

# Reducing Risk of Falls in Older Adults: Shoe-wear Recommendations, Modifications, and Special Considerations

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## Research Question

For older adults ( $\geq 65$  years-old), what are the most up-to-date shoe-wear recommendations for falls prevention?

## Background

The overwhelming prevalence of falls among older adults often prompts Physical Therapy intervention. In fact, falls within this population account for the majority of injuries that contribute to an increase in morbidity and mortality, and a reported \$50 billion in direct medical expenses.<sup>1</sup> While there are a number of considerations that any given provider should explore when screening patients for falls risk, shoe-wear concerns and subsequent intervention have been identified, but are often neglected.<sup>2</sup> My clinical experience suggests that older adults often ask about shoe-wear – “What is the best?” Alternatively, many patients have reported that they did not know that shoe-wear could contribute to falls.<sup>1</sup> Given these reasons, it is increasingly important to identify up-to-date information regarding appropriate shoe-wear for older adults in order to provide the best evidence-based interventions and recommendations for this growing population.

Older adults with a history of falls are more likely to have pre-existing foot pain and foot deformities and/or impairments.<sup>3</sup> As a result, I strive to dig deeper and ask, is it possible to address any combination of these concerns through shoe-wear modifications? If so, is it clinically significant? What are some other special considerations related to shoe-wear? For example, how can we ensure the understanding and implementation of these recommendations amongst those who share different cultures, languages, resources, or have cognitive disabilities?

**My goal is to develop a strong basis for shoe-wear recommendations for falls prevention, and to further deepen my understanding of these topics to educate providers, and ensure that I maximize the number of individuals who could benefit from these recommendations.**

## Evidence Table

### Search Strategy

Terms used to guide the search strategy			
Patient/Client Group	Intervention (or Assessment)	Comparison	Outcome(s)
Older adults Geriatric High Falls Risk	Shoe-wear Foot-wear Foot Feet	N/A <i>(Any studies included that have a comparison are incidental)</i>	Falls risk Falls prevention

1. Older adult OR geriat\* OR aged
2. Shoe\* OR foot-wear OR foot OR feet OR orthotic
3. Fall\*
4. Prevent\*
5. #1 AND #2 AND #3 AND #4 → PubMed generated 726 results.
6. #5 with the following filters: Meta-Analyses, Randomized Controlled Trials, Systematic Reviews → 114 results
  - a. Many of these articles did not directly measure fall risk, reviewed other interventions other than change in shoe-wear and/or included individuals with chronic conditions

#### Databases Searched

- Cochrane
- PEDro
- PubMed
- Web of Science

#### Limits to this Search Strategy (to narrow or widen search, if needed):

Needed to narrow search later in order to address concerns about specific populations and special considerations. However, it is most appropriate to start with a broader search strategy with a focus of older adults, shoe-wear, and fall risk to develop a clear understanding of general recommendations.

## Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"><li>• Older adults</li><li>• History of falls</li><li>• High falls risk</li><li>• Systematic Reviews</li><li>• Randomized Controlled Trials</li><li>• Clinical Practice Guidelines for shoe-wear related to falls</li></ul>	<ul style="list-style-type: none"><li>• Presence of neurological conditions</li><li>• Presence of acute injury or chronic conditions that could affect pain, sensation and subsequent gait pattern</li><li>• Narrative review</li><li>• Case studies</li><li>• Studies before 2010</li></ul>

## Included Studies

1. Summary of 4 most relevant articles retrieved that met inclusion and exclusion criteria and were reviewed in full

### Lower-Limb Factors Associated with Balance and Falls in Older Adults. Neville et al. (2019)

**Level of Evidence<sub>4</sub> and Study Design** 3a; Systematic Review and Meta-analysis of narrative reviews, clinical trials (RCTs), conference abstracts or case reports + Clinical Synthesis

## Relevance and Findings

**High-Moderate Relevance:** LE factors and footwear that may increase falls risk in older adults:

Findings are described well in pathway figures at end of work:

Plantar skin and soft tissue changes, and sensory impairment - Low quality evidence available. However, less compliance and poor hydration of tissues, and sensory impairment accompanied with aging may be a risk factor of foot pains and deformities, which do have stronger links to falls. Therefore, it is important screen for these changes early on.

Tx – Good hydration and shoe-wear prophylactically.

Ankle/foot ROM – The loss of DF at TCJ, flexibility at MPJ, and ankle inversion and eversion negatively affects gait and balance. Fallers (> 2x/yr) have reduced ankle ROM, but no significant differences at MPJ.

Tx – Multimodal interventions best: Small effect of stretching ankle on its own, whole-body vibration.

**Ankle/foot strength** – Generalized loss of m mass in older adults (Type II > Type I = poorer power and F production), and poorer neural activation = “” and slower response, which all contribute too poor balance.

Tx - Strengthen muscles for postural stability (TA, gastric, hamstrings, quads, and distal LE muscles that perform big and lesser toe movements). There is evidence backing exercises specific to the foot/ankle and a general strengthening program in order to improve balance *and* reduce falls.

**Ankle/foot deformities** – Aging is positively correlated with foot deformities, which is linked to poor balance. The presence of hallux valgus (bunion) has the strongest relationship with falls and balance. Pes planus (flattened arch) is explains medially-displaced loading, an increased presence of pain, and increased number of other foot deformities [bunion, hallux rigidus and hammer toes] which are linked to falls. (Pes planus has indirect relationship to falls risk).

Tx – Prevent arch collapse through orthotics, supportive shoes, strengthening. Surgical intervention as a last resort as needed.

**Shoe-wear (in general)** – The following has been shown to increase fall risk and/or reduce balance: high heels, low-collar shoes, and thick and compliant soles. High heels specifically (> 2.5 cm or ~1 in) have been extensively studied: There is an increased postural sway, careful walking pattern and nearly doubled fall risk (and fractures). There are mixed results, but there is some caution against barefoot walking and using sandals/slippers, especially when diabetes/neuropathy is present (more gait deviations).

Tx – < 2.5 cm heel, high-collar shoes with laces (limited evidence, but “promising” secondary to increased proprioception and m/l stability) → there is caution in restricting too much motion at the ankle joint, however; athletic and canvas shoes, and wide, thin, hard soles.

**Orthotics** – May improve static and dynamic balance by supporting and aligning the feet, and helping mechanoreceptors be better positioned to process information about the surface.

Tx – Various foot and ankle-foot orthotics have improved balance. Textured insoles to enhance mechanoreceptors?

**Pain** – 76% of older adults have pain (24% foot pain), which significantly increases the odds of falling by 87-260%, especially chronic pain. Plantar fasciitis had the greatest association (6.8x more likely to fall). Mechanisms include gait/balance deviations, decreased physical activity (contributes to frailty), and increased fear of falling (13.3x more likely to report with foot pain). Arthritis (chronic) is associated with falls. NM effects can slow response time and weaken muscle.

## **Interventions for preventing falls in older people living in the community (Review). Gillespie et al. (2012)**

**Level of Evidence<sub>4</sub> and Study Design** 1a; Cochrane Systematic Review of RCTs and quasi-randomized trials

### **Relevance and Findings**

**Moderate Relevance:** Discusses multiple interventions found in 159 trials. However, relatively little information reported on shoe-wear.

Some interventions explored included the following:

**Effective in reducing falls and/or fall risk:** home and group-based exercise, tai chi, multifactorial interventions, home safety assessments/ modifications, withdrawal of psychotropic medications, pacemakers when falls are associated with carotid sinus hypersensitivity, anti-slip shoes in icy conditions, foot and ankle exercises (to increase reps and resistance based on symptoms), and custom in-soles and foot-wear assessment when pain is present (see more below)

**Ineffective:** vitamin D, most vision treatments, education, cognitive behavioral intervention

**Shoe-wear:** Yaktrax in icy conditions and “balance-enhancing insoles” based on McKiernan et al. and Perry et al. studies from the 2000s with mostly low risk of bias were researched. The McKiernan study = significant reduction in outdoor falls. Balance-enhancing insoles did not produce significant results. However (Spink 2011) found a significant reduction in falls in people with “disabling” foot pain when they received “multifaceted podiatry” via custom orthoses with added Poron to redistribute pressures, footwear review (using Menz’ footwear assessment form), foot and ankle exercises, fall prevention education. Even 6 months post-intervention.

## **A systematic review of the effect of foot orthoses and shoe characteristics on balance in health older subjects. Aboutorabi et al. (2016)**

**Level of Evidence<sub>4</sub> and Study Design** 3a; Systematic reviews of all relevant studies (mostly non-randomized, controlled, or cohort studies; case-series; case-controlled or cross-sectional studies). There are very few RCTs.

### **Relevance and Findings**

**High Relevance:** Effectiveness of foot orthoses (FOs) and shoe-wear related to balance are discussed. 22 articles were reviewed. Remember, FOs improve postural stability by realigning the joints at the foot to become more stable and efficient. Shoe-wear is considered to be an easy, modifiable risk factor. View Table 3 in article.

**Shoe-wear:** Recommendations include 1) < 2.5 cm heel (less risk of falling). High heels displace the COP by 200% (forward) Explains increased supination angle of foot at heel strike and subsequent risk in spraining ankle. 2) Firm, thin midsoles (A-50 density) are recommended because the opposite (< shore A-33 density) causes instability. 3) High “topline” collars improve frontal plane stability both during static and dynamic tasks and increases proprioception at the ankle joint. And 4) canvas or athletic shoes instead of high heels, slippers, barefoot walking or walking in tights or compression socks. Barefoot had worse results than any walking shoe.

Unfortunately, the more comfortable the sole, the less stability there was.

Larger midsole flares do not change fall risk significantly. There are mixed results in the literature. Reasoning suggests that it could increase foot pronation moment during heel strike. Conversely, the increase in base of support is said to increase stability, which was evident in some studies.

Most common type of shoe-wear during falls are (based on report) slippers, walking shoes, and sandals. Walking shoes used usually had poor features (no fixation [i.e. no shoe laces] flexible heel counter or soles).

**FOs:** Static balance was most heavily researched, but only one RCT was reported. Recommendations include 1) More rigid insole 2) Custom orthotics 3) Vibrating insoles (maybe) 4) Proactive insoles with 1.75 cm arch height (increased contact). Textured insoles do not produce significant changes compared to smooth insoles, but spiked insoles in sandals helped some with postural stability compared to being barefooted, suggesting the spikes could optimize sensation. Sometimes benefits of FOs plateau or do not stay after several weeks.

Authors suggest that future studies should research effectiveness during dynamic tasks, evaluate long-term effects, and clarify the effects of types of textured insoles and wide soles.

**Summary of the Updated American Geriatrics Society/British Geriatrics Society Clinical Practice Guideline for Prevention of Falls in Older. Panel on Prevention of Falls in Older Persons. (2010)**

**Level of Evidence<sub>4</sub> and Study Design** Clinical Practice Guideline

## Relevance and Findings

**Moderate Relevance:** Discusses all decision-making related to screening and assessment, and subsequent interventions available in the literature up until 2008.

**Shoe-wear:** Foot problems such as bunions, toe and nail deformities, ulcers, and poor position awareness are common in older adults and are significantly associated with falls. Poor-fitting shoes, worn shoes, high-heels, and unfastened laces increase the risk of falling in older adults. The guidelines suggest low heels and increased contact area can reduce risk of falls. The authors suggest multiple interventions including shoe recommendations, and an assessment of foot deformities (new since the previous guideline in 2001) with a subsequent appropriate referral or treatment. They also recommend anti-slip shoe devices for slippery surfaces (i.e. Yaktrax on ice) can be beneficial.

**1a. Does not meet inclusion criteria, but this Footwear Assessment Form has been referenced in many of the works above:**

**The Footwear Assessment Form: a reliable clinical tool to assess footwear characteristics of relevance to postural stability in older adults. Menz et al. (1999)**

**High Relevance:** Although published in 1999, It directly examines 7 variables related to shoe-wear base on available literature at the time, creates a clinical tool to assess the quality of a shoe for balance, and has been used and/or referenced in many works found during the search for this project.

This was meant to allow researchers to have comparable, agreed-on characteristics

### General shoe style/covering

- |   |                                   |                                      |  |
|---|-----------------------------------|--------------------------------------|--|
| <input type="radio"/> barefoot                  | <input type="radio"/> socks only  | <input type="radio"/> stockings only | <input type="radio"/> backless slipper |
| <input type="radio"/> mule                      | <input type="radio"/> high heel   | <input type="radio"/> courtshoe      | <input type="radio"/> boot             |
| <input type="radio"/> slipper                   | <input type="radio"/> sandal      | <input type="radio"/> moccasin       | <input type="radio"/> athletic shoe    |
| <input type="radio"/> walking shoe              | <input type="radio"/> Oxford shoe | <input type="radio"/> ugg boot       | <input type="radio"/> thong            |
| <input type="radio"/> surgical/bespoke footwear |                                   |                                      |  |

### Heel height

- 0–2.5 cm     2.6–5.0 cm     >5.0 cm

### Fixation

- none     laces     straps/buckles     Velcro™     zips

### Heel counter stiffness

- minimal     <45°     >45°

### Longitudinal sole rigidity

- minimal     <45°     >45°

### Sole flexion point

- at level of MTPJs     before MTPJs

### Tread pattern

- textured     smooth (i.e. no pattern)     partly worn     fully worn

### Sole hardness

- soft     firm     hard

## 2. 2 of Dr. Mike Gross' relevant contributions to the subject, which may not meet exclusion criteria

### Shoe Wear Recommendations for the Older Adult. Gross et al. (2010)

**Level of Evidence** 4 and **Study Design** 5; Narrative Review

#### Relevance and Findings

**High Relevance:** Pertains directly to shoe recommendations, but is of relative low level of evidence and at a high risk of bias.

##### For Balance

- $\geq 1.3$  in heel lift = increase in postural sway, careful gait patterns (i.e. increased double limb support time, slowed gait speed), lessened forward reach, compared to standard heel lift of 0.55 in.
- Heel lift = reduced BOS in all directions (remember visual), increased contact pressure 2/2 reduced contact area, forward shift in center of pressure.
- However, clinical experience suggests that in cases of reduced PF extensibility and related reduced DF, heel lift is needed because of the posterior displacement of center of pressure from tightness. This should reduce backward falling
- Soft sole = increase in postural sway
- Greater width of shoe material (Wider BOS). Note that shoes with greater heel lift often are narrower.
- Higher heel counter or high collars on shoe
- Wear shoes → avoid walking barefooted!
- Avoid rocker bottoms (Reduced A/P stability)

##### Avoid Slipping i.e. mud or ice

- Avoid hard sole materials (Lower coefficient of friction which is needed to prevent slips)
- Shoes with wider and deeper grooves in sole material
- Rougher sole surfaces and metal coils (yak-trax)
- Take shorter steps on slippery surfaces

##### For falling

- Wear shoes indoors → not barefooted or sock-feet
- Lower heels, larger contact area
- Avoid slippers → wear SHOES
- Athletic-type/tennis shoes over other types



## Effect of Foot Orthoses on Balance in Older Adults. Gross et al. (2012)

**Level of Evidence<sup>4</sup> and Study Design** 4; Controlled laboratory study and single-cohort design

### Relevance and Findings

**Moderate Relevance:** Relevant when addressing foot deformities and balance, but low level of evidence and high risk of bias.

Provides limited evidence that custom orthotics can be helpful in improving balance which is associated with reducing one's risk of falling. (The author cited a study with findings of poor static and dynamic balance tasks in individuals who have suffered from an injurious fall compared to age-matched controls).

**Findings:** Improved SLS time (pre- compared to post-), tandem stance time (pre - compared to post-), tandem walking steps (pre- compared to 2-week follow-up), and number of steps taken during alternating step test (pre- compared to post-). There were no significant differences between immediate intervention and outcome 2 weeks later.

- Highlights the importance of taking static and dynamic balance measures because they are only moderately correlated.
- Current evidence suggests poorer balance in older adults is associated with:
  - High heels compared to walking shoes
  - Softer sole material
  - Smaller sole surface area
  - Bare feet or "sock feet"
  - Shoes without straps or laces, or those that have elastic laces
- Limited evidence suggests:
  - Ridged periphery of insoles improved lateral stability and reduces prevalence of falls, but were deemed to be uncomfortable
  - Custom orthoses have improved standing balance performance in younger individuals
- The authors' clinical judgement suggests that custom orthoses can help a person with either high arch/ excessive supination or excessive pronation/midfoot collapse increase their base of support or stabilizing hypermobile aspects of the feet with improved surface area respectively to improve sensory input and improve postural stability.

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