Prevention of falls and fractures
Risk Falls

• 1/3 third of women, 1/5 of men >70 years
• Major Risk factors:
  – Frailty, dementia, osteoarthritis, stroke
• Other Risk factors
  – older age, congestive heart failure, poorer quality of life
  – nutritional status as independent risk factors for recurrent and injurious falls among those with a previous hip fracture

Older People, Osteoporosis: Falls, Fracture

Risk of Falls

- **Age**
- Low physical activity
- Low body weight
- Low lean mass
- Low fat mass
- Low vitamin D status
- Malnutrition
- Medications
- Medical conditions
- Diabetes, Depression

Low BMD

- **Age**
- Low physical activity
- Low body weight
- Low lean mass

Lower peak bone mass

- Low dietary calcium
- Low vitamin D status
- Malnutrition
- Medications

Each SD below reference mean BMD

↑ fracture risk 4 times. LaFleur et al. 2001
Osteoporosis in Australia

• Every 5-6 mins: 1 person admitted hospital
• Women with osteoporosis:
  71% > 80 years

• 50% of people with one fracture due to osteoporosis will have another
  1/5 of those who fracture a hip will die within 6 months

  Survivors: 1/2 will not be able to walk without assistance

  1/2 half need full-time nursing care

Age-specific and sex-specific incidence of radiographic vertebral, hip, and distal forearm fractures

Data derived from European Prospective Osteoporosis Study 7 and General Practice Research
Reference Australian National Consensus Conference 1996. MJA 1997;167:S1-S2

http://www.osteoporosis.org.au/about/about-osteoporosis/what-is-osteoporosis/
Vitamin D

Sun rich cultures
135 - 220 nmol/L 25 (OH)D₃
Life guards 148 - 163 nmol/L

Nursing home residents
35 nmol/L 25 (OH)D₃
Prevalence Vit D Deficiency

Hostel Residents
n=373

Level of deficiency
<30nmol/L frank

31% deficient

Nursing Home Residents
n=767

59% deficient
Vitamin D status (25OHD) and disease

Level 1

• Vitamin D (plus calcium) for falls

• and fractures
  (DIPART, 2010, Institute of Medicine (IOM), 2011)

• All cause mortality

Meta-analysis RCTs
vitamin D supp
4 falls & fracture
3 mortality

Vitamin D: Effect on falls/fracture (compliance >50%)

- 2-year randomised, double-blind placebo controlled
  - >25 & <90 nmol/l 25(OH)D
  - (not frankly deficient)
  - All 600 mg Calcium
  - vitamin D (10,000 IU D2 1/wk or 1000IUn(25ug) 1/d)
  - placebo
- OR ever falling 0.70 (0.50–0.99) (30% reduction)
- OR ever fracture 0.68 (0.38–1.22)
  - 8 people needed to be treated for one year to prevent a fall occurring

Flicker et al. JAGS 2005 Nov
Summary: vitamin D

• vitamin D supplementation greatest effect in decreasing falls in:
  – older people who are frail
  – low/suboptimal serum vitamin 25 D levels

• Adequate Serum 25OH > 50nmol/L (60nmol/L summer)

• Some evidence (~75nmol/L(25(OHD)) desirable targets for optimal bone health

• Adequate calcium intake required
Calcium: Effect on Fractures

Meta analysis fracture: Ca or Ca + Vitamin D

17 studies: 52,625 >50 yrs: treat 3.5 years:
12% risk reduction

Fracture: Ca or Ca + Vitamin D

No significant difference Ca supp. + vitamin D versus Ca alone

Compliance with Ca supplements


- 85% consumed 50-59% supplements
- Only 9% took at least 80% supplement
Most benefit with Ca supplements:

<table>
<thead>
<tr>
<th>Sub-group analysis</th>
<th>n</th>
<th>% Risk Reduction</th>
<th>Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>49,233</td>
<td>6%</td>
<td>P=0.003</td>
</tr>
<tr>
<td>Institution</td>
<td>3,392</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>Serum 25(OH)D &lt;25mmol/L</td>
<td>10,144</td>
<td>14%</td>
<td>P=0.06</td>
</tr>
<tr>
<td>Serum 25(OH)D &gt;25mmol/L</td>
<td>39,167</td>
<td>6%</td>
<td></td>
</tr>
</tbody>
</table>

Most benefit with Ca supplements

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>% Risk</th>
<th>Interaction Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca Supp &lt; 1200mg/d</td>
<td>47,359</td>
<td>6%</td>
<td>P=0.006</td>
</tr>
<tr>
<td>Ca Supp ≥ 1200mg/d</td>
<td>5,266</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>(70% 840mg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 – 70 years</td>
<td>36,640</td>
<td>3%</td>
<td>P=0.003</td>
</tr>
<tr>
<td>70 - 80 years</td>
<td>12,481</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>&gt;80 years</td>
<td>3,504</td>
<td>24%</td>
<td></td>
</tr>
</tbody>
</table>

Calcium Recommendations

- 840 - 1000mg Ca/day
- 1110mg – 1300 Ca mg/day
- 1100mg – 1300 Ca mg

- Calcium predominantly milk/milk-based foods
- Adults average: 850mg/d
  - 40% comes from non-milk sources

- 11.8 MJ 9.6MJ Energy
- 9.5 MJ and 8.3MJ Energy 9 -16%
- 7.1 MJ 6.2MJ Energy 40 - 45%
- 13 - 16%
Women >50 yrs
Men. >70 years
AI- RDI
1110mg – 1300 Ca mg/day

Orange Juice
with added Calcium + Vitamins A, C & Folate
250ml glass: Ca 100mg

Bread
with added Calcium + fibre
2 slices (74g) Ca 200mg

Calcium fortified cereal
Per 30g serve: Ca 200mg
With ½ cup milk: Ca 359mg

Calcium fortified foods

<table>
<thead>
<tr>
<th>Serves</th>
<th>Ca mg</th>
<th>unfortified Ca mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 slices bread</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>1 glass milk</td>
<td>500</td>
<td>300</td>
</tr>
<tr>
<td>(1/2 on cereal)</td>
<td></td>
<td>neg</td>
</tr>
<tr>
<td>1 cereal (30g)</td>
<td>200</td>
<td>neg</td>
</tr>
<tr>
<td>1 orange juice (150ml)</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total Ca mg/day</strong></td>
<td><strong>960</strong></td>
<td><strong>512</strong></td>
</tr>
</tbody>
</table>

Difficult to achieve RDI for calcium without use of calcium fortified foods or supplements

Commercial Calcium Supplements

<table>
<thead>
<tr>
<th>Product name</th>
<th>Calcium (mg) Per Tablet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caltrate</td>
<td>600</td>
</tr>
<tr>
<td>Cal-Sup</td>
<td>500</td>
</tr>
<tr>
<td>Calvita Osti</td>
<td>600</td>
</tr>
<tr>
<td>Sandocal 600</td>
<td>600</td>
</tr>
<tr>
<td>Sandocal 1000</td>
<td>1000</td>
</tr>
</tbody>
</table>
Changes in Body Composition

• **Sarcopenia**: Age-related decrease in Muscle Mass
  • By 50 yrs: loss 10% muscle mass along with a corresponding decrease in strength
  • By 70 yrs: loss 40%.

- muscle 40% of body weight 30 years
- muscle 25-30% of body weight 90 years
Sarcopenia: Age-related muscle loss ageing

Number of fibres (vastus lateralis muscles men (18-82yrs)
From age 80, no. fibres 50% younger men

↓ type 2 muscle fibres
▪ Strength: ↓30% per yr >60yrs
▪ Sedentary loss and twice as high

number of motor units (extensor digitorum brevis) muscles
constant 5 to 50 yrs decreased linearly 95yrs

Underweight

↑ age  ↓ % overweight / obese

- Underweight
  - reduced skeletal muscle mass
  - increase risk of falls
  - increase susceptibility injury, bone fracture

- Weight loss or 10% or more:
  - ↑ hip fracture

- ↑ fracture low BMI
  - < 20


National Health Survey 2001
Obesity hits older population

- 1 million obese older Australians
- >one in five seniors
- 6–7kg heavier 20 yrs ago
- Gain weight into mid-70s
- Obese older Australians:
  - greater risk of chronic diseases, disability and social impairment
- ? Obesity osteoporosis:
  - BMI> 30 ↓bone health

Migliaccio S. et al. Diabetes Metab Syndr Obes. 2011;4:273-82. Is obesity in women protective against osteoporosis?
Sarcopenic obesity

- 30% men, 10% women >80 yrs:
- fat gain, re-enforces muscle loss
- ↓ resting metabolic rate and
- ↓ activity → + ve energy balance
- Direct catabolic effects
- ↑fat mass, ↓ muscle mass
  - physical activity becomes progressively more difficult
  - increased disability

Sarcopenia, Sarcopenic Obesity

Metanalysis (n=>250,000 person yrs)

**Hip fracture risk**
- BMI 20 versus BMI 25: ↑ X 2 risk
- BMI 30 compared to BMI 25: 17% ↓ risk

**Adjustment BMD**
- BMI 20 versus BMI 25: 33% ↑ risk
- BMI 30 compared to BMI 25: no change risk

? Obesity osteoporosis: BMI> 30 ↓ bone health (Migliaccio)

Dietary Protein

- Protein recommendations for the elderly
- 25% greater for those 70 years and older

- RDI (women):
  - < 70yrs: 0.75 g/kg
  - > 70yrs: 0.94 g/kg
  (increased from 46g/d to 57 g/d)

- Physically active: ≥ 1.2 – 1.5 g/kg/d?
Protein in Elderly

- Significant number clinical protein-energy malnutrition
- Falls are more likely in those with malnutrition
- Hip fracture in NHANES I was higher in those with low energy intake, low albumin, low muscle strength (Huang et al Am J Epidemiol 1996)
- RCT: Hip fracture patients protein (20g/d) supplements:
  - shorter hospital stay (21 days)
  - biceps muscle strength increased (16%)
  - less bone loss (50% less 1yr)
Elderly, Hip fracture and Protein Supplements:

Effect of protein supplements on bone mineral density (BMD) of the proximal femur in patients with hip fracture 12 months earlier. Results given as the mean +/- SE and are expressed as a percentage of baseline values. The solid line represents patients who received protein supplements; the dashed line represents controls. *P = 0.029 for comparison with controls (analysis of variance).

Elderly, Hip fracture and Protein Supplements:

Effect of protein supplements on serum levels of insulin-like growth factor-I (IGF-I) in patients with recent hip fracture. Results are the mean +/- SE and are expressed as a percentage of baseline values. The solid line represents patients who received protein supplements; the dashed line represents controls. *P = 0.055; **P = 0.003 for comparison with controls (analysis of variance).

Benefits of Resistance training

- ↑ mobility
- ↑ balance
- ↑ flexibility
- ↑ aids weight maintenance
- ↑ gait
- ↑ velocity
- ↑ muscle strength
- ↓ prevents falls
- ↑ improved appetite
- ↑ protein retention
- ↑ bone maintenance
WHAM
Womens’ Health and Muscle Health Study

Funded by Meat & Livestock Aust

Robin M. Daly,1 Stella O’Connell,1 Niamh Mundell,1 Carley Grimes,1 David Dunstan,2 Caryl Nowson1

1 Centre for Physical Activity and Nutrition Research (C-PAN), Deakin University, Melbourne; 2 Baker IDI Heart and Diabetes Institute, Melbourne
Study Aim and Hypothesis

Study Aim

• To investigate whether increasing dietary protein, when combined with resistance training enhanced muscle mass, strength and function in older women.

Study Hypothesis

• Modest increase dietary protein (~1.3 g/kg/d) through an increased intake of lean red meat (2Xday) (~80g/meal), combined with progressive RT will lead to greater gains in muscle mass, strength and function compared to PRT Control carbohydrate diet.
RCT Design: 16 week intervention

Enrollment
- Assessed for eligibility
- Randomised to diet groups by retirement village: independently living: self catering no meals provided
- Allocated: vitamin D supplement (1000IU/d)
  Resistance Training 2x week

Allocation
- Higher Protein Lean red meat
  16 weeks
  complete study
- Control carbohydrate 1 serve/day
  16 weeks
  complete study

Analysis
- Study Centre visit 1.
- Mid visit (pathology centre): blood test 24hr urinary sodium
- Study Centre visit 2.

Blood pressure:
5 min seated, automated (AND): 3 reading s (1min apart)(mean last 2)
Protein Intake (mean SEM)

Mean age 72 years

Baseline 4 wks 8 wks 12 wks 16 wks

Δ* baseline v intervention P<0.05

Dietary intake 24hr dietary recalls

Δ* baseline v intervention P<0.05

Significant difference between groups for protein g/kd/d & g/d P<0.05

1.3 0.1 g/kg/d (91g/d)

1.1 0.1 g/kg/d (75g/d)
**Effects on Total body Fat Mass (DXA)**

**Changes in total body fat mass (kg)**
- **RT + Protein**: -0.48 kg
- **RT + Control CHO**: -0.29 kg

*No significant difference between groups*

**Total body Lean Mass**
- **RT + Protein**: +0.6 kg
- **RT + Control CHO**: +0.1 kg

* ***p<0.001 vs baseline*

* **p<0.05**

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* *p<0.05 vs baseline*
Effects of Muscle Strength and Power

- RT + protein 40%
- RT + Control CHO 19%

** p<0.01, *** p<0.001 vs baseline

Leg Muscle Strength

RT+CHO

RT+Meat

** p<0.01, *** p<0.001 vs baseline
Key Findings

• Twice-weekly PRT in vitamin D replete older women when combined with:
  • Protein Group (1.3 g/kg/d)
    – 0.5kg greater Increase lean mass
    – 20% greater in Leg extension strength

• Conclusion
  – Older women require 1.3 g/kg/body weight higher dietary protein intake to induce anabolic response to resistance training
Strategies: reduce falls fractures

- Adequate vitamin D status
- Progressive resistance raining
- Maintain body weight (BMI 24 -30)
- Nutritionally adequate diet:
  - Energy
  - protein (∼36% higher RDI) 1.3g/kg body weight
  - Calcium

Prevention of falls and fractures

Protein Resistant Training

Adequate Protein

Adequate vitamin D status

Adequate Dietary Calcium

Adequate Energy Intake