Prescribing evidence-informed falls prevention exercise for older people

Professor Cathie Sherrington
csherrington@george.org.au
A fall occurs when an individual's physiology can’t cope with a task being undertaken and/or the environment in which the task is being undertaken
Key points

- Falls are usually the result of an interaction between the person’s physiology, their behaviour and the environment.
- Falls can happen to people with good physical function in a challenging environment.
- People with impaired physical function are likely to fall in less challenging environments, e.g., while walking on level ground.
Recommendations for exercise to prevent falls in older adults

1. Exercise must provide a moderate or high challenge to balance
2. Exercise must be of sufficient dose to have an effect
3. Ongoing exercise is necessary
4. Fall prevention exercise should be targeted at the general community as well as those at increased risk of falls
5. Fall prevention exercise may be undertaken in a group or home-based setting

Recommendations for exercise to prevent falls in older adults

6. Walking training may be included in addition to balance training but high risk individuals should not be prescribed brisk walking programs

7. Strength training may be included in addition to balance training

8. Exercise providers should make referrals for other risk factors to be addressed

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Sherrington et al 2011, meta-analysis

Exercise as a single intervention can prevent falls
Pooled rate ratio 0.84, 95% CI 0.77 to 0.91, I²=56%

Reductions in falls from different exercise programs

Table 1. Summary of meta-analysis results: reductions in falls from exercise programs with different components

<table>
<thead>
<tr>
<th>Component</th>
<th>Reduction in falls in studies with this component</th>
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<th>Variability explained (%)</th>
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<tbody>
<tr>
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<td>Exercise that aims to provide a moderate or high challenge to balance</td>
<td>22 14–30 43</td>
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</tr>
<tr>
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<td>23 11–32 30</td>
<td>8</td>
</tr>
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<td>10 0–20 39</td>
<td>27 14–37 21</td>
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CI = confidence interval.
Balance

- “the ability to maintain the projection of the body's centre of mass (CoM) within manageable limits of the base of support, as in standing or sitting, or in transit to a new base of support, as in walking” (from Winter 1995)
- control over movements of the body’s centre of mass
- necessary for safe performance of tasks

Howe et al, Cochrane Library 2007
High challenge to balance

Exercise in standing involving
- controlled movements of the body
- feet close together
- minimal arm support
Otago exercise programme
Otago exercise programme
Tai Chi
Other group exercise
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Evidence of Detraining After 12-Week Home-Based Exercise Programs Designed to Reduce Fall-Risk Factors in Older People Recently Discharged From Hospital

Constance M. Vogler, MBBS, FRACP, PhD, Jasmine C. Menant, PhD, Catherine Sherrington, PhD, Susan J. Ogle, MBBS, FRACP, Stephen R. Lord, PhD, DSc

Arch Phys Med Rehabil Vol 93, October 2012
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CI = confidence interval.
Interventions for preventing falls in older people living in the community

Lesley D Gillespie¹, M Clare Robertson¹, William J Gillespie², Catherine Sherrington³, Simon Gates⁴, Lindy M Clemson⁵, Sarah E Lamb⁴

Editorial Group: Cochrane Bone, Joint and Muscle Trauma Group

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DOI: 10.1002/14651858.CD007148.pub3

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### Analysis 2.1. Comparison 2 Group exercise: multiple categories of exercise vs control: subgroup analysis by falls risk at baseline, Outcome 1 Rate of falls.

**Review:** Interventions for preventing falls in older people living in the community

**Comparison:** 2 Group exercise: multiple categories of exercise vs control: subgroup analysis by falls risk at baseline

**Outcome:** 1 Rate of falls

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<tr>
<th>Study or subgroup</th>
<th>Intervention N</th>
<th>Control N</th>
<th>log [Rate Ratio] (SE)</th>
<th>Rate Ratio IV,Random,95% CI</th>
<th>Weight</th>
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</thead>
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<tr>
<td>Ballard 2004</td>
<td>20</td>
<td>19</td>
<td>-0.97 (0.59)</td>
<td></td>
<td>2.4 %</td>
<td>0.38 [0.12, 1.20]</td>
</tr>
<tr>
<td>Barnett 2003</td>
<td>76</td>
<td>74</td>
<td>-0.51 (0.26)</td>
<td></td>
<td>9.2 %</td>
<td>0.60 [0.36, 1.00]</td>
</tr>
<tr>
<td>Buchner 1997a</td>
<td>70</td>
<td>30</td>
<td>-0.49 (0.22)</td>
<td></td>
<td>11.4 %</td>
<td>0.61 [0.40, 0.94]</td>
</tr>
<tr>
<td>Lord 1995</td>
<td>75</td>
<td>94</td>
<td>-0.16 (0.2)</td>
<td></td>
<td>12.8 %</td>
<td>0.85 [0.58, 1.26]</td>
</tr>
<tr>
<td>Luukinen 2007</td>
<td>217</td>
<td>220</td>
<td>-0.07 (0.08)</td>
<td></td>
<td>23.9 %</td>
<td>0.93 [0.80, 1.09]</td>
</tr>
<tr>
<td>Rubenstein 2000</td>
<td>31</td>
<td>28</td>
<td>-0.17 (0.39)</td>
<td></td>
<td>5.0 %</td>
<td>0.84 [0.39, 1.81]</td>
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<tr>
<td>Skelton 2005</td>
<td>50</td>
<td>31</td>
<td>-0.37 (0.17)</td>
<td></td>
<td>15.1 %</td>
<td>0.69 [0.50, 0.96]</td>
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<td>Smulders 2010</td>
<td>47</td>
<td>45</td>
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<td></td>
<td>11.4 %</td>
<td>0.61 [0.40, 0.94]</td>
</tr>
<tr>
<td>Trombetti 2011</td>
<td>66</td>
<td>68</td>
<td>-0.78 (0.27)</td>
<td></td>
<td>8.8 %</td>
<td>0.46 [0.27, 0.78]</td>
</tr>
</tbody>
</table>

**Subtotal (95% CI)**

Heterogeneity: Tau² = 0.03; Chi² = 14.48, df = 8 (P = 0.07); I² = 45%
Test for overall effect: Z = 3.67 (P = 0.00024)
2 Not selected for higher risk of falling

<table>
<thead>
<tr>
<th>Study</th>
<th>n 1</th>
<th>n 2</th>
<th>Effect Size (SE)</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bunout 2005</td>
<td>111</td>
<td>130</td>
<td>0.2 (0.29)</td>
<td>9.9%</td>
<td>1.22 [0.69, 2.16]</td>
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<td>Carter 2002</td>
<td>40</td>
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<td>-0.13 (0.52)</td>
<td>4.0%</td>
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<td>Day 2002 (1)</td>
<td>541</td>
<td>549</td>
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<td>Lord 2003</td>
<td>259</td>
<td>249</td>
<td>-0.25 (0.12)</td>
<td>22.3%</td>
<td>0.78 [0.62, 0.99]</td>
</tr>
<tr>
<td>Means 2005</td>
<td>144</td>
<td>94</td>
<td>-0.89 (0.21)</td>
<td>14.5%</td>
<td>0.41 [0.27, 0.62]</td>
</tr>
<tr>
<td>Suzuki 2004</td>
<td>22</td>
<td>22</td>
<td>-1.05 (0.47)</td>
<td>4.7%</td>
<td>0.35 [0.14, 0.88]</td>
</tr>
</tbody>
</table>

Subtotal (95% CI)

<table>
<thead>
<tr>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>100.0%</td>
<td>0.72 [0.58, 0.90]</td>
</tr>
</tbody>
</table>

Heterogeneity: Tau^2 = 0.04; Chi^2 = 14.26, df = 6 (P = 0.03); I^2 = 58% 
Test for overall effect: Z = 2.93 (P = 0.0034) 
Test for subgroup differences: Chi^2 = 0.03, df = 1 (P = 0.86), I^2 = 0.0%
The role of exercise as a single fall prevention intervention in “special populations” is less clear

- Our recent trials in high risk groups have not found a fall prevention effect of exercise interventions that work in the general community
  - Dean et al (2012), circuit class in stroke survivors (IRR 0.96, 95% CI 0.59-1.51, \( p = 0.88 \))
  - Fairhall et al (2013), home exercise in frail older people (IRR 1.12, 95% CI 0.78 to 1.63, \( p = 0.53, n = 241 \))
  - Sherrington et al (under review), home exercise in people who have been in hospital (IRR 1.43, 95% CI 1.07 to 1.93, \( p = 0.017, n = 340 \))
WEBB post-hospital home exercise randomised controlled trial

- 340 people recruited when inpatients in 4 public hospitals in Sydney, Australia
- 60+, mobile, community/ hostel dwelling, MMSE > 24
- Seen at home after rehabilitation completed
- Random allocation to home exercise and control groups
WEBB post-hospital home exercise randomised controlled trial

- Exercises individually prescribed and progressed by an experienced physiotherapist
  - in 10 home visits and 5 phone calls over a 12 month period
  - home exercise to be completed 3-6 times weekly for 15-20 mins
  - dose individually negotiated
- Weight bearing Exercise for Better Balance, www.webb.org.au
WEBB post-hospital home exercise randomised controlled trial

Reducing base of support and controlled movement in standing
Stepping in different directions, stepping over obstacles, heel toe walking etc
Sit to stand, step ups, heel raises etc using weight belts/vests as able
Walking aid used outside at baseline

- None, n=124
- Walking stick, n=127
- Frame, n=87

Control vs Exercise

Mean (SE) falls per person year

- Control
- Exercise
Fall as a presenting problem on admission

No, n=197

Yes, n=143
History of neurological condition (incl. stroke, TIA)

- Control
- Exercise

Mean (SE) falls per person year

No, n=270

Yes, n=70
12-month between-group difference 0.13, 95% CI 0.04 to 0.21, p = 0.004

Sherrington et al, in preparation
A Short Physical Performance Battery Assessing Lower Extremity Function: Association With Self-Reported Disability and Prediction of Mortality and Nursing Home Admission

Jack M. Guralnik,¹ Eleanor M. Simonsick,¹ Luigi Ferrucci,² Robert J. Glynn,³ Lisa F. Berkman,⁴ Dan G. Blazer,⁵ Paul A (a)
This home exercise program in people after hospital stays improved mobility but increased falls

The increase in falls in the intervention group was particularly evident among those who walked more quickly

Differential impact of home exercise in people with neurological conditions and those presenting with falls warrants more intervention

Further studies in this population could evaluate supervised exercise, exercise plus safety interventions and multifactorial interventions
Overall
0.80, 95%CI 0.72 to 0.88

General population
0.76, 95%CI 0.68 to 0.86

Special population
0.95, 95%CI 0.82 to 1.10
Low-Intensity Exercise and Reduction of the Risk for Falls Among At-Risk Elders
Robert O Morgan; Beth A Virnig; Maurice Duque; Elsayed Abdel-Moty; Carolee A ...
*The Journals of Gerontology;* Oct 2004; 59A, 10; Health Module
pg. 1062

![Graph showing survival distribution function for different groups: 'High' Function / Control, 'High' Function / Exercise, 'Low' Function / Exercise, 'Low' Function / Control.](image)

**Figure 2.** Time to first fall.

O O O = Censored Observations
Effects of Exercise Programs on Falls and Mobility in Frail and Pre-Frail Older Adults: A Multicenter Randomized Controlled Trial

Marjan J. Faber, PhD, Ruud J. Bosscher, PhD, Marijke J. Chin A Paw, PhD, Piet C. van Wieringen, PhD

Table 5: Effects of the Interventions on Time to First Fall, After Correction for Confounders

<table>
<thead>
<tr>
<th>Group</th>
<th>Intervention Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>FW</td>
<td>1.59 (1.04–2.44)*</td>
</tr>
<tr>
<td>IB</td>
<td>1.09 (0.72–1.64)</td>
</tr>
<tr>
<td>Exercise†</td>
<td>1.36 (0.94–1.96)</td>
</tr>
<tr>
<td>Frail subgroup</td>
<td></td>
</tr>
<tr>
<td>Total period‡</td>
<td>2.95 (1.64–5.32)§</td>
</tr>
<tr>
<td>Pre-fragile subgroup</td>
<td></td>
</tr>
<tr>
<td>Total period (wk)‡</td>
<td>0.62 (0.29–1.33)</td>
</tr>
<tr>
<td>&lt;12</td>
<td>1.18 (0.55–2.54)</td>
</tr>
<tr>
<td>≥12</td>
<td>0.39 (0.18–0.88)*</td>
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NOTE. Values are HR (95% CI).
*P<.05.
†FW versus IB (P=.096); frailty effect modification (P=.002).
‡Time-dependent covariate: frail subgroup (P=.350), pre-fragile subgroup (P=.052).
§P<.001.
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3. Ongoing exercise is necessary

4a. Fall prevention exercise as a single intervention should be targeted at the general community as well as those at some increased risk of falls

4b. Exercise as a single intervention may not prevent falls in special populations (eg low vision)

4c. Home exercise as single intervention may be harmful in people who have recently been in hospital
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**Analysis 1.1. Comparison I Exercise vs control, Outcome I Rate of falls.**

Review: Interventions for preventing falls in older people living in the community

Comparison: Exercise vs control

Outcome: Rate of falls

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(Continued ...)
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Lord 2003 | 259 | 249 | -0.25 (0.12) | 10.8% | 0.78 [0.62, 0.99]
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Smulders 2010 | 47 | 45 | -0.49 (0.22) | 6.0% | 0.61 [0.40, 0.94]
Suzuki 2004 | 22 | 22 | -1.05 (0.47) | 1.9% | 0.35 [0.14, 0.88]
Trombetti 2011 | 66 | 68 | -0.78 (0.27) | 4.6% | 0.46 [0.27, 0.78]

**Subtotal (95% CI)**

| Heterogeneity: Tau² = 0.03; Chi² = 29.11, df = 15 (P = 0.02); I² = 48% |
| Test for overall effect: Z = 4.91 (P < 0.00001) |

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<th><strong>Rate Ratio IV,Random,95% CI</strong></th>
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2 Individual exercise at home: multiple categories of exercise vs control

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<tr>
<th>Study</th>
<th>N1</th>
<th>N2</th>
<th>Effect Size (SE)</th>
<th>% Effect</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bischoff-Ferrari 2010 (2)</td>
<td>87</td>
<td>86</td>
<td>-0.33 (0.14)</td>
<td>36.1 %</td>
<td>0.72 [ 0.55, 0.95 ]</td>
</tr>
<tr>
<td>Campbell 1997</td>
<td>116</td>
<td>117</td>
<td>-0.39 (0.14)</td>
<td>36.1 %</td>
<td>0.68 [ 0.51, 0.89 ]</td>
</tr>
<tr>
<td>Campbell 1999</td>
<td>45</td>
<td>48</td>
<td>-0.14 (0.45)</td>
<td>3.5 %</td>
<td>0.87 [ 0.36, 2.10 ]</td>
</tr>
<tr>
<td>Haines 2009 (3)</td>
<td>19</td>
<td>34</td>
<td>-0.33 (0.4)</td>
<td>4.4 %</td>
<td>0.72 [ 0.33, 1.57 ]</td>
</tr>
<tr>
<td>Lin 2007</td>
<td>50</td>
<td>50</td>
<td>-0.4 (0.33)</td>
<td>6.5 %</td>
<td>0.67 [ 0.35, 1.28 ]</td>
</tr>
<tr>
<td>Liu-Ambrose 2008</td>
<td>31</td>
<td>28</td>
<td>-0.43 (0.49)</td>
<td>2.9 %</td>
<td>0.65 [ 0.25, 1.70 ]</td>
</tr>
<tr>
<td>Robertson 2001a</td>
<td>121</td>
<td>119</td>
<td>-0.62 (0.26)</td>
<td>10.5 %</td>
<td>0.54 [ 0.32, 0.90 ]</td>
</tr>
</tbody>
</table>

**Subtotal (95% CI)**

Heterogeneity: Tau² = 0.0; Chi² = 1.30, df = 6 (P = 0.97); I² = 0.0%
Test for overall effect: Z = 4.55 (P < 0.00001)

3 Individual exercise: LiFE (balance and strength training in daily life activities) vs control

<table>
<thead>
<tr>
<th>Study</th>
<th>N1</th>
<th>N2</th>
<th>Effect Size (SE)</th>
<th>% Effect</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clemson 2010</td>
<td>18</td>
<td>16</td>
<td>-1.56 (0.62)</td>
<td></td>
<td>100.0 %</td>
</tr>
</tbody>
</table>

**Subtotal (95% CI)**

Heterogeneity: not applicable
Test for overall effect: Z = 2.52 (P = 0.012)
Recommendations for exercise to prevent falls in older adults

6. Walking training may be included in addition to balance training but high risk individuals should not be prescribed brisk walking programs

7. Strength training may be included in addition to balance training

8. Exercise providers should make referrals for other risk factors to be addressed

Additional benefits for additional activity but benefits from low levels of activity

Kenneth E. Powell,¹ Amanda E. Paluch,² and Steven N. Blair²

<table>
<thead>
<tr>
<th>Volume of activity</th>
<th>Health benefits</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>None</td>
<td>Being inactive is unhealthy</td>
</tr>
<tr>
<td>Above baseline but &lt;150 min/week of moderate intensity activity</td>
<td>Some</td>
<td>Low levels of activity are preferable to inactivity</td>
</tr>
<tr>
<td>150–300 min/week of moderate intensity activity</td>
<td>Substantial</td>
<td>Activity at the high end provides more benefits than at the low end</td>
</tr>
<tr>
<td>&gt;300 min/week of moderate intensity activity</td>
<td>Additional</td>
<td>Current scientific information does not indicate an upper limit for benefits nor an amount that appears to be hazardous.</td>
</tr>
</tbody>
</table>

¹One minute of vigorous intensity activity provides benefits roughly equal to two minutes of moderate intensity activity. The two intensities can be mixed in any ratio. Adapted from reference (95).
Randomized placebo-controlled trial of brisk walking in the prevention of postmenopausal osteoporosis

Shah Ebrahimp, Paul W. Thompson1, Vermala Baskaran2, Kathy Evans3

bone mineral density had increased to a similar extent (+0.017 g/cm²) in both groups. The cumulative risk of falls was higher in the brisk-walking group (excess risk of 15 per 100 person-years, 95% CI 1.4 - 29 per 100 person-years, P < 0.05). There were no significant differences in clinical or spinal x-ray fracture risk or self-rated health status
Recommendations for exercise to prevent falls in older adults

6. Walking training may be included in addition to balance training but high risk individuals should not be prescribed brisk walking programs
7. Strength training may be included in addition to balance training
8. Exercise providers should make referrals for other risk factors to be addressed

Ageing or disuse?

Chronic Exercise Preserves Lean Muscle Mass in Masters Athletes

© The Physician and Sportsmedicine, Volume 39, Issue 3, September 2011,

Andrew P. Wroblewski, MBS, BS¹,a
Francesca Amati, MD, PhD²,³,a
Mark A. Smiley, MBA, BS¹
Bret Goodpaster, PhD²
Vonda Wright, MD, MS¹,b

for Global Health
Recommendations for exercise to prevent falls in older adults

6. Walking training may be included in addition to balance training but high risk individuals should not be prescribed brisk walking programs

7. Strength training may be included in addition to balance training

8. Exercise providers should make referrals for other risk factors to be addressed

Successful community fall prevention interventions: Cochrane review, Gillespie et al, 2012

Exercise/Tai Chi, cataract surgery, pacemaker, medication, podiatry

Physical factors: balance, strength, vision, sensation, reaction time, cardiovascular

Home/community safety

Behaviour: choice of and care with activity

Environmental modification, anti-slip shoe

Environment triggers

Fewer falls
Prevalence and correlates of participation in fall prevention exercise/physical activity by older adults

Dafna Merom a,c,*, Victoria Pye b, Rona Macniven c, Hidde van der Ploeg c, Andrew Milat d, Catherine Sherrington e, Stephen Lord f, Adrian Bauman c

<table>
<thead>
<tr>
<th>Prompted activities</th>
<th>n</th>
<th>Prevalence % (95% CI)</th>
<th>Times/week Mean (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking for all purposes</td>
<td>4579</td>
<td>80.8 (79.7–82.1)</td>
<td>5.3 (5.2–5.4)</td>
</tr>
<tr>
<td>Strength/resistance</td>
<td>670</td>
<td>12.0 (11.0–13.0)</td>
<td>4.3 (4.0–4.6)</td>
</tr>
<tr>
<td>Group exercise</td>
<td>443</td>
<td>7.9 (7.12–8.73)</td>
<td>2.7 (2.5–3.0)</td>
</tr>
<tr>
<td>Lawn bowls or other bowls</td>
<td>369</td>
<td>6.54 (5.81–7.27)</td>
<td>1.8 (1.7–1.9)</td>
</tr>
<tr>
<td>Balance training</td>
<td>331</td>
<td>5.95 (5.25–6.65)</td>
<td>3.8 (3.4–4.2)</td>
</tr>
<tr>
<td>Golf</td>
<td>289</td>
<td>5.36 (4.68–6.05)</td>
<td>2.0 (1.8–2.1)</td>
</tr>
<tr>
<td>Dancing</td>
<td>206</td>
<td>3.41 (2.89–3.93)</td>
<td>1.9 (1.6–2.1)</td>
</tr>
<tr>
<td>Tai Chi</td>
<td>158</td>
<td>2.70 (2.22–3.17)</td>
<td>3.0 (2.5–3.4)</td>
</tr>
<tr>
<td>Tennis</td>
<td>126</td>
<td>2.40 (1.91–2.88)</td>
<td>1.4 (1.2–1.6)</td>
</tr>
<tr>
<td>Yoga</td>
<td>101</td>
<td>1.79 (1.40–2.18)</td>
<td>3.2 (2.7–3.7)</td>
</tr>
<tr>
<td>Team Sports</td>
<td>50</td>
<td>1.03 (0.70–1.36)</td>
<td>1.5 (1.1–1.8)</td>
</tr>
</tbody>
</table>
Most Australians are insufficiently active, particularly older people.

**Physical inactivity.** The percentage of adults who did not participate in sufficient regular physical activity to gain a health benefit. The recommended minimum level of activity is 150 minutes per week of walking or other moderate or vigorous activity, over at least five sessions.

- In 2007–08, most adults (62%) did not do the recommended amount of physical activity.

- Physical inactivity increased with age—76% of people aged 75 and over did not meet the guidelines, compared with 57% of people aged 18–34.

- Women were slightly more likely than men to be physically inactive.


Strategies for better implementation

- Individual
  - prescribe optimistically, realistically and safely
  - behaviour change strategies eg motivational interviewing, technology
  - strategies for maintaining exercise after discharge

- Program
  - availability of suitable programs

- Advocacy
  - general public
  - health professionals

- Collaboration: other conditions, physical activity promotion

Make your move – Sit less – Be active for life!

This page contains Australia's Physical Activity and Sedentary Behaviour Guidelines including links to brochures, tips and ideas and evidence review reports.

Page last updated: 06 February 2014

Australia's Physical Activity and Sedentary Behaviour Guidelines

Regardless of how young or old you are, there are physical activity and sedentary behaviour guidelines available for you.

- National Physical Activity Recommendations for Children 0-5 years
- Australia's Physical Activity and Sedentary Behaviour Guidelines for Children (5-12 years)
- Australia's Physical Activity and Sedentary Behaviour Guidelines for Young People (13-17 years)
- Australia's Physical Activity and Sedentary Behaviour Guidelines for Adults (18-64 years)
Australian physical activity guidelines for older adults

1. Older people should do some form of physical activity, no matter what their age, weight, health problems or abilities.

2. Older people should be active every day in as many ways as possible, doing a range of physical activities that incorporate fitness, strength, balance and flexibility.

3. Older people should accumulate at least 30 minutes of moderate intensity physical activity on most, preferably all, days.
4. Older people who have stopped physical activity, or who are starting a new physical activity, should start at a level that is easily manageable and gradually build up the recommended amount, type and frequency of activity.

5. Older people who continue to enjoy a lifetime of vigorous physical activity should carry on doing so in a manner suited to their capability into later life, provided recommended safety procedures and guidelines are adhered to.
Conclusions

- Falls are preventable in community dwelling older people with ongoing exercise that targets balance
- Widespread implementation of fall prevention strategies in community dwellers is urgently needed
- Greater understanding of optimal fall prevention strategies in high risk groups is needed
Thanks to

- NHMRC funding for salary and projects
- Co-investigators
- Staff and students
- Study participants