Bone density measurement: a systematic review

Authors' objectives
To determine the effectiveness of bone density measurements in predicting fractures among persons aged over 50 years.

Searching
MEDLINE and EMBASE were searched for studies published between 1986 and August 1994; MeSH terms and keywords are provided. References lists from selected studies were reviewed and experts in the field were contacted. Only studies written in English, French, German or Swedish were considered. Editorials, letters and overviews were excluded.

Study selection
Study designs of evaluations included in the review
Prospective cohort studies including a baseline bone density measurement and registered fractures, and whose primary aim was to determine whether BMD can predict fracture, were eligible for inclusion in the review. In addition, case-control studies comparing BMD in patients with hip fractures with age-matched controls, (within 14 days of fracture), were eligible for inclusion.

Retrospective studies and reports in summary form were excluded for most methods of bone density measurement, although those for ultrasound were included due to the lack of prospective studies. Where multiple reports were published on the same data, the report with the longest follow-up and available data was included. Follow-up periods ranged from less than 2 years to 24 years.

Specific interventions included in the review
To be eligible for inclusion in the review, studies had to include a baseline measurement of bone mineral density (BMD) using one of the following methods: single-photon absorptiometry, dual-photon absorptiometry, single X-ray absorptiometry, dual-energy X-ray absorptiometry, ultrasound, quantitative computerised tomography and quantitative magnetic resonance.

Studies based only on x-ray images or measurement of metacarpal bones were excluded.

For prospective cohort studies, measurement sites included the forearm, hip, (lumbar) spine, and calcaneus. The measurement sites used in the included case-control studies were the femoral neck, trochanter, Ward's triangle, and the lumbar spine.

Reference standard test against which the new test was compared
For prospective cohort designs, included studies had to report on the follow-up of fractures.

Participants included in the review
Prospective cohort studies:
The inclusion criteria specified persons aged over 50 years not previously diagnosed with metabolic bone disorders, and not taking medication for bone or hormonally-regulated diseases. The majority of included participants were women.

Case-control studies:
Only studies of adults were included. Individuals included in the study may not have been selected for any disorder other than hip fracture. The individuals in the control group must have been selected from a normal population.
Outcomes assessed in the review
No inclusion criteria relating to outcome measures were specified. The outcomes measured in included prospective cohort studies were fractures of forearm, hip, lumbar spine, calcaneus, and a combination of all of these fracture sites.

How were decisions on the relevance of primary studies made?
Three reviewers selected the papers for review.

Assessment of study quality
The authors do not report the method used to assess validity, or how the validity assessment was performed. Appendix 4 provides a form used to grade the scientific quality of the studies.

Data extraction
The authors do not state how the data were extracted for the review, or how many of the reviewers performed the data extraction.

Prospective cohort studies:
Data were extracted on the bibliographic details of studies, participant numbers, demographic characteristics of participants, length of follow-up, measurement method and site, and outcomes (fracture numbers and sites). Relative risks of fracture for one SD reduction in BMD with 95% CIs (adjusted for age) were calculated for each study.

Case-control studies:
Data were extracted on the bibliographic details of studies, demographic characteristics of cases and controls, study exclusion criteria, and BMD measurements. The standardised difference in BMD between case and control groups, and hence the increase in fracture risk (odds ratio) for one SD difference in BMD was calculated for each study.

Methods of synthesis
How were the studies combined?
The prospective cohort studies were combined by calculating the relative risk (RR) for one standard deviation (SD) reduction in BMD in relation to the normal value for each study, and then estimating the pooled RR of fracture for each measurement method and fracture type (with confidence intervals, CIs) using a fixed-effect model.

Case-control studies were combined by calculating the standardised difference between the BMD values for case and control, expressed in terms of SDs for the control group. Fracture risks were estimated for one SD difference in BMD, with pooling of weighted means and CIs.

How were differences between studies investigated?
No formal assessment of heterogeneity was undertaken, although the authors state that factors thought to affect fracture risk were adjusted for in the primary studies through logistic regression or Cox proportional hazard models. Factors included age, age at menopause, inherited risk, body weight and weight loss, sedentary life style, smoking and calcium intake.

Results of the review
Twelve prospective cohort studies (total of 15,446 participants) and 8 case-control studies (total of 1,133 participants) were included.

Analysis of the prospective cohort studies gave the RRs for fracture given a one SD reduction in BMD, presented according to measurement site and fracture type (measurement site: fracture site).

Proximal radius: forearm, 1.8 (95% CI: 1.5, 2.1, number of studies, n=4); hip, 2.1 (95% CI: 1.6, 2.7, n=4); lumbar spine, 2.2 (95% CI: 1.7, 2.6, n=3); all, 1.5 (95% CI: 1.3, 1.6, n=6).
Distal radius: forearm, 1.7 (95% CI: 1.4, 2.0, n=3); hip, 1.8 (95% CI: 1.4, 2.2, n=3); lumbar spine, 1.7 (95% CI: 1.4, 2.1, n=3); all, 1.4 (95% CI: 1.3, 1.6, n=4).

Hip: forearm, 1.4 (95% CI: 1.4, 1.6, n=2); hip, 2.6 (95% CI: 2.0, 3.5, n=2); lumbar spine, 1.8 (95% CI: 1.1, 2.7, n=1); all, 1.6 (95% CI: 1.4, 1.8, n=3).

Lumbar spine: forearm, 1.5 (95% CI: 1.3, 1.8, n=2); hip, 1.6 (95% CI: 1.2, 2.2, n=2); lumbar spine, 2.3 (95% CI: 1.9, 2.8, n=3); all, 1.5 (95% CI: 1.4, 1.7, n=4).

Calcaneus: forearm, 1.6 (95% CI: 1.4, 1.8, n=1); hip, 2.0 (95% CI: 1.5, 2.7, n=1); lumbar spine, 2.4 (95% CI: 1.8, 3.2, n=1); all 1.5 (95% CI: 1.3, 1.8, n=2).

All sites: forearm, 1.6 (95% CI: 1.5, 1.7, n=4); hip 2.0 (95% CI: 1.7, 2.4, n=4); lumbar spine, 2.1 (95% CI: 1.9, 2.3, n=4); all, 1.5 (95% CI: 1.4, 1.6, n=10).

Calcaneus (hip 2.2 (95% CI: 1.8, 2.7, n=2) and lumbar spine 1.8 (95% CI: 1.5, 2.2, n=2), measured by ultrasound): all, 1.5 (95% CI: 1.4, 1.7, n=1).

Similar results were evident for case-control studies; odds ratios are presented for hip fracture at 1 SD lower bone density, according to measurement site.

Femoral neck: women, 2.68 (n=8); men, 1.94 (n=3).

Trochanter: women, 2.79 (n=5); men, 2.70 (n=1).

Ward's triangle: women, 2.10 (n=5); men, 2.20 (n=1).

Lumbar spine: women, 1.81 (n=5); men, 2.00 (n=1).

**Authors’ conclusions**
Analysis of the prospective cohort studies and verification using case-control studies shows a relationship between bone density and bone fracture. Whilst it is not possible to establish a distinct bone density threshold that will distinguish individuals who will experience fracture, it is possible to identify people who are at increased risk.

**CRD commentary**
A broadly adequate systematic review was reported. The research question was clearly stated and defined in terms of the interventions, study populations, and study designs of interest.

The search strategy as discussed in the review and outlined in the accompanying appendix appeared to include some discrepancies concerning date restrictions, and was limited in terms of databases searched and language criteria. It seems unlikely that all available published data would have been retrieved using the methods reported. In addition, no attempt to identify unpublished data was reported, and the potential impact of publication bias was not assessed.

The review provided no discussion of validity criteria (Appendix 4 provided a form used in grading the scientific quality of the studies), and limited description of the review methodology. It is therefore difficult to assess the extent to which the review findings may have been prejudiced by methodological flaws in the primary studies, and/or the review process.

Details of the included primary studies were, however, clearly presented in a tabular format, in an appendix to the review. The methods used to combine the results of individual studies were reasonable given the limited data available, though the very limited treatment of study heterogeneity is of concern.

Overall, the authors’ conclusions were suitably cautious given the limitations outlined above.
Implications of the review for practice and research

Practice: The authors state that BMD measurement may be considered in patients at increased risk for osteoporosis, e.g. those receiving a treatment that can impact negatively on the skeleton (such as prolonged cortisone treatment; Trained staff and accurate, continuous quality control of equipment are necessary to provide BMD measurement services; the scientific evidence is insufficient to recommend BMD measurement in mass screening of asymptomatic individuals, including mass screening of post-menopausal women and opportunistic screening of patients who present no symptoms of osteoporosis but who contact health services for other reasons.

Research: The authors state that further experience and studies are necessary to clarify the role of BMD measurement in routine healthcare.

Bibliographic details

PubMedID
9042086

Other publications of related interest

Indexing Status
Subject indexing assigned by NLM

MeSH
Anti-Inflammatory Agents /therapeutic use; Drugs, Investigational /therapeutic use; Glucocorticoids /therapeutic use; Humans; Immunosuppressive Agents /therapeutic use; Inflammatory Bowel Diseases /drug therapy

AccessionNumber
11997000472

Date bibliographic record published
31/07/1998

Date abstract record published
31/07/1998

Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.