







This clinical guideline was endorsed by the Chartered Society of Physiotherapy (CSP) and the National Osteoporosis Society (NOS) in March 1999. The endorsement process has included review by relevant external experts as well as peer review. The rigour of the appraisal process can assure users of the guideline that the recommendations for practice are based on a rigorous and systematic process of identifying the best available evidence, at the time of endorsement.

Review date: 2001

# Acknowledgements

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- All the specialist advisers, especially Dr Ann Wales for her help with the literature searching
- Fenella Ritson who instigated the development of these guidelines
- The CSP and the NOS
- The Glasgow Royal Infirmary University NHS Trust for hosting the work of the guidelines
- Dr Rowena Murray for editing the guidelines.

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# Clinical Guidelines Core Development Group

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# Guidelines Development

The development of these guidelines has been managed under the umbrella of the Glasgow Royal Infirmary (GRI) Physiotherapy Department in an attempt to contribute to establishing evidence-based healthcare. Apart from Ann Hunter who was funded for a short period by the Scottish Office and who facilitated the initial meetings there has been no special funding to undertake the work.

Those who had responded to a nation-wide call in *Physiotherapy Frontline* (16/10/96 issue), which the GRI Physiotherapy Department initiated, formed an interest group. Two meetings of all those interested and able to attend were convened in Glasgow to brainstorm and plan the project. Those unable to attend were kept informed of progress. Needs for specialist assistance with the project (i.e. critical appraisal of literature) and expert advisers were identified.

Due to the lack of funding preventing many interested physiotherapists from taking time off and travelling to meetings, it was decided that a core development group should be formed to take the project forward. This group included a physiotherapist working with older people, exercise experts, a researcher and a manager. The larger interest group was kept informed of progress and supported the work by contributing in writing. The second draft was considered among this group and feedback was incorporated into the third draft.

Expert advisers from other professions and representatives of the Chartered Society of Physiotherapy's (CSP) Clinical Interest Groups contributed at the draft stages. Corrections and additions were incorporated and the core development group made relevant changes. The client's view was included by consulting at each stage with the National Osteoporosis Society (NOS), the representative body for osteoporosis sufferers.

Examples of feedback received from the larger interest group and the expert advisers, and the changes that were made in the document as a result of these, can be found in Appendix 1.



## Why these Guidelines?

Osteoporosis is a major public health problem and exercise is considered to be an effective strategy in both the prevention and treatment of the disorder. It is therefore necessary that physiotherapists are aware of the specific exercise strategies that may help in the management of the disorder. (A recent survey carried out by Ritson and Scott (1996)<sup>1</sup> found that the knowledge base of physiotherapists was poor in the management of the disorder, highlighting the need for guidelines).

### **Objectives**

- To raise awareness among physiotherapists of the need for their participation in the management of osteoporosis.
- To provide a source of evidence-based information for clinical decision making in the physiotherapy management of osteoporosis.
- To promote a consistent approach to best practice in the physiotherapy management of osteoporosis which optimises physiotherapists' contribution in the care of these patients.
- To reassure physiotherapists that much can be done to safely improve mobility, function, exercise tolerance and bone mineral density and reduce the risk of falling in these patient groups.



## How to use these Guidelines

These guidelines have been developed in order to provide a framework for practice for the effective physiotherapy management for those at risk from and those with a diagnosis of osteoporosis. As the target groups consist of individual patients, male and female of all ages, the guidelines are intended to be used selectively as a tool to aid clinical decision making which will include consideration of the individual's pathology, characteristics and preferences.

Physiotherapists are encouraged to develop local management protocols, based on these guidelines, in order to accommodate specific needs and circumstances. Junior staff especially may benefit from more detailed management protocols developed for particular client groups.

A quick reference guide to physiotherapy assessment and appropriate exercise management is available from the CSP and the NOS (see Section 8 for addresses).

## Dissemination and Implementation

These guidelines will be disseminated and implemented through the networks of the Clinical Interest Groups of the CSP. Copies will also be available to individuals by application to the CSP. Awareness of the guidelines will be raised through the publications of the CSP and the NOS and other appropriate journals. The guidelines will be promoted at relevant conferences and workshops.

## Review of Guidelines

The document will be reviewed in the year 2001 by members of the development group hosted by the Physiotherapy Department, Glasgow Royal Infirmary, with assistance from the CSP's Clinical Interest Groups, as follows:

- New evidence will be systematically appraised.
- Physiotherapists' awareness of their role in the management of osteoporosis will be reassessed.
- In conjunction with the NOS the views of osteoporosis sufferers will be obtained regarding contact with physiotherapists, the level of participation in exercise programmes, and satisfaction with pain management.
- The usefulness of these guidelines to physiotherapists will be tested by a survey of users identified by the Clinical Interest Groups.
- An audit tool will be developed to facilitate local implementation and use of guidelines.

# VII Methodology

Detailed in this section is a summary of the search strategies used to obtain the evidence base for our recommendations concerned with bone health. Search strategies are shown in full for each database in Appendix IV.

## **Search Strategies: exercise for prevention and control of osteoporosis**

The following electronic databases were searched:

- 1 MEDLINE 1966–June 1998 issue (OVID Technologies)
- 2 EMBASE 1980–June 1998 issue (OVID Technologies)
- 3 Cochrane Library–1998 Issue 3 (Update Software)
- 4 AMED 1985–02/98 issue (Silverplatter)
- 5 CINAHL 1982–June 1998 issue (OVID Technologies).
- 6 OCLC Papers First database searched online via OCLC First search in July 1998. (Grey literature resource: comprises over 580,000 papers included in every congress, conference, exposition, workshop, symposium and meeting received at the British Library from October 1993 to present.)

Hand searching was used to follow up references cited in bibliographies.

### **Medline**

In order to ensure comprehensive retrieval of all potentially relevant references, a subject search strategy including all appropriate subject heading and freetext terms, with no restriction by age group or language, was devised, as shown in Appendix IV, Section 1.1. This subject search was then combined in turn with each of the optimal research methodology search filters devised by the Cochrane Collaboration, the NHS Centre for Reviews and Dissemination, and McMaster University, as shown in Section 1.2–1.5. Filters were added consecutively, and references already retrieved by using an earlier filter were excluded using the “NOT” command.

### **Embase**

The subject heading and textword approaches used for the MEDLINE search were adapted to the EMBASE system, as shown in Appendix IV, Section 2.1. This subject search was then combined with the strategy shown in Section 2.2 for retrieving randomised controlled trials. An optimal strategy for this purpose on EMBASE has not yet been tested and formally approved. However, the strategy shown here has been employed in searches for the Cochrane Collaboration, and was taken from one of the search strategies detailed in a review in the Cochrane Database of Systematic Reviews.


### **Others**


For the other databases, subject searches using all possible subject heading and textword approaches were devised, as shown in Appendix IV, Section 3–6. No methodology filters were added for these databases. This would be redundant in the case of the Cochrane Library, while for the other databases, optimal methodology filters have not yet been devised.

For each database, all references of subject relevance were retrieved, and as many as possible graded according to the levels of evidence used by the Scottish Intercollegiate Guideline Network (SIGN) which originated from the US Agency for Health Care Policy and Research (Box 1 page 6) <sup>2</sup>. This was based on the information provided in the database citation. Some references were graded as 'level of evidence not clear' at this point. The graded lists of references were then passed over to the subject experts for selection based on a) strength of research methodology and b) subject relevance to each point being discussed. The references selected in this way were then subjected to critical appraisal according to established guidelines using the CASP system for both trials and reviews <sup>3,4</sup>. An example of a CASP appraisal is given in Appendix III. The same principles of appraisal were applied to other types of studies.

In addition to the extensive literature evidence obtained, the development group reached consensus on what constitutes good practice where the literature did not provide any evidence. This was based on extensive experience in the management of osteoporosis patients. For example, the Glasgow Royal Infirmary Physiotherapy Dept has been involved in the management of osteoporosis patients for over six years. In that time there has been a throughput of over 300 patients and effectiveness studies have been carried out <sup>5</sup>.

Recommendations were formulated by the development group on the basis of the above and they were graded A, B or C according to the level of evidence (Box 1). The recommendations appear throughout the Physiotherapy Management section of the guidelines and are boxed for easy recognition.

Good practice recommendations are not graded but are denoted by .

Caution points are highlighted by  where there may be a contra-indication for a certain group.

A key to the levels of evidence and grades of recommendations follows in Box 1.



## Box 1:

# Key to Evidence Statements and Grades of Recommendations

The definitions of the types of evidence and the grading of the recommendations used in these guidelines originate from the US Agency for Healthcare Policy and Research<sup>2</sup> and are set out in the following table.

<b>Level</b>	<b>Type of Evidence</b>
Ia	Evidence obtained from meta-analysis of randomised controlled trials
Ib	Evidence obtained from at least one randomised controlled trial
IIa	Evidence obtained from at least one well designed controlled study without randomisation
IIb	Evidence obtained from at least one other type of well designed quasi experimental study
III	Evidence obtained from well designed non experimental descriptive studies, such as comparative studies, correlation studies and case studies
IV	Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities

<b>Grade</b>	<b>Recommendation</b>
<b>A</b> (Evidence levels Ia, Ib)	Required – at least one randomised controlled trial as part of the body of literature of overall good quality and consistency addressing a specific recommendation.
<b>B</b> (Evidence levels IIa, IIb, III)	Required – availability of well conducted clinical studies but no randomised clinical trials on the topic of recommendation.
<b>C</b> (Evidence level IV)	Required – evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities.

# 1

## Introduction

In 1994 the World Health Organisation (WHO) defined osteoporosis as a disease characterised by low bone mass and microarchitectural deterioration of bone tissue, leading to increased bone fragility and a consequent increase in fracture risk.

One in three women and one in twelve men over 50 years of age are affected<sup>6</sup>.

The categories of the disease are defined in terms of bone mineral density (BMD) as follows:

### **Normal**

A value for BMD within 1 standard deviation (SD) of the young adult reference mean.

### **Low Bone Mass (osteopenia)**

A value for BMD more than 1 SD below the young adult mean but less than 2.5 SD below this value.

### **Osteoporosis**

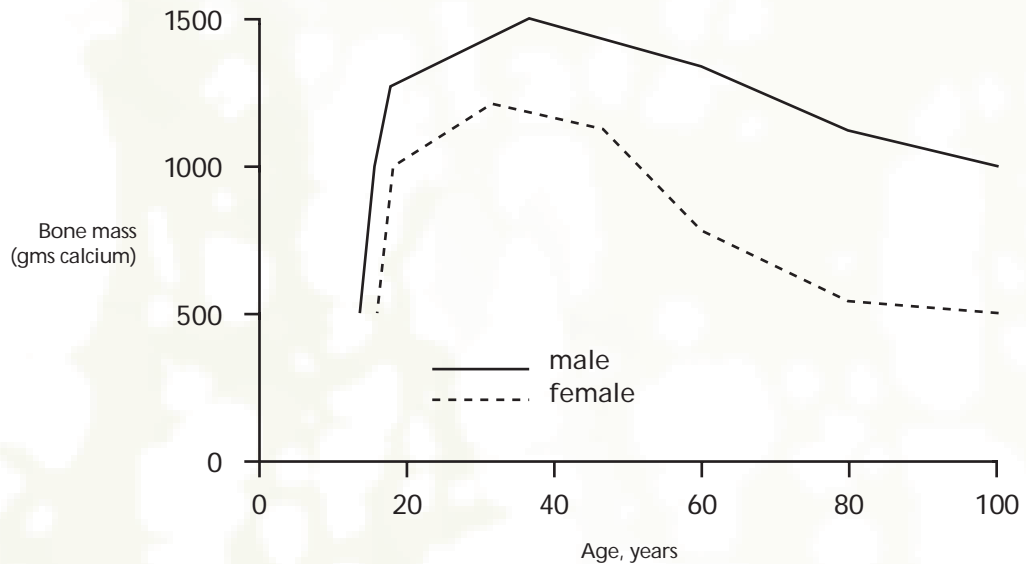
A value for BMD of 2.5 SD or more below the young adult mean.

While osteoporosis is strictly defined in terms of bone mineral density, access to BMD diagnostic facilities is still limited in the UK. In most cases physiotherapists will be referred patients following fracture, unless they are working in major centres.

The condition often becomes manifest when a fracture occurs through minimal trauma<sup>7</sup>. Hip, vertebral and wrist fractures are the most common. The prognosis for patients who have sustained a hip fracture is poor: 50% are never able to walk independently again and up to 25% die within 18 months<sup>7</sup>.

Alterations in bone density throughout life fall into three phases: growth, consolidation and loss<sup>8</sup>. It occurs in both sexes and in all races. Most cross-sectional studies demonstrate a biphasic pattern of bone loss. A slow rate of loss starts around 40 years in both sexes. The initial rate of loss is about 0.3–0.5% of peak bone mass per year, and this gradually decreases with age. Superimposed on this slow phase is an accelerated post-menopausal phase of bone loss in women. Rates of loss during this period may be as great as 5–6% per year. The graph below clearly shows the changes in bone mass with age in both men and women<sup>7</sup>.

Figure 1:  
Change in Bone Mass with Age



National Osteoporosis Society

Reference: Cooper and Melton 1992

The sequelae of osteoporosis are a major public health problem associated with high levels of mortality and morbidity including pain, deformities and loss of independence<sup>6</sup>. Hence osteoporosis is associated with high social and health service costs. Tessa Jowell, Minister for Public Health, when announcing a new strategy to prevent and tackle Osteoporosis in 1998, stated that 'Some active preventative work would actually save more than it would cost. For example, the cost of treating a fractured hip is £4,800. One in five of those who break a hip go on to need long-term residential nursing home care at an average cost of £19,000 per year.'

The osteoporotic condition develops slowly until so much bone has been lost that a dangerous threshold of vulnerability is reached. Preventative strategies are needed to preserve or enhance the trabecular architecture long before it becomes eroded to the point of imminent collapse. Advice should be given at the earliest opportunity to encourage individuals to achieve their optimal peak bone mass and thereafter to take steps to minimise bone loss.

The natural stimulus for bone to maintain its functional strength is the loading which results from gravitational forces and the tensions exerted by muscular activity. Exercise therefore has a role in reducing the long term risk of developing osteoporotic fracture. There is good evidence, which will be described throughout the guidelines, that site specific loading of bone through suitable physical activity produces changes in bone mass and density.

Exercise therapy also has an important role in the much frailer and often older group with severe bone changes. Here the aim is predominantly to prevent further fractures by improving muscle strength, exercise tolerance, balance and thereby reduce the risk of falling.

It is recognised that medical interventions such as hormone replacement therapy (HRT), Selective Estrogen Receptor Modulators (SERMS), bisphosphonate and calcitonin treatment and detailed dietary advice have important roles but are not within the scope of this document. Users of the guidelines should refer to the appropriate literature and to clinical colleagues for advice. Reference should be made to the Royal College of Physicians' Guidelines and the COMA report on Nutrition and Bone Health<sup>9,10</sup>.

## Risk Factors

Physiotherapists need to be aware of the major risk factors for osteoporosis so that they can effectively participate in all aspects of the prevention and management of this condition. The two major risk factors are being female and elderly. In addition, there are a number of other well established risk factors listed below<sup>6</sup>:

- Early menopause (age <45)
- Hypogonadism
- Physical inactivity
- Thin body type
- Major gynaecological surgery e.g. hysterectomy
- Amenorrhea
- Anorexia
- Heredity
- Rheumatological conditions e.g. rheumatoid arthritis, ankylosing spondylitis
- Smoking
- High alcohol
- High caffeine intake
- Insufficient dietary calcium and Vitamin D.

Secondary osteoporosis accounts for 20% of cases in women and 40% of cases in men and may occur as a result of<sup>11</sup>:

- Endocrine disorders (including thyrotoxicosis, primary hyperparathyroidism, Cushing's Syndrome).
- Rheumatological conditions
- Gastro-intestinal disorders (malabsorption, partial gastrectomy, liver disease)
- Malignancy (multiple myeloma, metastatic carcinoma)
- Certain drugs (corticosteroids, heparin).

# 3

## Target client groups for treatment by physiotherapists

For the purpose of these guidelines a pragmatic decision was made to separate the target client groups into 3 broad categories:

- 1 Those with normal bone mass concerned with reducing the risk together with people with mild bone changes (osteopenia).
- 2 People with a clinical diagnosis of osteoporosis without any history of fracture (#).
- 3 A frailer group with advanced bone changes usually having sustained fractures (#).

All categories can include both men and women of all ages. However the frailer group do tend to be older. Physiotherapists must use all available clinical information to ensure that clients are correctly categorised. If in doubt a definitive diagnosis should be obtained from the referring specialist.

The following symbols denote each group and are used throughout the recommendations to assist in the correct choice of assessment techniques and effective interventions for each category.

- Men and women who have been diagnosed with mild bone changes (i.e. BMD more than 1 SD below young average) (osteopenia) and those concerned with reducing the risk (prevention).
- Men and women who have been diagnosed with osteoporosis (i.e. BMD 2.5 SD below young adult mean) but have not yet sustained any fractures.
- ▲ A much frailer group with more severe osteoporotic changes (i.e. BMD more than 2.5 SD). This group mainly but not always comprises a more elderly population (both men and women). These patients may or may not have sustained one or more fractures.

These symbols are printed at the foot of each page as a reminder to the reader.



Denotes caution



Denotes good practice based on clinical experience as opposed to formal evidence

## Physiotherapy assessment

Once patients with a diagnosis of osteoporosis have been referred for physiotherapy, they should be correctly categorised and a detailed, standard physiotherapy assessment carried out. This will help to ensure that important issues are not inadvertently omitted. Accurate assessment of all aspects of impairment, disability and handicap, using reliable and appropriate measuring tools, is the key to delivering successful and appropriate management programmes, and assessing effectiveness. Listed below are assessment procedures applicable to osteoporosis patients, which are reliable and considered good practice by the Guideline Developers. Most of the testing procedures do not require sophisticated equipment and can therefore be used by most physiotherapists. They should be used selectively, according to the disease severity at the time of referral. Measurement of cervical/thoracic deformity, balance, lumbar spine endurance, flexibility and effect on life style should always be carried out when assessing any osteoporotic patient.

### 4.1 Anthropometric and spinal mobility assessment

These measures should always be assessed and recorded.

- ● ▲ **Height:**  
Measured in centimetres (cm), patient standing with back against the wall without shoes.
- ● ▲ **Weight:**  
In kilograms (kg) using calibrated scales.
- ● ▲ **Chest expansion measured at xiphisternum:**  
Record chest excursion with the patient standing with their hands on their head. Maximal inhalation is followed by exhalation. Total change is measured as the value at maximal inhalation minus the value at maximal exhalation. The measuring tape is placed around the xiphisternum. One measure is taken to the nearest cm<sup>12</sup>. A modified technique may have to be used for those osteoporotic patients who do not have sufficient range of movement to stand with their hands on their head.
- ● ▲ **Cervical/Thoracic deformity (tragus to wall):**  
Heels and buttocks touching the wall, the knees straight, pushing head back while still keeping the chin in neutral position. The distance between the tragus (mastoid process) and the wall is measured to the nearest 0.1 of a cm using a tape measure<sup>12</sup>.
- ● ▲ **Shoulder elevation:**  
Measurement is taken with the patient standing with their back against the wall. A goniometer is placed over the greater tuberosity. The patient is instructed to elevate their shoulder into flexion<sup>13</sup>. Again modifications may have to be made to the starting position for those patients with kyphotic changes.



Osteopenia



Osteoporosis (no #)



Severe osteoporotic changes

■ ● ▲ **Lumbar spine range of movement (Schober extension):**

Patient standing with knees straight and feet slightly apart. Three skin marks are made: the first at the lumbosacral junction, the second and third 5cm below and 10cm above this mark. The patient is then asked to extend their back. The approximation is measured and subtracted from 15cm. One measurement should be taken<sup>14</sup>.

## 4.2 Strength/endurance assessment

Some measure of strength/endurance should be assessed and recorded.

**Various methods of strength measurement are available:**

- ● The trunk extension endurance measurement is a simple method of measuring the trunk extensors. The procedure is as follows: the patient lies prone and holds their sternum off the floor. A small pillow is placed under the abdomen to decrease lumbar lordosis and the patient is asked to maintain cervical flexion and to demonstrate this position<sup>15</sup>. This assessment should not be maintained for longer than 20 seconds. It is contra-indicated for patients with a history of heart complaints as blood pressure may become elevated. Patients with a marked kyphosis must also be excluded.
- ● These client groups can use various modalities of other strength testing equipment, e.g. isometric, isotonic,<sup>16</sup> using the 1 Repetition Maximum (1RM) method or more sophisticated equipment, such as isokinetics.
- ▲ Measurement of 1RM can also be used in this group, but care should be taken to avoid using weights at the end of long levers.

## 4.3 Aerobic capacity assessment

Some measure of aerobic capacity should be assessed and recorded.

**Various methods of aerobic tolerance testing can be used, specific to the target group.**

- A submaximal progressive exercise test using either a treadmill or cycle ergometer can be used to estimate aerobic capacity<sup>17</sup>.
- ● Where testing equipment is not available, the Adapted Shuttle Walking Test<sup>18</sup> is a useful test and very easy to carry out. This test can safely be used on patients with moderate osteoporotic changes depending on their level of disability. The procedure is as follows: the patient is asked to walk up and down a 10m course. The speed is dictated by an audio signal played on a tape. The patient walks at the stated pace and aims to turn around when they hear the signal. The patient is asked



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to continue the test until they are unable to maintain the required speed, or a pre-determined endpoint is met e.g. 60% of age-adjusted predicted maximum heart rate. This is worked out by using the simple equation 220 minus the age of the patient. This gives predicted maximum heart rate. This figure is then multiplied by 0.60 to give the 60% maximum.

- ▲ Other walking tests may be appropriate for patients with more severe changes or those tested at home, for example, the Elderly Mobility Scale (EMS)<sup>19</sup> and the 'Timed Up and Go Test' (TUAG)<sup>20</sup>. The Guideline Developers consider these two tests appropriate for this patient group. The EMS is a 20 point scale measuring functional abilities such as transfers, balance and walking speed. For the TUAG test the subject is asked to stand up from a standard height chair walk 3 metres, turn around, walk back and sit down. The whole process is timed from initiation of standing to the sitting position.

#### 4.4 Balance assessment

This should always be assessed and recorded.

- ● ▲ Assessment of balance is an important measurement, as one of the main aims of a physiotherapy exercise programme is to reduce falls. A very simple test is the 'one legged stand'<sup>21</sup>. For this, the patient is asked to stand between a set of parallel bars on one leg without holding onto the bars. The subject is given a practice attempt and this is followed by a timed attempt. Testing can be carried out on both legs and can also be carried out with eyes closed. This should always be tested between parallel bars for safety. Other useful balance tests are described by Tinetti<sup>22</sup>. The reader can obtain further information regarding falls from the 'Guideline for the collaborative, rehabilitative management of elderly people who have fallen', available from the CSP, 14 Bedford Row, London WC1R 4ED.

#### 4.5 Functional assessment

Assessment of functional ability in the community should always be made. This will help to ensure the appropriate intervention for each individual.

- ▲ It is important to establish the extent of disability and handicap. This will help in the setting of treatment goals, plans for intervention, and so take the physiotherapy management effective for the patient; to reduce the chances of falling in the community. For an in-depth pain and activity record the Osteoporosis Functional Disability Questionnaire (OFDQ) is very useful<sup>23</sup>.
- ▲ An appropriate functional test for this group should be used e.g. 'timed sit to stand', grip strength, stair climbing or 20 metre timed walk<sup>24</sup>.



Osteopenia



Osteoporosis (no #)



Severe osteoporotic changes

## 4.6 Pain assessment

- ▲ There are various measurement tools applicable for these patient groups. For example: visual analogue scales<sup>25</sup>, the McGill pain questionnaire,<sup>26</sup> and the monitoring of daily analgesic intake. The QFDQ can also be used as a measurement of pain<sup>23</sup>.

## 4.7 Analysis of assessment and outcomes

- ● ▲ It is not enough to merely record a standard assessment and use standardised outcome measures. The findings of the assessment and the results of the outcome measures should be routinely analysed by individual clinicians and the Service as a whole. This will help clinicians to consider the effects of intervention and attribute the reasons for changes appropriately.



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## Physiotherapy management

The management section deals firstly with the unique exercise and lifestyle requirements for enhancing bone health and functional independence in each of the three target groups. This is followed by more general sections about balance, posture, education, psychological well-being and potential harms and risks which affect all three groups.

### ■ 5.1 Management for the osteopenic and prevention group

#### **Aims**

- Increase the peak bone mass in the at risk/preventative group
- Maintain or increase BMD in the osteopenic group and reduce the early rapid bone loss after menopause
- Improve muscle strength, balance, cardiovascular fitness
- Improve posture
- Improve psychological well-being
- Provide education.

#### ■ 5.1.1 Exercise management for bone health

Exercise therapy in the form of weight bearing aerobic training activity and or strength training activity is now recognised as a valid and important intervention in the management of bone health. It is thought that the mechanical stresses that are put through bone during exercise can affect bone density. Weight bearing activity stimulates bone remodelling. It has been hypothesised that bone hypertrophy occurs in response to microfractures at the level of the osteon. Microscopic damage occurs where the tendon attaches to the bone when the stress applied is in excess of the normal levels, e.g., during weight bearing physical activity<sup>27</sup>.


There is evidence that high impact exercise has the greatest potential to affect bone density in pre-menopausal women<sup>28, 29</sup>.

High impact exercise is suitable for those who regularly exercise. A lower impact programme of exercise is also appropriate especially for those not used to exercise. To be effective all exercise programmes need to be progressive in terms of impact and intensity as fitness and strength levels improve. However it is essential that all programmes begin at a low level which is comfortable for the patient. The assessment will give the physiotherapist a reference point from which to start the exercise programme. Reference should be made to the ACSM<sup>17</sup> on progression of exercise programmes. However it is generally accepted that microfracture is needed for an osteogenic response.

Many well designed randomised controlled trials have investigated the effects of exercise on bone health in the post menopausal osteopenic group. The aim of exercise in this group is to reduce the early rapid loss of bone density following the menopause and also maintain and sometimes increase bone mass.

- High impact exercise, e.g. skipping and jogging, has the greatest potential to improve BMD in pre-menopausal group<sup>28, 29</sup>. **Grade A Level 1b**

- Low to medium impact exercise, such as step aerobics, intermittent jogging is more appropriate for those not used to exercising and those over 50 years of age<sup>30</sup>. **Grade A Level 1b**


- Integrate high impact with medium and or low impact activities for a well designed and safe programme. People should be instructed in the use of rebound techniques, i.e. give or bend in the knees on take off and landing. 

- Strength training is useful in sedentary young individuals provided it is of a high enough intensity i.e. 70–80% 1RM. It not only improves strength, but is accompanied by improvements in BMD<sup>31</sup>. **Grade A Level 1b**

- All exercise programmes should start at an easy level and be progressive in terms of intensity and impact<sup>17</sup>. **Grade C, Level III**

#### ■ 5.1.2 Precautions

Although high impact exercise is recommended for improvements in bone health, prolonged periods of high impact exercise are not necessary and can cause soft tissue injuries and pelvic floor stress. Optimum benefits will only be achieved by ensuring safe design of programmes and correct performance which incorporates a balance of high/low impact exercise. All high impact exercise is inappropriate and unsafe if:

- People suffer from joint conditions
- People cannot perform exercise with correct technique i.e. unable to rebound effectively
- People with pelvic floor problems
- The design of the programme is unsafe, e.g. all of the exercise occurs on the spot, and if the programme does not incorporate medium and low impact exercise. 



Denotes caution



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## ● 5.2 The osteoporotic group who have not sustained fractures

### Aims

- Maintain bone strength
- Prevent fractures
- Improve muscle strength, balance, cardiovascular fitness
- Improve posture
- Improve psychological well-being
- Provide education
- Aim to reduce falls

### ● 5.2.1 Exercise management for bone health

The evidence of the effects of exercise on the skeleton is not as conclusive for those with an actual diagnosis of osteoporosis. Most of the studies have been carried out on postmenopausal sedentary women who are not actually osteoporotic<sup>32, 33</sup>. The conclusions from these studies are that exercise regimes are beneficial in promoting bone health. It has been inferred from these studies and others that these regimes could be used effectively for those with osteoporosis<sup>32, 33, 34</sup>. One study, which has investigated those patients with an actual diagnosis of osteoporosis, found improvements in bone mineral density of the distal forearm following high rates of dynamic loading<sup>35</sup>. This reinforces the hypothesis that exercise training is required to be site specific.

One study carried out by Kerr et al<sup>36</sup> concluded that post-menopausal bone mass can be significantly increased by a strength regimen that uses high load, low repetitions but not by an endurance regimen that uses low load, high repetitions. This suggests that peak load is more important than the number of loading cycles in increasing bone mass in early post-menopausal women.

Some of the principles also apply to the post menopausal osteopenic group and in these cases the ■ symbol will also be shown.



It is advised that the overload principle is applied through a high load and low repetitions regime. Any form of strength training does require to be site specific i.e. targeting areas such as the muscle groups around the hip, quadriceps, dorsi/plantar flexors, rhomboids, wrist extensors and back extensors<sup>16, 32, 33, 37</sup>. **Grade A, Level 1b**



Weight bearing exercises should be targeted to loading bone sites predominantly affected by osteoporotic change<sup>35</sup> i.e. hip, vertebrae and wrist. **Grade B, Level 2a**

The most recent meta-analysis concluded that exercise (aerobic and strength) helps to slow the rate of post-menopausal bone loss in post menopausal women<sup>38</sup>.



Osteopenia



Osteoporosis (no #)



Severe osteoporotic changes



Exercise should be used in combination with both adequate calcium intake and some type of hormone replacement therapy for maintaining and/or increasing bone mineral density in postmenopausal women at risk from osteoporosis<sup>38</sup>.

**Grade A, Level 1a**



All exercise programmes should start at an easy level and be progressive in terms of intensity and impact<sup>17</sup>.

**Grade C, Level III**

### 5.2.2 Precautions

The following activities should be avoided:

- High impact exercise
- Trunk flexion
- Trunk rotational torsion movements with any loading
- Lifting
- The pelvic floor precautions listed in the 5.1.2 section also apply.



Denotes caution



Denotes good practice based on clinical experience as opposed to formal evidence

### ▲ 5.3 Frailer group with severe changes who have often sustained fractures

#### Aims

- Falls reduction
- Prevention of further fractures
- Balance/co-ordination
- Improvements in muscle strength, flexibility, aerobic capacity, posture
- Gait re-education
- Psychological well-being and increased confidence
- Reduce/control pain

#### ▲ 5.3.1 Exercise Management

The aim of exercise therapy in this frailer group is predominantly to minimise the risk of falling and thereby risk of fracture, as opposed to affecting bone density. However, studies of this generally elderly group have found that improvements in muscle strength can be achieved <sup>39, 40</sup>.

The exercise tolerance of this group may be poor. Therefore any form of training must start with a very low intensity. McMurdo et al found that even seated exercise can result in functional improvements <sup>41</sup>.

▲ Exercise training must start at a very low intensity using low impact exercises.



▲ For strength training initially use very short levers or body resistance.



Exercises in warm water (hydrotherapy) are assisted by the physical properties of water, namely buoyancy and temperature. The weight relieving property of water immersion allows easier movement with less pain. There is no evidence to suggest that hydrotherapy has any effect on bone mineral density. However, there is evidence that other physiological parameters can be affected, such as muscle strength, aerobic capacity and pain control. There may also be an increase in psychological wellbeing <sup>42, 43, 44</sup>.

▲ Exercises that patients find difficult on dry land may be more easily carried out in water. For example, trunk extension will be impossible for some of these patients on dry land but can be achieved in water and resistance can gradually be increased.



▲ All exercise programmes should be progressive in terms of intensity and impact <sup>17</sup>. A very gentle low impact programme using gravity and body resistance exercise is recommended.

**Grade C, Level III**



Osteopenia



Osteoporosis (no #)



Severe osteoporotic changes

### 5.3.2 Precautions



No high intensity exercise  
All the precautions listed in the previous sections apply to this frail group.



### 5.3.3 Pain Management

Pain management in this group is a major part of the therapeutic intervention. These patients are often referred for physiotherapy following painful vertebral compression fractures. Pain management therefore becomes a priority before the patient can be introduced to any exercise programme. However, it should be noted that only 50% of patients with a vertebral fracture complain of pain<sup>45</sup>. Other causes of pain can be abnormal stress on joints and soft tissues due to postural changes, resulting in muscle spasms and imbalances. Another complaint is pain arising from the lower ribs pressing down onto the pelvis, due to reduction in height and kyphotic changes.

The following modalities may be effective for osteoporosis and apply to all those with associated pain in any of the target groups.

#### 5.3.3.a Hydrotherapy



Hydrotherapy should be considered as a treatment modality where the patient has pain from recent vertebral fractures, and/or postural and balance problems. Hydrotherapy is also a very useful modality to build confidence in very disabled people and those afraid of further falls.



#### 5.3.3.b Transcutaneous Electrical Nerve Stimulation (TENS)

TENS has been shown to be effective in some patients with chronic pain conditions<sup>46</sup>. The rationale for use is based on the activation of the pain gate mechanism<sup>47</sup>.



TENS should be considered as a modality for the osteoporotic patient with intractable pain<sup>46</sup>, especially those with chronic back pain and recent vertebral fractures.

**Grade A, Level Ib**

#### 5.3.3.c Interferential Therapy

The mechanism for pain relief is the same as for TENS.

#### 5.3.3.d Heat

Applied heat has several possible physiological benefits, such as reducing muscle spasm, increasing local blood flow and stimulating an analgesic effect<sup>48</sup>.



Patients should be instructed on how to use heat therapy safely at home to relieve pain symptoms



Denotes caution



Denotes good practice based on clinical experience as opposed to formal evidence

## 5.3.3.e Relaxation

Relaxation has long been advocated for reducing muscle tension and anxiety<sup>49</sup>. The two most widely accepted methods are the Jacobsen progressive relaxation and the Mitchell simple physiological technique.



The use of relaxation should be discussed with/offered to osteoporotic patients with intractable pain.



## 5.3.3.f Complementary Therapies

Recently other forms of pain management such as reflex therapy, aromatherapy and acupuncture<sup>50</sup> have become more popular as alternative ways of managing pain by physiotherapists. For more detailed information reference should be made to the specific literature and the appropriate CSP Clinical Interest Group.



Osteopenia



Osteoporosis (no #)



Severe osteoporotic changes

## 5.4 Balance and falls management



Exercise for all age groups has the potential to improve dynamic stability and co-ordination and therefore could have a protective role in preventing falls in later life<sup>51</sup>. The activity needs to be weight-bearing.

A study carried out on pre-menopausal women found that high impact loading exercise carried out once a week improved both balance and co-ordination<sup>29</sup>.

The diagnosis of osteoporosis becomes of clinical importance following fractures, which are generally the result of trauma from falls. Causes of falls are known to be multi-factorial. They include deficiencies in eyesight, footwear, balance, co-ordination, strength, home environment and general health, including diet and medication.

Tai Chi is an ancient exercise and martial art that has been practised in China for centuries by all age groups. There are various forms of Tai Chi. One particular form of Tai Chi is Chuan, which is especially useful for older people. It includes slow, controlled dimensional movements and has been shown to improve balance, muscle strength and to reduce significantly the fear of falling<sup>52, 53</sup>.

It is important particularly with the fragile groups to aim for a sensible balance between providing people with protective means, i.e. walking frames, hip protection pads, and enough exercise to obtain potential improvements in bone health, strength and balance. Physiotherapists, through their training, experience of exercise with other vulnerable groups, and skills in observation, are well placed to facilitate progress in these groups and should be encouraged to do so.



A thorough falls risk assessment should be made and risk factors eliminated as far as possible.



Some elements of Tai Chi could be incorporated into any exercise class but are especially effective for those elderly people where balance is a problem.



Any activity that promotes co-ordination and balance appropriate to the severity of the disease should be encouraged, i.e. simple balance exercises such as supported one leg stands can be effective.



The use of hydrotherapy is frequently indicated to reduce pain, and to provide a safe environment for balance exercises.



The reader can obtain further information regarding falls management from the 'Guideline for the collaborative, rehabilitative management of elderly people who have fallen', available from the CSP, 14 Bedford Row, London WC1R 4ED.



Denotes caution



Denotes good practice based on clinical experience as opposed to formal evidence

## 5.5 Posture and flexibility

■ ● ▲

Thoracic kyphosis, due to vertebral fractures, is often a clinical sign of osteoporosis and is often associated with pain. Postural education and awareness are important in preventing/minimising respiratory problems, neck pain and balance disorders<sup>54</sup>.

Severe kyphotic changes may be a problem for subjects in this group, possibly limiting their ability to exercise due to a compromised respiratory system and causing pain. It is especially important for those with postural deformities to maintain maximum range of movement of the shoulder girdle, spine and hips and prevent further postural changes. Stretching exercises should focus on the thoracic and cervical spine for these patients.

● ▲

Back extension exercises are very important for this group<sup>55</sup>. Kyphosis can often be improved as it is not totally dictated by the shape of the bones but also by muscle weakness and/or pain.

**Grade B, Level IIa**

● ▲

Back extension exercises can also be taught in the seated position for those unable to lie on their front.



● ▲

Exercises should concentrate on encouraging chest excursion, rhomboid exercises and balance. Gait re-education and appropriate walking aids may also be necessary.



■ ● ▲

Stretching to improve flexibility should be part of every exercise programme for all of the client groups. Stretching of all the major upper and lower limb muscle groups should be carried out.



■ ● ▲

Stretching should always be carried out following a warm-up period.



Ballistic stretching should always be avoided.



Osteopenia



Osteoporosis (no #)



Severe osteoporotic changes

## 5.6 Exercise prescription



It is important to consider the roles of Frequency/Intensity and Duration of Exercise Prescription in maximising the positive effects on bone health.

Studies have shown that weight-bearing exercise, with progressive increases in intensity, needs to be continued for more than nine months in order to achieve positive effects on bone density. Once exercise programmes are discontinued the positive effects will be reversed<sup>56</sup>.

There is now evidence of a dose response relationship between exercise and bone mineral accretion following a study by Korht et al<sup>57</sup>. She found a significant relationship between increases of whole body BMD and the net increase in energy expenditure (i.e. physical activity). She indicated that vigorous exercise training can induce significant increases in BMD in older post-menopausal women. However, more work needs to be done to determine whether single parameters of the amount of exercise, such as frequency, duration and intensity, can be predictive of changes in BMD.

In the absence of other specific literature on intensity of exercise needed to impact directly on bone health, it is suggested that the recommendations from the American College of Sports Medicine on dosage in connection with cardiovascular health might be applied. In 1990 it recommended a weekly minimum of at least three x 20-minute sessions of vigorous intensity exercise. However, in 1993 the Centre for Disease Control in conjunction with the American College of Sports Medicine recommended a general more active living approach with more frequent bouts of moderate intensity exercise<sup>17</sup>. Five x 30 minutes per week of moderate exercise is a general guideline.



As bone density changes due to weight-bearing exercise will not normally be detected before nine months<sup>58</sup>, exercise programmes should be designed and structured to enable and motivate clients to continue indefinitely and exercise with moderate intensity five x per week. Once exercise programmes are discontinued the positive effects will be reversed<sup>56</sup>. **Grade A Level 1b**



Denotes caution



Denotes good practice based on clinical experience as opposed to formal evidence

## 5.7 Psychology of exercise



Habitual exercise, particularly aerobic type activity, is well known to have beneficial psychological effects in all age groups. These effects have been well researched in a number of clinical populations. There are guidelines on constructing sessions to improve well-being in cardiac rehabilitation and chronic low back pain which could be adapted for the osteoporotic population<sup>59,60</sup>. A recent study by Bravo et al<sup>51</sup> found an improvement in self-perceived health in subjects who had exercised for one year, compared to their non-exercising counterparts.



Encourage habitual aerobic type exercise (dry land or water) for psychological health benefits<sup>50</sup>.

**Grade A, Level 1b**

### 5.7.1 Adherence

It is generally accepted that neither initial motivation nor sustained compliance to exercise are easy to achieve. Factors such as the enjoyment, convenience and intensity of prescribed exercise can have a significant impact on participation and adherence<sup>61</sup>. Group exercise has a number of potential advantages, including a large professional-to-subject ratio, on site supervision, visual modelling on the instructor, a set structure with regard to location, exercise format and duration, time and face-to-face encouragement<sup>62</sup>.

Gaining advice and information from fellow participants and group support is also helpful. Music in an exercise class is a useful way to create a positive atmosphere. Self-management techniques to use in conjunction with or following participation in exercise classes should be encouraged<sup>62</sup>.



A successful exercise programme, especially for an older population, should build on individuals' previous habits, tapping any skills that have been acquired. Above all, exercise must be seen to be personally rewarding. A skilled class leader can present participation as a means of escape from physical dependency, of earning the respect of significant others and of personal fulfilment<sup>63</sup>.



### 5.7.2 Promoting Habitual Exercise

The target groups will have to form a lifelong habit of exercising regularly. Once individuals can exercise safely and have an awareness of how to avoid potential risks they should start to participate in appropriate exercise groups in leisure facilities and sports centres. It should be recognised, however, that some individuals do not like exercising in a group. If this is the case individuals should be encouraged to enjoy an active lifestyle including exercises at home.



Physiotherapists should forge links with local institutions (leisure and sports facilities) and possibly contribute to the training of fitness instructors in order to facilitate continuing safe and effective exercise provision for these subject groups outside the healthcare setting.



Osteopenia



Osteoporosis (no #)



Severe osteoporotic changes

# 6

## Potential harms and risks

The physiotherapist must be aware that there are potential risks for those undertaking exercise and special care should be taken with the osteoporotic and frailer group.



Fracture is the main risk factor for all the client groups.



Exercises should not be high impact. Excessive rotational movements should be avoided as well as flexion exercises, as these have been shown to increase vertebral fractures.



Care should be taken with the exercise tolerance of the individual. If the individual has a poor exercise tolerance test result (See Section 4.3), exercises should be gentle but still progressive.



Forceful joint manipulation is contra-indicated when osteoporosis has been diagnosed<sup>64</sup>.



Denotes caution



Denotes good practice based on clinical experience as opposed to formal evidence

## Education

### 7.1 Patient Education



Patient education is an important part of physiotherapy management, both in obtaining adherence to an exercise programme and in helping to relieve pain, fear and anxiety when pain is a major symptom. It is the role of the physiotherapist therefore to:

- Guide patients to understand the implications and risk factors associated with osteoporosis and to motivate them to become active participants in all aspects of the management of their condition. ✓
- Give lifestyle advice on lifting and handling, diet, posture and safe exercise/activity ✓
- Encourage patients to achieve the correct balance between activity and rest and to set realistic individual goals, which will be dependent on the severity of their condition. ✓
- Make available to people additional information with regard to local self help groups, exercise classes in the community and the National Osteoporosis Society. ✓
- Liaise with other health care professionals such as dietitians, doctors, occupational therapists and specialist nurses. ✓

### 7.2 Health Education



Physiotherapists have a professional responsibility to promote exercise strategies for bone health for all age groups.

- Physiotherapists should especially involve themselves in promoting the benefits of exercise to raise physical activity levels for young people and therefore achieve a high peak bone mass. They should aim to highlight the importance of prevention to all age groups. ✓
- Lists of useful local information for sufferers should be available in physiotherapy departments. ✓

# 8

## Useful contacts

- 1** National Osteoporosis Society

PO Box 10  
Radstock  
Bath BA3 3YB  
Tel: 01761 471771  
Fax: 01761 471104
- 2** Exercise Association of England

Unit 4  
Angel Gate  
City Road  
London EC1 2PT  
Tel: 0171 278 0811
- 3** Keep Fit Association

Francis House  
Francis Street  
London SW1P 1DE  
Tel: 0171 233 8898
- 4** Extend Exercise Training

22 Mallings Road  
Wheathampstead  
Herts AL4 8QJ  
Tel: 01582 832760
- 5** Women's League of Health & Beauty

52 London Street  
Chertsey  
Surrey KT16 8AJ  
Tel: 01932 564567
- 6** Ramblers' Association

1-5 Wandsworth Road  
London SW8 2XX  
Tel: 0171 582 6878
- 7** Fitness Industry Training

Central YMCA  
112 Great Russell Street  
London  
Tel: 0171 343 1850

**8**      Physiotherapy Clinical Interest Groups:

ACPC	Association of Chartered Physiotherapists in the Community
ACPWH	Association of Chartered Physiotherapists in Women's Health.
AGILE	Association of Chartered Physiotherapists with a Special Interest in Older People.
HACP	Hydrotherapy Association of Chartered Physiotherapists
RCACP	Rheumatic Care Association of Chartered Physiotherapists.

For details of the Hon Secretaries of above groups, contact:

The Chartered Society of Physiotherapy	14 Bedford Row London WC1R 4ED Tel: 0171 306 6666 Fax: 0171 306 6611
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For additional information about exercise, fitness facilities and organisations, it is suggested that physiotherapists encourage patients to contact the library/media within their local area.

# References

## References

- 1 Ritson, F., Scott, S. (1996) Physiotherapy for Osteoporosis. *Physiotherapy*. 82: 7, 390–394.
- 2 US Department of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research. Acute pain management: operative or medical procedures and trauma. Rockville: The Agency; 1992. Clinical Practice Guideline No.1. AHCPR Pub 92-0023. 107.
- 3 Oxman, A.D. (1994) Users' guides to the medical literature, VI. How to use an overview. *Journal of the American Medical Association*. 272 (17): 1367–1371.
- 4 Guyatt, G.H., Sackett, D.L., Cook, D.J. (1993) Users' guide to the medical literature. II. How to use an article about therapy or prevention. *Journal of the American Medical Association*. 270: 2598–2601 and 271: 59–63.
- 5 Mitchell, S.L., Grant, S., Aitchison, T. (1998) Physiological effects of exercise on post-menopausal osteoporotic women. *Physiotherapy*. 84: 4, 157–163.
- 6 Barlow, D. et al (1994) Department of Health advisory group on osteoporosis. Report. London.
- 7 Cooper, C., Melton, L. (1992) Epidemiology of Osteoporosis. *Trends in Endocrinology and Metabolism*. 3: 224–229.
- 8 Riggs, B.L., Melton, L.J. (1986) Medical progress: involutinal osteoporosis. *New England Journal of Medicine*. 314: 1676–1686.
- 9 Royal College of Physicians (1999) Clinical Guidelines for strategies to prevent and treat Osteoporosis
- 10 COMA (1998) Nutrition and Bone Health. Report on Health and Social Subjects No 49. DH: The Stationery Office. ISBN 0 11 322262 9.
- 11 Peel, N., Eastell, R. (1995) ABC of Rheumatology - Osteoporosis. *British Medical Journal*. 310: 989–992.
- 12 Laurent, M.R., Buchanon, W.W., Bellamy, N. (1991) Methods of assessment used in Ankylosing Spondylitis clinical trials: A review. *British Journal of Rheumatology*. 30: 326–329.
- 13 Riddle, R.E. Rothstein, J.M., Lamb, R.L. (1987) Goniometric reliability in a clinical setting - shoulder measurements. *Physical Therapy*. 67: 668–673.
- 14 Moll, J.M.H., Liyanage, S.P., Wright, V. (1972) An objective clinical method to measure spinal extension. *Rheumatological Physical Medicine*. 11: 507–511.
- 15 Toshikazu, I., Shirado, O., Suzuki, H., Takahashi, M., Kanedo, K., Strax, T.E. (1996) Lumbar trunk muscle endurance testing: An inexpensive alternative to a machine for evaluation. *Archives of Physical Medicine and Rehabilitation*. 77: 75–79.
- 16 Nelson, M.E., Fiatarone, M.A., Morganti, C.M., Trice, I., Greenburg, R.A., Evans, W.J. (1994) Effects of high intensity strength training on multiple risk factors for osteoporotic fractures. *Journal of the American Medical Association*. 272: 1909–1914.
- 17 American College of Sports Medicine. (1990) The recommended quality and quantity of exercise for developing cardiorespiratory and muscular fitness in adults. *Medicine and Science in Sport and Exercise*. 22: 265–274.

- 18 Singh, S.J., Morgan, S.J., Hardman, A.E., Rowe, A.E., Bardsley, P.A. (1994) Comparison of oxygen uptake during a conventional treadmill test and the shuttle walking test in chronic airflow limitation. *European Respiratory Journal*. 11: 7, 2016–2020.
- 19 Smith, R. (1994) Validation of the elderly mobility scale. *Physiotherapy*. 80: 11, 744–747.
- 20 Podsiadlo, D., Richardson, S. (1991) The timed up and go: a test of basic functional mobility for frail elderly persons. *Journal of the American Geriatric Society*. 39: 142–148.
- 21 Iverson, B.D., Gossman, M.R., Shaddeau, S.A., Turner, M.E. (1990) Balance performance, force production, and activity levels in noninstitutionalised men 60–90 years of age. *Physical Therapy*. 70 (6): 348–55.
- 22 Tinetti, M.E., Baker, D.I., McAvey, G., Claus, E.B., Garrett, P., Gottschalk, P.T., Koch, M.L., Trainor, K., Horwitz, R.I. (1994) A multifactorial intervention to reduce the risk of falling among elderly people living in the community. *The New England Journal of Medicine*. 331: 821–827.
- 23 Helmes, E., Hodsman, A., Lazowski, D., Bhardwaj, A., Crilly, R., Nichol, P. et al (1995) A questionnaire to evaluate disability in osteoporotic patients with vertebral compression fractures. *Journal of Gerontology A Biol Sci Med Sci*. 50 (2): M91–8.
- 24 Hirsch, C.H., Fried, L.P., Harris, T., Fitzpatrick, A., Enright, P., Schultz, R. (1997) Correlates of performance-based measures of muscle function in the elderly: The Cardiovascular Health Study. *Journal of Gerontology*. 52 (4): M192–200.
- 25 Scott, J., Huskisson, E.C. (1976) Graphic representation of pain. *Pain*. 2: 175–184
- 26 Melzack, R. The McGill pain questionnaire In: *Pain measurement and assessment*. Ed. Melzack. New York, Raven Press. 1983: 41–46.
- 27 Carter, D.R. (1984) Mechanical influences in bone remodelling. *Calcified tissue International*. 36: (suppl) 19–24.
- 28 Bassey, E.J., Ramsdale, S.J. (1994) Increase in femoral bone density in young women following high impact exercise. *Osteoporosis International*. 4: 72–75.
- 29 Heinonen, A., Kannus, P., Sienanen, H., Oja, P., Pasanen, M., Rinne, M., Uusi-Rasi, K., Vuori, I. (1996) Randomised controlled trial of effect of high impact exercise on selected risk factors for osteoporotic fractures. *Lancet*. 348: 1343–7.
- 30 Kohrt, W., Snead, D., Slatopolsky, E., Birge, S.J. (1993) Additive effects of weight-bearing exercise and estrogen on bone mineral density in older women. *Journal of Bone and Mineral Research*. 10: 1303–1311.
- 31 Lohman, T., Going, S., Pamenter, R., Hall, M., Boyden, T., et al (1995) Effects of resistance training on regional and total bone mineral density in premenopausal women: a randomised prospective study. *Journal of Bone and Mineral Research*. 10: 1015–1024.
- 32 Presinger, E., Alaeamlioglu, Y., Pils, K., Bosina, E., Metka, M., Schneider, B., Ernst, E. (1996) Exercise therapy for osteoporosis: results of a randomised controlled trial. *British Journal of Sports Medicine*. 30: 209–212.

- 33 Welsh, L., Rutherford, O.M. (1996) Hip bone mineral density is improved by high impact aerobic exercise in post-menopausal women and men over 50 years. *European Journal of Applied Physiology*. 74 (6): 511–7.
- 34 Swezey, R.L. (1996) Spine update: exercise for osteoporosis – is walking enough? *Spine*. 21 (23): 2809–2813.
- 35 Ayalon, J., Simkin, A., Leichter, I., Raifmann, S. (1987) Dynamic bone loading exercises for postmenopausal women: effect on the density of the distal radius. *Archives of Physical Medicine and Rehabilitation*. 68, 11: 280–283.
- 36 Kerr, D., Morton, A., Dick, I., Prince, R. (1996) Exercise effects on bone mass in post-menopausal women are site specific and load dependent. *Journal of Bone and Mineral Research*. 11: 218–225.
- 37 Sinaki, M.D., Wahner, H.W., Offord, K.P., Hodgson, S.F. (1989) Efficiency of nonloading exercises in prevention of vertebral bone loss in postmenopausal women: a controlled trial. *Mayo Clinical Proceedings*. 64: 762–769
- 38 Kelley, G. (1998) Aerobic exercise and lumbar spine bone mineral density in post-menopausal women: A meta analysis. *Journal of the American Geriatric Society*. 46: 143–152.
- 39 Lord, S.R., Ward, J.A., Williams, P., Zivanovic, E. (1996) The effects of a community exercise programme on fracture risk factors in older women. *Osteoporosis International*. 6; (5): 361–367.
- 40 Fiatorone, M.A., O'Neill, E.F., Ryan, N.D., Clements, K.M. et al (1994) Exercise training and nutritional supplementation for physical frailty in very elderly people. *New England Journal Medicine*. 330: 1769–75.
- 41 McMurdo, M.E.T., Rennie, L. (1993) A controlled trial of exercise by residents of old people's homes. *Age and Ageing*. 22: 11–15.
- 42 Hall, J., Skevington, M., Maddison, P.J., Chapman, K. (1996) A randomised controlled trial of hydrotherapy in rheumatoid arthritis. *Arthritis Care and Research*. 9; 3: 206–215.
- 43 Simmons, V., Hansen, P.D. (1996) Effectiveness of water exercise on postural mobility in well elderly: An experimental study on balance enhancement. *Journal of Gerontology*. 51A; 5: M233–238.
- 44 Bravo, G., Gauthier, P., Roy P-M., Payette, H., Gaulin, P. (1997) A weight bearing, water based exercise programme for osteopaenic women: its impact on bone, functional fitness, and well-being. *Archives of Physical Medicine and Rehabilitation*. 78; (12): 1375–1380.
- 45 Melton, L.J., Chao, E.Y.S., Lane, J. Biomechanical aspects of fractures. In: Riggs, B.L., Melton L.J., eds. *Osteoporosis: aetiology, diagnosis, and management*. New York: Raven Press, 1988; 119–122.
- 46 Gadsby, J.G., Bennett, A., Flowerdew, M.W. (1995) The effectiveness of transcutaneous electrical nerve stimulation (TENS) and acupuncture like transcutaneous electrical nerve stimulation (ALTENS) in the treatment of patients with chronic low back pain. In (eds) CMSG Back Module of the Cochrane Database of Systematic Reviews. (updated 8 Sept 1996).

- 47 Melzack, R., Wall, P.D. (1965) Pain mechanisms; a new theory. *Science*. 150: 971–9.
- 48 Minor, M.A., Sanford, M.V. (1993) Physical interventions in the management of pain in arthritis. *Arthritis Care Research*. 6; (4): 197–206.
- 49 Takagi, A. (1992) A new concept of relaxation. *Journal of Physical Therapy and Science*. 4; (1): 45–52.
- 50 Jackson, D.A. (1997) Acupuncture for the relief of pain: a brief review. *Physical Therapy Reviews*. 2: 13–18.
- 51 Bravo, G., Gauthier, P., Roy, P.M., Payette, H., Gaulin, P., Harvey, M., Peloquin, L., Dubois, M.F. (1996) Impact of a 12 month exercise program on the physical and psychological health of osteopaenic women. *Journal of the American Geriatric Society*. 44 (7): 756–62.
- 52 Wolf, S., Barnhart, H.X., Ellison, G.L., Coogler, C.E. (1997) The effect of Tai Chi Quan and computerised balance training on postural stability in older subjects. *Physical Therapy*. 77: 4; 371–381.
- 53 Jacobson, B.H., Chen, H.C., Cashel, C., Guerrero, L. (1997) The effect of T'ai Chi Chuan training on balance, kinesthetic sense, and strength. *Perceptual and Motor Skills*. 84 (1): 27–33.
- 54 Itoi, E. (1991) Roentgenographic analysis of posture in spinal osteoporosis. *Spine*. 16: 750–756.
- 55 Sinaki, M., Mikkelsen, B.A. (1984) Postmenopausal spinal osteoporosis: flexion versus extension exercises. *Archives of Physical Medicine and Rehabilitation*. 65, (88): 593–596.
- 56 Drinkwater, B.L. (1994) 1994 C H. McCloy research lecture: does physical activity play a role in preventing osteoporosis? *Research Quarterly in Exercise and Sport*. 65: (3) 197–206
- 57 Korht, W.M., Ehsani, A.A., Birge, S.J. (1995) Effects of exercise involving predominantly either joint reaction or ground reaction forces on bone mineral density in older women. *Journal of Bone and Mineral Research*. 12: 1253–1261.
- 58 Dalsky, G., Stocke, K.S., Eshani, A.A., Slatopolsky, E., Lee, W.C., Birge, S.J. (1988) Weight bearing exercise training and lumbar bone mineral content in post menopausal women. *Annals of Internal Medicine*. 108: 824–828.
- 59 Newton, M., Mutrie, N., McArther, J.D. (1991) The effects of exercise in coronary rehabilitation programme. *Scottish Medical Journal*. 36: 38–41.
- 60 Weyerer, S., Kupfer, B. (1994) Physical Exercise and Psychological Health. *Sports Medicine*. 17: (2); 108–116.
- 61 King, A.C., Taylor, C.B., Haskell, W.L., DeBusk, R.F. (1990). Identifying strategies for increasing employee physical activity levels: Findings from the Stanford & Lockheed exercise survey. *Health Education Quarterly*. 17: 269–285.
- 62 Owen, N., Lee, C., Sedgwick, A.W. (1987) Exercise maintenance: developing self management guidelines for community fitness courses. *Australian Journal of Science and Medicine in Sport*. 8–12.
- 63 Dishman, R.K. (1994) *Advances in Exercise Adherence*. Human Kinetics.
- 64 Maitland, G.D. *Vertebral Manipulation*. 5th Edition. p15 p110.

# Appendix I

## Feedback from expert and wider interest groups

Comments from consultation process and resulting actions:

- 1 Advice: 'to distinguish more clearly between the role of exercise for reducing the risk of osteoporosis fracture and suitable exercises for those who already have a fragile skeleton' led to re-organisation of the target groups and separate sections on evidenced based exercise for each group.
- 2 Concern about systematic identification of evidence and interpretation of research results' prompted the co-option to the Advisory Group of Dr Ann Wales, medical librarian. As a result a formal search strategy was carried out and new material was critically appraised using the CASP framework.
- 3 Some reviewers were confused by the original grading of the recommendations which had been modelled on the Royal College of General Practitioners Guidelines for the management of acute back pain. In order to distinguish more clearly between the level of evidence and the weight of the recommendations it was decided to change to the format developed by the US Agency for Health Care Policy and Research. This system is the standard use for SIGN (Scottish Intercollegiate Guidelines Network) Guidelines.
- 4 A number of smaller practical points and corrections were made by the reviewers and incorporated. Below are some examples of actions taken by the development group.
  - Maximal back extension effort was reduced from a couple of minutes to 20 seconds.
  - Trunk flexion was further emphasised as a strong contra-indication for vulnerable people.
  - Chapter on falls prevention and management was expanded.
  - A flow chart to link assessment procedures with types of intervention was developed.
  - Advice regarding starting positions for certain exercises was incorporated.
  - The document was carefully reviewed to assure that men were equally included in the appropriate target groups.
  - More advice on important precautions for people carrying out high impact exercises were incorporated. 'For all impact activities ensure that you use the rebound techniques; i.e. give or bend in the knees at take off and landing.'
  - In the introduction, the paragraph on prevention was strengthened by adding: 'Advice should be given at the earliest opportunity to encourage individuals to achieve their optimal peak bone mass and thereafter to take steps to minimise bone loss.'

## Advisers to the Core Group

### 1 Specialist Advisers

Dr EJ Bassey	Senior Lecturer, Faculty of Medicine and Health Sciences, Queens Medical Centre, Nottingham.
Ms Susie Dinan	Senior Clinical Exercise Practitioner, University Dept of Geriatric Medicine and Old Age Psychiatry, Royal Free Hospital School of Medicine.
Ms Kathy Fraser	Senior Physiotherapist (Osteoporosis) Haywards Heath, West Sussex.
Ms Rachel Lewis	Superintendent Physiotherapist, Southmead National Healthcare Trust, Bristol (Physiotherapy adviser to NOS).
Ms Judy Mead	Head of Clinical Effectiveness, The Chartered Society of Physiotherapy, London.
Dr O Rutherford	Senior Lecturer, Dept of Physiology, Imperial College School of Medicine, London.
Ms Hailey Sewell	Research Physiotherapist, Royal National Hospital for Rheumatic Diseases, Bath (Physiotherapy adviser to NOS).
Prof DJ Stott	Professor of Geriatric Medicine, Academic Section Geriatric Medicine, Glasgow Royal Infirmary.
Ms Rosemary Rowe	Health Services Liaison Manager, National Osteoporosis Society, Bath.
Dr Ann Wales	Library Services Manager, Glasgow Royal Infirmary.

### 2 Clinical Interest Groups of the Chartered Society of Physiotherapy

The following groups were consulted at the draft stage:

ACPC	Association of Chartered Physiotherapists in the Community.
ACPWH	Association of Chartered Physiotherapists in Women's Health.
AGILE	Association of Chartered Physiotherapists with a special interest in older people.
HACP	Hydrotherapy Association of Chartered Physiotherapists.
RCACP	Rheumatic Care Association of Chartered Physiotherapists.

### 3 Language Editor

Dr R Murray	Centre for Academic Practice, Strathclyde University, Glasgow.
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**4 Supporting Group of Interested Chartered Physiotherapists**

Ms M Bray, Devon	Ms C Muddiman, Bristol
Ms E Brayshaw, Leeds	Ms E Muir, Maybole
Ms G Brook, Otley	Mr J Odoni, Lymington
Ms C Buckley	Ms J Pattman, Haywards Heath
Ms H Chubb, Surrey	Ms F Ritson, Newcastle
Ms A Clough, Leeds	Mr P Roach, Liverpool
Ms J Drinkell, London	Ms A Sandall, Reading
Ms P Ellis, Greenock	Ms A Shaw, Buckhaven
Ms G Evans, Crewe	Ms A Shelbourne, Farnham
Ms E Eversden, Birmingham	Ms S Sims, Angmering
Ms S Gaughan, Prestwick	Ms A Sinclair, Lanark
Ms J Guilford, Hartford	Ms S Strelley, Aberdeen
Ms S Hogg, Portsmouth	Ms J Thomas, Cardiff
Ms R Johnston, Newtown	Ms V Timbrell, Cheltenham
Ms H Keltie, Fort William	Ms E Turner, Cheltenham
Ms R Meadows-Smith	Mr M Urmston, Manchester
Ms C Moffat Davies, Edinburgh	Ms L Wilcox, Lancaster

## Example of a selected paper using the framework of Critical Appraisal Skills Programme (CASP)

Members of the Guideline group independently appraised this paper and then classified the evidence.

### **Paper title:**

Bravo, G., Gauthier, P., Roy, P.M., Payette, H., Gaulin, P., Harvey, M., Peloquin, L., Dubois, M.F. (1996) Impact of a 12 month exercise program on the physical and psychological health of osteopenic women. *Journal of the American Geriatric Society*. 44 (7): 756–62.

### **1 Did the trial address a clearly focused issue?**

- Population studied: Yes - focused - Clearly described both in the abstract and also in the methods section. The baseline characteristics were given in table 1.
- The intervention given: Yes - focused - described clearly in abstract and methods e.g. either exercise programme or educational input.
- Outcomes considered: Yes - outcomes clearly given in both abstract and methods.

### **2 Was assignment of patients randomised?**

- Yes - Methods; Subjects - randomisation process described. From baseline data groups in some aspects are not entirely comparable despite this process, however this is described in the results section and attempts are made to adjust statistically for differences.

### **3 Was follow-up complete?**

- Yes, however there were some subjects lost to follow-up. Results were analysed on both intention to treat and as-treated basis.

### **4 Were patients, health workers and study personnel blinded to treatment?**

- The patients were blinded as far as possible, through giving educational seminars to separate groups and not addressing potential of both physical activity in the information seminars.
- The technicians taking the bone density measurements were blinded to the group assignment. There was no information given as to whether the health workers and study personnel were blinded for the other measurements.

### **5 Were the groups similar at the start of the trial?**

- For some of the parameters there were significant differences between the groups, however this is discussed fully and attempts made to account for this.

### **6 Aside from the experimental intervention were the groups treated equally?**

- Yes.

**7 How large was the treatment effect?**

- Table 2 clearly shows the changes between the groups after the intervention.

**8 How precise was the treatment effect?**

- Standard deviations and significance levels are given in table 2.

**9 Can the results be applied to the local populations?**

- Only applies to this age group with low bone density.
- The subjects were volunteers

**10 Were all clinically important outcomes considered?**

- Other clinically relevant factors that were not considered may have been fractures/falls. This however, would require a longer follow-up period.
- Psychological as well as physical outcomes were considered.

**11 Are the benefits worth the harms and costs?**

- Question can not really be answered from this trial.
- The issue of staff time spent on intervention versus resources spent treating consequences of osteoporosis should in future be addressed.

The members of the guideline group agreed that the above paper represented level IB evidence. The paper was judged to be of good quality and consistency and addressing the specific subject matter, therefore the recommendation arising from this was graded A.

## Search Strategies

### 1 Search strategies for MEDLINE (OVID Technologies)

#### 1.1 Subject search for MEDLINE

- 1 exp exercise therapy/
- 2 exp exercise/
- 3 exercis\$.tw.
- 4 exp physical fitness/
- 5 exp sports/
- 6 exp locomotion/
- 7 exp motor activity/
- 8 (sport\$ or athletic\$ or activ\$ or fit or fitness or baseball or basketball or bicycl\$ or cycl\$ or box\$ or football\$ or golf\$ or gymnast\$ or hockey).tw.
- 9 (skip\$ or martial or mountaineer\$ or hillwalk\$ or climb\$ or tennis or badminton or run or runner or running or skat\$ or ski\$ or soccer or swim\$ or walk\$ or weightlift\$ or (weight adj1 lift\$) or weight-lift\$ or wrestl\$ or danc\$).tw.
- 10 (1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9)
- 11 exp osteoporosis/
- 12 exp bone demineralization, pathologic/
- 13 osteopo\$.tw.
- 14 bone density/
- 15 (bone\$ adj5 dens\$).tw.
- 16 fractur\$.tw.
- 17 exp fractures, spontaneous/
- 18 (11 or 12 or 13 or 14 or 15 or 16 or 17)
- 19 10 and 18

## 1.2 Systematic Review Search Strategy for Medline (OVID)

- 1 meta-analysis/
- 2 exp review literature
- 3 (meta-analy\$ or meta analy\$ or metaanaly\$).tw.
- 4 meta analysis.pt.
- 5 review academic.pt
- 6 review literature.pt.
- 7 letter.pt.
- 8 review of reported cases.pt.
- 9 historical article.pt.
- 10 review multicase.pt.
- 11 1 or 2 or 3 or 4 or 5 or 6
- 12 7 or 8 or 9 or 10
- 13 11 not 12
- 14 animal/
- 15 human/
- 16 14 and 15
- 17 14 not 16
- 18 13 not 17

This strategy was developed by the NHS Centre for Reviews and Dissemination at the University of York Website: <http://www.york.ac.uk/inst/crd/search.htm>.

### 1.3. Optimally sensitive search strategy for retrieving randomized controlled trials from MEDLINE.

- 1 randomized controlled trial.pt.
- 2 controlled clinical trial.pt.
- 3 randomized controlled trials/
- 4 random allocation/
- 5 double-blind method/
- 6 single-blind method/
- 7 1 or 2 or 3 or 4 or 5 or 6
- 8 limit 7 to animal
- 9 limit 7 to human
- 10 8 and 9
- 11 8 not 10
- 12 7 not 11
- 13 clinical trial.pt.
- 14 exp clinical trials/
- 15 clin\$ with trial\$.tw.
- 16 placebos/
- 17 placebo\$.tw.
- 18 random\$.tw.
- 19 exp research design/
- 20 13 or 14 or 15 or 16 or 17 or 18 or 19
- 21 limit 20 to animal
- 22 limit 20 to human
- 23 21 and 22
- 24 21 not 23
- 25 20 not 24
- 26 comparative study/
- 27 exp evaluation studies/
- 28 follow-up studies/
- 29 prospective studies/
- 30 (control\$ or prospectiv\$ or volunteer\$.).tw.
- 31 26 or 27 or 28 or 29 or 30)
- 32 limit 31 to animal
- 33 limit 31 to human
- 34 32 and 33
- 35 32 not 34
- 36 31 not 35
- 37 12 or 25 or 36

This strategy was developed by Carol Lefebvre at the UK Cochrane Centre, Oxford. Reference: Dickersin, K., Scherer, R., Lefebvre, C. Identifying relevant studies for systematic reviews. In: Systematic Reviews (Chalmers, I. and Altman, D.G., eds.) Chapter 3; pp 17–36. 1995: BMJ Publishing.

**1.4 Therapy methodological filter for Medline (OVID)**

- 1 randomized controlled trial.pt.
- 2 exp drug therapy/
- 3 tu.xs.
- 4 random\$.tw.
- 5 1 or 2 or 3 or 4

This filter was developed by Brian Haynes et al (J Am Med Informatics Assoc 1994 1(6) 447-58)

**1.5 Prognosis methodological filter for Medline(OVID)**

- 1 incidence/
- 2 exp mortality/
- 3 follow-up studies/
- 4 prognos\$.tw.
- 5 predict\$.tw.
- 6 course.tw.
- 7 1or 2 or 3 or 4 or 5 or 6

This filter was developed by Brian Haynes et al (J Am Med Informatics Assoc 1994 1(6) 447-58)

**2 Search strategies for EMBASE****2.1 Subject search for EMBASE (OVID format)**

- 1 exp Kinesiotherapy/
- 2 exp "Physical Activity, Capacity and Performance/"
- 3 exp Fitness/
- 4 exp Sport/
- 5 exp Sports Medicine/
- 6 exercis\$.tw.
- 7 exp Bone demineralization/
- 8 exp Bone Density/
- 9 (bone adj5 densit\$.tw.
- 10 (1 or 2 or 3 or 4 or 5 or 6) and (7 or 8 or 9)

## 2.2 Strategy for identifying randomized controlled trials on EMBASE. (OVID format)

- 1 controlled-study.sh.
  - 2 0197.tg.
  - 3 crossover-procedure.sh.
  - 4 double-blind-procedure.sh.
  - 5 phase-3-clinical-trial.sh.
  - 6 placebo\$.tw.
  - 7 randomized-controlled-trial.sh.
  - 8 single-blind-procedure.sh.
  - 9 blind\$.tw.
  - 10 comparative study.tw.
  - 11 (control\$ adj1 trial\$.tw.
  - 12 cross?over\$.tw.
  - 13 factorial\$.tw.
  - 14 placebo\$.tw.
  - 15 random\$.tw.
  - 16 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
  - 17 human.sh.
  - 18 nonhuman.sh.
  - 19 17 and 18
  - 20 18 not 19
  - 21 16 not 20
- 3 Search strategy for Cochrane Library 1998 Issue 3

- #1 OSTEOPOROSIS\*:ME
- #2 BONE-DENSITY\*:ME
- #3 EXERCISE-THERAPY\*:ME
- #4 EXERCISE\*:ME
- #5 PHYSICAL-THERAPY\*:ME
- #6 SPORTS-MEDICINE\*:ME
- #7 SPORTS\*:ME
- #8 OSTEOP\*
- #9 (BONE AND DENSIT\*)
- #10 EXERCIS\*
- #11 SPORT\*
- #12 (PHYSICAL NEAR THERAPY)
- #13 PHYSIOTHERAP\*
- #14 PHYSICAL-FITNESS\*:ME
- #15 (FIT OR FITNESS)
- #16 #1 OR #2 OR #8 OR #9
- #17 #3 OR #4 OR #5 OR #6 OR #7 OR #10 OR #11 OR #12 OR #13 OR #14
- #18 #16 AND #17

4 Search strategy for AMED (Allied and Alternative Medicine) (Silverplatter software)

- #1 explode "OSTEOPOROSIS"
- #2 explode "BONE-DENSITY"
- #3 explode "EXERCISE-THERAPY"
- #4 explode "EXERCISE"
- #5 explode "PHYSIOTHERAPY"
- #6 explode "PHYSIOTHERAPY-METHODS"
- #7 explode "SPORTS"
- #8 explode "SPORTS-MEDICINE"
- #9 explode "PHYSICAL-FITNESS"
- #10 explode "EXERTION"
- #11 osteop\* or (bone and densit\*)
- #12 exercis\* or sport\* or (physical near therapy) or physiotherap\* or fit or fitness
- #13 (#1 or #2 or #11)
- #14 (#3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #12)
- #15 #13 and #14

5 Search strategy for CINAHL (OVID)

- 1 osteoporosis/
- 2 bone density/
- 3 osteop\$.tw.
- 4 (bone and densit\$) or (bone and mass)).tw.
- 5 exp exertion/
- 6 exp physical therapy/
- 7 sports medicine/
- 8 exp sports/
- 9 exp physical fitness/
- 10 (exercis\$ or sport\$ or physiotherap\$ or fit or fitness).tw.
- 11 (1 or 2 or 3 or 4) and (5 or 6 or 7 or 8 or 9 or 10)

6 OCLC PapersFirst database (Through OCLC FirstSearch online; Telnet interface)

3 separate searches performed:

- 1 su: osteoporosis and su: exercise
- 2 su:osteoporosis and su:sport
- 3 su:bone density and su:exercise

