Annals of Internal Medicine | Clinical Guideline

Primary Care–Relevant Interventions to Prevent Falling in Older Adults: A Systematic Evidence Review for the U.S. Preventive Services Task Force

Yvonne L. Michael, ScD, SM; Evelyn P. Whitlock, MD, MPH; Jennifer S. Lin, MD, MCR; Rongwei Fu, PhD; Elizabeth A. O'Connor, PhD; and Rachel Gold, PhD, MPH

Background: Falls among older adults are both prevalent and preventable.

Purpose: To describe the benefits and harms of interventions that could be used by primary care practitioners to prevent falling among community-dwelling older adults.

Data Sources: The reviewers evaluated trials from a good-quality systematic review published in 2003 and searched MEDLINE, the Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, and CINAHL from the end of that review's search date to February 2010 to identify additional English-language trials.

Study Selection: Two reviewers independently screened 3423 abstracts and 638 articles to identify randomized, controlled trials (RCTs) of primary care–relevant interventions among community-dwelling older adults that reported falls or fallers as an outcome. Trials were independently critically appraised to include only good- or fair-quality trials; discrepancies were resolved by a third reviewer.

Data Extraction: One reviewer abstracted data from 61 articles into standardized evidence tables that were verified by a second reviewer.

Data Synthesis: Overall, the included evidence was of fair quality. In 16 RCTs evaluating exercise or physical therapy, interventions reduced falling (risk ratio, 0.87 [95% CI, 0.81 to 0.94]). In 9 RCTs of vitamin D supplementation, interventions reduced falling (risk ratio, 0.83 [CI, 0.77 to 0.89]). In 19 trials involving multifactorial assessment and management, interventions with comprehensive management seemed to reduce falling, although overall pooled estimates were not statistically significant (risk ratio, 0.94 [CI, 0.87 to 1.02]). Limited evidence suggested that serious clinical harms were no more common for older adults in intervention groups than for those in control groups.

Limitations: Interventions and methods of fall ascertainment were heterogeneous. Data on potential harms of interventions were scant and often not reported.

Conclusion: Primary care–relevant interventions exist that can reduce falling among community-dwelling older adults.

Primary Funding Source: Agency for Healthcare Research and Quality.

Ann Intern Med. 2010;153:815-825. www.annals.org
For author affiliations, see end of text.

Editor's Note: *As part of the U.S. Preventive Services Task Force's (USPSTF) ongoing commitment to clarity about its work and methods, the USPSTF is inviting public comment on all draft recommendation statements. The USPSTF's draft recommendation statement on primary care–relevant interventions to prevent falling in older adults will soon be available for public comment at* www.uspreventiveservicestaskforce.org/tfcomment.htm. *As a result, the recommendation on primary care–relevant interventions to prevent falling in older adults does not appear with this accompanying background review. Once finalized, the recommendation statement will reflect any changes made based on the public comments received. A summary of these changes will be included in a new section of the final recommendation statement.*

Falls are a serious threat to the lives, health, and independence of older adults. Falls are caused by complex interactions among multiple risk factors, which are characterized as intrinsic (patient related) or extrinsic (external to the patient) (1–3). Between 30% and 40% of community-dwelling persons 65 years or older fall at least once per year (4, 5). Falls were the leading cause of fatal and nonfatal injuries among persons 65 years or older (6). The death rate due to falls is 10 per 100 000 persons for those aged 65 to 74 years and 147 per 100 000 persons for those aged 85 years or older (7). The estimated direct medical costs for fatal and nonfatal fall-related injuries among community-dwelling persons 65 years or older in 2000 was $19.2 billion (8), with one study estimating that this cost could reach $43.8 billion by 2020 (9).

Falls among older adults are preventable (8, 10). In 2006, the American Geriatrics Society and the British Geriatrics Society published an updated evidence-based practice guideline recommending that older adults at high risk for falls receive a multifactorial fall-risk assessment and individualized, targeted interventions to address the risks and deficiencies identified in the assessment (8). Physicians

See also:

Print
Editorial comment. 843
Related article. 809

Web-Only
Appendix Tables
Appendix Figures
CME quiz
Conversion of graphics into slides

face significant barriers to intervening to prevent falls, however, including lack of awareness and appropriate knowledge, competing risks, and difficulty assessing risk (11–13). Therefore, we conducted a systematic review of outpatient interventions available to primary care clinicians to prevent falls in older adults to support the U.S. Preventive Services Task Force (USPSTF) recommendation process.

Methods

We followed a standard protocol for this review. The USPSTF gave guidance on formulating 4 key questions (**Appendix Figure 1**, available at www.annals.org), 2 of which are addressed in this review: Do primary care interventions reduce risk or rate of falls or fallers among community-dwelling older adults? What are the adverse effects associated with interventions to reduce falls or fallers? We grouped these interventions into 5 main categories: multifactorial assessment and management; single clinical treatment (vitamin D, vision correction, and medication management); clinical education or behavioral counseling; home-hazard modification; and exercise or physical therapy. Expanded definitions for the categories are provided in **Appendix Table 1** (available at www.annals.org), and a more detailed description of our methods is available in our full report (14).

Searches and Selection Process

We searched multiple databases (MEDLINE, Cochrane Database of Systematic Reviews, the Database of Abstracts of Reviews of Effects, and Health Technology Assessments) and Web sites (Institute of Medicine, the Agency for Healthcare Quality and Research [AHRQ], and National Institute for Health and Clinical Excellence) to identify relevant, good-quality systematic reviews published between January 1991 and October 2007. We found 13 existing systematic reviews for interventions to prevent falls. Using guidelines for integrating systematic reviews (15), 2 independent reviewers assessed relevancy (research questions and scope) and quality of identified reviews. We used citations from 1 recent good-quality review of fall interventions (16) and then searched MEDLINE, the Cochrane Central Register of Controlled Trials, and CINAHL from the end of the previous review's search date of January 2002 to February 2010 to identify additional trials. We searched MEDLINE and CINAHL from 1992 (the earliest publication date of the included trials) through February 2010 to locate studies of harms for the included interventions. Our review of harms of vitamin D supplementation and vision screening or early treatment was limited to previously synthesized evidence (17, 18). We included randomized, controlled trials (RCTs) of community-dwelling older adults (average age ≥65 years) in settings generalizable to U.S. primary care populations. We included trials if they were designed to assess fall prevention based on assessment of falling or falls as a primary or secondary outcome. We excluded trials not conducted in primary care or other settings with a primary care–comparable population (for example, hospitals, nursing homes, rehabilitation centers, or other long-term care facilities) and trials without a true control group. Inclusion and exclusion criteria and search strategies are available in the full report (14).

Quality Assessment and Data Abstraction

Two investigators independently screened all abstracts for inclusion. We screened 3423 abstracts and 638 full-text articles (**Appendix Figure 2**, available at www.annals.org). Two investigators independently critically appraised all articles by using the USPSTF quality criteria (19). In brief, the USPSTF quality criteria for RCTs includes consideration of assembly and maintenance of comparable groups; differential loss to follow-up or overall high loss to follow-up; a clear definition of the intervention; equal, reliable, and valid outcome measurement; and intention-to-treat analysis. Good-quality and fair-quality articles meeting the inclusion criteria were retained, and studies with fatal flaws were rated poor quality and not included. Discrepancies were resolved through consultation with a third investigator. One reviewer abstracted relevant information into standardized evidence tables for each included article, and a second reviewer checked the abstraction.

Data Synthesis and Statistical Analysis

We qualitatively synthesized the included trials and summarized the results in tables, stratifying the discussion of evidence by similar intervention groupings (for example, physical activity, vitamin D, vision correction, and multifactorial assessment and management). When possible, we also quantitatively pooled fall-related outcomes to estimate the effect size of these intervention groupings. Falling was assessed in a variety of ways (number of fallers, fall rate, time to first fall, and number of frequent fallers). Number of fallers was the most consistently assessed measure of falling; the other measures were used more selectively. Thus, primary analyses estimated relative risk for falling by using random-effects models (20, 21).

We conducted separate analyses for each intervention category. For single clinical treatments, the analyses were further stratified by treatment type. For trials with multiple intervention groups in which the interventions were variations of the same intervention type (for example, 2 exercise programs), we calculated estimates for the more intense groups. We assessed the presence of statistical heterogeneity among the studies by using standard chi-square tests and estimated the magnitude of heterogeneity by using the I^2 statistic (22). A series of random-effects meta-regression models were used to examine potential sources of heterogeneity in fall risks; such sources include mean age, average age of 80 years or older, proportion of women, proportion of participants with a history of falling in the previous year, comprehensiveness or intensity of the intervention, and whether the sample comprised high-risk participants. All meta-analyses were done by using Stata software, version 10.1 (StataCorp, College Station, Texas).

Role of the Funding Source

The AHRQ funded this work, provided project oversight, and assisted with internal and external review of the draft evidence synthesis. The authors worked with 3 members of the USPSTF to develop the analytic framework and resolve issues involving the scope of the review. The draft systematic review was reviewed by 8 external peer reviewers, then revised for the final version. Agency approval was required before this manuscript could be submitted for publication, but the authors are solely responsible for the content and the decision to submit it for publication.

Results

We included 54 RCTs (with a total of 26 102 participants) that tested primary care interventions to prevent falling. Only 41 of the 111 trials from the Cochrane review (16) were included in our review, owing to differences in inclusion criteria. The most common reasons for exclusion from our review were that a true control group was lacking, the population studied was institutionalized or recruited from inpatient settings, and interventions could not be conducted in primary care or be referred to from primary care. Evidence tables and tables of excluded studies for each key question are available in the full report (18). Details of each included study are summarized in **Appendix Tables 2** to **6** (available at www.annals.org). The **Table** shows a summary of evidence by intervention category.

Multifactorial Assessment and Management

We evaluated 19 multifactorial assessment and management trials (7099 participants) with 21 active intervention groups (23–41). All trials except 1 were limited to populations at high risk for falling (36). Most interventions assessed primary risk factors for falls that were identifiable during clinical evaluation: medication use, visual acuity, home environment, and gait and balance. On the basis of evidence that multifactorial assessment interventions that incorporate comprehensive management strategies are more successful in preventing falls (13), interventions were categorized during the abstraction phase by 2 independent investigators as comprehensive (complete and active management of fall risk factors and conditions identified in the multifactorial assessment, including provision of case managers or home nurses) or noncomprehensive (provide only partial or limited management of identified fall-related risk factors). Control groups primarily received usual care, although 2 trials used “attention control groups” (30, 32) and 1 trial provided “a minimal intervention of mainly education” as a control group (42).

The majority of studies were rated as fair quality. Most studies did not report whether treatment allocation was blinded or whether the persons who conducted follow-up assessments were blinded to the treatment condition. Most trials used prospective methods to assess falling; 4 noncomprehensive trials assessed falling retrospectively by using a questionnaire (23, 25, 29, 40). Studies made different assumptions in their analyses, including assumptions about loss to follow-up and falls that may have resulted in outcome misclassification. For example, 1 study counted all lost participants (including those who died) as fallers (24), but another included falls that occurred before loss to follow-up (30). The remaining studies excluded participants who were lost to follow-up or were dead from the analyses or did not report the analyses assumptions.

Efficacy

Pooled estimates involving all 19 multifactorial assessment and management trials suggested a possible reduction in falls with some of these interventions (risk ratio, 0.94 [95% CI, 0.87 to 1.02]), although this finding was not statistically significant. Pooled estimates for the 6 comprehensive trials also suggested a protective effect (risk ratio, 0.89 [CI, 0.76 to 1.03]), although this finding was not statistically significant either (**Figure 1**). Multifactorial and management interventions were clinically heterogeneous, and the pooled statistical heterogeneity, particularly for the comprehensive trials, was high ($I^2 = 73.1\%$). Meta-regression models did not identify any study-level variable, including the comprehensiveness of the intervention, that clearly explained the heterogeneity in the effect estimate. Of note, however, the 4 trials with retrospective assessment of falls more often reported greater reduction in the number of fallers in the intervention group than the control group, compared with trials that used prospective assessment methods. Removing these trials, all of which involved noncomprehensive interventions, further attenuated the observed effects of the noncomprehensive interventions toward the null.

Harms

We found no additional studies beyond the trials included in the efficacy section. Overall, there was limited evidence for clinically significant harms from multifactorial assessments. One good-quality trial conducted in New Zealand (312 participants) had a higher proportion of fallers and frequent fallers at 12 months in the intervention group than in the control group (27). Only 5 fair-quality trials explicitly reported additional adverse effects. Adverse effects in these trials were minor and included minor musculoskeletal symptoms or increases in nonurgent outpatient visits to primary care (28, 30, 33, 38, 40).

Exercise or Physical Therapy

We evaluated 18 trials of exercise or physical therapy interventions (3986 participants) that had 21 active intervention groups (43–60). Trials of exercise or physical ther-

Table. **Summary of Evidence, by Intervention Category**

Intervention	Studies, *n* (Reference)	Limitations	Consistency	Applicability	Overall Quality	Summary of Findings	Comments
Multifactorial assessment and management	19 (23–41)	Majority of trials were conducted outside of the United States and may vary from usual care in the United States	Heterogeneity in many dimensions, including age of participants, baseline risk for falling, intervention approach, country, treatment intensity, and duration of follow-up; high attrition in many trials; failure to blind assessors	Trial participants were primarily non-Hispanic white adults selected for being at high risk for falls	Fair	Pooled RR for comprehensive interventions, 0.89 (95% CI, 0.76–1.03); I^2 = 73.1% Pooled RR for noncomprehensive interventions, 0.98 (CI, 0.88–1.08); I^2 = 52.5% Paradoxical increase in falling in 1 trial No significant clinical harms	Pooled estimate was sensitive to the addition of new trial data
Exercise or physical therapy	18 (43–60)	Majority of trials did not include an intention control or report whether follow-up assessments were blinded	Heterogeneity in many dimensions, including age and sex of participants, baseline risk for falling, intervention approach, country, treatment intensity, and duration of follow-up; high attrition in many trials; failure to blind assessors	Trial participants were primarily non-Hispanic white adults	Fair	Pooled RR, 0.85 (CI, 0.78–0.92); I^2 = 21% No significant clinical harms	Meta-regression results indicate that more intensive exercise trials had a greater effect on risk for falling
Single clinical treatment							
Vitamin D	9 (63–71)	Majority of trials were not powered to observe a significant reduction in fall risk and assessed falls retrospectively	Heterogeneity in dosing and duration of follow-up	Trial participants were primarily non-Hispanic white women	Fair	Pooled RR, 0.83 (CI, 0.77–0.89); I^2 = 3.2% Potential increase in kidney stones with high levels of supplementation	Trials of vitamin D with calcium that were compared with no treatment or placebo did not support any added benefit of calcium
Vision correction	4 (49, 72–74)	No serious limitations	Heterogeneity of intervention approach; all trials included high-risk populations because of selection for frailty or presence of cataracts	Trial participants were primarily non-Hispanic white women selected for being at high risk for falls	Fair	No reduction in risk for falling; potential increase in falling	Fall rate was reduced in 1 trial of first cataract surgery
Medication assessment and withdrawal	1 (47)	Small sample size (48 participants)	NA	NA	Fair	Limited evidence of no benefit	Fall risk was not reported
Home-hazard modification	3 (48, 49, 75)	Assessment of outcomes not blinded; studies were conducted outside the United States	Heterogeneity in intervention approach and approach to selecting a high-risk population	Trial participants were primarily female	Fair	Limited evidence of benefit	Results from the trial groups that combined other interventions with home-hazard modification were generally similar
Clinical education or behavioral counseling	1 (76)	No serious limitations	NA	NA	Good	Limited evidence of no benefit	–

NA = not applicable; RR = relative risk.

apy tested a variety of interventions in 3 major categories: gait, balance, or functional training (exercises designed to develop dynamic strength, flexibility, and agility needed for everyday activities); strength or resistance exercise; and general exercise (including walking, cycling, aerobic activity, and endurance exercise). All but 1 trial (45) included some type of gait, balance, or functional training, and all but 6 trials (50–52, 58–60) used strategies in more than 1 category. Control groups received no intervention or education. Three trials evaluated interventions that lasted 12 months or longer (44, 48, 56). The duration of intervention in the remaining trials ranged from 6 to 26 weeks (median, 12.5 weeks). Treatment intensity (total hours of contact) ranged from 2 to 243 hours (median, 28 hours).

Several trials assessed falling retrospectively by using questionnaires (44, 50, 53, 54, 57).

Efficacy

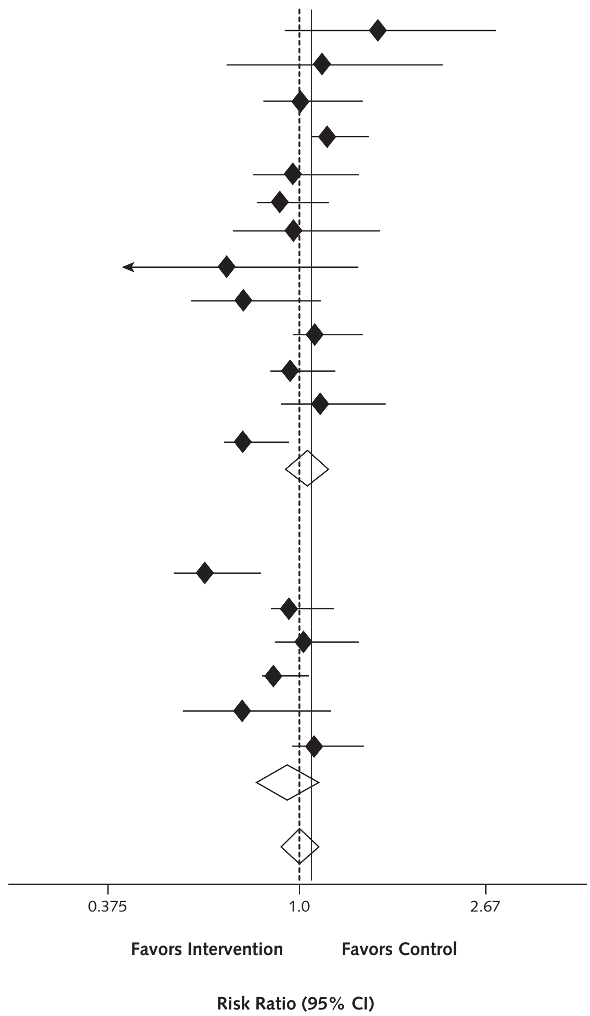
In pooled analysis, exercise or physical therapy interventions reduced the risk for falling by 13% (CI, 6% to 19%), although most trials showed non–statistically significant differences (**Figure 2**). In meta-regression models, the effect size of the pooled estimate was not influenced by age, sex, history of falling, or risk status of the participants. Meta-regression of the number of hours of physical activity, however, suggested that more intensive physical activity interventions produced a small but statistically significant reduction in the risk for being a faller.

Harms

We found no evidence of an increase in falls or fallers in 18 fair-quality or good-quality trials. These trials examined exercise or physical therapy interventions to prevent falls (43–60); in addition, 2 additional fair-quality trials (496 participants) were identified in our harms search (61, 62). Three of these trials reported other adverse effects. Two trials reported falls while exercising as instructed, although there was no increase in the number of fallers in the intervention group (56, 61). One fair-quality trial (424 participants) that explicitly evaluated for adverse effects found that persons in the exercise group had more physician visits for abnormal heart rhythm than did persons in the control group, but it reported no statistically significant differences for serious harms, including clinically signifi-

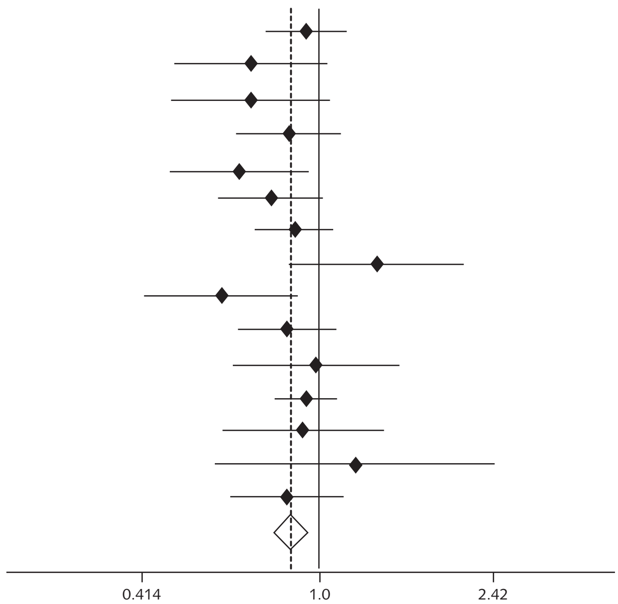
Figure 1. **Pooled risk for falling for multifactorial assessment and management interventions.**

Study, Year (Reference)	Risk Ratio (95% CI)	Analyzed Patients, *n* IG	CG
Noncomprehensive			
Ciaschini et al, 2009 (37)	1.51 (0.88–2.61)	101	100
Coleman et al, 1999 (25)	1.13 (0.65–1.97)	79	63
Dyer et al, 2004 (39)	1.01 (0.78–1.31)	102	94
Elley et al, 2008 (27)	1.16 (1.01–1.34)	135	145
Hendriks et al, 2008 (28)	0.97 (0.74–1.28)	124	134
Hogan et al, 2001 (32)	0.91 (0.76–1.09)	75	77
Lightbody et al, 2002 (33)	0.98 (0.67–1.42)	155	159
Newbury et al, 2001 (29)	0.69 (0.37–1.27)	45	44
Peri et al, 2008 (40)	0.75 (0.54–1.05)	73	76
Salminen et al, 2009 (38)	1.09 (0.91–1.30)	292	297
Shumway-Cook et al, 2007 (36)	0.96 (0.81–1.13)	226	227
Van Haastregt et al, 2000 (34)	1.12 (0.86–1.47)	127	120
Wagner et al, 1994 (23)	0.75 (0.64–0.88)	635	607
Subtotal (I^2 = 52.5%; P = 0.014)	0.98 (0.88–1.08)	4312	
Comprehensive			
Close et al, 1999 (31)	0.61 (0.49–0.77)	141	163
Davison et al, 2005 (26)	0.95 (0.81–1.12)	144	149
Lord et al, 2005 (35)	1.03 (0.83–1.27)	194	201
Spice et al, 2009 (24)	0.88 (0.78–0.99)	186	149
Tinetti et al, 1994 (30)	0.75 (0.51–1.10)	147	144
Vind et al, 2009 (41)	1.09 (0.91–1.31)	196	196
Subtotal (I^2 = 73.1%; P = 0.002)	0.89 (0.76–1.03)	2010	
Overall (I^2 = 61.5%; P < 0.001)	0.94 (0.87–1.02)	6322	



CG = control group; IG = intervention group.

Figure 2. **Pooled risk for falling for exercise or physical therapy interventions.**



Study, Year (Reference)	Risk Ratio (95% CI)	Analyzed Patients, *n* IG	Analyzed Patients, *n* CG
Ashburn et al, 2007 (43)	0.94 (0.77–1.15)	63	63
Barnett et al, 2003 (44)	0.71 (0.49–1.04)	76	74
Buchner et al, 1997 (45)	0.71 (0.48–1.05)	75	30
Campbell et al, 1997 (46)	086 (0.66–1.12)	116	117
Campbell et al, 1999 (47)	0.67 (0.47–0.95)	45	48
Campbell et al, 2005 (48)	0.79 (0.61–1.02)	97	96
Day et al, 2002 (49)	0.89 (0.73–1.08)	406	137
Green et al, 2002 (50)	1.34 (0.87–2.07)	72	74
Li et al, 2005 (51)	0.61 (0.42–0.91)	95	93
Logghe et al, 2009 (52)	0.85 (0.67–1.09)	114	99
Lord et al, 1995 (53)	0.99 (0.65–1.50)	75	94
Luukinen et al, 2007 (54)	0.94 (0.81–1.10)	217	220
Morgan et al, 2004 (55)	0.92 (0.62–1.38)	119	110
Rubenstein et al, 2000 (57)	1.20 (0.60–2.42)	31	28
Voukelatos et al, 2007 (58)	0.85 (0.64–1.13)	347	337
Overall (I^2 = 4.2%; P = 0.405)	0.87 (0.81–0.94)	3568	

CG = control group; IG = intervention group.

cant abnormal laboratory or other diagnostic testing, hospitalization, or life-threatening events (62).

Single Clinical Treatments

Vitamin D

We evaluated 9 trials of vitamin D supplementation (5809 participants) (63–71). Five of the trials included only women (66, 67, 69–71); the proportion of women in the other trials ranged from 51% to 80% (63–65, 68). Five trials were conducted in populations defined as high risk because of recent falls or vitamin D deficiency (64, 67–70). The remaining 4 studies used populations that were unselected except for age 65 years or older (63, 65, 66, 71). All studies were rated as fair quality. Only 3 trials assessed self-reported falls prospectively by using a diary or questionnaire (64, 66, 68). The remaining trials assessed self-reported falls retrospectively with periods of recall ranging from 6 weeks to 12 months (60, 62, 64, 66–68).

The daily oral doses of vitamin D in the intervention ranged from 10 IU (66) to 1000 IU (70) (median, 800 IU). One study provided a single intramuscular injection of 600 000 IU of vitamin D (64). The duration of active intervention ranged from 8 weeks (67) to 3 years (63, 66, 71) (median, 12 months). Two studies evaluated ergocalciferol (vitamin D_2) (64, 70), and the remaining studies evaluated cholecalciferol (vitamin D_3). Six trials included calcium supplements with vitamin D (63, 67–71). The control groups ranged from no intervention (69, 71) to placebo (63–66) or calcium supplements only (67, 68, 70).

Efficacy. Vitamin D with or without calcium was associated with a 17% (CI, 11% to 23%) reduced risk for falling during 6 to 36 months of follow-up (**Figure 3**). Trials of vitamin D with calcium compared with no treatment or placebo did not support any added benefit of calcium (63, 69, 71). Age, sex distribution, history of falling, or risk status of the participants did not affect the pooled estimate.

Harms. On the basis of the 9 fair-quality trials included in our review, we found no increase in falls, fallers, or other major adverse events. Only 3 trials (926 participants) specifically reported adverse effects—transient and asymptomatic hypercalciuria or hypercalcemia in the intervention group—but no differences in adverse effects or clinically significant harms, such as incident kidney stones, cancer, ischemic heart disease, or stroke (65, 66, 70).

Vision Correction

Four fair-quality or good-quality trials (1437 participants) evaluated the effect of surgical and nonsurgical vision correction (after screening for visual impairment) on risk for falling (49, 72–74). All of the trials included high-risk populations that were selected for frailty or presence of cataracts. Two trials evaluated expedited cataract surgery compared with routine wait-list controls (73, 74). The other 2 studies compared vision screening and referral or treatment with wait-list control or usual care (49, 72).

Efficacy. Vision correction did not reduce the proportion of fallers.

Harms. Although evidence on harms of vision screening or treatment of early impairment of visual acuity in older adults is sparse, 1 study suggested a possible harm (72). In a fair-quality trial conducted in Australia (616 participants), frail older adults received a comprehensive eye examination and approximately 44% received subsequent treatment of identified vision problems (72). Compared with control participants, persons in the intervention group had a higher proportion of fallers (65.0% vs. 49.8%; $P < 0.001$) and frequent fallers (37.9% vs. 30.6%; $P = 0.003$) (72). There was also a non–statistically significant increase in fall-related fractures. Trial investigators hypothesized that corrected vision may have increased the level of activity of these frail older adults, thereby increasing their risk for falling (72).

Medication Assessment and Withdrawal

We evaluated 1 small trial (48 participants) of medication assessment and withdrawal in older adults taking psychotropic medications compared with usual care (47). An additional 10 studies with multifactorial assessment and management interventions also included medication assessment and withdrawal (23–25, 31, 32, 37–41).

Efficacy. Medication assessment and withdrawal of therapy with medication alone were not associated with a reduced fall rate (47).

Harms. No harms were reported in the trials evaluating withdrawal of therapy with medication.

Home-Hazard Modification

We evaluated 3 trials of home-hazard modification (2348 participants) (48, 49, 75). All 3 trials evaluated an in-home assessment with modification of any identified hazards (for example, adding nonslip tape to rugs and steps) or provision of free safety devices (such as grab bars), compared with usual care or a social control. Two of these interventions also included behavioral counseling of intervention participants (48, 75).

Efficacy

Risk for falling was reduced by 7% to 41%, although only 1 home-hazard modification trial (196 participants) reported a statistically significant beneficial effect on risk for falling compared with control participants (48).

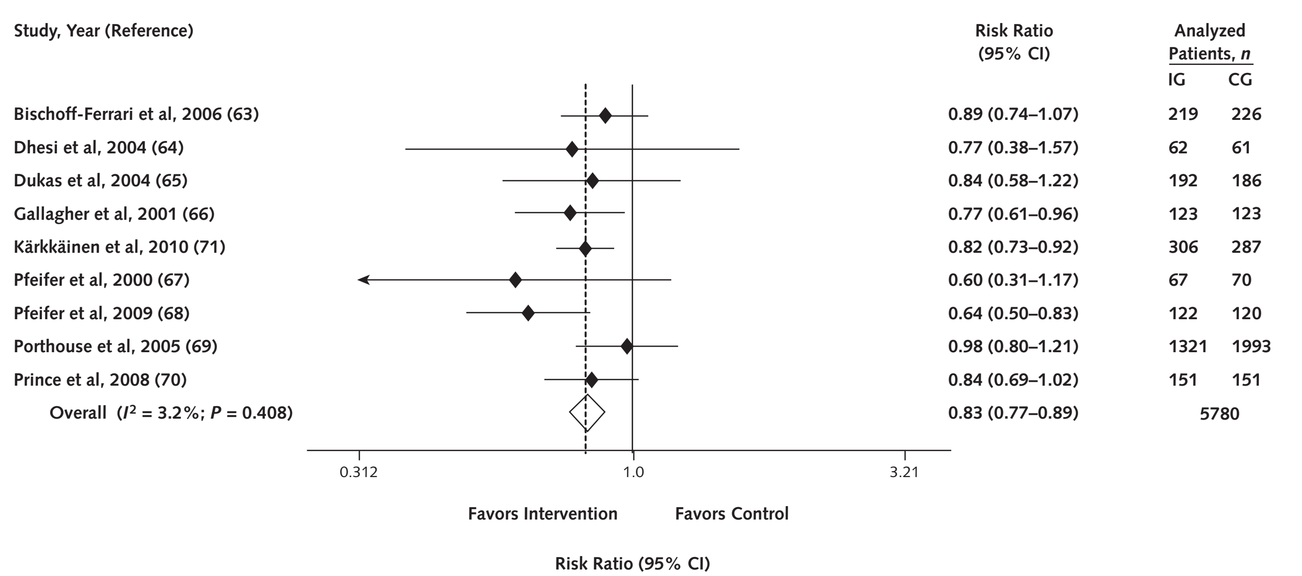
Harms

There was no evidence of increased falls or fallers, based on the 3 fair-quality trials that included home-hazard modification interventions. None of these trials reported additional adverse events.

Clinical Education or Behavioral Counseling

We evaluated 1 trial of behavioral counseling (310 participants) in high-risk older adults (76). The intervention group received seven 2-hour weekly group sessions

Figure 3. **Pooled risk for falling for single clinical treatment interventions: vitamin D.**



CG = control group; IG = intervention group.

conducted by an occupational therapist and one booster session held 3 months after the final group session. The control group received 2 social visits conducted by an occupational therapist. An additional 13 trials incorporated educational components into a multifactorial clinical assessment, clinical management, or home-hazard modification intervention (23–25, 30, 31, 33–38, 46, 75).

Efficacy

Education alone was not associated with a reduction in fall risk.

Harms

There was no increase in falls or fallers, and no additional adverse effects were reported.

Discussion

Although we conclude that exercise or physical therapy interventions and vitamin D supplementation reduce the risk for falling among community-dwelling older adults, it is unclear whether comprehensive multifactorial assessment and management interventions reduce the number of fallers. Overall, we found no major clinical harms for these effective interventions to prevent falls in older adults.

Most trials of vitamin D were not adequately designed to assess long-term adverse effects. On the basis of a recent AHRQ evidence report, we found limited evidence (based on 19 vitamin D trials in adults) that vitamin D intake above the current dietary reference amount may be harmful (17). The Women's Health Initiative reported a 17% increased risk for kidney stones in postmenopausal women aged 50 to 79 years whose daily vitamin D_3 supplementation was 400 IU combined with 1000 mg of calcium (17). In most trials, reports of hypercalcemia and hypercalciuria were not associated with clinically relevant events.

We found evidence of possible minor harms for vision correction, an intervention without evidence of effectiveness. In a recent USPSTF report evaluating the harms of vision screening and early vision correction in older adults, a single small observational study showed an association between multifocal lens use and an increased risk for falls (adjusted odds ratio, 2.09 [CI, 1.06 to 4.92]) (18). Other treatments for uncorrected refractive errors showed limited evidence of harm.

Our results are similar to those of previous systematic evidence reviews and meta-analyses (16, 77–79), but they differ in some ways. Relevant recent systematic evidence reviews evaluating specific types of interventions (for example, multifactorial assessment and exercise) also included institutional and hospitalized populations (79, 80). The purpose of our review was to evaluate outpatient approaches to falls prevention that are relevant to primary care to support the USPSTF recommendation process; thus, our review has a narrower focus than other reviews have had.

The most current review before ours, and the one that is most similar to ours, is a 2009 Cochrane Collaboration review (78). Like that review and meta-analyses, we found no statistically significant reduction in fall risk when all of the multifactorial assessment and management trials were pooled. Another recent systematic review and meta-analysis of multifactorial clinical assessment programs addressing fall risk also reported a lack of overall benefit (79), and a review addressing a broader grouping of complex interventions and outcomes reported a reduction in fall risk associated with these interventions (81). Although the lack of a consistent finding for an overall benefit may result from analyses combining studies that provide direct intervention with those studies that primarily provide referral (82, 83), comprehensiveness did not seem to be a predictor of successful interventions in our analysis or in the 2009 Cochrane review (78). However, the current body of literature is sensitive to changes as new trials are published. For example, a recent good-quality trial from the United Kingdom (204 participants) that was published after our review search period ended evaluated comprehensive multifactorial falls assessment and management among community-dwelling older adults who called an ambulance after a fall but were not taken to the emergency department (84). After 12 months, the relative risk for falling between the intervention group and usual care was 0.86 (CI, 0.78 to 0.94). Although the addition of this trial does not affect the pooled estimate of risk for falling, it does affect the overall statistical significance for comprehensive interventions (relative risk, 0.88 [CI, 0.78 to 0.98]; number of active study groups, 7; $I^2 = 70.2\%$). The characteristics of a comprehensive multifactorial assessment and management intervention have not been clearly defined, and different approaches to classification may also lead to different results, although our coding of level of comprehensiveness was internally valid.

We conclude that exercise programs are effective overall, as did other reviews (77, 78, 80). Like the 2009 Cochrane review (78), we did not find any evidence for differences in the results of fall prevention interventions on the basis of fall risk at baseline, although the intensity of the physical activity interventions was associated with greater reductions in the risk for falling (78, 80).

Unlike the recent Cochrane review and meta-analyses, we found that vitamin D supplementation was consistent with a reduced risk for falling. Our review, however, included data from 4 trials that were not included in the Cochrane review (65, 66, 68, 71); these data were generally protective. One large null study (85) included in the Cochrane review was excluded from our review owing to problems with the outcome reporting. After our search period ended, a good-quality trial evaluating a single large oral dose of vitamin D (500 000 IU) showed a paradoxical effect, in which the intervention group had an increase in fallers compared with the placebo control group at 12 months (74% vs. 68%; $P = 0.003$) (86). After we included this study in the meta-analysis, the relative risk reduction was attenuated but remained statistically significant (relative risk, 0.83 [CI, 0.71 to 0.97]). It was hypothesized that the mega-dose of oral vitamin D in the trial conducted by Sanders and colleagues (86) may have up-regulated CYP24, the enzyme that catabolizes 1,25-dihydroxyvitamin D, leading to decreased levels of vitamin D and increased falling in the intervention group (87). Only 1 other small trial included in this review administered a single mega-dose of vitamin D to vitamin D–deficient participants and reported no difference in risk for falling over 6 months (64).

Our review has limitations. First, we included only English-language RCTs with a true control group that were conducted in community-dwelling older adults and tested outpatient interventions most applicable to primary care clinicians. Second, the heterogeneity of interventions to prevent falling—from the identification of an at-risk population to intervention approaches to the different methods of assessing relevant outcomes—is an inherent limitation in the conduct and interpretation of statistical syntheses of this research. Third, among the intervention trials, we identified no consistent method of identifying people at increased risk for falls. Most studies (68%) enrolled participants who were preselected for increased risk factors for falls, including history of falls, gait and balance impairment, clinical history (for example, stroke, Parkinson disease, recent hospitalization, or medication use), and clinical examination findings (for example, frailty). Fourth, the interventions are heterogeneous even within intervention categories. In particular, the exercise intervention and the multifactorial assessment and management interventions vary considerably in terms of focus and components of care. Fifth, published studies use diverse terms to describe trial components, creating difficulty in categorizing studies. Sixth, very few trials replicated the same intervention, and none of the study-level characteristics helped to explain study effects or reduce heterogeneity. This makes providing clear clinical recommendations with regard to details of successful interventions difficult. Seventh, measurement of outcomes was variable in terms of the method of data collection (prospective vs. retrospective) and the specific measures that were collected (fallers vs. falls). Finally, we report here the proportion of fallers as our primary outcome, but in the full report, we describe other outcomes, including the rate of fallers and health outcomes (injury and fractures, quality of life, disability, and mortality). However, these outcomes were much less commonly reported: Only 20 of the included trials reported outcomes of fall-related fractures. In general, we found scant and inconclusive evidence on changing true health outcomes.

Recently, the Prevention of Falls Network Europe published a consensus document describing a common data set for fall prevention interventions; the routine use of these assessment instruments and procedures will enhance the quality and comparability of future trials and expand the available data on health outcomes and other positive outcomes (88). Although the consensus document does not address harms reporting, this is a critical need, particularly because harms were not systematically evaluated in the majority of fall prevention interventions in this review.

In conclusion, current research suggests that clinical interventions, such as vitamin D supplementation, exercise or physical therapy programs, and some comprehensive multifactorial fall assessment and management interventions, can reduce falls and are safe for community-dwelling older adults.

From Drexel University School of Public Health, Philadelphia, Pennsylvania, and Kaiser Permanente Center for Health Research and Oregon Health & Science University, Portland, Oregon.

Acknowledgment: The authors thank Sarah Zuber, Tracy Beil, Kevin Lutz, and Debra Burch for their assistance with manuscript preparation.

Grant Support: By the AHRQ (contract HHSA-290-2007-10057-I).

Potential Conflicts of Interest: Drs. Michael, Whitlock, Lin, Fu, and O'Connor: *Grant (money to institution):* AHRQ. *Payment for writing or reviewing the manuscript (money to institution):* AHRQ. Drs. Michael, Whitlock, Lin, and O'Connor: *Support for travel to meetings for the study or other purposes (money to institution):* AHRQ. Drs. Michael and Lin: *Provision of writing assistance, medicines, equipment, or administrative support (money to institution):* AHRQ. Dr. Gold: *Grant (money to institution):* AHRQ. Disclosures can also be viewed at www.acponline.org/authors/icmje/ConflictOfInterestForms.do?msNum=M10-0104.

Requests for Single Reprints: Yvonne L. Michael, ScD, SM, Epidemiology and Biostatistics, Drexel University School of Public Health, 1505 Race Street, 6th Floor, MS 1033, Philadelphia, PA 19102; e-mail, michaely@drexel.edu.

Current author addresses and author contributions are available at www.annals.org.

References

1. **Kannus P, Sievänen H, Palvanen M, Järvinen T, Parkkari J.** Prevention of falls and consequent injuries in elderly people. Lancet. 2005;366:1885-93. [PMID: 16310556]
2. **Tinetti ME.** Clinical practice. Preventing falls in elderly persons. N Engl J Med. 2003;348:42-9. [PMID: 12510042]
3. **Connell BR, Wolf SL.** Environmental and behavioral circumstances associated with falls at home among healthy elderly individuals. Atlanta FICSIT Group. Arch Phys Med Rehabil. 1997;78:179-86. [PMID: 9041900]
4. **Centers for Disease Control and Prevention (CDC).** Self-reported falls and fall-related injuries among persons aged > or = 65 years—United States, 2006. MMWR Morb Mortal Wkly Rep. 2008;57:225-9. [PMID: 18322444]
5. **Rubenstein LZ, Josephson KR.** The epidemiology of falls and syncope. Clin Geriatr Med. 2002;18:141-58. [PMID: 12180240]
6. **Centers for Disease Control and Prevention (CDC).** Fatalities and injuries from falls among older adults—United States, 1993-2003 and 2001-2005. MMWR Morb Mortal Wkly Rep. 2006;55:1221-4. [PMID: 17108890]
7. Public health surveillance of 1990 injury control objectives for the nation. MMWR CDC Surveill Summ. 1988;37:1-68. [PMID: 3127680]
8. Guideline for the prevention of falls in older persons. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopaedic Surgeons Panel on Falls Prevention. J Am Geriatr Soc. 2001;49:664-72. [PMID: 11380764]
9. **Englander F, Hodson TJ, Terregrossa RA.** Economic dimensions of slip and fall injuries. J Forensic Sci. 1996;41:733-46. [PMID: 8789837]
10. **National Institute for Health and Clinical Excellence.** Falls: The Assessment

and Prevention of Falls in Older People. London: National Institute for Health and Clinical Excellence; 2004.

11. **Chou WC, Tinetti ME, King MB, Irwin K, Fortinsky RH.** Perceptions of physicians on the barriers and facilitators to integrating fall risk evaluation and management into practice. J Gen Intern Med. 2006;21:117-22. [PMID: 16336618]

12. **Fortinsky RH, Iannuzzi-Sucich M, Baker DI, Gottschalk M, King MB, Brown CJ, et al.** Fall-risk assessment and management in clinical practice: views from healthcare providers. J Am Geriatr Soc. 2004;52:1522-6. [PMID: 15341555]

13. **Tinetti ME, Gordon C, Sogolow E, Lapin P, Bradley EH.** Fall-risk evaluation and management: challenges in adopting geriatric care practices. Gerontologist. 2006;46:717-25. [PMID: 17169927]

14. **Michael YL, Whitlock EP, Lin JS, O'Connor EA, Gold R, Zuber SP.** Interventions to Prevent Falls in Older Adults: An Updated Systematic Review. Evidence Report No. 80. AHRQ Publication No. 11-05150-EF-1. Rockville, MD: Agency for Healthcare Research and Quality; 2010.

15. **Whitlock EP, Lin JS, Chou R, Shekelle P, Robinson KA.** Using existing systematic reviews in complex systematic reviews. Ann Intern Med. 2008;148:776-82. [PMID: 18490690]

16. **Gillespie LD, Gillespie WJ, Robertson MC, Lamb SE, Cumming RG, Rowe BH.** Interventions for preventing falls in elderly people. Cochrane Database Syst Rev. 2003:CD000340. [PMID: 14583918]

17. **Cranney A, Hanley D, Horsley T, Fang M, O'Donnell S, Yazdi F, et al.** Effectiveness and Safety of Vitamin D in Relation to Bone Health. AHRQ Publication No. 07-E013. Rockville, MD: Agency for Healthcare Research and Quality; 2007.

18. **Chou R, Dana T, Bougastos C.** Screening for Visual Impairment in Older Adults: Systematic Review to Update the 1996 U.S. Preventive Services Task Force Recommendation. Rockville, MD: Agency for Healthcare Research and Quality; 2009.

19. **Harris RP, Helfand M, Woolf SH, Lohr KN, Mulrow CD, Teutsch SM, et al; Methods Work Group, Third US Preventive Services Task Force.** Current methods of the US Preventive Services Task Force: a review of the process. Am J Prev Med. 2001;20:21-35. [PMID: 11306229]

20. **DerSimonian R, Laird N.** Meta-analysis in clinical trials. Control Clin Trials. 1986;7:177-88. [PMID: 3802833]

21. **Laird RD, Studenski S, Perera S, Wallace D.** Fall history is an independent predictor of adverse health outcomes and utilization in the elderly. Am J Manag Care. 2001;7:1133-8. [PMID: 11767299]

22. **Higgins JP, Thompson SG.** Quantifying heterogeneity in a meta-analysis. Stat Med. 2002;21:1539-58. [PMID: 12111919]

23. **Wagner EH, LaCroix AZ, Grothaus L, Leveille SG, Hecht JA, Artz K, et al.** Preventing disability and falls in older adults: a population-based randomized trial. Am J Public Health. 1994;84:1800-6. [PMID: 7977921]

24. **Spice CL, Morotti W, George S, Dent TH, Rose J, Harris S, et al.** The Winchester falls project: a randomised controlled trial of secondary prevention of falls in older people. Age Ageing. 2009;38:33-40. [PMID: 18829689]

25. **Coleman EA, Grothaus LC, Sandhu N, Wagner EH.** Chronic care clinics: a randomized controlled trial of a new model of primary care for frail older adults. J Am Geriatr Soc. 1999;47:775-83. [PMID: 10404919]

26. **Davison J, Bond J, Dawson P, Steen IN, Kenny RA.** Patients with recurrent falls attending Accident & Emergency benefit from multifactorial intervention—a randomised controlled trial. Age Ageing. 2005;34:162-8. [PMID: 15716246]

27. **Elley CR, Robertson MC, Garrett S, Kerse NM, McKinlay E, Lawton B, et al.** Effectiveness of a falls-and-fracture nurse coordinator to reduce falls: a randomized, controlled trial of at-risk older adults. J Am Geriatr Soc. 2008;56:1383-9. [PMID: 18808597]

28. **Hendriks MR, Bleijlevens MH, van Haastregt JC, Crebolder HF, Diederiks JP, Evers SM, et al.** Lack of effectiveness of a multidisciplinary fall-prevention program in elderly people at risk: a randomized, controlled trial. J Am Geriatr Soc. 2008;56:1390-7. [PMID: 18662214]

29. **Newbury JW, Marley JE, Beilby JJ.** A randomised controlled trial of the outcome of health assessment of people aged 75 years and over. Med J Aust. 2001;175:104-7. [PMID: 11556409]

30. **Tinetti ME, Baker DI, McAvay G, Claus EB, Garrett P, Gottschalk M, et al.** A multifactorial intervention to reduce the risk of falling among elderly people living in the community. N Engl J Med. 1994;331:821-7. [PMID: 8078528]

31. **Close J, Ellis M, Hooper R, Glucksman E, Jackson S, Swift C.** Prevention of falls in the elderly trial (PROFET): a randomised controlled trial. Lancet. 1999;353:93-7. [PMID: 10023893]

32. **Hogan DB, MacDonald FA, Betts J, Bricker S, Ebly EM, Delarue B, et al.** A randomized controlled trial of a community-based consultation service to prevent falls. CMAJ. 2001;165:537-43. [PMID: 11563205]

33. **Lightbody E, Watkins C, Leathley M, Sharma A, Lye M.** Evaluation of a nurse-led falls prevention programme versus usual care: a randomized controlled trial. Age Ageing. 2002;31:203-10. [PMID: 12006310]

34. **van Haastregt JC, Diederiks JP, van Rossum E, de Witte LP, Voorhoeve PM, Crebolder HF.** Effects of a programme of multifactorial home visits on falls and mobility impairments in elderly people at risk: randomised controlled trial. BMJ. 2000;321:994-8. [PMID: 11039967]

35. **Lord SR, Tiedemann A, Chapman K, Munro B, Murray SM, Gerontology M, et al.** The effect of an individualized fall prevention program on fall risk and falls in older people: a randomized, controlled trial. J Am Geriatr Soc. 2005;53:1296-304. [PMID: 16078954]

36. **Shumway-Cook A, Silver IF, LeMier M, York S, Cummings P, Koepsell TD.** 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;62:1420-7. [PMID: 18166695]

37. **Ciaschini PM, Straus SE, Dolovich LR, Goeree RA, Leung KM, Woods CR, et al.** Community-based intervention to optimise falls risk management: a randomised controlled trial. Age Ageing. 2009;38:724-30. [PMID: 19767629]

38. **Salminen MJ, Vahlberg TJ, Salonoja MT, Aarnio PT, Kivelä SL.** Effect of a risk-based multifactorial fall prevention program on the incidence of falls. J Am Geriatr Soc. 2009;57:612-9. [PMID: 19392952]

39. **Dyer CA, Taylor GJ, Reed M, Dyer CA, Robertson DR, Harrington R.** Falls prevention in residential care homes: a randomised controlled trial. Age Ageing. 2004;33:596-602. [PMID: 15381507]

40. **Peri K, Kerse N, Robinson E, Parsons M, Parsons J, Latham N.** Does functionally based activity make a difference to health status and mobility? A randomised controlled trial in residential care facilities (The Promoting Independent Living Study; PILS). Age Ageing. 2008;37:57-63. [PMID: 17965045]

41. **Vind AB, Andersen HE, Pedersen KD, Jørgensen T, Schwarz P.** An outpatient multifactorial falls prevention intervention does not reduce falls in high-risk elderly Danes. J Am Geriatr Soc. 2009;57:971-7. [PMID: 19507291]

42. **Salminen M, Vahlberg T, Kivelä SL.** The long-term effect of a multifactorial fall prevention programme on the incidence of falls requiring medical treatment. Public Health. 2009;123:809-13. [PMID: 19958918]

43. **Ashburn A, Fazakarley L, Ballinger C, Pickering R, McLellan LD, Fitton C.** A randomised controlled trial of a home based exercise programme to reduce the risk of falling among people with Parkinson's disease. J Neurol Neurosurg Psychiatry. 2007;78:678-84. [PMID: 17119004]

44. **Barnett A, Smith B, Lord SR, Williams M, Baumand A.** Community-based group exercise improves balance and reduces falls in at-risk older people: a randomised controlled trial. Age Ageing. 2003;32:407-14. [PMID: 12851185]

45. **Buchner DM, Cress ME, de Lateur BJ, Esselman PC, Margherita AJ, Price R, et al.** The effect of strength and endurance training on gait, balance, fall risk, and health services use in community-living older adults. J Gerontol A Biol Sci Med Sci. 1997;52:M218-24. [PMID: 9224433]

46. **Campbell AJ, Robertson MC, Gardner MM, Norton RN, Tilyard MW, Buchner DM.** Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. BMJ. 1997;315:1065-9. [PMID: 9366737]

47. **Campbell AJ, Robertson MC, Gardner MM, Norton RN, Buchner DM.** Psychotropic medication withdrawal and a home-based exercise program to prevent falls: a randomized, controlled trial. J Am Geriatr Soc. 1999;47:850-3. [PMID: 10404930]

48. **Campbell AJ, Robertson MC, La Grow SJ, Kerse NM, Sanderson GF, Jacobs RJ, et al.** Randomised controlled trial of prevention of falls in people aged > or = 75 with severe visual impairment: the VIP trial. BMJ. 2005;331:817. [PMID: 16183652]

49. **Day L, Fildes B, Gordon I, Fitzharris M, Flamer H, Lord S.** Randomised factorial trial of falls prevention among older people living in their own homes. BMJ. 2002;325:128. [PMID: 12130606]

50. **Green J, Forster A, Bogle S, Young J.** Physiotherapy for patients with mobility problems more than 1 year after stroke: a randomised controlled trial. Lancet. 2002;359:199-203. [PMID: 11812553]

51. **Li F, Harmer P, Fisher KJ, McAuley E, Chaumeton N, Eckstrom E, et al.**

Tai chi and fall reductions in older adults: a randomized controlled trial. J Gerontol A Biol Sci Med Sci. 2005;60:187-94. [PMID: 15814861]

52. **Logghe IH, Zeeuwe PE, Verhagen AP, Wijnen-Sponselee RM, Willemsen SP, Bierma-Zeinstra SM, et al.** Lack of effect of Tai Chi Chuan in preventing falls in elderly people living at home: a randomized clinical trial. J Am Geriatr Soc. 2009;57:70-5. [PMID: 19054193]

53. **Lord SR, Ward JA, Williams P, Strudwick M.** The effect of a 12-month exercise trial on balance, strength, and falls in older women: a randomized controlled trial. J Am Geriatr Soc. 1995;43:1198-206. [PMID: 7594152]

54. **Luukinen H, Lehtola S, Jokelainen J, Väänänen-Sainio R, Lotvonen S, Koistinen P.** Pragmatic exercise-oriented prevention of falls among the elderly: a population-based, randomized, controlled trial. Prev Med. 2007;44:265-71. [PMID: 17174387]

55. **Morgan RO, Virnig BA, Duque M, Abdel-Moty E, Devito CA.** Low-intensity exercise and reduction of the risk for falls among at-risk elders. J Gerontol A Biol Sci Med Sci. 2004;59:1062-7. [PMID: 15528779]

56. **Robertson MC, Devlin N, Gardner MM, Campbell AJ.** Effectiveness and economic evaluation of a nurse delivered home exercise programme to prevent falls. 1: Randomised controlled trial. BMJ. 2001;322:697-701. [PMID: 11264206]

57. **Rubenstein LZ, Josephson KR, Trueblood PR, Loy S, Harker JO, Pietruszka FM, et al.** Effects of a group exercise program on strength, mobility, and falls among fall-prone elderly men. J Gerontol A Biol Sci Med Sci. 2000;55: M317-21. [PMID: 10843351]

58. **Voukelatos A, Cumming RG, Lord SR, Rissel C.** A randomized, controlled trial of tai chi for the prevention of falls: the Central Sydney tai chi trial. J Am Geriatr Soc. 2007;55:1185-91. [PMID: 17661956]

59. **Wolf SL, Barnhart HX, Kutner NG, McNeely E, Coogler C, Xu T.** Reducing frailty and falls in older persons: an investigation of Tai Chi and computerized balance training. Atlanta FICSIT Group. Frailty and Injuries: Cooperative Studies of Intervention Techniques. J Am Geriatr Soc. 1996;44:489-97. [PMID: 8617895]

60. **Kronhed AG, Hallberg I, Ödkvist L, Möller M.** Effect of training on health-related quality of life, pain and falls in osteoporotic women. Advances in Physiotherapy. 2009;11:154-65.

61. **Nelson ME, Layne JE, Bernstein MJ, Nuernberger A, Castaneda C, Kaliton D, et al.** The effects of multidimensional home-based exercise on functional performance in elderly people. J Gerontol A Biol Sci Med Sci. 2004;59:154-60. [PMID: 14999030]

62. **Pahor M, Blair SN, Espeland M, Fielding R, Gill TM, Guralnik JM, et al; LIFE Study Investigators.** Effects of a physical activity intervention on measures of physical performance: Results of the lifestyle interventions and independence for Elders Pilot (LIFE-P) study. J Gerontol A Biol Sci Med Sci. 2006;61:1157-65. [PMID: 17167156].

63. **Bischoff-Ferrari HA, Orav EJ, Dawson-Hughes B.** Effect of cholecalciferol plus calcium on falling in ambulatory older men and women: a 3-year randomized controlled trial. Arch Intern Med. 2006;166:424-30. [PMID: 16505262]

64. **Dhesi JK, Jackson SH, Bearne LM, Moniz C, Hurley MV, Swift CG, et al.** Vitamin D supplementation improves neuromuscular function in older people who fall. Age Ageing. 2004;33:589-95. [PMID: 15501836]

65. **Dukas L, Bischoff HA, Lindpaintner LS, Schacht E, Birkner-Binder D, Damm TN, et al.** Alfacalcidol reduces the number of fallers in a community-dwelling elderly population with a minimum calcium intake of more than 500 mg daily. J Am Geriatr Soc. 2004;52:230-6. [PMID: 14728632]

66. **Gallagher JC, Fowler SE, Detter JR, Sherman SS.** Combination treatment with estrogen and calcitriol in the prevention of age-related bone loss. J Clin Endocrinol Metab. 2001;86:3618-28. [PMID: 11502787]

67. **Pfeifer M, Begerow B, Minne HW, Abrams C, Nachtigall D, Hansen C.** Effects of a short-term vitamin D and calcium supplementation on body sway and secondary hyperparathyroidism in elderly women. J Bone Miner Res. 2000; 15:1113-8. [PMID: 10841179]

68. **Pfeifer M, Begerow B, Minne HW, Suppan K, Fahrleitner-Pammer A, Dobnig H.** Effects of a long-term vitamin D and calcium supplementation on falls and parameters of muscle function in community-dwelling older individuals. Osteoporos Int. 2009;20:315-22. [PMID: 18629569]

69. **Porthouse J, Cockayne S, King C, Saxon L, Steele E, Aspray T, et al.** Randomised controlled trial of calcium and supplementation with cholecalciferol (vitamin D3) for prevention of fractures in primary care. BMJ. 2005;330:1003. [PMID: 15860827]

70. **Prince RL, Austin N, Devine A, Dick IM, Bruce D, Zhu K.** Effects of ergocalciferol added to calcium on the risk of falls in elderly high-risk women. Arch Intern Med. 2008;168:103-8. [PMID: 18195202]

71. **Kärkkäinen MK, Tuppurainen M, Salovaara K, Sandini L, Rikkonen T, Sirola J, et al.** Does daily vitamin D 800 IU and calcium 1000 mg supplementation decrease the risk of falling in ambulatory women aged 65-71 years? A 3-year randomized population-based trial (OSTPRE-FPS). Maturitas. 2010;65: 359-65. [PMID: 20060665]

72. **Cumming RG, Ivers R, Clemson L, Cullen J, Hayes MF, Tanzer M, et al.** Improving vision to prevent falls in frail older people: a randomized trial. J Am Geriatr Soc. 2007;55:175-81. [PMID: 17302652]

73. **Foss AJ, Harwood RH, Osborn F, Gregson RM, Zaman A, Masud T.** Falls and health status in elderly women following second eye cataract surgery: a randomised controlled trial. Age Ageing. 2006;35:66-71. [PMID: 16364936]

74. **Harwood RH, Foss AJ, Osborn F, Gregson RM, Zaman A, Masud T.** Falls and health status in elderly women following first eye cataract surgery: a randomised controlled trial. Br J Ophthalmol. 2005;89:53-9. [PMID: 15615747]

75. **Stevens M, Holman CD, Bennett N, de Klerk N.** Preventing falls in older people: outcome evaluation of a randomized controlled trial. J Am Geriatr Soc. 2001;49:1448-55. [PMID: 11890582]

76. **Clemson L, Cumming RG, Kendig H, Swann M, Heard R, Taylor K.** The effectiveness of a community-based program for reducing the incidence of falls in the elderly: a randomized trial. J Am Geriatr Soc. 2004;52:1487-94. [PMID: 15341550]

77. **Chang JT, Morton SC, Rubenstein LZ, Mojica WA, Maglione M, Suttorp MJ, et al.** Interventions for the prevention of falls in older adults: systematic review and meta-analysis of randomised clinical trials. BMJ. 2004;328:680. [PMID: 15031239]

78. **Gillespie LD, Robertson MC, Gillespie WJ, Lamb SE, Gates S, Cumming RG, et al.** Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2009:CD007146. [PMID: 19370674]

79. **Gates S, Fisher JD, Cooke MW, Carter YH, Lamb SE.** Multifactorial assessment and targeted intervention for preventing falls and injuries among older people in community and emergency care settings: systematic review and meta-analysis. BMJ. 2008;336:130-3. [PMID: 18089892]

80. **Sherrington C, Whitney JC, Lord SR, Herbert RD, Cumming RG, Close JC.** Effective exercise for the prevention of falls: a systematic review and meta-analysis. J Am Geriatr Soc. 2008;56:2234-43. [PMID: 19093923]

81. **Beswick AD, Rees K, Dieppe P, Ayis S, Gooberman-Hill R, Horwood J, et al.** Complex interventions to improve physical function and maintain independent living in elderly people: a systematic review and meta-analysis. Lancet. 2008; 371:725-35. [PMID: 18313501]

82. **Spivack BS.** Preventing falls: direct intervention is needed [Letter]. BMJ. 2008;336:343. [PMID: 18276673]

83. **Tinetti ME.** Multifactorial fall-prevention strategies: time to retreat or advance [Editorial]. J Am Geriatr Soc. 2008;56:1563-5. [PMID: 18808601]

84. **Logan PA, Coupland CA, Gladman JR, Sahota O, Stoner-Hobbs V, Robertson K, et al.** Community falls prevention for people who call an emergency ambulance after a fall: randomised controlled trial. BMJ. 2010;340:c2102. [PMID: 20460331]

85. **Trivedi DP, Doll R, Khaw KT.** Effect of four monthly oral vitamin D3 (cholecalciferol) supplementation on fractures and mortality in men and women living in the community: randomised double blind controlled trial. BMJ. 2003; 326:469. [PMID: 12609940]

86. **Sanders KM, Stuart AL, Williamson EJ, Simpson JA, Kotowicz MA, Young D, et al.** Annual high-dose oral vitamin D and falls and fractures in older women: a randomized controlled trial. JAMA. 2010;303:1815-22. [PMID: 20460620]

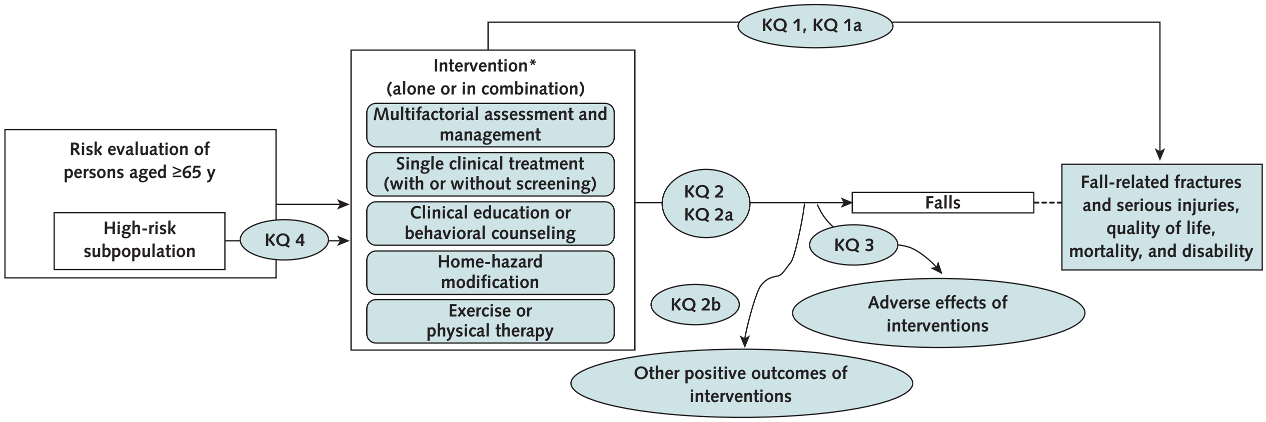
87. **Dawson-Hughes B, Harris SS.** High-dose vitamin D supplementation: too much of a good thing? [Editorial]. JAMA. 2010;303:1861-2. [PMID: 20460627]

88. **Lamb SE, Jorstad-Stein EC, Hauer K, Becker C; Prevention of Falls Network Europe and Outcomes Consensus Group.** Development of a common outcome data set for fall injury prevention trials: the Prevention of Falls Network Europe consensus. J Am Geriatr Soc. 2005;53:1618-22. [PMID: 16137297]

Current Author Addresses: Dr. Michael: Epidemiology and Biostatistics, Drexel University School of Public Health, 1505 Race Street, 6th Floor, MS 1033, Philadelphia, PA 19102.
Drs. Whitlock, Lin, O'Connor, and Gold: Kaiser Permanente Center for Health Research, 3800 North Interstate Avenue, Portland, OR 97227-1098.
Dr. Fu: Department of Public Health and Preventive Medicine, Oregon Health & Science University, 3181 SW Sam Jackson Park Road, Mail Code CB 669, Portland, OR 97239-3098.

Author Contributions: Conception and design: Y.L. Michael, E.P. Whitlock, J.S. Lin, E.A. O'Connor.
Analysis and interpretation of the data: Y.L. Michael, E.P. Whitlock, J.S. Lin, R. Fu, E.A. O'Connor, R. Gold.
Drafting of the article: Y.L. Michael, E.P. Whitlock, R. Fu, E.A. O'Connor.
Critical revision for important intellectual content: Y.L. Michael, E.P. Whitlock, J.S. Lin.
Final approval of the article: Y.L. Michael, E.A. O'Connor.
Statistical expertise: R. Fu, E.A. O'Connor.
Obtaining of funding: E.P. Whitlock.
Administrative, technical, or logistic support: E.A. O'Connor.
Collection and assembly of data: Y.L. Michael, J.S. Lin, R. Gold.

Appendix Figure 1. **Key questions.**



Key Questions

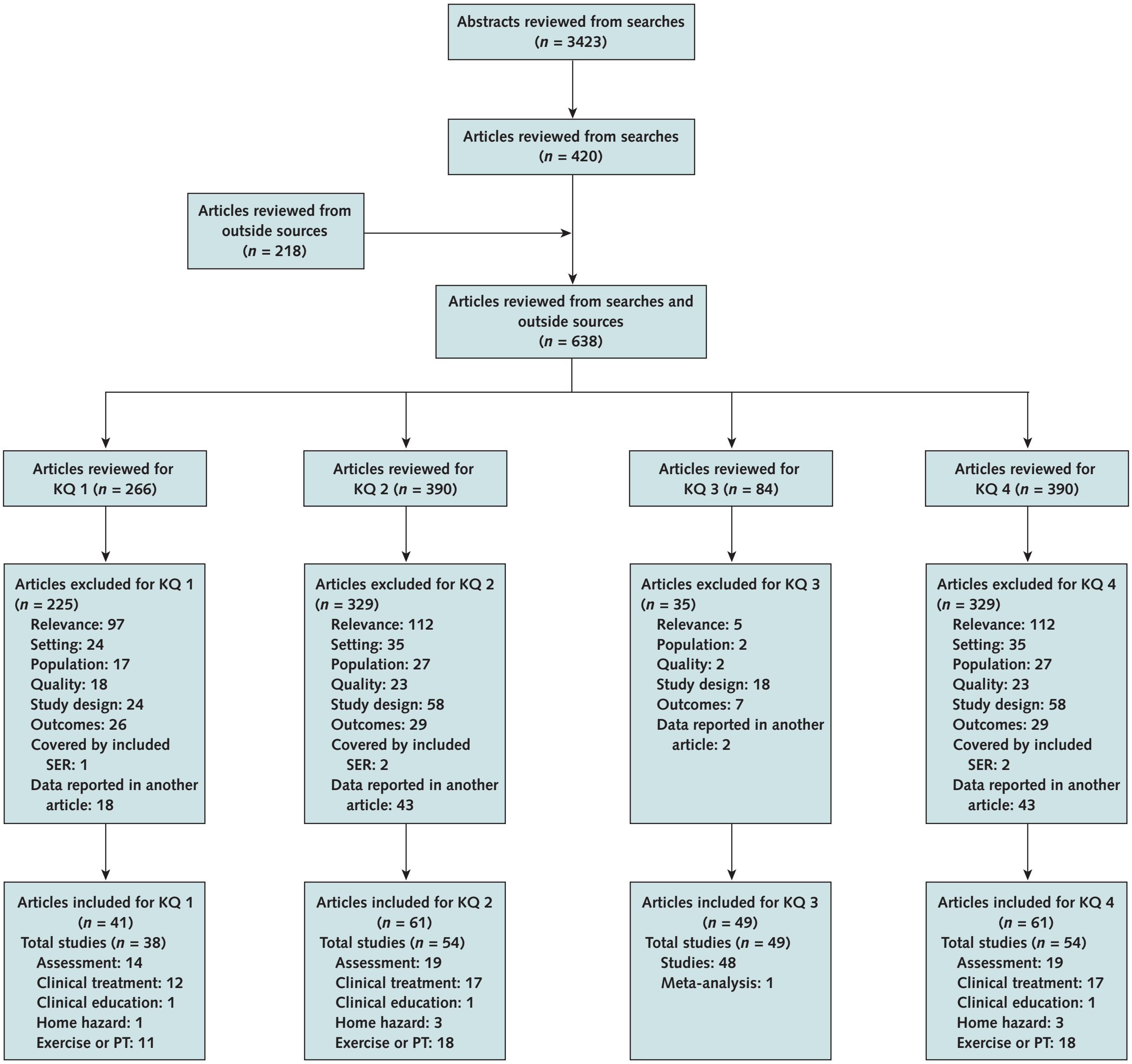
- KQ 1: Is there direct evidence that primary care interventions reduce fall-related injury, improve quality of life, reduce disability, or reduce mortality when used alone or in combination to reduce falls in community-dwelling older adults?
- KQ 1a: Do these interventions reduce injury, improve quality of life, reduce disability, or reduce mortality in older adults specifically identified as high risk for falls?
- KQ 2: Do primary care interventions used alone or in combination in community-dwelling older adults reduce risk for or rate of falls or fallers?
- KQ 2a: Do these interventions reduce falls in older adults specifically identified as high risk for falls?
- KQ 2b: Are there positive outcomes other than reduced falls, and related morbidity and mortality, that result from primary care fall interventions?
- KQ 3: What are the adverse effects associated with interventions to reduce falls?
- KQ 4: How are high-risk older adults identified for primary care fall interventions?

This review addresses KQs 2 and 3. KQ = key question.
* Multifactorial assessment and management includes multifactor risk assessment, comprehensive geriatric assessment, and ≥2 of the following screenings for fall risk: vision, gait, mobility, strength, medication review, cognitive impairment, orthostatic hypotension, and environmental risks. Single clinical treatment (with or without screening) includes vision correction, medication optimization or adjustment, assistive device prescription, pharmacologic or nutritional interventions, treatment of orthostatic hypotension, urinary incontinence, and hip protectors. Clinical education or behavioral counseling includes exercise, fall risk reduction, and a home-hazard checklist. Home-hazard modification includes identifying and removing potential fall hazards, adding grab bars and handrails, and modifying the environment to improve mobility and safety. Exercise or physical therapy includes physical exercise, mobility and gait training, muscle strengthening, balance training, and training for recurrent fallers.

Appendix Table 1. **Intervention Category Definitions**

Multifactorial assessment and management	Multifactorial assessment and management interventions include a clinical assessment of ≥2 domains of functioning, generally supplemented by assessment of falls-related or general geriatric risk factors or conditions, with assessment results used as a basis for remedial management. In this review, multifactorial risk assessments may have been a comprehensive geriatric assessment or a falls-focused assessment, generally including ≥2 of the following screenings: vision, gait, mobility, strength, medication review, cognitive impairment, orthostatic hypotension, and environmental risks. Management approaches were categorized as comprehensive (treatments and education to comprehensively address risks, conditions, or functional limitations identified through the assessment) or noncomprehensive (less comprehensive interventions that provided only referral or provided treatment of selected risks, conditions, or functional limitations).
Single clinical treatment	Single clinical treatment protocols were defined as those with or without screening to identify persons needing treatment for a single fall-related risk factor, including vision correction, medication optimization or adjustment, assistive device prescription, pharmacologic or nutritional interventions, treatment of orthostatic hypotension, urinary incontinence, and hip protectors.
Clinical education or counseling	Education or behavioral counseling included interventions delivered by primary care clinicians and related health care staff to assist patients in adopting, changing, or maintaining behaviors related to fall risk; interventions include exercise, fall risk reduction, or a home-hazard checklist.
Home-hazard modification	Home visits to identify and remove potential fall hazards, add grab bars and handrails, or otherwise modify the environment to improve mobility and safety.
Exercise or physical therapy	Organized programs for individuals or small groups that are part of a health care setting or widely available for referral in most communities, including physical exercise, mobility and gait training, muscle strengthening, balance training, and training for recurrent fallers. Programs may be home-based or be delivered in a community setting.

Appendix Figure 2. **Summary of evidence search and selection.**



Articles may have been included for more than 1 KQ and more than 1 intervention. KQ = key question; PT = physical therapy; SER = systematic evidence review.

Appendix Table 2. **Effectiveness of Multifactorial Assessment and Management Interventions to Prevent Falls in Older Adults**

Study, Year (Reference)	Setting	Participants: Randomly Assigned, *n*	Participants: Mean Age, *y*	Participants: Women, %	Participants: History of Falling, %	Intervention	Fallers, *n (%)*
Ciaschini et al, 2009 (37)	Canada	IG: 101 CG: 100	IG: 72 CG: 71	IG: 91 CG: 96	NR	IG: assessment with PT, OT, education, and referrals CG: usual care	IG: 26 (26) CG: 17 (17)
Close et al, 1999 (31)	United Kingdom	IG: 184 CG: 213	IG: 77 CG: 79	IG: 68 CG: 67	IG: 64 CG: 66	IG: assessment with CM CG: usual care	IG: 59 (32) CG: 111 (52)
Coleman et al, 1999 (25)	United States	IG: 96 CG: 73	IG: 77 CG: 77	IG: 48 CG: 49	IG: 44 CG: 49	IG: assessment and management in chronic care clinics CG: usual care	IG: 42 (44) CG: 28 (38)
Davison et al, 2005 (26)	United Kingdom	IG: 159 CG: 154	IG: 77 CG: 77	IG: 73 CG: 72	100	IG: assessment with CM, including home-hazard modification CG: usual care	IG: 95 (66) CG: 103 (69)
Dyer et al, 2004 (39)	United Kingdom	IG: 102 CG: 94	IG: 87 CG: 87	IG: 79 CG: 77	NR	IG: assessment with feedback to PCP, referrals for eye and foot care, and exercise training CG: assessment only	IG: 56 (55) CG: 51 (54)
Elley et al, 2008 (27)	New Zealand	IG: 155 CG: 157	IG: 80 CG: 81	IG: 68 CG: 70	100	IG: assessment with referrals and home exercise training CG: social visit	IG: 106 (68) CG: 98 (62)
Hendriks et al, 2008 (28)	The Netherlands	IG: 166 CG: 167	IG: 75 CG: 75	IG: 67 CG: 70	100	IG: assessment with feedback to PCP and patient CG: usual care	IG: 55 (46) CG: 61 (47)
Hogan et al, 2001 (32)	Canada	IG: 79 CG: 84	IG: 77.4 CG: 77.9	IG: 70 CG: 74	100	IG: assessment with referrals for services and exercise training CG: home visit with leisure assessment	IG: 54 (72) CG: 61 (79)
Lightbody et al, 2002 (33)	United Kingdom	IG: 171 CG: 177	IG: 75 CG: 75	IG: 77 CG: 72	IG: 42 CG: 42	IG: assessment with referrals and simple home-hazard modification CG: usual care	IG: 39 (25) CG: 41 (26)
Lord et al, 2005 (35)	Australia	IG (CM): 210 IG (NCM): 206 CG: 204	IG (CM): 80 IG (NCM): 81 CG: 80	IG (CM): 67 IG (NCM): 62 CG: 69	NR	IG (CM): assessment with individualized management and exercise training IG (NCM): assessment with referral CG: wait-list control	IG (CM): 93 (46) IG (NCM): 94 (49) CG: 90 (45)
Newbury et al, 2001 (29)	Australia	IG: 50 CG: 50	IG: 79 CG: 80	IG: 66 CG: 60	NR	IG: complete geriatric health assessment with feedback to PCP CG: usual care	IG: 12 (27) CG: 17 (39)
Peri et al, 2008 (40)	New Zealand	IG: 73 CG: 76	IG: 87 CG: 85	IG: 85 CG: 83	NR	IG: assessment with feedback to PCP and tailored physical activity plan for patient CG: usual care	IG: 31 (42) CG: 43 (57)
Salminen et al, 2009 (38)	Finland	IG: 293 CG: 298	IG: 73 CG: 73	IG: 86 CG: 82	100	IG: assessment with medication management, education, vision referral, and exercise training CG: social visit with fall prevention written material	IG: 140 (48) CG: 131 (44)
Shumway-Cook et al, 2007 (36)	United States	IG: 226 CG: 227	76	IG: 77 CG: 76	NR	IG: assessment with feedback to PCP, education, and exercise training CG: fall prevention written material	IG: 124 (55) CG: 130 (57)
Spice et al, 2009 (24)	United Kingdom	IG (CM): 213 CG: 162	IG: 81 CG: 83	IG: 71 CG: 76	100	IG: assessment with comprehensive management in multidisciplinary clinic CG: assessment only	IG: 158 (75) CG: 133 (84)
Tinetti et al, 1994 (30)	United States	IG: 153 CG: 148	IG: 78 CG: 78	IG: 69 CG: 69	IG: 41 CG: 44	IG: assessment with comprehensive management including home-hazard modification CG: social visits only	IG: 52 (35) CG: 68 (47)
Van Haastregt et al, 2000 (34)	The Netherlands	IG: 159 CG: 157	IG: 77 CG: 72	IG: 65 CG: 65	IG: 38 CG: 36	IG: assessment with referrals and simple home-hazard modification CG: usual care	IG: 63 (50) CG: 53 (44)
Vind et al, 2009 (41)	Denmark	IG: 196 CG: 196	IG: 74 CG: 75	IG: 73 CG: 75	100	IG: assessment with comprehensive management in geriatric clinic and through referrals CG: usual care	IG: 110 (56) CG: 101 (52)
Wagner et al, 1994 (23)	United States	IG: 635 CG: 607	IG: 73 CG: 73	IG: 60 CG: 59	IG: 35 CG: 33	IG: assessment with feedback to PCP, exercise training, and follow-up telephone calls CG: usual care	IG: 175 (28) CG: 223 (37)

CG = control group; CM = comprehensive management; IG = intervention group; NCM = noncomprehensive management; NR = not reported; OT = occupational therapy; PCP = primary care provider; PT = physical therapy.

Appendix Table 3. Effectiveness of Exercise or Physical Therapy Interventions to Prevent Falls in Older Adults

Study, Year (Reference)	Setting	Participants				Intervention	Fallers, *n (%)*
		Randomly Assigned, *n*	Mean Age, *y*	Women, %	History of Falling, %		
Ashburn et al, 2007 (43)	United Kingdom	IG: 70 CG: 72	IG: 73 CG: 72	IG: 46 CG: 33	100	IG: ST and balance training CG: usual care	IG: 46 (73) CG: 49 (78)
Barnett et al, 2003 (44)	Australia	IG: 83 CG: 80	IG: 74 CG: 75	IG: 69 CG: 64	IG: 43 CG: 41	IG: ST, ET, physical therapy, and education CG: fall prevention written material	IG: 27 (36) CG: 37 (50)
Buchner et al, 1997 (45)	United States	IG (ET): 25	IG (ET): 75	IG (ET): 52	IG (ET): 20	IG (ET): ET	IGs combined: 32 (42)
		IG (ST): 25 IG (ET + ST): 25 CG: 30	IG (ST): 74 IG (ET + ST): 75 CG: 75	IG (ST): 52 IG (ET + ST): 52 CG: 50	IG (ST): 16 IG (ET + ST): 28 CG: 23	IG (ST): resistance training IG (ET + ST): ET and ST and CG: usual care	CG: 18 (60)
Campbell et al, 1997 (46)	New Zealand	IG: 116 CG: 117	IG: 84 CG: 84	100	IG: 41 CG: 47	IG: ST, balance training, walking, and social visits CG: social visits only	IG: 53 (46) CG: 62 (53)
Campbell et al, 1999 (47)	New Zealand	IG1: 21 IG2: 24 CG: 24	IG1: 73 IG2: 76 CG: 75	IG1: 71 IG2: 79 CG: 79	IG1: 10 IG2: 54 CG: 33	IG: ST, balance training, walking, with or without medication management CG: medication management only	Reported rates only
Campbell et al, 2005 (48)	New Zealand	IG (EX): 97 CG: 96	IG (EX): 83 CG: 84	IG (EX): 74 CG: 70	IG (EX): 42 CG: 50	IG (EX): ST and balance training, walking CG: social visits	IG (ST): 47 (48) CG: 59 (61)
Day et al, 2002 (49)	Australia	IG (EX): 135 CG: 137	76.1	59.8	NR	IG: ST and balance and flexibility training CG: usual care	IG: 76 (56) CG: 87 (64)
Green et al, 2002 (50)	United Kingdom	IG: 85 CG: 85	IG: 72 CG: 74	IG: 42 CG: 46	NR	IG: physical therapy CG: usual care	IG: 30 (35) CG: 23 (27)
Kronhed et al, 2009 (60)	Sweden	IG: 31 CG: 34	IG: 72 CG: 71	100	IG: 19 CG: 44	IG: ST and balance training CG: usual care	Reported rates only
Li et al, 2005 (51)	United States	IG: 125 CG: 131	IG: 77 CG: 78	IG: 70 CG: 70	IG: 42 CG: 31	IG: tai chi CG: stretching and relaxation classes	IG: 27 (28) CG: 43 (46)
Logghe et al, 2009 (52)	The Netherlands	IG: 138 CG: 131	IG: 78 CG: 77	IG: 70 CG: 73	IG: 64 CG: 60	IG: tai chi and education CG: education only	IG: 58 (42) CG: 59 (45)
Lord et al, 1995 (53)	Australia	IG: 100 CG: 97	IG: 72 CG: 72	100	IG: 28 CG: 29	IG: ST, ET, and flexibility and coordination training CG: NR	IG: 26 (35) CG: 33 (35)
Luukinen et al, 2007 (54)	Finland	IG: 243 CG: 243	IG: 88 CG: 88	IG: 78 CG: 80	NR	IG: walking, standing exercises to improve strength and balance CG: usual care	IG: 126 (58) CG: 136 (62)
Morgan et al, 2004 (55)	United States	IG: 119 CG: 110	IG: 81 CG: 80	IG: 72 CG: 69	IG: 39 CG: 33	IG: ST, balance and flexibility training, walking CG: usual care	IG: 34 (29) CG: 34 (31)
Robertson et al, 2001 (56)	New Zealand	IG: 121 CG: 119	IG: 81 CG: 81	IG: 68 CG: 67	IG: 36 CG: 38	IG: ST, balance training, and walking CG: usual care	Reported rates only
Rubenstein et al, 2000 (57)	United States	IG: 31 CG: 28	IG: 76 CG: 74	0	IG: 48 CG: 64	IG: ST, ET, and balance training CG: usual care	IG: 12 (39) CG: 9 (32)
Voukelatos et al, 2007 (58)	Australia	IG: 353 CG: 349	IG: 69 CG: 69	IG: 85 CG: 83	IG: 31 CG: 36	IG: tai chi CG: wait-list control	IG: 71 (21) CG: 81 (24)
Wolf et al, 1996 (59)	United States	IG: 72 CG: 64	IG: 77 CG: 75	IG: 81 CG: 84	IG: 42 CG: 34	IG: tai chi CG: general education classes (not fall prevention)	Reported rates only

CG = control group; ET = endurance training; EX = exercise; IG = intervention group; NR = not reported; ST = strength training.

Appendix Table 4. Effectiveness of Single Clinical Treatment Interventions to Prevent Falls in Older Adults

Study, Year (Reference)	Setting	Participants				Intervention	Fallers, *n* (%)
		Randomly Assigned, *n*	Mean Age, *y*	Women, %	History of Falling, %		
Bischoff-Ferrari et al, 2006 (63)	United States	IG: 219 CG: 226	IG: 71 CG: 71	IG: 55 CG: 55	NR	IG: vitamin D CG: placebo	IG: 107 (49) CG: 124 (55)
Dhesi et al, 2004 (64)	United Kingdom	IG: 70 CG: 69	IG: 77 CG: 77	IG: 76 CG: 80	100	IG: vitamin D CG: placebo	IG: 11 (16) CG: 14 (20)
Dukas et al, 2004 (65)	Switzerland	IG: 193 CG: 187	IG: 75 CG: 75	51	NR	IG: vitamin D CG: placebo	IG: 40 (21) CG: 46 (25)
Gallagher et al, 2001 (66)	United States	IG: 123 CG: 123	IG: 72 CG: 71	100	NR	IG: vitamin D, dietary advice CG: placebo, dietary advice	IG: 59 (48) CG: 77 (63)
Kärkkäinen et al, 2010 (71)	Finland	IG: 287 CG: 306	IG: 67 CG: 67	100	NR	IG: vitamin D CG: no supplementation	IG: 179 (62) CG: 205 (67)
Pfeifer et al, 2000 (67)	Germany	IG: 74 CG: 74	IG: 75 CG: 75	100	NR	IG: vitamin D and calcium CG: calcium only	IG: 11 (16) CG: 19 (28)
Pfeifer et al, 2009 (68)	Austria and Germany	IG: 121 CG: 121	IG: 76 CG: 77	IG: 74 CG: 75	NR	IG: vitamin D and calcium CG: calcium only	IG: 49 (40) CG: 75 (63)
Porthouse et al, 2005 (69)	United Kingdom	IG: 1321 CG: 1993	IG: 77 CG: 77	100	IG: 34 CG: 44	IG: vitamin D and calcium, education CG: education only	Reported rates only
Prince et al, 2008 (70)	Australia	IG: 151 CG: 151	IG: 77 CG: 77	100	100	IG: vitamin D and calcium CG: calcium only	IG: 80 (53) CG: 95 (63)
Cumming et al, 2007 (72)	Australia	IG: 309 CG: 307	IG: 81 CG: 80	IG: 67 CG: 68	NR	IG: vision correction CG: usual care	IG: 201 (65) CG: 153 (50)
Day et al, 2002 (49)	Australia	IG: 139 CG: 137	76.1	59.8	NR	IG: vision correction CG: wait-list control	IG: 84 (60) CG: 87 (64)
Foss et al, 2006 (73)	United Kingdom	IG: 120 CG: 119	IG: 79 CG: 45	100	IG: 48 CG: 80	IG: expedited cataract surgery CG: routine wait for cataract surgery	IG: 48 (40) CG: 41 (34)
Harwood et al, 2005 (74)	United Kingdom	IG: 154 CG: 152	IG: 79 CG: 47	100	IG: 51 CG: 78	IG: expedited cataract surgery CG: routine wait for cataract surgery	IG: 76 (49) CG: 69 (45)
Campbell et al, 1999 (47)	New Zealand	IG: 24 CG: 24	IG: 75 CG: 75	IG: 75 CG: 79	IG: 46 CG: 33	IG: withdrawal of treatment with psychotropic medication CG: usual care	Reported rates only

CG = control group; IG = intervention group; NR = not reported.

Appendix Table 5. Effectiveness of Home-Hazard Modification Interventions to Prevent Falls in Older Adults

Study, Year (Reference)	Setting	Participants				Intervention	Fallers, *n* (%)
		Randomly Assigned, *n*	Mean Age, *y*	Women, %	History of Falling, %		
Campbell et al, 2005 (48)	New Zealand	IG: 100 CG: 96	IG: 83 CG: 84	IG: 66 CG: 70	IG: 45 CG: 50	IG: home-hazard modification CG: social visits only	IG: 36 (36) CG: 59 (61)
Day et al, 2002 (49)	Australia	IG: 136 CG: 137	76	59.8	NR	IG: home-hazard modification CG: usual care	IG: 78 (57) CG: 87 (64)
Stevens et al, 2001 (75)	Australia	IG: 635 CG: 1244	IG: 76 CG: 76	IG: 54 CG: 52	IG: 26 CG: 27	IG: home-hazard modification and education CG: education alone	Odds ratio, 0.97 (95% CI, 0.74–1.28)

CG = control group; IG = intervention group; NR = not reported.

Appendix Table 6. **Effectiveness of Clinical Education or Behavioral Counseling Interventions to Prevent Falls in Older Adults**

Study, Year (Reference)	Setting	Participants				Intervention	Fallers, *n* (%)
		Randomly Assigned, *n*	Mean Age, *y*	Women, %	History of Falling (≥2 Falls), %		
Clemson et al, 2004 (76)	Australia	IG: 157	IG: 78	IG: 74	IG: 48	IG: seven 2-h sessions weekly, plus home visit and booster session	IG: 82 (52)
		CG: 153	CG: 78	CG: 74	CG: 49	CG: up to 2 social visits	CG: 89 (58)

CG = control group; IG = intervention group; NR = not reported.