



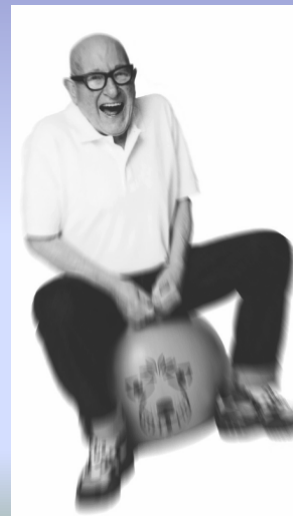
## Exercises for the Feet: Falls Prevention

Professor Dawn Skelton

**laterLife**  
**training**

## Summary of session

- How important are feet and footwear as risk factors for falls?
- What risk factors in particular
- The Interventions





## Risk factors for falls

- Identified from variable quality epidemiological studies; n=200 risk factors!
- Recent systematic review
  - Original Studies on risk factors for fall
  - At least 80% of the sample aged 65 years or older.
  - Prospective study design.
  - Sample size greater than 200 subjects.
  - At least 80% of subjects living in the community.
  - Number of subjects experiencing one or more falls during follow-up as an outcome.
- N=74 studies, mean age 75, risk factor analysis performed on 31 risk factors studied in at least 5 different studies

Deandrea S et al. *Epidemiology*. 2010;21: 658-668.

## Major risk factors

	All fallers (Odds Ratio)	Recurrent Fallers (Odds Ratio)
History of Falls	2.8	3.5
Gait Problems 	2.1	2.2
Walking Aids Use	2.2	3.1
Vertigo	1.8	2.3
Parkinson's Disease	2.7	2.8
Antiepileptic Drug Use	1.9	2.7
Physical Disability 	1.6	2.4
Disability in Instrumental Activities in Daily Life	1.5	2.0
Fear of Falling	1.6	2.5

All fallers = fell at least once during follow up

Recurrent fallers = fell at least twice during follow up

**But nothing particularly on feet or footwear**

Deandrea S et al. *Epidemiology*. 2010;21: 658-668.

## But...

- For some important factors (eg, balance and muscle weakness), Deandrea could not compute a summary estimate because the measures used in various studies were not comparable.
- ORs were generally higher for recurrent fallers than for all fallers.
- For some factors, there was substantial heterogeneity among studies.



Deandrea S et al. *Epidemiology*. 2010;21: 658-668.

## Other identified risk factors

- Prescribed medications/ multiple drug regimes
- Alcohol (>7 units per week)
- Poor vision (acuity, contrast, depth perception)
- Multiple conditions and co-morbidities (esp. Stroke, PD, dementias)
- Continence (urge, frequency, overactive bladder, nocturia)
- Environment
- **Poor foot health and foot pain**



Skelton & Todd 2004; NICE 2004; ABS BGS 2010

## Poor ankle and foot strength/ROM on balance and functional ability

- N=305 >65s
- Most of the correlations between the foot and ankle tests and performance on the balance and functional tests were statistically significant.
- **Hallux plantar flexion strength** and **ankle inversion-eversion range of motion** were the most consistent significant and independent predictors of balance and functional test performance, explaining up to 25% of the variance in the test scores.



*Spink MJ, Fotoohabadi MR, Wee E, Hill KD, Lord SR, Menz HB. Arch Phys Med Rehabil. 2011; 92(1): 68-75*

(b) Inversion and eversion  
Copyright © 2007 Elsevier. Cummings, an imprint of Elsevier Health Sciences, Inc.

## Foot function, functional ability and QoL in older people with foot pain

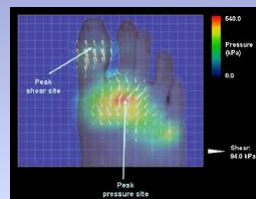
- N=312 >60s
- Participants with foot pain scored significantly lower on the total SF-36 and all subcomponents.
- Those with disabling foot pain have:
  - **Reduced** ankle dorsiflexion strength, hallux strength, toe flexor strength,
  - **Reduced** stride length, step length, time in single support and walking speed.
  - **Increased** foot reaction time, postural sway, time in double support



*Mickle KJ, Munro BJ, Lord SR, Menz HB, Steele JR. Arthritis Care Res. 2011 Nov;63(11):1592-8*

## Foot pain and falls in older people

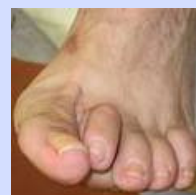
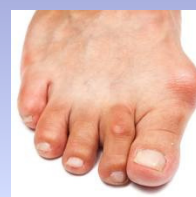
- N=312 >65s, 12 month follow up for falls
- Fallers had a significantly higher prevalence of foot pain than non-fallers (57.9% vs 42.1%).
- Fallers also generated a significantly **higher peak plantar pressure** and pressure-time integral under the foot than non-fallers.
- High plantar pressures generated during gait may contribute to foot pain and risk of falls.
- Providing interventions to older people with foot pain and high plantar pressures may play a role in reducing their falls risk.



Mickle KJ, Munro BJ, Lord SR, Menz HB, Steele JR. *J Am Geriatr Soc.* 2010; 58(10): 1936-40.

## Toe weakness and deformity and falls

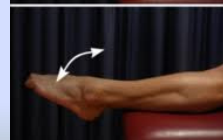
- N=312 >60s followed up for a year for falls
- Hallux valgus and lesser toe deformities are highly prevalent foot problems in older people.
- One factor contributing to the development of these toe deformities is reduced toe flexor strength.
- Compared to non-fallers, fallers had **less strength** of the hallux and lesser toes and were more likely to have hallux valgus and lesser toe **deformity**.



Mickle KJ, Munro BJ, Lord SR, Menz HB, Steele JR. *Clin Biomech.* 2009; 24(10): 787-91

## Other foot and Ankle Falls risk factors

- N=176, mean age 80 followed up for 12 months for falls
- Compared to non-fallers, fallers had:
  - decreased ankle flexibility
  - more severe hallux valgus deformity
  - decreased plantar tactile sensitivity
  - decreased toe plantarflexor strength
  - more disabling foot pain.
- **Decreased toe plantarflexor strength** and **disabling foot pain** were significantly and independently associated with falls after accounting for physiological falls risk factors and age.



*Menz HB, Morris ME, Lord SR. J Gerontol A Biol Sci Med Sci. 2006; 61(8): 866-70*

## Footwear and indoor and outdoor falls

- N=176 >60 followed up for 12 months for falls
- Footwear characteristics (shoe type, heel height, heel counter height, heel width, critical tipping angle, method of fixation, heel counter stiffness, sole rigidity and flexion point, tread pattern and sole hardness).
- Indoor falls
  - After controlling for age, gender, demographic characteristics, medication use, physiological falls risk factors and foot problems, those who fell indoors were **more likely to go barefoot or wear socks** inside the home (OR = 13.74)
- Outdoor falls
  - there were **no significant differences** in indoor or outdoor footwear characteristics between fallers and non-fallers.



## Footwear features and balance

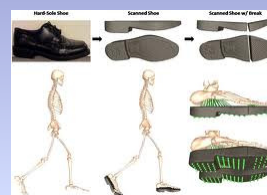
- N=29 mean age 79 years
- Effect of footwear on balance
- Standard shoe and seven other shoes that differed from the standard shoe in one feature only (namely: elevated heel (4.5 cm), soft sole, hard sole, flared sole, bevelled heel, high heel-collar and tread sole)
- Significantly **increased sway** in the **elevated heel** versus the standard shoe condition
- A high heel-collar and a hard sole showed trends towards being beneficial to balance



*Menant JC, Steele JR, Menz HB, Munro BJ, Lord SR. Gerontology. 2008;54(1):18-23.*

## What is the best footwear to prevent falls? A Review

- Footwear influences balance and the subsequent risk of slips, trips, and falls by altering somatosensory feedback to the foot and ankle and modifying frictional conditions at the shoe/floor interface.
- Walking indoors barefoot or in socks and walking indoors or outdoors in high-heel shoes have been shown to increase the risk of falls in older people.
- Based on findings of a systematic literature review, older people should wear shoes with low heels and firm slip-resistant soles both inside and outside the home.



*Menant JC, Steele JR, Menz HB, Munro BJ, Lord SR. J Rehabil Res Dev. 2008;45(8):1167-81*

## Interventions in the community



- Update of 2009 review
- 159 trials with 79,193 participants
- most common interventions tested
  - exercise as a single intervention (59 trials)
  - Multi-factorial programmes (40 trials)

### Conclusions:

- Group and home-based **exercise programmes**, and **home safety interventions** delivered by an occupational therapist reduce **rate of falls and risk of falling**.
- **Multi-factorial** assessment and **intervention** programmes reduce **rate of falls** but not risk of falling;
- **Tai Chi** reduces **risk of falling**.
- Insufficient evidence that interventions designed to prevent falls will also prevent hip or other fall-associated fractures.

Gillespie et al. Interventions for preventing falls in older people living in the community. Cochrane Library 2012

## Feet

- An anti-slip shoe device **reduced rate of falls in icy conditions** (RaR 0.42; 1 trial).
- One trial comparing multifaceted podiatry including foot and ankle exercises with standard podiatry in people with disabling foot pain **significantly reduced the rate of falls** (RaR 0.64) but not the risk of falling.



Gillespie et al. Interventions for preventing falls in older people living in the community. Cochrane Library 2012



## Podiatry Intervention

- Multifaceted podiatry intervention in preventing falls in community dwelling older people with disabling foot pain
- N=305, mean age 74 years
- RCT allocated to routine podiatry care or intervention
- 12 month follow up for falls
- Outcomes
  - Falls and injuries
- Intervention:
  - foot orthoses,
  - advice on footwear,
  - subsidy for new footwear (£65),
  - a home based programme of foot and ankle exercises,
  - a falls prevention education booklet,
  - routine podiatry care

*Spink MJ, Menz HB, Fotoohabadi MR, Wee E, Landorf KB, Hill KD, Lord SR. BMJ. 2011 Jun 16;342:d3411.*

## Podiatry intervention

- Adherence was good
  - 52% of the participants completed 75% or more of the requested three exercise sessions weekly
  - 55% of those issued orthoses reported wearing them most of the time.
- Intervention vs Control
  - **Better strength** (eversion),
  - **Better range of motion** (dorsiflexion/inversion/eversion),
  - **Better balance** (postural sway on the floor when barefoot and maximum balance range wearing shoes)
- Participants in the intervention group (n=153) experienced 36% fewer falls than participants in the control group (iRR 0.64, P=0.01).
- 1 fracture occurred in the intervention group and 7 in the control group (P=0.07).

*Spink MJ, Menz HB, Fotoohabadi MR, et al. BMJ. 2011 Jun 16;342:d3411.*

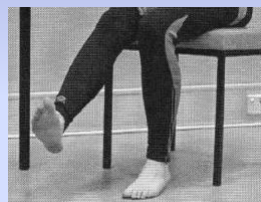
## Podiatry Intervention – predictors of adherence

- Adherence to the three components of the intervention:
  - foot orthoses – 69%
  - footwear advice and footwear cost subsidy – 54%
  - a home-based foot and ankle exercise programme – 72%
- Discriminant function analyses to determine predictors
- Foot orthoses
  - Being younger
- Footwear advice and replacement footwear
  - higher physical health status and lower fear of falling
- Home exercise programme
  - higher physical health status

*Spink MJ, Fotoohabadi MR, Wee E, Landorf KB, Hill KD, Lord SR, Menz HB. BMC Geriatr. 2011;11:51.*

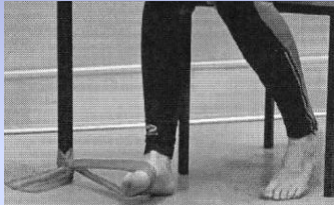
## What exercises?

- Warm up
- Ankle Circling

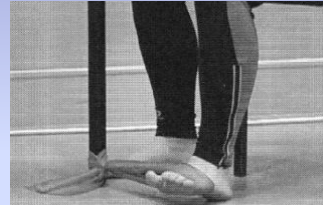


## What exercises?

- Ankle Inversion



- Ankle Eversion



- Ankle dorsiflexion

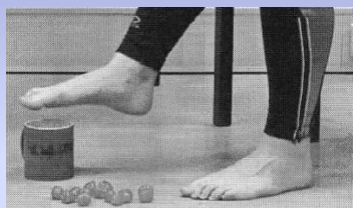


- Arch exerciser

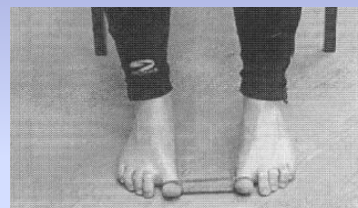


## What exercises?

- Toe strengthening



- Big toe stretch



- Double heel raise



- Calf stretch



## Conclusions

- Fallers have weaker foot and ankle muscles and worse range of motion than non-fallers
- Fallers have more foot deformities and more disabling foot pain (with higher under ball-of-foot pressures) than non-fallers
- Foot pain contributes to poor gait and balance
- Footwear is not that important to falls prevention but indoors people should be advised to wear shoes (not socks or go barefoot)
- A home exercise programme, with foot orthoses and new footwear as necessary, reduce rate of falls