# Diagnosis of Osteoporosis

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# Diagnosis of Osteoporosis

- Osteoporosis can currently be diagnosed by applying the WHO classification to bone mineral density (BMD) assessed by dual-energy x-ray absorptiometry (DXA).

- However, skeletal factors other than BMD contribute to bone strength and fracture risk.

# WHO - International Reference Standard

## Post-menopausal women and men >50 years

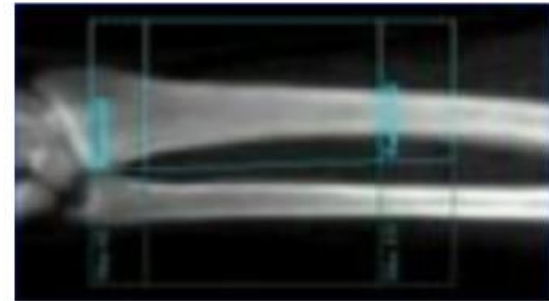| Category | T-score |
|---|---|
| Normal | ≥ -1.0 |
| Low bone mass/density (osteopenia) | -1.0 > SD < -2.5 |
| Osteoporosis | ≤ -2.5 |
| Severe or established osteoporosis | ≤ -2.5 with fragility fracture |

## Pre-menopausal women and men <50 years

| Category | Z-score |
|---|---|
| Within the expected range for age | > -2.0 |
| Below the expected range for age | ≤ -2.0 |

Kanis JA, et al. *J Bone Miner Res.* 1994;9:1137-1141.

# Indications for BMD Testing

- Women ≥65 years of age

- Men ≥70 years of age

- For post-menopausal women <65 and men <70 yrs of age, if they have a risk factor:
  - Low body weight
  - Prior fracture
  - High risk medication use
  - Disease or condition associated with bone loss

- Adults with a fragility fracture

- Adults with a disease or condition associated with low bone mass or bone loss

- Anyone being considered for pharmacologic therapy

- Anyone being treated, to monitor treatment effect

- Anyone not receiving therapy in whom evidence of bone loss would lead to treatment

# Skeletal Sites to Measure

- Both the PA spine and hip in all patients.

- Forearm (nondominant) BMD under the following circumstances:
  - Hip and/or spine cannot be measured or interpreted.
  - Hyperparathyroidism
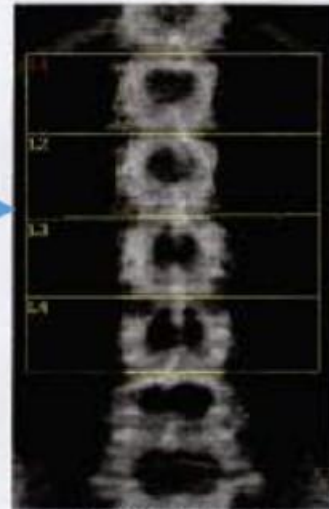  - Very obese patients (over the weight limit for DXA table)

# DXA Printouts: Common Features



Patient Demographics

Image

Raw data
T- and Z-scores

Graph
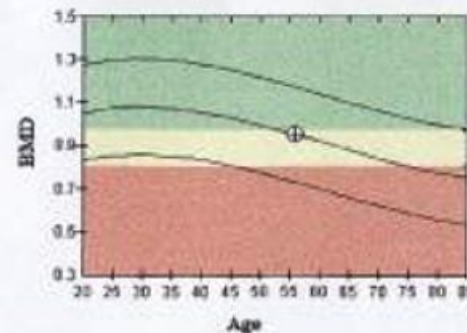
Official Positions of the ISCD 2023.

# DXA Diagnosis: What ROI to Use?

## Spine

- ✓ L1-L4 average, if possible
- ✓ never single vertebra

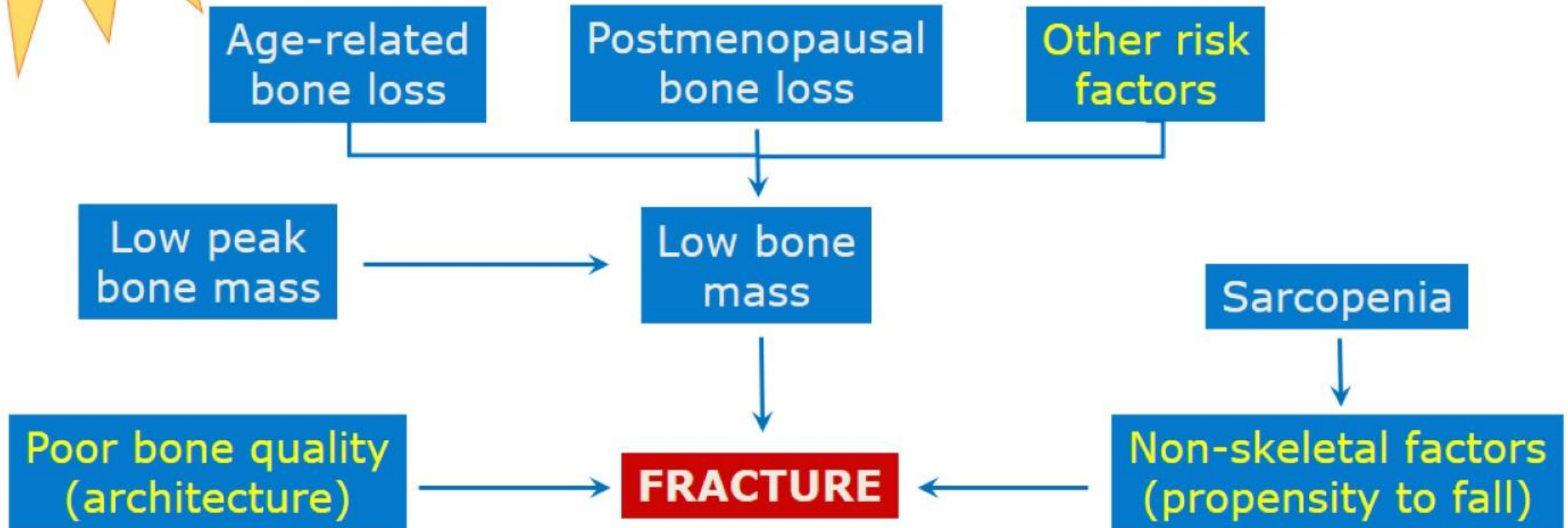| Region | BMD (g/cm²) [1] | Young-Adult T-Score [2] | Age-Matched Z-Score [3] |
|--------|------|-------------|-------------|
| L1 | 0.797 | -2.8 | -2.9 |
| L2 | 0.972 | -1.9 | -2.0 |
| L3 | 1.022 | -1.5 | -1.6 |
| L4 | 0.929 | -2.3 | -2.4 |
| L1-L2 | 0.882 | -2.2 | -2.3 |
| L1-L3 | 0.933 | -2.0 | -2.1 |
| L1-L4 | 0.932 | -2.1 | -2.2 |
| L2-L3 | 0.999 | -1.7 | -1.8 |
| L2-L4 | 0.977 | -1.9 | -2.0 |
| L3-L4 | 0.980 | -1.8 | -2.0 |

## Hip

- ✓ Femoral neck or total hip
- ✓ never Ward's triangle

| Region | BMD (g/cm²) [1] | Young-Adult T-Score [2] | Age-Matched Z-Score [3] |
|--------|------|-------------|-------------|
| Neck | 0.967 | -0.1 | -0.4 |
| Wards | 1.069 | 1.2 | 1.6 |
| Troch | 0.943 | 1.4 | 0.8 |
| Shaft | 1.251 | - | - |
| Total | 1.078 | 0.7 | 0.0 |

# Multiple Factors Related to Osteoporotic Fracture

**Nutrition**

| | | |
|---|---|---|
| Age-related bone loss | Postmenopausal bone loss | Other risk factors |

Low peak bone mass → Low bone mass

Sarcopenia

Poor bone quality (architecture) → **FRACTURE** ← Non-skeletal factors (propensity to fall)

Rizzoli R, et al. *Best Practice & Res Clin Endocrin & Metab*. 2008; 22(5):813-29.

# FRAX®: Fracture Risk Assessment Tool

**FRAX** ® Fracture Risk Assessment Tool

Home          Calculation Tool    ▼    Paper Charts        FAQ          References          English ▼

## Calculation Tool

Please answer the questions below to calculate the ten year probability of fracture with BMD.

Country: Iran          Name/ID: [        ]          About the risk factors

## Questionnaire:

1. Age (between 40 and 90 years) or Date of Birth
   Age:          Date of Birth:
   [    ]        Y: [    ]    M: [    ]    D: [    ]

2. Sex          ○ Male    ○ Female

3. Weight (kg)          [        ]

4. Height (cm)          [        ]

5. Previous Fracture          ● No    ○ Yes

6. Parent Fractured Hip          ● No    ○ Yes

7. Current Smoking          ● No    ○ Yes

8. Glucocorticoids          ● No    ○ Yes

9. Rheumatoid arthritis          ● No    ○ Yes

10. Secondary osteoporosis          ● No    ○ Yes

11. Alcohol 3 or more units/day          ● No    ○ Yes

12. Femoral neck BMD (g/cm$^2$)

    [ Select BMD ▼ ]  [        ]

    [ Clear ]    [ Calculate ]

**Weight Conversion**

Pounds ➡ kg

[        ]    [ Convert ]

**Height Conversion**

Inches ➡ cm

[        ]    [ Convert ]

**00009050**

Individuals with fracture risk
assessed since 1st June 2011

# FRAXplus® (beta version)

## The following adjustments are considered:

- **Recency of osteoporotic fracture:** The risk of a recurrent fragility fracture is particularly high immediately following a fracture.[1]

- **High exposure to oral glucocorticoids:** for high doses (>7.5 mg daily), MOF probabilities are upward revised.[2]

- **Type 2 diabetes mellitus:** FRAX® underestimates fracture risk in patients with T2D; adjustment for the duration of T2D.[3]

- **Information on Trabecular Bone Score (TBS)**[4]

- **Falls history:** Adjustments for a history of 0, 1, 2 and 3 or more falls in the previous year.

- **Hip axis length (HAL):** Longer than average hip axis length (HAL) is associated with an increase in hip fracture risk.[5]

- **Concurrent data on Lumbar Spine BMD:** much higher LS T-score than FN T-score will lower MOF, and vice versa.[6]

1- Kanis, JA, et al. *Osteoporos Int* 2023; 34:479–487. doi: 10.1007/s00198-022-06633-2
2- Kanis, JA, et al. *Osteoporos Int* 2011; 22: 809–816. doi: 10.1007/s00198-010-1524-7
3- Leslie, WD, et al. *J Bone Miner Res* 2018; 33: 1923–1930. doi: 10.1002/jbmr.3538
4- McCloskey et al. *J Bone Mineral Res* 2016; 31: 940-948.
5- Kanis, J.A., et al. *Osteoporos Int* 2023; 34:479-487.
6- Johansson, et al. *Calcif Tissue Int* 2014; 95:428-435.

# TBS (Trabecular Bone Score)

## focal variations of change in trabecular bone density



**NORMAL TRABECULAR STRUCTURE** — **ALTERED TRABECULAR STRUCURE**

TBS 1 > TBS 2
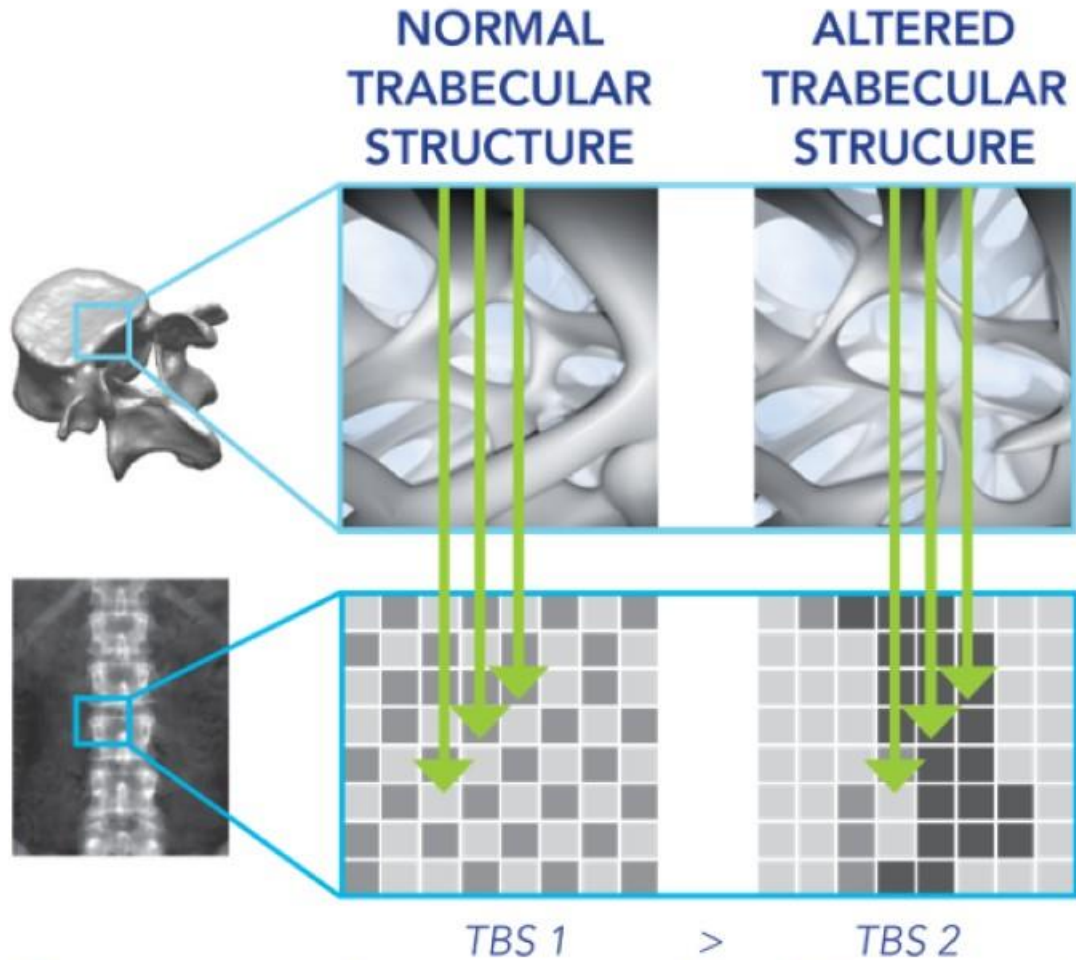
Texture parameter that can be computed from DXA images, and that quantifies local variations in pixels intensities.
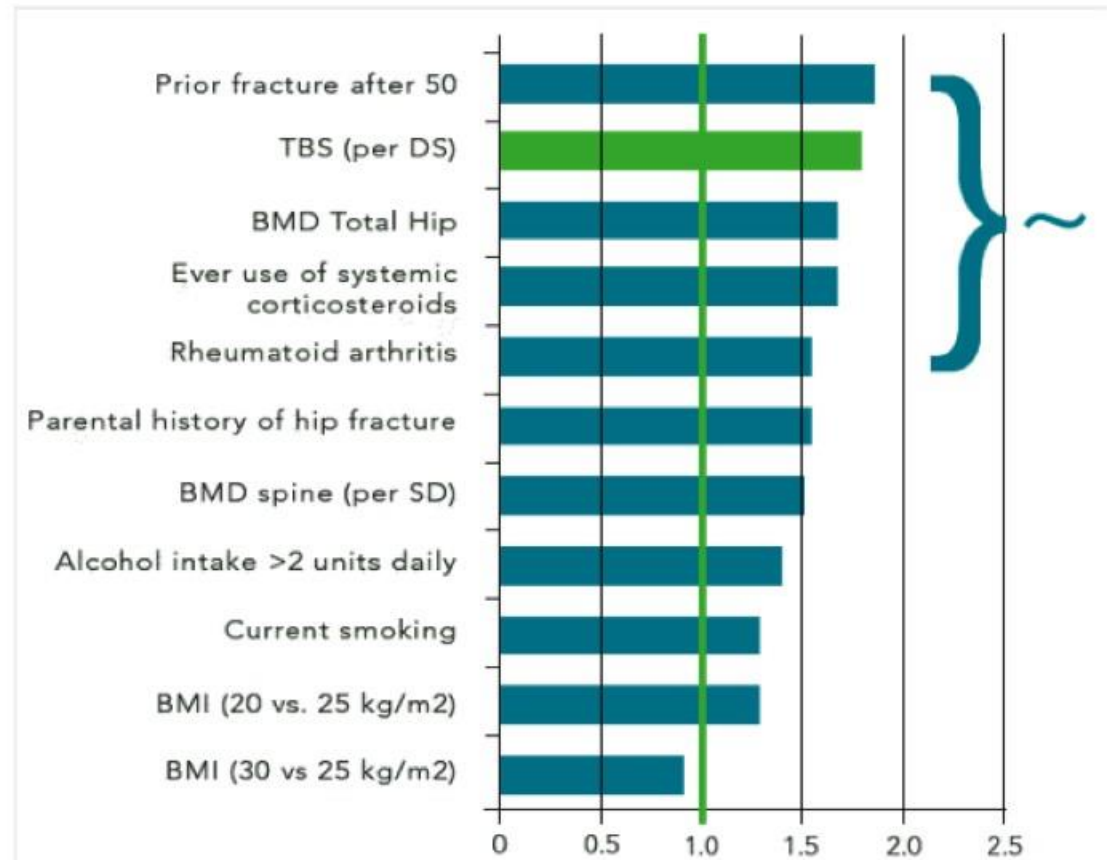
Relative Risk of fracture for TBS and BMD at the spine and total hip expressed by standard deviation and compared with relative risks of major fracture clinical risk factors included in FRAX®.

# Minimum Spine / Hip BMD T-score, WHO categories & Major OP Fractures
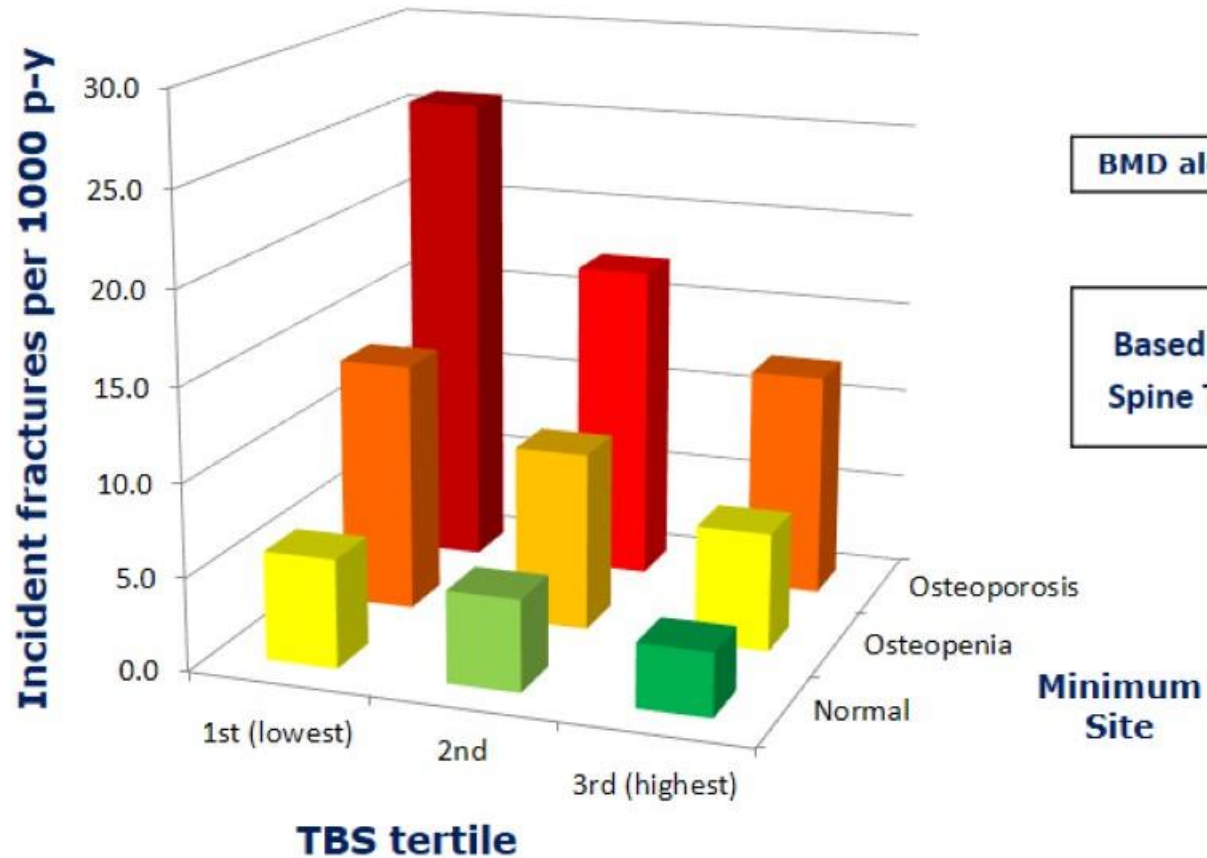


| | | Based on minimum hip or spine BMD T-score | | |
|---|---|---|---|---|
| | | Normal | Low bone mass | Osteoporosis |
| **BMD alone** | | | | |
| **Based on Spine TBS** | ≥ 1.300 | | | |
| | 1.200 < > 1.300 | | | |
| | ≤ 1.200 | | | |

| Color Code | Sub-category of risk of Major osteoporotic fracture per 1'000 person per year |
|---|---|
| | ≤ 4 |
| | ] 4 - 5 ] |
| | ] 5 - 7 ] |
| | ] 7- 10 ] |
| | ] 10 - 14 ] |
| | ] 14 - 20 ] |
| | > 20 |

The combination of BMD + TBS enables to identify women likely to have fractures whereas the women are in the low bone mass zone

Adapted from Hans et al. *J Bone Miner Res*. 2011; 26(11):2762-9.

# TBS complements BMD and FRAX



Hans et al. *J Bone Miner Res*. 2011; 26(11):2762-9.

# Vertebral Fracture Assessment (VFA)

- The most common osteoporotic fracture.
- Indication for treatment regardless of BMD.

934 women age 60 and older, hospitalized for various reasons chest x-rays reviewed for fracture



Bar chart — Patients (n):
- Fracture identified by study radiologists: 132
- Fracture noted in radiology report: 52
- Fracture noted in medical record: 17
- Received osteoporosis treatment: 7

Gehlbach S., et al. *Osteoporos Int* 2000;11:577-582.

# Indications for VFA

- Lateral spine imaging with standard radiography or densitometric VFA

- T-score <-1.0 and the presence of ≥1 of the following:
  - Women age ≥70 years or men ≥80 years of age
  - Historical height loss >4 cm
  - Self-reported but undocumented prior vertebral fracture
  - Glucocorticoid Rx ≈≥5 mg prednisone/day for ≥3 months

# Take Home Message

- DXA is the gold standard of BMD measurement.

- Correct performance and interpretation of DXA measurements:
    - demographic information
    - patient positioning
    - correct scan analysis (definition of ROI)
    - BMD pattern of individual vertebrae

- TBS and FRAX are complément to BMD.

- Vertébral fractures are largely unrecognized.