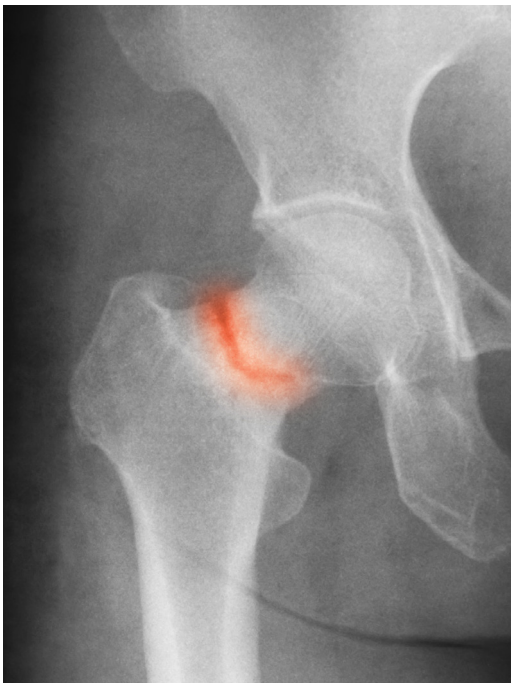

Menopause and osteoporosis: Epidemiology, pathophysiology, screening and diagnosis

Celyanda Goeltom, Shoshana Sztal-Mazer

Background
Osteoporosis is a silent disease disproportionately affecting women during peri- and postmenopause due to the associated reduction in oestrogen. It incurs a high fragility fracture risk and financial costs to society. General practitioners (GPs) are well placed to detect this, diagnose it and reduce the subsequent burden of disease.

Objective
To equip GPs with the understanding of the extent of the disease, pathophysiology and why early detection matters; while further developing screening and diagnostic skills to identify osteoporosis, especially in high-risk women.

Discussion
Osteoporosis is the result of resorption-formation uncoupling driven by oestrogen reduction during menopause. The incidence of osteoporosis is increasing. Screening to prevent fractures is essential, especially where risk factors, with a prior fracture being the biggest risk for future fractures, are present. Diagnosis on dual-energy X-ray absorptiometry (DXA) (although not always Medicare reimbursed) is with T-score ≤–2.5. X-rays can complement the work-up because a fragility fracture substantiates a diagnosis.

IN 2024, OVER 4 MILLION WOMEN over 50 years of age resided in Australia. The average Australian menopause age is 51–52 years[1,2] and female life expectancy in Australia is consistently rising; currently up to 85.1 years. Thus, for over 30 years women might have to live in a state of diminished oestrogen, predisposing them to osteoporosis. It is estimated that 2 out of 3 (or 7.5 million) Australian women over 50 years will be living with either osteoporosis or osteopenia,[3,4] and 50% of those will have a fragility fracture in their lifetime.[5] Importantly, the true prevalence is likely much higher, with many undiagnosed cases due to lack of screening and late intervention.[6]

There are an estimated 193,000 fragility fractures each year in Australia; 1 every 2.7 minutes,[3] and 1 in 10 of those who fracture will sustain another fracture within 12 months.[7,8] In 2023, the total cost of osteoporosis fractures was around $4.8 billion.[3] A woman's chance of sustaining a hip fracture, which itself incurs a significant mortality risk, is equivalent to the combined risk of her developing breast, uterine and ovarian cancers.[9]

Pathophysiology and risk factors

Bone is living tissue that continually turns over, transforming and repairing itself. Bone is composed of:

- Osteoblasts: bone forming cells
- Osteoclasts: bone resorbing cells
- Osteocytes: sensory and regulatory cells which affect the activity of osteoblasts, osteoclasts and non-skeletal tissues both directly and endocrinologically[10]
- Osteoid: the non-mineral, organic part of the bone matrix made of collagen and non-collagenous proteins
- Inorganic mineral salts deposited within the matrix.

The skeleton comprises:

- 80% cortical bone: this hard outer layer is strong and dense, predominating in the diaphysis (eg femur and other long bones).
- 20% trabecular bone: this spongy inner layer network of trabeculae is lighter and less dense than cortical bone, predominating in the metaphysis (eg vertebrae and pelvis).

Peak bone mass is formed around age 30 years. During young adulthood, balanced remodelling occurs; meaning there are essentially matched volumes of bone loss and replacement at various sites of the skeleton due to osteoclast–osteoblast coupling (Figure 1), in which oestrogen is instrumental.[10,11] Uncoupling then occurs with the decline of oestrogen from 1–2 years before menopause until the first 2 years post menopause whereby women can lose 10% of their bone density.[12,13] Regarding other

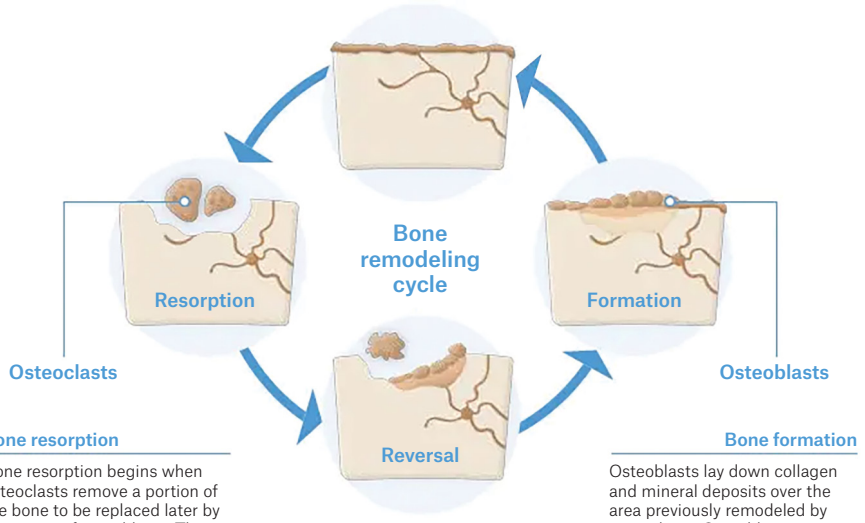

Figure 1. Bone remodelling cycle.

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gonadal hormones, progesterone does not have a significant effect on bone metabolism while testosterone has a positive influence, indirectly through its oestrogen metabolites and also directly.

Menopause is a major risk factor for osteoporosis. Other risk factors are outlined in Box 1.

Box 1. Risk factors for osteoporosis

- Menopause
- Advancing age
- Smoking
- Family history
- Hyperthyroidism
- Hyperparathyroidism
- Rheumatoid arthritis
- Diabetes (Type 1 and 2)
- Aromatase inhibitor use
- High dose or prolonged use of glucocorticoid therapy
- Malabsorption (eg coeliac disease)
- Restrictive eating disorders (eg anorexia nervosa)
- Excessive alcohol intake.

Early detection: Why it matters and how to facilitate this in general practice

Given the burden of disease, and its silent nature (with diagnosis usually made at the time of fracture), early identification is important, both to prevent the first fracture and to prevent subsequent fractures that we know occur in 10% of patients within 10 years of the incident fracture.

In the general practice setting, osteoporosis screening can be done opportunistically as follows:

- When a menopause-related health assessment, along with the implications on bone health, is indicated (Medicare Benefits Schedule (MBS) item number 695).
- By soliciting a baseline dual-energy X-ray absorptiometry (DXA) when a patient is aged 70 years or more (MBS listed).
- By measuring the height of postmenopausal women at each visit, ideally 6-monthly; whereby a reduction of ≥3 cm merits a thoracolumbar X-ray to exclude vertebral fracture.[14]
- When reviewing conditions that predispose to osteoporosis (Box 1).
- When referring a patient for a Home Medicines Review (HMR) (MBS item number 900).
- When discussing diet and exercise across the lifespan.
- During yearly health assessments for patients over 75 years (MBS item number 705).
- During Aboriginal and Torres Strait Islander health assessments (MBS item number 715).
- When implementing chronic condition management plans and reviews (CCGPMP) (MBS item numbers 965 and 967), enabling multidisciplinary team management (eg dietitian, exercise physiologist, physiotherapist).

Definitions, diagnosis and workup

The diagnosis of osteoporosis is made by DXA. A fragility fracture, however, usually described as a minimal trauma fracture (fracture from a fall from standing height or less but not including face, hands or feet) is considered an osteoporotic fracture, regardless of bone mineral density (BMD), thus a diagnosis of osteoporosis can also be made in this context.[14]

DXA measures the density of bone in 2–4 main regions of interest (ROI), reporting it in g/cm^2 and as the number of standard deviations away from normative databases as T- and Z-scores.[15]

T-scores reflect comparison with the young adult mean, which is representative of bone at peak mass. It is designed for postmenopausal women and in men ≥50 years. With every standard deviation decrease, the fracture risk doubles.[14,16] The T-score criteria are as follows:

- T-score ≥–1.0 is normal.
- T-score between –1.0 and –2.5 is osteopenia.
- T-score ≤–2.5 is osteoporosis.

Z-scores, comparing bone density with the same age, sex and, where available, ethnicity, are used in premenopausal females, all those aged under 50 years and where secondary osteoporosis is considered.[15] In turn, testing for secondary causes such at hyperthyroidism, hyperparathyroidism and coeliac disease are indicated when a Z-score of ≤–2 is found in any individual regardless of age or gender. The Z-score criterion is as follows:

- Z-score ≤–2 is low bone mass in those under 50 years.

The ROIs are: (1) lumbar spine; (2) femoral neck; (3) total hip; and, where any of the former cannot be studied, (4) the distal one-third radius. That is, where technical difficulty arises with imaging ROIs 1–3 because of circumstances such as joint replacement and bone deformity from conditions such as osteoarthritis and scoliosis, the latter density can be used

The DXA report

The level of detail provided in a DXA report varies. To comply with guidelines, all reports should state the make and model of the DXA machine used, BMD (measured in g/cm^2), T-score and Z-score. Many DXA reports also provide an Absolute Fracture Risk result.

T-score results
- **-2.5 or lower** is osteoporosis and
- T-score **between -1 and -2.5** is osteopenia

in over 50s and menopausal women.

Refer to RACGP Guidelines recommendation when individual has minimal trauma fracture*

Z-score
- Useful indicator of increased bone loss
- Particular importance in under 50s
- At any age Z-score **-2.0 or lower** is 'below expected range for age' and should trigger investigation to exclude underlying disease cause bone loss

Medical Imaging Centre – Bone Densitometry Report

Dear Doctor

Re: [Patient] **DOB: .....**

This patient attended on ..... for bone densitometry of AP spine and left hip.

Bone mineral density was measured by [DXA machine make and model]. The results are summarised below:

Scan date: ..... **Sex: Female**

Age at scan: ..... years **Ethnicity: .....**

L1–L4 or L2-L4 usually measured.

Total proximal femur and femoral neck reported. Bilateral hip scans preferable.

Scan site	Region	BMD	T-score	Z-score	Change vs Baseline (%)	Change vs last (%)
AP spine	L2-L4	0.890	-2.6	-1.1	##%	##%
Left femur	Total	0.822	-1.5	-0.4	##%	##%
	Neck	0.831	-1.5	-0.0	##%	##%

This percentage indicates the change in BMD compared to the first scan performed.

FRAX – Absolute fracture risk assessment tool. Most DXA centres can provide this as part of DXA report.

RACGP guidelines recommend treating patients over 50 years with a 10-year result of
- 20% or greater risk of major osteoporotic fracture (MOF)

or,
- 3% or greater risk of hip fracture

Absolute Fracture Risk (AFR):

Major Osteoporotic Fracture: 20% | **Hip Fracture:** 3.5%

Risk Factors: None

Trabecular Bone Score (TBS): L1-L4 is #.##

TBS – Trabecular Bone Score. Offered by some centers, to assess bone micro-architecture. TBS result can be used to adjust FRAX result. TBS does not attract an MBS rebate.

Vertebral fracture assessment: VFA demonstrates a deformity of L3, indicating a probable vertebral fracture. Confirmation with X-ray is recommended.

VFA (vertebral fracture assessment – also known as Lateral vertebral assessment LVA) is offered by some imaging centres. It is a useful screening tool for asymptomatic vertebral fracture. Fractures detected by VFA should be confirmed by plain x-ray. VFA does not attract an MBS rebate.

Figure 2. DXA report sample and interpretation.

AFR, absolute fracture risk; AP, anterior-posterior; BMD, bone mineral density; DOB, date of birth; DXA, dual-energy X-ray absorptiometry; LVA, lateral vertebral assessment; MBS, Medicare Benefits Schedule; MOF, major osteoporotic fracture; RACGP, Royal Australian College of General Practitioners; TBS, trabecular bone score; VFA, vertebral fracture assessment.

Adapted from Healthy Bones Australia. Bone density testing in general practice. Healthy Bones Australia, 2022, with permission from Healthy Bones Australia. Available at https://healthybonesaustralia.org.au/wp-content/uploads/2025/10/hba-gp-bone-density-brochure-2025-v11.pdf.

for diagnosis and treatment eligibility. Of note, a discrepantly low radial BMD is seen in hyperparathyroidism, thus this diagnosis should be considered when such a discrepancy is found.[15] An example of a DXA report and how to interpret it is presented in Figure 2.

In addition to DXA results, there are many other risk factors (Box 1) that contribute to determining fracture risk. Some of these can be entered, with or without DXA results, into fracture calculating tools such as FRAX (WHO Collaborating Centre for Metabolic Bone Diseases (University of Sheffield), Sheffield, South Yorkshire, UK) and Garvan Risk Calculator (Garvan Institute of Medical Research, Sydney, NSW), to determine absolute fracture risk over 5 or 10 years.[14,17] Both FRAX and Garvan calculators use data from the Dubbo Osteoporosis Epidemiology Study, but their algorithms are different. FRAX includes many more risk factors, however only Garvan includes consideration of falls in the past 12 months.

Many DXA results incorporate the FRAX fracture risk into their report with a FRAX score. Nevertheless, the Garvan calculator could be considered more appropriate in those who experience frequent falls as the fracture risk in these individuals is often underestimated by the FRAX tool.[18]

The Medicare rebate for initial DXA screening applies to:[19]

- Minimal trauma fracture (MTF)
- Patients aged 70 years and over for a baseline BMD
- Certain specific secondary causes of osteoporosis:
  - prolonged glucocorticoid therapy
  - conditions associated with excess glucocorticoid secretion
  - male hypogonadism
  - female hypogonadism lasting more than 6 months before the age of 45 years
  - primary hyperparathyroidism
  - chronic renal disease
  - proven malabsorptive disorders
  - rheumatoid arthritis
  - conditions associated with thyroxine excess.

Repeat studies are eligible for rebate between 1 and 5-yearly depending on the indication and T-score of the initial study.[20]

Some women at high risk do not meet Medicare criteria. Women on aromatase inhibitors, agents which bring about complete oestrogen deprivation leading to a 30% increased fracture risk, are not eligible for rebate for DXA; however, this does not mean DXA is not indicated in these women.[14,21,22] Thus, if financially feasible (~$120), it should be ordered privately. Similarly, in other situations such as glucocorticoid use at a lower dose than stipulated in the item number; or when considering a bisphosphonate pause in therapy, a DXA might be indicated medically but is not eligible for rebate by Medicare. Risk factors such as smoking, excess alcohol intake, family history and calcineurin inhibition therapy (particularly post-transplant), are also valid indications for bone density testing. In these cases, if a patient can afford it, it is advisable to order the DXA as indicated.

Indeed, in all women aged 50 years or during the menopause transition, a baseline DXA is helpful for monitoring and to stratify future fracture risk. That is, menopause itself, given the risk it incurs to bone fragility, is a valid indication for bone density assessment with DXA. Furthermore, using risk calculators alone, without bone density input, misses a substantial portion of diagnoses.[14,23] Nevertheless, cost analyses are not always in favour of this approach, which is why it is not eligible for rebate on the MBS.[24] Thus, although it can be ordered and followed up during the menopause health assessment (MBS item number 695), the test itself will need to be self-funded.

Work-up

The work-up for osteoporosis includes basic blood tests for full blood examination, urea and electrolytes, calcium, phosphate, vitamin D, parathyroid hormone, thyroid stimulating hormone and erythrocytes sedimentation rate.[25]

Thoracolumbar plain X-ray can also be done to check for asymptomatic (morphometric) vertebral fractures when patients present with loss of height,[14] kyphosis and/or unexplained acute back pain. A vertebral fracture (morphometric or clinical) can both substantiate the diagnosis of osteoporosis and satisfy criteria for osteoporosis treatment.

Bone turnover markers, especially C-telopeptide, are increased during high bone turnover indicating resorption, which can verify the diagnosis of osteoporosis.

Investigation for secondary causes of osteoporosis (Box 1) might be needed in cases of minimal trauma fracture with no clear risk, Z-score ≤–2, fracture on treatment and with poor BMD response to treatment.[14]

Conclusion

The decline in oestrogen at menopause significantly increases osteoporosis risk. This can be compounded by other known risk factors. Screening for osteoporosis in these at-risk women is important, so the diagnosis is not missed. A history of a minimal trauma fracture and/or a radiological diagnosis of osteoporosis on DXA signifies bone fragility and is a risk for subsequent fractures. Through regular patient contact across a lifetime, general practitioners are in an excellent position to screen and diagnose this silent disease.

Key points

- Menopause is associated with significant decline in oestrogen which causes accelerated bone loss.
- Prevalence of osteoporosis across the lifespan in women is 23% and in men only 6%.[6,26]
- The burden of osteoporosis is projected to increase.
- Being a silent disease, detection is important to prevent future fractures.
- A height reduction of ≥3 cm merits a thoracolumbar X-ray to exclude vertebral fracture which signifies osteoporosis.

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