An Update In The Prevention, Screening, Diagnosis, & Treatment Of **Osteoporosis**

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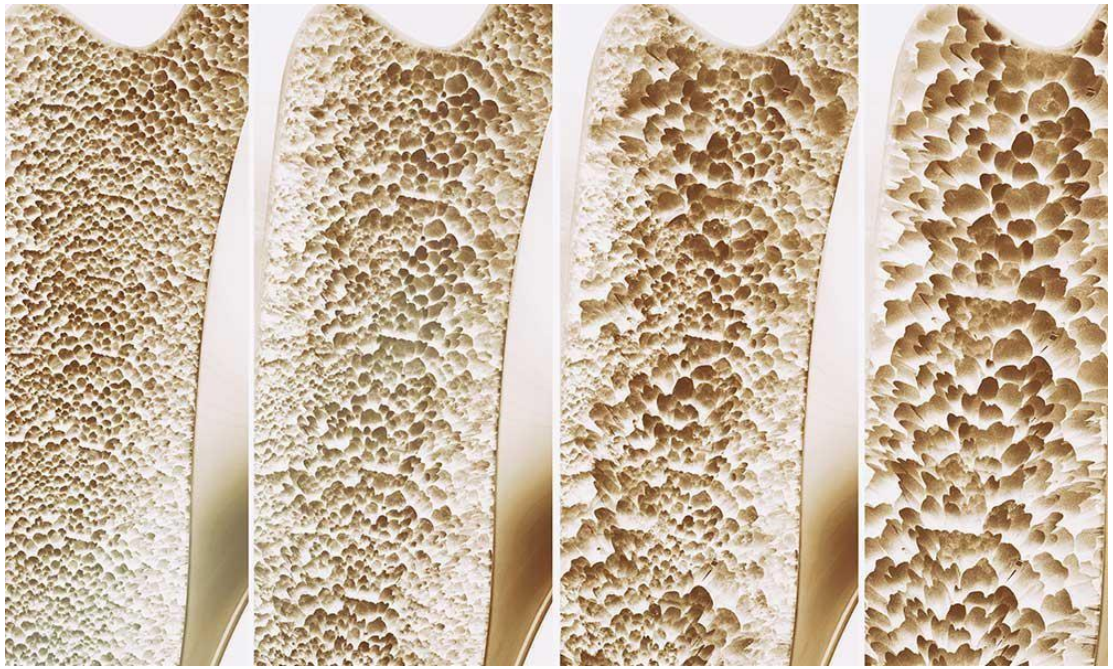
Outline

1) Definition of Osteoporosis
2) Epidemiology
3) Updates On Osteoporosis Risk Factor
4) Advances In Diagnosis And Assessment
5) Updates on Osteoporosis Treatment Strategies
6) Precision Medicine In Osteoporosis
7) Global Effort for Treatment of Osteoporosis and Prevention of Fragility Fx

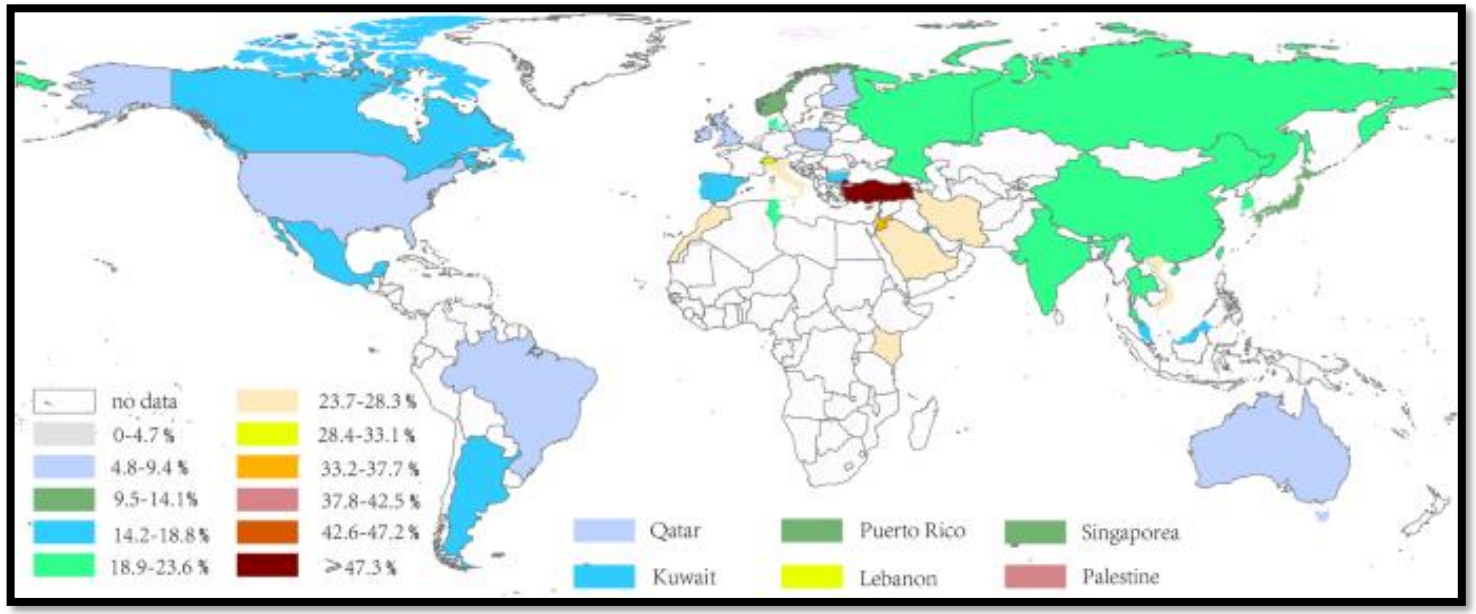
Definition



- Osteoporosis is a systemic skeletal disease, defined by low bone mass and structural damage to bone tissue which Leads to increased bone fragility and high fracture risk.
- Osteoporosis is often referred to as a 'silent disease' because it progresses without symptoms until a fracture occurs. The World Health Organization defines classify osteoporosis as a BMD T-score of -2.5 or lower, indicating substantial fracture risk

1. Bartl, R., Frisch, B., Bartl, R., & Frisch, B. (2004). Definition of osteoporosis. Osteoporosis: Diagnosis, Prevention, Therapy. A Practical Guide for all Physicians—from Pediatrics to Geriatrics, 24-32.
2. **Larijani B**, Mohageri Tehrani MR, Hamidi Z, Soltani A, Pajouhi M. Osteoporosis, prevention, diagnosis and treatment. J Reprod Infertil. 2005

Global Distribution Of Osteoporosis *June 2022*



The global prevalence of : Osteoporosis: **19.7%**

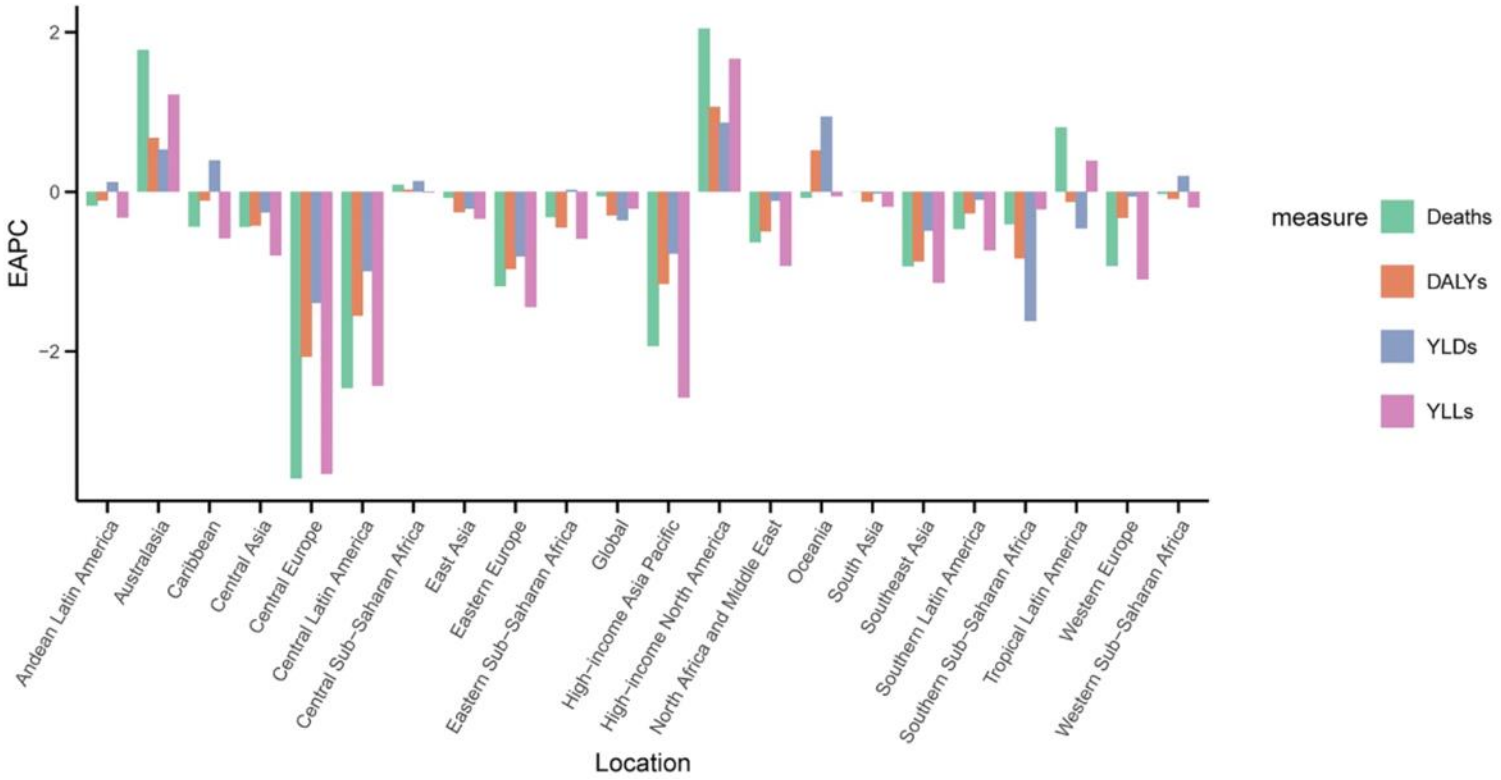
Osteopenia: **40.4%**

The prevalence was higher in developing countries (**22.1%**) than in developed countries (**14.5%**)

Xiao, P-L., et al. "Global, regional prevalence, and risk factors of osteoporosis according to the World Health Organization diagnostic criteria: a systematic review and meta-analysis." Osteoporosis International (2022)

Global Distribution Of LBMD Burden
The Age-standardized Deaths, DALYs, YLDs And YLLs Rates In 2021

- The global age-standardized death rate decreased slightly from 29.34 per 100,000 population in 1990 to 27.51 in 2021, with an EAPC of -0.05, while the total number of deaths more than doubled from 91,941 to 219,552 cases. A similar pattern was observed in DALYs.

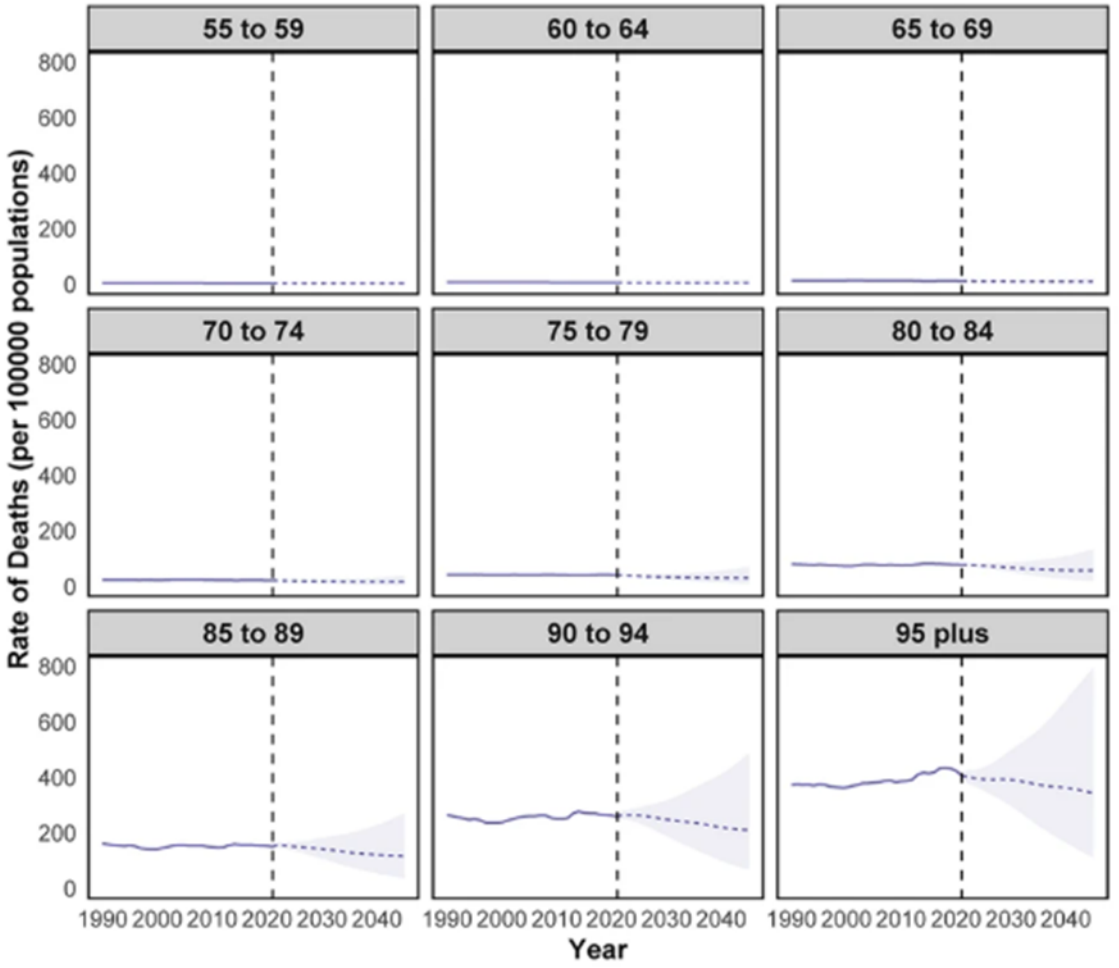


The estimated annual percentage change (EAPC) of age-standardized deaths, DALYs, YLDs and YLLs rates of LBMD among PMW from 1990 to 2021, in 21 GBD regions.

Liang, H., Chen, S., Shi, M. *et al.* Global epidemiology and burden of osteoporosis among postmenopausal women: insights from the Global Burden of Disease Study 2021. *npj Aging* **11**, 78 (2025). https://doi.org/10.1038/s41514-025-00269-2

Historical And Projected Trends In Rates Of Deaths Due To LBMD Across Nine Postmenopausal Age Groups From 1990 To 2045.

- PMW aged ≥85 years will remain the primary contributors to LBMD burden across all metrics, with particularly sharp increases expected in the 95+ age group.
- By 2045, the YLD ASR in women aged 95 and older is projected to reach 3,336.83 per 100,000 population—twice that of the 90-94 group.



Liang, H., Chen, S., Shi, M. *et al.* Global epidemiology and burden of osteoporosis among postmenopausal women: insights from the Global Burden of Disease Study 2021. *npj Aging* **11**, 78 (2025). https://doi.org/10.1038/s41514-025-00269-2

Prevalence Of Osteoporosis In Iran

Journal of Diabetes & Metabolic Disorders (2024) 23:229–237
https://doi.org/10.1007/s40200-023-01352-9

REVIEW ARTICLE

Check for updates

Prevalence of osteoporosis in the Iranian population: a systematic review and meta-analysis

Noushin Fahimfar[1,2] · Elahe Hesari[1] · Mohammad Javad Mansourzadeh[1] · Kazem Khalagi[1,3] · Mahnaz Sanjari[1] · Sepideh Hajivalizadeh[1] · Kiarash Tanha[4] · Hamed Moheimani[5] · Fatemeh Hajivalizadeh[6] · Amin Doosti Irani[7] · Shahrzad Nematollahi[8] · Bagher Larijani[9] · Afshin Ostovar[1,2,10]

Received: 15 August 2023 / Accepted: 11 November 2023 / Published online: 30 November 2023

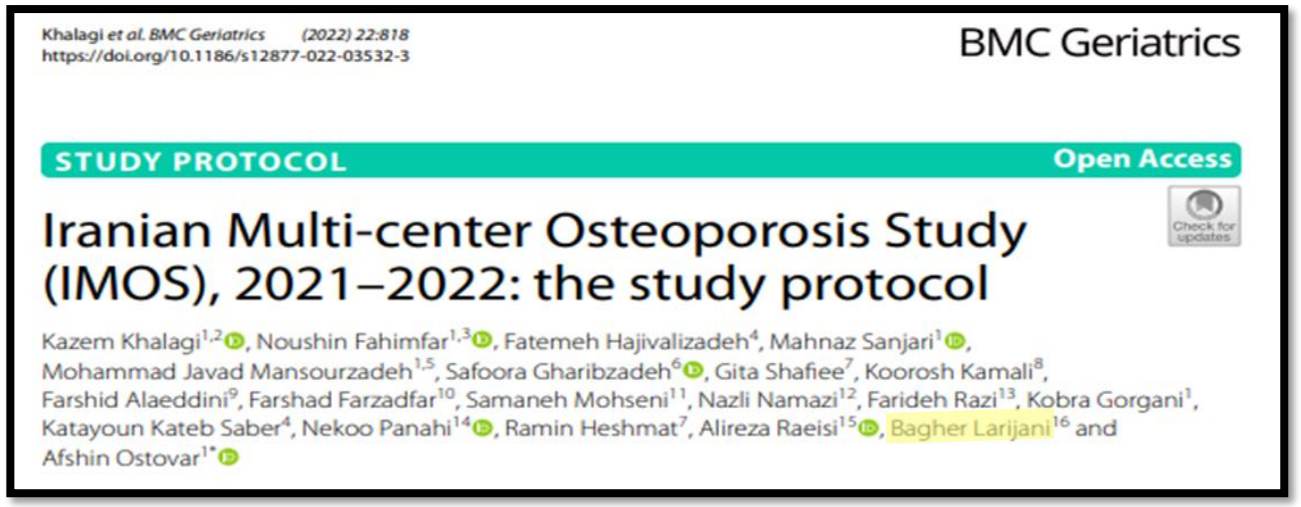
osteoporosis in the femoral neck region
Women: 0.19 (95%CI: 0.12–0.26)
Men: 0.19 (95%CI: 0.13–0.25)

osteoporosis in the Spinal region
Women: 0.29 (95%CI: 0.21–0.38)
Men: 0.16 (95%CI: 0.12–0.19)

Total Prevalence Of Osteoporosis
Women: 0.38
Men: .25

Iranian Multi-center Osteoporosis Study (IMOS), 2021–2022

- IMOS will provide valuable information on the prevalence and determinants of osteoporosis and sarcopenia at the national level, and the results can be used in evaluating health system interventions and policymaking in the field of musculoskeletal diseases.



- IMOS is positioned to fill gaps in knowledge regarding osteoporosis and sarcopenia in Iran, and is crucial for understanding the national burden of these conditions and developing targeted health strategies.

Khalagi K, …., **Larijani B**, Ostovar A. Iranian Multi-center Osteoporosis Study (IMOS), 2021-2022: the study protocol. BMC Geriatr. 2022 Oct

Journal of Diabetes & Metabolic Disorders (2024) 23:1449–1454
https://doi.org/10.1007/s40200-020-00600-6

REVIEW ARTICLE

Check for updates

Iranian Multicenter Osteoporosis Studies (IMOS) during last decade: rationale, main findings, lessons learned and the way forward

Noushin Fahimfar[1] · Safoora Gharibzadeh[2] · Patricia Khashayar[1,3] · Reza Rajabian[4] · Gholamhossein Ranjbar Omrani[5] · Amir Bahrami[6] · Iraj Nabipour[7] · Afshin Ostovar[1] · Bagher Larijani[8]

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	IMOS-I	IMOS-II	IMOS-III
Year	2001	2005	2011
Location	Tehran, Mashhad, Shiraz, Tabriz, and Bushehr	Sari and Yazd	Arak and Sanandaj
Age/Gender	men and women aged between 20 and 76 years	men and women aged between 20 and 70 years	Adults aged ≥ 20 years

Key Findings from IMOS Studies

Osteoporosis Prevalence

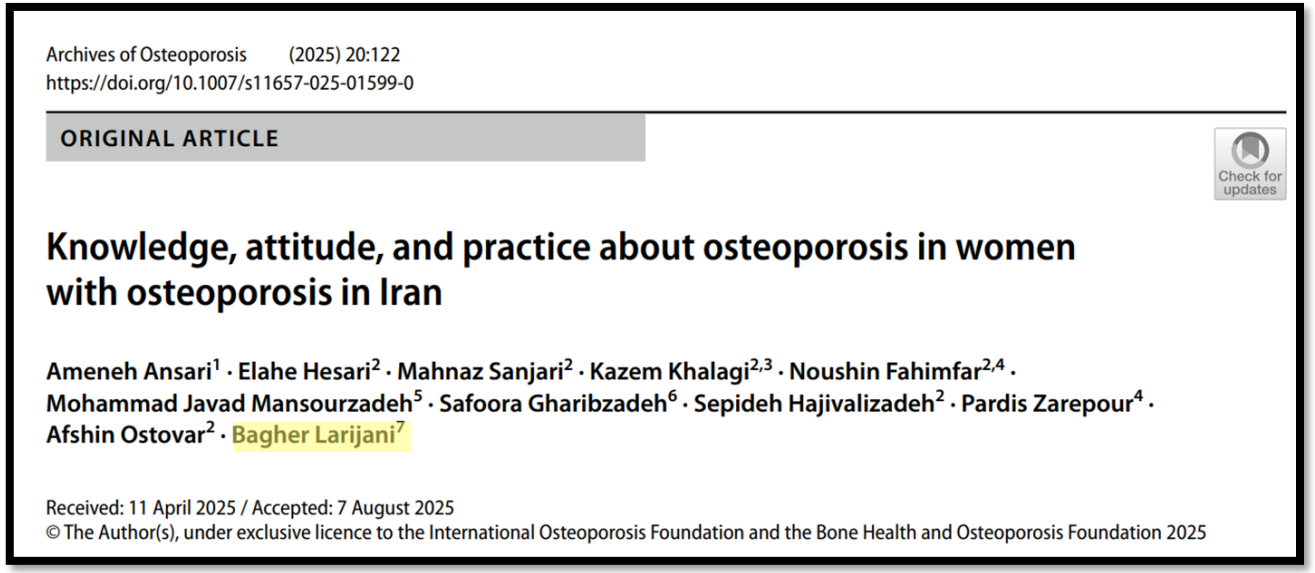
- IMOS-1: **78.2%** of postmenopausal women and **77.3%** of men (aged 50+) had had osteopenia or osteoporosis. osteoporosis.
- IMOS-3: Osteoporosis prevalence was **44%** in men (50+) and **37%** in postmenopausal women.

Vitamin D Deficiency

- IMOS-1: Moderate to severe deficiency affected **44-54%** across across age groups, with the **highest highest rate in Tehran**.
- IMOS-3: **66.4%** of the population population had vitamin D deficiency, deficiency, significantly higher in in women (68% vs. 63%).

Risk Factors & Knowledge Gaps

- IMOS-1: Identified **age, female sex, sex, and menopause** as primary risk primary risk factors for osteoporosis. osteoporosis.
- IMOS-3: **81.3%** of female heads of of household had poor osteoporosis osteoporosis knowledge. Higher Higher knowledge correlated with with increased vitamin D intake.



Archives of Osteoporosis (2025) 20:122
https://doi.org/10.1007/s11657-025-01599-0

ORIGINAL ARTICLE

Check for updates

Knowledge, attitude, and practice about osteoporosis in women with osteoporosis in Iran

Ameneh Ansari[1] · Elahe Hesari[2] · Mahnaz Sanjari[2] · Kazem Khalagi[2,3] · Noushin Fahimfar[2,4] · Mohammad Javad Mansourzadeh[5] · Safoora Gharibzadeh[6] · Sepideh Hajivalizadeh[2] · Pardis Zarepour[4] · Afshin Ostovar[2] · Bagher Larijani[7]

Received: 11 April 2025 / Accepted: 7 August 2025

- The study found that participants lacked sufficient knowledge about osteoporosis, despite having a somewhat positive attitude. Their performance in managing the condition was poor. This highlights the need for improved dissemination of information on osteoporosis management.

Initiating A Nationwide Virtual Training Program On Osteoporosis

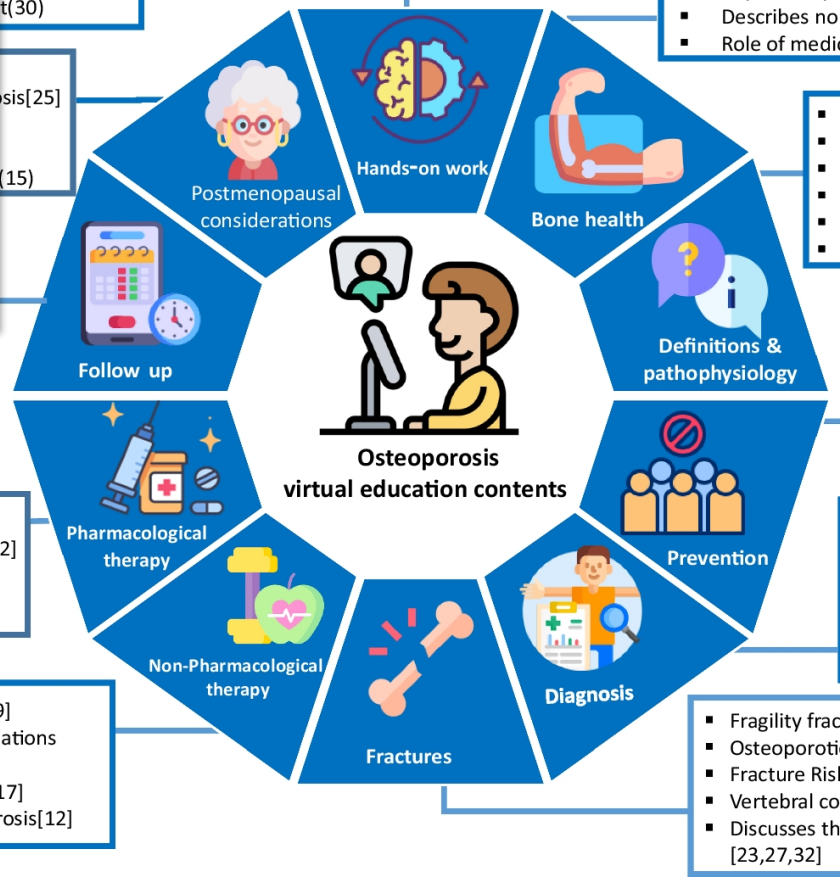
Journal of Diabetes & Metabolic Disorders (2024) 23:251–266
https://doi.org/10.1007/s40200-023-01361-8

REVIEW ARTICLE

Osteoporosis e-learning courses: A systematic review to develop a comprehensive virtual course for General Practitioners

Roya Naemi[1] · Mahnaz Sanjari[2] · Maryam Aalaa[3] · Rasha Atlasi[4] · Noushin Fahimfar[2] · Afshin Ostovar[2] · Mahin Nomali[5] · Neda Mehrdad[6] · Bagher Larijani[7]

Received: 23 August 2023 / Accepted: 23 November 2023 / Published online: 12 December 2023



- Bone physiology and anatomy [10,31]
- Bone remodeling [17,10]
- Impacts of pregnancy and lactation on bone [17]
- Describes normal and osteoporotic bone [28]
- Role of medications and nutrients in bone health[10,12,31]

- Osteoporosis classifications[10,28,31]
- Epidemiology of osteoporosis[10,28,29]
- Primary and secondary osteoporosis[18]
- Common causes of osteoporosis[28]
- Pathophysiology of osteoporosis [12]
- Various forms of transient osteoporosis[17]

- Fracture prevention[26,27,32]
- Osteoporosis prevention [14,21]
- Highlights 'at risk' groups [12,23,32]
- Secondary fracture prevention[33]

- Distinguish 'at risk' groups[27]
- DXA measurements [20,21,29]
- Diagnosis of osteoporosis from NICE, SIGN and NOGG [23,27,28,32]
- Identification of vertebral fractures in Imaging Departments[28]

- Fragility fractures and common mechanisms of injury[28]
- Osteoporotic vertebral fractures[28]
- Fracture Risk factors[8,14]
- Vertebral compression fractures[19]
- Discusses the FRAX and QFracture risk assessment tools [23,27,32]

- Non-pharmacological treatments[10,27,29]
- Lifestyle and Physical Activity Recommendations
- [14,33,14]
- Consider the impact of exercise on BMD [17]
- Best practice for management of osteoporosis[12]

- Osteoporosis treatments[10,27,29]
- Anabolic treatment after radiation therapy[12]
- Prescription in Osteoporosis care [14,33,12]
- HT in relation to osteoporosis therapies[15]

- Monitor patients at risk of fragility fractures[27]
- Follow-up and care coordination for the post-fracture patient[35]

Initiating A Nationwide Virtual Training Program On Osteoporosis

- This course was initiated for general practitioners in collaboration with the Ministry of Health.
- More than 1500 GPs have been trained.

Archives of Osteoporosis (2025) 20:45
https://doi.org/10.1007/s11657-025-01532-5

ORIGINAL ARTICLE

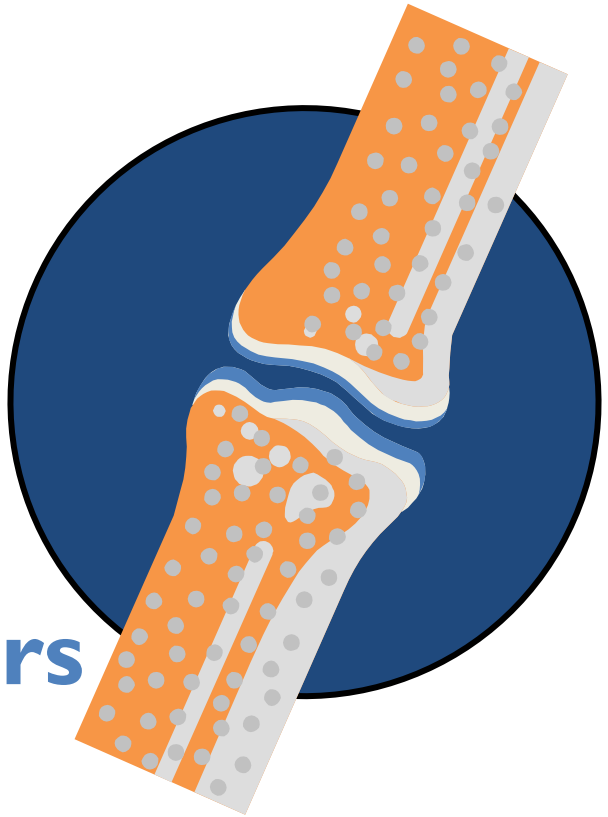
Check for updates

The impact of osteoporosis virtual training course for general practitioners

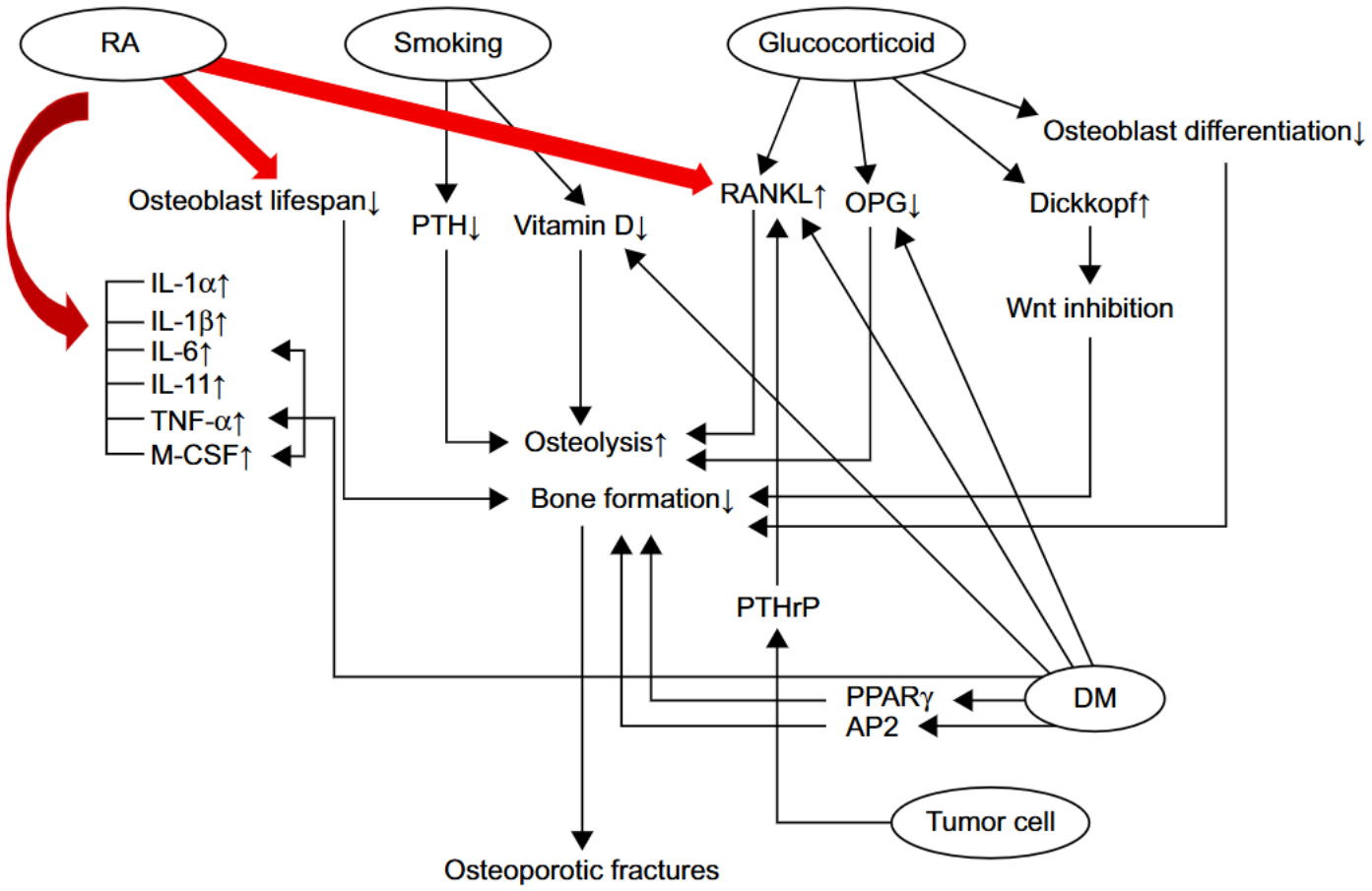
Elahe Hesari[1] · Fatemeh Hajivalizadeh[2] · Mahnaz Sanjari[1] · Kazem Khalagi[1,3] · Noushin Fahimfar[1,4] · Maryam Amini[5] · Mahbobe Darman[2] · Maryam Aalaa[6] · Pardis Zarepour[1,4] · Mohammad Javad Mansourzadeh[1] · Sepideh Hajivalizadeh[1] · Donya Sadeghi[7] · Afshin Ostovar[1] · Bagher Larijani[5]

- A total of 498 general practitioners participated in a virtual course on osteoporosis management.
- Knowledge scores significantly increased from 38 to 83.
- The study showed that virtual training course on osteoporosis management principles notably improved the knowledge of the general practitioners.

Updates On Osteoporosis Risk Factors



Osteoporosis Risk Factor



1. Major modifiable risk factors:
   - Inadequate nutritional absorption
   - Lack of physical activity or fall risk
   - Weight loss
   - Cigarette smoking
   - Alcohol consumption
   - Air pollution
   - Stress
2. Major non-modifiable risk factors:
   - History of falls
   - Older age
   - Gender
   - White ethnic background
   - Prior fracture
   - Reproductive factors (family history of osteoporosis)
3. Secondary causes of osteoporosis
   - Chronic use of certain medications (prolonged corticosteroid use, and so on)
   - Hypogonadism
   - Hyperparathyroidism
   - Chronic liver disease
   - Inflammatory diseases (rheumatoid arthritis, and so on)
   - Vitamin D deficiency
   - Renal disease (history of kidney stones)
   - Cardiovascular disease
   - Diabetes mellitus
   - Dementia

Pouresmaeili F, Kamalidehghan B, Kamarehei M, Goh YM. A comprehensive overview on osteoporosis and its risk factors. Therapeutics and clinical risk management. 2018 Nov 6:2029-49.

Age At First Fracture And Later Fracture Risk In Older Adults

Table 2. Fully AHRs (95% CIs) for Incident Fracture According to Age at First Fracture Before the Index Date Compared With Those Without Prior Fracture[a]

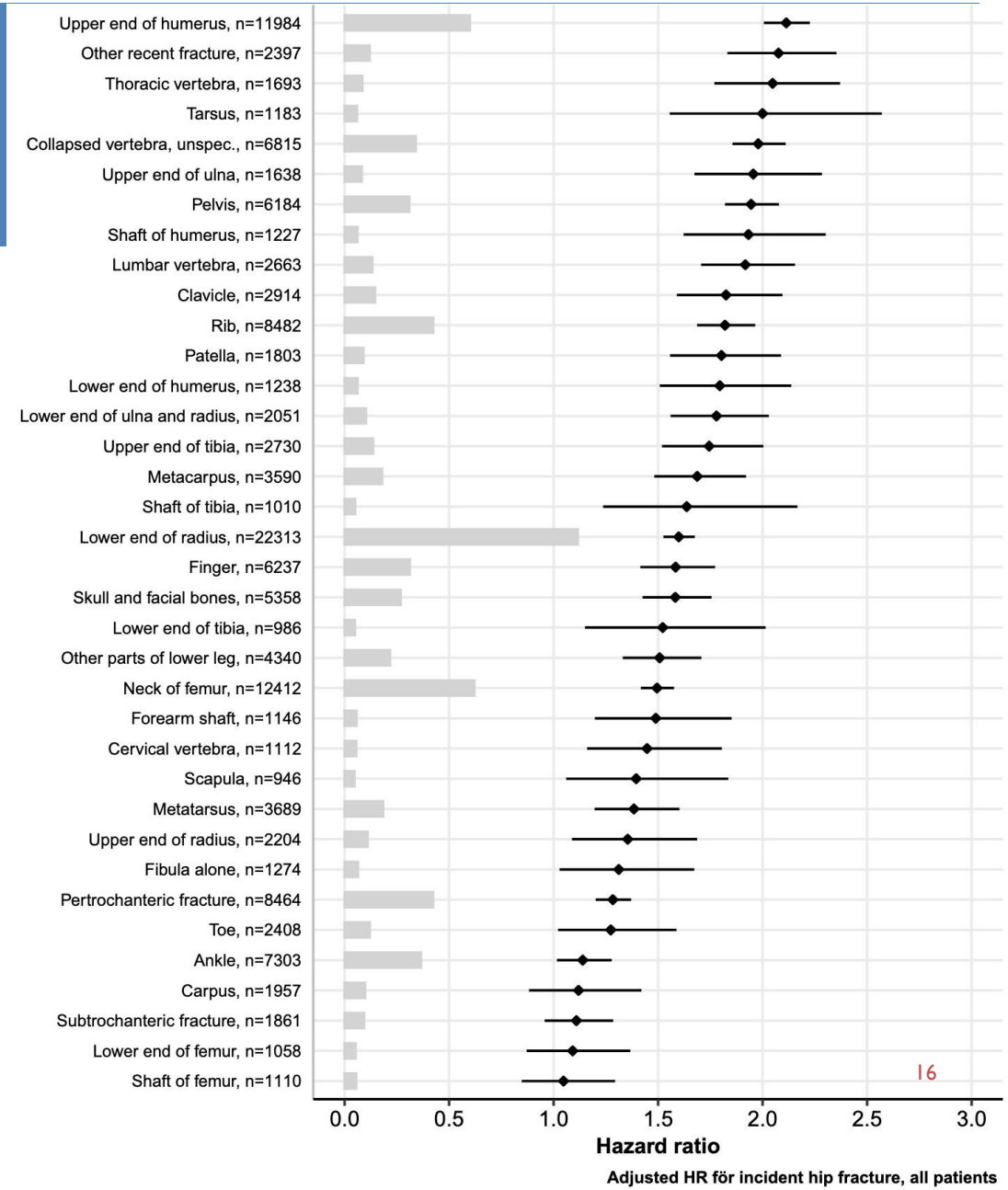
First prior fracture age group, y	AHR (95% CI)			
	All fractures	Osteoporosis fractures	MOFs	Hip fractures
20-29	2.12 (1.67-2.71)	2.11 (1.63-2.74)	2.18 (1.61-2.95)	2.34 (0.97-5.65)
30-39	2.10 (1.86-2.37)	2.11 (1.86-2.40)	2.08 (1.79-2.42)	3.43 (2.52-4.67)
40-49	1.71 (1.57-1.86)	1.71 (1.56-1.87)	1.67 (1.51-1.85)	2.02 (1.64-2.48)
50-59	1.59 (1.50-1.69)	1.57 (1.48-1.67)	1.53 (1.43-1.64)	1.47 (1.29-1.67)
60-69	1.51 (1.42-1.60)	1.49 (1.40-1.59)	1.46 (1.36-1.56)	1.33 (1.18-1.49)
70-79	1.70 (1.58-1.83)	1.69 (1.57-1.83)	1.58 (1.45-1.72)	1.26 (1.11-1.44)
≥80	1.70 (1.50-1.92)	1.68 (1.49-1.90)	1.47 (1.28-1.70)	1.25 (1.03-1.51)
P value for trend[b]	.12	.30	.71	.16

Fractures in adulthood were associated with future fractures regardless of the age at which they occurred. Thus, fractures in early adulthood should not be excluded when assessing an individual's ongoing fracture risk.

Ye et al JAMA Netw Open 2024

The Significance Of Recent Fracture Location For Imminent Risk Of Hip And Vertebral Fractures

- patients with a recent fracture at almost any site have a significantly increased risk of subsequent hip and vertebral fractures.
- This elevated risk is observed regardless of the type or location of the initial fracture, emphasizing that all patients with recent fractures should be considered for secondary fracture prevention programs.



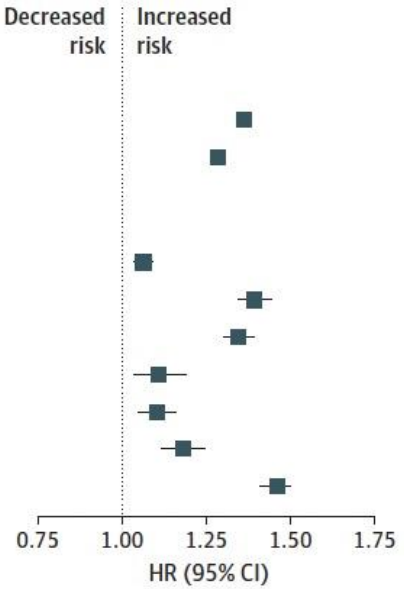
Lorentzon et al Osteoporos Int 2024

Risk Of Falls And Fractures In Individuals With Cataract, Age-related Macular Degeneration, Or Glaucoma

- individuals with any of these common age-related eye diseases have a significantly increased risk of both falls and fractures compared to those without these conditions.
- These patients may benefit from targeted fall prevention interventions and appropriate referrals to reduce their risk of injury and associated morbidity.

A Cataract cohort

Source	No. of events: Individuals with cataract	No. of events: Control individuals	HR (95% CI)
Primary outcome			
Incident falls	121855	283274	1.36 (1.35-1.38)
Incident fractures	58954	67715	1.28 (1.27-1.30)
Secondary outcome (incident fractures by body site)			
Hip	11933	52332	1.28 (1.27-1.30)
Spine	7478	15257	1.39 (1.34-1.44)
Forearm/wrist	7571	20084	1.34 (1.30-1.39)
Skull/facial bones	1604	5843	1.11 (1.03-1.19)
Pelvis	3121	11401	1.10 (1.05-1.16)
Ribs/sternum	2994	8938	1.18 (1.12-1.25)
Lower limb	9628	22988	1.46 (1.41-1.51)



Tsang JY, Wright A, Carr MJ, Dickinson C, Harper RA, Kontopantelis E, Van Staa T, Munford L, Blakeman T, Ashcroft DM. Risk of Falls and Fractures in Individuals With Cataract, Age-Related Macular Degeneration, or Glaucoma. JAMA Ophthalmol. 2024 Feb 1;142(2):96-106. doi: 10.1001/jamaophthalmol.2023.5858.

Association Between Visual Acuity And Prospective Fall Risk

- decreased visual acuity is an independent predictor of approximately a 20% increased risk of both all falls and injurious falls over a 3-year follow-up.
- This finding underscores the importance of regular eye examinations as part of fall risk assessment even in generally healthy, active older adults.

Incidence Rates of All Falls Among participants With and Without Decreased Visual Acuity at Baseline

	Decreased Visual Acuity (n = 1464; 68.7%)	Normal Visual Acuity (n = 667; 31.3%)
No. of all falls	2397	893
Crude estimates		
Incidence rate of all falls (95% CI), per person-year	0.60 (0.56, 0.64)	0.48 (0.43, 0.53)
Incidence rate ratio (95% CI)	1.25 (1.10, 1.41)	
P value	<.001	
Adjusted estimates		
Incidence rate of all falls (95% CI), per person-year	0.54 (0.51, 0.58)	0.45 (0.40, 0.50)
Incidence rate ratio (95% CI)	1.22 (1.07, 1.38)	
P value	.003	

Wieczorek M, Isler M, Landau K, et al. Association Between Visual Acuity and Prospective Fall Risk in Generally Healthy and Active Older Adults: The 3-Year DO-HEALTH Study. *J Am Med Dir Assoc*. 2024;25(5):789-795.e2. doi:10.1016/j.jamda.2024.03.005

Antihypertensive Medication And Fracture Risk

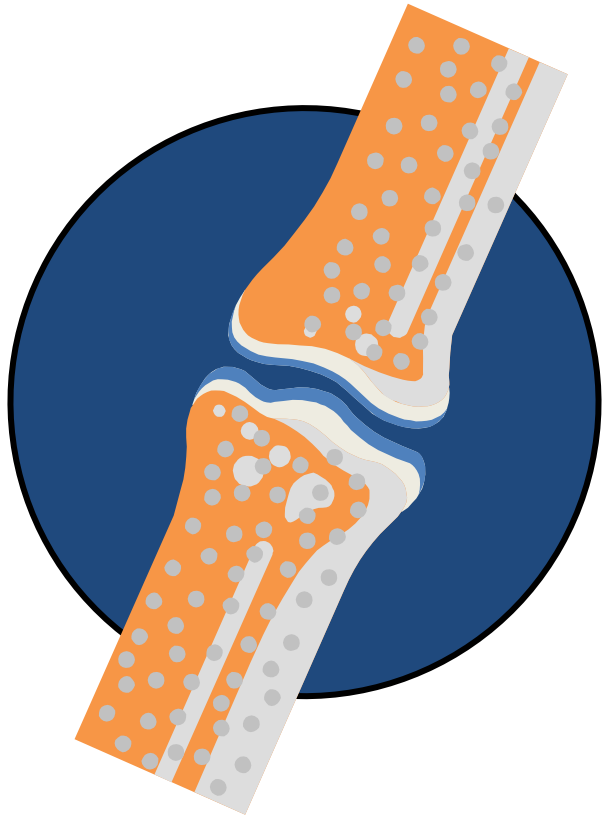
- initiation of antihypertensive medication in older nursing home residents is associated with a significantly increased risk of fractures, with a more than two-fold higher fracture incidence compared to those not starting these medications.
- This elevated fracture risk is accompanied by increased risks of severe falls and syncope, especially pronounced in subgroups with dementia, higher baseline blood pressure, or no recent prior antihypertensive use.

Table 3. Risk of Fall-Related Events Among Nursing Home Residents Initiating Antihypertensive Medication

Event	Pooled analysis		
	No. of events (IR)[a]		
	Treated (n = 12 942)	Control (n = 51 768)	HR (95% CI)
Fracture[b]	46 (5.4)	56 (2.2)	2.42 (1.43-4.08)
Severe fall	246 (28.8)	386 (15.5)	1.80 (1.53-2.13)
Syncope	135 (15.8)	231 (9.3)	1.69 (1.30-2.19)
Expanded outcome definition[b]	52 (6.1)	66 (2.6)	2.30 (1.44-3.69)

Dave CV, Li Y, Steinman MA, et al. Antihypertensive Medication and Fracture Risk in Older Veterans Health Administration Nursing Home Residents. *JAMA Intern Med*. 2024;184(6):661-669.

Advances In Diagnosis And Assessment



Diagnostic Tools

1. Bone Mineral Density (BMD) Testing
   - Dual-Energy X-ray Absorptiometry (DXA): This is the most widely used method for diagnosing osteoporosis. It measures bone density at critical sites like the hip and spine, providing T-scores that indicate bone health relative to a young adult population. A T-score of -2.5 or lower indicates osteoporosis.
   - Quantitative Computed Tomography (QCT): This technique provides a three-dimensional assessment of bone density, particularly useful for evaluating the spine. However, it is less commonly used due to higher radiation exposure compared to DXA.
   - Peripheral Quantitative Computed Tomography (pQCT): This method measures bone density in peripheral sites like the forearm or tibia, but its clinical utility is limited compared to central measurements like DXA
2. Additional Imaging Techniques
   - Vertebral Fracture Assessment (VFA): Often performed alongside DXA, this technique uses low-dose X-rays to identify vertebral fractures, which can indicate osteoporosis2.
   - Magnetic Resonance Imaging (MRI): MRI can be used to evaluate vertebral fractures and assess underlying conditions like cancer that may affect bone health1.

Lewiecki EM. Osteoporosis: Clinical Evaluation. [Updated 2021 Jun 7]. In: Feingold KR, Anawalt B, Blackman MR, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK279049/

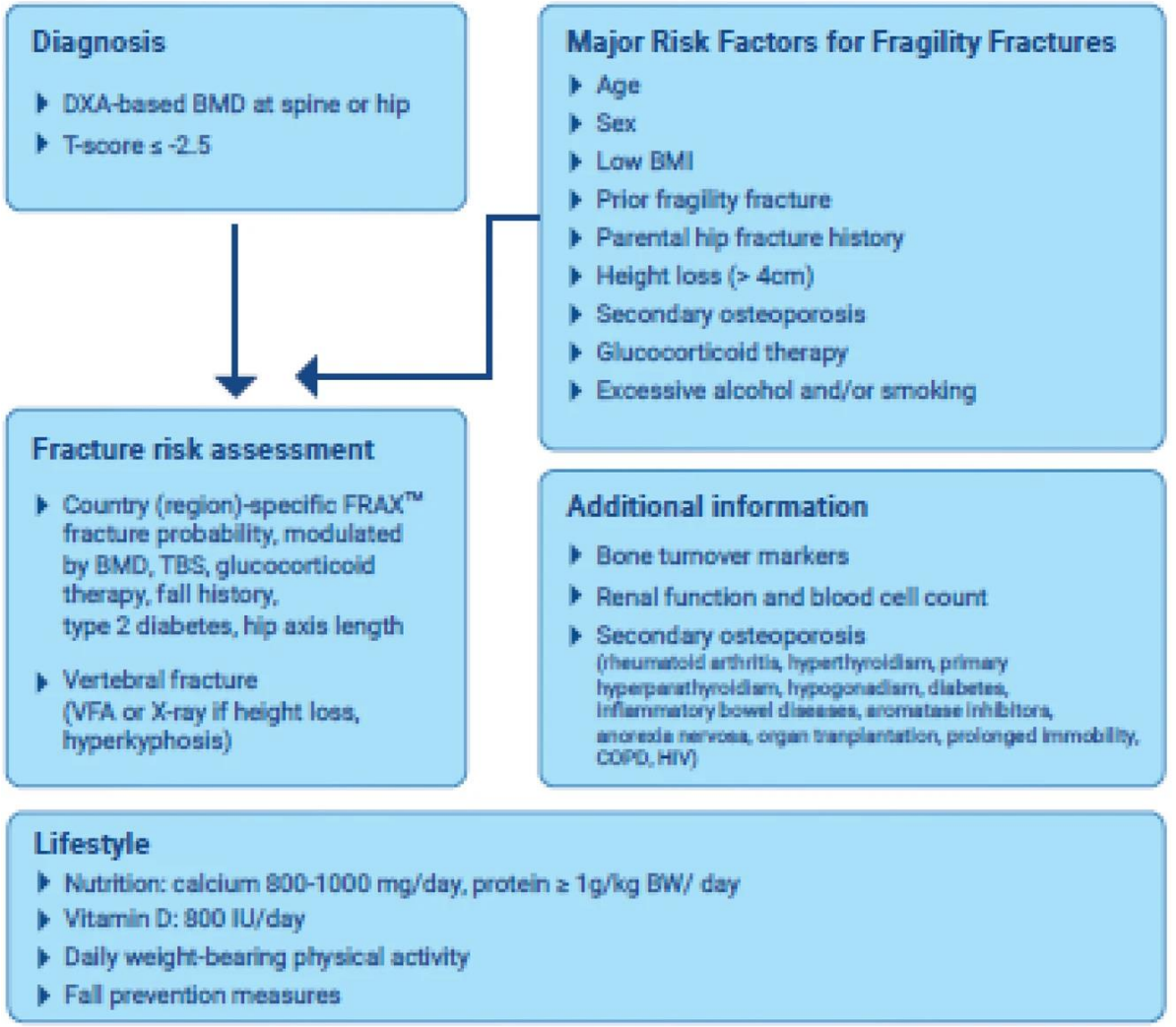
Diagnostic Tools

3. Bone Turnover Markers (BTM)
   - These markers can be measured in blood or urine samples and provide insights into bone metabolism. While they are useful in research settings, their diagnostic value for osteoporosis is limited; they cannot confirm or rule out the condition but may help monitor treatment efficacy
4. Fracture Risk Assessment Tools
   - FRAX®: Developed by the World Health Organization, this tool estimates the 10-year probability of major osteoporotic fractures based on clinical risk factors and BMD measurements. It helps in identifying individuals who may benefit from treatment236.

DXA remains the gold standard for measuring bone mineral density, while tools like FRAX® assist in evaluating fracture risk based on individual patient profiles. Additional methods such as BTMs and QUS provide supplementary information but are not substitutes for comprehensive BMD assessments.

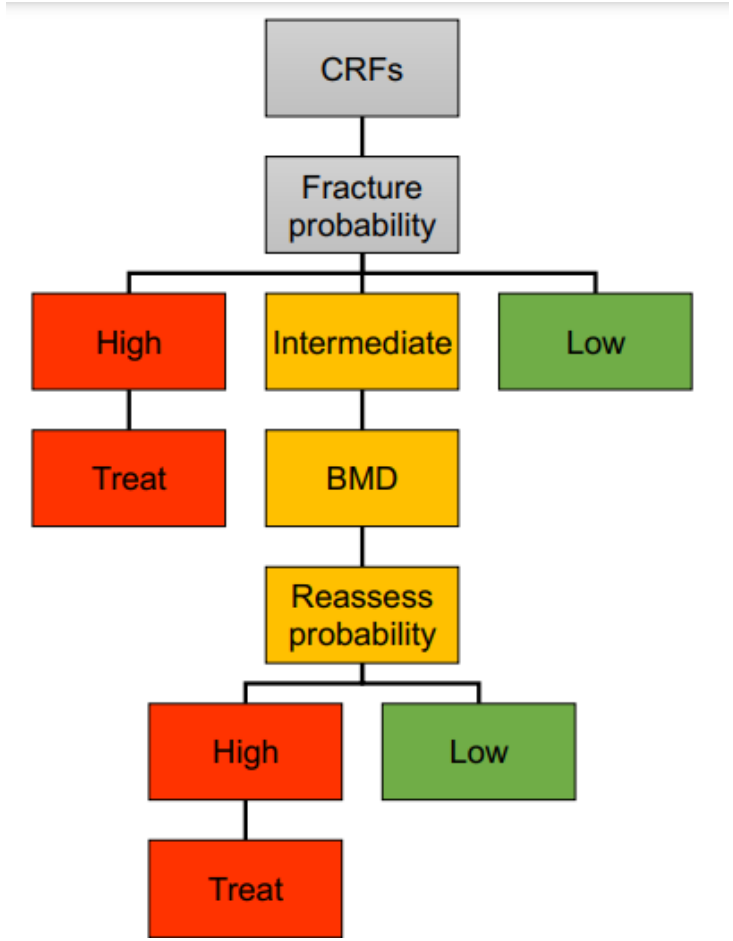
Lewiecki EM. Osteoporosis: Clinical Evaluation. [Updated 2021 Jun 7]. In: Feingold KR, Anawalt B, Blackman MR, et al., editors. Endotext [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK279049/

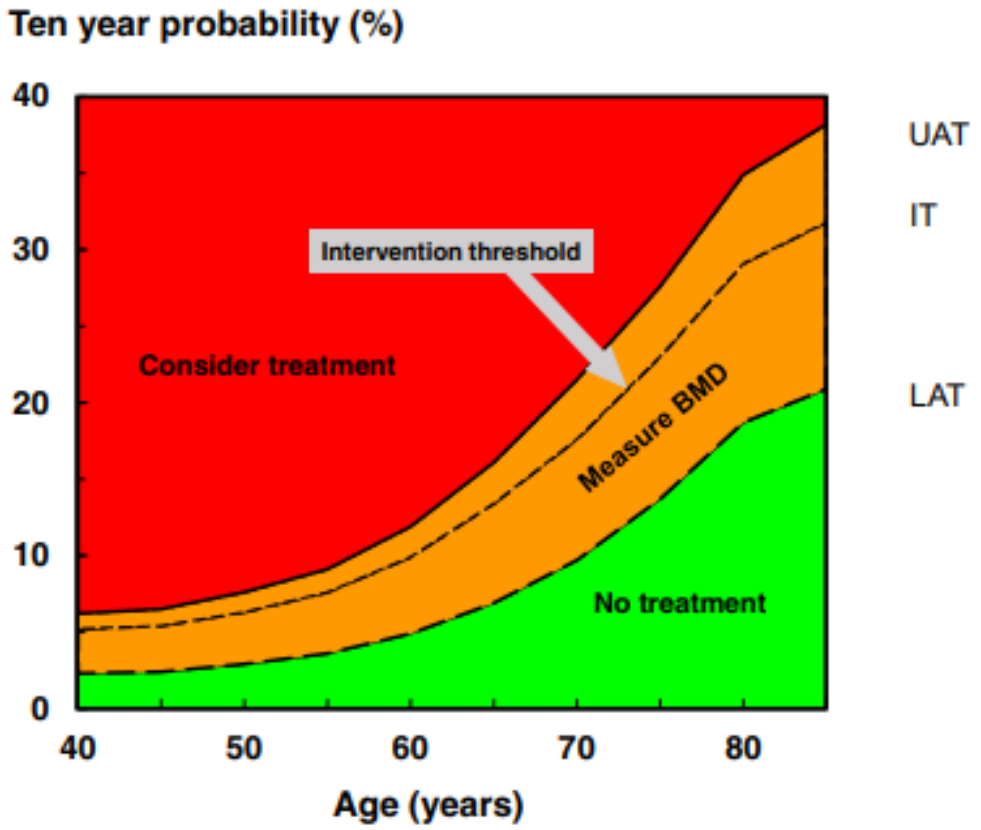
IOF Executive Summary Of The European Guidance For The Diagnosis And Management Of Osteoporosis In Postmenopausal Women



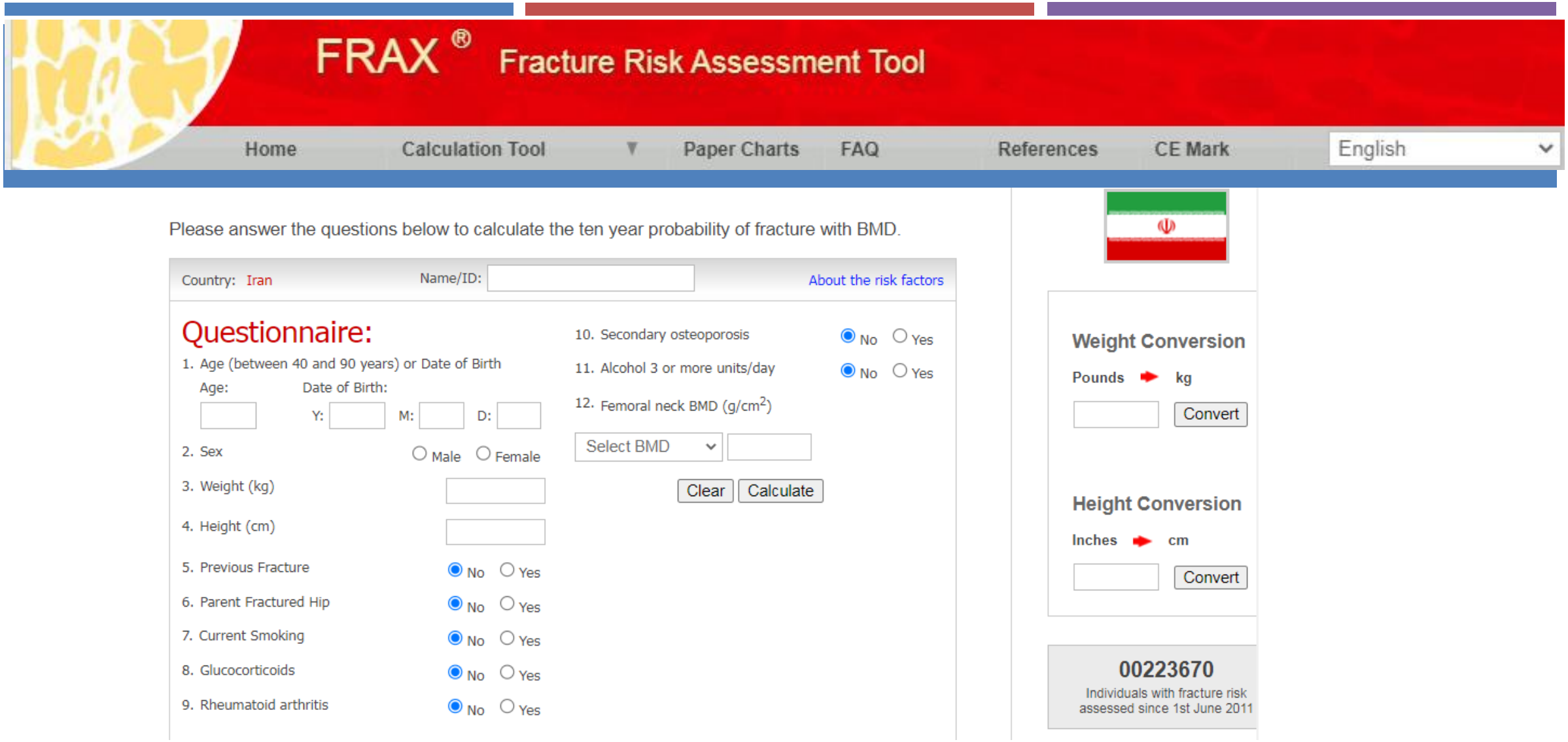
Kanis, J.A., Cooper, C., Rizzoli, R. et al. Executive summary of the European guidance for the diagnosis and management of osteoporosis in postmenopausal women. Calcif Tissue Int 104, 235–238 (2019).

Guidance For The Diagnosis And Management Of Osteoporosis





Kanis, J., Cooper, C., Rizzoli, R. et al. European guidance for the diagnosis and management of osteoporosis in postmenopausal women. Osteoporos Int 30, 3–44 (2019). https://doi.org/10.1007/s00198-018-4704-5



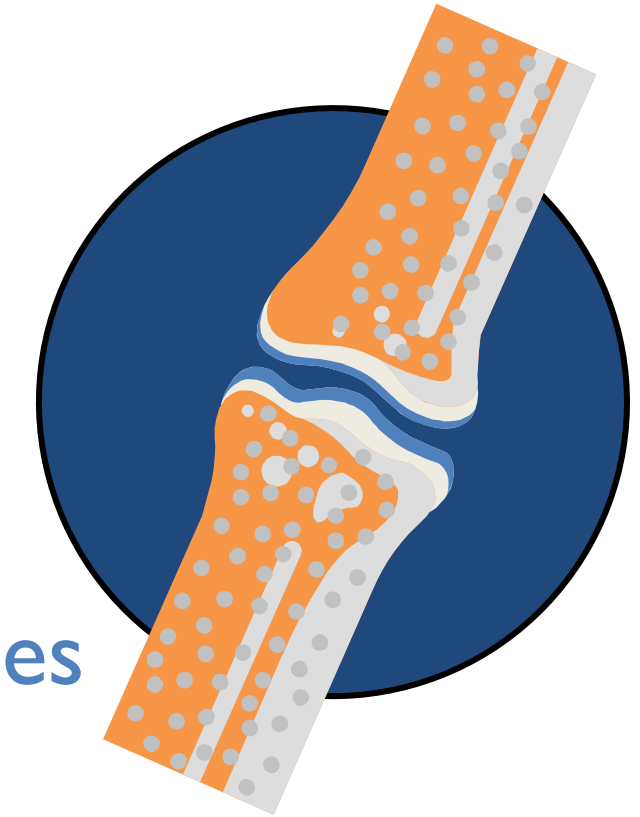
- In 2008, Sheffield university in the UK invented FRAX® as a fracture risk assessment tool for estimating the individualized 10-year probability of osteoporotic fractures.

The following adjustments are currently available on FRAXplus®:

- Recency of osteoporotic fracture
- High exposure to oral glucocorticoids
- Type 2 diabetes mellitus
- Information on Trabecular Bone Score (TBS)
- Falls history
- Hip axis length (HAL)
- Concurrent data on Lumbar Spine BMD

NEW FRAXplus® Fracture Risk Assessment Tool beta

Updates on Osteoporosis Treatment Strategies



Overview Of Medicines For Prevention And Treatment

Antiresorptive Agents

Bisphosphonates				
Alendronate	Fosamax®, Fosamax Plus D™	Oral (tablet, solution)	Daily/Weekly	Women & Men
Alendronate	Binosto®	Oral (effervescent tablet)	Weekly	Women & Men
Ibandronate	Boniva®	Oral (tablet)	Monthly	Women
Ibandronate	Boniva®	Intravenous (IV) injection	Every 3 months	Women
Risedronate	Actonel®	Oral (tablet)	Daily/Weekly/Monthly	Women & Men
Risedronate	Atelvia™	Oral (tablet)	Weekly	Women
Zoledronic Acid	Reclast®	Intravenous (IV) infusion	One Time per Year/Once every two years	Women & Men
RANK ligand (RANKL) inhibitor				
Denosumab	Prolia®	Injection	Every 6 Months	Women & Men
Estrogen* (Hormone Therapy)				
Estrogen	Multiple Brands	Oral (tablet)	Daily	Women
Estrogen	Multiple Brands	Transdermal (skin patch)	Twice Weekly/Weekly	Women
Estrogen Agonists/Antagonists also called selective estrogen receptor modulators (SERMs)				
Raloxifene	Evista®	Oral (tablet)	Daily	Women
Tissue Specific Estrogen Complex (TSEC)				
Estrogen/Bazodoxifene	Duavee®	Oral (tablet)	Daily	Women

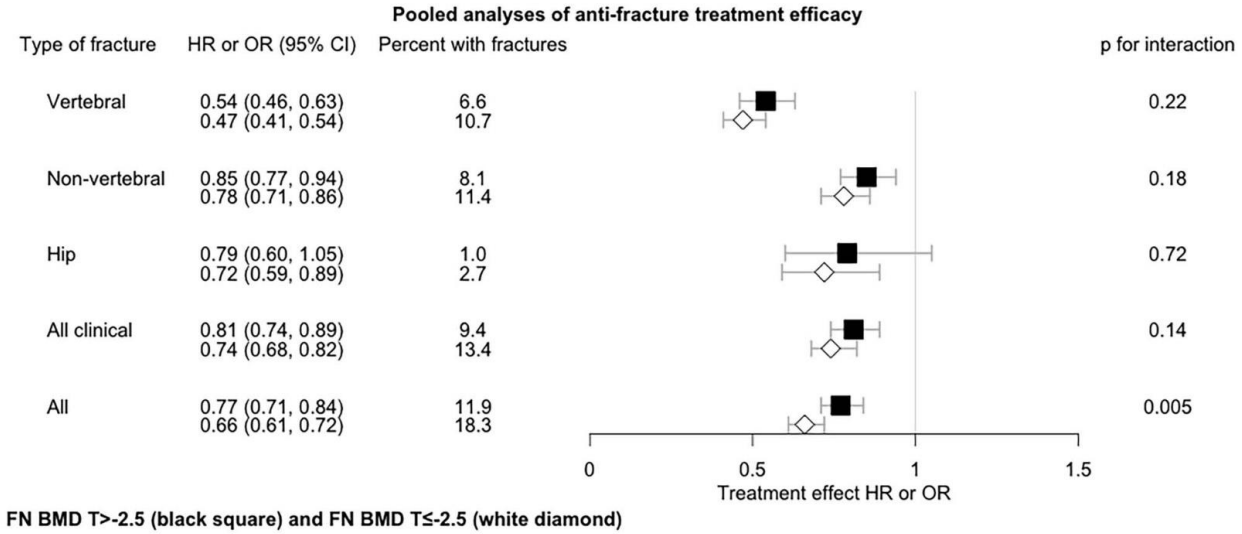
Anabolic Agents

Sclerostin Inhibitor				
Romosozumab-aqqg	Evenity®	Injection	2 injections once monthly for 12 months	Women
Parathyroid Hormone (PTH) Analog				
Teriparatide	Forteo®	Injection	Daily	Women & Men
Teriparatide	Bonsity®	Injection	Daily	Women & Men
Parathyroid Hormone-Related Protein (PTHrp) Analog				
Abaloparatide	Tymlos®	Injection	Daily	Women & Men

Pre-treatment Bone Mineral Density And The Benefit Of Pharmacologic Treatment On Fracture Risk And BMD Change: Analysis From The FNIH-ASBMR SABRE Project

- Anti-osteoporotic medications significantly reduce fracture risk in patients regardless of their baseline BMD levels.

- This indicates that pharmacologic treatment is beneficial across a broad spectrum of BMD levels, supporting early treatment decisions beyond those with extremely low BMD. The study also strengthens the rationale for using changes in total hip BMD as a surrogate endpoint in future osteoporosis clinical trials.

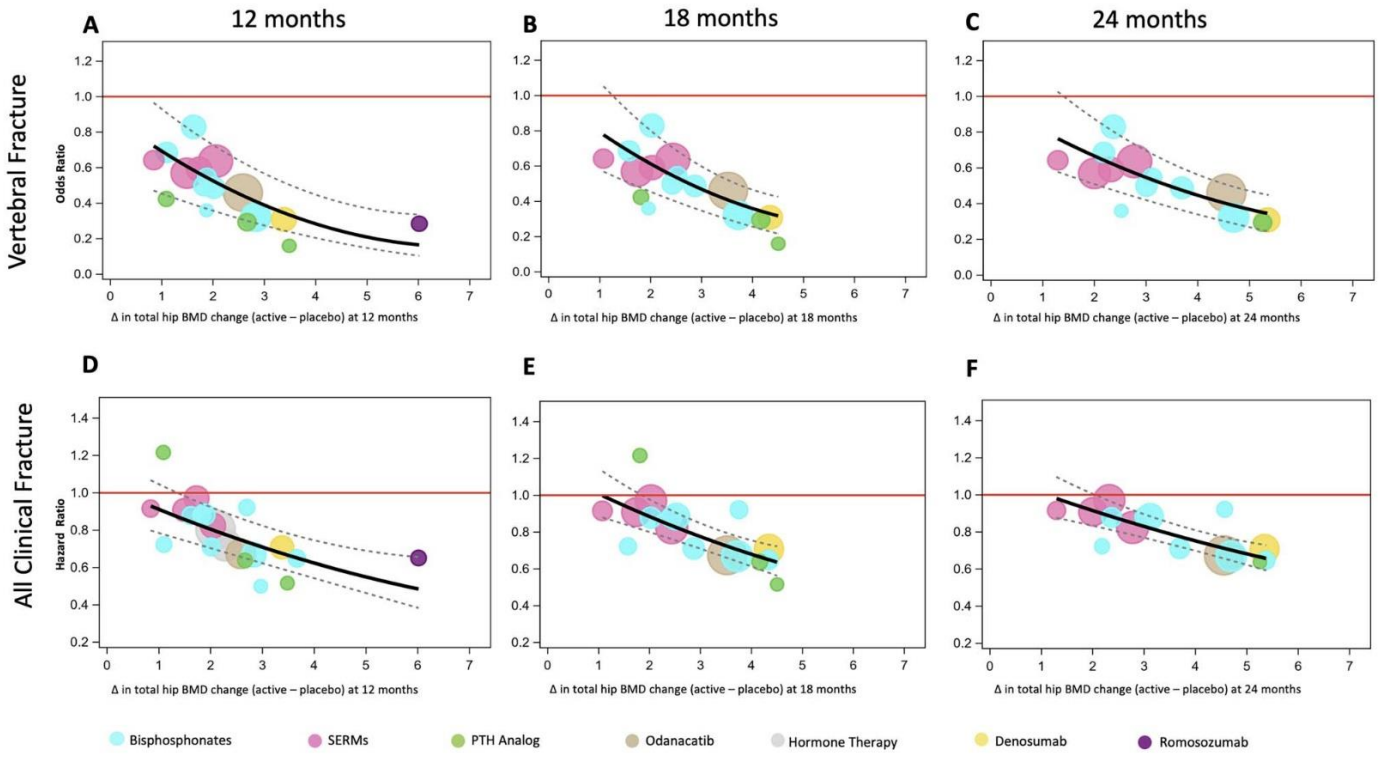


Bisphoshonates
(13 RCTsp)

*Schini e*Schini M, Vilaca T, Lui LY, et al. Pre-treatment bone mineral density and the benefit of pharmacologic treatment on fracture risk and BMD change: analysis from the FNIH-ASBMR SABRE project. *J Bone Miner Res*. 2024;39(7):867-876. doi:10.1093/jbmr/zjae068*t al JBMR 2024*

The Relationship Between Treatment-related Changes In Total Hip BMD Measured After 12, 18, And 24 Mo And Fracture Risk Reduction In Osteoporosis Clinical Trials

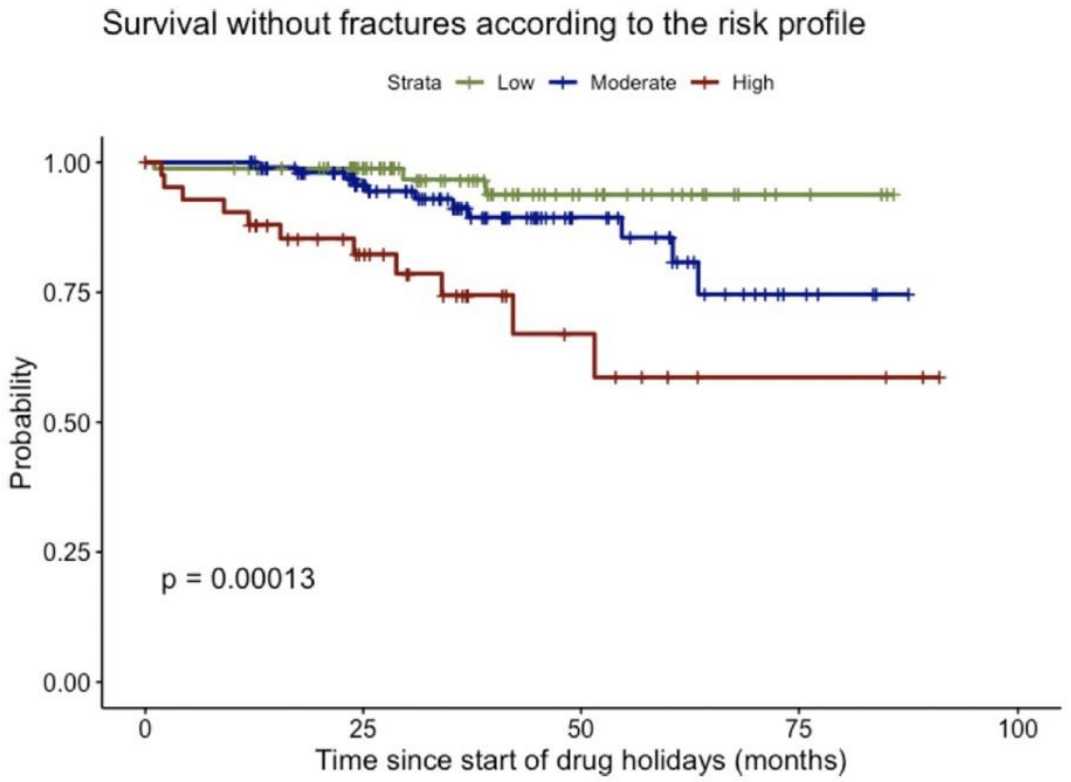
- increases in total hip bone mineral density after 12, 18, and 24 months of osteoporosis treatment are associated with significant reductions in fracture risk across multiple fracture types, including vertebral, hip, non-vertebral, and clinical fractures.
- These findings support using BMD changes as early surrogate markers for fracture prevention efficacy in clinical trials, with meaningful predictions possible even as early as 12 months into therapy.



Vilaca T, Schini M, Lui LY, et al. The relationship between treatment-related changes in total hip BMD measured after 12, 18, and 24 mo and fracture risk reduction in osteoporosis clinical trials: the FNIH-ASBMR-SABRE project. *J Bone Miner Res*. 2024;39(10):1434-1442. doi:10.1093/jbmr/zjae126

Bisphosphonate Drug Holidays According To Fracture Risk Profile

- drug holidays are recommended after 3 to 5 years of treatment in patients at low to moderate fracture risk to reduce the risk of rare but serious side effects.
- However, for patients at high fracture risk, continuation of bisphosphonate treatment without interruption is generally advised due to the substantial benefit in fracture prevention.
- The decision to start a drug holiday should be individualized based on fracture risk profile, bone mineral density, and overall clinical context, balancing long-term safety with ongoing fracture protection.



The probability of being fracture-free after discontinuation of BP treatment is lower in high-risk patients compared to others

Salmoral A, Peris P, López Medina C, et al. Bisphosphonate drug holidays in osteoporosis according to fracture risk profile. Osteoporos Int. 2025;36(2):245-254. doi:10.1007/s00198-024-07309-9

Osteoporosis Treatment Prevents Hip Fracture Similarly In Both Sexes

osteoporosis treatment effectively prevents hip fractures with similar efficacy in both men and women. These results support the use of standard osteoporosis therapies in men as well as women at high fracture risk to lower their chances of sustaining a hip fracture.

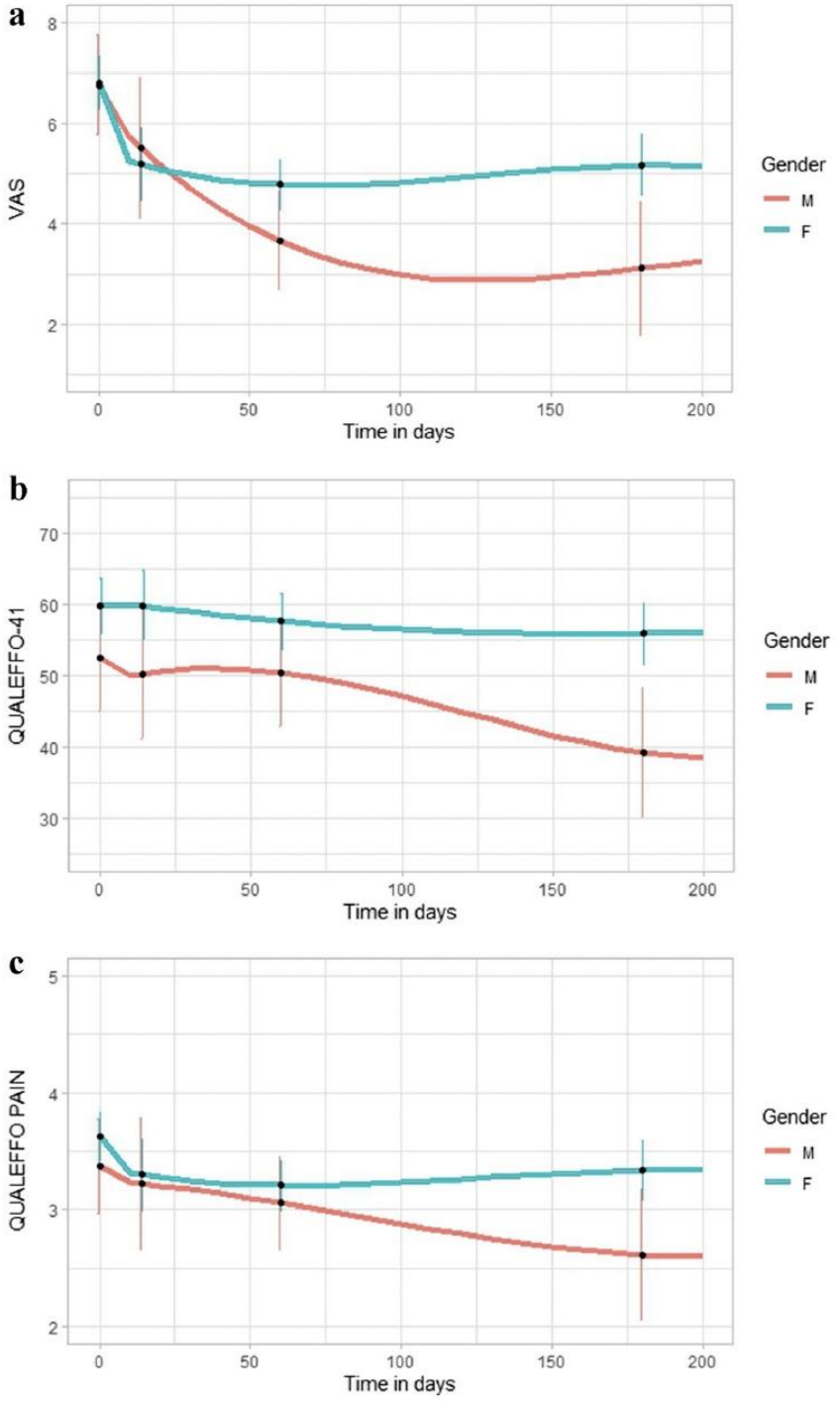
Table 3. Odds ratio (adjusted and crude) of hip fracture associated with osteoporosis treatment (treated vs not-treated patients; and partially-treated vs not-treated patients) for each sex at two-year follow-up.

		Adjusted odds ratio (95% CI)		Crude odds ratio (95% CI)	
Treated vs not-treated					
	Women	0.26	0.21–0.33	0.25	0.19–0.31
	Men	0.21	0.13–0.34	0.25	0.16–0.39
	Men:Women[a]	0.81	0.47–1.37	1.00	0.60–1.66
Partially-treated vs not-treated					
	Women	0.90	0.69–1.18	0.99	0.77–1.27
	Men	0.69	0.40–1.21	0.85	0.51–1.42
	Men:Women[a]	0.77	0.41–1.42	0.86	0.49–1.52

Keaveny TM, Adams AL, Orwoll ES, et al. Osteoporosis treatment prevents hip fracture similarly in both sexes: the FOCUS observational study. *J Bone Miner Res*. 2024;39(10):1424-1433. doi:10.1093/jbmr/zjae090

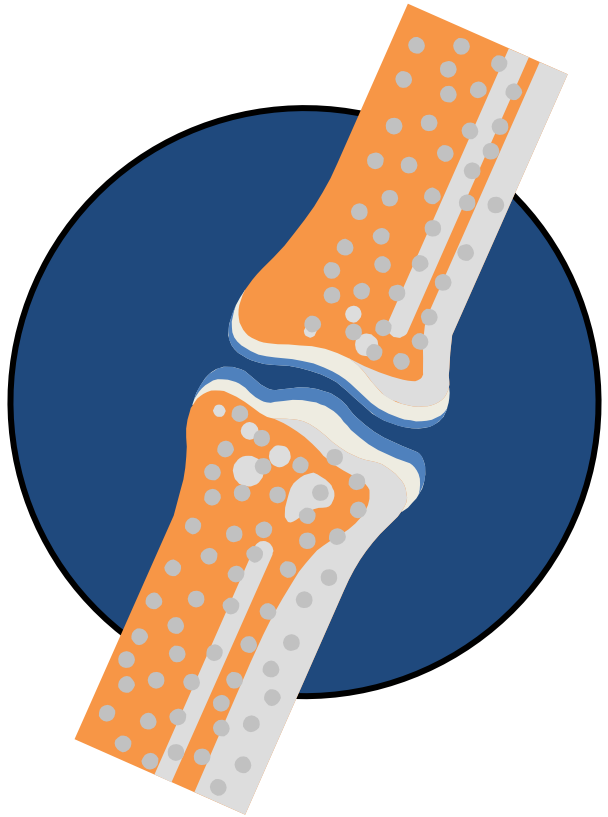
Effect Of Gender On The Evolution Of Pain And Quality Of Life After Treatment Of Symptomatic Vertebral Fragility Fractures

- women experience a worse trajectory in pain reduction and quality of life improvement following treatment for symptomatic vertebral fractures compared to men.
- The findings highlight that female patients may need more targeted pain management and supportive measures to improve their recovery outcomes after vertebral fragility fractures.



Peris P, Blasco J, Monegal A, Florez H, Guañabens N, Carrasco JL. Effect of gender on the evolution of pain and quality of life after treatment of symptomatic vertebral fragility fractures. *Osteoporos Int*. 2024;35(3):515-521.

Precision Medicine In Osteoporosis



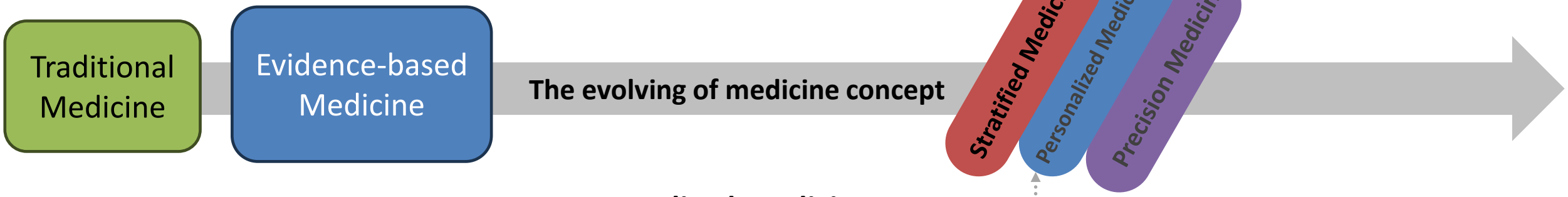
Definition of Precision Medicine

Precision Medicine

A Science and a healthcare approach that uses molecular information (genomic, proteomic, metabolic data), along with phenotypic and health data, to classify individuals into subpopulations that differ in disease susceptibility or treatment response

Stratified Medicine

grouping of patients based on risk of disease or response to therapy by using diagnostic tests or techniques



Personalized Medicine

A medical approach that uses an individual's genetic, environmental, and lifestyle information to guide prevention, diagnosis, and treatment decisions tailored specifically to that person.

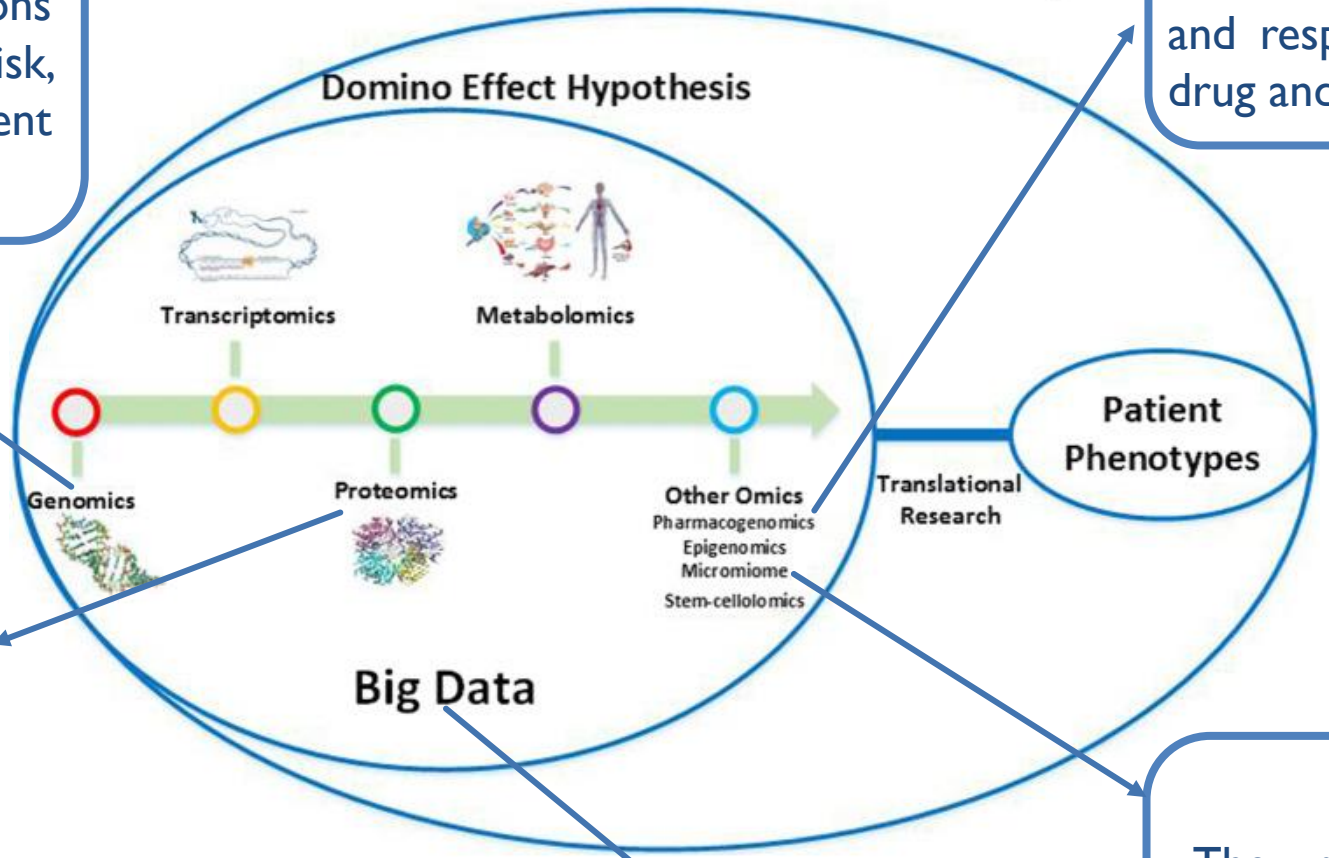
Hasanzad M, Sarhangi N, Naghavi A, Ghavimehr E, Khatami F, Ehsani Chimeh S, **Larijani B,** Aghaei Meybodi HR. Genomic medicine on the frontier of precision medicine. J Diabetes Metab Disord. 2021 Aug 24;21(1):853-861. doi: 10.1007/s40200-021-00880-6. PMID: 35673457; PMCID: PMC9167337.

Genomics

Study of the patient's genetic material to identify variations that influence disease risk, progression, and treatment response.

Proteomics

Analysis of protein expression patterns related to disease, aiding in diagnosis and targeted therapy development.



Pharmacogenomics

Understanding how genetic differences affect drug metabolism and response, allowing for optimal drug and dose selection

Data Analytics and Artificial Intelligence

Integration and analysis of large datasets (genomic, clinical, lifestyle) to guide decision-making and predict outcomes.

Microbiota

The microbiome's role in disease pathogenesis, drug metabolism, and as a potential therapeutic target.

Hasanzad M, Sarhangi N, Ehsani Chimeh S, Ayati N, Afzali M, Khatami F, Nikfar S, Aghaei Meybodi HR. Precision medicine journey through omics approach. J Diabetes Metab Disord. 2021 Nov 24;21(1):881-888. doi: 10.1007/s40200-021-00913-0. PMID: 35673436; PMCID: PMC9167178.

frontiers | Frontiers in Medicine

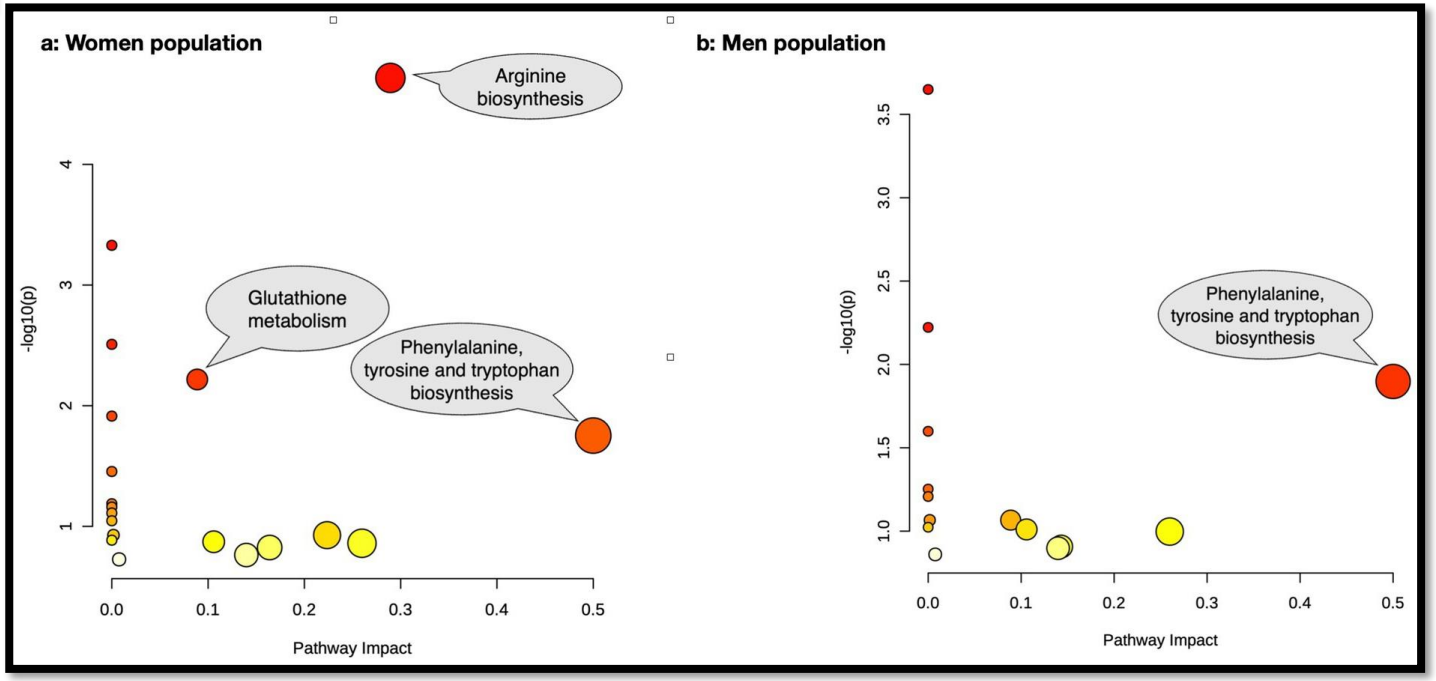
TYPE Original Research
PUBLISHED 02 May 2025
DOI 10.3389/fmed.2025.1515449

Metabolomic insights into amino acid signatures and pathways associated with osteoporosis in Iranian elderly population

Hojat Dehghanbanadaki[1], Azin Soltani[2,3], Ziba Majidi[4], Mostafa Rezaei-Tavirani[5], Gita Shafiee[6], Afshin Ostovar[7], Fatemeh Bandarian[1], Niloufar Najjar[1], Bagher Larijani[8], Iraj Nabipour[9], Patricia Khashayar[10], Noushin Fahimfar[7]* and Farideh Razi[1]*

- In women, higher levels of glycine, citrulline, serine, and aspartic acid are linked to increased risk of osteoporosis.
- In men, higher levels of tyrosine, leucine, valine, and lysine are associated with reduced osteoporosis risk.

- The metabolic pathway most impacted by osteoporosis in both sexes is phenylalanine, tyrosine, and tryptophan biosynthesis.
- These amino acid signatures and metabolic pathways could serve as potential targets for osteoporosis prevention and management.



Journal of Diabetes & Metabolic Disorders (2021) 20:1375–1383
https://doi.org/10.1007/s40200-021-00871-7

RESEARCH ARTICLE

Association of vitamin D receptor gene polymorphism with the occurrence of low bone density, osteopenia, and osteoporosis in patients with type 2 diabetes

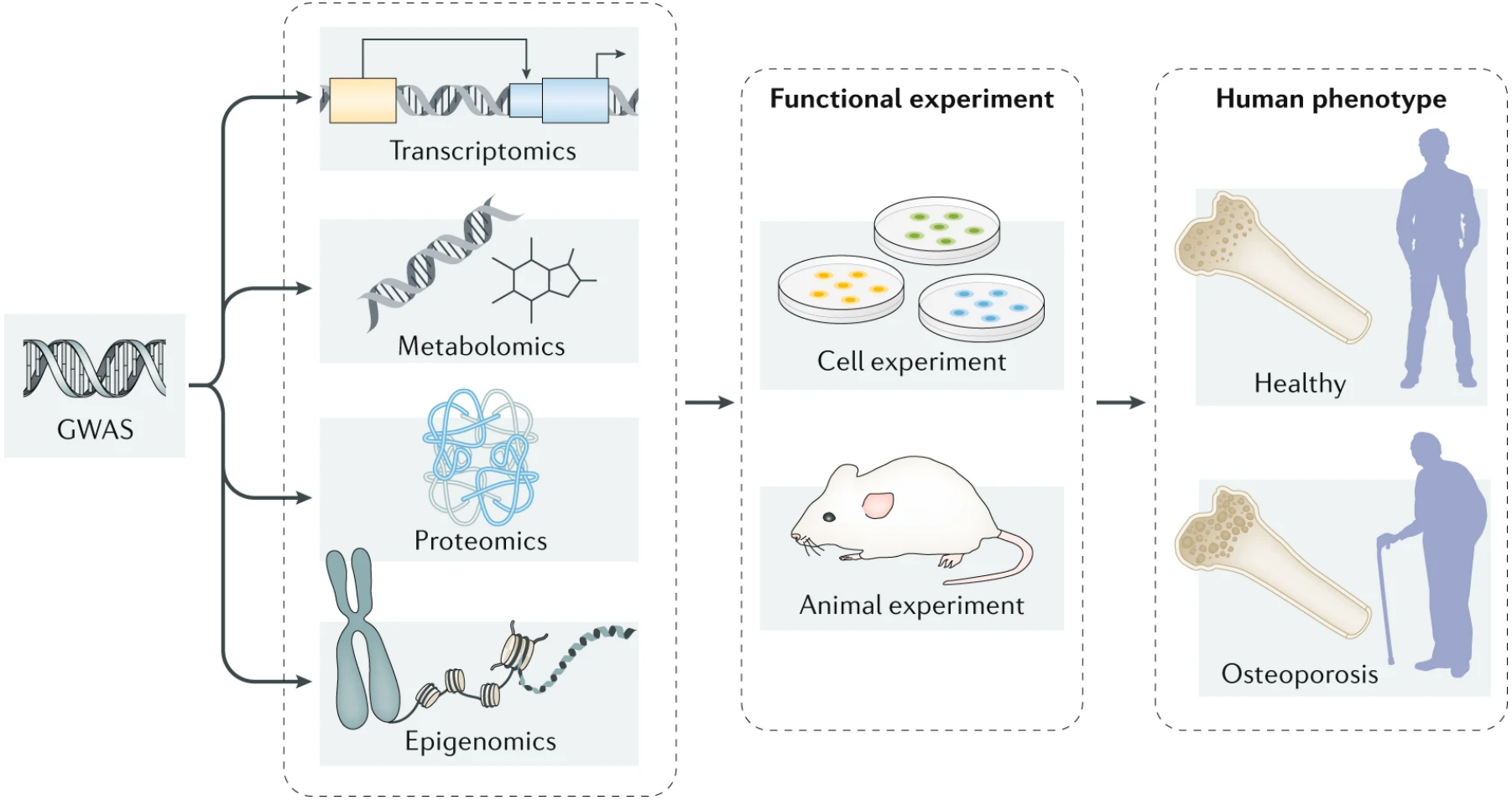
Maryam Ghodsi[1] · Abbas Ali Keshtkar[2] · Farideh Razi[1] · Mahsa Mohammad Amoli[3] · Ensieh Nasli-Esfahani[1] · Fariba Zarrabi[4,5] · Patricia Khashayar[6,7] · Alireza Khajavi[8] · Bagher Larijani[9] · Mohamad Reza Mohajeri-Tehrani[9]

Received: 25 May 2021 / Accepted: 31 July 2021 / Published online: 23 August 2021

- The polymorphism of both *TaqI* and *EcoRV* genes was associated with the risk of low bone density (LBD) /osteopenia/osteoporosis in women with T2D.

Table 2 Frequency of VDR gene's polymorphism (*ApaI*, *BsmI*, *EcoRV*, *FokI*, and *TaqI*) in women versus men in participants with type 2 diabetes

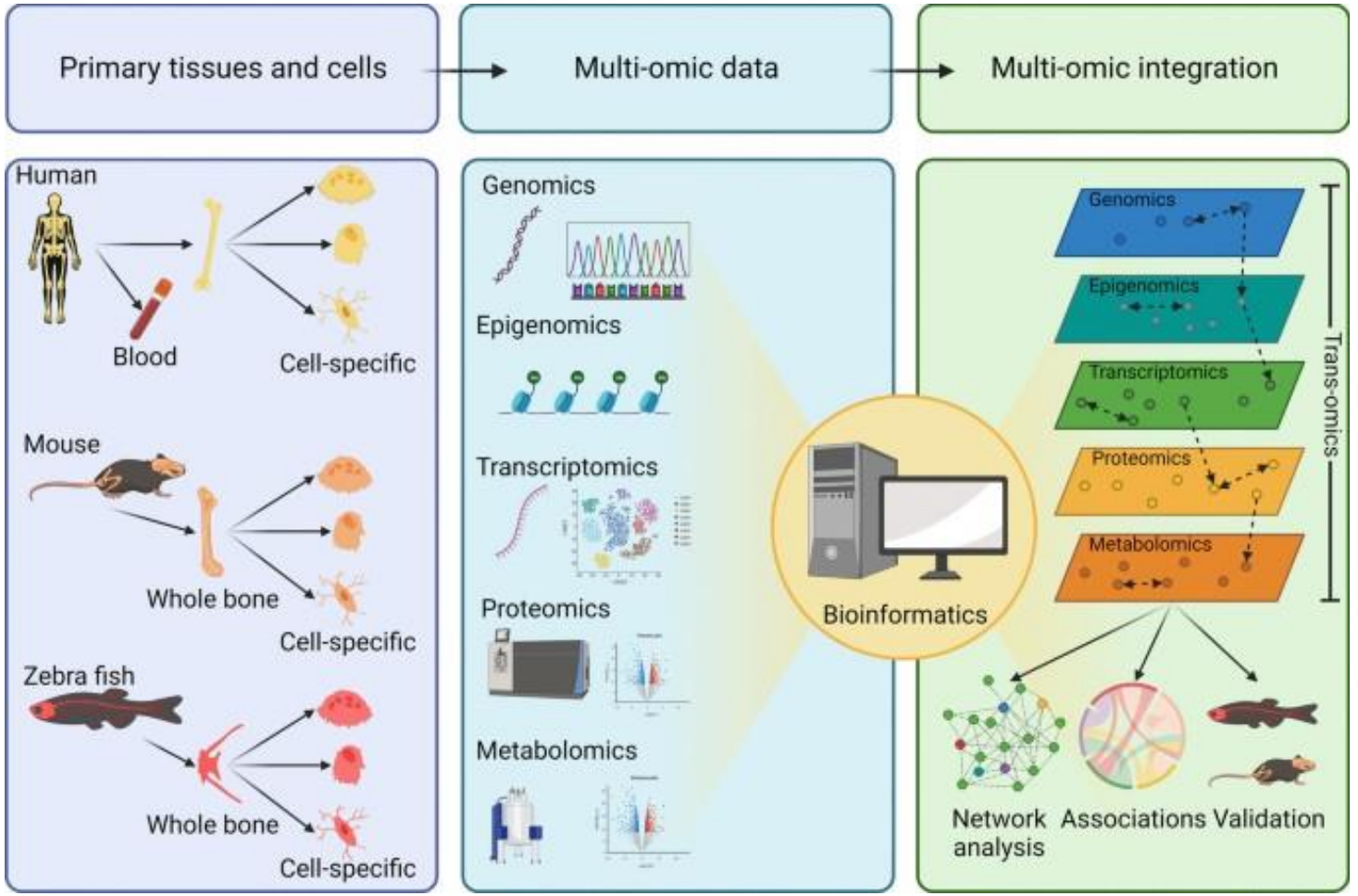
Gene	Polymorphism	Male	Female	Total	*P* value
ApaI	Aa	25 (44.46)	45 (47.37)	70 (46.36)	0.894[a]
	AA	21 (37.50)	32 (33.68)	53 (35.10)	
	aa	10 (17.86)	18 (18.95)	28 (18.54)	
	Total	56 (100)	95 (100)	151 (100)	
BsmI	Bb	40 (70.18)	59 (62.11)	99 (65.13)	0.544[b]
	BB	14 (24.56)	31 (32.63)	46 (29.61)	
	bb	3 (5.26)	5 (5.26)	8 (5.26)	
	Total	57 (100)	95 (100)	152 (100)	
EcoRV	EE	25 (44.64)	41 (43.16)	66 (43.71)	0.928[a]
	Ee	24 (42.86)	40 (42.11)	64 (42.38)	
	ee	7 (12.50)	14 (14.74)	21 (13.91)	
	Total	56 (100)	95 (100)	151 (100)	
FokI	FF	29 (50.88)	51 (53.13)	80 (52.29)	0.603[b]
	Ff	25 (43.86)	36 (37.50)	61 (39.87)	
	Ff	3 (5.26)	9 (9.38)	12 (7.84)	
	Total	57 (100)	96 (100)	153 (100)	
TaqI	Tt	26 (46.43)	45 (46.88)	71 (46.71)	0.685[a]
	TT	19.(33.93)	37 (38.54)	56 (36.84)	
	tt	11 (19.64)	14 (14.58)	25 (16.45)	
	Total	56 (100)	96 (100)	152 (100)	



Multiple omics technologies, including genomics transcriptomics, epigenomics, proteomics and metabolomics, have been applied to dissect the pathogenesis of osteoporosis. Each technology individually can only provide limited insights into the biological mechanisms of osteoporosis. By integrating multiple omics data and following-up functional experiments in cell lines and/or animal models, researchers could capture a comprehensive view of the pathogenesis of this disorder.

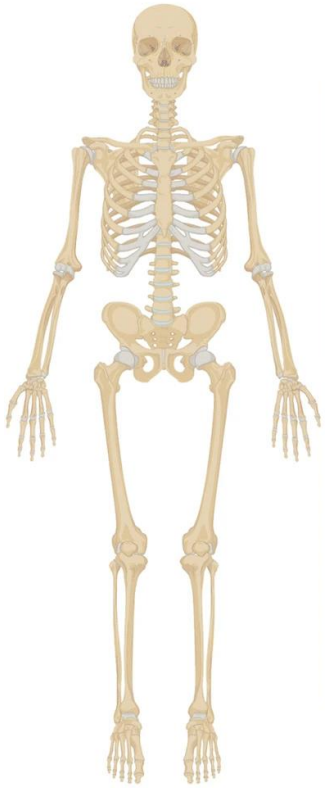
Bone Trans-omics

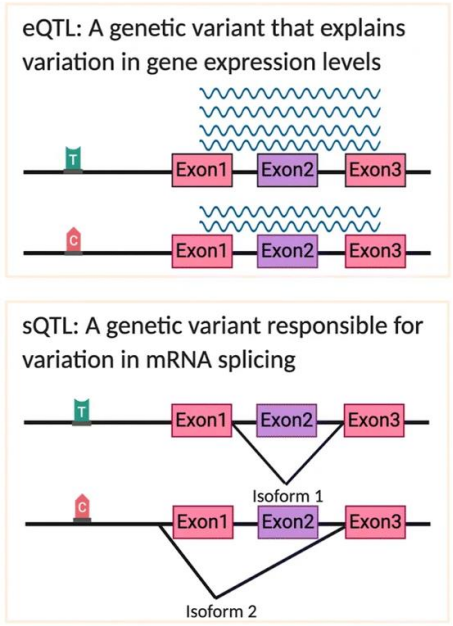
Recently, literature has grown on the implementation of integrative multi-omics to study bone biology, which combines computational and informatics support to connect multiple layers of data derived from individual "omic" platforms. This emerging discipline termed "trans-omics" has enabled bone biologists to identify and construct detailed molecular networks.

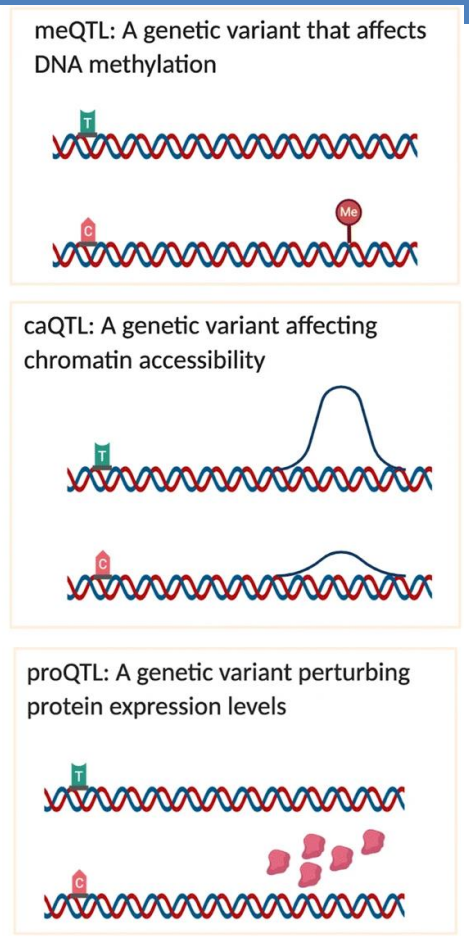


Mullin, B.H., Ribet, A.B.P. & Pavlos, N.J. Bone Trans-omics: Integrating Omics to Unveil Mechanistic Molecular Networks Regulating Bone Biology and Disease. Curr Osteoporos Rep 21, 493–502 (2023).

Using "-Omics" Data To Inform Genome-wide Association Studies



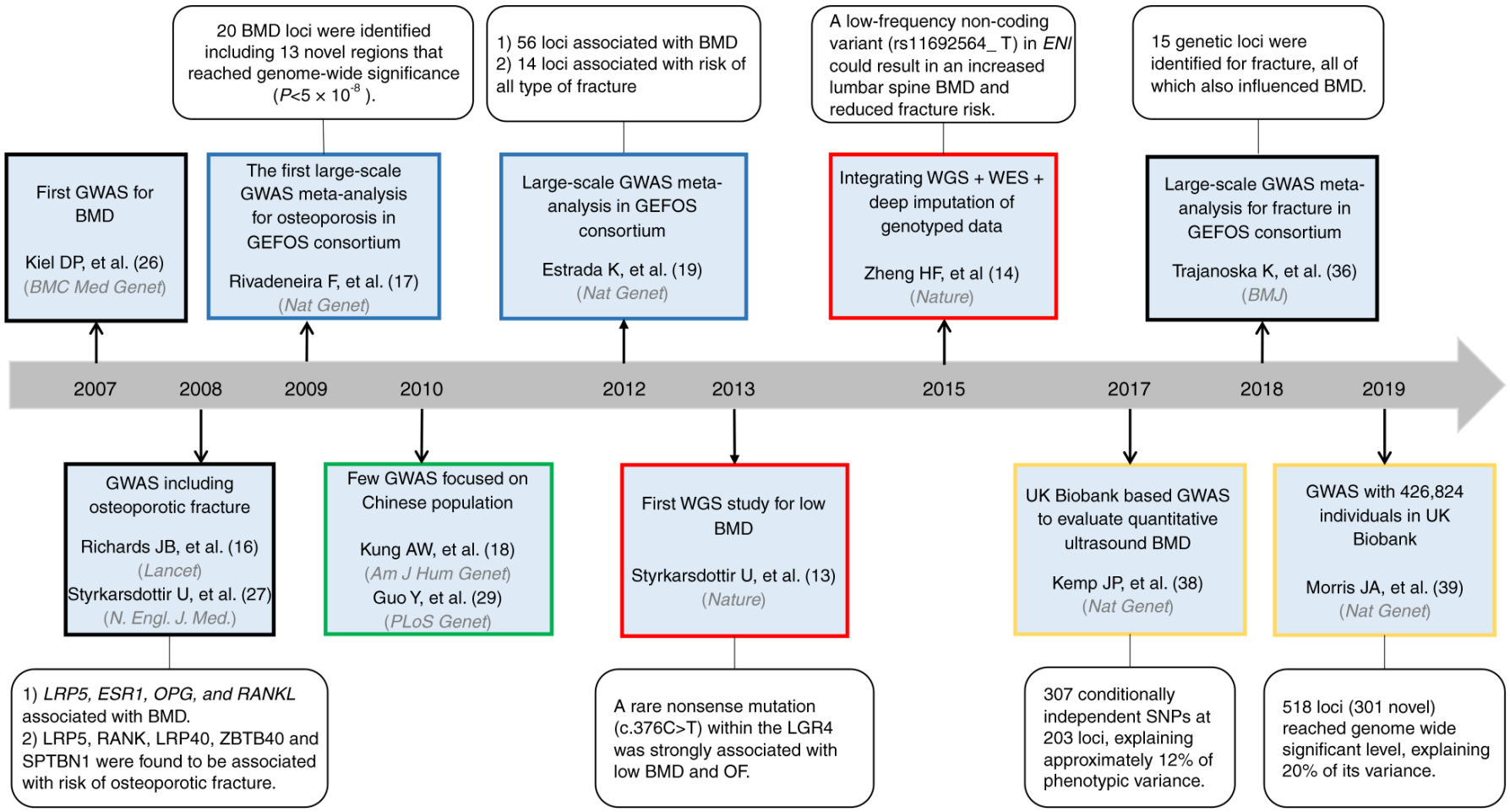




integrating multi-omics data, including transcriptomics, epigenomics, and metabolomics, with GWAS enhances the identification of causal genes and biological pathways underlying bone mineral density (BMD) and osteoporosis risk.

Abood, A., Farber, C.R. Using "-omics" Data to Inform Genome-wide Association Studies (GWASs) in the Osteoporosis Field. *Curr Osteoporos Rep* **19**, 369–380 (2021). https://doi.org/10.1007/s11914-021-00684-w

Twelve Years Of GWAS Discoveries For Osteoporosis

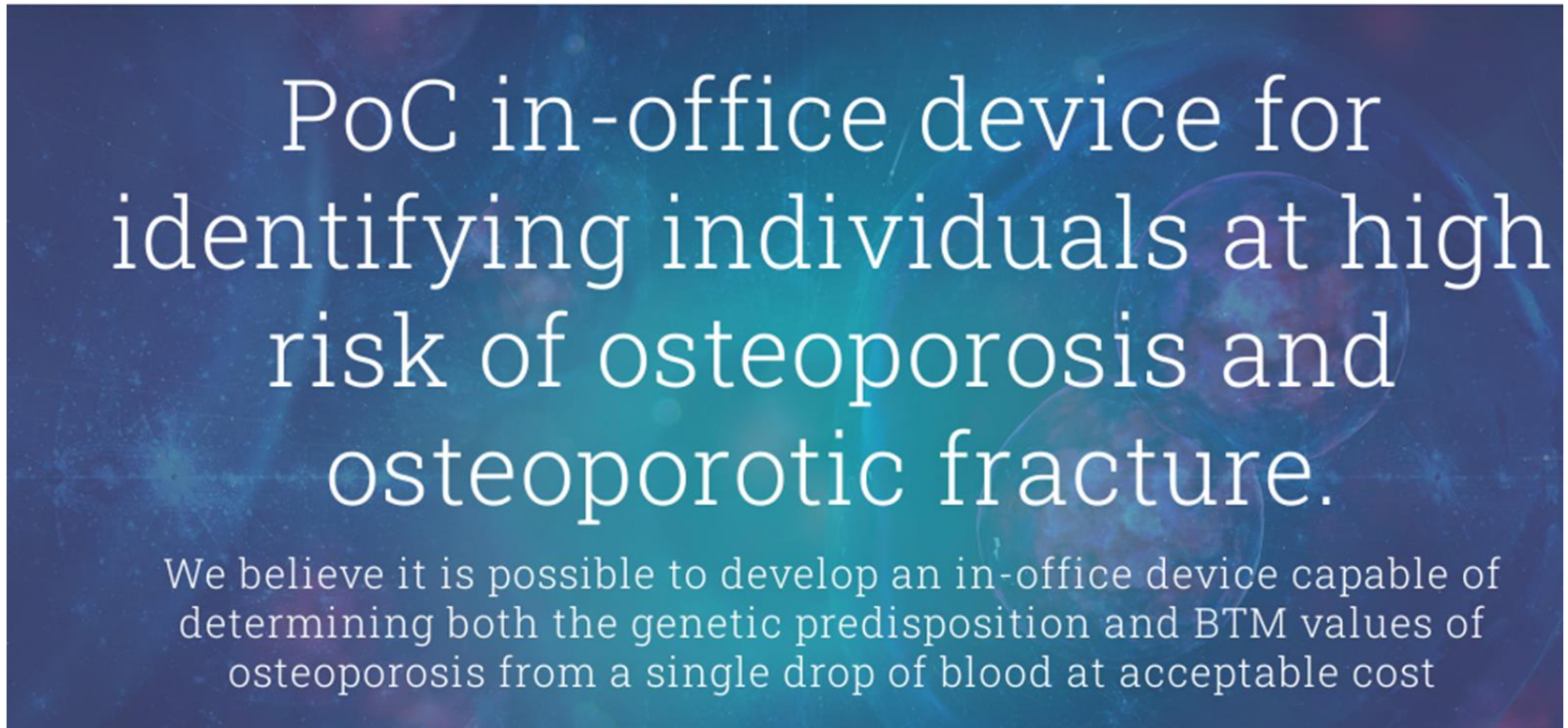


Despite mostly small effect sizes of individual variants, integrating GWAS findings with clinical and molecular data enables improved disease prediction and personalized treatment strategies.

Zhu, X., Bai, W. & Zheng, H. Twelve years of GWAS discoveries for osteoporosis and related traits: advances, challenges and applications. *Bone Res* **9**, 23 (2021).

Future Directions For Osteoporosis Management

Personalized Management :New Horizons Of Diagnosis And Treatment



EMRI

Medical University of Graz

UNIVERSITAT ROVIRA i VIRGILI

microLIQUID
experts in microfluidics

Fraunhofer IMM

EMFP

HEMISTRY UPRAMOLECULAR

Fundi€o

LABMAN

CMST

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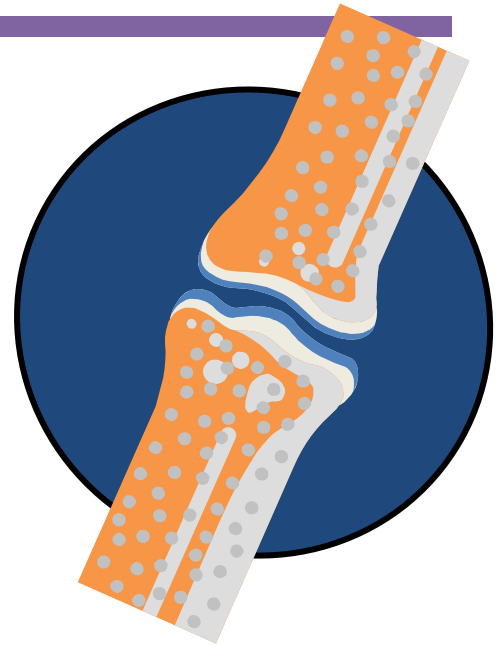
HORIZON 2020

IOF
International Osteoporosis Foundation

PoCOsteo

A PoC, in-office device for identifying individuals at high risk of osteoporosis and osteoporotic fracture



Global Effort for Treatment of Osteoporosis and Prevention of Fragility Fractures

Importance Of International Collaboration In Reducing Osteoporosis And Fragility Fractures

International collaboration is crucial in addressing the global challenge of osteoporosis and fragility fractures. These collaborations aim to enhance awareness, prevention, and treatment strategies on a global scale.

The International Osteoporosis Foundation (IOF), as the largest non-governmental organization focused on osteoporosis, plays a pivotal role in uniting stakeholders to share knowledge, research, and best practices.

IOF
International Osteoporosis Foundation

Key IOF Goals And Priorities

HEALTHCARE PROFESSIONALS

Educate, train & promote best practice

GENERAL PUBLIC

Inform & promote good bone health

PATIENTS

Empower, educate & mobilize

POLICY MAKERS

Alert to burden, engage & drive action

PATIENT SOCIETIES

Support, miximize outreach & effectiveness

RESEARCHERS

Support innovative research & promote young investigators

RELATED ORGANIZATIONS

Build alliances & identify common strategies

CORPORATE PARTNERS

Encourage support for effective programmes & projects

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Mexico

Middle East

NIZAR ABDULATEEF
Iraq

BAGHER LARIJANI
Iran

BASEL MASRI
Jordan

YOUSSEF SALEH
Saudi Arabia

North America

BESS DAWSON-HUGHES
United States of America

MICHAEL MCCLUNG
United States of America

DANIEL PINTO
United States of America

STUART SILVERMAN
United States of America

Capture The Fracture (CTF)

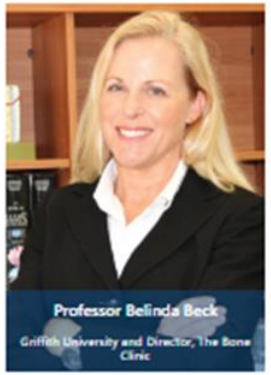
- Capture the Fracture (CTF) is a global initiative launched by the IOF in 2012, aimed at improving secondary fracture prevention for individuals who have already experienced a fragility fracture. This initiative seeks to address the significant care gap that often leaves these patients at risk for future fractures.

CTF Governance

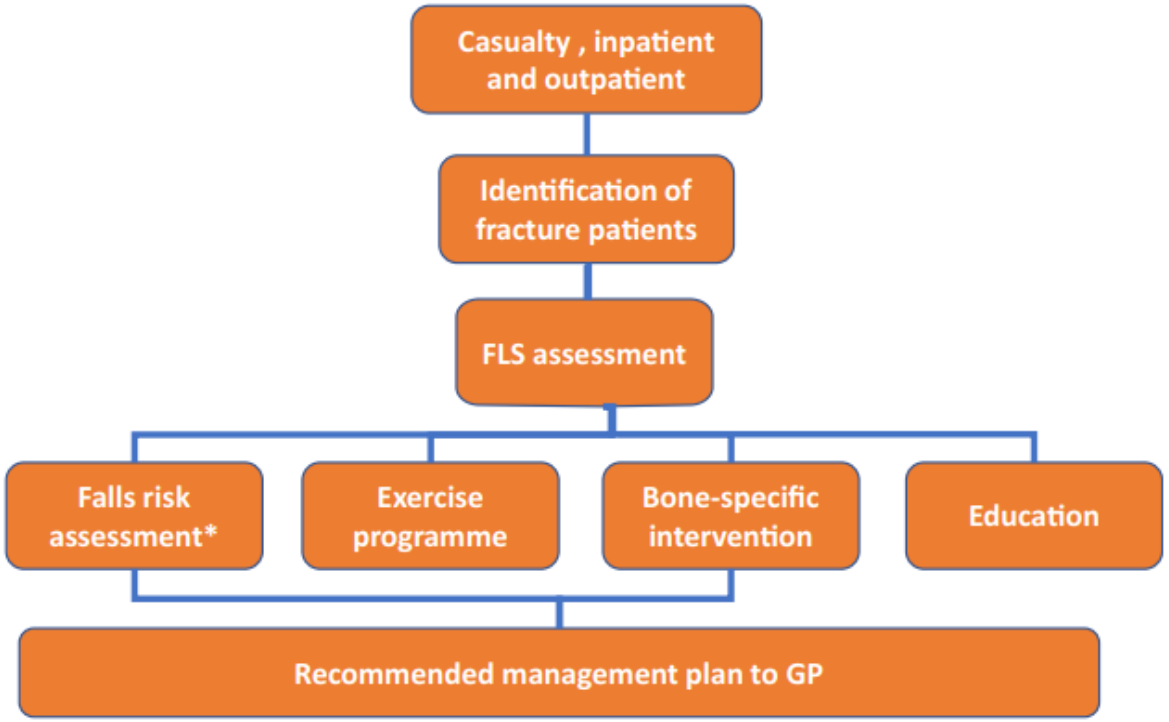
Chair

Vice-Chairs

FLS Expert Members



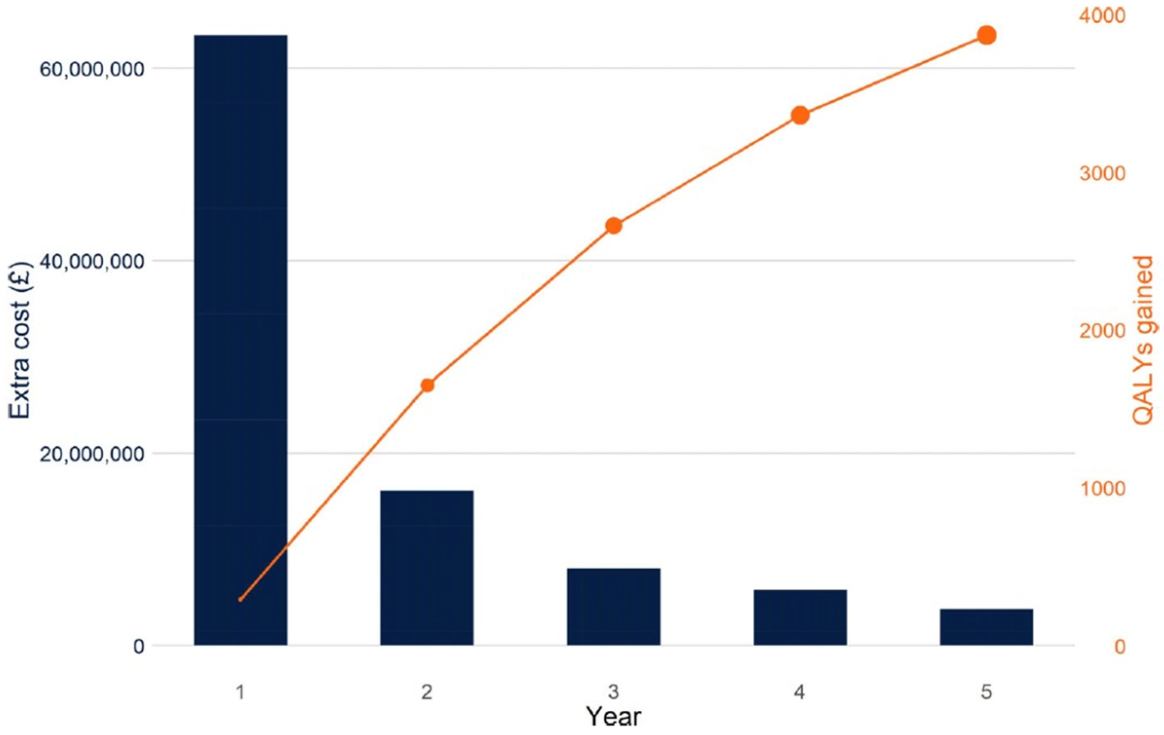
What Is Fracture Liaison Services



- Fracture Liaison Services (FLS) are specialized healthcare programs designed to provide secondary prevention for fragility fractures, particularly in older adults. These services aim to identify patients who have suffered a fragility fracture and assess their risk for future fractures, ensuring timely intervention and management.
- By providing comprehensive assessments, multidisciplinary care coordination, and targeted interventions, FLS effectively addresses the gaps in care for individuals who have sustained fragility fractures.

Expected Benefits And Budget Impact From A Microsimulation Model Support The Prioritization And Implementation Of Fracture Liaison Services

- This study showed that implementing FLS was projected to significantly reduce the incidence of subsequent fractures, leading to improved quality of life for patients.
- The analysis indicated that FLS could result in substantial cost savings for healthcare systems by preventing fractures and associated complications.
- The findings support the argument that investing in FLS is economically viable and beneficial for managing osteoporosis, ultimately leading to better patient outcomes and reduced healthcare costs.



Pinedo-Villanueva, Rafael et al. "Expected Benefits and Budget Impact From a Microsimulation Model Support the Prioritization and Implementation of Fracture Liaison Services." Journal of bone and mineral research : the official journal of the American Society for Bone and Mineral Research vol. 38,4 (2023): 499-511.

Fracture Liaison Services In Iran

- Set up 5 centers in the country (1 Gold, 3 silvers and 1 Bronze Medal).

Archives of Osteoporosis (2025) 20:72
https://doi.org/10.1007/s11657-025-01555-y

Cost-effectiveness analysis of fracture liaison services in Iran

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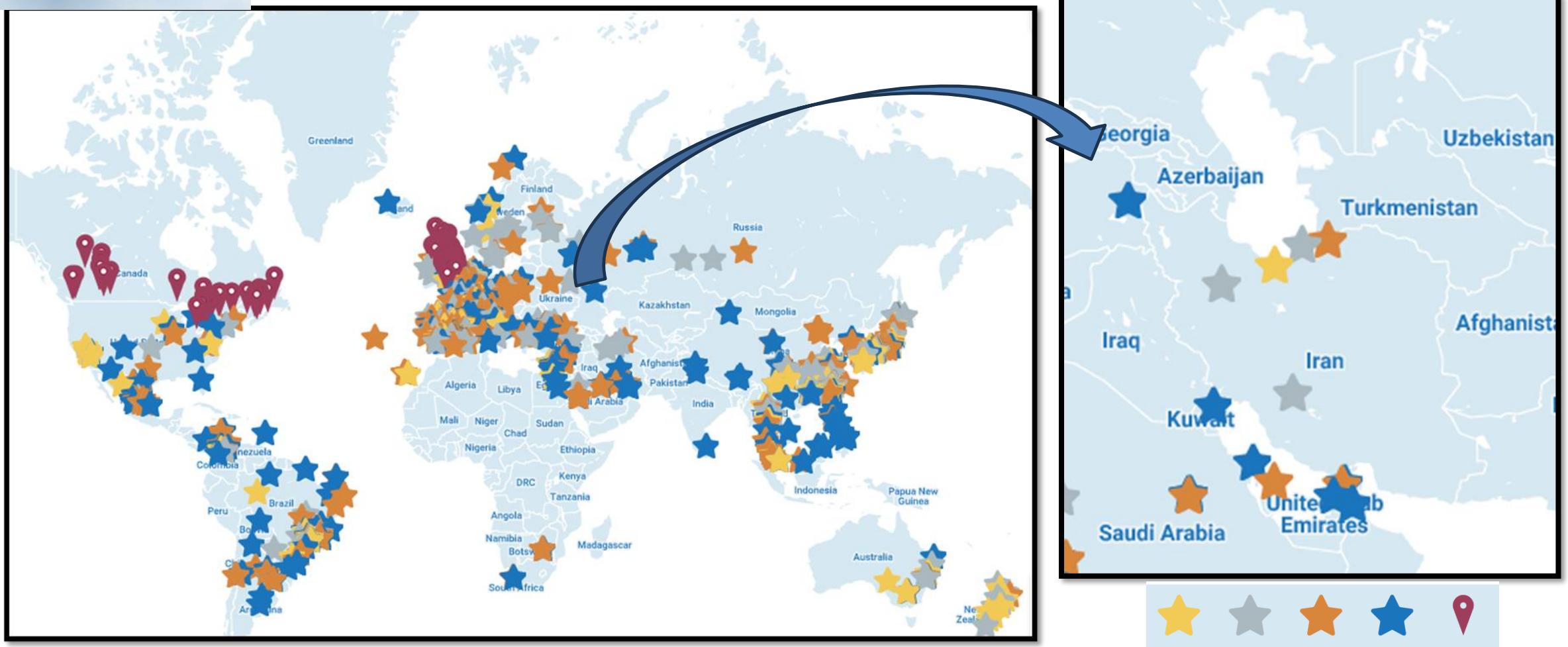
- The FLS was associated with an additional cost of $50 and a gain of 0.03 QALYs, resulting in an incremental cost-effectiveness ratio of $1663 per QALY, demonstrating its cost-effectiveness.
- The findings of this study demonstrate that **FLS is cost-effective compared to current practice in Iran.**

Fracture Liaison Services: Map Of Best Practice



استئوپاد

شبکه کلینیک‌های ارائه خدمات پیشگیری از شکستگی ثانویه ایران

ما در نظام یکپارچه پیشگیری از شکستگی ثانویه استئوپاد در تلاشیم تا در زمان شکستگی دسترسی آسان به مراقبت های پوکی استخوان را در اختیار بیماران قرار دهیم.

همکاران ما:

در کلینیک‌های استئوپاد چه می‌کنیم؟

شناسایی بیماران

شناسایی بیماران با شکستگی مهره‌ای و غیرمهره‌ای با ضربه خفیف در افراد بالای ۵۰ سال

معاینه و درمان

بررسی سوابق خطر و سبک زندگی، ارزیابی خطر سقوط، مشاوره عمومی و آموزش، ارزیابی وضعیت پوکی استخوان، درمان پوکی استخوان و ...

پیگیری‌های دوره‌ای

پیگیری‌های دوره‌ای و منظم برای شروع درمان، پایبندی به درمان، اصلاح عوامل خطر زمینه‌ای و ...

بیمارستان شفا یحیائیان

شهر: تهران

سال شروع فعالیت: ۱۳۹۹

سطح ارائه خدمت: نقره‌ای

اطلاعات بیشتر

بیمارستان شهید چمران

شهر: شیراز

سال شروع فعالیت: ۱۴۰۱

سطح ارائه خدمت: فاقد ارزیابی

اطلاعات بیشتر

بیمارستان امام خمینی

شهر: ساری

سال شروع فعالیت: ۱۴۰۱

سطح ارائه خدمت: فاقد ارزیابی

اطلاعات بیشتر

بیمارستان ۵ آذر

شهر: گرگان

سال شروع فعالیت: ۱۳۹۹

سطح ارائه خدمت: برنز

اطلاعات بیشتر

بیمارستان بعثت

شهر: همدان

سال شروع فعالیت: ۱۴۰۲

سطح ارائه خدمت: فاقد ارزیابی

اطلاعات بیشتر

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STUDY PROTOCOL

Iran osteoporosis registry: protocol for nationwide study

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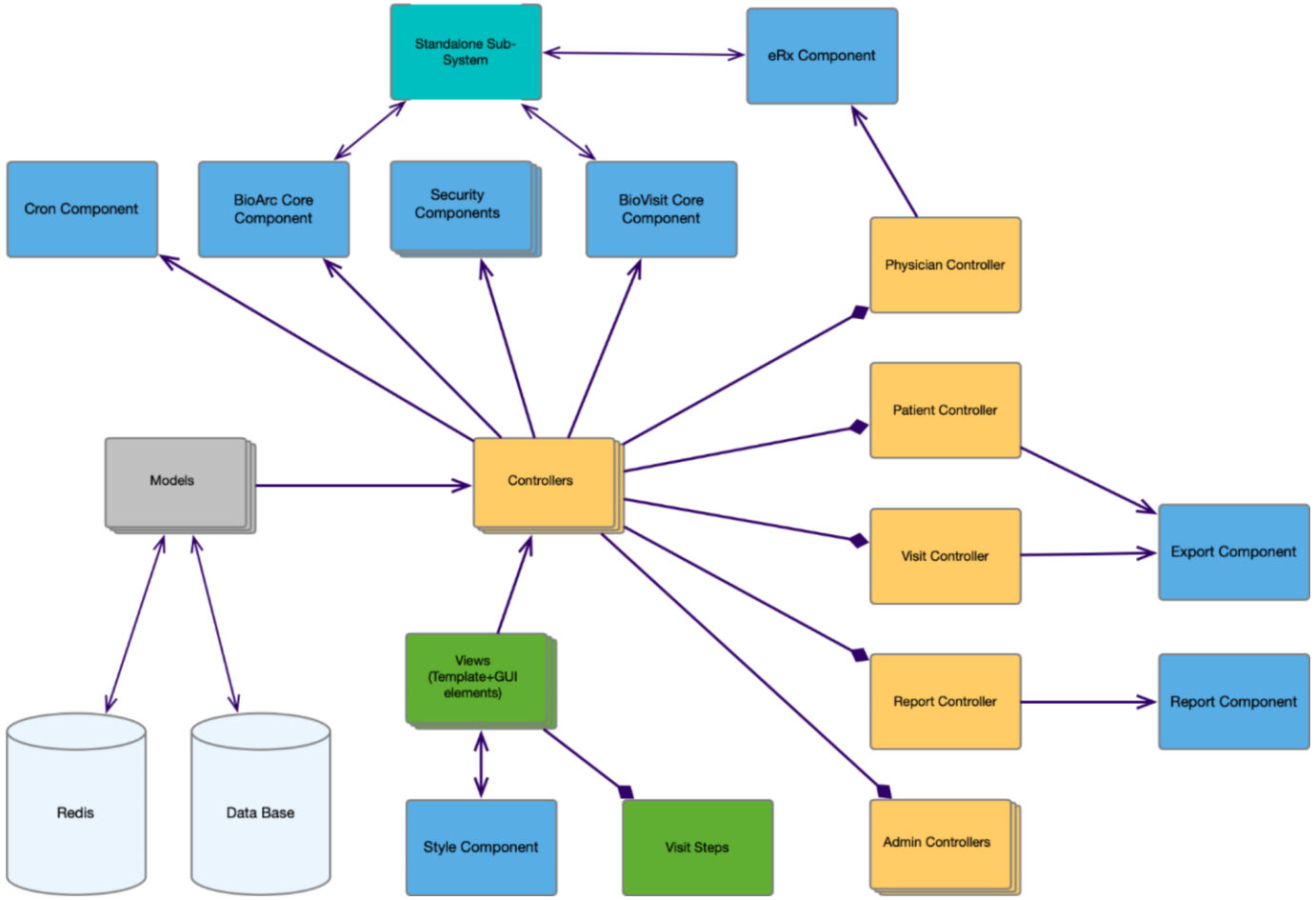

Architecture of Iran Osteoporosis Registry Software

Conclusions

- **Significant Global & National Burden:** Osteoporosis and osteopenia are highly prevalent worldwide and in Iran, posing a major public health challenge, especially for the aging population.
- **Multifactorial Risk & Comprehensive Diagnosis:** Fracture risk is influenced by a wide range of factors, from genetics and nutrition to vision and medication use. Diagnosis relies on DXA (the gold standard), FRAX® assessment, and clinical evaluation.
- **Effective Treatment Strategies:** Pharmacological therapies are effective in reducing fracture risk for both men and women, regardless of baseline BMD. Treatment decisions, including drug holidays, must be individualized based on fracture risk.
- **The Future is Precision Medicine:** Integrating multi-omics data (genomics, metabolomics, etc.) and advanced analytics paves the way for personalized risk prediction and tailored treatment strategies.
- **Global & Local Action is Key:** International collaboration, through initiatives like the IOF's Capture the Fracture, and the implementation of cost-effective Fracture Liaison Services (FLS) in Iran are vital for systematic secondary fracture prevention and improving patient outcomes.