Update on Falls Prevention Research

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Acknowledgments: Dr Jasmine Menant, Mr. Daniel Schoene

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Recent falls risk factor studies
Associations between obesity and overweight and fall risk, health status and quality of life in older people

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Objectives and methods

• Objectives: To determine whether overweight and obese individuals have higher reported fall and fall injury risk than individuals of healthy weight, and to examine the influence of BMI on health, quality of life and lifestyle characteristics of fallers

• Methods: A representative sample of 5,681 community-based individuals aged 65+ years in NSW was surveyed regarding their history of falls, height, weight, lifestyle and general health within a 12-month period (NSW Falls Prevention Baseline Survey)
<table>
<thead>
<tr>
<th>Fall injury and fall perception</th>
<th>Healthy weight</th>
<th></th>
<th></th>
<th></th>
<th>Obese</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% yes</td>
<td>RR</td>
<td>% yes</td>
<td>RR</td>
<td>95%CI</td>
<td>p-value</td>
<td>% yes</td>
<td>RR</td>
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<tr>
<td>Fall experience</td>
<td></td>
<td></td>
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<tr>
<td>Fall in the last 12 months</td>
<td>23.0</td>
<td>1.0</td>
<td>24.9</td>
<td>1.08</td>
<td>0.96-1.23</td>
<td>0.2</td>
<td>30.1</td>
<td>1.31</td>
</tr>
<tr>
<td>Multiple falls in the last 12 months</td>
<td>34.2</td>
<td>1.0</td>
<td>39.1</td>
<td>1.15</td>
<td>0.95-1.38</td>
<td>0.2</td>
<td>45.0</td>
<td>1.32</td>
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<tr>
<td>Fall injury</td>
<td></td>
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<tr>
<td>Fall-related injury</td>
<td>65.4</td>
<td>1.0</td>
<td>68.5</td>
<td>1.05</td>
<td>0.95-1.16</td>
<td>0.3</td>
<td>63.9</td>
<td>0.98</td>
</tr>
<tr>
<td>Falls requiring visit to hospital</td>
<td>19.5</td>
<td>1.0</td>
<td>20.3</td>
<td>1.04</td>
<td>0.78-1.39</td>
<td>0.8</td>
<td>15.6</td>
<td>0.80</td>
</tr>
<tr>
<td>Falls requiring hospital admission</td>
<td>10.4</td>
<td>1.0</td>
<td>8.7</td>
<td>0.84</td>
<td>0.54-1.31</td>
<td>0.4</td>
<td>11.0</td>
<td>1.06</td>
</tr>
<tr>
<td>Falls requiring medical treatment</td>
<td>20.4</td>
<td>1.0</td>
<td>22.2</td>
<td>1.08</td>
<td>0.82-1.42</td>
<td>0.6</td>
<td>24.2</td>
<td>1.17</td>
</tr>
<tr>
<td>Fall perception</td>
<td></td>
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<tr>
<td>Fear of falling</td>
<td>40.4</td>
<td>1.0</td>
<td>38.9</td>
<td>0.95</td>
<td>0.79-1.14</td>
<td>0.6</td>
<td>47.6</td>
<td>1.16</td>
</tr>
<tr>
<td>Limited activities due to fear of falling</td>
<td>49.4</td>
<td>1.0</td>
<td>48.1</td>
<td>1.00</td>
<td>0.78-1.27</td>
<td>1.0</td>
<td>49.7</td>
<td>1.01</td>
</tr>
<tr>
<td>Agrees nothing can be done to prevent older people falling</td>
<td>19.1</td>
<td>1.0</td>
<td>25.3</td>
<td>1.26</td>
<td>0.96-1.64</td>
<td>0.09</td>
<td>31.5</td>
<td>1.57</td>
</tr>
<tr>
<td>Agrees being active reduces the risk of falling</td>
<td>65.5</td>
<td>1.0</td>
<td>65.4</td>
<td>0.95</td>
<td>0.87-1.04</td>
<td>0.3</td>
<td>68.7</td>
<td>1.03</td>
</tr>
<tr>
<td>Perceived risk of falling is high</td>
<td>9.5</td>
<td>1.0</td>
<td>9.9</td>
<td>1.03</td>
<td>0.65-1.62</td>
<td>0.9</td>
<td>14.5</td>
<td>1.51</td>
</tr>
<tr>
<td>Why feel at risk of falling</td>
<td></td>
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<tr>
<td>Poor coordination and/or body unstable/dizziness</td>
<td>18.1</td>
<td>1.0</td>
<td>23.7</td>
<td>1.31</td>
<td>0.99-1.73</td>
<td>0.06</td>
<td>28.9</td>
<td>1.60</td>
</tr>
<tr>
<td>Physically active/ t/good balance</td>
<td>20.6</td>
<td>1.0</td>
<td>21.0</td>
<td>1.02</td>
<td>0.78-1.34</td>
<td>0.9</td>
<td>12.3</td>
<td>0.60</td>
</tr>
</tbody>
</table>
Figure 2: Conceptual diagram for the analysis of variable associations for mediation

- Path A: Obesity to Falls
- Path B: Mediator to Obesity
- Path C: Mediator to Falls
Figure 1: Putative mediators of the association between obesity and falls for older people

- Obesity
  - Chronic diseases e.g. diabetes
  - Sedentary behaviour
  - Pain
  - Depression and anxiety
  - Medication use
- Falls
Results and implications

• Obese individuals had a 31% higher risk of having fallen, but no higher risk of a fall related injury compared to healthy-weight individuals.

• The strongest mediators of the association between obesity and falls were:
  – sleeping tablet use ($t=-5.452; p<0.0001$),
  – sitting for 8+ hours per day on weekdays ($t=5.178; p<0.0001$),
  – heart disease/angina ($t=3.526; p<0.0001$)
  – anti-depressant use ($t=3.102; p=0.002$),
  – moderate/extreme anxiety or depression ($t=3.038; p=0.002$)
  – diabetes ($t=3.032; p=0.002$).

• Interventions aimed at weight reduction and increased activity may have benefits not only for fall prevention, but also for the mediating health, mood and lifestyle factors.
Background on dual-tasking

- **Walking is not just rhythmic and automatic**

  Slowing of gait may have its onset up to 12 years before the clinical presentation of cognitive changes in older adults who later convert to mild cognitive impairment (MCI) (Burrachio et al., 2010).

- **Dual-tasking**: walking while completing a secondary task – to examine the attentional requirement of balance

- **Decreased performance in one or both tasks** (Woollacott & Shumway-Cook, 2002)
  - in ageing (neural changes in frontal lobe; reduction in central neurons)
  - clinical groups with reduced sensorimotor and/or cognitive function
Background on dual-tasking

- **Gait speed**
  - Reliable measure, can be recorded without equipment
  - Quantitative estimate of future risk of hospitalization and decline in health and function (Guralnik et al., 2000; Studenski et al., 2003)
  - Predictor of mortality in older community-dwellers (Hardy et al., JAGS, 2000)
  - Predictor of falls in older people (Callisaya et al., 2011; Verghese et al., 2009)

- **Dual-tasking during gait**
  - Performance changes significantly associated with an increased risk of falling (Ziljstra et al., 2008; Beauchet et al., 2009)

- **Research question**: does a dual-task walking test predict risk of falls better than a single-task walking test?
Systematic literature search

- **Range of databases**
- **Strict inclusion / exclusion criteria**
  - gait speed over unobstructed flat path under single and dual-task conditions
  - Secondary cognitive task
  - Min age: 60 years and over or mean age: 65+ years
  - Fallers vs. non-fallers
  - No patient groups other than dementias and Alzheimer's
  - No abstracts, case studies or reviews
  - Only English, Dutch, French, or German articles
Systematic literature review results

- 31 studies included (34 groups)
- n=4524 participants
- 12 prospective studies
- Types of secondary cognitive tasks
  - Mental tracking (serial subtractions, reciting alternate letters of the alphabet...) – n=28
  - Verbal fluency (ex: generating as many animals names as possible) – n=7
  - Discrimination and decision making task (N=2)
- 7 studies included in a cognitive impairment sub-analysis
Gait speed – single task – all studies

Studies

Mean difference (95% CI)

0.06 (-0.06, 0.17) 1.46
0.06 (0.00, 0.12) 2.80
0.06 (-0.01, 0.12) 2.63
0.10 (0.06, 0.15) 3.06
0.11 (-0.13, 0.34) 0.49
-0.06 (-0.24, 0.13) 0.75
0.14 (-0.08, 0.36) 0.55
0.03 (-0.19, 0.25) 0.57
0.04 (0.01, 0.07) 3.57
0.08 (-0.04, 0.20) 1.41
0.01 (-0.21, 0.22) 0.58
0.02 (-0.03, 0.07) 2.86
-0.02 (-0.21, 0.18) 0.69
0.11 (0.00, 0.22) 1.63
0.01 (-0.10, 0.13) 1.50
0.07 (-0.22, 0.36) 0.33
0.05 (-0.07, 0.18) 1.33
0.22 (0.01, 0.43) 0.62
-0.01 (-0.07, 0.06) 2.59
0.04 (-0.08, 0.17) 1.30
0.06 (-0.05, 0.17) 1.57
0.07 (-0.07, 0.21) 1.13
0.11 (-0.06, 0.27) 0.86
0.25 (0.11, 0.39) 1.13
0.32 (0.17, 0.47) 1.06
0.15 (0.01, 0.30) 1.09
-0.04 (-0.10, 0.03) 2.56
0.09 (-0.05, 0.23) 1.13
0.17 (0.06, 0.28) 1.60
0.15 (-0.00, 0.30) 1.00
0.12 (0.01, 0.23) 1.48
0.02 (-0.01, 0.05) 3.40
0.08 (-0.08, 0.24) 0.94
0.23 (0.10, 0.37) 1.22
0.07 (0.05, 0.10) 50.90

NOTE: Weights are from random effects analysis

Fallers better than non-fallers
Fallers worse than non-fallers
Prospective falls follow-up

**Single task**
- Beauchet & Allali et al 2008
- Beauchet & Annweiler et al 2008
- Bootswana-van Der Wiel et al 2003
- Camicioli et al 2006 (EPS-)
- Camicioli et al 2006 (EPS+)
- Herman et al 2010
- Kearns et al 2012
- Kressig et al 2008
- Liu-Ambrose 2009
- Nordin et al 2010
- Taylor et al 2013
- Vergheese et al 2002
- Yamada et al JAGS 2011

Subtotal (I-squared = 47.7%, p = 0.028)

**Dual-task**
- Beauchet & Allali et al 2008
- Beauchet & Annweiler et al 2008
- Bootswana-van Der Wiel et al 2003
- Camicioli et al 2006 (EPS-)
- Camicioli et al 2006 (EPS+)
- Herman et al 2010
- Kearns et al 2012
- Kressig et al 2008
- Liu-Ambrose 2009
- Nordin et al 2010
- Taylor et al 2013
- Vergheese et al 2002
- Yamada et al JAGS 2011

Subtotal (I-squared = 21.5%, p = 0.226)
Gait speed – cognitive impairment

Single task - studies

Beauchet & Allali et al 2008
Beauchet & Annweiler et al 2008
Camicioli et al 2006 (EPS-)
Camicioli et al 2006 (EPS+)
Gomes de Melo Coelho et al 2012 (mild AD)
Gomes de Melo Coelho et al 2012 (med AD)
Kearns et al 2012
Kressig et al 2008
Taylor et al 2013
Subtotal (I-squared = 0.0%, p = 0.727)

Dual-task - studies

Beauchet & Allali et al 2008
Beauchet & Annweiler et al 2008
Camicioli et al 2006 (EPS-)
Camicioli et al 2006 (EPS+)
Gomes de Melo Coelho et al 2012 (mild AD)
Gomes de Melo Coelho et al 2012 (med AD)
Kearns et al 2012
Kressig et al 2008
Taylor et al 2013
Subtotal (I-squared = 13.8%, p = 0.319)

Mean difference (95% CI)

0.06 (0.00, 0.12) 17.96
0.06 (-0.01, 0.12) 14.56
0.11 (-0.13, 0.34) 1.01
-0.06 (-0.24, 0.13) 1.67
0.14 (-0.08, 0.36) 1.16
0.03 (-0.19, 0.25) 1.20
-0.02 (-0.21, 0.18) 1.51
0.11 (0.00, 0.22) 5.06
0.15 (0.01, 0.30) 2.74
0.07 (0.03, 0.10) 46.86
0.02 (-0.03, 0.07) 22.02
0.05 (-0.01, 0.10) 18.16
0.17 (-0.40, 0.74) 0.17
-0.03 (-0.22, 0.17) 1.46
0.10 (-0.08, 0.28) 1.83
-0.08 (-0.28, 0.12) 1.35
-0.04 (-0.21, 0.13) 1.98
0.13 (0.00, 0.26) 3.48
0.18 (0.03, 0.32) 2.69
0.04 (0.00, 0.08) 53.14

Fallers better than non-fallers ➜ Fallers worse than non-fallers
Systematic review & meta-analysis summary

- Gait speed under both single and dual-task significantly discriminates between fallers and non-fallers

- **However** the measurement of gait speed under dual-task paradigms does not add any value to the prediction of falls as compared to a single-task paradigm
  - Overall
  - In physically or cognitively frailer samples
  - Across different types of cognitive tasks

- Dual-task designs highly valuable to detect subtle deficits in executive function

- Simple tests of gait speed can be used as part of fall risk assessments
A Stroop stepping test for fall risk

Schoene et al., Age & Ageing, 2013

- 103 independent living older people aged 70-93 years
- Cognitively intact (mean (SD) MMSE: 28.9(1.1))
- 28% of participants : 1+ fall(s) in the past 12 months

- Stroop test adapted to a stepping mat:
  - Cognition: motor response inhibition
  - Stepping: balance, strength, reaction time
- Tests of executive & sensorimotor function
Methods

- 4 stepping directions
- “Step by the word”
- 20 trials
- Average step time & errors

Non-fallers

\[ \text{Mean time (seconds) } \pm \text{SE} \]

\[
\begin{align*}
\text{Non-fallers} & \quad 2.6 \\
\text{Fallers} & \quad 3.0
\end{align*}
\]

\[ p=0.04 \]

Fallers

\[ \text{Mean number errors } \pm \text{SE} \]

\[
\begin{align*}
\text{Non-fallers} & \quad 0.6 \\
\text{Fallers} & \quad 1.7
\end{align*}
\]

\[ p=0.01 \]
Stroop stepping and fall risk

- Each error on the SST task: increased odds of past fall 1.7 times [OR: 1.65 (1.17–2.34)]
- Longer SST time significantly associated with poorer executive function, processing speed, balance & step coordination
- Errors significantly associated with poorer executive function & proprioception
- Standard neuropsychological tests did not discriminate between fallers and non-fallers

- Feasibility of using a low-cost computer game device to screen older people for risk of falls
Recent interventions
Benefits of cognitive training

Anguera et al., Nature, 2013 “Video game training enhances cognitive control in older adults”

- Pilot RCT of computer game training on:
  - Performance in the game
  - Other cognitive functions: working memory, sustained attention
  - Neural changes in prefrontal cortex using electroencephalography

- 46 older people aged 60-85 years
Benefits of cognitive training

- Both single & multitask training (STT & MTT) groups improved in both tasks
- Only the MTT’s group multitasking performance improved significantly → interference resolution
- Multitasking training also led to
  - improvements in working memory and sustained attention
  - Enhancements in neural function (deactivation of medial prefrontal activity)
- Evidence that custom-designed video game training improves cognitive abilities in older people at both behavioural and neural levels

Anguera et al., Nature, 2013
Yoga to improve balance & mobility

- Exercise that challenges balance is effective in improving mobility and reducing the rate of falls in the community and subacute hospital settings (Gillespie LD et al., 2012; Cameron I et al., 2012).
- Problem: Uptake and adherence by older people

Tiedemann et al., J Gerontol Med Sci, 2013

- Pilot blinded RCT of yoga program
- 54 community-dwellers mean (SD) age: 68.0 (7.1) years
  - 12-week, 2x1hr sessions/week yoga (increasing balance challenge) & fall prevention education booklet (n=27)
  - vs. fall prevention education booklet (n=27)
- Outcome measures: balance, mobility and fear of falling.
- Feasibility: class attendance, enjoyment and adverse events.
Yoga to improve balance & mobility

- Mean attendance: 83% of all available classes
- No serious adverse events
- Intervention vs. control group – significant improvements in:
  - Standing balance
  - One-legged stance with eyes closed
  - Sit-to-stand (5 reps)
  - Timed 4-m walk
- Sit-to-stand & timed walk valid predictors of falls
- 13 participants still doing yoga classes 4 months after the end of the study

Beneficial effect of yoga program on balance and mobility, as well as demonstrated feasibility & enjoyment in participants in older community-dwellers → promising falls prevention strategy
Falls prevention – what works

- Highest level of evidence given by meta-analyses of RCTs
- Gillespie LD et al. Interventions for preventing falls in older people living in the community. Cochrane Database Syst Rev. 2012 Sep 12;9
- Cameron ID et al. Interventions for preventing falls in older people in care facilities and hospitals. Cochrane Database Syst Rev. 2012 Dec 12;12:
Gold bar evidence scale

- One good quality RCT
- At least two good quality RCTs – little inconsistency
- Multiple RCTs and/or systematic reviews – little inconsistency
Falls prevention – what works

- High level balance exercise in group or home settings (functional balance exercises, Otago, Tai Chi)
- Occupational therapy interventions (home safety modifications in association with transfer training and education) in high risk populations
- Expedited first eye cataract surgery
- Restriction of multifocal glasses use in older people who take part in regular outdoor activity
- Pharmacist-led education and GP medication review
- Podiatry intervention in people with disabling foot pain
Falls prevention – what works

- Withdrawal of psychoactive medications
- Intensive multidisciplinary assessment of high risk populations
- Intensive interventions in hospitals
- Comprehensive geriatric assessment in residential aged care
- Vitamin D supplementation in residential aged care
- Medication review in residential aged care
Thank you

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