UK National Screening Committee

Screening for osteoporosis

An evidence map to outline the volume and type of evidence related to screening for osteoporosis for the UK National Screening Committee

Version: 1

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The UK National Screening Committee secretariat is hosted by the Department of Health and Social Care

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About the UK National Screening Committee (UK NSC)

The UK NSC advises ministers and the NHS in the 4 UK countries about all aspects of population screening and supports implementation of screening programmes.

Conditions are reviewed against evidence review criteria according to the UK NSC's evidence review process.

Read a complete list of UK NSC recommendations.

UK National Screening Committee, Southside, 39 Victoria Street, London, SW1H 0EU

www.gov.uk/uknsc

Blog: https://nationalscreening.blog.gov.UK/

For queries relating to this document, please contact: https://view-health-screening-recommendations.service.gov.UK/helpdesk/

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Published Month 20XX

Summary

This document discusses the findings of the evidence map on screening for osteoporosis.

Evidence maps are a way of scanning published literature to look at the volume and type of evidence in relation to a specific topic. They inform whether the evidence is sufficient to commission a more sustained analysis on the topic under consideration.

In total,19 articles were included in the evidence map: three randomised controlled trials (RCTs) (SCOOP,[1] ROSE,[2] SALT (SOS)[3]); one nonconcurrent cohort study[4] and six systematic reviews.[5-10] There were five sibling papers related to the SCOOP RCT[11-15] and four related to the ROSE R CT.[16-19]

The three randomised trials and the cohort study provide evidence on the effectiveness of whole population screening in women over 65.[1-4] All of the included reviews were concerned, at least partially, with population screening in women over 65.[5-10] Findings were mixed across information sources.

None of the included trials or the cohort study provide evidence on the clinical benefit of targeted screening of women aged under 65 with risk factors for osteoporosis.

Two papers provide evidence of the cost effectiveness of screening (whole population or targeted) for osteoporosis[8, 11].

Based on the findings of this evidence map, the volume and type of evidence related to 2 of 3 research questions – targeted screening for osteoporosis among women under 65 with risk factors, and cost effectiveness of screening for osteoporosis (both population and targeted) – is currently insufficient to justify a full evidence summary at this stage. However the UK NSC Adult Reference Group recommended that a focused “review of reviews” (i.e., umbrella review) be commissioned to examine the main included studies, explore reasons for mixed conclusions across reviews, and offer direction on future research needed to inform a UK NSC decision.

Introduction and approach

Background and objectives

The UK National Screening Committee (UKNSC) external reviews (also known as evidence summaries or evidence reviews) are developed in keeping with the UKNSC evidence review process to ensure that each topic is addressed in the most appropriate and proportionate manner. Further information on the evidence review process can be accessed online.

Screening for osteoporosis is a topic currently due for an update external review.

Osteoporosis is a systemic skeletal disorder characterised by the deterioration of bone tissue leading to reduced bone density and increased susceptibility to fractures. Over three million people in the UK have the condition[20] with the greatest prevalence being among postmenopausal women. This is due to reduced oestrogen production resulting in accelerated loss of bone mineral density. Without intervention, bones will continue to lose mass which increases the risk of fragility fractures from minor external pressures. The disorder takes several years to develop and is usually painless until a fracture occurs.

Osteoporotic fractures are fragility fractures arising due to osteoporosis, most commonly occurring in the wrist, pelvis, spine, and hip, but also affecting other bones.[21] Fragility fractures are bone breaks that occur at relatively low loads, whether these are applied externally (e.g. from a fall or collision) or internally (e.g. as a result of movement). Fractures cause severe pain and disability to individuals, potentially leading to reduced mobility and loss of independence, with hip fractures the most common cause of death following a fall.[21] Pronounced excess mortality following hip fracture is well established, and particularly stark in the first 3 months and up to 1 year.[22-24] Osteoporotic fractures are estimated to cost the UK National Health Service over £4.7 billion annually.[21]

Suspected osteoporosis in people between 40 and 90 years of age is usually investigated using either the Fracture Risk Assessment Tool (FRAX) or Q-Fracture; two risk assessment tools which calculate the 10-year probability of fragility fracture occurring. A diagnosis can be given using a dual energy X-ray scan (DXA) which measures bone density and checks for standard deviation from the density as found in the bones of a healthy person of the same sex and age. National Institute for Health and Care Excellence (NICE) currently recommend a strategy of opportunistic risk assessment in women over the age of 65 or under the age of 65 with risk factors.[25]

Although there is no cure for osteoporosis there is medication coupled with supplements that could slow the progression, additionally, measures could be advised to minimise the risk of fractures by preventing falls and keeping the body active. The previous UKNSC review,[26] drew attention to clinical trials of screening which reported no significant difference in the reduction of osteoporotic fracture, all cause fracture or mortality compared to usual care. However, the report highlighted the paucity of evidence available to inform decision making.[27]

Systematic and comprehensive mapping of the available evidence is warranted, to gauge the volume and type of evidence which has been published on key issues and uncertainties relating to universal and targeted screening for osteoporosis. This will inform UK NSC discussion on whether a more substantial analysis of the evidence is justified at present. It will also provide a starting point for discussion on how the UK NSC should approach ongoing work to update the NICE (2012) guideline.

Previous review on screening for osteoporosis

The UK NSC currently recommends against screening for osteoporosis. The Committee based this recommendation on the evidence provided by the 2018-2019 review carried out by Solutions for Public Health.[26]

The 2019 UK NSC review searched for evidence on population screening for osteoporosis in postmenopausal women between January 2011 and September 2018. There were four key questions to the review:

1. What is the accuracy of screening tests for osteoporosis?

2. What is the effectiveness of interventions in reducing the risk of osteoporotic fracture?

3. Have RCTs demonstrated the clinical benefit of screening in reducing osteoporotic fractures in comparison to standard care?

4. Have UK evaluations demonstrated that screening for osteoporosis is cost-effective?

For key question 1, the review focused on screening strategies involving any combination of risk assessment plus DXA.

The review found new evidence (two RCTs, SCOOP and ROSE[1,2]) published since the previous review in 2013,[28] that compared screening to usual care. The review concluded that the results of those RCTs showed no significant reduction in osteoporotic fracture in postmenopausal women systematically screened using FRAX and DXA compared to usual care. Whilst the review reported that the included studies identified a number of different screening approaches, there was a lack of studies that met the inclusion criteria for some of the key questions. The report concluded that there was still insufficient evidence to propose a change in the recommendations for population screening for osteoporosis in postmenopausal women due to remaining areas of uncertainty and gaps in the evidence.[26]

Aims of the evidence map

Evidence maps are rapid evidence products which aim to gauge the volume and type of evidence relating to a specific topic.

This evidence map has been developed to assess whether a more sustained review on screening for osteoporosis should be commissioned in 2025 and to evaluate the volume and type of evidence on key issues related to screening for osteoporosis.

The evidence map aimed to address the following questions:

1. Question 1a – What is the volume and type of evidence exploring the clinical benefit of whole population screening in women over 65, in reducing osteoporotic fractures compared to standard care?
2. Question 1b – What is the volume and type of evidence exploring the clinical benefit of targeted screening of women aged under 65 with risk factors for osteoporosis, in reducing osteoporotic fractures compared to standard care?
3. Question 2 – What is the volume of evidence exploring the cost-effectiveness of screening (whole population and targeted) for osteoporosis?

The evidence map focused on the volume and type of evidence related to the clinical benefit of screening for osteoporosis within both whole population screening in women over 65 and as a targeted screening approach in women under 65 with risk factors for osteoporosis, in reducing osteoporotic fractures compared to standard care. The volume of evidence exploring the cost-effectiveness, of both screening approaches, for osteoporosis was also assessed.

The findings of this evidence map will provide the basis for discussion to support decision making on whether there is sufficient evidence to justify commissioning a more sustained review of the evidence on osteoporosis in 2025.

The aim of this document is to present the information necessary for the UK NSC to decide this.

Methods and results

Methods

Search methods

The search strategy was developed by two information specialists in Medline and translated to 10 other databases. The searches used a combination of relevant controlled vocabulary terms (e.g. Medical Subject Headings) and free text terms. No date limits or language restrictions were applied. Conference abstracts were excluded from Embase results. The searches were conducted on 12th November 2024 on 11 databases:

Medline (1946-current) and Embase (1974-current) via Ovid,
The Cochrane Database of Systematic Reviews (CDSR) (Cochrane),
Epistemonikos (https://www.epistemonikos.org/en/),
CEA Registry (https://cevr.tuftsmedicalcenter.org/databases/cea-registry),
CINAHL Ultimate (1937- current) via EBSCOhost,
Google Scholar (https://scholar.google.co.UK/),
International HTA Database (https://database.inahta.org/),
ProQuest Dissertations and Theses (PQDT) (1637 – current) via ProQuest,
Science Citation Index (SCI) (1900-current) and,
Social Sciences Citation Index (SSCI) (1900-current) via Clarivate's Web of Science.

Search results were downloaded into Endnote (Version 20, Clarivate Analytics, Philadelphia, PA, USA) and de-duplicated. Additional duplicates were identified using SR Accelerator (https://sr-accelerator.com/). Simple searches of the titles in Endnote were conducted to identify records referring to men and children. These were screened at title only and excluded on population only. Records were also excluded if they were conference proceedings, non-English language or clinical trial records.

Forward and backward citation searching of the references included at full text was conducted on Web of Science. Two references were not present on Web of Science. Forward citation searching of these two references was conducted using Google Scholar, while backward screening was conducted manually.

The search strategies are available in Appendix 1 along with the inclusion and exclusion criteria.

Study selection

Two reviewers independently applied the inclusion and exclusion criteria to the titles and abstracts of records identified by the search to identify records that were clearly irrelevant. The full text of each remaining record was then sought and screened by two independent reviewers to determine inclusion. Disagreements at each stage were resolved through discussion. The title and abstracts and subsequent full texts of the articles found through supplementary searches were single screened. The reference lists of any relevant guidelines identified in the searches were single screened for any potential inclusions. Any articles excluded at the full text screening stage were

coded to indicate the first reason for exclusion. The reasons for exclusion at full text can be found in Appendix 1.

Data extraction

Data extraction of key information was performed on studies included in the map. For each included record, one reviewer completed data extraction, and a second reviewer checked the extracted data for accuracy. This data included: author details, study type (design), objectives of the study, inclusion criteria of the study, outcomes reported by the study and study conclusions. Full texts were consulted for data extraction for all included records.

Patient and Public Involvement and Engagement

This Evidence Map has been produced in collaboration with PERSPEX, a group of 15 public collaborators who bring their carer, patient, or public perspective to the work of Isca Evidence. PERSPEX members meet monthly online, and membership is culturally, geographically and demographically diverse (https://www.exeter.ac.uk/research/groups/medicine/esmi/workstreams/perspex/).

PERSPEX members discussed the research question at their October and November 2024 online meetings. Discussions focussed on the population, which they would have preferred to expand, and the outcomes. They highlighted screening harms as an area of interest. These discussions informed the development of the protocol.

Results

Study selection

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) flow diagram shown in Figure 1 summarises the searching and study selection process. From the bibliographic database searches, 14,003 references were retrieved. After de-duplication, 6436 references were screened at title and abstract. At full-text, 90 articles were screened identifying 17 includes. A further 821 citations found through supplementary searching were screened at title and abstract, with 27 of these taken to full text screening, with one additional article being included. The screening of references of relevant guidelines identified one article for inclusion. In total,19 articles were included in the evidence map: three randomised controlled trials (RCTs) (SCOOP,[1]ROSE,[2] SALT (SOS)[3]); one nonconcurrent cohort study[4] and six systematic reviews.[5-10] There were five sibling papers related to the SCOOP RCT[11-15] and four related to the ROSE R CT.[16-19]

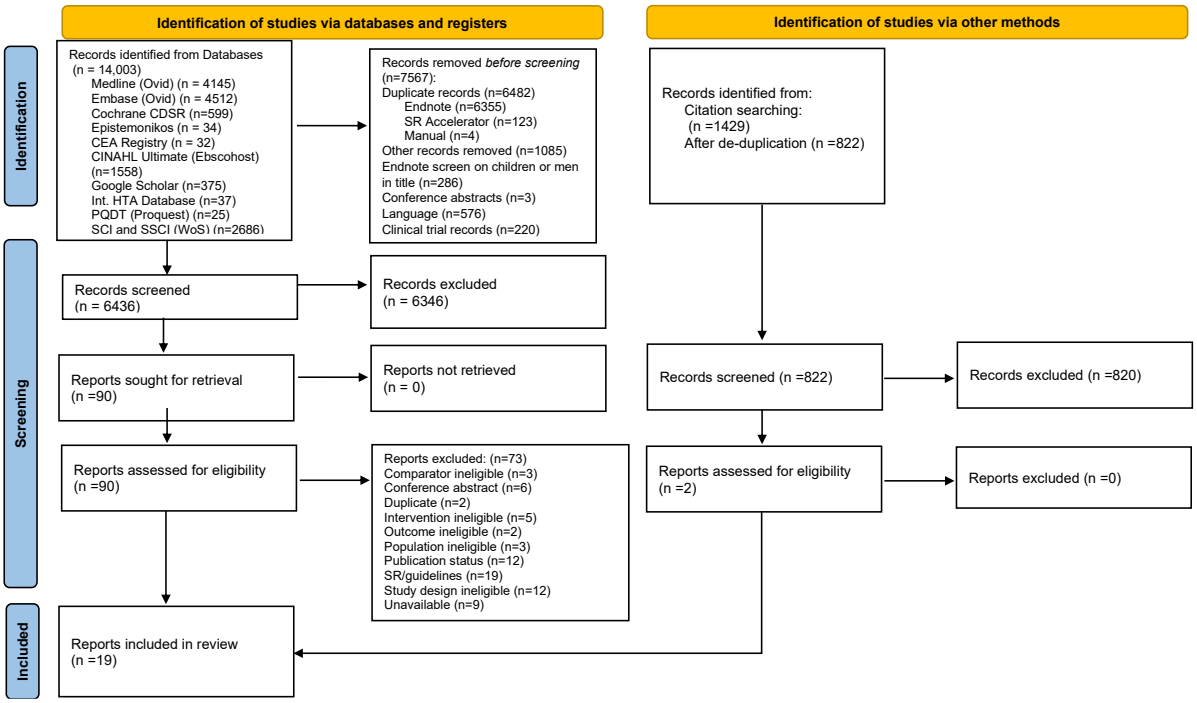

Figure 1. PRISMA flowchart summarising the results of the literature search and study selection process.

Summary of findings

Question 1a: What is the volume and type of evidence exploring the clinical benefit of whole population screening in women over 65, in reducing osteoporotic fractures compared to standard care?

Question 1a dealt with the volume and type of evidence for the benefit of whole population screening in women over 65. All four identified trials were relevant to question 1a, with the SCOOP[1] and ROSE[2] RCTs and the nonconcurrent cohort study by Kern[4] exclusively targeting women over 65. The SALT (SOS)[3] RCT targeted women over 65 but with one or more clinical risk factors for osteoporosis. All the included reviews were focussed, at least partially, with population screening in women over 65. Findings were mixed across information sources.

The SCOOP trial,[1] conducted in the UK, assessed the effectiveness of a Fracture Risk Assessment Tool (FRAX) based, community screening programme in reducing fracture incidence for UK women aged 70–85 years. After 5 years, the proportion of participants who had an osteoporosis-related fracture was not significantly different between the screening group and the control group (that did not undergo screening) (12.9% vs 13.6%) with an adjusted hazard ratio (HR) of 0.94; 95% confidence interval [CI]: 0.85 to1.03, p=0.178. However, screening did lead to a 28% decrease in risk of hip fracture compared with no screening (2.6% vs 3.5%; HR: 0.72; 95% CI: 0.59 to 0.89, p=0.002). In summary, whilst there was no overall reduction in fractures, these findings showed that community screening (using FRAX hip fracture probability) may lead to a significant reduction in hip fractures in older women.

The ROSE trial,[2] conducted in Denmark, investigated the effectiveness of a two-step population-based osteoporosis screening programme for women 65-80 years, using FRAX and then DXA, on fracture prevention. The intention to treat analysis found no overall significant benefit to 65–80-year-old women in overall fracture incidence or risk of osteoporotic fractures, compared to current standard of care. In their per-protocol analysis, a significant risk reduction was observed in major osteoporotic fracture, hip fracture, and all fractures for those in the DXA screening group, suggesting that women at moderate and high risk of osteoporotic fractures could stand to benefit from a screening programme. In conclusion, whilst this did not show an effect of screening on fracture risk for the primary outcome of any osteoporosis-related fracture, screening did lead to a statistically, and likely clinically, significant decrease in hip fractures. The ten-year follow-up of this trial reported no overall effect of the ROSE program on the incidence of major osteoporotic fractures, hip, all fractures, or mortality using an intention-to-treat analysis.[19]

The SALT (SOS) trial,[3] conducted in the Netherlands, examined whether screening women aged 65-90 years for fracture risk combined with subsequent treatment within primary care could reduce fracture incidence in comparison to usual care. This screening programme did not show a statistically significant reduction in fractures of any type (HR: 0.97; 95% CI 0.87–1.08), or secondary outcomes (osteoporotic fractures, hip fractures, falls, or mortality) in older women in primary care.

The study by Kern and colleagues[4] from the United States, was a non-concurrent study that examined whether a screening programme for osteoporosis using DXA at the hip was associated with reduced hip fracture incidence compared with usual care. The screening intervention was associated with a significantly lower risk of hip fracture than usual care before adjusting for

propensity to be screened (Cox proportional HR: 0.55; 95% CI: 0.32 to 0.92) but risks were similar between groups when adjusting for propensity to be screened (HR: 0.61; 95% CI: 0.35 to1.06).

The six reviews,[5-10] drew largely on these four studies and found mixed findings with regards to effectiveness of screening for older women. A 2006 evidence report by Johnell & Hertzman[10] concluded there is no direct scientific evidence to support mass screening for osteoporosis using bone density measurement, and that the effectiveness of interventions in asymptomatic populations is unclear. A 2018 systematic review by Viswanathan and colleagues,[7] including only one of the above RCTs, concluded that compared with no screening, screening led to fewer hip fractures (2.6%vs 3.5%), but no other statistically significant benefits or harms. The main finding of the 2019 EUnetHTA rapid effectiveness assessment[9] was that there is no (or only a small) benefit to osteoporosis screening in postmenopausal women regarding the impact on symptomatic fractures. The 2020 meta-analysis by Merljin[5] demonstrated a statistically significant and clinically relevant reduction of osteoporotic fractures (HR: 0.95; 95% CI: 0.89 to1.00), major osteoporotic fractures (HR: 0.91; 95%CI: 0.84 to 0.98), and hip fractures (HR:0.80; 95%CI: 0.71 to 0.91), but no statistically significant reduction of all fractures in screening compared to no screening. A 2023 scoping review by Auais and colleagues[8] indicated that clinical fracture-risk assessment screening tools were not more effective for preventing all osteoporosis-related fractures than usual care. And lastly, a 2023 systematic review by Gates et al[6] concluded that screening in primary care with clinical FRAX, followed by BMD assessment for increased risk, among selected females aged 65 years and older probably leads to a small reduction in the risk of clinical fragility fracture and hip fracture compared to no screening.

Since the previous review the SALT (SOS) trial[3] has been published, as have four of the systematic reviews mentioned above.[5,6,8-9] One other systematic review is mentioned in our findings that was not identified in the previous review.[10] Several sibling papers related to the SCOOP[1] and ROSE[2] trials have also been published,[12-15, 17-19] and details of these can be found in Appendix 2. The findings of the SALT (SOS) trial[3] reflect those of the SCOOP[1] and ROSE[2] trials and the systematic reviews published since the last review also draw on evidence from those three trials and the SALT (SOS) trial[3] described above.

Question 1b: What is the volume and type of evidence exploring the clinical benefit of targeted screening of women aged under 65 with risk factors for osteoporosis, in reducing osteoporotic fractures compared to standard care?

Question 1b focussed on the volume and type of evidence for the benefit of targeted screening in women under 65 with risk factors for osteoporosis. None of the included trials were directly relevant to this question. Two reviews considered women of age 40 and above.[6, 7] Given that the reviews drew on the trials we have identified, we can conclude there is minimal evidence to address Question 1b.

The 2023 systematic review by Gates et al[6] brought together the evidence relating to the accuracy of risk prediction tools used in primary care for the primary prevention of fragility fractures among adults aged 40 years and older. As part of this review, the authors assessed i) the benefits and harms of screening compared with no screening to prevent fragility fractures and related morbidity and mortality in primary care for adults ≥40 years, and ii) the effectiveness of screening to prevent fragility fractures by screening programme type (i.e., 1-step vs 2-step) or risk assessment tool. Evidence to answer these questions was drawn from four randomised controlled trials and one controlled clinical trial. The review located very limited evidence for males and younger females, and there were no screening trial data specific to females aged 55 to 65 years.

The earlier 2018 systematic review by Viswanathan et al[7] is an update of the evidence on screening to prevent osteoporotic fractures in women 40 years and older for the US Preventative Services Taskforce. This was a broad review evaluating the evidence for screening, diagnosis, and treatment. Whilst their findings in relation to the effectiveness of screening suggested that for women, screening to prevent osteoporotic fractures may lead to a reduction in hip fractures, this evidence was taken from one randomised trial and was not specifically for women under 65 years of age.

This question was not addressed in the previous review. There is minimal evidence available to address this question.

Question 2: What is the volume of evidence exploring the cost-effectiveness of screening (whole population and targeted) for osteoporosis?

Two references are relevant to question 2, which focussed on the cost-effectiveness of screening for osteoporosis, whether targeted or in the general population. One is a cost-effectiveness analysis of the SCOOP trial,[11] the other is a structured scoping review interested in assessment tools.[8]

The evaluation[11] of the SCOOP[1] trial included resource-use and outcome data collected during the trial to estimate the cost-effectiveness of the screening intervention over the 5-year period. Cost-effectiveness acceptability curves showed that the intervention had a 93% probability of being cost-effective, based on the NICE threshold of £20,000 per QALY. As a result of a reduction in fractures in the intervention group, the cost per fracture prevented was £4478 for all osteoporotic fractures and £7694 for hip fractures. The sibling paper[15] to this study found that over a mean of 14 years, screening 1,000 patients saved 9 hip fractures, and 20 non-hip fractures compared to usual management. Due to a fracture risk reduction, it was found that screening was expected to gain 0.015 QALYs per patient and cost savings of £286 per patient in comparison to usual care. The authors concluded that there was strong evidence to suggest that community screening with the FRAX tool to estimate the probability of hip fracture in older women, is likely to be a cost-effective and efficient use of health care resources.

The primary objective of the scoping review[8] was to review the evidence on the effectiveness of clinical fracture-risk assessment tools in reducing osteoporotic fractures and/or influencing other health outcomes. A secondary objective was to summarise the evidence relating to the cost-effectiveness of these clinical tools used in investigations in fracture prevention. Eight simulation studies estimated the cost-effectiveness of using these tools to screen for fractures, with the majority showing significant potential savings. Almost all studies found that different osteoporotic screening strategies using a clinical fracture risk assessment tool were cost-effective in comparison to the no-screening alternative.

Two references relevant to this question were identified in this evidence map. The evaluation of the SCOOP[1] trial by Turner at al[11] was included in the previous review.

Conclusions

Since the UK NSC's last review of the condition in 2019, the current evidence map has identified:

1. one new trial and five systematic reviews on the benefit of population screening among women over 65 years of age. Additionally, some previously known trials have published updated findings with extended follow-up periods. The five reviews reached mixed conclusions, despite including some of the same studies

2. no study specifically explored the benefit of targeted screening among women under 65 years of age with defined risk factors. However one study, the SALT study, explored screening in women over 65 years of age with at least one risk factor, and may be considered a study of targeted screening.

3. only one new study (scoping review) on the cost effectiveness of screening for osteoporosis (both population and targeted screening)

Recommendations

On the basis of this evidence map, the volume and type of evidence related to '2. targeted screening for osteoporosis among women under 65 with risk factors', and '3. cost effectiveness of screening for osteoporosis (both population and targeted screening)' is currently insufficient to justify full evidence summary at this stage. However, the UK NSC Adult Reference Group recommended that a focused "review of reviews" (i.e., umbrella review) be commissioned. This review should examine the main included studies, explore reasons for mixed conclusions across reviews, and offer direction on future research needed to inform a UK NSC decision.

Appendix 1 — Search strategy for the evidence map

Databases and platforms searched

We searched Medline (1946-current) and Embase (1974- current) via Ovid, The Cochrane Database of Systematic Reviews (CDSR) (2003 – current) via Wiley Cochrane Library, Epistemonikos (https://www.epistemonikos.org/en/), CEA Registry (https://cevr.tuftsmedicalcenter.org/databases/cea-registry), CINAHL Ultimate via EBSCOhost, Google Scholar (https://scholar.google.co.UK/) via Publish or Perish (https://harzing.com/resources/publish-or-perish/), International HTA Database (https://database.inahta.org/), ProQuest Dissertations and Theses (PQDT) (1637-current) via ProQuest, Science Citation Index (SCI) and Social Sciences Citation Index (SSCI)(Clarivate's Web of Science).

Search dates

12 November 2024

Search strategies

Medline

Ovid MEDLINE(R) ALL <1946 to November 11, 2024>

1	exp *osteoporosis/ or exp osteoporosis, postmenopausal/	52016
2	*Bone Density/	29315
3	*fractures, bone/ or osteoporotic fractures/	65440
4	(osteoporo* or osteopenia).tw.	101473
5	((densit* or loss or mass or strength*) adj2 bone*).tw.	112883
6	fractur*.ti.	177992
7	1 or 2 or 3 or 4 or 5 or 6	350266
8	*Mass Screening/	58590
9	(screen or screening or screened or prescreen*).ti.	227571
10	8 or 9	245035
11	7 and 10	1807
12	(screen or screening or screened or prescreen*).tw.	1044376
13	(fractur* or bone* or osteop*).tw.	1147350
14	((screen or screening or screened or prescreen*) adj2 (fractur* or bone* or osteop*)).tw.	2301
17		

15 11 or 14 3268

16 ((dexa or dxa) adj2 scan*).tw. 3262

17 dual energy x ray absorptiomet*.tw. 25525

18 (fracture* adj2 risk* adj2 assessment*).tw. 1762

19 FRAX.tw. 1875

20 16 or 17 or 18 or 19 29006

21 osteop*.tw. 140517

22 ((((dexa or dxa) adj2 scan*) or dual energy x ray absorptiomet* or (fracture* adj2 risk* adj2 assessment*) or FRAX) adj2 osteop*).tw. 426

23 15 or 22 3633

24 *Absorptiometry, Photon/ 4764

25 osteopor*.ti. 39965

26 24 and 25 539

27 23 or 26 4040

28 (scan* and osteop*).ti. 155

29 27 or 28 4145

Embase

Embase <1974 to 2024 November 11>

1 exp postmenopause osteoporosis/ 16311

2 *osteoporosis/ 62957

3 *bone density/ 32275

4 *fragility fracture/ 10209

5 *fracture/ 35822

6 (osteoporo* or osteopenia).tw. 155059

7 ((densit* or loss or mass or strength*) adj2 bone*).tw. 156306

8 fractur*.ti. 190294

9 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 421996

10 *mass screening/ 24071

11 (screen or screening or screened or prescreen*).ti. 300647

12 10 or 11 308635

13 9 and 12 2576

14 (screen or screening or screened or prescreen*).tw. 1461885

15 (fractur* or bone* or osteop*).tw. 1487075

16 ((screen or screening or screened or prescreen*) adj2 (fractur* or bone* or osteop*)).tw. 3819

17 13 or 16 5091

18 ((dexa or dxa) adj2 scan*).tw. 8379

19 dual energy x ray absorptiomet*.tw. 33900

20 (fracture* adj2 risk* adj2 assessment*).tw. 3101

21 FRAX.tw. 4807

22 18 or 19 or 20 or 21 43971

23 osteop*.tw. 206121

24 ((((dexa or dxa) adj2 scan*) or dual energy x ray absorptiomet* or (fracture* adj2 risk* adj2 assessment*) or FRAX) adj2 osteop*).tw. 948

25 17 or 24 5907

26 photon absorptiometry/ 4841

27 osteopor*.ti. 57821

28 26 and 27 703

29 25 or 28 6512

30 (scan* and osteop*).ti. 254

31 29 or 30 6692

32 limit 31 to conference abstract status 2180

33 31 not 32 4512

Web of Science: SCI and SSCI only

Search Query Results

1 TI=((osteoporo* or osteopenia)) Editions: WOS.SCI,WOS.SSCI 51788

2 TI=((screen or screening or screened or prescreen*)) Editions: WOS.SCI,WOS.SSCI 316347

3 #1 AND #2 Editions: WOS.SCI,WOS.SSCI 1310

4 AB=(osteop* NEAR/2 screen) Editions: WOS.SCI,WOS.SSCI 1154

5 AB=(osteop* NEAR/2 screened) Editions: WOS.SCI,WOS.SSCI 1154

6 AB=(osteop* NEAR/2 screening) Editions: WOS.SCI,WOS.SSCI 1160
7 AB=(osteop* NEAR/2 prescreen*) Editions: WOS.SCI,WOS.SSCI 12
8 #4 OR #5 OR #6 OR #7 Editions: WOS.SCI,WOS.SSCI 1167
9 #8 OR #3 Editions: WOS.SCI,WOS.SSCI 2168
10 TI=(densit* NEAR/2 bone*) Editions: WOS.SCI,WOS.SSCI 29213
11 TI=(loss NEAR/2 bone*) Editions: WOS.SCI,WOS.SSCI 11975
12 TI=(mass NEAR/2 bone*) Editions: WOS.SCI,WOS.SSCI 7672
13 TI=(strength* NEAR/2 bone*) Editions: WOS.SCI,WOS.SSCI 2978
14 #10 OR #11 OR #12 OR #13 Editions: WOS.SCI,WOS.SSCI 49649
15 #14 AND #2 Editions: WOS.SCI,WOS.SSCI 341
16 #15 OR #9 Editions: WOS.SCI,WOS.SSCI 2366
17 TI=(fractur*) Editions: WOS.SCI,WOS.SSCI 230398
18 #17 AND #2 Editions: WOS.SCI,WOS.SSCI 520
19 #18 OR #16 Editions: WOS.SCI,WOS.SSCI 2686

Epistemonikos

(title:(osteoporosis) OR abstract:(osteoporosis)) AND title:(screen*) Filter SRs n=37

OR (title:(screen* AND osteoporos*) OR abstract:(screen* AND osteoporos*)) SRs only n=397

International HTA Database

ALL: (osteop*) AND (screen*)

Cochrane Database of Systematic Reviews

ID Search Hits

#1 MeSH descriptor: [Mass Screening] explode all trees 6090

#2 screening:ti,ab 77563

#3 #1 OR #2 78951

#4 (Osteopor* OR "bone density" OR fracture* OR FRAX OR DEXA OR DXA):ti 20204

#5 MeSH descriptor: [Osteoporosis] explode all trees 5539

#6 MeSH descriptor: [Bone Density] explode all trees 6085

#7 MeSH descriptor: [Fractures, Bone] explode all trees 9703

#8 #4 OR #5 OR #6 OR #7 27293

#9 #3 AND #8 599 (N=7 reviews, n=592 “trials”)

Cinahl Ultimate

20

#	Query	Results
S1	(MH "Osteoporosis")	24,783
S2	(MH "Fractures+")	70,881
S3	(MH "Bone Density")	20,790
S4	osteoporos* or "bone density" or "bone loss" or osteopen* or fracture*	143,339
S5	S1 OR S2 OR S3 OR S4	143,705
S6	FRAX OR DEXA OR DXA	5,526
S7	(MM "Absorptiometry, Photon")	1,576
S8	S5 OR S6 OR S7	146,218
S9	(MH "Health Screening")	58,302
S10	TI screen*	81,702
S11	S9 OR S10	113,442
S12	S8 AND S11	1558

Proquest Dissertations and Theses Global

S1 title(osteoporo* OR osteopenia) AND title(screen*) 20

S2 abstract(osteop* NEAR/2 screen) OR abstract(osteop* NEAR/2 screened) OR abstract(osteop* NEAR/2 screening) OR abstract(osteop* NEAR/2 prescreen*) 2

S3 title(densit* NEAR/2 bone*) OR title(loss NEAR/2 bone*) OR title(mass NEAR/2 bone*) OR title(strength* NEAR/2 bone*) 1081

S4 title(screen or screening or screened or prescreen*) 12702

S5 [S3] AND [S4] 6

S6 [S1] OR [S2] OR [S5] 25

Google Scholar via Publish or Perish.

Keyword search:

Osteoporosis and screening

Osteoporosis and predict and scan

Numbers of results for each database and question if applicable

Database	Hits
Medline	4145
Embase	4512
Cochrane CDSR	599
Epistemonikos	34
CEA Registry	32
CINAHL (via EBSCOhost)	1558
Google Scholar	375
International HTA Database	37
PQDT	25
SCI and SSCI	2686

Inclusions and exclusions

The inclusion and exclusion criteria (according to PICO framework) applied to the studies identified through the search strategy are detailed below:

Population:

Include:

- 1) Women over the age of 65, or 2) below the age of 65 with risk factors for osteoporosis.

  Risk factors are as follows:[29]

  - previous fragility fracture
  - current use or frequent use of oral or systemic glucocorticoids
  - history of falls
  - family history of hip fracture
  - other causes of secondary osteoporosis. Causes of secondary osteoporosis include endocrine (hypogonadism in either sex including untreated premature menopause and treatment with aromatase inhibitors or androgen deprivation therapy; hyperthyroidism; hyperparathyroidism; hyperprolactinaemia; Cushing's disease; diabetes), gastrointestinal (coeliac disease; inflammatory bowel disease; chronic liver disease; chronic pancreatitis; other causes of malabsorption), rheumatological (rheumatoid arthritis; other inflammatory arthropathies), haematological (multiple myeloma; haemoglobinopathies; systemic mastocytosis), respiratory (cystic fibrosis; chronic obstructive pulmonary disease), metabolic (homocystinuria), chronic renal disease and immobility (due for example to neurological injury or disease
  - low body mass index (BMI) (less than 18.5 kg/m2)

- smoking
- alcohol intake of more than 14 units per week
- menopause

Exclude:

- male or mixed-gender samples (unless female sample data can be separated)
- samples of women under 65 where risk factors are not explicit
- samples where either risk factors or a mean age of 65 at study entry is not explicit

Intervention:

Include:

Any population or targeted screening intervention that involves any combination of risk assessment and dual energy x-ray scan (DXA) designed to identify women that have, or are at risk of, developing osteoporosis.

We used the NSC definitions of targeted and population screening:

Population screening: A large scale proactive (individuals are actively invited for screening) screening programme which aims to improve health outcomes in people with the condition being screened for and/or offer information to enable informed choices. It is offered to a group of people identified from the whole population and defined demographically such as by age or sex.

Targeted screening: A large scale, proactive screening programme which aims to improve health outcomes in people with the condition being screened for, among groups of people identified as being at elevated/above average risk of a specific condition. Compared to the general population, the people targeted may have higher risk because of lifestyle factors, genetic variants or having another health condition.

Targeted screening differs from population screening as it aims to identify groups of people with a higher risk of a specific condition beyond demographics such as age or sex. For example, individuals who smoke are at a higher risk of developing lung cancer regardless of their age or sex.

Comparator:

Include:

Standard care

Outcome:

For inclusion, studies must have reported at least one of the following:
In relation to prevention of osteoporosis:

- Osteoporotic fracture:
  - Vertebral
  - Non vertebral
  - Hip
- All cause fracture
- Mortality

Outcomes relating to the possible harms of screening / treatment, for example:

- Overdiagnosis/overtreatment
- False positive results
- Anxiety
- Thromboembolic event
- Osteonecrosis of the jaw
- Gastrointestinal problems

Study design:

For research questions 1a and 1b, the following types of study were captured:

- Systematic reviews
- Randomised controlled trials
- Non-randomised controlled trials
- Quasi-randomised controlled trials

For research question 2, any cost-effectiveness analysis studies or reviews were included.

Date limit:

No limit.

Geographical context:

No restriction.

Reasons for exclusions

At full-text, 92 articles were screened resulting in 19 included. The most common reasons for exclusion at the full text stage were study design (n=12 studies) and publication type (systematic review or guidelines (n=19)). Reasons for exclusion for each article screened at full text are listed below:

References excluded at full text screening, by reason for exclusion.

Reason: **Comparator (n=3)**

Buist, D S, 2004 A population-based osteoporosis screening program: who does not participate, and what are the consequences? https://dx.doi.org/10.1111/j.1532-5415.2004.52311.x

Yu, SF 2017 Beyond bone mineral density, FRAX-based tailor-made intervention thresholds for therapeutic decision in subjects on glucocorticoid: A nationwide osteoporosis survey https://dx.doi.org/10.1097/MD.0000000000005959

Zoulakis, M 2024 Real-world effectiveness of osteoporosis screening in older Swedish women (SUPERB) https://dx.doi.org/10.1016/j.bone.2024.117204

Reason: **Conference abstract (n=6)**

McCloskey, E, 2018 Women at high risk of hip fracture based on FRAX respond to appropriate osteoporosis management: analysis from the SCOOP study of population screening 10.1007/s00223-018-0418-0

Merlijn, T, 2018 Screening of high fracture risk in primary care to reduce fractures: the SALT Osteoporosis Study a randomized trial 10.1007/s00223-018-0418-0

Parsons, C 2018 Systematic screening using FRAX leads to increased use of, and adherence to, antiosteoporosis medications: the UK scoop trial 10.1007/s00198-018-4738-8

Parsons, C 2018 Systematic fracture risk screening using FRAX results in greater use of, and adherence to, anti-osteoporosis medications: the UK SCOOP Trial 10.1002/jbm4.10073

Rubin, KH 2017 The ROSE study: risk-stratified Osteoporosis Strategy Evaluation Effectiveness of a two-step population-based osteoporosis screening programme using FRAX®: a randomised prospective population-based study 10.1002/jbmr.3363

Swart, K 2018 Screening of high fracture risk in primary care not effective Thomas Merlijn.

Reason: **Duplicate (n=2)**

Nelson, H D 2002 Screening for Postmenopausal Osteoporosis.

Viswanathan, M, 2018 Screening to Prevent Osteoporotic Fractures: An Evidence Review for the U.S. Preventive Services Task Force.

Reason: **Intervention (n=5)**

Amarnath, A L, 2015 Underuse and Overuse of Osteoporosis Screening in a Regional Health System: a Retrospective Cohort Study https://dx.doi.org/10.1007/s11606-015-3349-8

Clark, E M 2012 Randomized controlled trial of a primary care-based screening programme to identify older women with prevalent osteoporotic vertebral fractures: Cohort for Skeletal Health in Bristol and Avon (COSHIBA) https://dx.doi.org/10.1002/jbmr.1478

Crandall, C J 2023 Race and Ethnicity and Fracture Prediction Among Younger Postmenopausal Women in the Women's Health Initiative Study https://dx.doi.org/10.1001/jamainternmed.2023.1253

Lee, K E, 2019 Five-year survival rate among older adults participating in the national geriatric screening program: A South Korean population-based cohort study https://dx.doi.org/10.1016/j.archger.2019.04.013

Nayak, S, 2011 Cost-effectiveness of different screening strategies for osteoporosis in postmenopausal women https://dx.doi.org/10.7326/0003-4819-155-11-201112060-00007

Reason: **Outcome (n=2)**

Middleton, E T 2008 Routine versus targeted vertebral fracture assessment for the detection of vertebral fractures https://dx.doi.org/10.1007/s00198-007-0548-0

Schneider, D L, 2010 The primary care osteoporosis risk of fracture screening (POROS) study: design and baseline characteristics https://dx.doi.org/10.1016/j.cct.2010.03.012

Reason: **Population (n=3)**

Barr, R J, 2010 Population screening for osteoporosis risk: a randomised control trial of medication use and fracture risk https://dx.doi.org/10.1007/s00198-009-1007-x

Hsu, C L, 2023 Clinical Outcomes and Cost-Effectiveness of Osteoporosis Screening With Dual-Energy X-ray Absorptiometry https://dx.doi.org/10.3348/kjr.2023.0555

Su, Y, 2018 Cost-effectiveness of osteoporosis screening strategies for hip fracture prevention in older Chinese people: a decision tree modeling study in the Mr. OS and Ms. OS cohort in Hong Kong https://dx.doi.org/10.1007/s00198-018-4543-4

Reason: **Publication status (n=12)**

Anonymous, 2011 Guidelines updated for screening, treatment of postmenopausal osteoporosis

Condurache, C, 2019 Does screening for high hip fracture risk impact on falls risk? A post hoc analysis from the SCOOP study 10.1007/s00223-019-00544-x

Cooper, C, 2017 Effect of fracture risk assessment on anti-osteoporosis medication use and adherence: findings from the scoop trial 10.1002/jbmr.3363

Harvey, N, 2012 Anxiety, fracture risk and adherence to treatment: the MRC scoop trial 10.1007/s00198-012-2005-y

McCloskey, E, 2021 Does screening for high hip fracture risk reduce fractures by modifying falls risk? A post hoc analysis from the SCOOP study 10.1002/jbm4.10475

McCloskey, E V, 2022 Population screening for fracture risk in postmenopausal women - a logical step in reducing the osteoporotic fracture burden? https://dx.doi.org/10.1007/s00198-022-06419-6

McCloskey, E V, 2017 Screening based on FRAX fracture risk assessment reduces the incidence of hip fractures in older community dwelling women-results from the scoop study in the UK 10.1002/jbmr.3107

Parsons, C M, 2021 Is fracture risk screening using FRAX effective for secondary fracture prevention? A post-hoc analysis of the scoop trial 10.1002/jbm4.10499

Rubin, KH 2015 The risk-stratified osteoporosis strategy evaluation study (ROSE): a randomized prospective population-based study. Design and baseline characteristics

Si, L, 2014 Cost-Effectiveness Analyses of Screening and Treatment Strategies for Postmenopausal Osteoporosis in Chinese Women https://dx.doi.org/10.1016/j.jval.2014.08.331

U.S. Preventive Services Task Force, 2002 U.S. Preventive Services Task Force: recommendations and rationale. Screening for osteoporosis in postmenopausal women: recommendations and rationale

Yoshimura, M, 2014 Health Economic Evaluation of Osteoporosis Screening and Treatment Strategy in the Elderly Japanese Women https://dx.doi.org/10.1016/j.jval.2014.08.2613

Reason: **Systematic review/guideline (n=19)**

Lentle, B, 2011 Osteoporosis Canada 2010 guidelines for the assessment of fracture risk

Allon, R, 2018 How to Best Predict Fragility Fractures: An Update and Systematic Review

Anonymous 1994 Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Report of a WHO Study Group

Calonge, N, 2011 Screening for Osteoporosis: US Preventive Services Task Force Recommendation Statement 10.7326/0003-4819-154-5-201103010-00307

Camacho, P M, 2020 AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS/AMERICAN COLLEGE OF ENDOCRINOLOGY CLINICAL PRACTICE GUIDELINES FOR THE DIAGNOSIS AND TREATMENT OF POSTMENOPAUSAL OSTEOPOROSIS-2020 UPDATE https://dx.doi.org/10.4158/GL-2020-0524SUPPL

Chelmow, D, 2021 Osteoporosis Prevention, Screening, and Diagnosis: ACOG Clinical Practice Guideline No. 1 https://dx.doi.org/10.1097/AOG.0000000000004514

Chin, W L, 2022 Screening and Diagnosing Osteoporosis Among Postmenopausal Women in Primary Care Settings in Malaysia: A Systematic Review https://dx.doi.org/10.26574/maedica.2022.17.2.492

Collins, R E, 2011 Emotional impact of screening: a systematic review and meta-analysis https://dx.doi.org/10.1186/1471-2458-11-603

Compston, J, 2017 UK clinical guideline for the prevention and treatment of osteoporosis https://dx.doi.org/10.1007/s11657-017-0324-5

Curry, S J, 2018 Screening for Osteoporosis to Prevent Fractures: US Preventive Services Task Force Recommendation Statement https://dx.doi.org/10.1001/jama.2018.7498

DeFrank, J T, 2015 The psychological harms of screening: the evidence we have versus the evidence we need https://dx.doi.org/10.1007/s11606-014-2996-5

Kanis, J A, 2008 European guidance for the diagnosis and management of osteoporosis in postmenopausal women https://dx.doi.org/10.1007/s00198-008-0560-z

Kanis, J A, 2019 European guidance for the diagnosis and management of osteoporosis in postmenopausal women https://dx.doi.org/10.1007/s00198-018-4704-5

Kanis, J A, 2013 European guidance for the diagnosis and management of osteoporosis in postmenopausal women https://dx.doi.org/10.1007/s00198-012-2074-y

Lim, L S, 2009 Screening for osteoporosis in the adult U.S. population: ACPM position statement on preventive practice https://dx.doi.org/10.1016/j.amepre.2009.01.013

Makras, P, 2019 The 2018 Guidelines for the diagnosis and treatment of osteoporosis in Greece https://dx.doi.org/10.1007/s11657-019-0584-3

Rossini, M, 2016 Guidelines for the diagnosis, prevention and management of osteoporosis https://dx.doi.org/10.4081/reumatismo.2016.870

Sanchez-Rodriguez, D, 2020 The Belgian Bone Club 2020 guidelines for the management of osteoporosis in postmenopausal women https://dx.doi.org/10.1016/j.maturitas.2020.05.006

Theriault, G, 2023 Recommendations on screening for primary prevention of fragility fractures https://dx.doi.org/10.1503/cmaj.221219

Reason: **Study design (n=12)**

Adler, G S, 2002 Screening for osteoporosis and colon cancer under Medicare

Anonymous 2011 Screening for osteoporosis: U.S. preventive services task force recommendation statement https://dx.doi.org/10.7326/0003-4819-154-5-201103010-00307

Dargent-Molina, P, 2003 A comparison of different screening strategies to identify elderly women at high risk of hip fracture: results from the EPIDOS prospective study https://dx.doi.org/10.1007/s00198-003-1506-0

Greene, D, 2010 Outcomes of an osteoporosis disease-management programme managed by nurse practitioners https://dx.doi.org/10.1111/j.1745-7599.2010.00515.x

Gregson, C L, 2022 UK clinical guideline for the prevention and treatment of osteoporosis https://dx.doi.org/10.1007/s11657-022-01061-5

Jaglal, S B, 2010 The Ontario Osteoporosis Strategy: implementation of a population-based osteoporosis action plan in Canada 10.1007/s00198-010-1206-5

Mueller, D, 2008 Cost effectiveness of ultrasound and bone densitometry for osteoporosis screening in post-menopausal women https://dx.doi.org/10.2165/00148365-200806020-00004

Mueller, D, 2009 Cost-effectiveness of using clinical risk factors with and without DXA for osteoporosis screening in postmenopausal women https://dx.doi.org/10.1111/j.1524-4733.2009.00577.x

Mueller, D, 2011 Cost Effectiveness of Secondary vs Tertiary Prevention for Post-Menopausal Osteoporosis 10.2165/11587360-000000000-00000

Nelson, H D, 2002 Screening for postmenopausal osteoporosis: a review of the evidence for the U.S. Preventive Services Task Force https://dx.doi.org/10.7326/0003-4819-137-6-200209170-00015

Poduval, M, 2023 A Review of Various Clinical Practice Guidelines on Osteoporosis in the Last 5 Years 10.1007/s43465-023-01031-0

Yang, J, 2020 Vertebral fracture assessment (VFA) for osteoporosis screening in US postmenopausal women: is it cost-effective? https://dx.doi.org/10.1007/s00198-020-05588-6

Reason: **Unavailable (n=9)**

Allen, M L, 2005 Guidelines for the diagnosis, screening, and treatment of osteoporosis in women

Anonymous 1996 Clinical practice guidelines for the diagnosis and management of osteoporosis. Scientific Advisory Board, Osteoporosis Society of Canada

Bowyer, M L 1996 Clinical practice guidelines for the diagnosis and management of osteoporosis

Peters, S, 2006 Impact of pharmacist-provided osteoporosis education and screening in the workplace https://dx.doi.org/10.1331/154434506776180603

NHS Centre for Reviews and Dissemination, 1992 Screening for osteoporosis to prevent fractures

Seurer, A, 2015 Screening and Treatment of Osteoporosis

Sullivan, T, 2006 Vertebral assessment with DEXA: Screening for vertebral fracture during risk assessment for osteoporosis

Torgerson, D,1997 Randomized trial of osteoporosis screening. Use of hormone replacement therapy and quality-of-life results https://dx.doi.org/10.1001/archinte.157.18.2121

Tosteson, A N, 1990 Randomized trial of osteoporosis screening. Use of hormone replacement therapy and quality-of-life results https://dx.doi.org/10.1001/archinte.157.18.2121

Appendix 2 – Abstract reporting

Full texts were consulted for all citation information listed below.

Questions 1a and 1b

Citation 1

Shepstone L, Lenaghan E, Cooper C, Clarke S, Fong-Soe-Khioe R, Fordham R, Gittoes N, Harvey I, Harvey N, Heawood A, Holland R, Howe A, Kanis J, Marshall T, O'Neill T, Peters T, Redmond N, Torgerson D, Turner D, McCloskey E; SCOOP Study Team. Screening in the community to reduce fractures in older women (SCOOP): a randomised controlled trial. Lancet. 2018 Feb 24;391(10122):741-747. doi: 10.1016/S0140-6736(17)32640-5. Epub 2017 Dec 16. PMID: 29254858.

Sibling papers:

- Condurache CI, Chiu S, Chotiyarnwong P, Johansson H, Shepstone L, Lenaghan E, Cooper C, Clarke S, Khioe RFS, Fordham R, Gittoes N, Harvey I, Harvey NC, Heawood A, Holland R, Howe A, Kanis JA, Marshall T, O'Neill TW, Peters TJ, Redmond NM, Torgerson D, Turner D, McCloskey E; SCOOP Study Team. Screening for high hip fracture risk does not impact on falls risk: a post hoc analysis from the SCOOP study. Osteoporos Int. 2020 Mar;31(3):457-464. doi: 10.1007/s00198-019-05270-6. Epub 2020 Jan 20. PMID: 31960099.

- McCloskey E, Johansson H, Harvey NC, Shepstone L, Lenaghan E, Fordham R, Harvey I, Howe A, Cooper C, Clarke S, Gittoes N, Heawood A, Holland R, Marshall T, O'Neill TW, Peters TJ, Redmond N, Torgerson D, Kanis JA; SCOOP Study Team. Management of Patients With High Baseline Hip Fracture Risk by FRAX Reduces Hip Fractures-A Post Hoc Analysis of the SCOOP Study. J Bone Miner Res. 2018 Jun;33(6):1020-1026. doi: 10.1002/jbmr.3411. Epub 2018 Mar 23. PMID: 29480960; PMCID: PMC6004119.

- Parsons CM, Harvey N, Shepstone L, Kanis JA, Lenaghan E, Clarke S, Fordham R, Gittoes N, Harvey I, Holland R, Redmond NM, Howe A, Marshall T, Peters TJ, Torgerson D, O'Neill TW, McCloskey E, Cooper C; SCOOP Trial Group. Systematic screening using FRAX® leads to increased use of, and adherence to, anti-osteoporosis medications: an analysis of the U K SCOOP trial. Osteoporos Int. 2020 Jan;31(1):67-75. doi: 10.1007/s00198-019-05142-z. Epub 2019 Oct 12. PMID: 31606826; PMCID: PMC6952271.

Study type

Pragmatic, unblinded, two-arm, parallel, randomised controlled trial.

Objectives

This study aimed to ascertain the effectiveness of a Fracture Risk Assessment Tool (FRAX) based, community screening programme in reducing fracture incidence for UK women aged 70–85 years.

Components of the study

Population: Women aged 70–85 years from the UK

Intervention: First, a FRAX questionnaire was administered to identify risk status. Next, femoral-neck dual energy x-ray absorptiometry (DXA) was used to assess bone mineral density (BMD) for participants with high risk of fracture, as indicated by the FRAX questionnaire. Finally, these BMD results were used to calculate 10-year hip fracture probability. If a participant had a fracture risk above the intervention threshold, they were advised to discuss treatment with their General Practitioner (GP).

Comparison: Usual care.

Outcome: The primary outcome was the proportion of participants who had suffered at least one osteoporosis-related fracture within the 5-year duration of the study's follow up period. There were several secondary outcomes, which included the proportion of participants who had at least one hip fracture, the proportion that had any clinical fracture (including all osteoporosis-related fractures as well as fractures of the hands, feet, ankle, face, and skull). They also recorded mortality, and any adverse events related to screening. The effect of screening on anxiety and health-related quality of life (HrQoL) were also investigated.

Sibling paper outcomes:

- Self-reported past falls and incident falls (up to 60 months post-randomisation).[13]
- Interactions between hip fracture risk at baseline (using FRAX 10-year probability of hip fracture) and the screening effectiveness on fracture outcome.[12]
- Self-reported anti-osteoporosis medication (up to 60 months post-randomisation).[14]

Outcomes reported

Primary outcome: Within the 5year follow up period, the proportion of participants who had an osteoporosis-related fracture was not significantly different between the screening group and the control group (12.9% vs 13.6%) with an adjusted hazard ratio (HR) of 0.94; 95% CI: 0.85 to1.03, p=0.178.

Secondary outcomes: The screening intervention led to a 28% relative reduction in hip fractures in comparison with usual care (2.6% vs 3.5%; HR: 0.72; 95% CI: 0.59 to 0.89, p=0.002). However, the proportion of participants who had any clinical fracture was not significantly reduced in the screening group compared with usual care. Rates of mortality were similar across groups. There was no evidence of any effect of screening on anxiety levels or quality of life. There were no recorded serious adverse events related to screening.

Sibling paper outcomes:

- No significant difference in falls occurrence between the two groups was observed. Furthermore, there was no evidence of interaction between baseline hip fracture probability (using FRAX) and falls risk in the two arms. This is consistent with no impact of screening on falls in women at high risk of hip fracture.[13]
- Increased incidence of hip and osteoporotic fractures was observed in the control group that did not undergo screening. Participants with a higher baseline fracture probability were more likely to suffer hip and osteoporotic fractures. Only in FRAX hip fracture probability did the hazard ratio show an interaction between fracture probability and outcome of hip fracture. When the indication of an interaction between fracture probability and screening was examined, age and body mass index (BMI) did not interact with screening, but prior fracture and parental history of fracture are risk factors which did. Patients with these risk factors may be more likely to benefit from screening to reduce hip fracture reduction.[12]
- 38.2% of high fracture risk participants in the screening group who were treated with anti-osteoporosis medication at 6 months had maintained treatment at 60 months. This is compared to 21.6% of controls. Some interactions were identified; older age was associated with poorer adherence (Odds ratio (OR) per year increase in age: 0.96; 95%CI: 0.93 to 0.99, p=0.01), whereas history of parental hip fracture was associated with greater adherence rates (OR:1.67; 95% CI: 1.23 to 2.26), p<0.01).[14]

Conclusions

In summary, there was no overall reduction in fractures. However, these findings show that community screening (using FRAX hip fracture probability) leads to a significant reduction in hip fractures in older women. The SCOOP study provides some suggestion that a community-based management strategy could reduce hip fractures, but the findings must be carefully interpreted.

- Effectiveness of screening for high FRAX hip fracture probability to reduce hip fracture risk was not mediated by a reduction in falls.[13]
- Prior fracture and parental history of hip fracture (FRAX hip fracture probability) positively influenced screening effectiveness on hip fracture risk.[12]
- Screening systematically for fracture risk (using FRAX) in primary care led to significantly increased use of anti-osteoporosis medications, in comparison with the usual care group. Adherence to this treatment also increased compared with usual care.[14]

Citation 2

Rubin KH, Rothmann MJ, Holmberg T, Høiberg M, Möller S, Barkmann R, Glüer CC, Hermann AP, Bech M, Gram J, Brixen K. Effectiveness of a two-step population-based osteoporosis screening program using FRAX: the randomized Risk-stratified Osteoporosis Strategy Evaluation (ROSE) study. Osteoporos Int. 2018 Mar;29(3):567-578. doi: 10.1007/s00198-017-4326-3. Epub 2017 Dec 7. PMID: 29218381.

Sibling papers:

- Holmberg T, Möller S, Rothmann MJ, Gram J, Herman AP, Brixen K, Tolstrup JS, Høiberg M, Bech M, Rubin KH. Socioeconomic status and risk of osteoporotic fractures and the

use of DXA scans: data from the Danish population-based ROSE study. Osteoporos Int. 2019 Feb;30(2):343-353. doi: 10.1007/s00198-018-4768-2. Epub 2018 Nov 21. PMID: 30465216.

- Rothmann MJ, Möller S, Holmberg T, Højberg M, Gram J, Bech M, Brixen K, Hermann AP, Glüer CC, Barkmann R, Rubin KH. Non-participation in systematic screening for osteoporosis-the ROSE trial. Osteoporos Int. 2017 Dec;28(12):3389-3399. doi: 10.1007/s00198-017-4205-y. Epub 2017 Sep 5. PMID: 28875257.

- Petersen TG, Abrahamsen B, Høiberg M, Rothmann MJ, Holmberg T, Gram J, Bech M, Åkesson KE, Javaid MK, Hermann AP, Rubin KH. Ten-year follow-up of fracture risk in a systematic population-based screening program: the risk-stratified osteoporosis strategy evaluation (ROSE) randomised trial. EClinicalMedicine. 2024 Apr 11;71:102584. doi: 10.1016/j.eclinm.2024.102584. PMID: 38638398; PMCID: PMC11024575.

- Høiberg MP, Rubin KH, Holmberg T, Rothmann MJ, Möller S, Gram J, Bech M, Brixen K, Hermann AP. Use of antiosteoporotic medication in the Danish ROSE population-based screening study. Osteoporos Int. 2019 Jun;30(6):1223-1233. doi: 10.1007/s00198-019-04934-7. Epub 2019 Mar 26. PMID: 30911782.

Study type

Randomised controlled trial.

Objectives

This study investigated the effectiveness of a two-step population-based osteoporosis screening programme. The programme involved selection of women using FRAX, screening using DXA, and subsequent standard osteoporotic treatment.

Components of the study

Population: Women aged 65–80 years living in Southern Denmark.

Intervention: A two-step programme: First, a fracture risk assessment and then a DXA scan. Both the screening group and the control group were sent a self-administered questionnaire to calculate a FRAX score. The participants in the intervention group were offered a DXA scan if they had a 10-year probability of major osteoporotic fractures of at least 15%. This information and DXA result were then passed to the participant's GP to initiate standard osteoporotic treatment if accepted. Control group participants did not receive the result of the preliminary FRAX score.

Comparison: Usual care (not informed of FRAX result, no DXA).

Outcomes: The primary outcome was the proportion of women with incident clinical fractures, defined as major osteoporotic fracture (MOF), during the follow-up period. Secondary outcomes included hip fractures and all potential osteoporotic fractures, except fractures of fingers, toes, skull, or face.

Sibling paper outcomes:

- Association of socioeconomic status with DXA utilisation and MOF.[18]

- Variables associated with dropout.[16]
- Mortality after 10 years.[19]
- Prescription of anti-osteoporosis medication.[17]

Outcomes reported

Primary and secondary outcomes: There was no overall significant benefit to 65–80-year-old women in fracture incidence or risk of osteoporotic fractures, compared to current standard of care. In the intention-to-treat analysis, there were no statistically significant differences observed between screening and control groups for MOF, hip fracture and all fractures. In the per-protocol analysis, the intervention group had DXA scans and were compared to controls with FRAX scores and in this analysis, a significant risk reduction was observed in MOF, hip fracture, and all fractures for those in the DXA screening group. This suggests that women at moderate and high risk of osteoporotic fractures could stand to benefit from a screening programme. However, there may have been a dilution of the population effect due to factors such as high dropout rates of women considered high-risk of fracture.

Sibling paper outcomes:

- No differences were found in socioeconomic status and risk of osteoporotic fractures. Women with further or higher education have a higher probability of undergoing a DXA scan compared to women with basic education and, with a similar association seen depending on income.[18]
- Screening dropout was associated with greater age, lower socioeconomic status, higher comorbidity, current smoking, high alcohol consumption, physical impairment, higher self-rated health, and low perceived fracture risk.[16]
- 7355 MOFs were observed in the 10-year follow-up data. No long-term effects of the screening intervention were observed in the intention-to-treat analysis. However, per-protocol analyses found women who were DXA-scanned exhibited a 14% lower MOF incidence (IRR: 0.86; 95% CI: 0.78 to 0.94) than controls with a FRAX value ≥15%. Similar trends were observed for secondary outcomes including hip fractures, all fractures, and mortality.[19]
- 30,719 of 34,229 women were treatment naïve. There was a statistically significant difference in the numbers of participants starting anti-osteoporosis medication between groups, with more participants in the screening group starting medication. However, no differences in medication adherence and persistence rates were observed. Older age was associated with a greater probability of initiating medication. A low Charlson comorbidity score was associated with higher treatment initiation but lower adherence and persistence of anti-osteoporosis treatment. 31.7% of participants advised to initiate treatment did not choose to do so.[17]

Conclusions

Compared to an office-based case-finding strategy, the two-step systematic screening strategy had no overall effect on fracture incidence, including no difference in MOF incidence. The programme could be beneficial in moderate- or high-risk patients (identified using FRAX).

Sibling paper conclusions:

- The study suggested that women with a higher education status are more likely to have a DXA scan compared to women with a lower income and education background. Because of this, the study suggested that the current case-finding strategy for osteoporosis does not work as intended.[18]

- The success of any screening programme is highly dependent on its ability to reach high-risk groups. Future population-based screening programmes for osteoporosis should consider how to reduce inequalities in screening uptake.[16]

- Intention-to-treat analyses showed no statistically significant effects of the ROSE programme screening after a ten-year follow-up. However, per-protocol analyses indicated a preventive effect in women with moderate to high fracture risk, particularly in the oldest age group. The reliability of FRAX diminishes over time due to the dynamic nature of health and aging and relies on self-administered questionnaires. These factors mean FRAX may not be the most appropriate measure to use in population-based screening programmes. However, these findings indicated that the programme can be effective if enough moderate-high risk individuals accept DXA. Therefore, future research should be aimed at enhancing fracture risk prediction and screening uptake.[19]

- There were significantly higher redemption rates of anti-osteoporosis drugs in the screening arm compared with the control arm. Additionally, there were no significant differences in adherence and persistence rates between groups. Higher comorbidity seemed to increase the likelihood of treatment initiation, alongside smaller negative effects on adherence. Socioeconomic factors did not seem to have any effect on treatment adherence and persistence. Importantly, around a third of patients advised to start treatment did not choose to and this questions the sustainability of this type of screening programme, where responsibility for treatment is in patient's hands.[17]

Citation 3

Merlijn T, Swart KM, van Schoor NM, Heymans MW, van der Zwaard BC, van der Heijden AA, Rutters F, Lips P, van der Horst HE, Niemeijer C, Netelenbos JC, Elders PJ. The Effect of a Screening and Treatment Program for the Prevention of Fractures in Older Women: A Randomized Pragmatic Trial. J Bone Miner Res. 2019 Nov;34(11):1993-2000. doi: 10.1002/jbmr.3815. Epub 2019 Aug 1. PMID: 31220365; PMCID: PMC6900199.

Study type

Pragmatic, parallel, randomized controlled trial.

Objectives

This study examined whether screening for fracture risk combined with subsequent treatment within primary care can reduce fracture incidence in comparison to usual care.

Components of the study

Population: Women aged 65-90 years with at least one clinical risk factor for fractures (including a previous fracture after age 50 years, a parental hip fracture, low body weight, rheumatoid arthritis, early menopause).

Intervention: A screening programme, involving DXA, vertebral fracture assessment (VFA), FRAX and falls, as well as blood tests to exclude secondary osteoporosis.

Comparison: Usual care.

Outcomes: The primary outcome was any type of fracture. Secondary outcomes included osteoporotic fractures, hip fractures, falls, and mortality. Post hoc, major osteoporotic fractures were added to compare findings across studies.

Outcomes reported

Primary outcome: Of the 5575 participants in the screening group, 1417 (25.4%) had an indication for anti-osteoporosis medication. Screening and subsequent treatment had no statistically significant effect on the primary outcome of any type of fracture.

Secondary outcomes: Screening and subsequent treatment also had no statistically significant effect on the secondary outcomes: osteoporotic fractures, major osteoporotic fractures, hip fractures, falls, or mortality. Post hoc explorative finding suggested that screening might be most effective after a recent fracture (HR: 0.65; 95% CI: 0.44 to 0.96 for major osteoporotic fractures and HR: 0.38; 95% CI: 0.18 to 0.79 for hip fractures).

Conclusions

This screening programme did not show a statistically significant reduction on its primary outcome (fractures of any type), or secondary outcomes (osteoporotic fractures, hip fractures, falls, or mortality) in older women in primary care.

However, considering some potentially confounding elements of the study (e.g. dilution in the intervention group because of screening and contamination of the control group because of usual care) there could still be clinical relevance in the reduction of (major) osteoporotic fracture and hip fracture.

Citation 4

Kern LM, Powe NR, Levine MA, Fitzpatrick AL, Harris TB, Robbins J, Fried LP. Association between screening for osteoporosis and the incidence of hip fracture. Ann Intern Med. 2005 Feb 1;142(3):173-81. doi: 10.7326/0003-4819-142-3-200502010-00007. PMID: 15684205.

Study type

Nonconcurrent cohort study.

Objectives

To determine whether a population-based screening programme for osteoporosis using DXA at the hip is associated with reduced hip fracture incidence than usual care.

Components of the study

Population: Older adults.

Intervention: Bone density scans (hip DXA).

Comparison: Usual care.

Outcome: Incident hip fractures.

Outcomes reported

Primary outcome: Within the female sample population the hip fracture incidence was lower in the intervention group than with usual care (5.3 vs 9.7 per 1000 person years). The screening intervention was associated with a significantly lower risk of hip fracture than usual care before adjusting for propensity to be screened (Cox proportional HR 0.55; 95% CI: 0.32 to 0.92) but risks were similar between groups when adjusting for propensity to be screened (HR 0.61; 95% CI: 0.35 to1.06).

Conclusions

The screening programme with DXA scans for osteoporosis in older adults (men and women) was associated with 36% fewer incident hip fractures over the 6-year study duration compared with usual care. Future research should aim to understand this association further.

Citation 5

Merlijn T, Swart KMA, van der Horst HE, Netelenbos JC, Elders PJM. Fracture prevention by screening for high fracture risk: a systematic review and meta-analysis. Osteoporos Int. 2020 Feb;31(2):251-257. doi: 10.1007/s00198-019-05226-w. Epub 2019 Dec 14. PMID: 31838551; PMCID: PMC7010619.

Study type

Systematic review and meta-analysis.

Objectives

To perform a systematic review and meta-analysis to determine the effectiveness of population screening for fracture prevention.

Components of the study

Population: Randomised controlled trials (RCTs) of screening in the general population up to June 2019.

Intervention: Screening using at least bone densitometry and subsequent treatment with anti-osteoporosis medication (including bisphosphonates, denosumab, or strontium ranelate).

Comparison: Usual care.

Outcomes: Studies had to include at least one fracture-related outcome (all fractures, (major) osteoporotic fractures, or hip fractures). Mortality was a secondary outcome.

Outcomes reported

This meta-analysis included three randomised studies: the ROSE study, the SCOOP study, and the SALT (SOS) study. The meta-analysis demonstrated a statistically significant and clinically relevant reduction of osteoporotic fractures (HR: 0.95; 95% CI: 0.89 to1.00), major osteoporotic fractures (HR: 0.91; 95%CI: 0.84 to 0.98), and hip fractures (HR:0.80; 95%CI: 0.71 to 0.91), but no statistically significant reduction of all fractures.

Conclusions

There is evidence that population screening programmes are effective to reduce osteoporotic fractures and hip fractures. Therefore, implementation of a screening programme in older women should be considered to prevent osteoporotic fractures, particularly hip fractures.

Citation 6

Gates M, Pillay J, Nuspl M, Wingert A, Vandermeer B, Hartling L. Screening for the primary prevention of fragility fractures among adults aged 40 years and older in primary care: systematic reviews of the effects and acceptability of screening and treatment, and the accuracy of risk prediction tools. Syst Rev. 2023 Mar 21;12(1):51. doi: 10.1186/s13643-023-02181-w. PMID: 36945065; PMCID: PMC10029308.

Study type

Systematic review with meta-analysis.

Objectives

To review evidence concerning the accuracy of risk prediction tools used in primary care for the primary prevention of fragility fractures among adults aged 40 years and older. The evidence will be used by the Canadian Task Force on Preventive Health Care to inform recommendations on screening for the purpose of preventing fragility fractures in adults 40 years and older in Canada. The review set to investigate four research questions. Questions 1a and 1b are relevant for this evidence map and described below:

1a: What are the benefits and harms of screening compared with no screening to prevent fragility fractures and related morbidity and mortality in primary care for adults ≥40 years?

1b: Does the effectiveness of screening to prevent fragility fractures vary by screening programme type (i.e., 1-step vs 2-step) or risk assessment tool?

Components of the study

Population: Asymptomatic adults in the general population ≥40 years.

Intervention: Screening to prevent fragility fracture with any of the following tools:

- Only fracture risk assessment (validated or non-validated tools).
- Only BMD measurement by DXA ± VFA/spinal radiography.
- Fracture risk assessment followed by BMD if indicated ± VFA/spinal radiography.

Treatment is offered to participants who meet the "high risk" threshold.

Comparison: 1a: no screening.

1b: a different screening strategy or screening using a different risk assessment tool.

Outcomes: Benefits: improvements in hip fractures, clinical fragility fractures, fracture-related mortality, functionality and disability, quality of life or wellbeing, all-cause mortality.

Harms: Serious adverse events (all serious cardiovascular events, serious cardiac rhythm disturbances, serious gastrointestinal adverse events, gastrointestinal cancer, atypical fractures, osteonecrosis of the jaw), overdiagnosis, discontinuation due to adverse events, non-serious adverse events (including "any" adverse events).

Outcomes reported

1a: included five trials with two associated publications. The trials consisted of 4 RCTs (ROSE,[2] SALT (SOS),[3] SCOOP[1] and APOSS[30]) and 1 controlled clinical trial.[4] 1b: included one RCT (OPRA[31]).

Benefits were seen for females aged 65 years and older who completed a mailed fracture risk questionnaire (known as "selected"). A 2-step screening using a risk assessment tool with or without measurement of BMD has a moderate certainty of reducing the risk of hip fractures by 6.2 fewer per 1000, and clinical fragility fractures, by 5.9 fewer per 1000. It probably does not reduce all-cause mortality and there is a low certainty of it affecting health-related quality of life.

Fracture outcome benefits were not replicated in a population with a low response rate to mailed screening questionnaires. In females aged 68–80 years, population screening may not reduce the risk of hip fractures or clinical fragility fractures over 5 years of follow-up.

The evidence for serious adverse events is very uncertain among all patients. Overdiagnosis was not directly reported in any of the trials. Estimates using data available suggest that among females offered screening who answered questionnaires, between 12 and 19% meeting thresholds based on clinical FRAX 10-year risks, may be over diagnosed as having a high risk of fracture. Of those at high risk who were referred for BMD assessment, 24% may be over diagnosed.

Conclusions

There is probably a small reduction in clinical fragility fracture and hip fracture risk for selected postmenopausal females with low prevalence of previous fracture offered 2-step screening with risk assessment and BMD measurement, in comparison to no screening. Screening in primary care with clinical FRAX, followed by BMD assessment for increased risk, among selected females aged 65 years and older probably leads to a small reduction in the risk of clinical fragility fracture and hip fracture compared to no screening. Limited direct evidence on harms of screening was available.

There was no improvement in patient-relevant outcomes in a population with low uptake of mailed screening questionnaires. Minimal information on harms was available, although we calculated overdiagnosis estimates for hip and major osteoporotic fractures.

The mechanism through which risk is reduced with screening is unclear, though some evidence suggests it may be attributed to pharmacologic treatment, not a reduction in falls or other risk behaviours. It is not clear which of the screening strategies would be most beneficial.

Citation 7

Viswanathan M, Reddy S, Berkman N, Cullen K, Middleton JC, Nicholson WK, Kahwati LC. Screening to Prevent Osteoporotic Fractures: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. JAMA. 2018 Jun 26;319(24):2532-2551. doi: 10.1001/jama.2018.6537. PMID: 29946734.

Study type

'"Evidence report" and systematic review.

Objectives

To update the evidence on the use of screening and treatment in the prevention of osteoporotic fractures for the US Preventive Services Task Force. The review considered three research questions. Questions 1 and 3 were relevant to this evidence map and are described below:

Q1. Does screening (clinical risk assessment, bone density measurement, or both) for osteoporotic fracture risk reduce fractures and fracture-related morbidity and mortality in adults?

Q3. What are the harms of screening for osteoporotic fracture risk?

Components of the study

Population: Adults 40 years and older; screening cohorts must not have prevalent low-trauma fractures while treatment cohorts must have increased fracture risk.

Intervention: Osteoporosis screening, bone measurement tests or clinical risk assessments, or pharmacologic treatment.

Comparison: Q1 & Q3: no screening.

Outcomes: Q1: Osteoporotic fracture, all clinical fractures, mortality, hip fracture incidence.

Q3: Anxiety (State-Trait Anxiety Inventory) and quality of life (EuroQoL 5 Dimension tool and the Short-Form Health Survey 12 [physical and mental health]).

Outcomes reported

One RCT (SCOOP) was reviewed for Q1 and Q3. Compared with no screening, screening led to fewer hip fractures (2.6%vs 3.5%), but no other statistically significant benefits or harms.

Conclusions

In women, screening to prevent osteoporotic fractures may lead to a reduction in hip fractures, while treatment reduces the risk of vertebral and nonvertebral fractures; evidence around treatment harms was inconsistent. There was variation in the accuracy of bone measurement tests or clinical risk assessments in identifying osteoporosis.

Citation 8

EUnetHTA OTCA19 Assessment Team. Screening for osteoporosis in the general population. Collaborative Assessment. Diemen (The Netherlands): EUnetHTA; 2019. Report No.: OTCA19. Available from https://www.eunetHTA.eu

Study type

Rapid Relative Effectiveness Assessment (REA).

Objectives

To investigate whether screening for osteoporosis in the general population offers an improvement in patient relevant outcomes in comparison to no screening.

Components of the study

Population: General population.

Intervention: Osteoporosis screening.

Comparison: No screening (i.e. usual care).

Outcomes: The critical outcome was symptomatic fractures. Other outcomes were: overall and fracture-related mortality; health-related quality of life (HrQoL); pain; body function and activities

of daily living; resource use (e.g. visits to doctors and hospitals, admission to nursing homes); (serious) adverse events (SAEs); and overdiagnosis and overtreatment.

Study design inclusion criteria (types of RCTs): Marker-based strategy design RCTs (main body of evidence) and enrichment-design RCTs (additional evidence).

Outcomes reported

Symptomatic fractures: all three strategy design RCTs included (SCOOP,[1] ROSE,[2] and COSHIBA[32]) collected data on this outcome. In all fracture (sub-) outcomes investigated, there was no advantage gained through the intervention. The evidence relating to hip fractures was inconclusive. Screening for osteoporosis probably leads to little or no difference in symptomatic fracture incidence compared to no screening. This conclusion was informed by evidence of moderate quality.

Mortality: Screening for osteoporosis results in little or no difference in mortality compared with no screening. This conclusion was based on high quality evidence.

Back pain: there was no data available from studies with marker-based strategy design, only enrichment design studies. It is unclear whether osteoporosis screening improves back pain. This conclusion is based on very low-quality evidence.

HrQoL: data was sourced from the SCOOP trial. The HrQoL was measured using the EQ-5D and SF-12 for mental health in addition to the SF-12 for physical health after 60 months of follow-up. No statistically significant difference between the two study arms was found for any of the three HrQoL tools. There is probably little or no difference in HrQoL with screening for osteoporosis compared to no screening. This conclusion is informed by moderate-quality evidence.

Utilisation of healthcare resources: data was only available from enrichment design studies in relation to this outcome. There was not a statistically significant difference in overall hospital stays or stays in nursing homes / rehab, however there was a statistically significant reduction in fracture-related resource use and emergency room visits in the intervention group. There is uncertainty around whether osteoporosis screening lowers fracture-related utilisation of healthcare resources. This conclusion was based on very low-quality evidence.

The strategy-design RCTs did not adequately report SAEs. GPs were [only] required to record adverse events related to screening in the SCOOP trial.[1] Data on SAEs was therefore only sourced from enrichment studies. Evidence quality was low as a result of indirectness.

Overdiagnosis: There was no data relating to this outcome and therefore it was not possible to estimate the frequency or proportion of overdiagnoses due to osteoporosis.

Conclusions

The main finding of this rapid REA is that there is no (or only a small) benefit to osteoporosis screening in postmenopausal women regarding the impact on symptomatic fractures.

Since the available moderate quality studies do not show screening to have any effect on the incidence of symptomatic fractures, there is probably little or no benefit to screening for osteoporosis in postmenopausal women. These findings are mostly based on studies investigating a screening strategy which uses FRAX for risk assessment and DXA for BMD

measurement. The included studies did not allow any evaluation of screening strategies using different screening tools. As with any screening intervention, many factors may impact the benefits and harms, such as the type and uptake of screening and treatment. There were no studies found on screening for osteoporosis in men or younger women.

Citation 9

Auais M, Angermann H, Grubb M, Thomas C, Feng C, Chu CH. The effectiveness and cost-effectiveness of clinical fracture-risk assessment tools in reducing future osteoporotic fractures among older adults: a structured scoping review. Osteoporos Int. 2023 May;34(5):823-840. doi: 10.1007/s00198-022-06659-6. Epub 2023 Jan 4. PMID: 36598523.

Study type

Structured scoping review.

Objectives

The primary objective was to review the evidence on how effective clinical fracture-risk assessment tools are in reducing osteoporotic fractures and/or influencing other health outcomes.

One key secondary objective was to summarize any evidence relating to the cost-effectiveness of these clinical tools used in investigations in fracture prevention.

Components of the study

Population: Older adults in all settings.

Intervention: Fracture risk assessment with a validated screening tool.

Comparison: NR

Outcomes: Primary outcome - fracture prevention.

Secondary outcomes: impact of clinical osteoporosis screening programmes; health perspectives, anxiety, quality of life; cost-effectiveness.

Outcomes reported

Four randomised controlled trials (SCOOP[1], ROSE[2], OPRA[31], SALT (SOS)[3]) investigated how effective clinical fracture-risk assessment tools are for reducing all fractures in older women. Use of these assessment tools did not lead to a statistically significant reduction in the risk of osteoporotic fractures in comparison to usual care; however, further analyses of two of the trials indicated a trend of reducing hip fractures, with results that may be clinically significant. Four studies analysed the impact of screening programmes on other health outcomes, with participants reporting positive results. Eight simulation studies estimated the cost-effectiveness of using these tools to screen for fractures, with the majority showing significant potential savings. Overall, almost all studies found that different osteoporotic screening strategies using a clinical fracture risk assessment tool were cost-effective in comparison to the no-screening alternative.

Conclusions

This review indicated that clinical fracture-risk assessment screening tools were not more effective for preventing all osteoporosis-related fractures than usual care. However, use of screening tools had a positive influence on women's perspectives on osteoporosis and may have reduced the risk of hip fractures.

Citation 10

Johnell O, Hertzman P. (2006). What evidence is there for the prevention and screening of osteoporosis? Copenhagen, WHO Regional Office for Europe (Health Evidence Network report; http://www.euro.who.int/document/e88668.pdf, accessed 18 May 2006).

Study type

Synthesis report.

Objectives

The primary objective was to determine the effectiveness of osteoporosis prevention and screening.

Components of the study

Population: General population.

Intervention: Osteoporosis screening.

Comparison: NR (unspecified).

Outcomes: Effectiveness of general osteoporosis screening; cost-effectiveness.

Outcomes reported

There is no direct scientific evidence to support mass screening for osteoporosis using bone density measurement. The effectiveness of interventions in asymptomatic populations is unclear. The true cost–effectiveness of different strategies for osteoporosis and related fracture prevention has not been established, particularly within routine clinical care.

Conclusions

The review did not find direct evidence for fracture reduction as a result of screening for osteoporosis but found good indirect evidence in two specific situations. First, screening is effective for identifying postmenopausal women with low bone mineral density. Second, treating osteoporosis can reduce the risk of wrist and spine fractures in this population. However, there are several remaining questions that must be answered before it is possible to recommend such programmes at the population level. Also, many countries may find the total cost of a general screening programme for women more than 65 years of age to be unaffordable or not cost effective. Moreover, there is insufficient evidence relating to the effectiveness of treating low-risk populations.

Question 2

Citation 1

Turner DA, Khioe RFS, Shepstone L, Lenaghan E, Cooper C, Gittoes N, Harvey NC, Holland R, Howe A, McCloskey E, O'Neill TW, Torgerson D, Fordham R; SCOOP Study Team. The Cost-Effectiveness of Screening in the Community to Reduce Osteoporotic Fractures in Older Women in the UK: Economic Evaluation of the SCOOP Study. J Bone Miner Res. 2018 May;33(5):845-851. doi: 10.1002/jbmr.3381. Epub 2018 Feb 22. PMID: 29470854; PMCID: PMC5993187.

Sibling paper:

- Söreskog E, Borgström F, Shepstone L, Clarke S, Cooper C, Harvey I, Harvey NC, Howe A, Johansson H, Marshall T, O'Neill TW, Peters TJ, Redmond NM, Turner D, Holland R, McCloskey E, Kanis JA; SCOOP study team. Long-term cost-effectiveness of screening for fracture risk in a UK primary care setting: the SCOOP study. Osteoporos Int. 2020 Aug;31(8):1499-1506. doi: 10.1007/s00198-020-05372-6. Epub 2020 Apr 1. PMID: 32239237; PMCID: PMC7115896.

Study type

Pragmatic, unblinded, two parallel group randomised controlled trial - cost-effectiveness analysis ("Within trial" economic analysis).

Objectives

This study aimed to use resource-use and outcome data collected during the SCOOP[1] trial to estimate the cost-effectiveness of the screening intervention used in SCOOP[1] over a 5-year time horizon.

Components of the study

Population: Women aged 70–85 years from the UK

Intervention: First, a FRAX questionnaire was administered to identify risk status. Next, femoral-neck DXA was used to assess BMD for participants with high risk of fracture, as indicated by the FRAX questionnaire. Finally, these BMD results were used to calculate 10-year hip fracture probability. If a participant had a fracture risk above the intervention threshold, they were advised to discuss treatment with their GP.

Comparison: Usual care.

Outcomes: Primary outcome: cost per QALY gained over a 5-year period calculated with the 3-level EQ-5D; Secondary outcomes: cost of prevention of each osteoporosis-related fracture and hip fracture.

Sibling paper outcomes:

- Life years, QALYs, costs and incremental cost per QALY (ICER).[15]

Outcomes reported

Over a 5-year follow-up period, the screening arm was associated with an average incremental QALY gain of 0.0237 (95% CI: -0.0034 to 0.0508). The incremental cost per QALY gained was £2772. Cost-effectiveness acceptability curves showed that the intervention had a 93% probability of being cost-effective, based on the NICE threshold of £20,000 per QALY. As a result of a reduction in fractures in the intervention group, the cost per fracture prevented was £4478 for all osteoporotic fractures and £7694 for hip fractures.

Sibling paper:

- Findings over the remaining lifetime (mean 14 years) suggested that screening 1,000 patients saved 9 hip fractures and 20 non-hip fractures compared to usual management. Due to a fracture risk reduction, it was found that screening was expected to gain 0.015 QALYs per patient and cost savings of £286 per patient in comparison to usual care.[15]

Conclusions

There is strong evidence from this study to suggest that community screening with the FRAX tool to estimate the probability of hip fracture in older women, is likely to be a cost-effective and efficient use of health care resources.

The longer-term cost-effectiveness study findings suggest that a UK screening programme for older women based on fracture risk would gain quality of life and life years and reduce fracture costs. The cost reduction would more than offset the running costs.

Sibling paper:

- The findings suggest that a UKscreening programme based on fracture risk in older women would lead to an increase in quality of life and life years while reducing fracture costs, which would more than offset the programme running costs.[15]

Citation 2

Auais M, Angermann H, Grubb M, Thomas C, Feng C, Chu CH. The effectiveness and cost-effectiveness of clinical fracture-risk assessment tools in reducing future osteoporotic fractures among older adults: a structured scoping review. Osteoporos Int. 2023 May;34(5):823-840. doi: 10.1007/s00198-022-06659-6. Epub 2023 Jan 4. PMID: 36598523.

Study type

Structured scoping review.

Objectives

The primary objective was to review the evidence on the how effective clinical fracture-risk assessment tools are in reducing osteoporotic fractures and/or influencing other health outcomes.

One key secondary objective was to summarise any evidence relating to the cost-effectiveness of these clinical tools used in investigations in fracture prevention.

Components of the study

Population: Older adults in all settings.

Intervention: Fracture risk assessment with a validated screening tool.

Comparison: NR

Outcomes: Primary outcome - fracture prevention.

Secondary outcomes: impact of clinical osteoporosis screening programmes; health perspectives, anxiety, quality of life; cost-effectiveness.

Outcomes reported

Four randomised controlled trials (SCOOP[1], ROSE[2], OPRA[31], SALT (SOS)[3]) investigated clinical fracture-risk assessment tool effectiveness in reducing all fractures in older women. Eight simulation studies estimated the cost-effectiveness of using these tools in fracture screening, with most showing significant potential savings.

Conclusions

This review suggested that clinical fracture-risk assessment screening tools were not more effective than usual care in preventing all osteoporosis-related fractures. However, use of screening tools had a positive influence on women's perspectives on osteoporosis, may have reduced the risk of hip fractures, and could potentially be cost-effective.

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