# Clinical practice guidelines for physical therapy in patients with osteoporosis

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## Introduction

Although osteoporosis per se is not an indication for physical therapy, problems related to osteoporosis, such as a fear of movement or poor balance, may require the attention of a physical therapist. In addition, physical therapists may treat patients with other conditions who also have osteoporosis or who might develop it in the future. The contents of these guidelines have been brought into line with the recommendations of the guidelines on osteoporosis issued by the Dutch College of General Practitioners and those issued by the multidisciplinary Dutch Collaborating Center for Quality Assurance in Healthcare. The second part of these guidelines, entitled "Review of evidence", explains the choices made in producing these guidelines and contains an extensive review of the relevant scientific literature. The abbreviations and key concepts used are explained in an appended abbreviations list and glossary.

The guidelines on osteoporosis issued by the Royal Dutch Society for Physical Therapy give a broad description of the role of the physical therapist. The physical therapist must himself* select the relevant information for each individual patient.

### Goal

The aim of these guidelines is to inform physical therapists about osteoporosis, the problems related to osteoporosis, and the way in which both can be influenced. Treatment plans for individual patients can be adjusted on the basis of this information. These guidelines are applicable to patients with primary and secondary osteoporosis. In patients with secondary osteoporosis, the primary disorder, which may be chronic obstructive pulmonary disease, rheumatoid arthritis or autoimmune disease, may limit full implementation of these guidelines. Moreover, the presence of one of these pathological conditions could provide a reason for not following guideline recommendations.

### Definition of osteoporosis and magnitude of the problem

Osteoporosis is a skeletal disorder characterized by low bone mineral density (BMD) and a loss of bone structure, which result in greater bone fragility and thus a higher risk of fracture. In white postmenopausal women over the age of 50 years, the estimated prevalence of osteoporosis is 30%. Common locations for osteoporotic fractures are the thoracic spine , the hips (neck of femur) and the wrists. About one in five persons over the age of 55 has or has had a vertebral fracture. Hip fractures mainly occur in women over 70 years of age and wrist fractures mainly in women in the age range 40–60 years. Fractures are practically always caused by a fall, but in severe cases of osteoporosis they can occur either spontaneously or as a result of minor trauma. Every year in the Netherlands, one in three

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* *The combinations 'himself/herself', 'he/she' and 'his/her' have been avoided in these guidelines to facilitate readability. The terms 'himself', 'he' and 'his' should be understood to apply to both sexes.*

persons over the age of 65 is involved in a fall. Less than 10% of these falls result in fractures.

**The consequences of fractures**
A fracture and its direct consequences have a major impact on an individual's quality of life. This is especially true for the elderly because they need more time to recover, are at a greater risk of not recovering completely, and are very susceptible to social isolation.

Vertebral fractures may be asymptomatic, with about two in every three patients reporting no complaints. However, these fractures can also be accompanied by an episode of severe pain, which usually subsides in one to three months. As a result of thoracic kyphosis, vertebral fractures may, over time, lead to problems such as a reduction in the distance between the ribs and pelvis, increased pressure on internal organs, and chronic low back pain. Increasing thoracic kyphosis changes the body posture, as a result of which patients may easily lose balance during daily activities. Chronic pain and disability due to vertebral fractures mainly occur in patients with severe deformities of the spine.

Hip fractures nearly always necessitate hospital admission. A hip fracture has far-reaching implications in the long term. It can, for example, lead to limited mobility, loss of independence, and the need for long-term care in a nursing home.

Wrist fractures only temporarily restrict the activities of the arm involved.

In general, one may state that fractures, especially hip and vertebral fractures, cause immobility, which may be temporary. In time, immobility is associated with a decrease in BMD and poorer functioning of the musculoskeletal system, involving for example decreased muscle strength and co-ordination. The result is an increased risk of further fractures. Furthermore, immobility increases the risk of social isolation, especially in the elderly. The fear of new fractures and immobility due to a fear of falling may result in psychosocial problems in patients with osteoporosis.

**Risk factors for fractures**
Women have a higher risk of fractures than men. The elderly also have a higher risk of fractures, even when changes in BMD are discounted. An individual who has once had a fracture, especially if it occurs after the menopause, has a higher risk of suffering new fractures. In addition, low body weight and a low activity level both increase the risk of fractures. One reason the elderly have a higher risk of fractures is that they are more likely to fall. Other risk factors associated with falls are the person's use of medications, such as antidepressants and analgesics, and their general state of health, which may be affected by impaired balance, decreased muscle strength in or decreased mobility of the joints in the lower extremities, impaired vision or cerebrovascular accident. Environmental factors, such as badly fitting shoes, poor lighting, loose-lying rugs, or stairs without rails, may also increase the risk of falling and thus the risk of fracture. Physical activity on a regular basis in safe surroundings decreases the risk of falling.

**The role of physical therapy**
Generally, the goal of physical therapy is to neutralize or decrease impairments, disabilities and problems with participating in life, thereby improving the patient's quality of life. The role of the physical therapist who treats patients with osteoporosis is threefold:

1. to prevent new fractures by increasing BMD and decreasing the risk of falling. Starting points are impairments, such as decreased muscle strength or poor balance, and disabilities, such as difficulty with walking or transferring between locations.
2. to prevent the development of musculoskeletal complaints related to osteoporosis (i.e. secondary prevention) and caused by changes in body posture (e.g. increased kyphosis), decreased muscle strength, poor balance, a decreased range of motion, or fear of falling. Pain can also be related to osteoporosis, for instance as a result of vertebral fractures.
3. to support patients. This encompasses giving information and advice on osteoporosis, on the consequences of osteoporosis in daily life, and on the use of walking or other aids, if needed.

**Collaboration with other disciplines**
Collaboration between the physical therapist and practitioners of other disciplines is essential. It will increase the efficiency and effectiveness of care. It is important that all healthcare workers have knowledge about each other's professions and the way they work. Furthermore, the information given to patients should be consistent with and take into account that provided by other professionals. Collaboration between primary care physicians and physical therapists can be aided by the use of specially developed recommended procedures.

The policy of primary care physicians and physical therapists on patients with osteoporosis is to prevent new fractures, to decrease fear of movement, and to increase participation in life. In the elderly, attention is also paid to increasing mobility and preventing falls.

Indications for referring patients with osteoporosis to a physical therapist are:
1. musculoskeletal impairments and disabilities, and immobility;
2. a clinical vertebral fracture in the sub-acute phase in a patient who, after receiving advice from a primary care physician, is not able to solve his own problems or who needs more guidance.

An important part of the collaboration between primary care physician and physical therapist is the sharing of mutual information about patients who are at a high risk of developing osteoporosis or having fractures due to, for example, there being an increased risk of falling. The physical therapist will inform the referring physician about the patient's health and condition. For example, the physical therapist may judge that it is no longer safe for an individual patient to walk or perform transfers independently. If the physical therapist decides that treatment by another discipline is needed, he will contact the referring physician. In secondary osteoporosis, collaboration with all the medical specialists involved is necessary.

**Main problems in osteoporosis patients**
Depending on his needs and the way he functions, the osteoporosis patient may experience several problems, either alone or in combination with each other:
1. immobility or a tendency towards immobility. Over time, immobility may decrease BMD and give rise to various impairments and disabilities. In turn, these increase the risk of fractures. A fear of falling or moving may maintain immobility.
2. increased risk of falling. Impairments and disabilities may increase the risk of falling. For example, decreased muscle strength, a decreased range of motion, and poor balance may affect activities in daily life.
3. poor health status after a fracture. Specific impairments, disabilities and participation problems may occur after the patient has suffered a fracture, depending on its localization. For example, vertebral fractures have important implications for posture and balance. In hip fractures, the patient's walking pattern and performance of transfers may be affected. In all patients, it is important to focus on the functions and abilities needed for daily life. The recommendations made in these guidelines focus on the sub-acute phase after a fracture, usually a vertebral fracture, has occurred.

## Diagnosis

The objectives of the diagnostic process are to assess the severity and the nature of the patient's health problems and to evaluate the extent to which physical therapy can influence these problems. In patients with osteoporosis or with osteoporosis-related complaints, the physical therapist determines which problems are most important. The starting point is the patient's needs.

**Referral**
Implementation of these guidelines is based on the presupposition that a referral has been made by a primary care physician or a medical specialist. The referring physician will state the reasons for referral. There may also be additional referral data on the medications taken and on any relevant medical and psychosocial information, detailing for example the patient's lifestyle.

**History-taking**

During history-taking, the physical therapist should focus on:

- making an inventory of the patient's needs and expectations;
- making an inventory of symptom onset;
- making an inventory of the complaint's course over time, including details of:
  - the severity and type of any impairments, disabilities or participation problems;
  - any additional disorders, such as (chronic) joint complaints, respiratory complaints, constipation, problems with bending or lifting, or acute or chronic back pain;
  - factors related to the onset and maintenance of any of these features; and
  - prior diagnostic tests and treatment;
- making an inventory of the status praesens, including details of:
  - current impairments, disabilities and participation problems related to osteoporosis;
  - any other pathological conditions;
  - current medication use and treatment;
  - the number of falls the patient has had in the last year; and
  - the patient's present level of activity and participation, and the activities he enjoys.

If the patient is at an increased risk of fractures, history-taking should include an inventory of the risk factors. Table 1 contains a checklist of possible risk factors. Impairments in muscle or joint functionand problems with gait or balance may increase the risk on falling, thereby increasing the risk of fractures. For details of assessment, see the description of the physical examination given below.

**Assessment**

Assessment consists of inspection and observation, palpation, and a physical examination. The extent of and strategy for carrying out the assessment depend on the patient's specific needs and problems. The objective is to make an inventory of the patient's actual impairments and disabilities in relation to his problems with participating in life.

*Inspection and observation, and palpation*

- Look for any signs of vertebral compression. The characteristics of vertebral compression are diminished physical height or thoracic kyphosis, or both, and pain in the mid-thoracic vertebrae.
- Observe the patient's standing and sitting postures, for example, at a table, while watching TV or in bed, in his home environment, if possible. The central question is whether posture could give rise to complaints.

*Physical examination*

The physical therapist will assess the patient's muscle function and mobility of the spine , and his performance of functions and activities related to the risk of falling (see Table 2). The patient's ability to carry out certain movements that are dependent on gait and balance indicates the risk of falling. These

*Table 1. Checklist of risk factors for fractures and falls.*

**Increased risk of fractures**

- age over 55 years
- previous fracture occurring after the age of 50 years, or current vertebral fracture
- family history includes mother with a hip fracture
- body weight less than 67 kg
- corticosteroid use greater than 7.5 mg/day
- visual impairment
- severe immobility

**Increased risk of falling**

- use of medications such as antidepressants or sedatives
- cognitive impairment, with a score on the Mini-Mental State Examination less than 24

movements can easily be performed during the diagnostic or therapeutic process. If the performance of any of these movements indicates an increased risk of falling, a full assessment of gait and balance will be necessary.

Characteristics* prognostic of a high risk of falling:
- inability to get out of a chair without using the arms, or the GUGT takes more than 20 seconds;
- diminished balance noted during 360-degree turns, during the one-leg stance balance test, or while reaching above the head;
- the need to stop walking while talking, a diminished step height (i.e. foot not lifted completely off the ground), a reduced step length (i.e. one foot not placed fully in front of the other foot), diminished step continuity (i.e. stopping between steps), or difficulty with turning while walking (i.e. turning is not fluid).

* These characteristics are derived from the GUGT and the Tinetti scale (see Table 10).

These guidelines recommend the use of specific measuring instruments, as noted in Table 2, during physical examination. These instruments provide an objective and reproducible form of assessment that can also be used to evaluate functions and activities after treatment.

If desired, the physical therapist may perform additional assessments, such as:
- analyzing the patient's environment and footwear. Patients may check safety in and around their house by themselves using a specially designed safety checklist;
- determining the patient's quality of life by using the quality of life questionnaire produced by the European Foundation for Osteoporosis. Questionnaires can be used to make findings more objective and to evaluate treatment results;
- determining the relationship between load and the patient's load-bearing capacity. The physical therapist can test physical capacity using the six-minute walking test, the Astrand cycling test, or a walking test involving increasing speed.

*Table 2. Details of the physical examination. The recommended measuring instruments are listed in the notes below.*

**Muscle strength and endurance, and range of spinal motion:**
- strength and endurance of spinal extensors;
- range of motion (i.e. extension) of the spine.[a]

**Factors related to the risk of falling:**
- strength and endurance of muscles in the lower extremities, especially the musculus tibialis anterior[b]
- range of motion of the joints in the lower and upper extremities[c]
- movement patterns, especially concerning gait and balance[d]
- ability to transfer from one location to another

Notes:

[a] a flexion-curve ruler or a kyphometer is recommended for measuring the range of motion of the spine

[b] a simple test of global muscle strength of the leg extensors is the 'timed standing test'. A handheld dynamometer is useful for measuring muscle strength. A standard protocol that describes the position of the dynamometer should be used.

[c] goniometry is useful for measuring the angular range of motion of joints

[d] the working group recommends the use of the Tinetti scale, the Functional Reach test, and the Get-Up-and-Go test (GUGT). First, the presence of prognostic factors for an increased risk of falling should be ascertained. Then, full tests on gait and balance should be performed. Alternative tests of balance and gait are the Berg balance test and the 'one-leg stance test'.

**Analysis**
In carrying out his analysis, the physical therapist should answer the following questions:

- What is (are) the main problem(s)? (Is there a tendency towards immobility, an increased risk of falling, or a poor health status after a fracture?)
  - Which are the most important impairments, disabilities and participation problems?
  - Which impairments and disabilities are related to an increased risk of falling?
- Which factors either limit or promote improvements in the patient's health problems?
  - Which risk factors for fractures are present (e.g. psychosocial circumstances, environmental factors including footwear used, or any co-morbid pathological conditions)?
  - Is the patient motivated to move or engage in physical activity? Which activities does he enjoy?
- Can the patient's impairments and disabilities be improved by physical therapy?

After analysis, it must be clear that there is an indication for physical therapy and that the patient can be treated according to these guidelines. Thereafter, a treatment plan is devised in co-operation with the patient. Individual treatment goals and interventions are stated. If needed, the referring physician is contacted to discuss the usefulness of calling in practitioners from other disciplines.

In addition to the problems mentioned above, the patient may have other health conditions that are potentially related to osteoporosis, such as osteoarthritis, a cardiopulmonary disorder, or acute pain. These conditions may be indications for further physical therapy intervention, if agreed in co-operation with the referring physician. In secondary osteoporosis, the primary disorder may provide a reason for adjusting the treatment plan.

**Treatment plan**
The primary goal of treatment in patients with osteoporosis or problems related to osteoporosis is the prevention of new fractures. Therefore, the physical therapist will help the patient to discontinue or to decrease immobility, to decrease the risk of falling, to regain or maintain independence after a fracture, and to adopt a healthy lifestyle. The central components of treatment are giving information and advice, and the exercise therapy. As the value of therapeutic techniques such as electrotherapy, transcutaneous electrical nerve stimulation and ultrasound therapy is not clear, their use is not covered by these guidelines.

Giving information and advice about healthy lifestyles, the risk of falling, and how to handle walking aids forms part of treatment. If possible, advice should be tailored to the patient's home situation. The patient should be aware of loose mats and the need for stair rails, for example.

Exercise therapy is aimed at training osteogenetic activities and at decreasing of the risk of falling. The physical therapist will stimulate the patient to build these activities into daily life in a way that enables him to continue practicing them independently when treatment is finished. The physical therapist deals with the patient's pain symptoms primarily by giving information and advice, and by providing exercise therapy. In this, a behavioral approach is used. The presence of very intense pain is a reason for contacting the referring physician.

Risk factors for fractures will be present in all patients. Those risk factors that can be influenced need to be taken into account during patient education aimed at promoting a healthy lifestyle. Factors that cannot be altered, such as gender and hereditary characteristics, also need to be taken into account as they can limit the extent to which the health problem can be improved.

## Therapy

The therapeutic process is geared to the individual patient's treatment plan as devised in co-operation with the patient. The physical therapist will carry out

> Although physical activities increase BMD, their efficacy in decreasing the rate of occurrence of fractures is not yet clear. Likewise, multifaceted programs aimed at preventing falls decrease the risk of falling but their efficacy in preventing fractures is still unknown. For details, see part two, the "Review of the evidence".

a systematic evaluation of the goals of treatment, which may lead to changes in the treatment plan.

The focal points of treatment and guidance are:
- to develop an efficient and effective form of training. Training should offer the appropriate intensity of stimuli, be low-risk, be pleasant, promote compliance, be cheap, and fit into the patient's complete lifestyle program;
- to encourage patients to keep moving independently both during and after treatment. When physical activity is not maintained after treatment, its effects diminish;
- to avoid flexion exercises of the thoracic spine because of the risk of compression fractures;
- to make use of a behavioral approach in patients with pain or a fear of movement as this may contribute to achieving treatment goals; and
- to avoid the negative effects of exercise, such as weight loss in patients with low body weights.

Details of how to give information and advice and how to implement exercise therapy are described sequentially below.

**Giving information and advice**
The goal is to give the patient insight into the nature of osteoporosis, the dangers of immobility, the risk factors for falling, and fall prevention.

The physical therapist will give information and advice on lifestyle, medications, moving safely, risks in the home, and coping with pain. Factors that increase the risk of fractures or of falling are discussed, as are ways of managing these factors. The patient also needs to learn how to estimate his own potential and limitations. Other subjects are how to lift, bend and use aids, and details of the best way to load the spine safely.

A professional approach to educating patients requires the physical therapist to have knowledge of and insights into how to provide the appropriate educational form and content, and the factors that can have a positive or negative influence on achieving the desired behavioral change. To change behavior, the patient has to go through six stages:
- *Being open* to information on the necessity of changing behavior;
- *Understanding and remembering* that information;
- *Wanting* to change behavior;
- *Being able* to change behavior;
- *Doing,* by demonstrating the new behavior; and
- *Keep doing* the new behavior over the long term.

An analysis of these stages can reveal the possible causes of any problems the patient may have complying with therapy. Essential factors in bringing about a change of behavior are the patient's confidence in his own efficacy (i.e. his personal efficacy) and the patient's belief that the advantages of the behavioral change outweigh the disadvantages.

**Behavioral approach**
A behavioral approach is adopted to the treatment of those patients with pain and those who fear movement. In this approach, the central aims are to increase healthy behavior, such as moving and restarting hobbies or work, and to decrease pain behavior, such as the use of unnecessary aids or medications. Treatment consists of an exercise program and the provision of information and advice. It is directed at encouraging the patient to maintain, or if need be, teaching the patient to carry out, activities despite pain. The exercise program will build up activities step by step to a desired final level. The information and advice given will deal with, among other things, pain, pain behavior and coping with pain. The patient learns that moving is not harmful but has, instead, a positive effect.

**Exercise therapy**
In exercise therapy, a distinction is made between three main problems: (i) immobility or the tendency towards immobility, (ii) an increased risk of falling, and (iii) poor health status after a fracture.

*Immobility or the tendency towards immobility*
Treatment goals are to stimulate the patient to undertake osteogenetic physical activity, to attain an active lifestyle, and to decrease or neutralize impairments and disabilities that either cause or maintain ill health. In patients with a fear of falling or of moving, treatment is aimed at increasing their self-confidence about moving. The treatment goals of physical therapy will have been met when the conditions necessary for the patient to attain an

active lifestyle have been reached. The aim of achieving the desired level of physical activity is to maintain or increase BMD. The intensity of physical activity attained depends on the individual patient's level of fitness. It may vary from walking or working in the garden to taking part in endurance sports or fitness classes. A final goal is to incorporate the learned activities into normal daily life, into leisure activities and into sport.

Important features of exercise therapy:

- activities should load bones to a relatively high level, where high means 50% more than in the past;
- dynamic exercises that use the patient's own body weight and gravity produce a high load on bones;
- exercises must put a load on the spine, hips and lower arms, as the effect of training is specific;
- exercises aimed at increasing muscle strength will have an osteogenetic effect if the load is 60–80% of maximum muscle strength;
- the frequency and duration of the movement program depend on the training goals. To influence bone mass, it is recommended that the patient carries out daily training that has a short duration (five minutes), that exerts high bone strain, and that involves only a few repetitions. To improve general exercise capacity, it is recommended that the patient carries out training that has a duration of at least 30 minutes, that is of low intensity (60–70% of maximum heart rate) and that involves many repetitions.

*An increased risk of falling*
Treatment goals are to decrease the risk of falling by decreasing or neutralizing impairments and disabilities (see Table 3). These goals will have been met when individual impairments and disabilities have been neutralized as far as possible.

*Poor health status after a fracture*
Treatment goals are to help the patient maintain or regain independence by decreasing impairments and disabilities that are caused by the fracture and to encourage the integration of new physical activities into the patient's normal daily life. Treatment is aimed at the specific impairments and disabilities that cause or maintain the patient's disability or participation problems. Treatment also aims to stimulate physical activity, as was done in treating immobility above, and to decrease the risk of falling, as above. If a fracture is present or suspected, the functions or activities undertaken are exercised without loading the fractured bone.

**Final evaluation, conclusion and reporting**
At the end of treatment, the effects of the therapeutic intervention will be evaluated in company with the

*Table 3. Examples of treatment goals and forms of treatments in patients with an increased risk of falling.*

| Item to be improved | Recommended actions |
|---|---|
| **Muscle function** | Prescribe exercise three times a week with an intensity of 60–70% of maximum strength. Each session should consist of three sets of ten repetitions. Muscle function should be exercised in a functional context. |
| **Joint function** | Give advice on functions and activities for increasing joint mobility. |
| **Balance and ability to transfer** | Prescribe dynamic exercises, such as the sequence: start a movement, slow down, change direction, and stand on one leg without moving. |
| **Gait** | Prescribe dynamic exercises, such as: walking while changing direction, avoiding and stepping over obstacles, and walking on different types of ground. |
| **Body posture** | Prescribe extension exercises in both the movement program and in activities in daily life in order to prevent increasing kyphosis. |

patient. The physical therapist will make a written report on the findings in accordance with guidelines issued by the Royal Dutch Society for Physical Therapy (KNGF), entitled "Physiotherapeutic documentation and reporting." The referring physician should be informed at the end of the treatment, and possibly during treatment, about the treatment objectives, the treatment process and treatment results. This should be done in accordance with the guidelines issued by the KNGF entitled "Communicating with and reporting back to general practitioners". Five specific types of documentation can be used to ensure good communication between primary care physician and physical therapist: guides on indication setting, on consultation, on letters of referral, on maintaining contact during treatment, and on reporting.

**Perseverance with an active lifestyle**

To maintain the benefits of treatment, patients need to persist with an active lifestyle after treatment. The physical therapist will inform the patient about local and regional opportunities for him to stay active that are adapted to his individual level and interests, such as local sports clubs or gymnastics classes for the elderly.

# Review of the evidence

## General introduction

The guidelines on osteoporosis issued by the Royal Dutch Society for Physical Therapy (KNGF) provide a guide to the physical therapy of patients with osteoporosis and osteoporosis-related health problems. The guidelines describe a methodical approach to the diagnostic and therapeutic processes involved in providing physical therapy. At present in the Netherlands, there are two other sets of guidelines concerning the diagnosis and treatment of osteoporosis: the Dutch College of General Practitioners (NHG) guidelines (het heet officieel wel standaard, maar dat zal voor buitenlanders alleen maar verwarrend zijn) on osteoporosis[1] and multidisciplinary guidelines on osteoporosis produced by the (Dutch) Collaborating Center for Quality Assurance in Healthcare (CBO).[2] The KNGF guidelines on osteoporosis broadly conform to both guidelines.

**Definition** kngf guidelines are defined as "a systematic development from a centrally formulated guide, which has been developed by professionals, that focuses on the context in which the methodical physical therapy of certain health problems is applied and that takes into account the organization of the profession".[3,4]

### Objective of the KNGF guidelines on osteoporosis

The objective of the guidelines is to describe the optimal physical therapy, in terms of effectiveness, efficiency and appropriateness, for patients with osteoporosis or osteoporosis-related health problems as derived from current scientific knowledge. The care provided should lead to the cessation or amelioration of the condition and optimize functioning.

In addition to the above-mentioned guideline goals, KNGF guidelines are explicitly designed:

- to adapt the care provided to take account of current scientific research and to improve the quality and uniformity of care;
- to define and provide some insight into the tasks and responsibilities of the physical therapist and to stimulate cooperation with other professions; and
- to aid the physical therapist's decision-making process and to assist in the use of diagnostic and therapeutic interventions.

To apply the guidelines, recommendations are formulated with regard to professionalism and expertise which are necessary to ensure treatment according to the guidelines.

### Main clinical questions

The working group that formulated these guidelines set out to answer the following questions:

- What are the known risk factors for osteoporosis and to what extent can they be influenced by physical therapy?
- Which health problems and areas of concern are of central importance in osteoporosis?
- What is the role and main objective of physical therapy?
- Which parts of the physical therapy diagnostic process are valid, reliable and useful in daily practice?
- Which interventions are useful in the prevention of osteoporosis?

### The monodisciplinary working group

In December 1998, a monodisciplinary working group of professionals was formed to find answers to these clinical questions. In forming the working group, an attempt was made to achieve a balance between professionals with experience in the area of concern and those with an academic background. All members of the working group stated that they had no conflicts of interest in participating in the development of these guidelines. Guideline development took place from December 1998 through June 2000, simultaneously with the development of the multidisciplinary guidelines on osteoporosis. Therefore, it was possible to bring the two sets of guidelines into agreement with one another.

The guidelines were developed in accordance with concepts outlined in a document entitled "A method

for the development and implementation of clinical guidelines".[3–6] This document includes practical recommendations on the strategies that should be used for collecting scientific literature. Below, in this review of the evidence for these guidelines, details are given of the specific terms used in literature searches, the sources searched, the publication period of the searched literature, and the criteria used to select relevant literature. The recommendations made on therapy are almost entirely based on scientific evidence. If no scientific evidence was available, guideline recommendations were based on the consensus reached within the working group or between those working in the field.

The members of the working group individually selected and graded the documentation that was under consideration as scientific evidence. Thereafter, a final summary of the scientific evidence, which included details of the amount of evidence available, was made. In addition to scientific evidence, other important factors were taken into account in making recommendations, such as: the achievement of a general consensus, cost-effectiveness, the availability of resources, the availability of the necessary expertise and educational facilities, organizational matters, and the desire for consistency with other monodisciplinary and multidisciplinary guidelines.

Once the draft monodisciplinary guidelines were completed, they were sent to a secondary working group comprising external professionals or members of professional organizations, or both, so that a general consensus with other professional groups or organizations and with any other existing monodisciplinary or multidisciplinary guidelines could be achieved. In addition, the wishes and preferences of patients were taken into account through consultations with representatives of the Dutch osteoporosis foundation.

**Validation by intended users**

Before they were published and distributed, the guidelines were systematically reviewed by intended users for the purpose of validation. The draft KNGF guidelines on osteoporosis were presented for assessment to a randomly selected group of 55 physical therapists who were working in different settings and to the physical therapy working group of the Dutch Association for Rheumatology (NVR). Physical therapists' comments and criticisms were recorded and discussed by the working group. If possible or desirable, they were taken into account in the final version of the guidelines. The final recommendations on practice, then, are derived from the available evidence and take into account the other above-mentioned factors and the results of the guideline evaluation carried out by intended users (physical therapists).

**Composition and implementation of the guidelines**

The guidelines comprise three parts: the practice guidelines themselves, a schematic summary of the most important points of the guidelines, and a review of the evidence. Each part can be read individually. The guidelines were implemented in accordance with a standard strategy for implementation.[3–7]

## Introduction to these guidelines

**Information sources**

The background literature for the present guidelines on osteoporosis for physical therapists was collected using the MEDLINE (1990 – February 2000), CINAHL (1990 – February 2000) and Cochrane (rehabilitation and therapy field) databases and the database of the Dutch Institute of Allied health professionals (NPi). The keywords used for the searches, which were carried out in both Dutch and English, were osteoporosis and fracture. With regard to interventions, the searches were for reviews on movement or physical activity, and the keywords used were exercise, exercise therapy, movement therapy, physical therapy, paramedical, physical activity, prevention, and rehabilitation. With respect to article design, additional keywords were review, randomized controlled trial, trial, overview, and effect. In addition, further material was obtained from members of the working group and from references cited in the literature used.

Treatment procedures for patients suffering from osteoporosis have not only been described by those working in the field of physical therapy but also by practitioners of other disciplines. In early 1999, the Dutch College of General Practitioners (NHG) issued

their guidelines on osteoporosis.[1] The KNGF guidelines have been brought into line with these guidelines. And, at more or less the same time as the KNGF guidelines were under development, interdisciplinary guidelines were also being drawn up under the auspices of the Dutch Collaborating Center for Quality Assurance in Healthcare (CBO) by a project team representing all the organizations involved*. The premises of and the scientific evidence used to formulate the CBO guidelines[2] have, where relevant, been taken into account in the guidelines presented here.

**Definition of osteoporosis and magnitude of the problem**

Osteoporosis is a skeletal disorder characterized by low bone mineral density (BMD) and a loss of bone structure, resulting in an increased risk of fracture.[8] According to the World Health Organization,[9] osteoporosis is present when the BMD is more than 2.5 standard deviations lower than the average in young adults. In adult white women, BMD is measured in the lumbar spine and the femoral neck. Normal bone mass has a BMD that is at most one standard deviation lower than the average in young adults. The intermediate stage between normal bone mass and osteoporosis is called osteopenia.

Osteoporosis can be either primary or secondary. In secondary osteoporosis, it is possible to identify specific factors that can cause osteoporosis or indicate a predisposition for the disorder. In primary osteoporosis, such factors cannot be found.

*Social implications*

In recent years, interest in osteoporosis has been growing. Medical guidelines on the examination and treatment of patients with osteoporosis have been published in, for example, Great Britain,[10] Canada[11] and Australia.[12] In England, guidelines on osteoporosis for physical therapists have been issued.[13] In the Netherlands, important publications include the recently published report by the Dutch Health Council[14] and the guidelines on osteoporosis issued by the Dutch College of General Practitioners (NHG-guidelines ).[1]

There are, however, discrepancies between the recommendations made by the Dutch Health Council and those of the Dutch College of General Practitioners. The Dutch Health Council advocates an active approach to identifying adults at a high risk of fractures and the prescription of preventive pharmacological therapy. The NHG-guidelines takes the view that extensive case-finding is undesirable at present because the predictive value of the various risk factors is in doubt and because here is a lack of data on the effectiveness of medication in adults who have not had osteoporotic fractures.

*Prevalence of osteoporosis*

When evaluated according to the above-mentioned criteria of the World Health Organization,[9] the prevalence of osteoporosis in white women over the age of 50 has been estimated to be 30%. Table 4 shows prevalence rates classified by age. In males, it is not possible to make such estimates and the classification, therefore, only applies to women.

Thoonen and Knottnerus[15] note that, according to reports by Dutch primary care physicians in 1990, the prevalence of osteoporosis is five in every 1,000 patients in the Netherlands. The article does not reveal how osteoporosis was defined. However, considering the normal age range of patients attending general medical practices, the known approximate prevalence of osteoporosis, and the fact that a diagnosis is usually not made until a fracture has occurred, this figure is probably a gross underestimate.

*Prevalence of fractures*

Most fractures occur in women and the prevalence of osteoporotic fractures increases with age. The most common locations are the hips, the wrist and the vertebra (see Table 5).

* *Dutch Society of Internists, Dutch Society for Calcium and Bone Metabolism, Dutch Society for Geriatrics, Dutch Society for Obstetrics and Gynaecology, Dutch Orthopaedic Association, Dutch Society for Radiodiagnostics, Dutch Society of Rheumatologists, Dutch Society for Rehabilitation Consultants, Dutch Society of Hospital Pharmacists, Dutch College of General Practitioners, and the Royal Tuch Society for Physical Therapy.*

*Table 5. The estimated risk of 50-year-old men and women sustaining hip, vertebra or wrist fractures during the remainder of their lives.*[16] *The 95% confidence intervals (95%CI) are shown in brackets.*

| Fracture location | Women (95%CI) | Men (95%CI) |
|---|---|---|
| **Hip** | 17.5% (16.8%–18.2%) | 6.0% (5.6%–6.5%) |
| **Vertebra (clinical diagnosis)** | 15.6% (14.8%–16.3%) | 5.0% (4.6%–5.4%) |
| **Wrist** | 16.0% (15.7%–16.7%) | 2.5% (2.2%–3.1%) |

Vertebral fractures are not always symptomatic, which makes it difficult to establish their actual frequency. However, vertebral fractures lead to deformity of the spinal column. Studies investigating the incidence of deformities of the spinal column, therefore, give an indication of the incidence of spinal fractures. A prospective cohort study in Dutch men and women over the age of 55 years showed that 12% of men and 15% of women had spinal deformities.[17] In both men and women, the prevalence showed a sharp increase with age. The prevalence of severe spinal deformities also increased steeply with age, in particular in women older than 70 years. In men and women in the age range 55–64 years, prevalences were 4% and 3%, respectively; in the age range 65–74 years, the figures were 6% and 8%, respectively; and in those over the age of 75 years, 9% and 25%, respectively.[18] Studies carried out in the United States and England using the same research methods show similar prevalence rates.[19,20]

Hip fractures rarely occur in people younger than 50 years of age. In 1987, the incidence of hip fractures in men and women between the ages of 50 and 54 years in the Netherlands was 28 and 33 per 100000, respectively. The incidences increased exponentially with age, to 1263 and 2489 per 100000, respectively, in those over 85 years.[21]

Fractures of the lower arm mainly occur in the middle-aged and elderly. The incidence of wrist fractures in women increases sharply after the menopause but stabilizes again after the age of 60.[22] The incidence of wrist fractures in women increases from 355 per 100000 for those in the age range 50–54 years to 670 per 100000 in the 70–74-year age group.[22] The incidence of wrist fractures in men is lower in all age groups compared to that in women.

*Costs*

The total cost of treating osteoporosis-related fractures in the Netherlands is estimated at 191 million euro.[23] Hip fractures account for 86% of the costs. More than one-third of these costs is for the treatment of patients over the age of 85 years, although this group forms only 1.3% of the total population.[23] Polder et al. (24) estimate that osteoporosis-related fractures account for 0.6% of the total public healthcare budget. Taking into account population growth predictions made by the Dutch Central Statistical Office, De Leat et al.[23] predict that the number of patients with fractures will double in the next 50 years.

**Consequences of fractures**

The main consequences of osteoporosis are fractures and their resulting complications, such as pain, decreased joint mobility and loss of independence.

Vertebral fractures can occur without the development of any complaints, with about two in three fractures being asymptomatic.[25,26] However, they can be accompanied by episodes of severe pain. Normally, the pain subsides after one to three months. Wedge-shaped deformities and vertebral compression may lead to increased thoracic kyphosis. One result is that the distance between the ribs and the pelvis is reduced[27] and this is often accompanied by a reduction in rib spread and lung capacity.[28] This deformity can also lead to increased pressure on internal organs, which can result in gastrointestinal complaints. These, in turn, may have serious implications for the patient's daily activities and social participation.[29] Lynn et al.[30] have shown that

patients with osteoporosis, specifically those suffering from thoracic kyphosis, use different balance strategies and exhibit more postural swaying than healthy adults. As a result, patients with osteoporosis can more easily lose their balance during daily activities. Prospective studies have shown that pain or functional limitations, or both, occur with severe deformities of the spine, in particular.[17,31] Lyles et al.[32] showed that vertebral fractures themselves affect physical and psychosocial functioning without other chronic disorders having to play a role.

Hip fractures are often associated with a high morbidity and mortality and may lead to a loss of independence. Moreover, patients may need to move to specially adapted living accommodation.[9,14] A survey carried out in the Dutch town of Utrecht found that one year after the occurrence of hip fractures, 24% of women and 33% of men affected had died.[33] Of the survivors, 55% showed a deterioration in their general condition and 25% had to move to specially adapted living accommodation as a direct consequence of the fractures.[34]

Wrist fractures are usually caused by falling with outstretched arms. They restrict activities involving the affected arm for one or several months. Usually, the arm is put in a plaster cast for four to six weeks.[9] After removal of the cast, there is usually full recovery of the original function.

*Osteoporosis and quality of life*

In a review of the quality of life of women with osteoporosis, Gold[35] concludes that, apart from the clear physical and functional consequences of osteoporosis, the condition also has psychosocial sequelae. In the early stages of osteoporosis, patients are often anxious about the occurrence of fractures and physical deformities. This fear of fractures may lead to inactivity. When patients experience illness-related problems, such as a hip fracture, multiple vertebral fractures or pain, problems may arise in the performance of normal activities and in social participation. This can lead to feelings of depression and social isolation since the patient can no longer perform habitual social functions. Healthcare and social workers may easily underestimate the signs of a loss of self-confidence and the symptoms of depression as they may attribute these to the normal aging process rather than to osteoporotic fractures.

**Primary prevention**

Since osteoporosis is usually asymptomatic until a fracture occurs, there is now some discussion in the public health sector about the importance of primary prevention, that is, the prevention of osteoporosis. This could be achieved by trying to increase BMD, for example, by encouraging young people to take adequate exercise and to adhere to a healthy diet, and also by advocating measures that help maintain and improve BMD. One element of primary prevention is early screening to find those individuals at a high risk of osteoporosis. This may be done by case-finding, that is, by medical professionals identifying people at a high risk of fractures.[14] As yet, there is no consensus in the public healthcare sector on the importance of case-finding in osteoporosis. Primary prevention is consistent with the approach adopted by physical therapists, that is, the promotion of an active lifestyle. Because physical therapists treat many patients who are at risk of developing osteoporosis or of incurring osteoporosis-related fractures, their contribution to case-finding and to the primary prevention of osteoporosis could be considerable. Patients at a high risk of developing osteoporosis or of suffering osteoporosis-related fractures could be given advice about sensible movement strategies and active lifestyles, and given help in adopting them.

## Pathophysiology and risk factors

Healthy bone has a normal bone structure. In it, there is a balance between the resorption of old bone tissue by osteoclasts and the production of new bone tissue by osteoblasts in a process that ensures stable bone mass and bone strength. The structure of the bone surface is influenced centrally by hormonal factors and locally by biomechanical factors. The hormonal system controls the blood calcium concentration and, thus, reacts to the production and resorption of bone tissue.[36] Biomechanical forces on bone, due to pressure or traction for example, stimulate osteoblast activity, which, in turn, leads to adaptations in bone structure and bone mass (see the section on exercise below).

**Risk factors for low bone mass**

Osteoporosis is said to be present when the bone mass is reduced, that is, when bone density is low and there is a loss of bone structure. The two factors mainly responsible for the loss of bone mass are a low BMD and accelerated loss of bone in adulthood.[37] An individual's maximum BMD is largely genetically determined, but factors such as physical activity during childhood, nutrition and hormonal status are also involved.[37] The maximum BMD reached in women is lower than in men and, therefore, women are at a higher risk of developing osteoporosis.

From the age of 35 years onward, the percentage annual loss of bone tissue in men and women is estimated to be 0.5–1%.[9] In menopausal women, the ensuing drop in estrogen level is concomitant with an increase in bone tissue loss, particularly in trabecular bones, to 3–5% a year. This phase lasts on average 10 years.[9] According to Riggs and Melton,[38] one-third to a half of bone tissue loss in women can be attributed to the menopause and its attendant reduction in estrogen level.

At a more advanced age, approximately after the age of 70 years, a gradual loss of bone occurs in both men and women. Moreover, functional deterioration in the organs involved in regulating calcium level may lead to calcium deficiency.[29] An unbalanced diet and too little exposure to sunlight can also cause calcium and vitamin-D deficiencies. In order to maintain the blood calcium level, the body may have to extract calcium from the skeleton. In addition, the reduced level of physical activity common at older ages also plays a part in the imbalance between bone production and bone reduction

Table 6 provides a summary of the risk factors for a low BMD. It is based on four literature reviews.[9,14,29,39] A distinction is made between risk factors that can and cannot be influenced. However, risk factors only partly explain variations in BMD. On the basis of several studies, the Dutch Health Council[14] concluded that approximately 60% of BMD variation can be explained by genetic factors.

**Risk factors for fractures**

In patients with osteoporosis, fractures can be caused by a fall but, if the osteoporosis is severe, fractures can also occur spontaneously or result from minor trauma. A vertebral fracture is the most specific expression of osteoporosis because, in these fractures, falling only plays a minor role. Spinal fractures can occur during such normal activities as bending over, raising oneself into a sitting position, getting up from a chair, or getting out of bed. The risk of sustaining a fracture is closely linked to BMD and also to the risk of falling.[9] Although a low BMD increases the chance of a

*Table 6. Overview of risk factors for low bone mineral density (BMD) classified according to whether they can or can not be influenced.*[9,14,29,39]

**Risk factors that cannot be influenced**

- advanced age[9,14,29,39]
- female sex[14,29,39]
- previous osteoporotic fracture[14]
- positive family anamnesis; hip fractures in mother[9,14,39]
- genetic predisposition; especially limiting maximum BMD[9,14,29]
- small and slender build[9,29,39]
- ethnic origin; white races have a higher risk of fractures[9,14,29,39]
- in women: late menarche[14], prolonged periods of amenorrhea, and early menopause whether naturally occurring or surgically induced[9,29,39]

**Risk factors that can be influenced**

- lack of physical exercise[9,14,29,39]
- low body weight; rapid loss of body weight[9,14,29]
- vitamin-D deficiency through lack of exposure to sunlight and absence of supplements[9,14,29]
- insufficient intake of dietary calcium[9,14,29,39]
- excessive alcohol intake[9,14,29,39]
- excessive consumption of caffeine, proteins, fiber or salt[9,14,29,39]
- excessive cigarette smoking[9,14,29,39]

fracture occurring, the relationship between the two is not linear. A number of prospective studies have shown that a drop in BMD of one standard deviation increases the risk of a fracture by a factor of 1.5–2.5,[40–42] whereas a drop in BMD of two standard deviations is associated with a 4-fold to 6-fold increase. If the patient has previously had a vertebral fracture, the risk of another occurring increases 5-fold.[43] Table 7 presents a summary of the factors that increase the risk of hip or vertebral fractures.

**Risk factors for falls**

Every year, nearly one-third of all people over the age of 65 years are involved in falls. The incidence increases with age and is much higher for elderly people who are receiving long-term care in a nursing home than for those who are still living in the community. On the basis of a number of prospective studies, the Dutch Health Council reported that the annual risk of falling in people over 60 years of age who still live independently is around 30%.[14] In nursing homes, the risk may be as high as 50% annually. A review conducted by Gillespie et al.[44] concludes that medical care is required in approximately 20% of falls and that less than 10% result in fractures. A fall may also lead to a drop in self-confidence. A quarter of people who have been involved in a fall cut down on their daily activities, partly because of the injuries sustained but also because of a fear of falling again.[45,46]

The risk of falling is higher in elderly people who have already been involved in a fall and in older adults who experience problems maintaining their balance or sustaining their gait pattern.[45,47–50] Dysfunction of the lower extremities, in terms of balance, muscle strength or joint mobility, also increases the risk of falling([45,51,52] Here, weakened dorsal flexors in the foot play a special role.[53] Physical inactivity is an independent risk factor for fractures. Although people who take little exercise have a greater chance of sustaining fractures,[40,54,55–58] it is not clear whether a more active lifestyle decreases the risk proportionally. It should be noted that different measures of physical activity have been used in the studies referred to above. For Cummings et al.,[40] for example, being active implies being on one's feet for more than four hours a day. Jaglal et al.,[55] Paganini-Hill et al.[58] and Tromp et al.[57] all use a sum score related to the frequency and duration of activities such as strenuous domestic chores, gardening, walking, cycling and taking part in sport, while Wickham et al.[56] only mention outdoor activities.

Other factors that increase the risk of falling

*Table 7. Summary of the relative risks of hip or vertebral fractures associated with particular risk factors. The data refer to women unless otherwise stated. Data are taken from a CBO consensus document on osteoporosis[2] and are based on the results of several studies.*

| Risk factor | Hip fracture | Vertebral fracture |
|---|---|---|
| Fracture after the age of 45 years | 1.5–2.9 | |
| Previous vertebral fracture | | 4.1–5.8 |
| Hip fracture in mother | 1.8–3.7 | 1.3 (in men) |
| Corticosteroids intake more than 2.5 mg/day | 1.6–2.0 | 2.2–3.1 |
| Weight lower than 67 kg | 2.2 | |
| Height, per 10 cm increase | 1.6 | |
| Immobility (lower muscle strength and impairments in balance and walking) | 1.2–3.6 | |
| Many physical activities, such as walking | 0.7 | |
| Impaired vision | 1.4–1.7 | |
| Taking long-acting sedatives | 1.6 | |

are:[45,48,56,59]

- the individual's general state of health, including conditions such as cerebrovascular accidents, Parkinson's disease, dementia, cognitive disorders, depression, dizziness and impaired vision, and the use of medications that have a protracted sedative effect or that affect reaction speed;
- environmental factors, including shoe type, loose-lying rugs, badly placed furniture, bad lighting, walking aids, thresholds, and stairs. Carter et al.[60] have shown that the bathroom is the most dangerous place in the home and that 80% of all private homes contain at least one hazardous environmental factor.

Most falls are caused by a combination of factors.

**Influencing risk factors**

*Estrogen supplementation*

On the basis of a number of studies, the Dutch Health Council concluded that the administration of sex hormones slows down bone tissue reduction and, thus, deterioration of bone structure.[14] Estrogen supplementation in postmenopausal women even results in an increase in BMD up to an advanced age. It is deemed advisable that women take these supplements for the remainder of their lives in order to reduce the risk of fractures later on. In addition to positive effects on BMD, estrogen supplementation also has beneficial effects on the risk of cardiovascular disorders. However, supplementation also appears to increase the risks of mammary and endometrial carcinomas. Basing its conclusions on at least three meta-analyses, the CBO consensus document on osteoporosis[2] states that there is strong evidence* that bone mass does not decline for a period of at least five year during estrogen supplementation. This is the case if estrogen supplementation is started shortly after the menopause and also if it is started many years later. There is moderate evidence that the current use of estrogens protects against vertebral fractures and there is limited evidence that it protects against other fractures. If supplementation is stopped, bone mass declines at the same rate as that in non-treated control subjects. There is limited evidence that most of the resulting reduction in the fracture rate is lost when supplementation stops.

*Calcium supplementation*

On the basis of several studies, the Dutch Health Council concluded that the recommended daily intake of calcium in elderly people over the age of 65 years in the Netherlands should be 1000 mg.[29] According to nutrition and consumption surveys in the Netherlands, most people in all age groups take in sufficient calcium. Correcting a low calcium intake by physiological supplementation has beneficial effects on BMD and can reduce the risk of fractures. There is no evidence that a calcium intake exceeding the recommended amount has a positive affect on achieving the desired BMD or helps decrease the rate of bone reduction after the menopause or during old age.[14] The CBO consensus document on osteoporosis[2] states that "There is moderate evidence that a very low intake of calcium of less than 500 mg/day increases bone loss and the risk of fractures and that, in individuals with a low calcium intake, the intake of extra calcium may prevent fractures."

*Vitamin D supplementation*

On the basis of several studies, the Dutch Health Council concluded that vitamin-D deficiency results in a reduction of BMD.[14] Vitamin D is produced in the skin by exposure to sunlight. In addition, vitamin D can be absorbed from food. The former Dutch Food and Nutrition Council recommended a daily vitamin D intake of 2.5 mg. For people over the age of 75 years and for those who have insufficient sunlight exposure, a daily dose of 7.5–10 mg is recommended. Natural intake of vitamin D may be insufficient in later life and the average Dutch diet cannot compensate for this insufficiency. Vitamin D intake is probably inadequate in the housebound elderly and in residents of nursing homes, in particular. In these cases, supplementation by means of an enhanced diet

* *Strong evidence (level 1) is evidence based on the findings of at least two independently performed, high-quality clinical trials (i.e., double-blind randomized controlled trials) that are sufficiently large and consistent, or on the findings of one meta-analysis that includes at least some high-quality studies with results that are consistent with those of independent trials. Moderate evidence (level 2) is evidence based on the findings of at least two independently performed randomized clinical trials, which may be of only moderate quality or which may not be large enough, or on the findings of other comparative studies. Limited evidence (level 3) is evidence that is not supported by a sufficient number of high-quality or moderate-quality studies.(61)*

may be required if the recommended level is to be achieved. The CBO consensus document on osteoporosis[2] notes that it is not sufficiently clear whether vitamin-D supplementation actually reduces the risk of fractures.

*Exercise*
The continuous processes of bone reduction and bone production occur in response to pressure and traction forces applied to bone. In this way, the body adapts bone mass and bone structure to the demands placed on the skeleton. The production of bone tissue involves two processes, termed modeling and remodeling. Modeling refers to the sum of the mechanisms that enlarge bones and that adapt their shapes to the mechanical load applied during growth. Remodeling entails a process of bone mass replenishment. With every stage of renewal, however, some bone tissue is lost. This means that remodeling is accompanied by bone mass reduction.[62] In order to establish an increase in the amount of bone tissue, a certain magnitude of strain has to be exceeded. Frost[63] stated that a load in excess of 1500–3000 microstrain (a measure of bone deformity) sets the modeling process in motion, whereas a load below 100–300 microstrain, due perhaps to physical inactivity or prolonged bed rest, primes the remodeling process. In the elderly and in people who take little exercise, the threshold for modeling will probably be reached at an earlier stage because the bones are, or have become, weaker.

Animal experiments have shown that the osteogenic response is positively related to the magnitude of the applied strain[64] and to the strain rate[65] and that only a few repetitions are required to achieve the optimal effect.[61] It has also become clear that the modeling process is dependent on the application of an 'unusual' load, which is a load that is unusual as far as its magnitude and distribution are concerned,[65] and that the response to dynamic bone loading is higher than that due to static loading.[66] Accordingly, it is well known that people who take regular exercise have a higher maximum BMD than those who do not exercise and that physically active individuals have a higher bone mass than the less active.[67,68]

In summary, in order to strengthen bone tissue, strain must be applied to the bones. The load intensity has to be sufficiently high (i.e. 'unusual' relative to the current BMD) and the load has to be dynamic (i.e. high speed with few repetitions) in nature.

*Hip protectors*
A hip protector is a synthetic disk that is placed over the top of the hip by means of a specially designed undergarment. When there is a fall, the protector absorbs the forces that would otherwise have been exerted on the top of the hip and distributes them throughout the surrounding tissues. The results of one controlled study[69] and three observational studies on hip protectors[70–72] are promising. However, compliance with wearing hip protectors is low.[69–71] The hip protector is primarily suitable for those individuals who are at a great risk of falling and in whom the risk cannot be reduced,[14] for instance, in patients suffering from dementia.

## Diagnosis

The physical therapist must determine the main problems affecting patients with osteoporosis or complaints related to osteoporosis. These could be immobility, an increased risk of falling, poor health status after a fracture, or a combination of these factors. Of prime importance are the patient's needs.

**History-taking**
The purpose of history-taking is to gain some insight into the patient's condition, which will include details of its nature, cause, progression, localization, severity and disease course. The physical therapist will determine risk factors for low BMD and for falling (see section above on pathophysiology and risk factors) and determine whether the patient is at a high risk of fractures.

Cognitive disorders are associated with an increased risk of falling. If indicated, history-taking may also include an evaluation of cognitive disorders, for which the Mini-Mental State Examination can be applied. The Mini-Mental State Examination is a reliable, valid and useful measuring instrument for detecting cognitive disorders in the elderly.[73,74] It comprises a questionnaire consisting of two parts. The first part evaluates orientation, memory and attention. The second part assesses the patient's

ability to identify, follow and carry out verbal and written instructions. The maximum total score is 30. In general, a score under 24 is indicative of a cognitive disorder.[75]

**Examination**

*Inspection and observation, and palpation*

The presence of vertebral compression is indicated by diminished physical height after the age of 40 years (a 1.5 cm reduction in 10 years is normal, more than 3 cm is abnormal) and by thoracic kyphosis, abdominal protrusion, a short upper body, increased cervical lordosis, the lower ribs approaching the crista iliaca, or a difference of more than 5 cm between the outstretched arm span and body height. Local pain, axial pain and pain on palpation also indicate vertebral pathology. However, the absence of these symptoms does not exclude pathology, according to Hirchberg et al., as quoted in the NHG-guidelines .[1]

*Physical examination*

*Assessing joint function in the spine*

De Brunner's kyphometer and the flexion-curve ruler are reliable instruments for measuring kyphosis. The kyphometer is more reliable but the flexion-curve ruler has the advantage that it enables the quantitative measurement of posture.[77] Another method involves the patient standing with his back against the wall while the physical therapist measures the distance between the seventh cervical vertebra and the wall. This distance gives an indication of the severity of the kyphosis. Sequential measurements give some insight into possible progression.

*Muscle function tests*

The hand-held dynamometer provides a reliable way of measuring muscle strength. The instrument is practical, inexpensive, portable and accurate.[78,79] Its reliability can be enhanced by using a standardized measurement protocol[80] as measurement depends, for example, on the position of the dynamometer. The protocol should also require the following items to be recorded: the patient's posture, the technique and procedure used, the name of the physical therapist conducting the test, the instructions given to the patient, and the type of dynamometer used. Normal values for the results of muscle strength tests are presented in Table 8. Using the pyramid diagram shown in Figure 1, it is possible to make an assessment of the patient's maximum muscle strength without him having to perform a test of maximum strength. Maximum strength is derived from the weight a patient can lift once, but not twice. The pyramid diagram is used as follows. Select a weight that the patient should be able to lift about 10

*Table 8. Normal values for the results of the standing test[82] and muscle strength tests[83] in elderly people.*

| **Timed standing test** | | | **Dorsal ankle flexion** | | |
|---|---|---|---|---|---|
| Age (years) | Female (s) | Male (s) | Age (years) | Female Left-Right (kg) | Male Left-Right (kg) |
| 50 | 20.9 | 18.1 | 55-64 | 22.3-22.0 | 29.4-30.2 |
| 60 | 22.6 | 20.1 | 65-74 | 20.8-21.5 | 27.9-28.1 |
| 70 | 24.3 | 22.0 | | | |
| 80 | 26.1 | 24.0 | 75+ | 17.8-18.5 | 25.9-26.5 |
| **Knee flexion** | | | **Knee extension** | | |
| Age | Female Left-Right (kg) | Male Left-Right (kg) | Age | Female Left-Right (kg) | Male Left-Right (kg) |
| 55-64 | 17.7-18.0 | 25.8-26.2 | 55-64 | 24.0-23.9 | 30.4-30.0 |
| 65-74 | 13.8-13.8 | 22.2-22.0 | 65-74 | 21.4-21.3 | 28.4-27.8 |
| 75+ | 12.3-12.6 | 18.8-18.7 | 75+ | 19.5-19.7 | 25.4-25.5 |

times. Perform the test. The number of times the patient is actually able to lift the weight is linked to a percentage on the pyramid diagram. An estimate of maximum muscle strength can then be obtained by multiplying the weight (in kg) by 100 and dividing the result by the percentage.

A simple test of the global muscle strength of the leg extensors is the timed standing test.[82] It is carried out as follows. The physical therapist uses a stopwatch to record the time it takes a patient to stand up ten times from a seated position. Prior to the actual test, the patient is allowed to practice getting up once. The patient is not allowed to use his arms. During the test, the physical therapist gives encouragement to the patient. Normal values obtained with this test are given in Table 8.

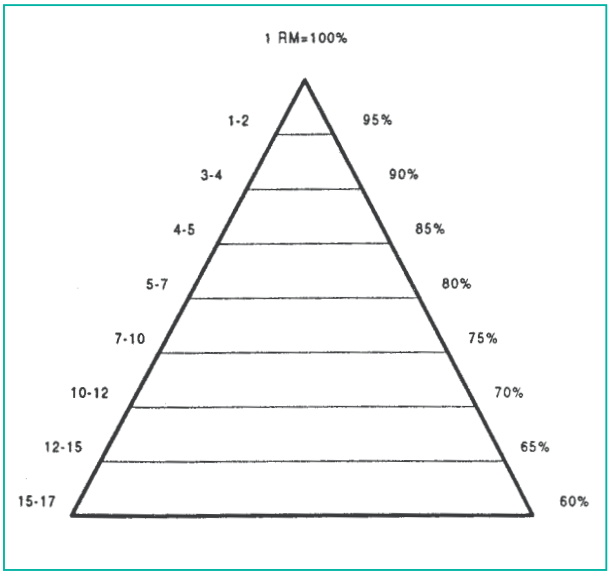


*Figure 1. Pyramid curve showing the relationship between the muscle strength needed for a certain number of repetitive movements and maximum muscle strength. For an explanation, see the main text. Taken from Wingerden.[81]*

*Indication for treatment:* muscle strength less than 70% of expected muscle strength.

*Testing the range of motion of the upper and lower extremities*

A goniometer can be used to test the range of motion of a joint. The measuring instrument is easy to use, non-invasive and inexpensive. The goniometer has good reliability provided that a standardized procedure is followed.[84,85]

*Indication for treatment:* mobility is less than that required for performing normal daily activities (see Table 9).[86]

*Assessing balance, balance control and ability to transfer location*

The Tinetti scale balance item, the Berg Balance Scale, the Functional Reach test and the Get-Up-and-Go Test (GUGT) are reliable and valid instruments for assessing balance and balance control. Descriptions of these tests are given in Table 10. The Tinetti scale and the Berg Balance Scale are both designed to test balance. The Tinetti scale has only two response categories and is, therefore, less refined and less sensitive than the Berg Balance Scale, which has four response categories. The Tinetti scale does, however, have the advantage that it also contains an item for the analysis of gait patterns. The Functional Reach test and GUGT are simple tests, take little time and can be used as screening tools, as can the fast test in which the patient has to stand on one leg.

*Table 9. Joint mobility required for the performance of normal activities in daily life.*

| **Shoulder** | **Elbow** | **Hip** | **Knee** | **Ankle** |
|---|---|---|---|---|
| flexion: 150° | flexion: 140° | flexion: 90° | flexion: 90° | plantar flexion: neutral |
| extension: 20° | extension: 20° | extension: 10° | extension: 10° | dorsal flexion: neutral |
| abduction: 90° | | | | |

*Indications for treatment:* the patient needs several attempts to transfer, leans excessively in a particular direction, loses balance and falls towards a particular direction, or needs to hold on to something or someone to maintain balance, or an unsafe situation develops during transfers (e.g. the patient sits too close to the edge of a chair).[86]

*Table 10. Descriptions of measurement instruments for assessing balance and balance control.*

**1. Tinetti scale** [87]

This test consists of two parts: one on balance (nine items) and one on gait analysis (seven items). Examples of the balance items assessed are: balance while seated, balance while standing, and balance while making a 360° standing turn. The maximum score is 16. Examples of the gait items assessed are: step height, step symmetry and torso stability. The maximum score is 12. The total maximum score for the entire test is 28. A number of items on both scales are prognostic for an increased risk of falling.[47] In the balance assessment, these are: diminished balance during 360° turns and diminished balance while standing on one leg and reaching up. In the gait assessment, these are: diminished step height, reduced step length, diminished step continuity, and difficulty in turning while walking.

**2. Functional reach** [88]

Functional reach is defined as the maximum distance a person can reach forward while maintaining a stable standing position. The feet are placed at shoulder width and one arm is raised at a 90° angle. The patient is instructed to try and reach forward as far as possible without moving the feet. The physical therapist measures the range from the third digit of the hand. The reliability and validity of the Functional Reach test in elderly men and women who are in the age range 70–87 years and who are living at home have been established. The predictive value of this test in identifying persons with a predisposition to falling has been established in a random sample of men in the age range 70–100 years. A functional reach of less than 15 cm is predictive of an increased risk of falling in elderly men.[88] In the community-dwelling elderly, significant differences in scores on the Functional Reach test were found between individuals who repeatedly fell (mean reach, 14 cm) and those who did not (mean reach, 22 cm) and between men who had fallen only once (mean reach, 17 cm) and those who had never fallen.[88]

Normal values on the Functional Reach test:[89]

| Age (years) | Male (cm) | Female (cm) |
|---|---|---|
| 20–40 | 43 | 38 |
| 41–69 | 38 | 35 |
| 70–87 | 33 | 28 |

**3. The Get-Up-and-Go Test (GUGT)** [90]

The GUGT grades, on an ordinal scale, a person's ability to perform the following action sequence: get up from a chair with arm rests, walk three meters towards a wall, turn without touching the wall, walk back to the chair and resume a seated position.[90] The GUGT is a reliable and valid measure of balance in the elderly, both for those living in the community and for those admitted to hospital or residing in nursing homes.[90,91] Performance on the GUGT reveals differences between elderly people who are prone to falling and those who are not. Elderly people living at home who have never fallen before prove to be more stable on the turning item of the GUGT than those who have fallen.[91] Anacker and Di Fabio [90] found that elderly people living at home who were prone to falling (mean age, 85 years) had a worse performance on the GUGT than those who were not prone to falling (mean age, 78 years). However, the difference in mean age between the two groups may have affected the results. Taking longer than 20 seconds to perform the GUGT is also indicative of an increased risk of falling,[92] as is the inability to get up from a chair without using the arms.[93]

*Vervolg tabel 10*

**4. Standing on one leg**[94,95]
This is a simple test of balance. The person, who should be wearing shoes, is instructed to stand on the dominant leg for as long as possible and the best of three attempts is recorded.

Normal values for length of time for standing one leg:

| **Women** | | | **Men** | | |
|---|---|---|---|---|---|
| Age (years) | Eyes open (s) | Eyes closed (s) | Age (years) | Eyes open (s) | Eyes closed (s) |
| 60–69 | 55.9 | 24.6 | 60–90 | 54.7 | 24.6 |
| 70–79 | 39.7 | 14.1 | | | |
| 80–86 | 45.5 | 21.7 | | | |

**5. Berg Balance Scale**[96]
The Berg Balance Scale quantifies functional balance. On this scale, 14 activities are each rated on a scale of 0 (impossible) to 4 (completely independent performance). Among the activities assessed are: getting up from a seated position, standing without support with eyes closed, and standing on one leg. The Berg Balance Scale can be roughly divided into three elements: the ability to maintain a posture, the ability to go from the posture to motion, and the reaction to external perturbations.[96] The scale has been shown to be a valid and reliable instrument for measuring balance in the elderly.[96,97] In a study of older residents in a retirement home, an overall score of less than 45 points, out of a maximum of 56, on the Berg Balance Scale was associated with a 2.7 times increased risk of a future fall.[97] Bogle[98] reported that the scale had an 82% accuracy in predicting which residents in a nursing homes were at a risk of falling. To date, the accuracy and reliability of the Berg Balance Scale have not been tested in a relatively healthy population, such as the non-institutionalized elderly.

*Gait analysis*
The Tinetti scale contains items for conducting an analysis of gait (see Table 10).

*Indications for treatment:* the patient stumbles or misses steps, there is a loss of balance due to excessive lateral or backward inclination, there is a loss of balance while performing a turn, the patient reaches for support while walking, there is a reduced step length resulting in a consistent preference to stand on one particular leg, there is diminished step height or step push, or the patient's direction of walking deviates, resulting in lateral sway. These symptoms may all become more pronounced when the patient is instructed to walk faster.[86]

*Additional examinations*

*Quality-of-life questionnaire*
A quality-of-life questionnaire has been developed by a working group of the European Foundation for Osteoporosis.[99] This questionnaire's target group includes patients with vertebral fractures due to osteoporosis. The reliability of the questionnaire in patients with osteoporosis and at least one vertebral fracture is good. Patients with a vertebral fracture have a lower score on this questionnaire than healthy persons matched by age and gender.[100] The questionnaire has five domains: pain, physical functioning (daily activities, work in and around house, and movement), free time and social activities, thoughts about health in general, and mood. Each domain is scored from 0 to 100. A low score is associated with a good quality of life.

*Physical condition*
Reliable and valid instruments for assessing physical condition are the six-minute walking test[101,102] the Astrand sub-maximal cycling test,[103] and a test that involves walking at an increasing speed.[104]

**Analysis and treatment plan**

At the end of the diagnostic process, the patient's complaints are analyzed on the basis of the information specified in the referral and on the results of the physical therapy examination. The physical therapist will evaluate whether there are any indications for physical therapy, and whether consultation or collaboration with a third party is required. During the diagnostic process the physical therapist determines the primary cause or causes of the patient's complaints and draws up a relevant treatment plan. The treatment plan will detail treatment goals, interventions, treatment strategy, and tasks for the patient as well as for the physical therapist. As an illustration, Table 11 describes the various sub-goals and therapeutic interventions in three categories of complaint. It goes without saying that individual sub-goals depend on the outcome of the diagnostic process.

## Therapy

This section of the review of the evidence is divided into four parts dealing with the effects of physical activity on (a) bone mass, (b) the prevention of falls, (c) balance, and (d) other outcome measures, such as pain, mobility and quality of life. Literature reviews were available on the first three topics. A distinction has been made between systematic and non-systematic reviews because a non-systematic search of the literature could lead to selection bias. In effect, this would mean that a review's conclusions may not have been based on all available studies but only on a selection, thereby possibly leading to distorted conclusions .

**Effectiveness of physical activity in increasing bone mass**

*Guideline recommendations*

On the basis of a meta-analysis of the effects of physical activity on bone mass, it can be concluded that there is a positive influence in both premenopausal and postmenopausal women. There is also limited evidence that physical activity has a positive effect on bone mass in people with mild forms of osteoporosis. It is unclear whether the effects of physical activity can prevent fractures. The literature does not provide any clear criteria on exercise intensity or on the number of repetitions

*Table 11. Possible treatment sub-goals related to a patient's specific complaints.*

**Group 1: patients experiencing immobility or a tendency towards immobility**

Treatment is aimed at promoting physical activity in the patient. The objective is to establish a change in the patient's attitudes and lifestyle.

Possible sub-goals:

- an increase in physical activity;
- a reduction in the fear of falling; and
- the elimination of or reduction in impairments and limitations.

**Group 2: patients at risk of falling**

Treatment is geared to reducing or eliminating those impairments and limitations that increase the risk of falling.

Possible sub-goals:

- improvement of muscle function;
- improvement in balance and balance control; and
- improvement in gait pattern.

**Group 3: patients with a poor health status after a vertebral fracture**

Treatment focuses on reducing the impairments and limitations that result from the fracture and on stimulating activities in normal daily life.

Possible sub-goals:

- the maintenance or improvement of muscle function and balance;
- an increase in physical activity; and
- the learning of skills for increasing activities in daily life.

required for beneficial effects on bone mass. Therefore, the guideline recommendations made on the content of exercise therapy (i.e. its frequency, intensity and nature) are based partly on consensus.

*Results of the literature search*
The search produced 18 reviews, of which six were systematic reviews.[108–113] As a result of the search procedure employed, the review carried out by Wolff et al.[111] was taken to be the standard against which all other reviews were compared in looking for overlaps. With the exception of the review by Ernst,[112] all the studies discussed in the reviews were covered in Wolff et al.'s review. Ernst's review included two additional studies that were published in 1997. Wolff et al.[111] conducted a meta-analysis of the effectiveness of training programs on bone mass. In premenopausal and postmenopausal women, bone mass is measured in the lower lumbar spine and in the neck of the femur. Distinctions were made between programs aimed at increasing strength and those that trained endurance, as well as between randomized and non-randomized controlled trials. In general, the treatment effects found in non-randomized controlled trials proved to be almost twice as great as those found in randomized controlled trials. This seems to indicate that a high degree of confounding occurred because patients were not randomly assigned to groups. Therefore, only the results of randomized controlled trials have been taken into account.

*Results of the review*
Wolff et al.[111] included sixteen randomized controlled trials in their review. The pooled treatment effects of these trials indicate that a bone loss of approximately 1% per year (lumbar spine, 0.84% per year; femur neck, 0.89% per year) can be prevented. Positive effects were found in both premenopausal (lumbar spine, 0.91% per year; femur neck, 0.90% per year) and postmenopausal women (lumbar spine, 0.79% per year; femur neck, 0.89% per year). Endurance training also showed significant treatment effects on bone loss (lumbar spine, 0.96% per year; femur neck, 0.90% per year). The pooled treatment effects of strength training were not significant. This may have been due to the limited number of studies found or to the fact that the load intensity may not have been sufficiently high for treatment to have any effect.

*Specific results from Wolff et al.: studies in premenopausal women*
The meta-analysis carried out by Wolff et al. included four studies into the effects of exercise programs on bone mass in premenopausal women. All four report positive results.[114–117] The interventions employed were running, aerobics involving jumping exercises, or weight training. All the interventions were aimed at achieving a high load, e.g., a heart rate of 70–85% of maximum, ground reaction forces of at least twice body weight, and strength training at 65–85% of maximum strength.

*Specific results from Wolff et al.: studies of strength training in postmenopausal women*
The meta-analysis carried out by Wolff et al. included six studies into the effects of strength training in postmenopausal women. Kerr et al.[118] showed that strength training generates site-specific effects. When the studies were divided into those involving an adequate training load, that is more than 60% of maximum strength,[119] and those involving an inadequate training load, that is less than 50% of maximum strength, three of the four studies that used adequate loads[118,119,121] showed positive results whereas both studies that employed inadequate training loads[122,123] did not. It should be noted that several muscles or muscle groups were trained in all the programs except that reported in the study by Sinaki et al.,[122] in which only extensors in the back were trained. In Pruit et al.'s study,[123] in which a subgroup failed to show positive results despite adequate training loads, the participants' BMD was high, at 100% of that in age-matched controls, and more than half the participants, who were not equally distributed between the groups, had been prescribed hormone-replacement therapy.

*Specific results from Wolff et al.: studies of endurance training in postmenopausal women*
The meta-analysis carried out by Wolff et al. included eight studies in which postmenopausal women received endurance training. Two compared an endurance-training program with a high load to one with a low load.[124,125] Grove and Londeree[124] could

not find any differences between the effects of high-impact exercise programs (loading greater than or equal to twice body weight; jumping and running exercises) and low-impact programs (loading less than 1.5 times body weight; walking exercises). Both types of program prevented reductions in BMD compared with control groups. Hatori et al.[125] compared the effects of high-intensity walking (heart rate above the anaerobic threshold) to those of low-intensity walking (heart frequency below the anaerobic threshold). In this study, high-intensity walking was found to have a positive effect on BMD whereas low-intensity walking did not. Martin and Notelovitz[126] also investigated the effects of walking on BMD. They compared the effect of walking with a heart rate of 70–85% maximum to effects in a control group. They did not find any difference in BMD between the two groups. The authors report that participants had relatively normal BMDs and that the moderate training load may have been insufficient to produce training effects. Prince et al.[127] showed that an endurance training program that combines weight-bearing exercises with walking exercises carried out at an intensity greater than 60% of the maximum heart rate affects BMD positively. Another study, which also investigated a high-intensity intervention (50 heel drops a day, with an impact of 2.5–3 times body weight), revealed no difference in BMD in either the femur neck or the lumbar spine.[128] Again, the authors of this study reported that participants had a relatively good BMD and that differences in BMD could have been a confounding factor. They also remarked that muscle-contraction forces might play a role in stimulating bone production.

*Results of other systematic reviews*

Both Kelley[108] and Swezey[110] concluded that strength training as well as endurance training may help maintain bone mass in postmenopausal women. Sheth[113] recommended the use of progressive resistance training as a way of improving BMD. In addition, Berard et al.[109] described the positive effects of exercise programs on BMD in postmenopausal women. It should be noted that these findings only apply to BMD in the lumbar spine and not in the femur. The authors did not distinguish between strength and endurance programs. For each study, they also calculated the intensity of the training program and related it to the size of the treatment effect. They did not find any relationship between the two. In addition, Kelley did not find any relationship between the characteristics of the training program and treatment effects. In his review, Swezey[110] reports that individuals with osteoporosis and low bone mass tend to have bigger responses. Only one randomized controlled trial studied the effect of exercise in women with mild forms of osteoporosis.[129] The intervention consisted of weight-bearing exercises (walking and step exercises), aerobics and mobilizing exercises. Education took place on a two-monthly basis. The study showed that this intervention may help maintain bone density in women with osteopenia. Bone density in women in the control group deteriorated. Ernst[112] concluded

*Table 12. Important aspects of exercise therapy.*

- In patients with, or suspected of having, osteoporosis, extension exercises are more appropriate than flexion exercises because of the increased risk of compression fractures.[105]
- The ground reaction force determines the extent of the load on bones. This load can be divided into four categories according to the magnitude of the force applied, as expressed in multiples of the body weight.[106] Examples of activities in each category are:[107]
  > 4 times body weight: activities that involve breaking contact with the ground, such as baseball, gymnastics, ballet and volleyball;
  2–4 times body weight: activities that include sprinting or turning, such as tennis, badminton, aerobics classes, fitness classes, heavy or moderate housekeeping activities, and climbing stairs;
  1–2 times body weight: weight-bearing activities, such as running, ballroom dancing, golf, hill-walking, and light housekeeping activities;
  < 1 times body weight: other activities, such as cycling, swimming and walking.

that regular exercise programs are effective in the prevention and treatment of osteoporosis.

**Effectiveness of physical activity in preventing falls**

*Guideline recommendations*

On the basis of a meta-analysis of the effects of physical activity in preventing falls, it can be concluded that there is a positive effect on reducing the incidence of falls. The exercise program employed has be geared to the results of screening for individual risk factors for falling, such as low muscle mass, diminished muscle strength, diminished mobility, poor balance, and poor co-ordination. The effect of physical activity on preventing fractures is not yet clear. Since the literature does not provide clear criteria on the frequency, content and nature of exercise therapy programs, the recommendations made in these guidelines are based partly on consensus.

*Results of literature search*

Four reviews that discuss the effectiveness of physical activity in preventing falls were found. Two are systematic reviews.[44,59] Because of the search procedure employed, the review by Gillespie et al. (44) was taken as the standard with which the studies in Myers et al.'s review[59] were compared. It was found that the two reviews completely overlapped.

*Results of the review*

Gillespie et al.[44] conducted a best-evidence review of the effectiveness of programs aimed at reducing the number of falls in the elderly. No exclusion criteria were set regarding the sex, age or living conditions of the participants. This review includes 18 randomized controlled trials and one meta-analysis. Gillespie et al. concluded that physical activity alone does not prevent falls. Neither did they find that physical activity combined with education or education alone had a protective effect. However, interventions that were geared to the results of health assessments in individuals were found to be effective. These interventions can be divided into two groups: multifaceted interventions aimed at reducing the individual's risk of falling (odds ratio, 0.77; 95%CI, 0.64–0.91) and behavioral interventions aimed at reducing hazardous behavior, for example, in relation to environmental risks (odds ratio, 0.81; 95%CI, 0.71–0.93). The above-mentioned results are the pooled results of five and two studies, respectively, one of which has not been published. Three of the total of six studies show positive results[130–132] and three show negative results.[133–135] They do not provide the basis for a more detailed discussion of the features of effective interventions because all of the studies report on combinations of interventions. However, a single stand-alone intervention does not seem to be effective since the only study in which only one intervention was used[133] showed no effect on the prevention of falls.

*Results of other reviews*

Myers et al.[59] report that those studies in which interventions focused on specific risk factors, and in which load was one of the components, demonstrated a reduction in the number of falls. Furthermore, they concluded that these effects were found in non-institutionalized elderly adults but not in residents of nursing homes. Province et al.[136] carried out a meta-analysis and concluded that interventions using either general exercises or involving programs that included balance items both reduce the risk of falling (odds ratio, 0.90; 95%CI, 0.81–0.99; and odds ratio, 0.83 95%CI, 0.70–0.98, respectively). Prior et al.[137] concluded that moderate physical activity may reduce the risks both of falling and of fractures in people with osteoporosis. They recommend regular assessment of the risk of falling in the elderly to identify those individuals at a high risk. In this respect, Myers et al.'s conclusions and the results of non-systematic reviews are in accordance with Gillespie et al.'s conclusions.[44]

**Effectiveness of physical activity in improving balance**

*Guideline recommendations*

On the basis of the results of one systematic review of the effects of exercise therapy on balance, it can be concluded that there is a positive effect on balance control in the elderly. However, it is not clear whether exercise therapy also prevents fractures. Since the literature does not provide clear criteria on the frequency, content and nature of the exercise therapy programs, the recommendations made in these guidelines are based partly on consensus.

*Results of literature review*
One systematic review of the effectiveness of exercise therapy in improving balance in the non-institutionalized elderly was found.[138] It covers 17 studies. All the studies report that exercise therapy has a positive effect on balance control in the relatively healthy elderly. Since the exercise programs assessed mostly consisted of combinations of exercises, no conclusions can be drawn about the effectiveness of either specific programs or particular exercises. Most of the studies involved programs that consisted of two or more weekly sessions with a minimum duration of two hours a week. In 14 studies, the exercise programs included strength training or balance training, or both. The effectiveness of exercise therapy in improving balance in the institutionalized elderly cannot be proven.[139]

**Effectiveness of physical activity in improving other outcomes**
*Guideline recommendations*
On the basis of one systematic review of the effects of exercise therapy on outcome measures such as pain and quality of life in patients with osteoporosis, it can be concluded that there are positive effects. The interventions used and the results reported are too diverse to allow the formulation of any general criteria on the content (i.e., the frequency, intensity and nature) of exercise therapy. Consequently, the recommendations made in these guidelines are founded partly on consensus.

*Results of literature search*
Since other outcome measures are also relevant for assessing the usefulness of physical therapy, a systematic search was made for studies reporting on the effectiveness of exercise in improving outcome measures such as pain and quality of life. Only studies involving patients suffering from osteoporosis were evaluated. The search revealed six randomized controlled trials.[119,129,140–143] The studies were evaluated for methodological quality and it was found that their quality varied from two to six points on a 10-point scale. All the studies in which an exercise program was administered showed positive results. The three studies that used pain as an outcome measure showed that pain was reduced after the exercise program. Of the three studies on quality of life, two reported positive results. The one study that did not find evidence for an effect on quality of life did not, however, involve an exercise program. It consisted instead of advising patients to take up brisk walking. Apart from beneficial effects on the outcome measures of pain and quality of life, several studies reported findings showing that physical activity favorably affects muscle function (including strength, endurance and dexterity), the range of joint motion, and balance. Malmros et al.[140] found evidence that the positive effects of an exercise program were still present five months after the conclusion of the program. With the exception of the study by Ebrahim et al.,[141] which documents an increased risk of falling, none of the studies report that exercise programs have negative effects.

**Promoting behavioral change**
Van der Burgt and Verhulst[142] carried out an overview of the models employed in health promotion and education programs and translated them into a patient information model for use by the allied health professions. They integrated the Attitude, Social Influence and Personal Efficacy determinant model with the step-by-step educational model proposed by Hoenen et al.[145] In the Attitude, Social Influence and Personal Efficacy determinant model, it is assumed that the patient's willingness to change behavior is determined by a combination of attitude (How does the patient regard the behavioral change?), social influence (How do others regard the behavioral change?) and perceived effectiveness (Will I succeed or not?). The step-by-step model recommended by Hoenen et al. distinguishes the following steps: "being open", "understanding", "wanting", and "doing". Taking into account allied health professionals' practice, Van der Burgt and Verhulst added two other steps: "being able" and "keeping on doing ". Van der Burgt and Verhulst regard the act of providing patients with information as a process in which behavioral change is the final step. This step cannot be taken before earlier steps have been taken. The six steps that need to be taken in succession are described in Table 13.

*Table 13. The six steps in the patient information process.*

1. Being open: the physical therapist tries to respond sensitively to the patient's experiences, expectations, questions and worries.
2. Understanding: information must be offered in such a way that the patient is able to understand and remember it.
3. Wanting: the physical therapist evaluates what either drives or prevents the patient from performing a particular behavior; the physical therapist offers support and provides information about possibilities and alternatives; agreements made should be feasible.
4. Being able: the patient must be able to perform the desired behavior; functional activities are practiced.
5. Doing: the physical therapist makes clear, concrete and feasible agreements with the patient and sets concrete targets.
6. Keeping doing: during each treatment session there must be communication about whether or not the patient thinks he will be able to perform and maintain the new behavior; if there are problems, solutions must be sought.

*Patient instruction and education plan*

The physical therapy treatment program should include a separate patient instruction and education plan in which sub-goals are formulated for each step. The instruction plan should be seen as a component of a methodical physical therapy intervention. First, during history-taking, the patient's need for information is analyzed. What does the patient know about his complaint, about any medication he may have to take, and about how to live healthily? For each item, attention must be paid to any problems the patient may encounter. This approach can provide insights into the possible causes of any problems the patient has in complying with therapy or with the regimen recommended for healthy living.

An education plan for patients at an increased risk of developing osteoporosis or osteoporosis-related fractures should cover the following subjects:

- medical aspects of osteoporosis, including the nature and implications of the disorder;
- a recommended regimen for healthy living, including individual advice on good movement strategies and a healthy diet;
- possible ways of improving social participation, including making use of local facilities that can help the patient learn to keep moving independently.

*Behavioral principles*

Behavioral principles are aimed at preventing progressive disability.[146] Treatment can be geared to pain management (the operant approach), to the identification of stressors (the respondent approach), or to the patient's expectations and ideas (the cognitive approach). The operant approach is the most suitable in the physical therapist's field of work. Fordyce et al. first described the operant approach in 1973.[146] Its objective is to increase the patient's activity level and to improve pain management so that, despite pain, the patient will be able to increase the number of activities he wishes to carry out. According to Vlaeyen et al.,[147] use of the operant approach leads to an increase in activity level and to a decrease in disabling sickness behavior. More information on behavioral principles can be found in the Dutch book entitled "Chronic pain and rehabilitation".[146]

**Keep moving**

It takes a year for the effects of physical activity aimed at improving bone mass to become evident. The effects of interventions aimed at improving balance or muscle strength become clear much earlier.

## Legal significance of the guidelines

These guidelines are not statutory regulations. They provide knowledge and make recommendations based on the results of scientific research, which healthcare workers must take fully into account if high-quality care is to be provided. Since the recommendations mainly refer to the average patient, healthcare workers must use their professional

judgement to decide when to deviate from the guidelines if that is required in a particular patient's situation. Whenever there is a deviation from guideline recommendations, it must be justified and documented.[4,5] Responsibility, therefore, resides with the individual physical therapist.

**Guideline revisions**

These KNGF guidelines are the first such clinical guidelines to be developed for diagnosis, treatment and prevention in patients with osteoporosis. Subsequent developments that could lead to improvements in the application of physical therapy in this group of patients may have an impact on the knowledge contained in these guidelines. The prescribed method for developing and implementing guidelines in general proposes that all guidelines should be revised a maximum of three to five years after the original publication.[3-6] This means that the KNGF, together with the working group, will decide whether these guidelines are still accurate by 2006 at the latest. If necessary, a new working group will be set up to revise the guidelines. These guidelines will no longer be valid if there are new developments that necessitate a revision.

Before any revision is carried out, the recommended method of guideline development and implementation should also be updated on the basis of any new knowledge and to take into account any cooperative agreements made between the different groups of guideline developers working in the Netherlands. The details of any consensus reached by Evidence-Based Guidelines Meetings (i.e., the EBRO platform), which are organized under the auspices of the (Dutch) Collaborating Center for Quality Assurance in Healthcare (CBO), will also be taken into account in any updated version of the method of guideline development and implementation. For example, the stipulation that uniform and transparent methods are necessary for determining the amount of evidence needed and for deriving practice recommendations would constitute an important improvement.

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## List of abbreviations and glossary

| | | | |
|---|---|---|---|
| **BMD** | Bone mineral density | **GUGT** | Get-Up-and-Go Test |
| **CBO** | (Dutch) Collaborating Center for Quality Assurance in Healthcare | **KNGF** | Royal Dutch Society for Physical Therapy |
| **CI** | Confidence interval | **NHG** | Dutch College of General Practitioners |

| | |
|---|---|
| **Activity** | Execution of a task or action by an individual |
| **95%CI** | A range of values within which there is a 0.95 probability that the real value of ameasured parameter is included |
| **Disability** | Inability to perform an activity in the normal manner or to the normal extent |
| **Functions** | Physiological functions of body systems (including psychological functions) |
| **Immobility** | Insufficient physical exercise or level of physical activity |
| **Impairment** | Problem with body function or structure, such as a significant deviation or loss |
| **Incidence of fractures** | Number of new fractures occurring in a certain period |
| **Osteogenic activities** | Activities that stimulate bone tissue to increase bone mass |
| **Participation** | Involvement in a life situation |
| **Participation restriction** | Problem an individual may experience with involvement in a life situation |
| **Relative risk** | The ratio of the incidences in two groups being compared (for example, the incidence in people with a certain risk divided by the incidence in people without that risk) |
| **Structure** | Anatomical part of the body, such as an organ or limb or its component |
| **Vertebral compression** | Compression of the vertebrae |

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