord, 2005	✓	✓	✓	✓	✓
	Salminen, 2009	✓	✓	✓	✓	✓
	Tinetti, 1994	✓	✓	✓	✓	✓
	Vind, 2009	✓	✓	✓	✓	✓
Fair	Ciaschini, 2009	✓	✓	▲	✓	✓
	Close, 1999	✓	✓	✓	▲	✓
	Cohen, 2015	▲	▲	✓	▲	✓
	Davison, 2005	✓	✓	✓	✓	✓
	de Vries, 2010	✓	▲	✓	✓	✓
	Elley, 2008	▲	▲	✓	✓	✓
	Ferrer, 2014	✓	✓	✓	▲	✓
	Hendriks, 2008	✓	▲	✓	✓	✓
	Hogan, 2001	✓	✓	✓	▲	✓
	Imhof, 2012	✓	✓	▲	✓	✓
	La Porta, 2022	✓	✓	✓	▲	✓
	Lightbody, 2002	▲	✓	▲	✓	✓
	Moller, 2014	✓	✓	▲	▲	✓
	Palvanen, 2014	✓	✓	▲	✓	✓
	Perula, 2012	✓	✓	▲	✓	✓
	Russell, 2010	✓	▲	✓	✓	✓
	Spice, 2009	▲	✓	✓	✓	✓
	van Haastregt, 2000	✓	✓	✓	▲	✓
	Wagner, 1994	▲	✓	▲	✓	✓

Risk of bias
✓ Low
▲ Moderate

Appendix A Figure 2. Risk of Bias in Exercise Intervention Trials, by Domain

Quality	Author	Domain: Randomization process/confounding	Domain: Intervention deviations	Domain: Outcome measurement	Domain: Missing data	Domain: Selective reporting
Good	Bruce, 2021	✓	✓	✓	✓	✓
	Delbaere, 2021	✓	✓	✓	✓	✓
	Kovacs, 2013	✓	✓	✓	✓	✓
	Uusi-Rasi, 2015	✓	✓	✓	✓	✓
	Voukelatos, 2007	✓	✓	✓	✓	✓
Fair	Barnett, 2003	▲	✓	✓	▲	✓
	Buchner, 1997	▲	✓	✓	▲	✓
	Callisaya, 2021	✓	✓	✓	▲	✓
	Campbell, 1997	▲	▲	✓	▲	✓
	Chyu, 2010	✓	✓	▲	✓	✓
	El-Khoury, 2015	▲	✓	✓	▲	✓
	Fitzharris, 2010	▲	✓	✓	✓	✓
	Goldberg, 2019	▲	✓	▲	▲	✓
	Karinkanta, 2015	▲	✓	✓	✓	✓
	Korpelainen, 2006	▲	✓	✓	▲	✓
	Kronhed, 2009	▲	✓	✓	✓	✓
	Lamb, 2018	✓	✓	▲	✓	✓
	Lipsitz, 2019	✓	✓	✓	▲	✓
	Logghe, 2009	✓	✓	✓	▲	✓
	Luukinen, 2007	✓	▲	▲	▲	✓
	Merom, 2016	▲	✓	✓	✓	✓
	Miko, 2018	▲	✓	✓	✓	✓
	Morgan, 2004	▲	✓	✓	▲	✓
	Ng, 2015	✓	✓	▲	✓	✓
	Ohman, 2016	▲	✓	✓	✓	▲
	Oliveira, 2019	▲	✓	✓	✓	✓
	Rikkonen, 2023	▲	✓	✓	✓	✓
	Robertson, 2001	▲	✓	✓	▲	✓
	Rosado, 2021	▲	✓	▲	✓	✓
	Sherrington, 2014	▲	✓	✓	✓	✓
	Siegrist, 2016	▲	✓	✓	▲	✓
	Stathi, 2022	✓	✓	▲	▲	✓
	Suikkanen, 2021	✓	✓	▲	✓	✓
	Tomita, 2016	▲	✓	✓	▲	✓
	Trombetti, 2011	✓	✓	✓	▲	✓
	Tuvemo Johnson, 2021	▲	✓	✓	▲	✓
	Voukelatos, 2015	✓	✓	✓	▲	✓

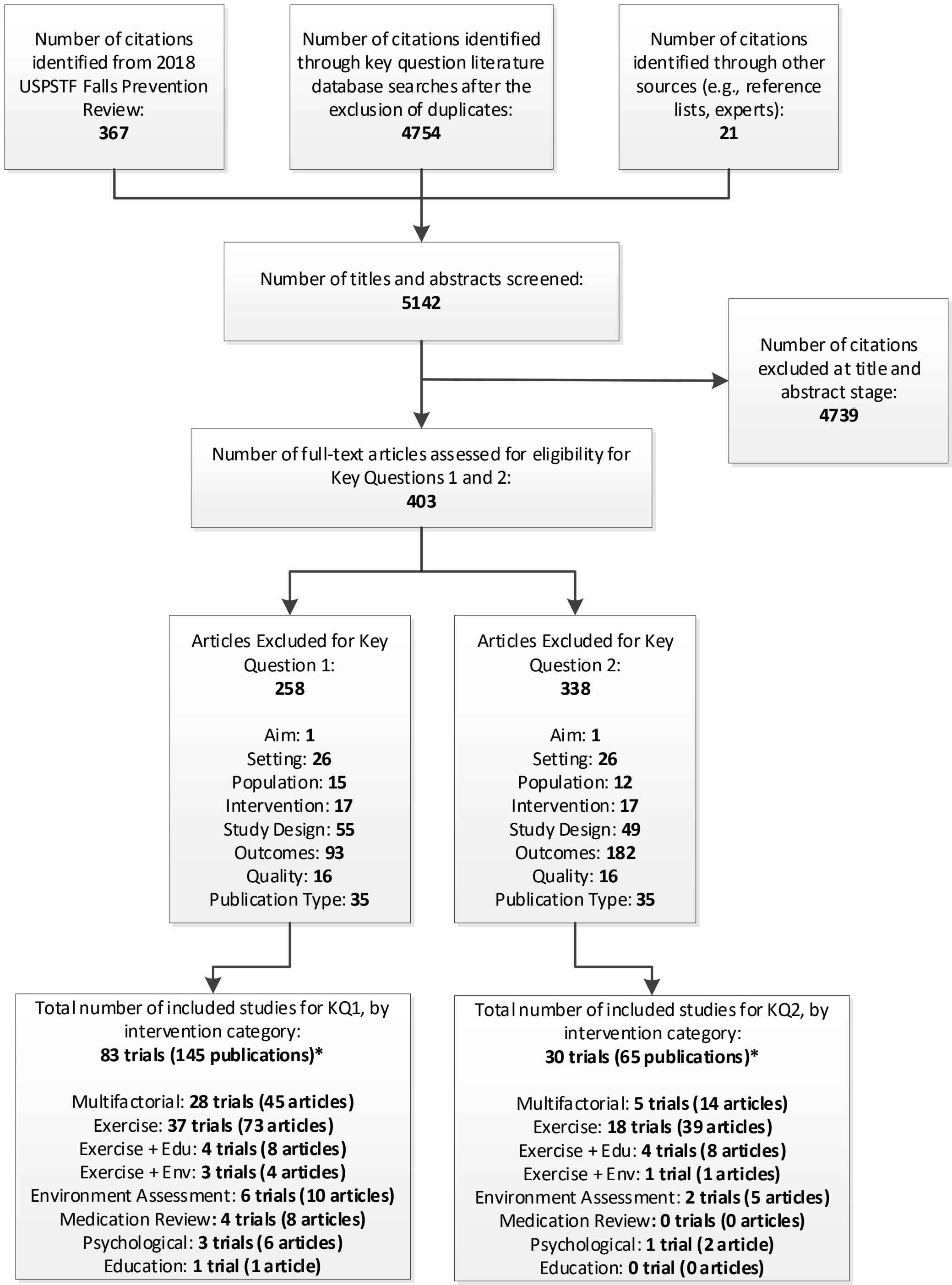
Risk of bias
✓ Low
▲ Moderate

Appendix A Figure 3. Risk of Bias in Other Intervention Trials, bBy Domain

Quality	Author	Domain: Randomization process/confounding	Domain: Intervention deviations	Domain: Outcome measurement	Domain: Missing data	Domain: Selective reporting
Good	Boye, 2017	Low	Low	Low	Low	Low
	Cockayne, 2021	Low	Low	Low	Low	Low
	Daly, 2020	Low	Low	Low	Low	Low
	Matchar, 2017	Low	Low	Low	Low	Low
	Pighills, 2011	Low	Low	Low	Low	Low
	Romskaug, 2020	Low	Low	Low	Low	Low
	Sherrington, 2020	Low	Low	Low	Low	Low
	Shumway-Cook, 2007	Low	Low	Low	Low	Low
	Stark, 2021	Low	Low	Low	Low	Low
Fair	Blalock, 2010	Low	Low	Low	Moderate	Low
	Chu, 2017	Moderate	Low	Low	Low	Low
	Clemson, 2004	Moderate	Low	Low	Low	Low
	Dorresteijn, 2016	Low	Low	Low	High	Low
	Fitzharris, 2010	Moderate	Low	Low	Low	Low
	Lim, 2023	Low	Low	Low	Moderate	Low
	Mott, 2016	Moderate	Low	Moderate	Moderate	Low
	Smulders, 2010	Moderate	Low	Low	Low	Low
	Stevens, 2001	Moderate	Low	Low	Low	Low
	Taylor, 2021	Low	Low	Low	Moderate	Low
	Zijlstra, 2009	Low	Low	Low	Moderate	Low

Risk of bias
- ✕ High
- ✓ Low
- △ Moderate

Appendix B Figure 1. Literature Flow Diagram



*Study may appear in more than one intervention category.

Included studies List, by Key Question (KQ) and Intervention Type

Ancillary publication(s) indented under primary article

KEY QUESTION 1

Multifactorial

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KEY QUESTION 2

Multifactorial

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12. Rikkonen T, Sund R, Koivumaa-Honkanen H, et al. Effectiveness of exercise on fall prevention in community-dwelling older adults: a 2-year randomized controlled study of 914 women. Age & Ageing. 2023;52(4):01. PMID: 37097767. https://dx.doi.org/10.1093/ageing/afad059

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Month Follow-Up of a Randomized, Controlled Trial. J Appl Gerontol. 2021;40(3):289-99. PMID: 32114877. https://dx.doi.org/10.1177/0733464820902652

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    b. Uusi-Rasi K, Patil R, Karinkanta S, et al. A 2-Year Follow-Up After a 2-Year RCT with Vitamin D and Exercise: Effects on Falls, Injurious Falls and Physical Functioning Among Older Women. J Gerontol A Biol Sci Med Sci. 2017;72(9):1239-45. PMID: 28369286. https://dx.doi.org/10.1093/gerona/glx044
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Exercise + Education

1. Daly RM, Gianoudis J, Kersh ME, et al. Effects of a 12-Month Supervised, Community-Based, Multimodal Exercise Program Followed by a 6-Month Research-to-Practice Transition on Bone Mineral Density, Trabecular Microarchitecture, and Physical Function in Older Adults: A Randomized Controlled Trial. Journal of Bone & Mineral Research. 2020;35(3):419-29. PMID: 31498937. https://dx.doi.org/10.1002/jbmr.3865
    a. Gianoudis J, Bailey CA, Ebeling PR, et al. Effects of a targeted multimodal exercise program incorporating high-speed power training on falls and fracture risk factors in older adults: a community-based randomized controlled trial. J Bone Miner Res. 2014;29(1):182-91. PMID: 23775701. http://dx.doi.org/10.1002/jbmr.2014

b. Gianoudis J, Bailey CA, Sanders KM, et al. Osteo-cise: strong bones for life: protocol for a community-based randomised controlled trial of a multi-modal exercise and osteoporosis education program for older adults at risk of falls and fractures. BMC Musculoskelet Disord. 2012;13:78. PMID: 22640372. http://dx.doi.org/10.1186/1471-2474-13-78

2. Sherrington C, Fairhall N, Kirkham C, et al. Exercise to Reduce Mobility Disability and Prevent Falls After Fall-Related Leg or Pelvic Fracture: RESTORE Randomized Controlled Trial. Journal of General Internal Medicine. 2020;35(10):2907-16. PMID: 32016702. https://dx.doi.org/10.1007/s11606-020-05666-9
   a. Sherrington C, Fairhall N, Kirkham C, et al. Exercise and fall prevention self-management to reduce mobility-related disability and falls after fall-related lower limb fracture in older people: protocol for the RESTORE (Recovery Exercises and STepping On afteR fracturE) randomised controlled trial. BMC Geriatrics. 2016;16:34. PMID: 26838998. https://dx.doi.org/10.1186/s12877-016-0206-5
3. Shumway-Cook A, Silver I, Mary L, et al. Effectiveness of a community-based multifactorial intervention on falls and fall risk factors in community-living older adults: a randomized, controlled trial. J Gerontol A Biol Sci Med Sci. 2007;62(12):1420-7. PMID: 18166695.
4. Smulders E, Weerdesteyn V, Groen BE, et al. Efficacy of a short multidisciplinary falls prevention program for elderly persons with osteoporosis and a fall history: a randomized controlled trial. Arch Phys Med Rehabil. 2010;91(11):1705-11. PMID: 21044715. http://dx.doi.org/10.1016/j.apmr.2010.08.004

Exercise + Environment

1. Taylor ME, Wesson J, Sherrington C, et al. Tailored Exercise and Home Hazard Reduction Program for Fall Prevention in Older People With Cognitive Impairment: The i-FOCIS Randomized Controlled Trial. Journals of Gerontology Series A-Biological Sciences & Medical Sciences. 2021;76(4):655-65. PMID: 32949456. https://dx.doi.org/10.1093/gerona/glaa241

Environment

1. Cockayne S, Pighills A, Adamson J, et al. Home environmental assessments and modification delivered by occupational therapists to reduce falls in people aged 65 years and over: the OTIS RCT. Health Technol Assess. 2021;25(46):1-118. PMID: 34254934. https://dx.doi.org/10.3310/hta25460
   a. Cockayne S, Pighills A, Adamson J, et al. Can occupational therapist-led home environmental assessment prevent falls in older people? A modified cohort randomised controlled trial protocol. BMJ Open. 2018;8(9):e022488. PMID: 30206086. https://dx.doi.org/10.1136/bmjopen-2018-022488
   b. Cockayne S, Pighills A, Fairhurst C, et al. Home hazard assessment and environmental modification to prevent falls in older people: the OTIS trial. F1000Res. 2021;25 June 2021:1-18. https://doi.org/10.12688/f1000research.52313.1
2. Stark S, Keglovits M, Somerville E, et al. Home Hazard Removal to Reduce Falls Among Community-Dwelling Older Adults: A Randomized Clinical Trial. JAMA

netw. 2021;4(8):e2122044. PMID: 34463746. https://dx.doi.org/10.1001/jamanetworkopen.2021.22044

a. Stark S, Somerville E, Keglovits M, et al. Protocol for the home hazards removal program (HARP) study: a pragmatic, randomized clinical trial and implementation study. BMC Geriatrics. 2017;17(1):90. PMID: 28427336. https://dx.doi.org/10.1186/s12877-017-0478-4

Psychological

1. Zijlstra GA, van Haastregt JC, Ambergen T, et al. Effects of a multicomponent cognitive behavioral group intervention on fear of falling and activity avoidance in community-dwelling older adults: results of a randomized controlled trial. J Am Geriatr Soc. 2009;57(11):2020-8. PMID: 19793161. https://doi.org/10.1111/j.1532-5415.2009.02489.x

   a. Kempen GI, Oude Wesselink SF, van Haastregt JC, et al. Long-term effect on mortality of a multicomponent cognitive behavioural group intervention to reduce fear of falling in older adults: a randomised controlled trial. Age Ageing. 2011;40(4):519-23. PMID: 21551460. http://dx.doi.org/10.1093/ageing/afr041

Appendix D. Excluded Studies List

Reason for Exclusion*
E1. Aim/relevant
E1a. Falls prevention not primary or secondary aim
E2. Study design
E3. Setting
E3a. Not a very high HDI country
E3b. Not primary care referable/feasible (e.g., intervention setting not accessible to general population, pre-existing social ties)
E4. Population
E4a. Adults <65 years
E4b. Adults not representative of general primary care population (e.g., Parkinson's, moderate to severe dementia, adults living in long-term care)
E5. No relevant outcomes
E5a. No additional relevant data (primary article included)
E5b. Only intermediate outcomes reported
E6. Intervention
E6a. <6 months followup
E6b. Comparative effectiveness trial
E6c. Not an included intervention type
E6d. Not minimal control group
E7. Publication
E7a. Publication type not included (correction, abstract)
E7b. Publication type not included (non-English)
E8. Full Text Unavailable
E9. Primary article excluded
E9a. Primary was poor quality
E10. Study quality

* Assigned at full-text phase

1. Adnan, M, Anjum, H, et al. Effectiveness of Physical Activity in Geriatric Population to Decrease the Risk of Fall a Randomized Control Trial. Pakistan journal of medical and health sciences. 16(12): 589-591. 2022. PMID: . https://dx.doi.org/10.53350/pjmhs20221612589 **KQ1E3a; KQ2E3a**
2. Agarwal, G, Angeles, R, et al. Evaluation of a community paramedicine health promotion and lifestyle risk assessment program for older adults who live in social housing: a cluster randomized trial. CMAJ Canadian Medical Association Journal. 190(21): E638-E647. 2018. PMID: 29807936. https://dx.doi.org/10.1503/cmaj.170740 **KQ1E5; KQ2E5**
3. Aibar-Almazan, A, Martinez-Amat, A, et al. Effects of Pilates on fall risk factors in community-dwelling elderly women: A randomized, controlled trial. European Journal of Sport Science EJSS : Official Journal of the European College of Sport Science. 19(10): 1386-1394. 2019. PMID: 30990762. https://dx.doi.org/10.1080/17461391.2019.1595739 **KQ1E5b; KQ2E5b**
4. Ailliaud, A, Moulis, É, et al. Assessment in the home of the elderly following a first fall with Samu intervention. Soins Gerontol. 27(153): 23-25. 2022. PMID: NONE. 10.1016/j.sger.2021.11.008 **KQ1E7b; KQ2E7b**
5. Alakare, Janne, Kemp, Kirsi, et al. Systematic geriatric assessment for older patients with frailty in the emergency department: a randomised controlled trial. BMC Geriatr. 21(1): 1-11. 2021. PMID: NONE. 10.1186/s12877-021-02351-2 **KQ1E3; KQ2E3**

6. Allison, SJ, Brooke-Wavell, K, et al. High and odd impact exercise training improved physical function and fall risk factors in community-dwelling older men. Journal of Musculoskeletal Neuronal Interactions. 18(1): 100-107. 2018. PMID: 29504585. **KQ1E2; KQ2E2**
7. Altamirano, Guerrero O, Balarezo, Garcia Mg, et al. Effectiveness of a preventive program for the reduction of falls in older adults. NeuroQuantology. 20(13): 287-292. 2022. https://dx.doi.org/10.14704/NQ.2022.20.13.NQ88038 **KQ1E3a; KQ2E3a**
8. Althomali, MM, Vallis, LA, et al. Can older adults' balance and mobility improve with visual attention training?. Eur J Appl Physiol. 119(7): 1649-1661. 2019. PMID: 31055677. https://dx.doi.org/10.1007/s00421-019-04153-2 **KQ1E5; KQ2E5**
9. Amaha, K, Arimoto, T. IFFAS-S13 03 Randomized control study of toe exercise for prevention from fall in elderly people. Foot Ankle Surg. 23(): 22-. 2017. PMID: NONE. 10.1016/j.fas.2017.07.1107 **KQ1E7a; KQ2E7a**
10. Anderson, ML, Allen, KD, et al. Fall Risk and Utilization of Balance Training for Adults With Symptomatic Knee Osteoarthritis: Secondary Analysis From a Randomized Clinical Trial. Journal of Geriatric Physical Therapy. 42(2): E39-E44. 2019. PMID: 30407270. https://dx.doi.org/10.1519/JPT.0000000000000213 **KQ1E5b; KQ2E5b**
11. Anonymous, . E-health StandingTall balance exercise for fall prevention in older people: results of a two year randomised controlled trial. BMJ. 374(): n1908. 2021. PMID: 34404632. https://dx.doi.org/10.1136/bmj.n1908 **KQ1E7a; KQ2E7a**
12. Ansai, JH, Aurichio, TR, et al. Effects of two physical exercise protocols on physical performance related to falls in the oldest old: A randomized controlled trial. Geriatr Gerontol Int. 16(4): 492-9. 2016. PMID: 25868484. https://dx.doi.org/10.1111/ggi.12497 **KQ1E3a; KQ2E3a**
13. Apostolo, J, Dixe, MDA, et al. Effectiveness of a Combined Intervention on Psychological and Physical Capacities of Frail Older Adults: A Cluster Randomized Controlled Trial. International Journal of Environmental Research & Public Health [Electronic Resource]. 16(17): 28. 2019. PMID: 31466229. https://dx.doi.org/10.3390/ijerph16173125 **KQ1E5; KQ2E5**
14. Aranda-Reneo, I, Albornos-Munoz, L, et al. Cost-Effectiveness of an Exercise Programme That Provided Group or Individual Training to Reduce the Fall Risk in Healthy Community-Dwelling People Aged 65-80: A Secondary Data Analysis. Healthcare. 9(6): 10. 2021. PMID: 34200873. https://dx.doi.org/10.3390/healthcare9060714 **KQ1E6b; KQ2E6b**
15. Areeudomwong, P, Saysalum, S, et al. Balance and functional fitness benefits of a Thai boxing dance program among community-dwelling older adults at risk of falling: A randomized controlled study. Arch Gerontol Geriatr. 83(): 231-238. 2019. PMID: 31102925. https://dx.doi.org/10.1016/j.archger.2019.04.010 **KQ1E5; KQ2E5**
16. Arena, SK, Wilson, CM, et al. Impact of the HOP-UP-PT program on older adults at risk to fall: a randomized controlled trial. BMC Geriatr. 21(1): 520. 2021. PMID: 34598692. https://dx.doi.org/10.1186/s12877-021-02450-0 **KQ1E10; KQ2E5**
17. Arghavani, H, Zolaktaf, V, et al. Comparing the effects of anticipatory postural adjustments focused training and balance training on postural preparation, balance confidence and quality of life in elderly with history of a fall. Aging-Clinical & Experimental Research. 32(9): 1757-1765. 2020. PMID: 31608424. https://dx.doi.org/10.1007/s40520-019-01358-5 **KQ1E5; KQ2E5**
18. Arkkukangas, M, Stromqvist Baathe, K, et al. High Challenge Exercise and Learning Safe Landing Strategies among Community-Dwelling Older Adults: A Randomized Controlled Trial. International Journal of Environmental Research & Public Health [Electronic Resource]. 19(12): 16. 2022. PMID: 35742618. https://dx.doi.org/10.3390/ijerph19127370 **KQ1E5b; KQ2E5b**

19. Arnold, CM, Faulkner, RA. The effect of aquatic exercise and education on lowering fall risk in older adults with hip osteoarthritis [corrected] [published erratum appears in J AGING PHYS ACTIVITY 2010 Oct;18(4):477-479]. J Aging Phys Act. 18(3): 245-260. 2010. PMID: NONE. **KQ1E5; KQ2E5**
20. Barker, A, Cameron, P, et al. Evaluation of RESPOND, a patient-centred program to prevent falls in older people presenting to the emergency department with a fall: A randomised controlled trial. PLoS Medicine / Public Library of Science. 16(5): e1002807. 2019. PMID: 31125354. https://dx.doi.org/10.1371/journal.pmed.1002807 **KQ1E6d; KQ2E6d**
21. Barker, AL, Cameron, PA, et al. RESPOND--A patient-centred programme to prevent secondary falls in older people presenting to the emergency department with a fall: protocol for a multicentre randomised controlled trial. Inj Prev. 21(1): e1. 2015. PMID: 24958769. http://dx.doi.org/10.1136/injuryprev-2014-041271 **KQ1E9; KQ2E9**
22. Barker, AL, Talevski, J, et al. Feasibility of Pilates exercise to decrease falls risk: a pilot randomized controlled trial in community-dwelling older people. Clin Rehabil. 30(10): 984-996. 2016. PMID: 26385357. **KQ1E6d; KQ2E6d**
23. Bayliss, EA, Shetterly, SM, et al. The OPTIMIZE patient- and family-centered, primary care-based deprescribing intervention for older adults with dementia or mild cognitive impairment and multiple chronic conditions: study protocol for a pragmatic cluster randomized controlled trial. Trials [Electronic Resource]. 21(1): 542. 2020. PMID: 32552857. https://dx.doi.org/10.1186/s13063-020-04482-0 **KQ1E5; KQ2E5**
24. Belleville, S, Cuesta, M, et al. Rationale and protocol of the StayFitLonger study: a multicentre trial to measure efficacy and adherence of a home-based computerised multidomain intervention in healthy older adults. BMC Geriatr. 20(1): 315. 2020. PMID: 32859156. https://dx.doi.org/10.1186/s12877-020-01709-2 **KQ1E5; KQ2E5**
25. Bellumori, Maria, Uygur, Mehmet, et al. High-Speed Cycling Intervention Improves Rate-Dependent Mobility in Older Adults. Med Sci Sports Exerc. 49(1): 106-114. 2017. PMID: NONE. 10.1249/MSS.0000000000001069 **KQ1E5b; KQ2E5b**
26. Benavent-Caballer, V, Rosado-Calatayud, P, et al. The effectiveness of a video-supported group-based Otago exercise programme on physical performance in community-dwelling older adults: a preliminary study. Physiotherapy. 102(3): 280-6. 2016. PMID: 26395209. https://dx.doi.org/10.1016/j.physio.2015.08.002 **KQ1E5; KQ2E5**
27. Bernabei, R, Landi, F, et al. Multicomponent intervention to prevent mobility disability in frail older adults: randomised controlled trial (SPRINTT project). BMJ. 377(): e068788. 2022. PMID: 35545258. 10.1136/bmj-2021-068788 **KQ1E6c; KQ2E6c**
28. Bernardelli, G, Roncaglione, C, et al. Adapted physical activity to promote active and healthy ageing: the PoliFIT pilot randomized waiting list-controlled trial. Aging-Clinical & Experimental Research. 31(4): 511-518. 2019. PMID: 30019265. https://dx.doi.org/10.1007/s40520-018-1002-1 **KQ1E6a; KQ2E6a**
29. Birimoglu, Okuyan C, Bilgili, N. Effect of tai chi chuan on fear of falling, balance and physical self-perception in elderly: a randomised controlled trial. Turk geriatri dergisi. 20(3): 232-241. 2017. PMID: NONE. **KQ1E4b; KQ2E4b**
30. Bischoff-Ferrari, HA, de Godoi Rezende Costa Molino, C, et al. DO-HEALTH: Vitamin D3 - Omega-3 - Home exercise - Healthy aging and longevity trial - Design of a multinational clinical trial on healthy aging among European seniors. Contemp Clin Trials. 100(): 106124. 2021. PMID: 32858228. https://dx.doi.org/10.1016/j.cct.2020.106124 **KQ1E9; KQ2E9**

31. Bischoff-Ferrari, HA, Freystatter, G, et al. Effects of vitamin D, omega-3 fatty acids and a simple home strength exercise program on fall prevention: the DO-HEALTH randomized clinical trial. Am J Clin Nutr. 07(): 07. 2022. PMID: 35136915. https://dx.doi.org/10.1093/ajcn/nqac022 **KQ1E6d; KQ2E6d**
32. Bischoff-Ferrari, HA, Orav, EJ, et al. Effect of cholecalciferol plus calcium on falling in ambulatory older men and women: a 3-year randomized controlled trial. Arch Intern Med. 166(4): 424-430. 2006. PMID: 16505262. https://doi.org/10.1001/archinte.166.4.424 **KQ1E6c; KQ2E6c**
33. Bjerk, M, Brovold, T, et al. A falls prevention programme to improve quality of life, physical function and falls efficacy in older people receiving home help services: study protocol for a randomised controlled trial. BMC Health Serv Res. 17(1): 559. 2017. PMID: 28806904. https://dx.doi.org/10.1186/s12913-017-2516-5 **KQ1E6a; KQ2E5**
34. Bjerk, M, Brovold, T, et al. Effects of a falls prevention exercise programme on health-related quality of life in older home care recipients: a randomised controlled trial. Age Ageing. 48(2): 213-219. 2019. PMID: 30615055. https://dx.doi.org/10.1093/ageing/afy192 **KQ1E6a; KQ2E6a**
35. Bjerk, M, Brovold, T, et al. Effects of a falls prevention programme on health-related quality of life in older home care recipients: a randomised controlled trial. Eur Geriatr Med. 9(): S169-. 2018. PMID: NONE. 10.1007/s41999-018-0097-4 **KQ1E7a; KQ2E7a**
36. Bjerk, M, Brovold, T, et al. Evaluating a falls prevention intervention in older home care recipients: a comparison of SF-6D and EQ-5D. Qual Life Res. 28(12): 3187-3195. 2019. PMID: 31364036. https://dx.doi.org/10.1007/s11136-019-02258-x **KQ1E2; KQ2E2**
37. Bjerk, M, Brovold, T, et al. Health-related quality of life in home care recipients after a falls prevention intervention: a 6-month follow-up. Eur J Public Health. 30(1): 64-69. 2020. PMID: 31169888. https://dx.doi.org/10.1093/eurpub/ckz106 **KQ1E6a; KQ2E5**
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Appendix E Table 1. Multifactorial Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Target population	Recruitment setting(s)	N rand	Mean age (range)	Female, %	Race/ethnicity, %
Bruce, 2021[3] Prevention of Fall Injury Trial (PreFIT)	Good	GBR	Community-dwelling older people aged ≥70 years	PC/GP	9803	78 (≥70)	53	White: 99
Bhasin, 2020[4] Strategies to Reduce Injuries and Develop Confidence in Elders (STRIDE)	Good	US	Community-dwelling older adults, ≥70 years, at increased risk for fall injuries	PC/GP	5451	80 (≥70)	62	White: 91 Black: 5 Hispanic/Latino: 8 Other: 3.5
Ciaschini, 2009[5]	Fair	CAN	Community dwelling persons aged ≥55 years identified to be at a risk for fall-related fractures	Clinical, NOS or varied; ED; Hospital; Other	201	72 (≥55)	94	Aboriginal origin: 6
Close, 1999[6] Prevention of falls in the elderly trial (PROFET)	Fair	GBR	Aged ≥65 years, living in the community, and presenting to an accident and ED with a fall	ED	397	78 (≥65)	68	NR
Cohen, 2015[7] Living Independently and Falls-free Together (LIFT) Wellness Program	Fair	US	Community-dwelling older adults aged ≥75 years	Insurance	5310	81 (≥75)	58	NR
Conroy, 2010[8]	Good	GBR	Older people aged ≥70 years	PC/GP	364	79 (≥70)	60	NR
Davison, 2005[9]	Fair	GBR	Cognitively intact men and women aged ≥65 years presenting to Accident & ED with a fall or fall-related injury	ED	313	77 (≥65)	72	NR
de Vries, 2010[10]	Fair	NLD	Persons ≥65 years who consulted the ED or their family physician after a fall	ED; PC/GP	217	80 (≥65)	70	NR

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Author, year Study name	QR	Country	Target population	Recruitment setting(s)	N rand	Mean age (range)	Female, %	Race/ethnicity, %
Elley, 2008[11]	Fair	NZL	Community-living people aged ≥75 years who had fallen in the previous year	PC/GP	312	81 (≥75)	69	Maori or Pacific people (age range 61–75): 3
Fairhall, 2014[12] The Frailty Intervention Trial	Good	AUS	Community-dwelling adults aged ≥70 years without severe cognitive impairment who met the Cardiovascular Health Study frailty definition	Clinical, NOS or varied	241	83 (≥70)	68	NR
Ferrer, 2014[13]	Fair	ESP	Community-dwelling adults born in 1924	Clinical, NOS or varied; PC/GP	328	85 (85)	62	NR
Hendriks, 2008[14]	Fair	NLD	Community-dwelling people aged ≥65 years who were seen in an ED after a fall	ED	333	74 (≥65)	69	NR
Hogan, 2001[15]	Fair	CAN	Community-dwelling persons aged ≥65 years who had fallen within the previous 3 months	NR	163	77.6 (≥65)	72	NR
Imhof, 2012[16]	Fair	CHE	Community dwelling adults aged ≥80 years	Community-based; Hospital; PC/GP; Other	461	85 (≥80)	72.7	NR
La Porta, 2022[17]	Fair	ITA	Community-dwelling older adults at moderate to high risk of falling.	Hospital	403	76 (≥65)	66	NR
Lightbody, 2002[18]	Fair	GBR	Patients aged ≥65 attending the Accident and ED with a primary diagnosis of a fall	ED	348	75 (≥65)	74	NR

Appendix E Table 1. Multifactorial Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Target population	Recruitment setting(s)	N rand	Mean age (range)	Female, %	Race/ethnicity, %
Logan, 2010[19]	Good	GBR	Adults aged ≥60 years living at home or in residential care who had fallen and called an emergency ambulance but were not taken to the hospital	Other	204	82 (≥60)	64.7	NR
Lord, 2005[20]	Good	AUS	Community-dwelling adults aged ≥75 years	Insurance	414	80 (≥75)	68	NR
Moller, 2014[21]	Fair	SWE	Persons aged ≥65 years living in the study municipality	PC/GP; Other	153	82 (≥65)	67	NR
Palvanen, 2014[22] Chaos Clinic Falls Prevention Programme	Fair	FIN	Home-dwelling people aged ≥70 years or older	Clinical, NOS or varied; Other	1314	78 (≥70)	86	NR
Perula, 2012[23]	Fair	ESP	Community-dwelling adults aged ≥70 years	PC/GP	404	76 (≥70)	53	NR
Russell, 2010[24]	Fair	AUS	Community-dwelling adults aged ≥60 years, presenting to an ED after a fall and discharged directly home	ED	712	75 (≥60)	70	NR
Salminen, 2009[25]	Good	FIN	Community-dwelling adults aged 65 years or older who had fallen at least once during the previous 12 months	Clinical, NOS or varied; Community-based; Hospital' PC/GP; Other	591	73 (≥65)	84	NR

Appendix E Table 1. Multifactorial Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Target population	Recruitment setting(s)	N rand	Mean age (range)	Female, %	Race/ethnicity, %
Spice, 2009[26] Winchester falls project	Fair	GBR	Community-dwelling adults aged 65 years or older who had two or more falls in the previous year and did not present to an ED with the index fall	PC/GP	375	82 (≥65)	73	NR
Tinetti, 1994[27]	Good	US	Community-dwelling adults aged ≥70 years	Insurance	301	78 (≥70)	69	NR
van Haastregt, 2000[28]	Fair	NLD	Community-dwelling adults aged ≥70 years with moderate impairments in mobility or a history of recent falls	PC/GP	316	77 (≥70)	66	NR
Vind, 2009[29]	Good	DNK	Older adults who had visited the ED or had been hospitalized due to a fall	ED; Hospital	392	74 (≥65)	74	NR
Wagner, 1994[30]	Fair	US	Ambulatory older adults aged ≥65 years	Insurance	1242	73 (≥65)	60	NR

Abbreviations: AUS = Australia; CAN = Canada; CHE = Switzerland; DNK = Denmark; ED = Emergency department; ESP = Spain; FIN = Finland; GBR = Great Britain; N = Number of participants; NLD = Netherlands; NOS = Not otherwise specified; NR = Not reported; NZL = New Zealand; PC/GP = Primary care/General practitioner; QR = Quality rating; Rand = Randomized; SWE = Sweden; US = United States.

Appendix E Table 2. Multifactorial Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Bruce, 2021[3] Prevention of Fall Injury Trial (PreFIT)	43.8	Fall in the previous 12 mo and current balance problems whilst walking, dressing, toileting or taking a bath.	Met Strawbridge Frailty Index, %: 21	≥3 coexisting conditions, %: 19	NR	Possible cognitive impairment (as indicated by CDT), %: 9
Bhasin, 2020[4] Strategies to Reduce Injuries and Develop Confidence in Elders (STRIDE)	100	≥2 falls or had a fall-related injury in the previous 12 mo; or afraid of falling because of problems with balance or walking.	NR	Mean # of chronic coexisting conditions: 2.1	NR	Clinically significant cognitive impairment, %: 3
Ciaschini, 2009[5]	100	Presented to ED due to a fall and TUG of more than 14s; or referred because at high risk of fracture and TUG of more than 14s; or attended hospital fracture clinic for a non-pathological fracture of the vertebrae, hip, or wrist; or had a BMD in the previous 12 mo with a t-score of ≤−2.0.	NR	NR	Taking ≥4 meds, %: 56.2	NR
Close, 1999[6] Prevention of falls in the elderly trial (PROFET)	100	Presented to ED due to a fall.	NR	NR	NR	NR

Appendix E Table 2. Multifactorial Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Cohen, 2015[7] Living Independently and Falls-free Together (LIFT) Wellness Program	19	1+ fall in the previous 6 mo.	NR	NR	NR	NR
Conroy, 2010[8]	100	A previous fall or ≥2 of the following falls risk factors: ≥1 falls in the previous 12mo, taking >4 prescribed medications, previous stroke, Parkinson's disease, inability to stand from a chair without using arms to push up, symptoms of dizziness on standing, use of a mobility aid and being housebound.	NR	NR	Taking >4 meds, %: 53	NR
Davison, 2005[9]	100	Presented to A&E with a fall or fall-related injury.	NR	NR	NR	Median MMSE score: 28
de Vries, 2010[10]	100	Consulted the ED or family physician after a fall.	NR	Median # of chronic diseases: 1	Mean # of meds: 5.8	Median MMSE score: 28
Elley, 2008[11]	100	Fall or trip in the previous 12 mo.	NR	Mean # of medical conditions: 7.0	Mean # of meds: 5.5 Psychotropic meds, %: 29 Bone-sparing meds*, %: 28	NR
Fairhall, 2014[12] The Frailty Intervention Trial	100	Met specified cut-offs for ≥3 of the CHS frailty criteria: slow gait, weak grip, exhaustion, low energy expenditure and weight loss.	≥3 CHS frailty criteria, %: 100 <3 frailty criteria present, %: 65 <4 frailty criteria present, %: 26 <5 frailty criteria present, %: 9	Medical conditions (0-26)†: 7.4	Mean # of meds: 6.9 Psychotropic, %: 17 Benzodiazepine, %: 7	Mean MMSE score: 26.3

Appendix E Table 2. Multifactorial Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Ferrer, 2014[13]	NR	NA	NR	Charlson Comorbidity Index (0–37), median: 1	Median # of drugs: 6	Median MEC score‡: 28.5 Dementia, %: 9
Hendriks, 2008[14]	100	Presented to ED due to a fall.	NR	Mean # of illnesses: 3	NR	NR
Hogan, 2001[15]	100	Fall within the previous 3 mo without resulting in a lower-extremity fracture.	NR	NR	NR	Mean MMSE score: 27.7
Imhof, 2012[16]	40	Falls within last 12 mo.	NR	NR	NR	NR
La Porta, 2022[17]	100	Moderate-to-high fall risk associated with age and/or neurological conditions (i.e., PD and stroke)	NR	Parkinsons, %: 19 Stroke, %: 15	NR	NR
Lightbody, 2002[18]	100	Presenting to A&E due to a fall.	NR	NR	Taking ≥3 meds, %: 48.8 On target meds, %: 71.5	NR
Logan, 2010[19]	100	Fallen and contacted an ambulance service through the emergency telephone system but had not been taken to a hospital.	NR	NR	Taking ≥4 drugs, %: 56.8	NR
Lord, 2005[20]	NR	NA	NR	NR	Taking ≥4 meds, %: 50.5 Musculoskeletal, %: 25.8 CV, %: 72.4 Psychoactive, %: 14.5	NR
Moller, 2014[21]	100	Help needed with ≥2 activities of daily living, admitted to hospital ≥2 times, or have had ≥4 outpatient contacts during the previous 12 mo.	NR	Median # of health complaints: 11	NR	NR

Appendix E Table 2. Multifactorial Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Palvanen, 2014[22] Chaos Clinic Falls Prevention Programme	100	At least one of the following: problems in mobility and everyday function, ≥3 falls during the previous 12 mo, a previous fracture after the age 50, an osteoporotic fracture (hip fracture) in a close relative (mother or father), osteoporosis (diagnosed or a strong clinical suspicion such as thoracic kyphosis), low body weight (BMI<19), and sickness or illness essentially increasing the risk for osteoporosis, falls, and fractures.	NR	Mean # of medical conditions: 4.7	Mean # of meds: 5.6	Mean MMSE score: 27.3
Perula, 2012[23]	31	Fall in the previous 12 mo.	NR	Comorbidity, %: 61.8	Mean # of prescribed meds: 15.5 People who take drugs associated w fall risks, %: 60.9	NR
Russell, 2010[24]	100	Presented to ED after a fall and were discharged directly home.	NR	Mean # of medical conditions: 2.8	Mean # of meds: 5.0	Abbreviated Mental Test Score <7 (cognitively impaired), %: 4.2
Salminen, 2009[25]	100	1+ fall in the previous 12 mo.	NR		≥4 prescribed meds, %: 49.7	Median MMSE score: 72.75
Spice, 2009[26] Winchester falls project	100	≥2 falls in the previous 12 mo.	NR	NR	Mean # of drugs: 5 Taking ≥4 drugs: 65%	Mean AMT: 9

Appendix E Table 2. Multifactorial Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Tinetti, 1994[27]	100	At least one of the following risk factors for falling: postural hypotension; use of sedatives; use of ≥4 prescription medications; and impairment in arm or leg strength or range of motion, balance, ability to move safely from bed to chair or to the bathtub or toilet (transfer skills), or gait (from inclusion)	NR	1 chronic condition, %: 19.2 ≥2 chronic conditions, %: 73.1	Use of ≥4 prescription meds, %: 41 Use of benzodiazepine or other sedative-hypnotic agents, %: 19	MMSE score of 25+, %: 83.7
van Haastregt, 2000[28]	100	≥2 falls in the previous 6 mo or have scored three or more on the mobility control scale of the short version of the sickness impact profile.	NR	NR	NR	Mean mental health§; 22
Vind, 2009[29]	100	Presented to ED or had been hospitalized due to a fall.	NR	≥3 comorbidities, %: 39	Takes daily prescription drugs: 85%	NR
Wagner, 1994[30]	34	Fall in previous 12 mo.	NR	NR	NR	NR

* Includes bisphosphonate, vitamin D supplement, calcium supplement, and multivitamin
† Self-reported, doctor diagnosed medical conditions
‡ Spanish version of the MMSE (cognitive impairment,24/35)
§ RAND-36, 5 to 30 (favorable)

Abbreviations:
A&E = Accident and Emergency; AMT = Abbreviated Mental Test; BMD = Bone mineral density; BMI = Body Mass Index; CDT = Clostridioides difficile infection; CHS = Cardiovascular Health Study; Cog = Cognitive; CV = Cardiovascular; ED = Emergency department; MEC = Medical eligibility criteria; Meds = Medications; MMSE = Mini-Mental State Examination; Mo = Months; NA = Not applicable; NR = Not reported; S = seconds; TUG = Timed Up and Go Test.

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
Bruce, 2021[3]	Multifactorial falls prevention assessment followed by recommendations or further onward referral to another service, when indicated.	Hospital; GP/PC office	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	1 hr assessment
Bhasin, 2020[4]	Standardized assessment, followed by recommendations for management of risk factors with motivational interviewing, development of individualized care plan, implementation of care plan including referrals as needed, and followup care.	NR	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	NA
Ciaschini, 2009[5]	Multifaceted intervention providing pt-specific evidence-based recommendations targeted to reduce falls risk based on assessment of falls risk, functional status and home environment.	Home	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	1x assessment
Close, 1999[6]	Assessment of patient and home, modification of fall risk factors if possible, advice/education provided, referrals if needed.	Hospital; Home	Two 1x assessments; duration of tx varied based on recommendations/referral(s)	NA	1x medical assessment, 1x home visit
Cohen, 2015[7]	Assessment of patient and home followed by customized recommendations, fall prevention and wellness toolkit, education, and coaching with regard to tailored action plan.	Home	1x home assessment, 1 FU phone call (duration NR), printed newsletter 1-2 yrs, Exercise recommendations given (duration NR)	NA	1x home assessment & 1 FU phone call

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
Conroy, 2010[8]	Day hospital-delivered multifactorial falls prevention program, consisting of a medical review, home hazards assessment, and strength and balance training.	Hospital	1x assessment, program duration NR	NR	NR, assumed varied by tx recommendations
Davison, 2005[9]	Hospital-based medical assessment, and home-based physiotherapy and occupational therapy assessment followed by individualized intervention(s) for fall risk factors as indicated.	Hospital; Home	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	1x assessment
de Vries, 2010[10]	Multifactorial fall-risk assessment followed by referrals as needed. Discussion of referrals to medical specialists, medication changes and followup with PCP.	Geriatric clinic	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	1x assessment + referrals
Elley, 2008[11]	Home visit by nurse to conduct a standardized health assessment and an evidence-based algorithm to assess risk of falls and refer participants as appropriate to an optometrist, podiatrist, physical therapist, or occupational therapist and to receive a home-based exercise program to address identified risks.	Home	1x assessment, duration of exercise component 12mo	5 sessions over 12 mo (length of sessions NR)	1x assessment plus 5 exercise home visits from PT for 1 year (during home visits at Weeks 1, 2, 4, and 8 and after 6 mo); assume independent exercises encouraged but duration or frequency NR.

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
Fairhall, 2014[12]	Multifactorial, interdisciplinary intervention tailored to each participant based on baseline CHS frailty criteria and issues identified during comprehensive geriatric evaluation. Intervention could include case mgmt, exercise, nutritional & phycological mgmt.	In home	1x assessment; duration of tx varied based on recommendations/referral(s) [up to 12mo]	NA	PT: median of eight sessions. The median number of face-to-face sessions with a physiotherapist was 10 (range 0–24)
Ferrer, 2014[13]	Multifactorial falls-risk assessment followed by a tailored treatment plan devised based existing medical care and service networks in the community.	Clinic, NOS	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	1x assessment, FU tx varied
Hendriks, 2008[14]	Multifactorial intervention which included a detailed medical and occupational-therapy assessment to assess and address potential risk factors for new falls, followed by recommendations and referrals if indicated.	Hospital; In home	Two 1x assessments; duration of tx varied based on recommendations/referral(s)	NA	2, 1x assessments + recommendations
Hogan, 2001[15]	Multifactorial, in-home assessment, followed by recommendations, referrals, and a tailored care plan	Home	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	1 home assessment (Initial visit took 1-2 hrs), Subjects participated on average 3x in the exercise class (those that were referred, n=NR)
Imhof, 2012[16]	A 9-month in-home health consultation program (HCP) delivered by an advanced practice nurse. The HCP included a standardized comprehensive geriatric assessment, followed by 4 in-home, tailored consultations & followup phone calls.	Home	9	NA	4 home visits (mean length 46 ±6 minutes) after 4, 12, 24, and 36 weeks, and three telephone calls (mean length 17 ±4 minutes) after 8, 18, and 30 weeks. Total intervention time per participant averaged 4 hrs.

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
La Porta, 2022[17]	Multiple component intervention which included (1) group exercise classes, (2) group educational sessions on fall risk factors, (3) environment/home risk assessment & personalized recommendations, (4) personalized home exercise program, and (5) multifactorial assessment & referrals based on individual fall-risk profile	Class outside of home; Home, supervised	2.5 months	60min group session 1x/wk for 11wks;	Group exercise: one weekly six-person group session of sixty minutes for eleven weeks; Personalized, independent home exercise program (in addition to group exercise): 2x/wk for 30min plus 30min walk 2x/wk on rest days from other exercises .
Lightbody, 2002[18]	In-home assessment of risk factors for falls by a nurse after discharge from ED, followed by recommendations and referrals as indicated.	Home	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	1x assessment

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
Logan, 2010[19]	Individualized multifactorial intervention program which included medication review, in-home home hazard assessment and modification, individual training in strength and balance, and group community classes on falls prevention.	Home; Community	1x assessment, home exercise & group session up to 6wks	Up to 6 sessions but varied based on pt needs or interest (length and duration NR)	1x assessment plus (1) home training in strength and balance for at least six sessions led by the physiotherapist, and (2) rolling program of 12 group sessions on fall prevention, twice weekly over six weeks, in local community centers. Participants received as many sessions in their own homes as deemed clinically necessary and attended as many group sessions in the rolling program as they wished, up to a maximum of 12. The mean number of home or group sessions was 9.9 (SD 8.8), and the median duration of contact time for face-to-face therapy was 490 minutes (interquartile range 250-1257 minutes). Seventy-three participants received seven or more therapy sessions. Participants received a median of eight muscle strengthening sessions (interquartile range 6-12 sessions), 7.5 balance training (interquartile range 2-12) sessions, and 13.5 sessions on functional activities and reduction of hazards (interquartile range 6-18 sessions).

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
Lord, 2005[20]	Individualized falls prevention program comprising of an assessment, and if indicated, falls prevention counseling, or referrals for an exercise program or to an eye care specialist.	Clinic, NOS	1x assessment, ; duration of tx varied based on recommendations/referral(s) (up to 12mo if referred to exercise)	NR	1x assessment. If referred to exercise classes - these were conducted twice weekly over a 12-month period. The average number of exercise classes offered to the 153 subjects in the EIG was 78 (range 67–90).
Moller, 2014[21]	Home-based care management intervention, that included home visits delivering falls prevention education, a tailored independent, exercise program, brief home hazard assessment, and if indicated, referrals to PT or OT.	Home	12	NA	Intended: The case manager (CM) performed at least one home visit per month during 12 mo. Because of the variability in the participant's functional ability, the intensity, frequency, and duration of the individual exercise programs varied. Efforts were made to continuously, (i.e., at least once a month) support and motivate the participants to be physically active and to evaluate and modify the home exercise program if needed. Delivered: The case manager or PT performed at least one home visit per month during 12 mo. During the 12-month intervention the PTs performed visits (mean = 10.4) and telephone calls (mean = 0.8) and the nurses performed an average of 11.1 home visits and 1.9 telephone calls for those completing the intervention.

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
Palvanen, 2014[22]	A multifactorial, individualized falls prevention program, which included medical review and referrals, medication review, home hazard assessment and modification, and recommendations for strength and balance training if indicated.	Clinic, NOS; Home	Three 1x assessments; duration of tx varied based on recommendations/referral(s)	NA	Multiple assessments (total ~3hr): 1hr structured home visit; 1hr PT assessment at clinic, 1hr assessment w nurse in clinic. Exercise referrals: intensity NR, but assume for 12mo
Perula, 2012[23]	Multifactorial intervention consisting of individual advice, group physical exercise program, group health education, and a home visit for environmental home hazard risk assessment and intervention.	Class outside of home; Home	Three 1x assessments, duration of all given IGs NR (supervised exercise component 3wks)	Five 90-minute sessions over 3 weeks of treatment	5 90-min exercise sessions over 3 weeks plus recommended walking at least 30min a day and doing the exercises for 30min at least 4d/wk. 2 home visits on home hazard assessment
Russell, 2010[24]	Targeted referrals to existing community services and health promotion recommendations, based on the falls risk factors found in a baseline assessment.	Home	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	Assessment & referrals.
Salminen, 2009[25]	Geriatric assessment, counseling and guidance in fall prevention, home hazards assessment, group physical exercise, home exercise, group falls prevention lectures in groups, and psychosocial groups.	Class outside of home; In home	12	Group exercise 45–50 minutes sessions every second week for 1yr	One 45-minute assessment, 1 home hazard assessment, group exercise 45–50 minutes sessions every second week for 1yr; psychosocial groups 1x/mo for 12 mo, falls prevention lecture 1x/mo for 12mo

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
Spice, 2009[26]	Intervention assessments were standardised: further management of each participant was then individualised, with no specific protocol.	Clinic, NOS	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	The mean duration of the secondary care intervention was 121 min for assessment by doctor, nurse, physiotherapist and occupational therapist.
Tinetti, 1994[27]	Patients were assessed by a nurse and physical therapist during an in-home visit. Medication review, environmental changes, and physical therapy were provided as appropriate.	In home	2x assessment; duration of exercise component (if indicated) could be up to 3mo	NA	1 medical assessment, 1 PT assessment, followed by PT exercises if indicated: 2x/day for 15-20min, IG phase lasted ~3mo.
van Haastregt, 2000[28]	Five home visits by a community nurse over a period of one year. Visits consisted of screening for medical, environmental, and behavioral factors causing falls and impairments in mobility, followed by specific advice, referrals, and other actions aimed at dealing with the observed hazards	In home	5 home visits over 12mo	NA	5 home visits over 12 mo, on average the home visits lasted 51 minutes.
Vind, 2009[29]	A team assessed patients over two visits to the clinic through a physical exam and questionnaires to tailor followup such as medical management, CVD management, and physical therapy with referrals to outside providers as appropriate for conditions such as neurological conditions, CVD specialists, vision correction.	Clinic, NOS	3, 1x assessments, duration of tx varied based on recommendations/referral(s) [IG lasted a median of 13 weeks]	NA	1hr physician assessment; 1.5hr nurse assessment, 1.5hr PT assessment. Intervention lasted for a median of 13 weeks (IQR 9–17). Each participant in the intervention group visited the outpatient clinic a median of 6 times (IQR 4–9) and had 2 (IQR 2–3) visits to the doctor, 1 (IQR 1–1) to the nurse, 3 (IQR 2–4) to the physiotherapist, and 1 (IQR 1–3) for supplementing examinations.

Appendix E Table 3. Multifactorial Interventions: Intervention Components

Author, year	Brief intervention description	Setting	Intervention duration	Frequency of supervised IG	Intensity
Wagner, 1994[30]	Participants had an assessment visit with questionnaires and clinical assessment to develop a tailored intervention plan to address risk factors.	Geriatric clinic	1x assessment; duration of tx varied based on recommendations/referral(s)	NA	One 60 to 90min assessment

Abbreviations: Apr = April; CG = Control group; Descr = Description; CHS = Cardiovascular Health Study; CVD = Cardiovascular disease; ED = Emergency department; EIG = Exercise intervention group; Freq= Frequency; FU = Followup; GP/PC = General practitioner/Primary care provider; Hr = Hour; IG = intervention group; IQR = Interquartile range; Mgmt. = Management; Min = Minutes; Mo = Months; NA = Not applicable; NR = Not reported; NOS = Not otherwise specified; OEP = Otago Exercise Program; OT = Occupational therapy; PCP = Primary care provider; PT = physical therapy; SD = Standard deviation; Sep = September; Tx = Treatment; Wk = Week; X = Times; Yrs = Years.

Appendix E Table 4. Multifactorial Interventions: Falls

Author, year	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Bruce, 2021[3]	18	4842 (1.27)	4309 (1.06)	1.13 (0.98, 1.30)
Close, 1999[6]	12	183 (0.99)	510 (2.39)	0.39 (0.23, 0.60)
Cohen, 2015[7]	6	NR	NR	0.79 (0.69, 0.91)
	9	NR	NR	0.80 (0.71, 0.89)
	12	NR	NR	0.87 (0.79, 0.96)
Conroy, 2010[8]	12	260 (1.7)	417 (2.7)	0.64 (0.43, 0.95)
Davison, 2005[9]	12	435 (3.3)	1251 (5.1)	0.64 (0.46, 0.90)
Elley, 2008[11]	12	285 (1.91)	299 (2.01)	0.96 (0.70, 1.34)
Fairhall, 2014[12]	12	183 (1.54)	178 (1.5)	1.12 (0.78, 1.63)
Ferrer, 2014[13]	12	57 (0.35)	62 (0.38)	0.85 (0.51, 1.40)
Hogan, 2001[15]	12	241 (3.05)	311 (3.7)	0.82 (0.70, 0.97)
La Porta, 2022[17]	12	337 (1.66)	353 (1.765)	0.94 (0.71, 1.25)
Lightbody, 2002[18]	6	141 (1.82)	171 (2.15)	0.85 (0.68, 1.06)
Logan, 2010[19]	12	NR (3.46)	NR (7.68)	0.45 (0.35, 0.58)
Lord, 2005[20]	12	183 (0.91)	175 (0.87)	1.03 (0.78, 1.35)
Moller, 2014[21]	12	96 (1.2)	85 (1.16)	1.03 (0.77, 1.38)
Palvanen, 2014[22]	12	608 (0.95)	825 (1.31)	0.72 (0.61, 0.86)
Russell, 2010[24]	12	908 (2.77)	1449 (4.24)	0.87 (0.65, 1.17)
Salminen, 2009[25]	12	243 (0.83)	271 (0.91)	0.92 (0.72, 1.19)
Tinetti, 1994[27]	12	94 (0.62)	164 (0.94)	0.69 (0.52, 0.90)
Vind, 2009[29]	12	422 (2.15)	398 (2.03)	1.06 (0.75, 1.51)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix E Table 5. Multifactorial Interventions: Falls, Exploring Heterogeneity

Characteristic/ Component	Groups	k	IRR (95% CI)	Test of group differences, p
ED/hospital recruitment	ED/hospital	6	0.68 (0.45, 1.01)	0.07
	Other	14	0.91 (0.83, 0.99)	
Fall risk	Selected for fall risk	17	0.82 (0.71, 0.95)	0.34
	Unselected for fall risk	3	0.89 (0.75, 1.04)	
Quality	Good	9	0.86 (0.68, 1.10)	0.69
	Fair	11	0.82 (0.73, 0.93)	
Conducted in the US	US	3	0.90 (0.65, 1.23)	0.40
	Non-US	17	0.82 (0.71, 0.96)	

Note: Also visually inspected plots sorted by publication year, mean age, followup, CG event rate

* Not statistically significant after adjusting for multiple comparisons

Abbreviations: CI = Confidence interval; ED = Emergency department; IRR = Incidence rate ratio; k = Number of studies.

Appendix E Table 6. Multifactorial Interventions: People With a Fall

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Bruce, 2021[3]	Fallers (1 plus falls)	18	1301/3301 (39.4)	1276/3223 (39.6)	1.00 (0.93, 1.07)
	Fallers (2 plus falls)	18	743/3301 (22.5)	715/3223 (22.2)	1.01 (0.91, 1.13)
Ciaschini, 2009[5]	Fallers (1 plus falls)	6	26/101 (25.7)	17/100 (17)	1.51 (0.88, 2.61)
Close, 1999[6]	Fallers (3 plus falls)	12	21/184 (11.4)	55/213 (25.8)	0.44 (0.28, 0.70)
	Fallers (1 plus falls)	12	59/184 (32.1)	111/213 (52.1)	0.62 (0.48, 0.79)
Cohen, 2015[7]	Fallers (1 plus falls)	6	229/1661 (13.8)	305/1815 (16.8)	0.82 (0.70, 0.96)
	Fallers (1 plus falls)	9	312/1615 (19.3)	434/1756 (24.7)	0.78 (0.68, 0.89)
	Fallers (1 plus falls)	12	416/1586 (26.2)	504/1715 (29.4)	0.89 (0.79, 1.00)
Conroy, 2010[8]	Fallers (1 plus falls)	12	69/136 (50.7)	73/138 (52.9)	0.96 (0.76, 1.21)
	Fallers (2 plus falls)	12	38/136 (27.9)	38/138 (27.5)	1.01 (0.69, 1.49)
Davison, 2005[9]	Fallers (1 plus falls)	12	94/144 (65.3)	102/149 (68.5)	0.95 (0.81, 1.12)
de Vries, 2010[10]	Fallers (1 plus falls)	12	55/106 (51.9)	62/111 (55.9)	0.93 (0.73, 1.19)
	Fallers (2 plus falls)	12	37/106 (34.9)	35/111 (31.5)	1.11 (0.76, 1.62)
Elley, 2008[11]	Fallers (1 plus falls)	12	106/155 (68.4)	98/157 (62.4)	1.10 (0.93, 1.29)
	Fallers (2 plus falls)	12	69/155 (44.5)	54/157 (34.4)	1.29 (0.98, 1.71)
Fairhall, 2014[12]	Fallers (1 plus falls)	12	72/120 (60)	67/121 (55.4)	1.08 (0.87, 1.35)
	Fallers (2 plus falls)	12	32/120 (26.7)	37/121 (30.6)	0.87 (0.58, 1.30)
Ferrer, 2014[13]	Fallers (1 plus falls)	12	40/142 (28.2)	33/131 (25.2)	1.12 (0.75, 1.66)
Hendriks, 2008[14]	Fallers (1 plus falls)	12	55/124 (44.4)	61/134 (45.5)	0.97 (0.74, 1.28)
	Fallers (2 plus falls)	12	32/124 (25.8)	34/134 (25.4)	1.02 (0.67, 1.54)
Hogan, 2001[15]	Fallers (1 plus falls)	12	54/79 (68.4)	61/84 (72.6)	0.94 (0.77, 1.15)
	Fallers (3 plus falls)	12	26/79 (32.9)	35/84 (41.7)	0.79 (0.53, 1.18)
La Porta, 2022[17]	Fallers (1 plus falls)	12	119/203 (58.6)	117/200 (58.5)	1.00 (0.85, 1.18)
	Fallers (2 plus falls)	12	71/203 (35)	77/200 (38.5)	0.91 (0.70, 1.17)
Lightbody, 2002[18]	Fallers (1 plus falls)	6	39/155 (25.2)	41/159 (25.8)	0.98 (0.67, 1.42)
Logan, 2010[19]	Fallers (1 plus falls)	12	81/102 (79.4)	96/102 (94.1)	0.84 (0.76, 0.94)
Lord, 2005[20]	Fallers (1 plus falls)	12	93/202 (46)	90/201 (44.8)	1.03 (0.83, 1.27)
	Fallers (2 plus falls)	12	49/202 (24.3)	45/201 (22.4)	1.08 (0.76, 1.54)
Moller, 2014[21]	Fallers (1 plus falls)	12	44/80 (55)	35/73 (47.9)	1.15 (0.84, 1.56)

Appendix E Table 6. Multifactorial Interventions: People With a Fall

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
	Fallers (2 plus falls)	12	19/80 (23.8)	23/73 (31.5)	0.75 (0.45, 1.27)
	Fallers (3 plus falls)	12	13/80 (16.3)	11/73 (15.1)	1.08 (0.52, 2.25)
Palvanen, 2014[22]	Fallers (1 plus falls)	12	296/661 (44.8)	349/653 (53.4)	0.84 (0.75, 0.94)
Perula, 2012[23]	Fallers (1 plus falls)	6	10/133 (7.5)	31/271 (11.4)	0.66 (0.33, 1.30)
		12	23/133 (17.3)	64/271 (23.6)	0.73 (0.48, 1.12)
Russell, 2010[24]	Fallers (1 plus falls)	12	163/320 (50.9)	151/330 (45.8)	1.11 (0.95, 1.31)
Salminen, 2009[25]	Fallers (1 plus falls)	12	140/292 (47.9)	131/297 (44.1)	1.09 (0.91, 1.30)
Spice, 2009[26]	Fallers (1 plus falls)	12	158/210 (75.2)	133/159 (83.6)	0.90 (0.78, 1.04)
Tinetti, 1994[27]	Fallers (1 plus falls)	12	52/147 (35.4)	68/144 (47.2)	0.76 (0.58, 0.98)
van Haastregt, 2000[28]	Fallers (1 plus falls)	12	63/129 (48.8)	53/123 (43.1)	1.13 (0.87, 1.48)
		18	68/120 (56.7)	58/115 (50.4)	1.12 (0.88, 1.43)
	Fallers (2 plus falls)	12	34/129 (26.4)	29/123 (23.6)	1.12 (0.73, 1.72)
		18	43/120 (35.8)	35/115 (30.4)	1.18 (0.82, 1.70)
Vind, 2009[29]	Fallers (1 plus falls)	12	110/196 (56.1)	101/196 (51.5)	1.09 (0.91, 1.31)
	Fallers (3 plus falls)	12	43/196 (21.9)	44/196 (22.4)	0.98 (0.67, 1.42)
Wagner, 1994[30]	Fallers (1 plus falls)	12	175/635 (27.6)	223/607 (36.7)	0.75 (0.64, 0.88)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix E Table 7. Multifactorial Interventions: Injurious Falls

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Bhasin, 2020[4]	Fall resulting in injuries	44	2268 (0.36)	2298 (0.38)	0.94 (0.84, 1.06)
	Fall resulting in serious injuries	44	330 (0.05)	336 (0.06)	0.93 (0.68, 1.26)
Elley, 2008[11]	Fall resulting in injuries	12	170 (1.14)	156 (1.05)	1.09 (0.87, 1.35)
	Fall resulting in moderate injuries	12	156 (1.05)	149 (1)	1.05 (0.84, 1.31)
	Fall resulting in serious injuries	12	14 (0.09)	7 (0.05)	1.80 (0.73, 4.46)
Fairhall, 2014[12]	Fall resulting in injuries	12	75 (0.63)	78 (0.64)	0.97 (0.71, 1.33)
La Porta, 2022[17]	Falls resulting in injuries	12	110 (0.542)	115 (0.575)	0.94 (0.73, 1.22)
	Falls resulting in moderate injuries	12	90 (NR)	91 (NR)	NR (NR)
	Falls resulting in serious injuries	12	20 (NR)	24 (NR)	NR (NR)
Lightbody, 2002[18]	Fall resulting in serious injuries	6	3 (0.04)	6 (0.08)	0.51 (0.13, 2.05)
Lord, 2005[20]	Fall resulting in injuries	12	119 (0.59)	108 (0.54)	1.07 (0.79, 1.44)
Moller, 2014[21]	Fall resulting in injuries	12	40 (0.5)	38 (0.52)	0.96 (0.62, 1.50)
	Fall resulting in medical care	12	19 (0.24)	15 (0.21)	1.16 (0.59, 2.27)
Palvanen, 2014[22]	Fall-related injuries	12	351 (0.55)	468 (0.75)	0.74 (0.61, 0.89)
Russell, 2010[24]	Fall-related injuries	12	352 (1.07)	344 (1.01)	1.08 (0.78, 1.48)
	Fall-related serious injuries	12	30 (0.09)	26 (0.08)	1.31 (0.77, 2.23)
Salminen, 2009[25]	Fall resulting in medical care	12	48 (0.16)	48 (0.16)	1.04 (0.64, 1.69)
		24	80 (0.14)	98 (0.16)	0.83 (0.62, 1.12)
		36	124 (0.14)	146 (0.16)	0.87 (0.63, 1.21)
	Fall resulting in serious injuries	12	14 (0.05)	10 (0.03)	1.42 (0.63, 3.21)
		24	26 (0.04)	26 (0.04)	1.02 (0.59, 1.75)
		36	39 (0.04)	37 (0.04)	1.07 (0.68, 1.68)
Tinetti, 1994[27]	Fall resulting in medical care	12	25 (0.17)	36 (0.25)	0.68 (0.34, 1.37)
	Fall resulting in serious injuries	12	13 (0.09)	18 (0.13)	0.71 (0.26, 1.89)
Vind, 2009[29]	Fall resulting in medical care	12	44 (0.22)	56 (0.29)	0.79 (0.53, 1.17)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix E Table 8. Multifactorial Interventions: Fractures

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Bhasin, 2020[4]	Fall-related fracture	44	211 (0.02)	230 (0.02)	0.87 (0.59, 1.27)
	Hip fracture	44	40 (0)	43 (0)	0.88 (0.37, 2.10)
Bruce, 2021[3]	Fracture	18	173 (0.04)	133 (0.03)	1.30 (0.99, 1.71)
	Hip fracture	18	28 (0.01)	33 (0.01)	0.83 (0.46, 1.49)
Fairhall, 2014[12]	Fall resulting in fractures	12	13 (0.11)	12 (0.1)	1.09 (0.50, 2.39)
Palvanen, 2014[22]	Fall-related fracture	12	33 (0.05)	42 (0.07)	0.77 (0.48, 1.23)
Russell, 2010[24]	Fall-related fracture	12	11 (0.03)	17 (0.05)	0.76 (0.35, 1.63)
Salminen, 2009[25]	Fall-related fracture	12	11 (0.04)	8 (0.03)	1.40 (0.56, 3.48)
		24	16 (0.03)	19 (0.03)	0.86 (0.44, 1.67)
		36	27 (0.03)	28 (0.03)	0.98 (0.58, 1.66)
	Fall-related hip fracture	12	1 (0)	1 (0)	1.02 (0.06, 16.26)
		24	2 (0)	2 (0)	1.02 (0.14, 7.22)
		36	4 (0)	4 (0)	1.02 (0.25, 4.07)
Vind, 2009[29]	Fall-related fracture	12	24 (0.12)	16 (0.08)	1.50 (0.80, 2.82)
	Hip fracture	12	6 (0.03)	11 (0.06)	0.55 (0.20, 1.47)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix E Table 9. Multifactorial Interventions: People With a Fall Resulting in Injuries or Medical Care

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Bhasin, 2020[4]	Serious injurious faller	44	291/2802 (10.4)	301/2649 (11.4)	0.91 (0.67, 1.24)
Close, 1999[6]	Injurious fallers	12	8/184 (4.3)	16/213 (7.5)	0.58 (0.25, 1.32)
Cohen, 2015[7]	Injurious fallers	6	136/1661 (8.2)	189/1815 (10.4)	0.79 (0.64, 0.98)
		9	186/1615 (11.5)	276/1756 (15.7)	0.73 (0.62, 0.87)
		12	254/1586 (16)	333/1715 (19.4)	0.82 (0.71, 0.96)
Conroy, 2010[8]	Injurious fallers	12	56/136 (41.2)	55/138 (39.9)	1.03 (0.78, 1.38)
Hendriks, 2008[14]	Injurious fallers	12	14/124 (11.3)	20/134 (14.9)	0.76 (0.40, 1.43)
Imhof, 2012	Injurious fallers	9	131/207 (63.3)	162/206 (78.6)	0.80 (0.71, 0.91)
Lord, 2005[20]	Injurious fallers	12	80/202 (39.6)	67/201 (33.3)	1.19 (0.92, 1.54)
Moller, 2014[21]	Injurious fallers	12	30/80 (37.5)	27/73 (37)	1.01 (0.67, 1.53)
	Person with fall resulting in medical care	12	15/80 (18.8)	9/73 (12.3)	1.52 (0.71, 3.26)
Russell, 2010[24]	Injurious fallers	12	118/320 (36.9)	115/330 (34.8)	1.06 (0.86, 1.29)
	Serious injurious faller	12	23/320 (7.2)	23/330 (7)	1.03 (0.59, 1.80)
Tinetti, 1994[27]	Person with fall resulting in medical care	12	21/147 (14.3)	26/144 (18.1)	0.79 (0.38, 1.64)
	Serious injurious faller	12	12/147 (8.2)	14/144 (9.7)	0.84 (0.30, 2.32)
van Haastregt, 2000[28]	Injurious fallers	12	26/129 (20.2)	21/123 (17.1)	1.18 (0.70, 1.98)
		18	33/120 (27.5)	25/115 (21.7)	1.26 (0.80, 1.99)
	Person with fall resulting in medical care	12	15/129 (11.6)	11/123 (8.9)	1.30 (0.62, 2.72)
		18	21/120 (17.5)	14/115 (12.2)	1.44 (0.77, 2.69)
Vind, 2009[29]	Injurious fallers	12	34/196 (17.3)	35/196 (17.9)	0.97 (0.63, 1.49)
Wagner, 1994[30]	Injurious fallers	12	63/635 (9.9)	88/607 (14.5)	0.68 (0.51, 0.93)
	Person with fall resulting in medical care	12	42/635 (6.6)	57/607 (9.4)	0.70 (0.48, 1.03)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix E Table 10. Multifactorial Interventions: People With a Fall-Related Fracture

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Bhasin, 2020[4]	Person with fall-related fracture	44	184/2802 (6.6)	203/2649 (7.7)	0.86 (0.58, 1.26)
	Person with hip fracture	44	38/2802 (1.4)	42/2649 (1.6)	0.86 (0.35, 2.07)
Bruce, 2021[3]	Person with fracture	18	143/3301 (4.3)	110/3223 (3.4)	1.27 (0.96, 1.68)
Ciaschini, 2009[5]	Person with fracture	6	1/101 (1)	6/100 (6)	0.17 (0.02, 1.35)
Davison, 2005[9]	Person with fracture	12	7/159 (4.4)	13/154 (8.4)	0.52 (0.21, 1.27)
	Person with hip fracture	12	1/159 (.6)	2/154 (1.3)	0.48 (0.04, 5.29)
Perula, 2012[23]	Person with fall-related fracture	12	1/133 (.8)	2/271 (.7)	1.02 (0.02, 11.17)
Russell, 2010[24]	Person with fall-related fracture	12	8/320 (2.5)	15/330 (4.5)	0.55 (0.24, 1.28)
Spice, 2009[26]	Person with fall-related fracture	12	40/210 (19)	35/159 (22)	0.87 (0.49, 1.54)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix E Table 11. Multifactorial Interventions: Mortality

Author, year	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Bruce, 2021[3]	18	107/3301 (3.2)	93/3223 (2.9)	1.12 (0.82, 1.54)
Bhasin, 2020[4]	42	235/2802 (8.4)	220/2649 (8.3)	1.01 (0.71, 1.44)
Ciaschini, 2009[5]	6	6/101 (5.9)	4/100 (4)	1.49 (0.43, 5.10)
Close, 1999[6]	12	19/184 (10.3)	27/213 (12.7)	0.81 (0.47, 1.42)
Conroy, 2010[8]	12	9/182 (4.9)	9/181 (5)	0.99 (0.40, 2.45)
Davison, 2005[9]	12	3/159 (1.9)	5/154 (3.2)	0.58 (0.14, 2.39)
Elley, 2008[11]	12	7/155 (4.5)	4/157 (2.5)	1.77 (0.53, 5.93)
Ferrer, 2014[13]	12	9/164 (5.5)	8/164 (4.9)	1.13 (0.44, 2.84)
Hendriks, 2008[14]	12	5/166 (3)	1/167 (.6)	5.03 (0.59, 42.60)
Hogan, 2001[15]	12	2/79 (2.5)	5/84 (6)	0.43 (0.08, 2.13)
Imhof, 2012	9	8/231 (3.5)	7/230 (3)	1.14 (0.42, 3.09)
Lightbody, 2002[18]	6	11/171 (6.4)	7/177 (4)	1.63 (0.65, 4.10)
Logan, 2010[19]	12	14/102 (13.7)	16/102 (15.7)	0.88 (0.45, 1.70)
Lord, 2005[20]	6	1/210 (.5)	3/204 (1.5)	0.32 (0.03, 3.09)
	12	2/210 (1)	6/204 (2.9)	0.32 (0.07, 1.59)
Moller, 2014[21]	6	6/80 (7.5)	1/73 (1.4)	5.47 (0.68, 44.40)
	12	9/80 (11.3)	3/73 (4.1)	2.74 (0.77, 9.72)
Palvanen, 2014[22]	12	3/661 (.5)	8/653 (1.2)	0.37 (0.10, 1.39)
Perula, 2012[23]	12	1/133 (.8)	2/271 (.7)	1.02 (0.02, 55.72)
Russell, 2010[24]	12	13/351 (3.7)	9/361 (2.5)	1.49 (0.64, 3.43)
Salminen, 2009[25]	12	6/293 (2)	4/298 (1.3)	1.53 (0.43, 5.35)
	24	9/293 (3.1)	10/298 (3.4)	0.92 (0.38, 2.22)
	36	17/293 (5.8)	14/298 (4.7)	1.24 (0.62, 2.46)
Spice, 2009[26]	12	34/210 (16.2)	29/159 (18.2)	0.89 (0.47, 1.69)
Tinetti, 1994[27]	12	7/147 (4.8)	5/144 (3.5)	1.37 (0.29, 6.46)
van Haastregt, 2000[28]	18	10/159 (6.3)	14/157 (8.9)	0.71 (0.32, 1.54)
Vind, 2009[29]	12	4/196 (2)	4/196 (2)	1.00 (0.25, 3.94)
Wagner, 1994[30]	24	17/635 (2.7)	22/607 (3.6)	0.74 (0.40, 1.38)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix E Table 12. Multifactorial Interventions: People With a Fall Resulting in Hospitalization or Emergency Department Visit

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Bhasin, 2020[4]	Person with hospitalization	44	1139/2802 (40.6)	1108/2649 (41.8)	0.97 (0.85, 1.10)
Ciaschini, 2009[5]	Person with hospitalization/ED visit	6	2/101 (2)	3/100 (3)	0.66 (0.11, 3.87)
Close, 1999[6]	Person with hospitalization	12	NR/184 (NR)	NR/213 (NR)	OR 0.61 (0.35, 1.05)
Davison, 2005[9]	Person with fall-related ED visit	12	25/159 (15.7)	27/154 (17.5)	0.90 (0.55, 1.47)
	Person with fall-related hospitalization	12	14/159 (8.8)	17/154 (11)	0.80 (0.41, 1.56)
Hogan, 2001[15]	Person with ED visit	12	9/79 (11.4)	8/84 (9.5)	1.20 (0.49, 2.95)
	Person with fall-related hospitalization	12	5/79 (6.3)	6/84 (7.1)	0.89 (0.28, 2.79)
Logan, 2010[19]	Person with fracture-related hospitalization	12	3/102 (2.9)	6/102 (5.9)	0.50 (0.13, 1.95)
	Person with hospitalization	12	53/102 (52)	54/102 (52.9)	0.98 (0.76, 1.27)
Spice, 2009[26]	Person with fall-related hospitalization	12	39/210 (18.6)	27/159 (17)	1.09 (0.58, 2.07)
Wagner, 1994[30]	Person with hospitalization	12	3/635 (.5)	5/607 (.8)	0.57 (0.14, 2.39)

Abbreviations: CG = Control group; CI = Confidence interval; ED = Emergency department; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix E Table 13. Multifactorial Interventions: Instrumental Activities of Daily Living

Author, year	Outcome (Instrument)	Timepoint, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)
Bhasin, 2020[4]*	IADL, physical function (Late-Life Function)	0	380	358	60.2 (0.46)	58.9 (0.47)	--	--
		12	313	284	59.8 (0.54)	58.9 (0.57)	--	--
		24	290	257	59.1 (0.61)	58.0 (0.53)	--	--
	IADL, disability (Late-Life Disability)	0	380	358	57.3 (0.53)	56.2 (0.51)	--	--
		12	313	283	56.4 (0.64)	55.8 (0.66)	--	--
		24	290	256	56.7 (0.76)	55.8 (0.63)	--	--
de Vries, 2010[10]	IADL (Lawton and Brody)	12	106	111	--	--	-0.15 (1.73)	0.01 (1.61)
Elley, 2008[11]	ADL/IADL (Nottingham Extended Activities of Daily Living)	0	135	145	Median: 19.0 (IQR 18.0, 21.0)	Median 19.0 (IQR 16.0, 20.0)	--	--
		12	135	145	Median: 18.0 (IQR 17.0, 20.0)	Median 19.0 (IQR 17.0, 20.0)	--	--
Hendriks, 2008[14]	IADL (Frenchay Activities Index)	0	166	167	23.3 (8.7)	23.7 (8.6)	--	--
		12	124	134	25.6 (8.0)	24.5 (9.1)	--	--
Logan, 2010[19]	ADL/IADL (Nottingham Extended Activities of Daily Living)	0	102	102	Median: 6.0 (IQR 3.0, 9.0)	Median 8.5 (IQR 4, 12)	--	--
		12	102	102	Median: 8.0 (IQR 4.0, 13.0)	Median 6.0 (IQR 1.0, 10.0)	--	--
Moller, 2014[21]	ADL/IADL (Sonn and Asberg)	0	80	73	Median: 2.0 (IQR 1.0, 3.0)	Median 2.0 (IQR 1.0, 3.0)	--	--
		12	80	73	Median: 2.0 (IQR 1.0, 3.35)	Median 2.0 (IQR 1.0, 3.5)	--	--
Vind, 2009[29]	IADL (Frenchay Activities Index)	0	196	196	29.5 (6.7)	28.5 (8.2)	--	--
		6	196	196	29.4 (6.9)	28.2 (7.9)	--	--
		12	196	196	30.1 (6.9)	29.4 (7.3)	--	--

* Random subgroup of adults aged 75 years or older

Abbreviations: ADL = Activities of daily living; BL = Baseline; CG = Control group; IADL = Instrumental activities of daily living; IG = Intervention group; IQR = Interquartile range; Mo = Months; N = Number of participants; SD = Standard deviation.

Appendix E Table 14. Multifactorial Interventions: Quality of Life

Author, year	Instrument	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
Bhasin, 2020[4]	QOL-EQ-5D-VAS	0	2771	2627	78.9 (16.3)	78.8 (16.2)	NA	NA	NA
		12	2360	2247	77.0 (17.3)	76.6 (17.0)	NR	NR	NR
		24	2234	2122	77.3 (17.3)	76.7 (16.9)	NR	NR	NR
Bruce, 2021[3]	SF-12 Physical Component	0	3301	3223	50.0 (10.5)	50.3 (10.2)	NA	NA	NA
		18	2216	2234	49.8 (10.3)	49.9 (10.0)	NR	NR	0.08 (-0.32, 0.47) p=0.70
	SF-12 Mental Component	0	3301	3223	50.1 (9.3)	50.2 (9.3)	NA	NA	NA
		18	2216	2234	49.9 (9.5)	50.0 (9.0)	NR	NR	-0.19 (-0.62, 0.25) p=0.40
de Vries, 2010[10]	EQ-5D	12	106	111	NR	NR	0.01 (0.16)	0.07 (0.16)	NR
	SF-12 Mental Component	12	106	111	NR	NR	-0.31 (-1.43)	-1.43 (10.23)	NR
	SF-12 Physical Component	12	106	111	NR	NR	2.60 (8.6)	1.86 (10.23)	NR
Elley, 2008[11]	SF-36 Mental Component	0	135	145	Median 57.5 (IQR 50.1, 61.8)	Median 58.7 (IQR 53.1, 62.5)	NA	NA	NA
		12	135	145	Median 56.7 (IQR 48.8, 61.3)	Median 57.7 (IQR 49.4, 61.9)	NR	NR	NR
	SF-36 Physical Component	0	135	145	Median 35.4 (IQR, 29.4, 43.8)	Median 36.5 (IQR 29.7, 43.9)	NA	NA	NA
		12	135	145	Median 39.4 (IQR, 29.9, 46.0)	Median 37.2 (IQR 29.0, 45.4)	NR	NR	NR
Fairhall, 2014[12]	EQ-5D VAS	0	120	121	58.2 (15.8)	57.9 (18.4)	NA	NA	NA
		12	107	108	57.5 (20.8)	57.7 (19.7)	NR	NR	NR
		0	196	196	61.4 (27)	62.4 (27)	NA	NA	NA

Appendix E Table 14. Multifactorial Interventions: Quality of Life

Author, year	Instrument	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
Vind, 2009[29]	SF-36 Physical Component	6	196	196	69.1 (24)	66.6 (28)	NR	NR	NR
		12	196	196	67.9 (25)	65.2 (27)	NR	NR	NR
	SF-36 Mental Component Component	0	196	196	77.4 (19)	76.1 (23)	NA	NA	NA
		6	196	196	80.6 (18)	79.4 (21)	NR	NR	NR
		12	196	196	81.5 (18)	78.1 (23)	NR	NR	NR

Abbreviations: ADL = Activities of daily living; BL = Baseline; CG = Control group; CI = Confidence interval; EQ-5D = EuroQol instrument; IADL = Instrumental activities of daily living; IG = Intervention group; Mo = Months; n = Number of participants; NA = Not applicable; NR = Not reported; QoL = Quality of life; SD = Standard deviation; SF = Short Form Survey; Time = Timepoint; VAS = Visual analogue scale.

Appendix E Table 15. Multifactorial Interventions: Harms

Author, year	Outcome	FU, mo	IG n/n	CG n/n
Bruce, 2021[3]	Serious AE directly related to the intervention	18	0/3301	NR
	AE	18	0/3301	NR
Fairhall, 2014[12]	Back pain	12	2/3279*	NR
Hendriks, 2008[14]	AE	12	0/166	0/166
Salminen, 2009[25]	Fall during intervention	12	3/292	NR
Tinetti, 1994[27]	AEs during intervention - musculoskeletal complaints	12	10/153	NR

*Events, not people

Abbreviations: AE = Adverse event; CG = Control group; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; NR = Not reported

Appendix F Table 1. Exercise Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Intervention component(s)	Target population	Recruitment setting	N rand	Age, mean (range)	Female, %	Race/ ethnicity, %
Barnett, 2003[31]	Fair	AUS	Exercise	Older adults aged ≥65 years at risk of falling.	Clinical, NOS or varied; Hospital	163	75 (≥65)	67	NR
Bruce, 2021[3] Prevention of Fall Injury Trial (PreFIT)	Good	GBR	Exercise	Older adults aged ≥70 years.	PC/GP	9803	78 (≥70)	53	White: 99 Other: 1
Buchner, 1997[32] Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT)	Fair	US	Exercise	Older adults aged 68-85 years with at least mild deficits in strength and balance.	Insurance	55	75 (68-85)	51	White: 93
Callisaya, 2021[33] StandingTall	Fair	AUS	Exercise	Older adults aged ≥60 years with subjective and/or objective cognitive impairment.	Community-based; Hospital; PC/GP	93	72.8 (≥60)	58	White: 97
Campbell, 1997[34]	Fair	NZL	Exercise + Behavior change support	Women aged ≥80 years.	Clinical, NOS or varied	233	84 (80+)	100	NR
Chyu, 2010[35]	Fair	US	Exercise	Postmenopausal women aged ≥65 with osteopenia.	Community-based	61	72 (≥65)	100	NR
Delbaere 2021[36]	Good	AUS	Exercise	Older adults aged ≥70 years.	Community-based	503	77 (≥70)	67	NR
El-Khoury, 2015[37] Ossebo Intervention	Fair	FRA	Exercise	Women aged 75-85 years with diminished balance and gait capacities.	Population-based register	706	78 (75-85)	100	NR
Fitzharris, 2010[38] Whitehorse NoFalls trial	Fair	AUS	Exercise	Older adults aged 70 + years.	Population-based register	543	76.1 (≥70)	60	NR

Appendix F Table 1. Exercise Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Intervention component(s)	Target population	Recruitment setting	N rand	Age, mean (range)	Female, %	Race/ ethnicity, %
Goldberg 2019[39] Promoting activity, Independence and stability in early dementia (PrAISED trial)	Fair	GBR	Exercise + Behavior change support	Older adults aged ≥65 years with mild dementia or mild cognitive impairment.	Clinical, NOS or varied	41	76 (≥65 (65-91))	46	White: 98
Karinkanta, 2015[40] The KAAMU Study	Fair	FIN	Exercise	Women aged ≥70 years.	Population-based register	75	73 (70-79)	100	NR
Korpelainen, 2006[41]	Fair	FIN	Exercise	Older Women with low BMD.	Population-based register	160	73 (70-73)	100	NR
Kovacs, 2013[42]	Good	Hungary	Exercise	Women aged ≥60 years.	Community-based	72	68 (≥60)	100	NR
Kronhed, 2009[43]	Fair	SWE	Exercise	Women aged 60-81 years with osteoporosis.	Hospital	73	71 (60-81)	100	NR
Lamb, 2018[44] Dementia and Physical Activity trial (DAPA)	Fair	GBR	Exercise + Behavior change support	Adults aged 18+ years with mild to moderate dementia.	Clinical, NOS or varied; Population-based register; Other	494	77 (18+)	39	White: 97 Other: 3
Lipsitz, 2019[45] Mind Body-Wellness in Supportive Housing (Mi-WISH)	Fair	US	Exercise	Older adults aged ≥60 and living in low-income housing.	Community-based	180	75 (≥60)	67	White: 62 Black: 32 Asian: 2 Hispanic/ Latino: 4 Other: 3

Appendix F Table 1. Exercise Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Intervention component(s)	Target population	Recruitment setting	N rand	Age, mean (range)	Female, %	Race/ ethnicity, %
Logghe, 2009[46]	Fair	NLD	Exercise	Older adults aged ≥70 with a high risk of falling.	Clinical, NOS or varied	269	77 (69-93)	71	NR
Luukinen, 2007[47]	Fair	FIN	Exercise	Older adults aged ≥85 years.	Population-based register	437	88 (85+)	79	NR
Merom, 2016[48]	Fair	AUS	Exercise	Resident of participating retirement villages.	Retirement villages	530	NR (NR)	85	NR
Miko, 2018[49]	Fair	Hungary	Exercise	Women aged ≥65 years with osteoporosis and at least one previous fracture.	Clinical, NOS or varied	100	69 (≥65)	100	NR
Morgan, 2004[50]	Fair	US	Exercise	Older adults aged ≥60 years with either a hospital admission lasting 2 days or longer or had been on bed rest for 2 days or more within the past month.	Clinical, NOS or varied	219	81 (≥60)	71	NR
Ng, 2015[51]	Fair	Singapore	Exercise	Frail and prefrail older adults aged ≥65 years.	Community-based	98	70 (≥65)	56	NR
Ohman, 2016[52] Effects of the Finnish Alzheimer Disease Exercise Trial (FINALEX)	Fair	FIN	Exercise	Older adults aged ≥65 with Alzheimer's.	Insurance	69	77 (≥65)	32	NR
Oliveira, 2019[53]	Fair	AUS	Exercise + Behavior change support	Older adults aged ≥60 years.	Community-based	131	72 (≥60)	71	NR

Appendix F Table 1. Exercise Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Intervention component(s)	Target population	Recruitment setting	N rand	Age, mean (range)	Female, %	Race/ ethnicity, %
Rikkonen, 2023[54]	Fair	FIN	Exercise	Home-dwelling older women	Population-based register	914	76 (71–85)	100	NR
Robertson, 2001[55]	Fair	NZL	Exercise	Older adults aged ≥75 years.	Clinical, NOS or varied	240	81 (75-95)	68	NR
Rosado, 2021[56]	Fair	PRT	Exercise	Older adults aged ≥65 years.	Community-based	35	75.6 (≥65)	82	NR
Sherrington, 2014[57]	Fair	AUS	Exercise + Behavior change support	Older adults aged ≥60 years and had been admitted to and subsequently discharged from a hospital.	Hospital	340	81 (≥60)	74	NR
Siegrist, 2016[58] PreFalls	Fair	DEU	Exercise + Behavior change support	Older adults at high risk of falls.	PC/GP	378	78 (≥65)	75	NR
Stathi, 2022[59] Retirement in Action (REACT)	Fair	GBR	Exercise + Behavior change support	Older adults aged ≥65 years at increased risk of mobility limitations.	Community-based; PC/GP; Other	777	78 (≥65)	66	White: 95 Black: 2 Asian: 1 African or Caribbean: 2.5 Other/ mixed: 1
Suikkanen, 2021[60]	Fair	FIN	Exercise	Older adults aged ≥65 years with signs of frailty.	Community-based	300	82 (≥65)	75	NR
Tomita, 2016[61] Virtual-Group Exercise at Home (V-GEAH)	Fair	US	Exercise	Older adults aged 60–90 years and had a fall within the past 12 mo.	Community-based	56	73 (60 to 90)	88	NR

Appendix F Table 1. Exercise Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Intervention component(s)	Target population	Recruitment setting	N rand	Age, mean (range)	Female, %	Race/ ethnicity, %
Trombetti, 2011[62]	Fair	CHE	Exercise	Older adults aged ≥65 years at increased risk of falling.	Community-based	134	76 (≥65)	96	NR
Tuvemo Johnson, 2021[63]	Fair	SWE	Exercise	Older adults aged ≥75 years who needed walking aids and/or home help service.	Clinical, NOS or varied; Social service	175	83 (≥75)	70	NR
Uusi-Rasi, 2015[64]	Good	FIN	Exercise	Women aged 70 to 80 years old.	Population-based register	205	74 (70-80)	100	NR
Voukelatos, 2007[65]	Good	AUS	Exercise	Relatively healthy older adults aged ≥60 years.	Community-based	702	69 (60-96)	84	NR
Voukelatos, 2015[66] Easy Steps	Fair	AUS	Exercise + Behavior change support	Inactive, older adults aged ≥65 years.	Community-based	386	73 (65-90)	74	NR

Abbreviations: AUS = Australia; BMD = Bone mineral density; CAN = Canada; CHE = Switzerland; DEU = Germany; DNK = Denmark; FIN = Finland; FRA = France; GBR = Great Britain; mo = months; N = Number of participants; NLD = Netherlands; NOS = Not otherwise specified; NR = Not reported; NZL = New Zealand; PC/GP = Primary care/General practitioner; PRT = Portugal; QR = Quality rating; Rand = Randomized; SWE = Sweden; US = United States.

Appendix F Table 2. Exercise Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Barnett, 2003[31]	100	One or more physical performance impairments that have been found to be important risk factors for falls that could be addressed by exercise participation: lower limb weakness, poor balance and slow reaction time.	NR	NR	Taking ≥4 meds: 48.5%	NR
Bruce, 2021[3] Prevention of Fall Injury Trial (PreFIT)	43.8	Fall in the previous 12 mo and current balance problems whilst walking, dressing, toileting or taking a bath.	Met Strawbridge Frailty Index, %: 21	≥3 coexisting conditions, %: 19	NR	Possible cognitive impairment (as indicated by CDT), %: 9
Buchner, 1997[32] Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT)	25	Fall in previous 12 mo.	NR	NR	NR	NR
Callisaya, 2021[33] StandingTall	35.5	Fall in the previous 12 mo.	NR	NR	NR	MoCA <24 (MCI or more), %: 15.1
Campbell, 1997[34]	51.0	Fall in the previous 12 mo.	NR	NR	Mean # of meds: 3.2	NR
Chyu, 2010[35]	100	Diagnosis of osteopenia, defined as bone mineral density T-score at the spine and/or hip between 1 and 2.5 standard deviation (SD) below the young normal sex-matched bone mineral density of the reference database.	NR	NR	NR	NR
Delbaere 2021[36]	38	Fall in the previous 12 mo.	NR	Median # of medical conditions: 0	Median # of prescription drugs: 3	Median MoCA score: 27
El-Khoury, 2015[37] Ossebo Intervention	100	Diminished balance or gait capacities.	NR	NR	NR	NR

Appendix F Table 2. Exercise Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Fitzharris, 2010[38] Whitehorse NoFalls trial	6	Fall in previous 1 mo.	NR	NR	Mean # of meds: 3.4	NR
Goldberg 2019[39] Promoting activity, Independence and stability in early dementia (PrAISED trial)	NR	NA	NR	NR	NR	Mean MMSE score: 25.4 Dementia, %: 92
Karinkanta, 2015[40] The KAAMU Study	NR	NA	NR	NR	NR	NR
Korpelainen, 2006[41]	100	Diagnosed osteopenia.	NR	NR	NR	NR
Kovacs, 2013[42]	38	Fall in the previous 12 mo.	NR	NR	Medication >4, %: 21	NR
Kronhed, 2009[43]	100	Established osteoporosis.	NR	NR	NR	NR
Lamb, 2018[44] Dementia and Physical Activity trial (DAPA)	30	Fall in the previous 6 mo.	NR	NR	Mean # of meds: 5.6 (By dementia meds available)	Per inclusion criteria, 100% have probable dementia according to the DSM-IV criteria or have probable MMD (a score of > 10 on the sMMSE). The overall mean imputed ADAS-Cog score was 21.5 (SD 9.0) out of a possible score of 70, for which a higher score indicates greater cognitive impairment.
Lipsitz, 2019[45] Mind Body-Wellness in Supportive Housing (Mi-WISH)	48	Fall in the previous 12 mo.	NR	Mean # of health problems: 5.1	NR	Mean MMSE score: 25.7

Appendix F Table 2. Exercise Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Logghe, 2009[46]	100	Fall in the previous 12 mo or ≥2 of the following fall risk factors: disturbed balance, mobility problems, dizziness, and the use of benzodiazepines or diuretics.	NR	NR	Medication use, %; 98.5	NR
Luukinen, 2007[47]	100	>2 falls in the previous 12 mo; frequent feelings of loneliness; poor self-rated health; poor visual acuity; poor hearing; depression; poor cognition; impaired balance; impaired chair rise; OR slow walking speed.	NR	NR	Mean # of used meds: 6	Mean MMSE score (30-0): 23.5
Merom, 2016[48]	28	≥1 fall in previous 12 mo.	NR	≥2 chronic conditions, %: 71	Taking ≥5 meds, %: 40 Taking psychoactive meds, %: 5	MMSE score 28-30, %: 70 MMSE score <27, %: 30
Miko, 2018[49]	100	Established postmenopausal osteoporosis based on WHO criteria (T-score below –2.5 SD in lumbar spine, femur neck or total femur region; and at least 1 osteoporotic fracture in their personal medical history	NR	NR	NR	NR
Morgan, 2004[50]	100	Hospital admission lasting ≥2 days or had been on bed rest ≥2 days in the past 1 month.	NR	NR	Mean # of meds: 4	NR
Ng, 2015[51]	100	Prefrail and frail older adults.	Mean frailty score (range 0-5): 2.2 Prefrail, %: 60.4 Frail, %: 39.6*	≥5 medical comorbidities, %: 10.4	NR	Mean MMSE score: 29.1
Ohman, 2016[52] Effects of the Finnish Alzheimer Disease Exercise Trial (FINALEX)	100	≥1 fall in the previous 12 mo, reduced walking speed, or unintentional weight loss.	Per inclusion criteria, 100% considered frail†	Charlson comorbidity index: 2.7	Mean # of meds: 6.4	Per inclusion criteria, 100% had established diagnosis of AD‡, mean MMSE score: 22.8

Appendix F Table 2. Exercise Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Oliveira, 2019[53]	28	Fall in the previous 12 mo.	NR	Mean # of comorbidities: 2.6	Mean # of meds: 2.2	NR
Rikkonen, 2023[54]	NR	NA	NR	Osteopenia: 51.6% Osteoporosis: 7.6%	NR	NR
Robertson, 2001[55]	37	Fall in previous 12 mo.	NR	NR	Mean # of prescribed drugs: 3 Taking psychotropic drugs, %: 19	NR
Rosado, 2021[56]	100	≥1 fall in the previous 6 mo or at high risk of falling§	NR	NR	NR	Mean MMSE score: 28.1
Sherrington, 2014[57]	100	Recent discharge from hospital.	NR	NR	Mean # of meds: 7.5 Psychotropic medication, %: 14 Benzodiazepine medication, %: 15	Mean MMSE score: 28
Siegrist, 2016[58] PreFalls	100	≥1 fall in the previous 12 mo, low physical function‖	NR	NR	Taking ≥4 meds, %: 62.8	NR
Stathi, 2022[59] Retirement in Action (REACT)	100	At increased risk of mobility limitation.	NR	1 chronic illness, %: 23.5 ≥2 chronic illnesses, %: 43.3	NR	Mean MOCA score: 24.37
Suikkanen, 2021[60]	100	Score of ≥1 point on the FRAIL questionnaire AND fulfilled ≥1 phenotype criterion of frailty: criteria used were weight loss ≥5% during the previous 12 mo, physical activity <30 min/wk, a feeling of “not getting going” or “everything is an effort” for most or all of the time, handgrip strength under cutoff values based on BMI, sex, and walking speed <0.46 m/s (walking length either 4 or 2.44m).	Met 1-2 frailty criteria, %: 61 Met ≥3 frailty criteria, %: 39	NR	Mean # of regular meds: 6.8	Mean MMSE score: 24.4

Appendix F Table 2. Exercise Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Tomita, 2016[61] Virtual-Group Exercise at Home (V-GEAH)	100	Presentation to ED or visit to PCP due to a fall in home environment or a workplace within the previous 12 mo.	NR	Mean # of illnesses: 3.5	Mean # of meds: 3.7 Mean # of meds that may cause drowsiness: 1.1	NR
Trombetti, 2011[62]	100	At least one of the following: ≥1 falls after the age of 65 years; balance impairment as assessed by a simplified Tinetti test with a score higher than 2 of 7; and 1 or 2 criteria of physical frailty ¶	Only frailty components reported#	Charlson comorbidity index, mean score: 1	Mean # of meds: 3.5current use of psychotropic medication, %: 23	MMSE, mean: 26 MMSE, score <24, %: 3
Tuvemo Johnson, 2021[63]	100	Needed walking aids and/or home help service.	NR	NR	NR**	Mean MMSE score: 28
Uusi-Rasi, 2015[64]	100	≥1 fall in the previous 12 mo.	NR	NR	Mean # of meds: 2.3	Mean MMSE score: 28.2
Voukelatos, 2007[65]	33	≥1 fall in the previous 12 mo.	NR	NR	NR	NR
Voukelatos, 2015[66] Easy Steps	22	Fall in the previous 12 mo.	NR	NR	NR	NR

*Prefrail and frail older adults were identified based on 5 CHS criteria defining physical frailty4 : unintentional weight loss, slowness, weakness, exhaustion, and low activity, which were scored 1 if present and 0 if absent. The total summed scores ranging from 0 to 5 were used to classify a participant as robust (score=0), prefrail (score=1 to 2), or frail (score= 3 to 5).
† ≥1 fall in the previous 12 mo, reduced walking speed, or unintentional weight loss.
‡ Diagnosed with AD by a geriatrician or a neurologist based on the NINCDS-ADRDA Alzheimer's criteria.
§ A score of ≤25 points on the Fullerton Advanced Balance Scale.
‖ TUG or Chair-Stand-Test >10 seconds) or subjective or objective balance deficits or fear of falling.
¶ Unintentional weight loss, exhaustion, low physical activity level, slow walking speed, grip strength.
# Unintentional weight loss, exhaustion, low PA level, slow walking speed, grip strength
** By medication available: Hypnotics, %: 32.9Tranquilizer, %: 7.5

Abbreviations: AD = Alzheimer's Disease; ADAS = Alzheimer's Disease Assessment Scale; BMD = Bone mineral density; BMI = Body Mass Index; CDT = Clostridioides difficile infection; CHS = Cardiovascular Health Study; Cog = Cognitive; DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, fourth edition; ED = Emergency department; FRAIL = Fatigue, Resistance, Ambulation, Illnesses, and Loss of Weight; MCI = Mild cognitive impairment; m = Meters; Meds = Medications; MMD = MMSE = Mini-Mental State Examination; Mo = Months; MoCA = Montreal Cognitive Assessment; NA = Not applicable; NINCDS-ADRDA = National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer's Disease and Related Disorders Association; NR = Not reported; PCP = Primary care physician; S = seconds; SD = Standard deviation; TUG = Timed Up and Go Test; WHO = World Health Organization.

Appendix F Table 3. Exercise Interventions: Intervention Components

Author, year	Arm	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
Barnett, 2003[31]	IG1	Group exercises to improve balance, coordination, and muscle strength plus independent exercise instruction.	Individual; Group	Class outside of home; Home	Exercise Instructor	37 wkly, 1-hr group exercise sessions were provided. Participants were also provided with a home exercise program with a diary to record sessions.	Thirty-seven, 1hr group classes every wk in 4 sessions over 12 mo (37 classes total)	Minimal intervention
Bruce, 2021[3]	IG1	Prescribed, home exercise program (based on OEP) plus recreational walking	Individual	Home	Exercise Instructor; Occupational therapist; Physical therapist	"Recommended six contacts over 6 mo: three face-to-face appointments and three telephone contacts.	3 face-to-face visits, 3 phone contacts over 6 mo	Minimal intervention
Buchner, 1997[32]	IG1	Exercise consisted of endurance training and/or strength training in supervised classes followed by self-supervised exercise for 24 to 26 wks.	Individual; Group	Class outside of home; Home	NR	The walking plan advice was to walk at the usual pace for up to 30 mins at least twice per wk. Outdoor walking was recommended if the physiotherapist felt that it was safe for participants. Walks could be broken up into shorter sessions (e.g. three 10-min daily walks) and recommendations were given about how to incorporate walking into daily activities.	1hr group class 3x/wk over 6mo	Usual care
Callisaya, 2021[33]	IG1	Tablet-delivered, cognitive-motor program focused on mobility.	Individual	Home	Physiotherapist; Self-directed (manual or instructions given)	3 x 1 hr sessions per wk (180 min); 78 total sessions. At discharge from supervised exercise all subjects agreed to try to continue exercising.	NA, primarily self-directed	Minimal intervention
Campbell, 1997[34]	IG1	Individually tailored home exercise program with regular phone calls to maintain motivation.	Individual	Home	Physical therapist	2 h of balance exercises per wk (from 40 min in wks 1 and 2, to 120 min from wk 9 onwards. Participants could choose the time they wished to exercise (e.g. 10, 15, 20, 25 or 30 min) to reach the wkly time goal.	Four, 1hr PT visits	Attention control

Appendix F Table 3. Exercise Interventions: Intervention Components

Author, year	Arm	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
Chyu, 2010[35]	IG1	Supervised, group tai chi classes.	Group	Class outside of home	Exercise Instructor	3 x 30 min sessions per wk; 156 total sessions (78 hrs). Encouraged to walk outside the home at least three times a wk.	3, 60min group class/wk for 24wks	No intervention
Delbaere 2021[36]	IG1	Tailored, tablet-delivered balance exercises	Individual	Home	Self-directed (manual or instructions given)	3, 60-min instructed tai chi group sessions each wk for 24 wks (72 hrs total)	NA	Attention control
El-Khoury, 2015[37]	IG1	Supervised group sessions of progressive balance training offered in community based premises for two years, supplemented by individually prescribed home exercises.	Individual; Group	Class outside of home; Home	Exercise Instructor	2 hrs of exercise per wk for 24 mo.	1h group class/wk for 2yrs	Usual care
Fitzharris, 2010[38]	IG1	Group exercise classes supplemented by independent home exercises	Individual; Group	Class outside of home; Home	Physical therapist	1 hr group session per wk; total of 96 sessions.; also expected to perform exercises at home at least once a wk .	1hr group exercise class/wk for 15 wks	Usual care
Goldberg 2019[39]	IG1	High intensity, supervised tailored exercise program with behavior change support.	Individual	Home	Occupational therapist; Physical therapist; Rehabilitation support workers	1 hr/wk for 15 wks	Aim of 3 hr/wk for 12 mo (50 home visits offered over 12mo)	Minimal intervention
Karinkanta, 2015[40]	IG1	Combination training program consisting of resistance and balance-jumping training in alternating wks	Group	Class outside of home	Exercise Instructor	High intensity with 50 individual sessions offered over 12 mo. In the high intensity supervision group, participants completed a mean of 71 min (SD = 56; range 11 to 246 min) per wk of physical activity.	3, 45 min group sessions per wk for 12 mo	Usual care
Korpelainen, 2006[41]	IG1	Supervised, group exercise program in addition to an	Individual; Group	Class outside of	Physical therapist	3 x 45 min sessions per wk (135 min); 156 total sessions (117 hrs).	1, 1hr group class/wk for 6mo	Usual care

Appendix F Table 3. Exercise Interventions: Intervention Components

Author, year	Arm	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
		independent home exercise program.		home; Home				
Kovacs, 2013[42]	IG1	Adapted Physical Activity program with structured group exercises and physical games.	Group	Class outside of home	Physical therapist	The mean duration of moderate non-intervention physical activity (4.5) during the intervention was 7 (SD 4) hr/wk in the IG and CG groups.	2, 1hr group sessions/wk for 25 wks	Usual care
Kronhed, 2009[43]	IG1	Supervised, group strength-training program.	Group	Class outside of home	Physical therapist	Over 30 mo: Sep-Mar (6mo): 1hr group exercise classes 1x/wk; Apr-Sep (6mo): 20min daily home exercises.	2, 1hr group sessions/wk for 4mo	Usual care
Lamb, 2018[44]	IG1	12-mo exercise intervention (4mo supervised group exercise, followed by 8mo unsupervised exercise program) combined with behavior change support.	Individual; Group	Class outside of home; Home	Exercise Instructor; Physical therapist	2 x 1 hr sessions per wk (120 min/wk); total of 50 sessions (50 hrs)	1hr group exercise 2x/wk for 4mo	Usual care
Lipsitz, 2019[45]	IG1	Group Tai Chi class supplemented with independent, home exercises.	Individual; Group	Class outside of home; Home	Exercise Instructor; Self-directed (manual or instructions given)	Total number of 30, 1hr group exercise training sessions, delivered twice-wkly for 4 mo; participants encouraged to continue the training exercise program on their own at senior gyms after the supervised group exercise training period.	2 group classes (length NR)/wk for up to 52wks	Attention control
Logghe, 2009[46]	IG1	Tai Chi Chuan training in group class, supplemented by independent practice at home.	Individual; Group	Class outside of home; Home	Exercise Instructor	"Twice-wkly exercise sessions of approximately 1 hr's duration for 4 mo. After the 4 mo of exercise classes, all of the 150 mins of activity per wk at moderate intensity was carried out unsupervised for another 8 mo.	1hr groups sessions 2x/wk for 26 wks	Usual care

Appendix F Table 3. Exercise Interventions: Intervention Components

Author, year	Arm	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
Luukinen, 2007[47]	IG1	Prescribed exercise intervention that could consist of home exercise, walking exercise, group exercise, and/or self-care exercises.	Individual; Group	Class outside of home; Home	Occupational therapist; Physical therapist	Average # of sessions attended was 21.	Varied based on ability and recommendations.	Usual care
Merom, 2016[48]	IG1	Community group dance classes.	Group	Class outside of home	Exercise Instructor	2/wk supervised group classes (Length of class NR) plus 3/wk 20-min independent exercise sessions encouraged.	1hr group class 2x/wk (total of 80hr) over 12 mo	No intervention
Miko, 2018[49]	IG1	Supervised balance-training program, supplemented with independent, at-home exercise and walking program based on elements of the Otago exercise program.	Individual	Home; Outpatient	Physiotherapist	1 hr sessions 2x/wk per wk (120 total min per wk); 26 sessions total	3, 30min sessions/wk for 12mo	No intervention
Morgan, 2004[50]	IG1	Group exercise sessions focusing on gait, balance, flexibility utilizing physical therapy exercises.	Group	Class outside of home	Physical therapist	Variable, not clearly described.	3, 45min group sessions/wk for 8wks	Usual care
Ng, 2015[51]	IG1	Tailored physical exercise program which included supervised group classes, followed by independent, home-based exercises.	Individual; Group	Class outside of home; Home	Other modern health professionals	Dance classes were offered for one hr, twice a wk, for a total of 80 h over 12 mo (allowing for short breaks).	2, 90min group classes/wk for 6wks	Usual care
Ohman, 2016[52]	IG1	Based on participant ability, assigned to either (1) supervised, home-based exercise program, or (2) supervised, group-based exercise class outside the home.	Individual; Group	Class outside of home; Home	Physical therapist	Planned: 30 mins/session *3 sessions/wk*52 wks + 25–35 min walks at home (days/wks NR)	Varied based on ability but could be (1) 2, 1hr PT home visit/wk for 12 mo OR (2) 2, 1hr group classes/wk for 12mo	Usual care

Appendix F Table 3. Exercise Interventions: Intervention Components

Author, year	Arm	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
Oliveira, 2019[53]	IG1	Health coaching for mobility-related goals.	Individual	Home	Physical therapist	3 sessions per wk, 45 mins, 8 wks	NA	Usual care
Robertson, 2001[55]	IG1	Prescribed at-home exercise and walking program; included 5 home visits by instructor.	Individual	Home	Nurse	2, 90 min sessions per wk (180 min per wk); 48 total sessions (72 hrs), followed by 12 wks of home-based exercises (duration or freq NR)	5 home visits over 1yr (length of visit NR)	Usual care
Rosado, 2021[56]	IG1	Supervised, group multimodal exercise program combining physical with cognitive training.	Group	Class outside of home	Physical therapist	1 hr, twice per wk, for 1 year (individual at home OR group classes based on ability). The mean active exercise time per person was approximately 1 h/d because of breaks and waiting times.	3, 74min group sessions/wk for 24wks	No intervention
Sherrington, 2014[57]	IG1	At-home exercise program with behavioral change support; 10 home visits from PT.	Individual	Home	Physical therapist	2 hr home visit + telephone coaching every 2 wks for 6mo	Up to 10 home visits over 12mo	Minimal intervention
Siegrist, 2016[58]	IG1	Group exercise sessions & prescribed home-exercise program addressing strength, balance, and gait plus cognitive behavioral program to reduce fear of falling by increasing self-efficacy.	Individual; Group	Class outside of home; Home	Exercise InstructorPhysical therapist	Recommended 3, 30 min strength sessions and 2 walking sessions per wk.	One, 1hr group session per wk	Usual care
Stathi, 2022[59]	IG1	Community-based exercise program combined with a behavioral maintenance program.	Group	Class outside of home	Exercise Instructor	24 wks, 75 min/session; 3x/wk on alternate days	1h group classes 2x/wk for 12wks, then 1x/wk for an additional 40 wks (64 group sessions in total over 12mo)	Minimal intervention
Suikkanen, 2021[60]	IG1	Supervised, multicomponent home physical exercise	Individual	Home	Physical therapist	20-30 mins of at-home exercise sessions for 6 days	2, 1hr PT sessions/wk for 12mo	Usual care

Appendix F Table 3. Exercise Interventions: Intervention Components

Author, year	Arm	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
		program based on the OEP.				per wk. Up to 10 home visits from PT over a year.		
Tomita, 2016[61]	IG1	Supervised, virtual-group, home exercise program.	Group	Home	Other modern health professionals	One 60-min supervised exercise session (group) per wk over 16 wks, plus a cognitive behavioral program intensity NR. After four wks the patients were asked to add an unsupervised session per wk (12 sessions in all) according to a booklet with written information and images on how to perform the exercise at home, as well as safety issues.	3 virtual group sessions/wk for 24wks	Minimal intervention
Trombetti, 2011[62]	IG1	Group dance and music class sessions aiming to improve gait, balance, and function.	Group	Class outside of home	Exercise Instructor	1-hr exercise sessions were delivered twice a wk for 12 wks, reduced to once a wk for a further 40 wks (64 sessions in total over 12 mo)	1, 60min group class 1/wk for 6mo	Usual care
Tuvemo Johnson, 2021[63]	IG1	Independent, home-based Otago Exercise Programme; Home visits and phone support incorporating behavior change support.	Individual	Home	Physical therapist	Two, 1hr PT-delivered exercise sessions each wk for 1 year; encouraged participant to be physically active outside the supervised exercise sessions	6, 1hr PT home visits over 12mo (length NR)	No intervention
	IG2	Independent, home-based Otago Exercise Program; home visits and phone support.	Individual	Home	Physical therapist	Planned: 72 sessions (25 to 40 mins per session, 3 sessions per wk for 24 wks). At the end of the intervention, the last 34-min exercise instruction on YouTube was provided to the treatment group and they were encouraged to continue the exercise.	6, 1hr PT home visits over 12mo (length NR)	No intervention
Uusi-Rasi, 2015[64]	IG1	Exercise program consisting of group and individual	Individual; Group	Class outside of home; Home	Physical therapist	60 min session once per wk for 6 mo	Group class 2x/wk for 12mo, then 1x/wk for an additional 12mo	Usual care

Appendix F Table 3. Exercise Interventions: Intervention Components

Author, year	Arm	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
		sessions over 24 mo with placebo.						
Voukelatos, 2007[65]	IG1	Community-based, group Tai Chi classes.	Group	Class outside of home	Exercise Instructor	Each home-exercise session was estimated to take 30 min and to be performed at a rate of 3 times per wk.6 home visits, 3 phone calls from PT. Walks were endorsed on days when no exercise was performed for a minimum of 3 times per wk.	1, 60min group class/wk for 16wks.	Usual care
Voukelatos, 2015[66]	IG1	Self-managed, at-home walking program with telephone coaching at 3 timepoints.	Individual	Home	Self-directed (manual or instructions given); Unclear	Each home-exercise session was estimated to take 30 min and to be performed at a rate of 3 times per wk.6 home visits, 3 phone calls from PT. Walks were endorsed on days when no exercise was performed for a minimum of 3 times per wk.	NA, self-directed	Attention control

Abbreviations: Apr = April; CG = Control group; Descr = Description; Freq= Frequency; Hr = Hour; IG = Intervention group; min = minutes; mo = Months; NA = Not applicable; NR = Not reported; OEP = Otago Exercise Program; PT = Physical therapy; SD = Standard deviation; Sep = September; wk = Week; X = Times; yrs = Years.

Appendix F Table 4. Exercise Interventions: Falls

Author, year	FU, mo	IG n	CG n	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Barnett, 2003[31]	12	76	74	NR (0.61)	NR (0.95)	0.60 (0.36, 0.99)
Bruce, 2021[3]	18	3279	3223	4277 (1.04)	4309 (1.06)	0.99 (0.86, 1.14)
Campbell, 1997[34]	12	116	117	88 (0.87)	152 (1.34)	0.47 (0.04, 0.90)
Chyu, 2010[35]	6	26	28	39 (3)	70 (5)	0.60 (0.41, 0.89)
Delbaere 2021[36]	12	254	249	NR (0.61)	NR (0.75)	0.82 (0.66, 1.02)
	24	254	249	NR (1.17)	NR (1.39)	0.84 (0.72, 0.98)
El-Khoury, 2015[37]	24	352	354	533 (0.79)	640 (0.92)	0.86 (0.77, 0.96)
Fitzharris, 2010[38]	18	135	137	181 (1.05)	211 (1.2)	0.87 (0.72, 1.07)
Goldberg 2019[39]	12	18	16	NR	NR	1.20 (0.32, 4.50)
Korpelainen, 2006[41]	30	84	76	88 (0.42)	101 (0.53)	0.79 (0.59, 1.05)
Kronhed, 2009[43]	12	31	34	19 (0.61)	27 (0.79)	0.77 (0.43, 1.39)
Lamb, 2018[44]	6	281	137	335 (2.38)	180 (2.63)	1.20 (0.81, 1.74)
	12	281	137	661 (2.35)	417 (3.04)	0.77 (0.68, 0.87)
Lipsitz, 2019[45]	6	77	67	26 (0.46)	16 (0.26)	1.76 (0.58, 5.31)
Logghe, 2009[46]	12	138	131	115 (0.83)	90 (0.69)	1.21 (0.92, 1.60)
Luukinen, 2007[47]	16	217	220	NR (1.15)	NR (1.23)	0.93 (NR)
Merom, 2016[48]	12	275	247	257 (1.03)	187 (0.8)	1.19 (0.83, 1.71)
Miko, 2018[49]	12	49	48	7 (0.14)	16 (0.33)	0.53 (0.22, 1.30)
Ohman, 2016[52]	12	44	22	NR (1.24)	NR (1.84)	0.65 (0.42, 1.01)
Oliveira, 2019[53]	6	57	52	57 (0.95)	52 (0.8)	1.30 (0.70, 2.20)
Rikkonen, 2023[54]	24	457	457	641 (0.744)	739 (0.865)	0.86 (0.77, 0.96)
Robertson, 2001[55]	12	121	119	80 (0.69)	109 (1.01)	0.54 (0.32, 0.90)
Rosado, 2021[56]	6	16	19	10 (1.25)	18 (1.89)	0.66 (0.30, 1.43)
Sherrington, 2014[57]	12	171	169	177 (1.04)	123 (0.73)	1.43 (1.07, 1.93)
Siegrist, 2016[58]	12	222	156	291 (1.3)	367 (2.4)	0.68 (0.42, 1.22)
	24	212	144	517 (1.22)	588 (2.04)	0.63 (0.44, 0.94)
Stathi, 2022[59]	6	335	295	194 (1.16)	180 (1.22)	0.95 (0.77, 1.16)
	12	330	300	425 (1.29)	399 (1.33)	0.97 (0.84, 1.11)
Suikkanen, 2021[60]	12	133	127	NR (1.4)	NR (3.1)	0.47 (0.40, 0.55)
Tomita, 2016[61]	6	25	26	8 (0.64)	16 (1.23)	0.52 (0.22, 1.22)

Appendix F Table 4. Exercise Interventions: Falls

Author, year	FU, mo	IG n	CG n	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Tuvemo Johnson, 2021[63]	12	58	56	79 (1.4)	36 (0.6)	2.33 (1.57, 3.46)
		61	56	70 (1.1)	36 (0.6)	1.83 (1.23, 2.74)
Uusi-Rasi, 2015[64]	24	103	102	NR (1.21)	NR (1.18)	1.07 (0.77, 1.45)
	48	86	89	NR (1.02)	NR (1.11)	0.93 (NR)
Voukelatos, 2007[65]	6	347	337	86 (0.5)	126 (0.75)	0.67 (0.47, 0.94)
Voukelatos, 2015[66]	12	159	180	NR	NR	0.88 (0.60, 1.29)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix F Table 5. Exercise Interventions: Falls, Exploring Heterogeneity

Characteristic/ Component	Groups	k	IRR (95% CI)	Test of group differences, p
Group versus individual	Any group (+/- any individual)	18	0.84 (0.76, 0.94)	0.95
	Any supervised individual (+/- unsupervised individual)	8	0.86 (0.54, 1.36)	
	Unsupervised individual only	3	0.87 (0.64, 1.18)	
General PA	General PA	11	0.81 (0.60, 1.09)	0.54
	No general PA	18	0.88 (0.78, 1.00)	
Endurance	Endurance	5	0.61 (0.46, 0.81)	0.01*
	No endurance	24	0.91 (0.81, 1.03)	
Flexibility	Flexibility	5	0.69 (0.47, 1.01)	0.15
	No flexibility	24	0.89 (0.78, 1.02)	
Gait	Gait	22	0.82 (0.71, 0.95)	0.32
	No gait	7	0.95 (0.69, 1.31)	
Strength	Strength	19	0.82 (0.69, 0.97)	0.42
	No strength	10	0.90 (0.74, 1.09)	
3D	3D	6	0.91 (0.64, 1.29)	0.56
	No 3D	23	0.83 (0.72, 0.96)	
Cognitive task exercises	Cognitive task exercises	2	0.77 (0.03, 21.10)	0.77
	No cognitive tasks	27	0.85 (0.75, 0.97)	
Behavior change component	Behavior change	8	0.93 (0.72, 1.20)	0.35
	No behavior change	21	0.82 (0.70, 0.96)	
ED/hospital recruitment	ED/hospital	2	1.11 (0.02, 52.5)	0.35
	Other	27	0.83 (0.73, 0.94)	
Fall risk	Selected for fall risk	17	0.83 (0.69, 1.01)	0.97
	Unselected for fall risk	12	0.84 (0.77, 0.91)	
Quality	Good	4	0.90 (0.68, 1.18)	0.53
	Fair	25	0.84 (0.72, 0.97)	
Conducted in the US	US	3	0.69 (0.20, 2.39)	0.37
	Non-US	26	0.86 (0.76, 0.98)	

* Not statistically significant after adjusted for multiple comparisons.

Note: Also visually inspected plots sorted by intervention duration, publication year, mean age, followup, CG fall event rate

Abbreviations: 3D = Three dimensional; CI = Confidence interval; ED = Emergency department; IRR = Incidence rate ratio; K = Number of studies; PA = Physical activity; US = United States.

Appendix F Table 6. Exercise Interventions: People With a Fall

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Barnett, 2003[31]	Person with 1+ falls	12	27/76 (35.5)	37/74 (50)	0.71 (0.49, 1.04)
	Person with 2+ falls	12	8/76 (10.5)	18/74 (24.3)	0.44 (0.21, 0.96)
Bruce, 2021[3]	Person with 1+ falls	18	1277/3279 (38.9)	1276/3223 (39.6)	0.98 (0.92, 1.06)
	Person with 2+ falls	18	687/3279 (21)	715/3223 (22.2)	0.94 (0.85, 1.05)
Buchner, 1997[32]	Person with 1+ falls	12	32/75 (42.7)	18/30 (60)	0.71 (0.48, 1.05)
Callisaya, 2021[33]	Person with 1+ falls	6	13/44 (29.5)	11/49 (22.4)	1.32 (0.66, 2.63)
	Person with 2+ falls	6	6/44 (13.6)	4/49 (8.2)	1.67 (0.50, 5.53)
Campbell, 1997[34]	Person with 1+ falls	12	53/116 (45.7)	62/117 (53)	0.86 (0.66, 1.12)
	Person with 2+ falls	12	22/116 (19)	34/117 (29.1)	0.65 (0.41, 1.05)
Delbaere 2021[36]	Person with 1+ falls	12	88/254 (34.6)	100/249 (40.2)	0.90 (0.72, 1.12)
	Person with 1+ falls	24	NR/254 (NR)	NR/249 (NR)	0.87 (0.74, 1.02)
El-Khoury, 2015[37]	Person with 1+ falls	24	189/352 (53.7)	222/354 (62.7)	0.86 (0.75, 0.97)
Fitzharris, 2010[38]	Person with 1+ falls	18	76/135 (56.3)	87/137 (63.5)	0.89 (0.73, 1.08)
	Person with 2+ falls	18	40/135 (29.6)	45/137 (32.8)	0.90 (0.63, 1.28)
	Person with 3+ falls	18	30/135 (22.2)	25/137 (18.2)	1.22 (0.76, 1.96)
Kovacs, 2013[42]	Person with 1+ falls	6	6/36 (16.7)	15/36 (41.7)	0.40 (0.17, 0.92)
Lamb, 2018[44]	Person with 1+ falls	6	93/281 (33.1)	45/135 (33.3)	0.99 (0.74, 1.33)
Lipsitz, 2019[45]	Person with 1+ falls	6	21/77 (27.3)	11/67 (16.4)	1.66 (0.73, 3.78)
Logghe, 2009[46]	Person with 1+ falls	12	58/138 (42)	59/131 (45)	0.93 (0.71, 1.23)
Luukinen, 2007[47]	Person with 1+ falls	16	126/217 (58.1)	136/220 (61.8)	0.94 (0.81, 1.10)
	Person with 3+ falls	16	38/217 (17.5)	43/220 (19.5)	0.90 (0.60, 1.33)
Miko, 2018[49]	Person with 1+ falls	12	6/49 (12.2)	11/48 (22.9)	0.53 (0.21, 1.33)
Morgan, 2004[50]	Person with 1+ falls	12	34/119 (28.6)	34/110 (30.9)	0.92 (0.62, 1.38)
Ng, 2015[51]	Person with 1+ falls	6	3/48 (6.3)	5/50 (10)	0.63 (0.16, 2.47)
	Person with 1+ falls	12	3/48 (6.3)	5/50 (10)	0.63 (0.16, 2.47)
Oliveira, 2019[53]	Person with 1+ falls	6	27/60 (45)	27/64 (42.2)	1.00 (0.70, 1.50)
Rikkonen, 2023[54]	Person with 1+ falls	24	268/457 (58.6)	278/457 (60.8)	0.96 (0.87, 1.07)
Sherrington, 2014[57]	Person with 1+ falls	12	98/171 (57.3)	70/169 (41.4)	1.38 (1.11, 1.73)
Siegrist, 2016[58]	Person with 1+ falls	12	93/222 (41.9)	77/156 (49.4)	0.85 (0.59, 1.22)
Tomita, 2016[61]	Person with 1+ falls	9	4/25 (21)	5/25 (27)	0.80 (0.24, 2.64)
Trombetti, 2011[62]	Person with 1+ falls	6	19/66 (28.8)	32/68 (47.1)	0.69 (0.44, 1.07)
	Person with 2+ falls	6	3/66 (4.5)	16/68 (23.5)	0.21 (0.06, 0.67)

Appendix F Table 6. Exercise Interventions: People With a Fall

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Tuvemo Johnson, 2021[63]	Person with 1+ falls	12 (IG1)	33/58 (56.9)	19/56 (33.9)	1.68 (1.09, 2.57)
		12 (IG2)	22/61 (36.1)	19/56 (33.9)	1.06 (0.65, 1.74)
		24 (IG1)	24/47 (51.1)	30/51 (58.8)	0.87 (0.60, 1.25)
		24 (IG2)	21/44 (47.7)	30/51 (58.8)	0.81 (0.55, 1.19)
	Person with 2+ falls	12 (IG1)	14/58 (24.1)	10/56 (17.9)	1.35 (0.66, 2.79)
		12 (IG2)	10/60 (16.7)	10/56 (17.9)	0.93 (0.42, 2.07)
		24 (IG1)	13/47 (27.7)	15/51 (29.4)	0.94 (0.50, 1.76)
		24 (IG2)	8/44 (18.2)	15/51 (29.4)	0.62 (0.29, 1.32)
Uusi-Rasi, 2015[64]	Person with 1+ falls	24	NR/103 (NR)	NR/102 (NR)	HR 0.93 (0.66, 1.31)
		48	NR/86 (NR)	NR/89 (NR)	HR 1.01 (0.74, 1.39)
	Person with 2+ falls	24	NR/103 (NR)	NR/102 (NR)	HR 1.14 (0.76, 1.71)
Voukelatos, 2007[65]	Person with 1+ falls	6	71/347 (20.5)	81/337 (24)	0.86 (0.65, 1.14)
	Person with 2+ falls	6	15/347 (4.3)	27/337 (8)	0.54 (0.28, 0.96)
Voukelatos, 2015[66]	Person with 1+ falls	12	54/159 (34)	68/180 (37.8)	0.90 (0.67, 1.20)
	Person with 2+ falls	12	25/159 (15.7)	28/180 (15.6)	1.01 (0.61, 1.67)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix F Table 7. Exercise Interventions: People With a Fall, Exploring Heterogeneity

Characteristic/ Component	Groups	k	RR (95% CI)	Test of group differences, p
Group versus individual	Any group (+/- any individual)	16	0.90 (0.85, 0.96)	0.80
	Any supervised individual (+/- unsupervised individual)	5	0.97 (0.70, 1.36)	
	Unsupervised individual only	4	0.90 (0.77, 1.05)	
General PA	General PA	10	0.95 (0.89, 1.01)	0.60
	No general PA	15	0.92 (0.81, 1.03)	
Endurance	Endurance	4	0.84 (0.66, 1.08)	0.23
	No endurance	21	0.93 (0.87, 1.00)	
Flexibility	Flexibility	6	0.88 (0.80, 0.97)	0.30
	No flexibility	19	0.94 (0.86, 1.02)	
Gait	Gait	20	0.91 (0.85, 0.99)	0.84
	No gait	5	0.93 (0.79, 1.09)	
Strength	Strength	16	0.92 (0.82, 1.03)	0.55
	No strength	9	0.89 (0.83, 0.95)	
3D	3D	4	0.96 (0.84, 1.09)	0.42
	No 3D	21	0.91 (0.84, 0.98)	
Cognitive task exercises	Cognitive task exercises	1	1.32 (0.66, 2.63)	0.31
	No cognitive tasks	24	0.92 (0.86, 0.98)	
Behavior change component	Behavior change	6	1.00 (0.81, 1.23)	0.31
	No behavior change	19	0.91 (0.86, 0.96)	
ED/hospital recruitment	ED/hospital	1	1.38 (1.11, 1.72)	0.00
	Other	24	0.91 (0.87, 0.96)	
Fall risk	Selected for fall risk	13	0.92 (0.82, 1.03)	1.00
	Unselected for fall risk	12	0.92 (0.85, 0.99)	
Quality	Good	4	0.92 (0.72, 1.16)	0.92
	Fair	21	0.92 (0.85, 1.00)	
Conducted in the US	US	4	0.88 (0.55, 1.41)	0.73
	Non-US	21	0.93 (0.87, 0.99)	

Abbreviations: 3D = Three dimensional; CI = Confidence interval; ED = Emergency department; RR = Relative risk; K = Number of studies; PA = Physical activity; US = United States.

Appendix F Table 8. Exercise Interventions: Injurious Falls

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Barnett, 2003[31]	Fall resulting in injuries	12	NR (0.4)	NR (0.54)	0.66 (0.38, 1.15)
Delbaere 2021[36]	Fall resulting in injuries	24	NR (0.71)	NR (0.88)	0.80 (0.66, 0.98)
El-Khoury, 2015[37]	Fall resulting in injuries	24	NR (0.45)	NR (0.56)	0.80 (NR)
	Fall resulting in serious injuries	24	68 (0.1)	87 (0.12)	0.79 (0.57, 1.08)
Fitzharris, 2010[38]	Fall resulting in injuries	18	101 (0.58)	115 (0.65)	0.89 (0.68, 1.17)
	Fall resulting in medical care	18	16 (0.09)	18 (0.1)	0.91 (0.46, 1.79)
Karinkanta, 2015[40]	Fall resulting in injuries	60	14 (0.07)	22 (0.12)	0.49 (0.25, 0.98)
Luukinen, 2007[47]	Fall-related injuries, serious	16	NR (0.18)	NR (0.19)	0.95 (NR)
Oliveira, 2019[53]	Fall resulting in injuries	6	24 (0.84)	33 (1.27)	0.66 (0.39, 1.12)
	Fall resulting in medical care	6	5 (0.18)	7 (0.27)	0.65 (0.21, 2.05)
Rikkonen, 2023[54]	Fall-related injuries	24	359 (0.393)	380 (0.416)	0.94 (0.182, 1.09)
	Fall-related injuries, moderate	24	335 (NR)	343 (NR)	0.59 (0.36, 0.99)
	Fall-related injuries, serious	24	24 (NR)	37 (NR)	NR (NR)
	Fall-related medical attention	24	78 (NR)	93 (NR)	0.83 (0.61, 1.12)
Robertson, 2001[55]	Fall resulting in injuries	12	42 (0.36)	49 (0.45)	0.80 (0.53, 1.20)
	Fall resulting in medical care	12	18 (0.15)	26 (0.22)	0.68 (0.37, 1.24)
	Fall resulting in serious injuries	12	2 (0.02)	9 (0.08)	0.22 (0.05, 1.01)
Sherrington, 2014[57]	Fall resulting in medical care	12	61 (0.36)	53 (0.31)	1.14 (0.76, 1.73)
Siegrist, 2016[58]	Fall-related injuries	12	NR (NR)	NR (NR)	0.79 (0.49, 1.33)
		24	188 (0.44)	197 (0.68)	0.69 (0.47, 0.97)
Tuvemo Johnson, 2021[63]	Fall-related injuries	12 (IG1)	36 (0.62)	19 (0.34)	1.83 (1.05, 3.19)
		12 (IG2)	28 (0.46)	19 (0.34)	1.35 (0.76, 2.42)
	Fall-related injuries, minor	12 (IG1)	33 (0.57)	16 (0.29)	1.99 (1.10, 3.62)
		12 (IG2)	27 (0.44)	16 (0.29)	1.55 (0.83, 2.88)
	Fall-related injuries, serious	12 (IG1)	3 (0.05)	3 (0.05)	0.97 (0.19, 4.78)
		12 (IG2)	1 (0.02)	3 (0.05)	0.31 (0.03, 2.94)
Uusi-Rasi, 2015[64]	Fall resulting in injuries	24	NR (0.06)	NR (0.13)	0.46 (0.22, 0.95)
		48	NR (0.09)	NR (0.19)	0.46 (NR)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix F Table 9. Exercise Interventions: Fractures

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Bruce, 2021[3]	Fracture	18	152 (0.03)	133 (0.03)	1.20 (0.91, 1.59)
	Hip fracture	18	26 (0.01)	33 (0.01)	0.77 (0.43, 1.41)
Karinkanta, 2015[40]	Fall-related fracture	60	NR	NR	0.26 (0.07, 0.97)
Korpelainen, 2006[41]	Fall-related fracture	30	6 (0.03)	16 (0.08)	0.34 (0.13, 0.87)
		85	17 (0)	23 (0)	0.68 (0.34, 1.32)
	Fall-related hip fracture	85	0.5 (0)	5 (0.01)	0.09 (0.00, 1.66)
Kronhed, 2009[43]	Fall-related fracture	12	0.5 (0.02)	0.5 (0.01)	1.10 (0.02, 55.28)
Lamb, 2018[44]	Fall-related fracture	6	4 (0.03)	1 (0.01)	1.95 (0.22, 17.45)
		12	11 (0.04)	5 (0.04)	1.07 (0.37, 3.09)
Ohman, 2016[52]	Fall-related fracture	12	2 (0.05)	2 (0.09)	0.50 (0.07, 3.55)
	Hip fracture	12	0.5 (0.01)	1 (0.05)	0.25 (0.01, 7.45)
Rikkonen, 2023[54]	Fall-related fracture	24	28 (0.031)	45 (0.049)	0.62 (0.39, 0.99)
	Fall-related hip fracture	24	5 (NR)	6 (NR)	NR
Sherrington, 2014[57]	Fall-related fracture	12	14 (0.08)	15 (0.09)	0.92 (0.45, 1.91)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix F Table 10. Exercise Interventions: People With a Fall Resulting in Injuries or Medical Care

Author, year	Outcomes	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Barnett, 2003[31]	Injurious fallers	12	22/76 (28.9)	28/74 (37.8)	0.77 (0.48, 1.21)
Campbell, 1997[34]	Injurious fallers	12	27/103 (26.2)	43/110 (39.1)	0.67 (0.45, 1.00)
Delbaere 2021[36]	Injurious fallers	24	95/254 (37.4)	115/249 (46.2)	0.87 (0.71, 1.06)
El-Khoury, 2015[37]	Injurious fallers	24	170/352 (48.3)	189/354 (53.4)	0.90 (0.78, 1.05)
Karinkanta, 2015[40]	Injurious fallers	60	11/37 (29.7)	17/35 (48.6)	0.61 (0.34, 1.12)
Rikkonen, 2023[54]	Injurious fallers	24	207/457 (45.3)	195/457 (42.7)	1.06 (0.92, 1.23)
Siegrist, 2016[58]	Injurious fallers	12	63/222 (28.4)	59/156 (37.8)	0.75 (0.47, 1.20)
Stathi, 2022[59]	Injurious fallers	6	43/328 (13.1)	40/291 (13.7)	0.95 (0.64, 1.42)
Tuvemo Johnson, 2021[63]	Injurious fallers	12 (IG1)	25/58 (43.1)	12/56 (21.4)	2.01 (1.12, 3.60)
		12 (IG2)	16/61 (26.2)	12/56 (21.4)	1.22 (0.64, 2.36)
Uusi-Rasi, 2015[64]	Injurious fallers	24	NR/103 (NR)	NR/102 (NR)	HR 0.47 (0.23, 0.99)
		48	NR/86 (NR)	NR/89 (NR)	HR 0.46 (0.28, 0.76)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix F Table 11. Exercise Interventions: People With a Fall-Related Fracture

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Bruce, 2021[3]	Person with fracture	18	126/3279 (3.8)	110/3223 (3.4)	1.13 (0.84, 1.51)
Korpelainen, 2006[41]	Person with fall-related fracture	30	6/84 (7.1)	15/76 (19.7)	0.36 (0.15, 0.89)
Lamb, 2018[44]	Person with fall-related fracture	6	4/281 (1.4)	1/137 (0.7)	1.95 (0.22, 17.28)
Rikkonen, 2023[54]	Person with fall-related fracture	24	24/457 (5.2)	39/457 (8.5)	NR (NR)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix F Table 12. Exercise Interventions: Mortality

Author, year	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Barnett, 2003[31]	12	.5/83 (.6)	3/80 (3.8)	0.16 (0.01, 3.16)
Bruce, 2021[3]	18	89/3279 (2.7)	93/3223 (2.9)	0.94 (0.67, 1.31)
Campbell, 1997[34]	12	2/116 (1.7)	4/117 (3.4)	0.50 (0.09, 2.70)
El-Khoury, 2015[37]	12	2/352 (.6)	3/354 (.8)	0.67 (0.11, 3.99)
	24	5/352 (1.4)	6/354 (1.7)	0.84 (0.26, 2.72)
Karinkanta, 2015[40]	60	.5/37 (1.4)	1/35 (2.9)	0.47 (0.02, 13.66)
Korpelainen, 2006[41]	85	1/84 (1.2)	8/76 (10.5)	0.11 (0.01, 0.85)
Lamb, 2018[44]	12	13/329 (4)	5/165 (3)	1.30 (0.47, 3.60)
Luukinen, 2007[47]	16	31/217 (14.3)	35/220 (15.9)	0.90 (0.58, 1.40)
Ng, 2015[51]	12	.5/48 (1)	1/50 (2)	0.52 (0.02, 15.17)
Robertson, 2001[55]	12	1/121 (.8)	6/119 (5)	0.16 (0.02, 1.34)
Sherrington, 2014[57]	12	10/171 (5.8)	9/169 (5.3)	1.10 (0.46, 2.63)
Siegrist, 2016[58]	12	8/222 (3.6)	10/156 (6.4)	0.56 (0.13, 2.46)
	24	11/222 (5)	16/156 (10.3)	0.48 (0.14, 1.61)
Suikkanen, 2021[60]	12	5/150 (3.3)	10/149 (6.7)	0.50 (0.17, 1.42)
	24	18/150 (12)	19/149 (12.8)	0.94 (0.51, 1.72)
Trombetti, 2011[62]	12	1/66 (1.5)	1/68 (1.5)	1.03 (0.07, 16.13)
Uusi-Rasi, 2015[64]	24	.5/103 (.5)	2/102 (2)	0.25 (0.01, 5.42)
	48	.5/103 (.5)	2/102 (2)	0.25 (0.01, 5.42)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix F Table 13. Exercise Interventions: People With a Fall Resulting in Hospitalization/Emergency Department Visit or People With Institutionalization

Outcome	Author, year	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
People with a fall resulting in hospitalization or ED visit	Ng, 2015[51]	6	1/48 (2.1)	2/50 (4)	0.52 (0.05, 5.56)
		12	3/48 (6.3)	2/50 (4)	1.56 (0.27, 8.95)
People with institutionalization	Kovacs, 2013[42]	6	0/36 (0)	1/36 (2.8)	0.50 (0.02, 14.44)
	Suikkanen, 2021[60]	24	11/150 (7.3)	13/149 (8.7)	0.84 (0.39, 1.82)
	Trombetti, 2011[62]	12	0/66 (0)	1/68 (1.5)	0.52 (0.02, 15.10)

Abbreviations: CG = Control group; CI = Confidence interval; ED =Emergency department; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix F Table 14. Exercise Interventions: Instrumental Activities of Daily Living

Author, year	Outcome (Instrument)	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
Buchner, 1997[32]	IADL (modified Lawton and Brody)	0	24	29	4.6 (1.0)	4.6 (0.7)	NA	NA	NA
		6	24	29	NR	NR	0.1 (0.4)	0.2 (0.7)	NR
		9	22	NR	NR	NR	-0.1 (0.4)	NR	NR
Goldberg, 2019[39]	IADL (Nottingham Extended Activities of Daily Living)	0	17	10	16 (5)	16 (4)	NA	NA	NA
		12	17	10	15 (5)	15 (6)	NR	NR	NR
Delbaere 2021[36]	IADL (WHO-DAS)	0	254	249	Median 4.1 (IQR 0, 9.3)	Median 6.3 (IQR 0, 12.5)	NA	NA	NA
		12	254	249	Median 6.3 (IQR 0, 13.4)	Median 8.8 (IQR, 1.45 to 16.2)	NR	NR	-0.2 (-2.7, 2.3)
		24	254	249	Median 7.7 (IQR 0.4, 15)	Median 6.3 (IQR 0, 16.5)	NR	NR	0.2 (-2.0, 2.5)
Suikkanen, 2021[60]	IADL (Lawton and Brody)	0	150	149	23 (5)	23 (6)	NA	NA	NA
		12	NR	NR	NR	NR	-1.4 (95% CI, -1.9, -0.9)	-2.1 (95% CI, -2.6, -1.6)	NR

Abbreviations: BL = Baseline; CG = Control group; IADL = Instrumental activities of daily living; IG = Intervention group; IQR = Interquartile range; Mo = Months; N = Number of participants; NA = Not applicable; NR = Not reported; SD = Standard deviation; Time = Timepoint; WHO-DAS = World Health Organization - Disability Assessment Schedule.

Appendix F Table 15. Exercise Interventions: Quality of Life

Author, year	Instrument	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
Bruce, 2021[3]	SF-12 Mental	0	3279	3223	50.3 (8.9)	50.2 (9.3)	NA	NA	NA
		18	2214	2234	50.3 (9.1)	50.0 (9.0)	NR	NR	0.02 (-0.41, 0.45)
	SF-12 Physical	0	3279	3223	50.5 (10.3)	50.3 (10.2)	NA	NA	NA
		18	2214	2234	50.4 (10.0)	49.9 (10.0)	NR	NR	0.24 (-0.15, 0.64)
Chyu, 2010[35]	SF-36 Mental Component	0	30	31	51.82 (11.2)	55.01 (8.30)	NA	NA	NA
		6	26	28	55.03 (8.76)	55.30 (6.07)	NR	NR	NR
	SF-36 Physical Component	0	30	31	43.29 (9.02)	44.60 (10.06)	NA	NA	NA
		6	26	28	47.09 (7.07)	45.17 (9.39)	NR	NR	NR
Delbaere 2021[36]	EQ-5D VAS	0	254	249	Median 90 (IQR 82.5, 97.5)	Median 85 (IQR 77.5, 92.5)	NA	NA	NA
		12	254	249	Median 89 (IQR 83.5, 94.5)	Median 83 (73.5, 92.5)	NR	NR	0 (-4, 4)
		24	254	249	Median 88 (IQR 81, 95)	Median 80 (70, 90)	NR	NR	1 (-4, 6)
Goldberg 2019[39]	EQ-5D-3L	0	16	13	0.8 (0.2)	0.8 (0.2)	NA	NA	NA
		12	16	13	0.8 (0.2)	0.7 (0.2)	NR	NR	NR
Lamb, 2018[44]	EQ-5D-3L	0	278	137	0.84 (0.19)	0.86 (0.16)	NA	NA	NA
		6	292	139	0.80 (0.21)	0.83 (0.21)	NR	NR	NR
		12	261	131	0.81 (0.22)	0.82 (0.25)	NR	NR	NR
	QoL-AD	0	278	137	39.1 (5.4)	39.4 (5.0)	NA	NA	NA
		6	263	124	38.9 (6.1)	39.0 (5.9)	NR	NR	NR
		12	237	119	38.4 (5.8)	39.1 (5.7)	NR	NR	NR
Lipsitz, 2019[45]	SF-12 Mental	0	93	87	51.8 (9.8)	52.3 (10.0)	NA	NA	NA
		6	93	87	NR	NR	-1.81 (SE 1.16)	-0.71 (SE 1.19)	-1.104 (-4.41, 2.21)
	SF-12 Physical	0	93	87	40.6 (10.7)	40.8 (10.9)	NA	NA	NA
		6	93	87	NR	NR	0.22 (SE 0.99)	-0.64 (SE 1.04)	0.854 (-2.00, 3.71)
Merom, 2016[48]	SF-12 Mental	0	275	247	52.1 (8.4)	51.9 (7.6)	NA	NA	NA

Appendix F Table 15. Exercise Interventions: Quality of Life

Author, year	Instrument	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
		12	275	247	49.4 (10.8)	50.3 (9.5)	NR	NR	-0.9 (-2.9, 2.0)
	SF-12 Physical	0	275	247	43.0 (8.8)	44.3 (8.7)	NA	NA	NA
		12	275	247	39.8 (10.9)	40.8 (10.8)	NR	NR	0.0 (1.8, 1.9)
Oliveira, 2019[53]	EQ-5D-3L	0	64	67	0.8 (0.2)	0.8 (0.1)	NA	NA	NA
		6	54	55	0.8 (0.1)	0.8 (0.1)	NR	NR	0.02 (-0.01, 0.05)
		12	46	52	0.8 (0.1)	0.8 (0.1)	NR	NR	-0.01 (-0.04, 0.02)
Sherrington, 2014[57]	SF-12 Mental	0	171	169	54.71 (6.49)	54.70 (6.79)	NA	NA	NA
		12	157	155	55.87 (5.02)	55.19 (7.09)	NR	NR	NR
	SF-12 Physical	0	171	69	37.44 (8.90)	38.17 (8.36)	NR	NR	NR
		12	157	155	40.37 (8.29)	39.27 (9.26)	NR	NR	NR
Stathi, 2022[59]	EuroQol EQ-5D	0	357	352	0.69 (0.16)	0.68 (0.17)	NA	NA	NA
		6	346	299	0.68 (0.15)	0.70 (0.15)	NR	NR	NR
		12	337	293	0.69 (0.14)	0.70 (0.14)	NR	NR	NR
		24	330	302	0.69 (0.16)	0.67 (0.16)	NR	NR	NR
	SF-36 Mental Component	0	353	392	54.55 (8.33)	53.77 (8.66)	NA	NA	NA
		6	342	293	54.41 (6.88)	54.19 (7.46)	NR	NR	NR
		12	334	293	53.95 (7.81)	54.52 (7.52)	NR	NR	NR
		24	306	295	54.33 (9.18)	54.73 (7.64)	NR	NR	NR
	SF-36 Physical Component	0	353	392	29.7 (10.96)	30.01 (10.61)	NA	NA	NA
		6	342	293	32.75 (8.42)	30.64 (8.68)	NR	NR	NR
		12	334	293	32.25 (8.23)	29.66 (8.53)	NR	NR	NR
		24	306	295	30.84 (10.04)	29.38 (9.39)	NR	NR	NR
Tuvemo Johnson, 2021[63]	EuroQol EQ-5D	0 (IG1)	42	44	0.70 (0.20)	0.69 (0.21)	NA	NA	NA
		0 (IG2)	38	44	0.74 (0.09)	0.69 (0.21)	NA	NA	NA
		24 (IG1)	42	44	0.70 (0.22)	0.66 (0.21)	0.00	0.03	NR
		24 (IG2)	38	44	0.70 (0.21)	0.66 (0.21)	0.03	0.03	NR
	EQ-5D VAS	0 (IG1)	42	44	66 (16)	62 (15)	NA	NA	NA
		0 (IG2)	38	44	65 (14)	62 (15)	NA	NA	NA

Appendix F Table 15. Exercise Interventions: Quality of Life

Author, year	Instrument	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
		24 (IG1)	42	44	65 (15)	58 (19)	0.69	3.75	NR
		24 (IG2)	38	44	64 (20)	58 (19)	0.79	3.75	NR
Uusi-Rasi, 2015[64]	Leipad QOL	0	103	102	15.8 (7.7)	14.9 (7.02)	NA	NA	NA
		12	91	95		()	% change -0.2 (95% CI -10.4, 11.3)	% change -1.8 (95% CI -12.1, 9.7)	NR
		24	91	95		()	% change 2.4 (95% CI -8.6, 14.6)	% change -0.9 (95% CI -11.7, 11.2)	NR
Voukelatos, 2015[66]	Australian QoL	0	191	194	0.81 (95% CI, 00.79, 0.83)	0.81 (95% CI 0.79, 0.83)	NA	NA	NA
		6	144	169	0.84 (95% CI 0.82, 0.86)	0.83 (95% CI 0.81, 0.85)	NR	NR	NR

Abbreviations: AD = Alzheimer's Disease; ADL = Activities of daily living; BL = Baseline; CG = Control group; CI = Confidence interval; EQ-5D/3L = EuroQol instrument 5 Dimensions/3 Level Version; IADL = Instrumental activities of daily living; IG = Intervention group; Mo = Months; n = Number of participants; NA = Not applicable; NR = Not reported; QoL = Quality of life; SD = Standard deviation; SE = Standard error; SF = Short Form Survey; Time = Timepoint; VAS = Visual analogue scale.

Appendix F Table 16. Exercise Interventions: Harms

Author, year	Outcome	FU, mo	IG n/n	CG n/n
Bruce, 2021[3]	AE	18	1/3279	NR
	Serious AE directly related to the intervention	18	0/3279	NR
Callisaya, 2021[33]	AEs during intervention	6	7*/44	NR
	Fall during intervention	6	1*/44	NR
	Serious AE directly related to the intervention	6	0/44	NR
Delbaere 2021[36]	Fall during intervention	24	5/254	NR
El-Khoury, 2015[37]	AE	24	7*/352	NR
	AEs during intervention	24	4*/352	NR
	Fracture during intervention	24	1/352	NR
Karinkanta, 2015[40]	Fall during intervention	12	2/37	NR
Lamb, 2018[44]	AE	12	31/281	0/137
	AEs during intervention	12	15/281	NR
	SAE	12	4/281	0/137
Lipsitz, 2019[45]	AE	6	32/77	11/67
	Arthralgia	6	5/77	0/67
	Musculoskeletal discomfort	6	18/77	1/67
	Nervous system disorders	6	6/77	0/67
	Other musculoskeletal and connective tissue disorders	6	29/77	4/67
Merom, 2016[48]	AEs during intervention	12	0/275	NR
Miko, 2018[49]	AEs during intervention	12	0/49	NR
Ng, 2015[51]	AEs during intervention - musculoskeletal complaints	6	2/48	NR
Oliveira, 2019[53]	AEs during intervention	6	5/60	NR
Rikkonen, 2023[54]	SAE	24	0/457	0/457
	AEs during intervention - increased joint pain	24	14/457	NR
	AEs during intervention - pre-syncope symptoms	24	2/457	NR

Appendix F Table 16. Exercise Interventions: Harms

Author, year	Outcome	FU, mo	IG n/n	CG n/n
	AEs during the intervention - angina pectoris-like chest pain	24	2/457	NR
Sherrington, 2014[57]	AEs during intervention	12	12/171	NR
Siegrist, 2016[58]	AEs during intervention	12	0/222	NR
Stathi, 2022[59]	SAE	24	59/334	34/294
	Serious AE directly related to the intervention	24	1/334	NR
Suikkanen, 2021[60]	AEs during intervention - musculoskeletal complaints	12	87/150	NR
	Fall during intervention	12	17*/150	NR
	Injurious fall during intervention	12	1/150	NR
Trombetti, 2011[62]	AE	12	0/66	0/68
	AEs during intervention	12	0/66	NR
Tuvemo Johnson, 2021[63]	Fall during intervention	12 (IG1)	1/58	NR
	Fall during intervention	12 (IG2)	0/61	NR
Uusi-Rasi, 2015[64]	AEs during intervention	24	3/103	NR
	Back pain	24	4/103	NR
	Fall during intervention	24	2/103	NR
	Musculoskeletal discomfort	24	22/103	1/102
	Serious AE directly related to the intervention	24	0/103	NR

***** Events, not people

Abbreviations: AE = Adverse event; CG = Control group; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; NR = Not reported; SAE = Serious adverse event.

Appendix G Table 1. Exercise + Education Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Intervention component(s)	Target population	Recruitment setting	N rand	Age, mean (range)	Female, %	Race/ ethnicity, %
Daly, 2020[67] Strong Bones for Life study (Osteo-cise)	Good	AUS	Exercise + Edu + Behavior change support	Older adults aged ≥60 years with osteopenia or at increased falls risk.	Clinical, NOS or varied; Community-based; Other	162	67 (≥60)	73	NR
Sherrington, 2020[68] Recovery Exercises and STepping On afteR fracturE (RESTORE)	Good	AUS	Exercise + Edu + Behavior change support	Older adults aged ≥60 years with fall-related lower limb or pelvic fracture in the previous 2 years.	Community-based; ED; Hospital	336	78 (59-99)	76	NR
Shumway-Cook, 2007[69]	Good	US	Exercise + Edu + PC communication	Older adults aged ≥65 years.	Community-based	453	76 (≥65)	77	White: 95
Smulders, 2010[70]	Fair	NLD	Exercise + Edu	Older adults aged ≥65 years with osteoporosis and a fall history.	Community-based; Hospital; Other	96	71 (≥65)	94	NR

Abbreviations: AUS = Australia; Edu = Education; ED = Emergency department; N = Number of participants; NLD = Netherlands; NOS = Not otherwise specified; NR = Not reported; PC = Primary care; QR = Quality rating; Rand = Randomized; US = United States.

Appendix G Table 2. Exercise + Education Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Daly, 2020[67] Strong Bones for Life study (Osteo-cise)	100	Diagnosis of osteopenia (T-score between −1.0 and −2.5 SD) at the total hip, femoral neck or lumbar spine OR have a total risk score of ≥3 points on a short falls and fracture risk questionnaire.	NR	NR	NR	NR
Sherrington, 2020[68] Recovery Exercises and STepping On afteR fracturE (RESTORE)	100	Fall-related lower limb or pelvic fracture in the 24 mo before recruitment.	NR	Mean # of comorbidities: 8	Mean # of meds: 6.5	Mean cognition score, SPMSW: 0.45
Shumway-Cook, 2007[69]	27	Fall in the previous 3 mo.	NR	≥2 chronic conditions, %: 86.5	Taking ≥4 meds, %: 63	Mental health examination, no errors, %: 60.5
Smulders, 2010[70]	100	Osteoporosis and ≥1 fall in the previous 12 mo.	NR	Mean # of comorbid conditions: 1.2	Mean # of meds used: 2.5	NR

Abbreviations: Cog = Cognitive; Mo = Months; NR = Not reported; SD = Standard deviation; SPMSW = Short Portable Mental Status Questionnaire.

Appendix G Table 3. Exercise + Education Interventions: Intervention Components

Author, year	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
Daly, 2020[67]	Exercise program with behavioral change and education components	Group	Class outside of home	Exercise Instructor	Group exercise program 3x/wk for 18 mo plus behavioral modification support/strategies and social support; 3 educational seminars	60min group classes 3days/wk for18 mo	Minimal intervention
Sherrington, 2020[68]	Self-managed, home exercise program with behavior change support plus fall prevention education based on the Stepping On program.	Individual; Group	Class outside of home; Home	Physical therapist	Participants could receive up to ten visits with the prescribing PT in the 12-month study period, to prescribe and modify a home exercise program. Participants were asked to undertake a 20- to 30-min program of lower limb balance and strengthening exercises at least three times per wk at home for 12 mo. Participants randomized to the intervention group received an average of 8.4 (SD 2.9, median 10, range 0 to 13) home visits and 4.3 (SD 1.9, median 5, range 0 to 10) phone calls from the study physiotherapists.	Home visits up to 10x over 12mo (duration NR)	Usual care
Shumway-Cook, 2007[69]	Multifaceted intervention including exercise, education, and sending results of comprehensive falls risk assessment to PCP.	Group	Class outside of home	Exercise Instructor; Nurse	3 1-hr exercise classes per wk; 1 1-hr education class per month	1hr group exercise classes 3x/wk for up to 12 mo	Minimal intervention
Smulders, 2010[70]	Multicomponent exercise intervention, including education and fall techniques	Group	Hospital	Occupational therapist; Physical therapist	11 sessions during 5.5 wks	11 group sessions over 5.5wks	Usual care

Abbreviations: CG = Control group; Descr = Description; Freq= Frequency; Hr = Hour; IG = Intervention group; Min = Minutes; Mo = Months; NA = Not applicable; NR = Not reported; PCP = Primary care physician; PT = Physical therapy; SD = Standard deviation; Wk = Week; X = Times; Yrs = Years.

Appendix G Table 4. Exercise + Education Interventions: Falls

Author, year	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Daly, 2020[67]	12	46 (0.57)	34 (0.42)	1.22 (0.72, 2.04)
	18	59 (0.00)	53 (0.00)	1.08 (0.70, 1.67)
Sherrington, 2020[68]	12	131 (0.78)	129 (0.77)	0.96 (0.69, 1.34)
Shumway-Cook, 2007[69]	12	297 (1.33)	398 (1.77)	0.75 (0.52, 1.09)
Smulders, 2010[70]	12	34 (0.72)	52 (1.18)	0.61 (0.40, 0.94)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix G Table 5. Exercise + Education Interventions: People With a Fall

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Daly, 2020[67]	Fallers (1 plus falls)	12	29/81 (35.8)	25/81 (30.9)	1.15 (0.66, 1.99)
		18	37/81 (45.7)	35/81 (43.2)	1.07 (0.57, 2.00)
	Fallers (2 plus falls)	12	13/81 (16)	6/81 (7.4)	1.99 (0.74, 5.36)
		18	15/81 (18.5)	10/81 (12.3)	1.59 (0.67, 3.81)
Sherrington, 2020[71]	Fallers (1 plus falls)	12	72/168 (42.9)	70/168 (41.7)	1.03 (0.80, 1.32)
	Fallers (2 plus falls)	12	34/168 (20.2)	34/168 (20.2)	1.00 (0.65, 1.53)
	Fallers (3 plus falls)	12	12/168 (7.1)	14/168 (8.3)	0.86 (0.41, 1.80)
Shumway-Cook, 2007[69]	Fallers (1 plus falls)	12	124/226 (54.9)	130/227 (57.3)	0.96 (0.82, 1.13)
Smulders, 2010[70]	Fallers (1 plus falls)	12	21/47 (44.7)	23/45 (51.1)	0.87 (0.57, 1.34)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix G Table 6. Exercise + Education Interventions: Injurious Falls (Including Fracture) and Fall-Related Hospitalization

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Sherrington, 2020[68]	Fall resulting in fractures	12	12 (0.07)	18 (0.11)	0.64 (0.30, 1.35)
	Fall resulting in hospital admission	12	16 (0.10)	18 (0.11)	0.85 (0.43, 1.68)
	Fall resulting in medical care	12	42 (0.25)	39 (0.23)	1.02 (0.61, 1.68)
Shumway-Cook, 2007[69]	Fall resulting in medical care	12	NR (0.18)	NR (0.21)	0.72 (0.45, 1.15)
Smulders, 2010[70]	Fall resulting in minor injuries	12	19 (0.40)	28 (0.62)	0.65 (0.36, 1.16)
	Fall resulting in serious injuries	12	1 (0.02)	5 (0.11)	0.19 (0.02, 1.64)
	Fall-related fracture	12	1 (0.02)	3 (0.07)	0.32 (0.03, 3.07)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix G Table 7. Exercise + Education Interventions: Mortality

Author, year	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Daly, 2020[67]	12	1/81 (1.2)	1/81 (1.2)	1.00 (0.06, 15.72)
	18	1/81 (1.2)	1/81 (1.2)	1.00 (0.06, 15.72)
Shumway-Cook, 2007[69]	12	2/226 (.9)	3/227 (1.3)	0.67 (0.11, 3.97)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix G Table 8. Exercise + Education Interventions: Quality of Life

Author, year	Outcome (Instrument)	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
Daly, 2020[67]	QOL-EQ-5D-VAS	0	74	69	80.70 (12.83)	83.06 (13.27)	NA	NA	NA
		6	74	69	NR	NR	1.08 (95% CI: -2.26, 4.42)	0.15 (95% CI: -2.55, 2.86)	0.93 (-3.33, 5.19)
		12	74	69	NR	NR	1.43 (95% CI: -1.16, 4.02)	-0.73 (95% CI: -3.86, 2.40)	2.16 (-1.85, 6.17)
		18	74	69	NR	NR	1.68 (95% CI: -1.69, 5.04)	-1.42 (95% CI: -4.06, 1.22)	3.10 (-1.19, 7.38)
Smulders, 2010[70]	QOL-QUALEFFO-41	0	46	37	25.2 (10.0)	28.7 (10.9)	NA	NA	NA
		12	46	37	26.2 (10.6)	27.3 (11.0)	NR	NR	NR

Abbreviations: BL = Baseline; CG = Control group; CI = Confidence interval; EQ-5D = EuroQol instrument; IG = Intervention group; Mo = Months; n = Number of participants; NA = Not applicable; NR = Not reported; QoL = Quality of life; SD = Standard deviation; Time = Timepoint; VAS = Visual analogue scale.

Appendix G Table 9. Exercise + Education Interventions: Harms

Author, year	Outcome	FU, mo	IG n/n	CG n/n
Daly, 2020[67]	AEs during intervention - musculoskeletal complaints requiring treatment	12	27/81*	NR
		18	32/81*	
	AEs during intervention - musculoskeletal complaints	12	34/81	
			40/81*	
		18	41/81	
			47/81*	
	Withdrew due to AEs	12	6/81	
	Fracture during intervention	12	1/81	
Sherrington, 2020[68]	AEs during intervention	12	6/168	NR
Shumway-Cook, 2007[69]	AEs during intervention	12	0/226	0/227
Smulders, 2010[70]	AEs during intervention	12	0/47	NR

* Events, not people

Abbreviations: AE = Adverse event; CG = Control group; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; NR = Not reported.

Appendix H Table 1. Exercise + Environment Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Target pop	Recruitment setting	N rand	Female, %	Age, mean (range)	Race/ ethnicity, %
Fitzharris, 2010[38] Whitehorse NoFalls trial	Fair	AUS	Older adults aged ≥70 years.	Population-based register	543	60	76.1 (≥70)	NR
Matchar, 2017[72] Steps to Avoid Falls in the Elderly (SAFE)	Good	Singapore	Older adults aged ≥65 years at higher risk of falling.	ED	354	77	78 (65-99)	Chinese: 83% Non-Chinese: 17%
Taylor, 2021[73] Intervention for Falls in Older Cognitively Impaired Subjects (i-FOCIS)	Fair	AUS	Older adults aged ≥65 years with cognitive impairment	Assisted living/day care; Clinical, NOS or varied	309	49	82.3 (≥65)	NR

Abbreviations: AUS = Australia; ED = Emergency department; N = Number of participants; NOS = Not otherwise specified; NR = Not reported; Pop = Population; QR = Quality rating; Rand = Randomized.

Appendix H Table 2. Exercise + Environment Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Fitzharris, 2010[38] Whitehorse NoFalls trial	6	Fall in previous 1 month.	NR	NR	Mean # of meds: 3.4	NR
Matchar, 2017[72] Steps to Avoid Falls in the Elderly (SAFE)	100	Presentation to ED for a fall or fall-related injury.	NR	Multiple comorbidities, %: 47*	Polypharmacy, %: 55	Mean MoCA score: 18.6
Taylor, 2021[73] Intervention for Falls in Older Cognitively Impaired Subjects (i-FOCIS)	52.8	Fall in previous 12 mo.	NR	Mean # of comorbidities: 3.5	Mean # of meds: 5.6	Mean MoCA score: 25.4 Mean m-Ace score: 14.4 Mean ACE-III score: 63†

* NOTE: Two or more of emphysema, cardiac failure, circulation problem, stroke, Parkinson disease, cancer, and MoCA<26
† NOTE: Higher scores indicate better performance for ACE-III (/100), m-ACE (/30)

Abbreviations: ACE-III = Addenbrooke's cognitive examination III; Cog = Cognitive; ED = Emergency department; m-ACE = Mini-Addenbrooke's Cognitive Examination; Meds = Medications; Mo = Months; MoCA = Montreal Cognitive Assessment; NR = Not reported.

Appendix H Table 3. Exercise + Environment Interventions: Intervention Components

Author, year	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	Freq of supervised IG	CG descr
Fitzharris, 2010[38]	Group exercise classes supplemented by independent home exercises, plus removal or modification of home hazard(s) identified in risk factor assessment.	Individual; Group	Class outside of home; Home	City staff; Physical therapist	Exercise: 1 h per wk for 15 wks Environment: 1 time	1hr group exercise class/wk for 15 wks	Usual care
Matchar, 2017[72])	Group or individual exercise program, determined by SPPB score plus home environment assessment and recommendations.	Individual; Group	Class outside of home; Home	Physical therapist	Home exercise 12 sessions 3x per wk for 3 mo transitioning to group sessions. Group sessions 2x per wk for 3 mo*	Varied based on BL assessment. Could be 2x/wk for 3 mo (Group, supervised) OR 3x/wk (individual, Unsupervised)	Usual care
Taylor, 2021[73]	Exercise and home hazard reduction program designed and delivered based on participants' functional cognition.	Individual	Home	Occupational therapist; Physiotherapist	Planned: The intervention visit schedule comprised 11 visits† and up to 10 support telephone calls during the 12-month study period. OT (home hazard): 90- to 120-min sessions Physiotherapy (exercise): 40–60 mins	NR‡	Usual care

* Individual and group offered simultaneously, participants could not participate in both at the same time.)
† A variable combination of physiotherapy and occupational therapy based on identified need)
‡ Varied based on needs, up to 10 home visits but not specified if this was PT

Abbreviations: BL = Baseline; CG = Control group; Descr = Description; Freq= Frequency; Hr = Hour; IG = Intervention group; Min = Minutes; Mo = Months; NR = Not reported; OT = Occupational therapy; SPPB = Short Physical Performance Battery; Wk = Week; X = Times; Yrs = Years.

Appendix H Table 4. Exercise + Environment Interventions: Falls

Author, year	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Fitzharris, 2010[38]	18	153 (0.88)	211 (1.20)	0.73 (0.60, 0.90)
Taylor, 2021[73]	12	NR	NR	0.78 (0.57, 1.07)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix H Table 5. Exercise + Environment Interventions: People With a Fall

Author, year	Outcomes	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Fitzharris, 2010[38]	Fallers (1 plus falls)	18	72/135 (53.3)	87/137 (63.5)	0.84 (0.69, 1.03)
	Fallers (2 plus falls)	18	30/135 (22.2)	45/137 (32.8)	0.68 (0.46, 1.01)
	Fallers (3 plus falls)	18	14/135 (10.4)	25/137 (18.2)	0.57 (0.31, 1.05)
Matchar, 2017[72]	Fallers (1 plus falls)	9	54/177 (30.5)	67/177 (37.9)	0.81 (0.60, 1.08)
Taylor, 2021[73]	Fallers (1 plus falls)	12	94/153 (61.4)	87/156 (55.8)	0.99 (0.82, 1.19)
	Fallers (2 plus falls)	12	49/153 (32)	58/156 (37.2)	0.73 (0.54, 0.99)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix H Table 6. Exercise + Environment Interventions: Injurious Falls (Including Fracture) and Fall-Related Hospitalization

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Fitzharris, 2010[38]	Fall resulting in injuries	18	100 (0.57)	115 (0.65)	0.88 (0.67, 1.15)
	Fall resulting in medical care	18	14 (0.08)	18 (0.10)	0.79 (0.39, 1.60)
Taylor, 2021[73]	Fall-related hospitalization/ED visit	12	67 (0.44)	47 (0.30)	1.39 (0.90, 2.14)
	Fall-related medical attention	12	298 (1.95)	251 (1.61)	1.18 (0.76, 1.82)

Abbreviations: CG = Control group; CI = Confidence interval; ED = Emergency department; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix H Table 7. Exercise + Environment Interventions: People With a Fall Resulting in Injuries or Hospitalization

Author, year	Outcomes	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Matchar, 2017[72]	Injurious fallers	9	25/177 (14.1)	40/177 (22.6)	0.63 (0.40, 0.98)
Taylor, 2021[73]	Person with fall-related fracture	12	10/153 (6.5)	9/156 (5.8)	1.08 (0.45, 2.58)
	Person with fall-related hospitalization	12	24/153 (15.7)	16/156 (10.3)	1.46 (0.81, 2.64)

Abbreviations: CG = Control group; CI = Confidence interval; ED = Emergency department; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix H Table 8. Exercise + Environment Interventions: Mortality

Author, year	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Taylor, 2021[73]	6	1/153 (.7)	2/156 (1.3)	0.51 (0.05, 5.56)
	12	3/153 (2)	9/156 (5.8)	0.34 (0.09, 1.23)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix H Table 9. Exercise + Environment Interventions: Quality of Life

Author, year	Outcome (Instrument)	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
Taylor, 2021[73]	QOL-EuroQol EQ-5D	0	153	156	0.78 (95% CI, 0.75, 0.81)	0.79 (95% CI, 0.76, 0.82)	NA	NA	NA
		6	153	156	0.83 (95% CI, 0.80, 0.86)	0.80 (95% CI, 0.77, 0.83)	NR	NR	0.03 (-0.01, 0.08)
		12	153	156	0.78 (95% CI, 0.82, 0.77)	0.77 (95% CI, 0.73, 0.81)	NR	NR	-0.04 (-0.04, 0.07)

Abbreviations: BL = Baseline; CG = Control group; CI = Confidence interval; EQ-5D = EuroQol instrument; IG = Intervention group; Mo = Months; n = Number of participants; NA = Not applicable; NR = Not reported; QoL = Quality of life; SD = Standard deviation; Time = Timepoint.

Appendix I Table 1. Environmental Interventions: Study and Population Characteristics

Author, year	QR	Country	Target population	Recruitment setting	N rand	Female, %	Age, mean (range)	Race/ Ethnicity, %
Chu, 2017[74]	Fair	HKG	Individuals aged ≥65 years who had fallen	ED	204	71	78 (≥65)	NR
Cockayne, 2021[75] Occupational Therapist Intervention Study (OTIS)	Good	GBR	Community-dwelling people aged ≥65 years who are at risk of falling	Community-based	1331	66	80 (65-99)	NR
Fitzharris, 2010[38] Whitehorse NoFalls	Fair	AUS	Older adults aged ≥70 years	Population-based register	1090	60	76.1 (≥70)	NR
Pighills, 2011[76]	Good	GBR	Community dwelling adults aged ≥70 years with a history of falls in the previous year	Community-based; PC/GP	238	69	79 (≥70)	NR
Stark, 2021[77] Home Hazard Removal Program (HARP)	Good	US	Community-dwelling older adults at risk for falling who received services from an Area Agency on Aging	Community-based	310	78	75 (≥65)	Black: 55.6
Stevens, 2001[78]	Fair	AUS	People aged 70 years and older living independently	Population-based register	1879	52	76 (≥70)	NR

Abbreviations: AUS = Australia; ED = Emergency department; GP = General practitioner; HKG = Hong Kong; N = Number of participants; NR = Not reported; PC = Primary care; QR = Quality rating; Rand = Randomized; US = United States.

Appendix I Table 2. Environmental Interventions: Fall Risk and Comorbidities

Author, year	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Chu, 2017[74]	100	Presentation to ED primarily because of a fall.	NR	NR	Taking ≥4 meds,%: 33	Mean MMSE score: 20.0
Cockayne, 2021[75] Occupational Therapist Intervention Study (OTIS)	86	Fall in the previous 12 mos or balance problems while walking or dressing, or at least moderate problems doing usual activities	NR	NR	Taking >4 meds prescribed by doctor, %: 50	NR
Fitzharris, 2010[38] Whitehorse NoFalls	6	Fall in previous 1 mo	NR	NR	Mean # of meds: 3.4	NR
Pighills, 2011[76]	100	Fall in the previous 12 mos	NR	NR	Mean # of daily meds: 5	NR
Stark, 2021[77] Home Hazard Removal Program (HARP)	100	≥1 fall in the previous 12 mos or worried about falling	NR	NR	Mean # of meds: 7.5	Mean cognitive dysfunction score, Short Blessed Test of memory and concentration*, score: 2.9
Stevens, 2001[78]	27	Fall in previous 12 mos	NR	NR	NR	NR

* Score of ≥10 = cog impairment

Abbreviations: Cog = Cognitive; ED = Emergency department; Meds = Medications; MMSE = Mini-Mental State Examination Mo = Months; NR = Not reported.

Appendix I Table 3. Environmental Interventions: Intervention Components

Author, year	Brief IG descr	Format	Setting(s)	Provider(s)	Intensity	CG descr
Chu, 2017[74]	Occupational therapy home visit program for reducing subsequent falls in older community-dwelling adults	Individual	In-home, supervised	Occupational therapist	1 home visit lasting 1.5 hrs + followup phone call 2 mos after home visit	Attention control
Cockayne, 2021[75]	One time home environmental assessment and modification offered.	Individual	In-home, supervised	Occupational therapist	1x assessment (Home hazard assessments average 1.5 hrs to deliver (ranging from 25 mins to 3 hrs).	Usual care
Fitzharris, 2010[38]	Removal or modification of home hazard(s) identified in risk factor assessment.	Individual	Home	City staff	1 time assessment	Usual care
Pighills, 2011[76]	Occupational therapist led environmental assessment	Individual	In-home, supervised	Occupational therapist	Initial assessment of 1.5-2 hrs and 2 followup phone calls.	Usual care
Stark, 2021[77]	Brief program focused on removing home hazards and teaching self-management strategies to prevent falls	Individual	Home	Occupational therapist	Planned: 3 sessions (totaling 170 mins over 3.9 wks) + booster at 6 mos	Usual care
Stevens, 2001[78]	Home hazard assessment from a trained research nurse, installation of free safety devices, and recommendations for strategies to remove or modify home hazards.	Individual	In-home, supervised	Nurse	Single visit	Usual care

Abbreviations: CG = Control group; Descr = Description; Hr = Hour; IG = Intervention group; Min = Minutes; Mo = Months; Wk = Week; X = Times.

Appendix I Table 4. Environmental Interventions: Falls

Author, year	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Chu, 2017[74]	6	3 (7.60)	12 (23.40)	0.32 (0.09, 1.15)
	12	16 (16.80)	30 (29.80)	0.56 (0.31, 1.03)
Cockayne, 2021[75]	12	826 (1.97)	1434 (1.61)	1.17 (0.99, 1.38)
Fitzharris, 2010[38]	18	212 (1.18)	211 (1.20)	0.98 (0.81, 1.19)
Pighills, 2011[76]	12	175 (2.01)	290 (3.72)	0.54 (0.36, 0.83)
Stark, 2021[77]	12	201 (1.50)	316 (2.30)	0.62 (0.41, 0.95)
Stevens, 2001[78]	12	NR (0.69)	NR (0.72)	1.02 (0.83, 1.27)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; NR = Not reported; P-y = Person-year.

Appendix I Table 5. Environmental Interventions: People With a Fall

Author, year	Outcomes	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Chu, 2017[74]	Fallers (1 plus falls)	6	3/95 (3.2)	12/103 (11.7)	0.27 (0.08, 0.93)
		12	13/95 (13.7)	21/103 (20.4)	0.67 (0.36, 1.26)
	Fallers (2 plus falls)	6	0/95 (0)	2/103 (1.9)	0.27 (0.01, 5.94)
		12	2/95 (2.1)	6/103 (5.8)	0.36 (0.07, 1.75)
Cockayne, 2021[75]	Fallers (1 plus falls)	12	245/430 (57)	506/901 (56.2)	1.01 (0.92, 1.12)
	Fallers (2 plus falls)	12	148/430 (34.4)	298/901 (33.1)	1.04 (0.89, 1.22)
Fitzharris, 2010[38]	Fallers (1 plus falls)	18	78/136 (57.4)	87/137 (63.5)	0.90 (0.74, 1.10)
	Fallers (2 plus falls)	18	42/136 (30.9)	45/137 (32.8)	0.94 (0.66, 1.33)
Pighills, 2011[76]	Fallers (1 plus falls)	12	50/87 (57.5)	54/78 (69.2)	0.83 (0.66, 1.05)
Stark, 2021[77]	Fallers (1 plus falls)	12	67/135 (49.6)	74/140 (52.9)	0.94 (0.74, 1.18)
	Fallers (2 plus falls)	12	39/135 (28.9)	46/140 (32.9)	0.88 (0.62, 1.25)
	Fallers (3 plus falls)	12	22/135 (16.3)	27/140 (19.3)	0.85 (0.51, 1.41)
Stevens, 2001[78]	Fallers (1 plus falls)	12	NR/570 (NR)	NR/1167 (NR)	0.93 (0.75, 1.15)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix I Table 6. Environmental Interventions: Injurious Falls (Including Fracture) and Fall-Related Hospitalization

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Fitzharris, 2010[38]	Fall resulting in injuries	18	114 (0.63)	115 (0.65)	0.97 (0.75, 1.26)
	Fall resulting in medical care	18	27 (0.15)	18 (0.10)	1.47 (0.81, 2.67)
Cockayne, 2021[75]	Fall-related fracture	12	16 (0.04)	41 (0.05)	0.83 (0.46, 1.47)
	Fall-related injuries	12	326 (0.78)	651 (0.73)	1.06 (0.93, 1.21)
	Fall-related injuries, minor	12	287 (0.68)	582 (0.66)	1.04 (0.91, 1.20)
	Fall-related overnight hospitalization	12	15 (0.04)	47 (0.05)	0.67 (0.38, 1.21)
	Hip fracture	12	4 (0.01)	5 (0.01)	1.69 (0.45, 6.30)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix I Table 7. Environmental Interventions: People With a Fall Resulting in Injuries or Hospitalization

Author, year	Outcomes	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Chu, 2017[74]	Person with ED visit	6	3/95 (3.2)	8/103 (7.8)	0.41 (0.11, 1.49)
		12	13/95 (13.7)	20/103 (19.4)	0.70 (0.37, 1.34)
	Person with hospitalization	12	4/95 (4.2)	6/103 (5.8)	0.72 (0.21, 2.48)
Cockayne, 2021[75]	Person with fall-related fracture	12	16/430 (3.7)	38/901 (4.2)	0.88 (0.50, 1.56)

Abbreviations: CG = Control group; CI = Confidence interval; ED = Emergency department; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix I Table 8. Environmental Interventions: Mortality

Author, year	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Cockayne, 2021[75]	8	5/394 (1.3)	6/840 (0.7)	1.78 (0.55, 5.79)
	12	12/377 (3.2)	14/824 (1.7)	1.87 (0.87, 4.01)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix I Table 9. Environmental Interventions: Quality of Life

Author, year	Outcome (Instrument)	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
Cockayne, 2021[75]	QOL-EQ-5D-5L VAS	0	398	840	73.3 (17.3)	73.7 (17.1)	NA	NA	NA
		8	386	823	71.9 (18.2)	72.3 (17.8)	NR	NR	NR
		12	371	815	71.5 (18.4)	72.1 (18.4)			
Pighills, 2011[76]	QOL-EuroQol EQ-5D	0	87	78	0.60 (0.30)	0.60 (0.30)	NA	NA	NA
		12	87	78	0.58 (95% CI 0.55, 0.62)	0.56 (95% CI 0.53, 0.60)	NR	NR	NR
	QOL-SF-12 Mental	0	87	78	49 (11)	47 (11.11)	NA	NA	NA
		12	87	78	50 (95% CI 48, 51)	49 (95% CI 48, 50)	NR	NR	NR
	QOL-SF-12 Physical	0	87	78	33 (14)	33 (12.12)	NA	NA	NA
		12	87	78	35 (95% CI 34, 37)	34 (95% CI 32, 36)	NR	NR	NR
Stark, 2021[77]	QOL-SF-36	0	135	140	41.81 (10.98)	44.44 (10.38)	NA	NA	NA
		12	135	140	42.26 (11.01)	43.74 (11.10)	NR	NR	NR

Abbreviations: BL = Baseline; CG = Control group; CI = Confidence interval; EQ-5D = EuroQol instrument; IG = Intervention group; Mo = Months; n = Number of participants; NA = Not applicable; NR = Not reported; QoL = Quality of life; SD = Standard deviation; SF = Short Form Survey; Time = Timepoint; VAS = Visual analogue scale.

Appendix I Table 10. Environmental Interventions: Instrumental Activities of Daily Living

Author, year	Outcome (Instrument)	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)
Chu, 2017[74]	IADL-Frenchay Activities Index	0	95	103	19.4 (7.3)	19.4 (7.4)	NA	NA
		8	95	103	19.0 (8.1)	19.5 (8.2)	NR	NR
		12	95	103	19.0 (8.1)	19.5 (7.8)		

Abbreviations: BL = Baseline; CG = Control group; IADL = Instrumental activities of daily living; IG = Intervention group; Mo = Months; N = Number of participants; NA = Not applicable; NR = Not reported; SD = Standard deviation; Time = Timepoint.

Appendix J Table 1. Medication Review/Modification Interventions: Study and Participant Characteristics

Author, year Study name	QR	Country	Target population	Recruitment setting	N rand	Female, %	Age, mean (range)	Race/ ethnicity, %
Blalock, 2010[79]	Fair	US	Individuals at high risk for falling, specifically those ≥65 years of age	Other	186	71	75 (≥65)	White: 89 Other: 11
Boye, 2017[80] Improving Medication Prescribing to reduce Risk Of FALLs (IMPROveFALL)	Good	NLD	Community-dwelling older adults who visited the ED due to a fall	ED	612	62	76 (≥65)	NR
Mott, 2016[81]	Fair	US	Older adults who completed a fall prevention workshop.	Community-based	80	79	76 (≥65)	White: 99 Hispanic: 1
Romskaug, 2020[82] The COOP Study	Good	US	Home-dwelling patients 70 years or older using at least 7 medications regularly.	PC/GP	174	68	83 (≥70)	NR

Abbreviations: ED = Emergency department; N = Number of participants; NOS = Not otherwise specified; ; NLD = Netherlands; NR = Not reported; PC/GP = Primary care/General practitioner; QR = Quality rating; Rand = Randomized; US = United States.

Appendix J Table 2. Medication Review/Modification Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Blalock, 2010[79]	100	≥1 fall in previous 12 mo (not attributable to syncope) and taking ≥4 different chronic prescription medications, ≥1 of which was a CNS-active medication.	NR	Mean # of high-risk conditions: 1.62*	# of prescriptions for high-risk medication filled during previous year: 14.2	NR
Boye, 2017[80] Improving Medication Prescribing to reduce Risk Of FALLs (IMPROveFALL)	100	Presentation to ED due to a fall incident.	NR	Charlson comorbidity index: 1.9	Mean # of drugs: 6.4 Participants using ≥3 FRIDs, %: 71	Mean MMSE score: 27.0
Mott, 2016[81]	100	Fall in the previous 12 mo or have a fear of falling.	NR	NR	Using ≥1 FRID at time of intervention, %: 35	NR
Romskaug, 2020[82] The COOP Study	NR	NA	NR	Mean cumulative illness rating scale summary score: 16.7	Mean # regularly used drugs: 9.8	Mean CDR score: 2.4

* NOTE: conditions included in the count were dizziness, DM, urinary incontinence, arthritis, PD, history of stroke

Abbreviations: CDR = Clinical dementia rating scale; CNS = Central nervous system; Cog = Cognitive; DM = Diabetes mellitus; ED = Emergency department; FRID = Fall risk increasing drugs; MMSE = Mini-Mental State Examination; Mo = Months; NR = Not reported; PD = Parkinson's disease.

Appendix J Table 3. Medication Review/Modification Interventions: Intervention Components

Author, year	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	CG descr
Blalock, 2010[79]	An in-person medication review by a pharmacy resident to identify medications that increase the risk of falling. If participant was interested in making a change in medication regimen, the provider was contacted to approve the change.	Individual	Pharmacy	Pharmacy resident	One 45-min medication assessment.	Usual care
Boye, 2017[80]	A systematic fall-related medication assessment combined with drug withdrawal or modification, if safely possible.	Individual	In home	Geriatrician; research nurse	1x assessment & med review, wkly counseling offered by telephone calls over a period of 1 mo	Usual care
Mott, 2016[81]	An in-person medication review by a pharmacist to develop an action plan to modify falls risk-increasing medication use.	Individual	Pharmacy	Pharmacist	One 60-min review, 1 followup phone call at 3 mo by the pharmacist	Usual care
Romskaug, 2020[82]	Clinical geriatric assessments and collaborative medication reviews by geriatrician and family physician, including meeting between the geriatrician and family physician and clinical followup	Individual	Clinic	Geriatrician	1 hr consultation between geriatrician + 15 min discussion between geriatrician & FP + FU with FP (NOS)	Usual care

Abbreviations: CG = Control group; Descr = Description; FP = Family physician; FU = Followup; Hr = Hour; IG = Intervention group; Min = Minutes; Mo = Months; NOS = Not otherwise specified; Wk = Week; X = Times.

Appendix J Table 4. Medication Review/Modification Interventions: Falls

Author, year	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Blalock, 2010[79]	12	151 (2.11)	171 (2.13)	1.01 (0.81, 1.26)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix J Table 5. Medication Review/Modification Interventions: People With a Fall

Author, year	Outcome	FU	IG n/n (%)	CG n/n (%)	RR (95% CI)
Blalock, 2010[79]	Fallers (1 plus falls)	12	53/93 (57)	52/93 (55.9)	1.02 (0.79, 1.31)
Boye, 2017[80]	Fallers (1 plus falls)	12	115/308 (37.3)	91/272 (33.5)	1.12 (0.89, 1.39)
	Fallers (2 plus falls)	12	50/308 (16.2)	38/272 (14)	1.16 (0.79, 1.71)
Mott, 2016[81]	Fallers (1 plus falls)	6	11/39 (28.2)	10/41 (24.4)	1.16 (0.55, 2.41)
	Fallers (2 plus falls)	6	6/39 (15.4)	3/41 (7.3)	2.10 (0.56, 7.83)
	Fallers (3 plus falls)	6	2/39 (5.1)	2/41 (4.9)	1.05 (0.16, 7.10)
Romskaug, 2020[82]	Fallers (1 plus falls)	6	NR/82 (NR)	NR/76 (NR)	OR: 0.75 (0.35, 1.60)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix J Table 6. Medication Review/Modification Interventions: Injurious Falls

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Blalock, 2010[79]	Fall resulting in injuries	12	55 (0.75)	72 (0.90)	0.87 (0.62, 1.24)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix J Table 7. Medication Review/Modification Interventions: People With a Fall Resulting in Medical Care, Hospitalization, or Emergency Department Visit

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Boye, 2017[80]	Person with fall resulting in medical care	12	36/308 (11.7)	46/272 (16.9)	0.69 (0.46, 1.04)
	Person with fall-related ED visit	12	16/308 (5.2)	21/272 (7.7)	0.67 (0.36, 1.26)
Romskaug, 2020[82]	Person with hospitalization	6	31/82 (37.8)	17/76 (22.4)	1.69 (1.00, 2.85)

Abbreviations: CG = Control group; CI = Confidence interval; ED = Emergency department; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix J Table 8. Medication Review/Modification Interventions: Mortality

Author, year	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Blalock, 2010[79]	12	3/93 (3.2)	2/93 (2.2)	1.50 (0.26, 8.77)
Romskaug, 2020[82]	6	3/82 (3.7)	7/76 (9.2)	0.40 (0.10, 1.55)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix J Table 8. Medication Review/Modification Interventions: Quality of Life

Author, year	Outcome (Instrument)	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean diff in change from BL (95% CI)
Boye, 2017[80]	QOL-SF-12 Physical	0	283	258	45.6 (9.5)	46.2 (9.9)	NA	NA	NA
		12	283	258	43.0 (10.7)	42.2 (11.6)	-2.6 (8.5)	-3.9 (8.5)	NSD
	QOL-SF-12 Mental	0	283	258	53.3 (9.5)	53.2 (9.0)	NA	NA	NA
		12	283	258	52.5 (9.0)	52.5 (9.2)	-0.8 (9.7)	-0.7 (9.7)	NSD
Romskaug, 2020[82]	QOL-15D	0	87	87	0.708 (0.121)	0.714 (0.113)	NA	NA	NA
		6	82	76	0.675 (0.186)	0.620 (0.216)	NR	NR	0.052 (-0.002, 0.105)* p=NSD

* After adjustment for the Clinical Dementia Rating Scale Sum of Boxes score, the between-group difference was 0.064 (95% CI, 0.011-0.116; P = .02). Analyzed by linear mixed model, the between-group difference was 0.061 (95% CI, 0.004-0.118; P=0.04).

Abbreviations: BL = Baseline; CG = Control group; CI = Confidence interval; EQ-5D = EuroQol instrument; IG = Intervention group; Mo = Months; n = Number of participants; NA = Not applicable; NR = Not reported; NSD = Non-significant difference; QoL = Quality of life; SD = Standard deviation; SF = Short Form Survey; Time = Timepoint; VAS = Visual analogue scale.

Appendix K Table 1. Psychological Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Target population	Recruitment setting	N rand	Female, %	Age, mean (range)	Race/ ethnicity, %
Dorresteijn, 2016[83]	Fair	NLD	Frail community-dwelling older adults aged ≥70 years with some concerns about falls and related activity avoidance	Population-based register	389	70	78 (≥70)	NR
Lim, 2022[84]	Fair	AUS	Community-dwelling older adults with fear of falling.	Community-based	50	70	74 (66 to 91)	NR
Zijlstra, 2009[85]	Fair	NLD	Adults aged ≥70 who reported fear of falling and fear-induced activity avoidance	Population-based register	540	72	78 (≥70)	NR

Abbreviations: N = Number of participants; AUS = Australia; NLD = Netherlands; NR = Not reported; QR = Quality rating; Rand = Randomized.

Appendix K Table 2. Psychological Interventions: Fall Risk and Comorbidities

Author, year	Risk for falls %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Dorresteijn, 2016[83]	100	Reported at least some concerns about falls; reported at least some associated avoidance of activity; perceived their general health as fair or poor.	NR	NR	NR	NR
Lim, 2022[84]	44	1+ fall in previous 12mo. [56% self reported moderate to high risk of falling]	NR	Charlson comorbidity index: 3.16	Medication, mean: 2.3	Executive Function - Trails B-A score: 51.8 (Major CI excluded per inclusion criteria)
Zijlstra, 2009[85]	100	Some fear of falling and at least some activity avoidance due to fear of falling.	NR	NR	NR	NR

Abbreviations: Cog = Cognitive; NR = Not reported.

Appendix K Table 3. Psychological Interventions: Intervention Components

Author, year Study name	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	CG descr
Dorresteijn, 2016[83]	Home-based, cognitive behavioral program consisting of 7 sessions including three home visits and four telephone contacts aimed to instill adaptive and realistic views of fall risks and to increase activity and safe behavior.	Individual	Class outside the home	Nurse	3 home visits of 60-75 min and 4 phone calls of 35 min over a 4 mo period.	Usual care
Lim, 2022[84]	Three modules from an online CBT program (myCompass).	Individual	In home	Self-directed	6 wk access to online modules	Minimal intervention
Zijlstra, 2009[85]	8 wkly, 2-hr multicomponent cognitive behavioral group sessions addressing fear of falling, safely increasing activity, home environment changes, and exercise.	Group	Class outside the home	Nurse	2 hr sessions once per wk	Usual care

Abbreviations: CBT = cognitive behavioral therapy; CG = Control group; Descr = Description; Hr = Hour; IG = Intervention group; Min = Minutes; Mo = Months; Wk = Week.

Appendix K Table 4. Psychological Interventions: Falls

Author, year	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Dorresteijn, 2016[83]	12	362 (2.13)	429 (2.38)	0.86 (0.65, 1.13)
Zijlstra, 2009[85]	14	302 (0.93)	381 (1.26)	0.86 (0.65, 1.14)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix K Table 5. Psychological Interventions: People With a Fall

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Dorresteijn, 2016[83]	Fallers (1 plus falls)	12	94/166 (56.6)	106/180 (58.9)	0.96 (0.80, 1.15)
	Fallers (2 plus falls)	12	55/166 (33.1)	67/180 (37.2)	0.89 (0.67, 1.19)
Lim, 2022[84]	Fallers (1 plus falls)	12	NR/25 (NR)	NR/25 (NR)	OR: 1.40 (0.45, 4.37)
Zijlstra, 2009[85]	Fallers (1 plus falls)	8	80/280 (28.6)	95/260 (36.5)	0.78 (0.61, 1.00)
		14	91/280 (32.5)	117/260 (45)	0.72 (0.58, 0.90)
	Fallers (2 plus falls)	8	35/280 (12.5)	53/260 (20.4)	0.61 (0.41, 0.91)
		14	48/280 (17.1)	76/260 (29.2)	0.59 (0.43, 0.81)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix K Table 6. Psychological Interventions: Injurious Falls

Author, year	Outcome	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Dorresteijn, 2016[83]	Fall resulting in medical care	12	106 (0.61)	87 (0.48)	1.42 (0.96, 2.10)
Zijlstra, 2009[85]	Fall-related injuries, serious	14	75 (0.27)	102 (0.34)	0.78 (0.45, 1.35)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix K Table 7. Psychological Interventions: Mortality

Author, year	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Dorresteijn, 2016[83]	12	7/194 (3.6)	7/195 (3.6)	1.01 (0.36, 2.81)
Zijlstra, 2009[85]	14	6/280 (2.1)	6/260 (2.3)	0.93 (0.30, 2.84)
	84	90/280 (32.1)	85/259 (32.8)	0.98 (0.77, 1.25)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix K Table 8. Psychological Interventions: Instrumental Activities of Daily Living

Author, year	Outcome (Instrument)	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean diff in change from BL (95% CI)
Dorresteijn, 2016[83]	IADL-Groningen Activity Restriction Scale	0	141	171	15.64 (5.1)	15.03 (4.9)	NA	NA	NA
		12	141	171	14.82 (5.0)	15.35 (5.1)	NR	NR	-1.01 (-∞, -0.41)
Zijlstra, 2009[85]	IADL-Frenchay Activities Index	0	280	260	39.5 (7.2)	382 (7.2)	NA	NA	NA
		8	280	260	40.3 (6.9)	38.0 (7.4)	NR	NR	0.94 (0.13, 1.74) p=0.02
		14	280	260	39.6 (7.4)	37.7 (7.6)	NR	NR	0.54 (-0.35, 1.42)

Abbreviations: BL = Baseline; CG = Control group; IADL = Instrumental activities of daily living; IG = Intervention group; Mo = Months; N = Number of participants; NA = Not applicable; NR = Not reported; SD = Standard deviation; Time = Timepoint.

Appendix L Table 1. Education Interventions: Study and Population Characteristics

Author, year Study name	QR	Country	Target population	Recruitment setting	N rand	Female, %	Age, mean (range)	Race/ ethnicity, %
Clemson, 2004[86] Stepping On	Fair	AUS	Community residents aged ≥70 years who had a fall in the previous 12 mo or were concerned about falling.	Community-based	310	74	78 (≥70)	NR

Abbreviations: AUS = Australia; Mo = Months; N = Number of participants; NR = Not reported; QR = Quality rating; Rand = Randomized.

Appendix L Table 2. Education Interventions: Fall Risk and Comorbidities

Author, year Study name	Risk for falls, %	Fall risk criteria	Frailty	Comorbidities	Medications	Cog impairment
Clemson, 2004[86] Stepping On	100	Fall the previous 12 mo or concerned about falling.	NR	NR	Use of psychotropic drugs, %: 20	NR

Abbreviations: Cog = Cognitive; Mo = Months; NR = Not reported.

Appendix L Table 3. Education Interventions: Intervention Components

Author, year	Brief IG descr	Format	Setting(s)	Provider(s)	IG intensity	CG descr
Clemson, 2004[86]	Participants attended group sessions of the Stepping On program to improve fall self-efficacy, encourage behavioral change, and reduce falls. Program focuses on balance and strength, vision screening, medication management, home safety, and community safety.	Group	Class outside of home; In-home	Occupational Therapist	7, 2-hr group sessions, plus 1 home visit*	Attention control

* There was a total of 15.5 hrs intervention constituting the seven 2-hr program sessions (including one community mobility session) and the individual home visit. A booster session conducted 3 mo after session seven, lasting 1.5 hrs, occurred at the program venue.

Abbreviations: CG = Control group; Descr = Description; Hr = Hour; IG = Intervention group; Mo = Month.

Appendix L Table 4. Education Interventions: Falls

Author, year	FU, mo	IG events (event rate p-y)	CG events (event rate p-y)	IRR (95% CI)
Clemson, 2004[86]	14	179 (0.91)	255 (1.43)	0.68 (0.57, 0.83)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; IRR = Incidence rate ratio; Mo = Months; P-y = Person-year.

Appendix L Table 5. Education Interventions: People With a Fall

Author, year	Outcome	FU, mo	IG n/n (%)	CG n/n (%)	RR (95% CI)
Clemson, 2004[86]	Fallers (1 plus falls)	14	82/157 (52.2)	89/153 (58.2)	0.90 (0.73, 1.10)
	Fallers (2 plus falls)	14	40/157 (25.5)	53/153 (34.6)	0.74 (0.52, 1.04)

Abbreviations: CG = Control group; CI = Confidence interval; FU = Followup; IG = Intervention group; Mo = Months; n/n = Number of people with event/number of participants; RR = Relative risk.

Appendix L Table 6. Education Interventions: Quality of Life

Author, year	Outcome (Instrument)	Time, mo	IG n	CG n	IG Mean (SD)	CG Mean (SD)	IG Mean change from BL (SD)	CG Mean change from BL (SD)	Mean difference in change (95% CI)
Clemson, 2004[86]	QOL-SF-36 Mental Component	0	157	153	53.21 (11.08)	54.29 (10.26)	NA	NA	NA
		14	133	125	NR	NR	0.01 (9.65)	-0.52 (10.00)	0.53 (-2.95, 1.88)
	QOL-SF-36 Physical Component	0	157	153	38.37 (10.84)	38.79 (10.74)	NA	NA	NA
		14	133	125	NR	NR	-0.02 (8.34)	0.68 (9.04)	0.70 (-2.94, 1.88)

Abbreviations: BL = Baseline; CG = Control group; CI = Confidence interval; IG = Intervention group; Mo = Months; n = Number of participants; NA = Not applicable; NR = Not reported; QoL = Quality of life; SD = Standard deviation; SF = Short Form Survey; Time = Timepoint.

Appendix M Table 1. Ongoing Studies

Trial Identifier	Study Name	Country	N	Aim	Relevant Outcome(s)	Status 2023
NCT 04993781	Electronic Strategies for Tailored Exercise to Prevent FallS (eSTEPS)	US	8353	Test the efficacy a tailored fall prevention exercise (eSTEPS) intervention on falls and injurious falls in patients over age 65 at high risk for falls.	Falls; injurious falls	Recruiting Estimated completion date: December 2025
NCT 05807724	Geriatric Emergency Department (ED) Fall Injury Prevention Project	US	1600	Assess whether certain ED patients at high risk of recurrent falls and injuries related to falls will benefit from the recommendations of the Center for Disease Control and Prevention's Stopping Elderly Accidents, Deaths and Injuries program.	Recurrent fall requiring ED revisit; injurious falls; fall-related mortality	Recruiting Estimated completion date: September 2024
NCT 05691166	Reducing Falls with Progressive Resistance Training (ReFit) for the Oldest Old Adults With Sarcopenia. A 12-month Randomized Controlled Trial	US	240	Investigate the effects of 12 mo of high-intensity progressive resistance training compared with a control group on fall-rate in older adults with sarcopenia.	Falls	Recruiting Estimated completion date: December 2025
NCT 05016141	Health in Motion- A Pragmatic Clinical Trial-Home	US	120	Evaluate the use of a digital solution that translates evidence-based fall prevention programs (such as Otago Exercise Program and Matter of Balance) to a digital solution (Health in Motion Fall Prevention Platform), as an alternative to home-based fall prevention programs that is affordable, scales to the millions of older adults across the country at risk for falls and is sustainable for the older adult's life.	Falls	Active Estimated completion date: July 2023
NCT 03963570	The Effectiveness of a Self-managed Digital Exercise Program to Prevent Falls in Older	SWE	1628	Evaluate the effectiveness of a digital self-management exercise program in preventing falls in community dwelling older people.	Falls	Completed, no results posted

Appendix M Table 1. Ongoing Studies

Trial Identifier	Study Name	Country	N	Aim	Relevant Outcome(s)	Status 2023
	Community-dwelling People (SafeStepRCT)					Estimated completion date: May 2022
NCT 05694494	Training- and Cost-effectiveness of an Internet-based Lifestyle-integrated Functional Exercise Program (iLiFE)	HK	322	Compare the effectiveness of an internet-based LiFE program in reducing subsequent falls and promoting exercise adherence in community-dwelling older adults.	Falls	Enrolling by invitation Estimated completion date: November 2024
NCT 05406323	The Effect of a Web-Based Fall Prevention Program on Fall, Fall Risk and Fall Fear Among Elderly	TR	72	Assess the effect of Web-Based Fall Prevention Program on falling, fall risk and fear of fall.	Falls	Not yet recruiting Estimated completion date: July 2023
NCT 04787432	Salutogenic Frailty Prevention Program for Women Aged 55 Years and Over (SAFRAPP)	TR	84	Examine the effectiveness of Salutogenic Model-Based Frailty Prevention Program (SAFRAPP) for pre-frail women.	Falls	Unknown Estimated Study Completion Date: January 2022
NCT 05615077	Effectiveness of Comprehensive Intervention for the Prevention of Fall in Older Adults; a Randomized Controlled Trial	KOR	484	Demonstrate the effect of combined exercise-education intervention in old adults with fall risk. This study will be conducted with prospectively randomized controlled trial comparing outcome of combined exercise-education intervention with conventional medical care.	Falls, injurious falls	Recruiting Estimated completion date: May 2026
NCT 05192408	Multi-component Intervention for Reducing Fear of Falling in Community-dwelling Older Adults	SGP	420	Compare the effectiveness of a multi-component intervention comprising exercise recommendations, cognitive behavioral therapy components and motivational interviewing-based telephone review against usual care reducing fear of falling and falls in community-dwelling older adults.	Falls	Recruiting Estimated completion date: May 2023

Appendix M Table 1. Ongoing Studies

Trial Identifier	Study Name	Country	N	Aim	Relevant Outcome(s)	Status 2023
NCT 04801316	Steady Feet	SGP	290	Evaluate the effects of a strength and balance intervention (Steady Feet) among older adults aged 60 years and above who are at high risk of falls.	Injurious falls	Recruiting Estimated completion date: December 2022
DRKS 00016609	A multi-centre, parallel-group, randomized controlled trial to assess the efficacy and safety of eurythmy therapy and tai chi in comparison with standard care in chronically ill elderly patients with increased risk of falling (ENTAiER)	DEU	550	Determine whether eurythmy therapy and Tai Chi can reduce the risk of falling (i.e. experiencing at least one fall), which usually marks the beginning of dependency and the decline of mobility.	Falls	NR Registered: July 2019
NCT 04911179	Combined Exercise and Cognitive Stimulation for Falls Prevention	ESP	310	Investigate the effect of the combined intervention (exercise and cognitive intervention) in frail older participants living in the community and at risk of falling.	Falls; fall-related hospitalizations; fall-related factures; fall-related death	Recruiting Estimated completion date: April 2024
NCT 05449470	Falls Prevention Improvement Through Developing a Computerized Clinical Support System: Effectiveness of Individualized Medication Withdrawal	NLD	800	Assess whether of the use of a clinical decision support system and a patient portal for communicating medication-related fall risk to fall clinic patients may improve joint medication management between patients and physicians and reduce the incidence of injurious falls.	Falls; injurious falls	Recruiting Estimated completion date: June 2024
NCT 04717258	Safe and Well Visits by the Fire and Rescue Service to Prevent Falls and Improve Quality of Life in Older People (FIREFLI)	UK	1156	Assess whether Safe and Well Visits delivered by the Fire and Rescue Service will lead to a reduction in the number of falls and an improvement in health-related quality of life in older people.	Falls; injurious falls; people experiencing a fall	Recruiting Estimated completion date: September 2024

Appendix M Table 1. Ongoing Studies

Trial Identifier	Study Name	Country	N	Aim	Relevant Outcome(s)	Status 2023
NCT04313062	Older People Self-Caring Through a Comprehensive Model Based on House Calls and Oriented Towards Falling Prevention (PM ACTIVAS)	CHL	220	Design, implement and evaluate a comprehensive model based on house calls and oriented towards falling prevention (PM ACTIVAS' model), with the hypothesis that people who received the educational intervention following the PM ACTIVAS' model will: fall less frequently, improve their management on falls risk factors present at home, and have a higher falls risk perception than the control group.	Falls	Completed, no results posted Estimated completion date: April 2022
NCT 05533333	Self-administered Dual-task Training for Reducing Falls Among the Older Adults	HK	190	Evaluate the effectiveness and cost-effectiveness of self-administered dual-task training for preventing falls among older adults.	Falls	Recruiting Estimated completion date: December 2024

Abbreviations: AUS = Australia; CHL = Chile; ESP = Spain; DEU = Germany; HK = Hong Kong; KOR = South Korea; NLD = Netherlands; NR = Not reported; SGP = Singapore; SWE = Sweden; TR = Turkey; US = United States.

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