Osteoporosis and Fractures
The Size of the Problem

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A million fragility fractures a year

But can we do more?
Lecture content

- **Definition of Osteoporosis**
- **Epidemiology of Osteoporosis**
  - Ageing populations
  - prevalence and incidence of osteoporotic fractures
  - prevalence of low bone mass
- **Quality of Life**
  - morbidity and mortality
  - pain and limitations
- **Economic burden**
Definition of osteoporosis

“…a systemic skeletal disease characterized by low bone mass and micro-architectural deterioration of bone tissue, leading to enhanced bone fragility and a consequent increase in fracture risk.”

World Health Organization (WHO), 1994
Trabecular bone

normal

osteoporotic

Bone quality is not the only factor …
Pathogenesis of fragility fractures

Neuromuscular function
Environmental risks
Age

Type of fall
Energy reduction
External protection

Bone mass
Bone structure
Bone quality

Fall Risk
Impact of fall
Skeletal strength

Fracture risk
Lecture content

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- Quality of Life
  - morbidity and mortality
  - pain and limitations
- Economic burden
The ageing population

In western countries

In Europe, population over 65:

- 12-17 % in 2002
- 20-25 % by 2025
Life expectancy in men and women

<table>
<thead>
<tr>
<th>Age (in years)</th>
<th>Life expectancy (in years) in 1999</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>At birth (0)</td>
<td></td>
<td>75.4</td>
<td>80.2</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>71.0</td>
<td>75.7</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>56.2</td>
<td>60.8</td>
</tr>
<tr>
<td>30</td>
<td></td>
<td>46.7</td>
<td>51.0</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>27.9</td>
<td>32.0</td>
</tr>
<tr>
<td>60</td>
<td></td>
<td>19.4</td>
<td>23.0</td>
</tr>
<tr>
<td>70</td>
<td></td>
<td>12.2</td>
<td>15.1</td>
</tr>
<tr>
<td>80</td>
<td></td>
<td>7.0</td>
<td>8.7</td>
</tr>
</tbody>
</table>

and life expectancy is increasing

Data from the UK
The ageing population

In developing countries

0 - 15 years 30 %
Over 65 years 5.5 %

But changes are expected…
Biological age – a factor beyond chronological age

Higher fracture rate in women with high biological age

Higher mortality in women with high biological age

N=1044 women 75 years old

Gerdhem et al Gerontology 2004; 50:309-14
Epidemiology of fractures

- Incidence and prevalence depend on:
  - definition of fracture
  - diagnostic method:
    - clinical vs. radiological
    - quantitative vs. qualitative
    - morphometric method
  - study population
Age- and sex-specific incidence of all limb fractures

Fracture and quality of life over the life span

Morbidity

Hip fracture

Vertebral fracture

Colles’ fracture

Age

50 60 70 80 90
Osteoporotic fracture incidence

Women

- Forearm
- Vertebrae
- Hip

Men

- Forearm
- Vertebrae
- Hip

Incidence per 100,000 person-years

Age (years)
Number of osteoporotic fractures worldwide

![Bar chart showing the number of incident and prevalent fractures for men, women, and total.](chart.png)
# Remaining lifetime fracture risk (%) in Caucasian population at the age of 50

<table>
<thead>
<tr>
<th>Type of Fracture</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forearm</td>
<td>4.6</td>
<td>20.8</td>
</tr>
<tr>
<td>Hip</td>
<td>10.7</td>
<td>22.9</td>
</tr>
<tr>
<td>Spine</td>
<td>8.3</td>
<td>15.1</td>
</tr>
<tr>
<td>Proximal Humerus</td>
<td>4.1</td>
<td>12.9</td>
</tr>
<tr>
<td>Other</td>
<td>22.4</td>
<td>46.4</td>
</tr>
</tbody>
</table>

Johnell et al. Osteoporos Int 2005; 16 Suppl 2:S3-7
### Prior fracture increase risk for subsequent fracture

<table>
<thead>
<tr>
<th>Site of prior fracture</th>
<th>Hip</th>
<th>Spine</th>
<th>Forearm</th>
<th>Minor fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip</td>
<td>2.3</td>
<td>2.5</td>
<td>1.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Spine</td>
<td>2.3</td>
<td>4.4</td>
<td>1.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Forearm</td>
<td>1.9</td>
<td>1.7</td>
<td>3.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Minor Fracture</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Mortality after major types of osteoporotic fracture in men and women

5-year prospective cohort study

<table>
<thead>
<tr>
<th>Fracture</th>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal femur</td>
<td>2.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Vertebral</td>
<td>1.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Other major</td>
<td>1.9</td>
<td>2.2</td>
</tr>
<tr>
<td>Other minor</td>
<td>0.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Center et al. Lancet 1999; 353:878-882
Vertebral fractures: grading of severity

Fracture Grade
0- Normal

1- Mild (20-25%*)

2- Moderate (26-40%*)

3- Severe (>40%*)

Adapted from Genant HK et al. J Bone Miner Res 1993; 8:1137-1148
Incidence of vertebral fractures in women and men

The EPOS Study

EPOS Group, J Bone Miner Res 2002; 17:716-24
Proportion with vertebral deformity

Vertebral fracture prevalence

McCloskey Method

O’Neill, J Bone Miner Res 1996; 11:1010
Only 30% of morphometric vertebral fractures are "clinically apparent"
Risk for new vertebral fracture following first vertebral fracture

Incidence of new vertebral fractures (%)

Number of vertebral fractures at start of study

2725 post-menopausal women, randomized placebo-controlled

Lindsay et al. JAMA 2001; 285:320-23
Vertebral deformity and the risk of future fracture

Cumulative proportion without fracture

Risk increase
HR 2.0

Without Vfx
With Vfx

Hasserius et al. Osteoporos Int. 2003; 14:61-8
Vertebral fractures and mortality

Fig. 1 Cumulative survival rate, adjusted to age 65 years, in men with a prevalent vertebral deformity, using deformity criterion $-3$ SD, at baseline compared with men without a vertebral deformity, during a 10-year follow-up period.

Fig. 2 Cumulative survival rate, adjusted to age 65 years, in women with a prevalent vertebral deformity, using deformity criterion $-3$ SD, at baseline compared with women without a vertebral deformity, during a 10-year follow-up period.
Hip fracture incidence

Incidences per 100,000 person-years

Age (years)

Men

Femoral Neck

Intertrochanteric

Women

Femoral Neck

Intertrochanteric

Melton et al. Calcif Tissue Int 1987; 41:57
Hip fracture incidence
Geographic variation

Kanis et al, J Bone Miner Res. 2002; 17:1237
Incidence of hip fractures in women and men

The Medos Study
Projected number of osteoporotic hip fractures worldwide

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Hip Fractures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950</td>
<td>1.66 million</td>
</tr>
<tr>
<td>2050</td>
<td>6.26 million</td>
</tr>
</tbody>
</table>

Estimated number of hip fractures: (1000s)

Adapted from Cooper et al, Osteoporos Int. 1992; 2:285-9
Distal radius fractures

- The most common fracture in women at middle age
- Incidence increase begins just after menopause in women
- The most common fracture in men below age 70 years

Holmberg et al, Osteoporos Int. 2006; 7:1065-77
Distal radius fractures

- It is estimated that 16.6% of women and 2.9% of men will suffer a distal radius fracture from the age of 50 years in the UK.
- Only 50% report good functional outcome at 6 months and up to 30% of individuals may suffer some long-term complications.

Proximal humerus fracture

- Estimated that fractures of the proximal part of the humerus account for 4-8% of all fractures
- In persons over 40, fractures of the proximal humerus account for 76% of all fractures of the humerus
- Data suggest that fracture of the proximal humerus is the third most common fracture over age 65
- Fractures of the proximal humerus have shown a pattern of increase similar to other common fragility fractures
Epidemiology of low bone mass

Prevalence depends on:
- definition of low bone mass (WHO)
- densitometry technique (DXA)
- skeletal site
- study population
### WHO criteria for osteoporosis

T-score: Difference expressed as standard deviation compared to young reference population

<table>
<thead>
<tr>
<th></th>
<th>T-score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>- 1.0 and above</td>
</tr>
<tr>
<td>Osteopaenia</td>
<td>- 1.0 to - 2.5</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>- 2.5 and below</td>
</tr>
<tr>
<td>Severe (established)</td>
<td>- 2.5 and below, plus one or more osteoporotic fracture(s)</td>
</tr>
</tbody>
</table>
Prevalence of osteoporosis in men and women by gender-specific scores

Schuit et al. Bone 2004; 34:195
Prevalence of osteoporosis in women at different skeletal sites

Melton et al. J Bone Miner Res 1995; 10:175
Prevalence of osteoporosis at the femoral neck in Caucasian women

Kanis et al, Calcif Tissue Int 2001; 69:218
Prevalence of low bone mass in male Caucasians aged 50 years and older

- **Osteopaenia**: T-score -1 to -2.5
- **Osteoporosis**: T-score ≤ -2.5

<table>
<thead>
<tr>
<th></th>
<th>Female cut off points</th>
<th>Male cut off points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Femoral Neck</strong></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Prevalence</td>
<td>33%</td>
<td>47%</td>
</tr>
<tr>
<td>Prevalence</td>
<td>4%</td>
<td>6%</td>
</tr>
</tbody>
</table>

Bone density is not the only factor of fracture risk …

- Bone mass
- Bone structure
- Bone quality

- Neuromuscular function
- Environmental risks
- Age

- Type of fall
- Energy reduction
- External protection

- Fall Risk
- Impact of fall
- Skeletal strength

- Fracture risk
Osteoporotic fracture and BMD

Fractures per 1,000 person-years

Number of fractures

Fracture rate
Women with fractures

Ten-year probability of hip fracture in Sweden
Ten-year probability of hip fracture in women at T–score = –2.5
Fracture risk – multifactorial

The relative importance of risk factors

BMD independent factors

BMD dependent factors

Age
Fracture risk – multifactorial

The relative importance of risk factors

Vertebral fractures

BMD independent factors

BMD dependent factors

Age
Fracture risk – multifactorial

The relative importance of risk factors

- BMD independent factors
- BMD dependent factors
- Non-vertebral fractures
Fracture risk is...

- highest in the oldest population
- highest in women
- highest in those with previous fracture
- high in those with low bone density
- high in very thin people
- high in those with comorbidity
- high in those on steroid treatment
- high in those who smoke
Lecture content

• Definition of Osteoporosis

• Epidemiology of Osteoporosis
  – ageing populations
  – prevalence and incidence of osteoporotic fractures
  – prevalence of low bone mass

• Quality of Life
  – morbidity and mortality
  – pain and limitations

• Economic burden
Active women have fewer fragility fractures and better quality of life

City-living women

Ringsberg et al. Gerontology 2001; 47:15-20
All fractures are associated with morbidity

One year after a hip fracture:
- Death within one year: 20%
- Unable to walk independently: 30%
- Permanent disability: 40%
- Unable to carry out at least one independent activity of daily living: 80%
Morbidity after vertebral fractures

• Back pain
• Loss of height
• Deformity (kyphosis, protuberant abdomen)
• Reduced pulmonary function
• Diminished quality of life
  – loss of self-esteem, distorted body image
  – dependence on sleeping tablets, sleep disorders
  – depression
  – loss of independence
Vertebral fractures restrict daily activities

People with vertebral fractures have greater pain, disability and healthcare utilisation, on average, than those without fracture

Adapted from Ross PD et al.
All vertebral fractures are clinically important

Outcome after hip fracture
The situation one year after fracture

Loss of function 50%
Mortality 20%
Regained functional capacity 30%
Improvement in quality of life after surgery for hip fracture

SF-36 at baseline and 3, 6, and 9 months after surgery

Optimal fracture treatment – a prerequisite for maintaining quality of life
Lecture content

• **Definition of Osteoporosis**

• **Epidemiology of Osteoporosis**
  – aging populations
  – prevalence and incidence of osteoporotic fractures
  – prevalence of low bone mass

• **Quality of Life**
  – morbidity and mortality
  – pain and limitations

• **Economic burden**
Cost of osteoporosis in the United States

Total annual cost

- Hospitalization: $8.6 billion (62%)
- Nursing Home: $3.9 billion (28%)
- Outpatient: $1.3 billion (10%)

Total annual cost: $13.8 billion
### Economic impact of osteoporosis

Annual economic cost of treating fractures in the USA is similar to that of treating cardiovascular disease and asthma

<table>
<thead>
<tr>
<th>Disease</th>
<th>Prevalence (millions)</th>
<th>Annual direct cost including hospitalization (US$ billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiovascular disease</td>
<td>4.6</td>
<td>20.3</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>10</td>
<td>13.8</td>
</tr>
<tr>
<td>Asthma</td>
<td>15</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Information supplied by National Heart, Lung & Blood Institute, National Osteoporosis Foundation, American Heart Association
Osteoporotic fractures: comparison with other diseases

- Osteoporotic fractures:
  - 1500000 annual incidence all ages
  - 750000 vertebral
  - 250000 hip
  - 250000 forearm
  - 250000 other sites

- Annual estimate women 29+
  - 513000

- Annual estimate women 30+
  - 228000

- Breast cancer
  - 184300

1996 new cases, all ages

Annual incidence x 1000

American Heart Association, 1996
American Cancer Society, 1996
Riggs & Melton Bone, 1995; 17:505S-511S
The burden of osteoporosis
Lecture summary

• Epidemiology of osteoporosis
  – Prevalence and incidence of osteoporotic fractures is high and increases exponentially with age

• Quality of Life
  – Morbidity and mortality are significantly increased after fractures
  – Osteoporotic fractures result in pain and reduced quality of life

• Economic costs are huge
  – In comparison with other diseases, osteoporosis is very common
  
  Osteoporosis = important public health problem

30-50% of women and 15-30% of men will suffer an osteoporotic fracture