

Osteoporosis – Prevention, Diagnosis and Treatment

A Systematic Review

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Summary and Conclusions of the SBU Report on:

Osteoporosis – Prevention, Diagnosis and Treatment

A Systematic Literature Review

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Conclusions

- ❑ Osteoporosis is a common condition in Sweden. One in three women aged 70 through 79 years is found to have osteoporosis, revealed by measuring bone density in the hip. Osteoporosis may lead to fractures following minor stress on the bone. Annually, osteoporosis is associated with approximately 70 000 fractures, whereof 18 000 are hip fractures. The quality of life deteriorates for many hip fracture patients, and the mortality rate is high. Hip fractures account for more than one half of all direct healthcare costs related to fractures. The national economic costs for osteoporosis and osteoporosis-related fractures total approximately 3.5 billion SEK per year.
- ❑ Patients with osteoporosis-related fractures are an under-treated group as regards pharmacotherapy and other interventions to prevent new fractures. A diagnosis of osteoporosis is seldom included in the admission or discharge reports of patients with hip fractures.
- ❑ Important risk factors for osteoporosis-related fractures that can be treated are physical inactivity, low weight, tobacco smoking, high alcohol consumption, tendency to fall, impaired vision, low exposure to sunlight, and use of corticosteroids.
- ❑ Osteoporosis is only one of several risk factors for fractures. Bone density measurement has little likelihood of predicting hip fracture in individuals who are otherwise at small risk for fracture. Important risk factors that cannot be influenced include old age, female gender, previous fracture, and heredity. The value of bone density measurement is greater in those with multiple risk factors.

- ❑ No particular diagnostic method or measurement site is optimal for determining the risk for fracture in all parts of the skeleton. Measurement of bone density in the hip is best for predicting the risk for hip fracture. Measurements in the vertebrae are best for predicting vertebral fracture. There is more uncertainty regarding comparisons of the various measurement methods – dual energy x-ray absorptiometry (DXA), ultrasound, and computed tomography (CT).
- ❑ Physical exercise for at least 30 minutes, 2 to 3 times per week, has a positive effect on bone density in both girls and boys. This effect probably remains throughout young adulthood. Physical activity is particularly important in children and teenagers, when maximum bone mass is formed. Weight-bearing training such as jumping, aerobic exercise, endurance training, and weight lifting probably have the greatest effects on bone density.
- ❑ High calcium intake, mainly from dairy products, is thought to increase bone density in children and teenagers, but the effect on ultimate bone mass has not been sufficiently studied. Increased calcium intake prior to menopause is thought to be important, but the positive effects may be a consequence of generally favorable nutritional conditions.
- ❑ There is no scientific evidence to support the use of bone density measurement as a screening method in healthy, middle-aged individuals. However, bone density measurement plays an important role in examining individuals with multiple risk factors to predict their fracture risk and initiate preventive interventions.
- ❑ Pharmacotherapy: Calcium and vitamin D are shown to reduce the risk for hip fracture and other fractures, except vertebral fractures, in elderly women. Alendronate and

risedronate (bisphosphonates) are shown to reduce the number of fractures, mainly vertebral fractures, in postmenopausal women with osteoporosis. Estrogen has been shown to reduce the number of fractures, but its applicability is limited due to increased risk for undesirable side effects. Selective estrogen-receptor modulators (SERM) are shown to reduce the risk for vertebral fractures in postmenopausal women with osteoporosis.

- ❑ Hip protectors appear to reduce the risk for hip fractures or falls among the elderly in residential facilities (nursing homes).
- ❑ To reduce the number of falls among elderly, the following interventions are shown to be important: individually designed muscle strength and balance training, interventions against the risk for falls at home, combination of training and modification of risk for falls, including a reduction in medication.
- ❑ The following important knowledge gaps have been identified:
 - studies in men concerning pharmacotherapy, fracture prediction by bone density measurement, and assessment of rehabilitation interventions following fracture
 - studies of hip protectors and interventions to prevent falls and reduce fractures among unselected groups in various residential care settings
 - studies concerning the effects of physical activity on the risk for fractures
 - studies concerning individuals with impaired cognitive function.

Economic assessments are lacking, due mainly to insufficient knowledge concerning the effects of various osteoporosis treatments on risks, mortality, quality of life, and costs in different age groups and risk groups.

Summary

Consequences of Osteoporosis

Osteoporosis is a common condition in Sweden. Measurement of bone density in the hip shows that one in three women aged 70 to 79 years has osteoporosis. This means that the skeleton is too thin and its strength so low that fracture can occur following minor mechanical stress, ie, low-energy fracture.

Annually, approximately 70 000 fractures in Sweden are associated with osteoporosis, whereof approximately 18 000 are hip fractures. The number of hip fractures has increased in recent years, mainly because more people are living longer.

In Sweden, the risk that a 50-year-old woman will have an osteoporosis-related hip fracture at some time during the remainder of her life is 23 per cent (11 per cent in men). Corresponding figures for vertebral fracture are 15 per cent (9 per cent), wrist fracture 22 per cent (5 per cent), and upper arm fracture 13 per cent (4 per cent). The risk that a middle-aged woman, at some point during the remainder of her life, will have one or more osteoporosis-related fractures is approximately 50 per cent, and the figure for a middle-aged man is approximately 25 per cent. Women are at higher risk because they have a thinner skeleton than men do, lose bone mass more quickly in conjunction with menopause, and because they live longer.

The fracture risk varies among nations, even within Europe. Sweden and Norway have the highest fracture rates. Although the reasons have not been confirmed, some of the factors discussed include heredity, body physique, low level of physical activity, dietary patterns, and vitamin D deficiency.

The number of hip fractures has increased in recent decades, mainly due to the aging population. In 1988, Sweden reported

18 417 hip fractures, while in 1999 the figure was 19 715, an increase of 7 per cent. Age standardization, which considers that fractures are more common in higher ages, shows that the incidence (the annual number of cases per inhabitant) has declined by 5 per cent among women, but increased equally as much in men.

Osteoporosis-related vertebral fractures and rib fractures may be spontaneous or caused by minimum stress, while wrist and hip fractures always occur in conjunction with a fall. Falls may result from the individual having poor balance, weak muscles, or factors in the external environment.

Mortality from hip fractures is high. Within one year following a fracture, mortality in the hip fracture group is 10 per cent to 15 per cent higher than in a corresponding group of the same gender and age without hip fracture. The social consequences from osteoporosis fracture are also substantial. Following a hip fracture, not everyone can return to his or her own residence, and walking ability deteriorates, which may increase social isolation. For many patients, quality of life deteriorates. This also concerns individuals affected by vertebral fractures. For these patients, pain and altered appearance contribute toward social isolation.

Costs to Society

Hip fractures account for more than one half of all fracture-related, direct healthcare costs. Among women over 45 years of age, the annual number of patient days in acute care hospitals for hip fractures is higher than for, eg, myocardial infarction, breast cancer, chronic obstructive pulmonary disease, or diabetes mellitus.

Patient rehabilitation, primary care, and municipal housing also generate major expenditures. The total direct costs for osteoporosis-related fractures is approximately 3.1 billion SEK. This corresponds to 1.9 per cent of the cost for health care. Indirect costs, ie, for lost productivity, are approximately 440 million SEK. The total cost in Sweden for osteoporosis and osteoporosis-related fractures is approximately 3.5 billion SEK. Table 1 presents the cost distribution.

Table 1. Costs in Sweden for osteoporosis and osteoporosis-related fractures during the first year following fracture (2001 price level)

Costs (million SEK)	
Inpatient care	1 617
Outpatient care	177
Pharmaceuticals	230
Social service	1 032
Total direct costs	3 056
Sick leave	340
Early retirement	100
Total indirect costs	440
Total costs in Sweden	3 496

Background

Osteoporosis results from a reduction in the quantity of bone tissue and the deterioration of bone microstructure, leading to a general loss in bone strength.

The skeleton consists of two types of bone tissue. *Cortical* bone is the compact tissue that forms an outer shell (cortical=outer) covering every part of the skeleton. The inner part of the skeleton consists of cancellous tissue, or *trabecular* bone, constructed of small “beams”. Trabecular bone contains more bone cells and is

replaced faster than cortical bone. The percentage of cortical bone and trabecular bone varies among the different parts of the skeleton. The center of the long bones contains, almost exclusively, cortical bone while the vertebrae contain approximately 75 per cent trabecular bone. The basic substance of bone (matrix) consists of protein. Its hardness and strength depends on the storage of minerals, mainly calcium salts.

The skeleton is formed (modeled) as the individual grows. Height increases and dimensions become greater. However, bone tissue continues to be replaced and modeled even after growth ceases, adapting to mechanical stresses for the remainder of one's life. Small injuries are continually repaired.

If the calcium content in blood becomes too low, calcium is released from the skeleton. Normal replacement and development of bone tissue requires sufficient nutrition, normal hormone formation in the body, and sufficient stress on the skeleton.

Bone tissue includes various types of cells. The *osteoblasts* build bone by mineralizing tissue, while *osteoclasts* break down bone tissue. When people are young, the system is in balance and the skeleton is maintained. When women reach menopause, the production of estrogen declines and eventually ceases completely, and the breakdown of bone tissue increases. At higher ages, in both men and women, the production of constructive hormones is diminished, as is the formation of active vitamin D in the kidneys. Frequently, physical activity and nutritional intake also decline. Combined, these factors lead toward greater loss of bone tissue and diminished bone quality in the elderly.

Diagnosis of Osteoporosis

To diagnose osteoporosis, several methods have been developed to measure bone density. The methods assessed in this report include dual energy x-ray absorptiometry (DXA), quantitative computed tomography (QCT), and quantitative ultrasound (QUS). A diagnosis is needed to assess the risk for fracture and to design treat-

ment. The risk for fracture is associated with the total decrease in bone density, ie the decrease associated with age and possibly greater deterioration compared with others of the same age. This increasing decrease in bone density is usually expressed as a T-score, ie the number of standard deviation units from the mean value in a young, healthy population of the same gender. The standard deviation units from the mean value in individuals of the same age and gender (Z-score) provides other information, ie how deviating the measured value is for an individual of this age. Hence, an older person may have a T-score value indicating osteoporosis, but show a normal value for the age group (Z-score). (See Figure 1.)

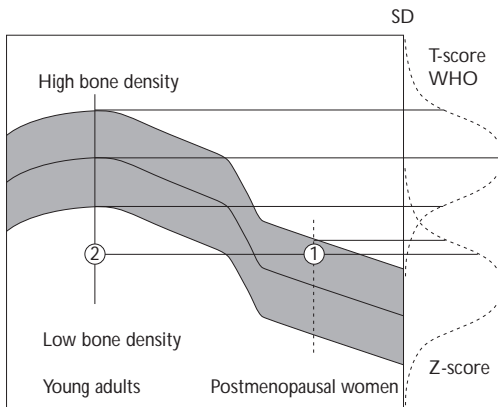


Figure 1. The curve represents the normal age-related decrease of bone density in women. In assessing T-scores, a postmenopausal woman with a measured value corresponding to point ① should be compared with the normal distribution shown at the upper right of the figure. She would have a T-score corresponding to minus 3 SD, ie, osteoporosis value based on the WHO criteria. Thus, she is compared with the normal values for a young healthy individual. Compared with the normal distribution for women of the same age (lower right), her measured value is above the mean value for her age group (Z-score), or plus 1.5 SD. A young woman (point ②) with the same measured value for bone density would have both a T-score and Z-score corresponding to minus 3 SD.

An expert group under the World Health Organization (WHO) proposed a definition for osteoporosis based on DXA to measure bone density in the hip, vertebra, or lower arm in postmenopausal women. Other measurement methods for bone density may use other diagnostic boundaries. Neither children, adolescents, men, nor very old people are included in this classification since there is insufficient information on the “normal” bone density values in these groups.

WHO Definition

Normal bone density: The measured value is no more than 1 standard deviation (SD) below the mean for young adults in the same population.

Reduced bone density (osteopenia): The measured value is between 1 and 2.5 standard deviations below the mean for young adults in the same population.

Osteoporosis: The measured value is more than 2.5 standard deviations below the mean for young adults in the same population.

Established osteoporosis: Value is more than 2.5 standard deviations below the mean for young adults in the same population, and patients have at least one fracture caused by low energy trauma.

Osteoporosis is common in the natural, biological aging process, but does not affect everyone equally. Two different types have been defined:

Primary osteoporosis is caused by natural aging, menopause, and lifestyle factors such as smoking, alcohol, diet, and physical inactivity.

Secondary osteoporosis is caused by some diseases and drugs.

Among younger individuals and males, secondary osteoporosis is most common.

Osteoporosis in elderly women is due mainly to normal aging and general morbidity. Osteoporosis per se does not yield symptoms and is viewed more as a risk factor than as a disease. The clinical manifestation of osteoporosis is low-energy fracture.

Project Scope and Design

New methods for diagnosing osteoporosis have emerged in recent years. Several pharmaceuticals have been approved for treating osteoporosis and preventing fractures. Protective devices to help prevent damage caused by falls have become available. These interventions provide some advantages, but also generate costs and, in some cases, disadvantages for the patients. The aim of the project has been to systematically and critically assess the scientific evidence on the effectiveness of various interventions. It was particularly important to address the following issues:

- Can different risk groups be defined?
- Can preventive interventions be recommended?
- Is general screening justified?
- How should new diagnostic methods be assessed?
- How should pharmacotherapy be assessed?

The charge to the Project Group also included assessment of the costs and cost effectiveness of the various treatment models.

This report was compiled by a Project Group of 15 individuals representing most of the specialties that care for patients with osteoporosis.

Relevant questions were formulated and criteria were established to include or exclude studies in the areas to be reviewed. The criteria established for the studies' design, outcome measures, followup period, population size, and time periods vary among different subject areas, depending mainly on the availability of studies. In pharmacotherapy, randomized controlled trials were required, usually with fracture as an endpoint. For diagnostics, risk factors, and rehabilitation, an epidemiological study was usually required. In addition to fracture, other accepted outcome measures include quality of life and the secondary endpoints of bone density and bone mass.

The first step in researching the literature was to investigate the availability of systematic reviews and meta-analyses in the Cochrane Library databases as regards the questions to be answered. Thereafter, several searches were conducted in Medline.

Sources, mainly the Cochrane Library, were periodically checked to identify any new systematic reviews. Complementary searches related to certain questions were conducted in the EmBase, Cinahl, Cats, and SciSearch databases. In addition, reference lists were reviewed and relevant journals and Swedish dissertations were checked.

The first selection of studies was carried out by reviewing how well the summaries identified in the database searches fulfilled the predetermined criteria. The next stage involved ordering full text articles or other documents. From the studies selected, the data that would be essential for the final assessment were extrapolated and tabulated.

Synthesis and Grading the Conclusions

Each study was reviewed, and its quality was assessed. The strength of the synthesized evidence presented was graded according to the scale below.

Evidence Grade 1: Strong scientific evidence; at least two studies presenting high study quality and relevance.

Evidence Grade 2: Moderately strong scientific evidence; one study presenting high and at least two studies presenting medium study quality and relevance.

Evidence Grade 3: Limited scientific evidence; at least two studies presenting medium study quality and relevance.

Results

Risk Factors for Osteoporosis and/or Fractures

The only risk factor for secondary osteoporosis that has been evaluated is the effect of synthetic glucocorticoids (cortisone) on bone density and fractures. The risk factors can be divided into non-treatable and treatable categories. Table 2 presents a summary of the factors discussed in the following text.

Table 2 Risk Factors

Non-treatable risk factors	Treatable risk factors
High age	Physical inactivity
Previous fracture	Low weight/low BMI
Female gender	Cortisone treatment
Menopause	Low bone density
Heredity	Tendency to fall
Ethnicity	Tobacco smoking
Body height	Alcohol consumption
	Low exposure to sunlight
	Impaired vision

Non-treatable Risk Factors

High Age

Bone density declines in both genders as age increases. In women, bone loss is more rapid following menopause and continues throughout life. In men, bone loss is more continuous. Parallel with bone loss, the risk for fracture among women aged 80 years and older is approximately 30 per cent higher than in women aged 50 to 59 years. High age increases the risk for low bone density, and for fractures in both women and men (Evidence Grade 1).

Previous Fracture

Both women and men who previously experienced vertebral compression or fractures in the wrist, upper arm, or hip are at increased risk for hip fracture and vertebral compression (Evidence Grade 1). For example, the risk for hip fracture is more than double in those who have already experienced such a fracture.

Female Gender

Women between the ages of 60 and 80 years lose nearly twice the bone density than men of the same age. The risk for hip fracture in women is also nearly doubled. In both women and men the risk for hip fracture doubles every fifth year. Men in a particular age group have the same incidence of hip fracture as women in a group 5 years younger. The prevalence of vertebral fracture in a Swedish population was twice as high in women as in men. (Evidence Grade 1)

Menopause

The average age of menopause among Swedish women is 51 years. In menopause, the production of estrogen in the ovaries declines and eventually ceases, leading to increased bone loss. Bone loss is greatest during the first years following menopause (Evidence Grade 1). Menopause is usually defined as early if it occurs prior to 45 years of age. Women with early menopause have less bone density than women of comparable age with normal menopause. The risk for osteoporosis-related fractures in women with early menopause is triple that of comparably aged women with normal menopause. The importance of this risk factor is thought to decline after 70 years of age. (Evidence Grade 2)

Heredity

Women having a mother with osteoporosis run a slightly higher risk for osteoporosis. If the mother experienced a hip fracture, the risk for the daughter is moderately increased (Evidence Grade 2). There is some evidence that hip fracture in the mother increases the risk for vertebral compression in her sons (Evidence Grade 3). Studies of twins have yielded inconsistent findings.

Ethnicity

Different ethnic groups have different maximum bone mass and different rates of bone loss following menopause. This is probably

due to the fact that body measurements and lifestyle differ among different ethnic groups. Studies in the United States show that bone density was highest among Afro-Americans, lower among whites, and lowest among Asian women. The risk for fracture was, nevertheless, lower among Asian women than among white women, but lowest among Afro-American women. These differences can be partly explained by differences in body composition. (Evidence Grade 2)

Body Height

Tall women are at greater risk for osteoporosis and fractures (Evidence Grade 1). There is weak evidence that tall body height at 25 years of age can predict later fracture (Evidence Grade 3).

Treatable Risk Factors

Physical Inactivity

The percentage of physically inactive individuals increases with increasing age. Elderly women are more inactive than elderly men. Physical inactivity comprises an independent risk factor for hip fractures in both women and men. The absence of weight-bearing muscle exercise increases the risk for hip fracture (Evidence Grade 1).

Low Weight and BMI

Women having low weight and low BMI run a higher risk for osteoporosis and fractures (Evidence Grade 1). Furthermore, it appears that weight loss, and oscillating weight loss and gain, comprise risk factors for fracture (Evidence Grade 2). Even among men, low body weight, tall body height, low BMI, and oscillating weight comprise risk factors for hip fracture (Evidence Grade 3).

Corticosteroids Treatment

Treatment (tablets) based on a daily dose corresponding to at least 5 mg prednisolone reduces bone density and increases the risk for fracture. A single daily dose of 7.5 mg prednisolone for a longer period doubles the risk for hip fracture and nearly triples the risk for vertebral fracture (Evidence Grade 1). Low and moderate doses of inhalation steroids for longer periods in treating asthma do not increase the risk for osteoporosis and fracture (Evidence Grade 2).

Low Bone Density

Low bone density is a major risk factor for future fractures in the wrist, upper arm, vertebrae, and hip. The level of increased risk varies among studies. A review addressing age and other risk factors accentuated the importance of bone density. Bone density is a continuous variable, and the risk for fracture increases as bone density decreases in both genders (Evidence Grade 1).

Tendency to Fall

Fractures in the hip and the wrist are often caused by a fall on a level plane. Falling sideways is of importance in hip fractures. One fourth of those over 65 years of age have fallen at least once in the past year. For individuals aged 80 through 84 years, the figure is approximately 40 per cent. Factors shown to increase the risk for fracture by falling include major body instability, low muscle strength, impaired mobility, urinary incontinence in the oldest age group, medications that reduce the awareness level, and impaired vision. The increased tendency to fall is a major risk factor for fractures among the elderly (Evidence Grade 1).

Tobacco Smoking

Tobacco smoking influences metabolism in the skeleton, both indirectly via the hormone system, but also through direct toxic effects on bone tissue. Bone density is lower among smokers and

ex-smokers. This applies to both genders (Evidence Grade 1). The risk for hip fracture among women who smoke is up to three times higher than among non-smokers. The greatest risk is found among low weight women. Even men who smoke are at an increased risk for hip fracture (Evidence Grade 1). Although smoking cessation will reduce the risk, some elevated risk will remain.

Alcohol Consumption

The risk for hip fracture increases in both genders as alcohol intake increases. Men who are high consumers of alcohol have a five times greater risk for hip fracture than those who abstain. Women with high alcohol consumption have a 40 per cent increase in the risk for hip fracture (Evidence Grade 2). This increase in risk may be associated with the poor nutritional situation and increased tendency to fall among alcoholics.

Low Exposure to Sunlight

The patient registry at the National Swedish Board of Health and Welfare was used to study the prevalence of hip fracture in all individuals aged over 50 years between 1987 and 1996. The study shows that hip fractures increase with the Northern latitude and also show seasonal variations. One reason may be that the low angle of the sun in Nordic countries leads to poor vitamin D levels that increase the risk for osteoporosis and hip fracture. Other studies support the Swedish findings (Evidence Grade 2).

Impaired Vision

In people aged 75 years and older, impaired vision is included as an independent risk factor for falls and fractures. The risk for hip fractures five times greater among women with impaired vision at a mean age of 80 years. Impaired vision is an important risk factor for accidental falls leading to hip fracture in both genders (Evidence Grade 2).

Methods to Determine Bone Mass and Predict Fracture Risk

The bone density measurement methods that have been adequately assessed scientifically, and assessed in this section, include DXA, QCT, and QUL. As presented in the introduction, osteoporosis is defined by WHO as bone density that is at least 2.5 standard deviations below the mean value in a young, healthy, gender-matched population. A low value measured in part of the skeleton is sufficient to establish a diagnosis of osteoporosis. If several parts of the skeleton are measured, the probability for establishing a diagnosis increases.

What are the characteristics of the various methods used to measure bone density?

Table 3 presents a comparison of various methods for measuring bone density.

Table 3 Comparison of the most common methods for determining bone density.

Method	Body part	Examination time (min)	Accuracy %	Precision %	Advantages	Disadvantages
DXA (DEXA)	Whole body Lumbar spine Hip Heel	3–10 per body part	3–9	0.5–3	Relatively high precision Low radiation dose Many body parts including central skeleton	Measure in gram per surface area, size dependent. Relatively high price. Influenced by arthrosis and vascular calcification
Ultrasound	Heel (Finger, wrist, knee)	5	* (20)	1.5–6	No ionizing radiation. Low price. Mobile equipment	Not validated using durability or ash weight
QCT	Vertebrae Wrist	5–30	5–15	2–6	Provides true density. High resolution. Describes the difference between trabecular and cortical bone	High radiation dose. High price. Major errors associated with accuracy and precision

* Ultrasound measurements use sound speed and ultrasound attenuation in bone. Hence, accuracy is not relevant in relation to bone density. Measuring a certain sound speed with a certain accuracy does not tell how accurately the bone density has been indirectly estimated.

There are no optimal diagnostic methods or measurement sites for determining fracture risks in all parts of the skeleton. Measuring bone density in the hip is best for predicting the risk for hip fracture. Comparisons of the various measurement methods – DXA, ultrasound, and CT – are less certain. This uncertainty is not due solely to the methods themselves, but also to biological variations; bone density declines in winter but is unchanged or increases in the summer.

Can bone density measurement predict fracture risk?

The findings are summarized in Table 4.

Table 4 Relative risk for fracture in postmenopausal women with T-score –1.

Measure- ment site	Type of fracture			
	Lower arm	Hip	Vertebrae	All
Wrist	1.7 (1.4–2.0)	1.8 (1.4–2.2)	1.7 (1.4–2.1)	1.4 (1.3–1.6)
Hip	1.4 (1.4–1.6)	2.6 (2.0–3.5)	1.8 (1.1–2.7)	1.6 (1.4–1.8)
Lumbar vertebrae	1.5 (1.3–1.8)	1.6 (1.2–2.2)	2.3 (1.9–2.8)	1.5 (1.4–1.7)
Heel	1.6 (1.4–1.8)	2.0 (1.5–2.7)	2.4 (1.8–3.2)	1.5 (1.3–1.8)
All	1.6 (1.5–1.7)*	2.0 (1.7–2.4)*	2.1 (1.9–2.3)*	1.5 (1.4–1.6)*
Heel as measured by ultrasound		2.2 (1.8–2.7)	1.8 (1.5–2.2)	1.5 (1.4–1.7)

* The confidence interval is equivalent to the lowest individual confidence interval for each measurement site.

Table 5 compares the absolute 10-year risk for hip fracture in both genders having osteoporosis at different ages (T-score -2.5 SD) with the absolute fracture risk in corresponding age groups.

Table 5 Fracture risk in osteoporosis at different ages. Absolute 10-year risk for fractures in women and men (T-score -2.5 SD) compared to absolute fracture risk in comparable age groups (shown in percent).

Women	Relative risk for hip fracture versus the population	Absolute risk for hip fracture	Absolute risk for hip, wrist, vertebral, shoulder fracture
60 yr	1.9	4.4	16.2
70 yr	1.2	8.6	22.8
80 yr	0.74	11.3	25.6

Men	Relative risk for hip fracture versus the population	Absolute risk for hip fracture	Absolute risk for hip, wrist, vertebral, shoulder fracture
60 yr	3.1	3.8	9.5
70 yr	2.5	8.4	13.1
80 yr	1.8	13.0	18.7

The relative risk (RR) for fracture is high among 60-year-old women and men with osteoporosis compared to corresponding age groups. In the group aged 80 years (T-score -2.5 SD) there is no such difference in the risk for fracture. However, the opposite applies regarding the absolute risk, ie, the younger group with a high relative risk have a lower absolute risk than 80-year-old group.

Is there evidence to recommend a particular measurement method?

It has been shown that the values of bone density from various methods are not comparable. Precision is limited, and the correlations are poor among measurement values from the different methods. Hence, comprehensive assessments are needed to determine a standard to compare various measurement values and measurement sites for the purpose for predicting fracture risks. The same problem is also found in regard to selecting the measurement site to determine treatment for osteoporosis. Most pharmacological studies have been performed using DXA of the hip and/or lumbar spine.

Using DXA to examine the hip requires a high standard of accuracy. Nevertheless, it offers better opportunities for predicting all types of fractures than do examinations of the lumbar spine (Evidence Grade 2). DXA studies of the hip are best at predicting hip fracture (Evidence Grade 1).

DXA measurement of the heel has been used in a few studies involving different types of equipment. Studies using older heel measurement devices show that fractures can be predicted. New DXA equipment is being developed.

Agreement between DXA hip and back studies is limited, and no longitudinal studies have yet confirmed how well the new measurements can predict the risk for fracture.

In women over the age of 65 to 70 years, ultrasound examination of the heel offers about the same reliability in predicting the risk for hip and vertebral fracture as DXA does for the hip or back (Evidence Grade 2). In women below 65 years of age, the scientific evidence is insufficient regarding ultrasound examination of

the heel in predicting fractures.

Ultrasound studies of the fingers, wrist, and knee are not shown to be superior to studies of the heel, which is therefore recommended among the ultrasound examination options (Evidence Grade 3). Quantitative computed tomography of central aspects of the skeleton is a research method, since it yields a high radiation dose and poor accuracy (Evidence Grade 1).

Is there scientific evidence that screening is warranted and cost effective?

The goal of screening is to reduce the number of individuals who contract and die prematurely from a disease by detecting and treating the disease before it generates symptoms or has caused irreparable damage. With osteoporosis, it is fractures that need to be prevented. Osteoporosis is one of several risk factors for fracture, but is not defined as a preliminary stage. Hence, screening to measure bone density cannot be compared with, eg, mammography screening. A better comparison would be measurement of cholesterol or blood pressure to detect the risk for cardiovascular disease.

The WHO list of standards can be used to analyze screening involving bone density measurement to detect osteoporosis. Such an analysis shows that general screening is not warranted to measure bone density to prevent fractures. The most important reason is that we are dealing with a risk factor, not an early diagnosis of a disease. Furthermore, there is uncertainty about the examination methods. No randomized controlled trials compare the outcome in a screened group versus the outcome in a non-screened group. Cost effectiveness has not been assessed.

Hence, there is no scientific evidence to support the use of bone density measurement as a screening method in healthy, middle-aged individuals. However, measurement of bone density plays an important role in the examination of individuals with several risk factors to predict their fracture risk (Evidence Grade 1).

Biomedical and Genetic Markers for Bone Remodeling

In the remodeling of mature bone, several different substances are released that can serve as markers of bone metabolism. These markers circulate in the blood and are excreted in the urine where they can be analyzed. The hope is that these substances can be used to identify individuals at increased risk for fracture, to facilitate diagnosis and to predict the effects of osteoporosis treatment. Research is under way to investigate the genetic background of osteoporosis.

Biochemical markers are currently a research instrument, and are not used in routine health services. Genetic markers for bone density also remain at the research stage and cannot be used in clinical practice.

Physical Activity

Total physical activity refers to how much a person moves on his or her way to and from work, during work, at home, and during leisure-time activities. The higher incidence of osteoporosis could possibly reflect a change in life style that involves reduced physical activity.

A mechanical load that places greater stress on a part of the skeleton leads to the formation of new bone in that part. Too little load in any part of the skeleton leads to degradation of bone and a reduction in bone mass. Biomechanical stresses and muscles play a role in the formation of bone tissue. Heavy, quick, and varied load or stress probably has the greatest effect on bone formation. Continual weight-bearing stimuli are thought to have the greatest effect on maintaining bone mass.

In assessing the effect of physical activity on health and bone mass, one must consider several factors that may influence the outcome. Individuals who are physically active may differ from others in several respects. People with good health, good muscle power, and good dietary habits are probably more physically active than others. Hence, it is important to assess the population

studied, how exercise is designed and registered, and how the outcome measures are selected in relation to the population and its level of physical activity. In most cases, bone mass or bone density are used as outcome measures. Isolated studies have reported on the rate of fracture. There are many types of physical activity: regular walking, aerobics, jogging, jumping, bodybuilding, weight lifting, school gymnastics, bicycling, and swimming. Other activities also apply to those heavily involved in sports.

Can physical activity increase/maintain bone mass and/or reduce the loss of bone mass and influence the occurrence of fractures?

In both girls and boys, physical activity for at least 30 minutes at least 2 to 3 times per week has a positive effect on bone density, mainly in the femur and the lumbar spine. The normal increase in bone mass is greatest around the time of puberty. According to some studies, the effects of increased physical activity are greatest prior to puberty, but other studies report around puberty or shortly after it starts. The effects probably remain in young adults (Evidence Grade 2). In healthy women prior to menopause (aged 20–50 years) the effects of exercise on bone density are less certain (Evidence Grade 3). In women following menopause (aged 50–65 years), bone density in the hip, lumbar spine, lower arm, and heel, and the rate of fractures, have been studied. Moderate evidence suggests that exercise increases bone density (Evidence Grade 2). Weaker evidence suggests that exercise can prevent fractures (Evidence Grade 3).

Studies in women older than 65 years of age have investigated bone density in different parts of the skeleton, fracture rates, and general physical ability including strength and well being. These studies have yielded contradictory results about the effects of physical exercise on bone density. One study reports a reduced risk for hip fracture. A general increase in physical ability has been shown. (Evidence Grade 3) Studies of men are few, and the data are insufficient to assess the effects of physical activity.

Studies of people involved in sports have included rowers, tennis players, bicyclists, and runners. All studies are small, and reasons other than exercise cannot be excluded in explaining differences. Generally, one finds an increase in bone mass in parts of the skeleton that have been subjected to substantial load (Evidence Grade 3).

What types of physical activity can influence bone mass?

The interventions that have yielded positive results in children and teenagers are weight-bearing exercises such as jumping, aerobic exercise, weight lifting, and school gymnastics (Evidence Grade 2).

Even in postmenopausal women various types of weight bearing exercise such as walking, aerobic exercise, endurance, and strength training have the greatest effects on bone density (Evidence Grade 2).

Which age groups benefit from physical activity?

As presented in the section on risk factors, physical inactivity presents a substantial risk factor for the development of osteoporosis and fracture. Physical activity is therefore important in all age groups. Particularly important is activity in children and teenagers when the formation of maximum bone mass occurs. Moderate evidence also suggests that physical exercise in women following menopause prevents the loss of bone mass and prevents fractures. Physical activity is also valuable in women over 65 years of age, primarily because it improves general physical performance.

Does physical activity have effects in individuals with confirmed osteoporosis?

The few studies that have been conducted show that physical exercise increases well being, but has no confirmed effects on falls and fracture prevalence in patients with osteoporosis.

Does physical activity have different effects in men and women?

Most studies are conducted on women. Among children and teenagers, one observes the same positive effects in both genders (Evidence Grade 2). A few studies in adult men found no effects on bone density from physical activity, but a possible effect in terms of reduced risk for vertebral compression after long-term exercise.

Diet

Dietary habits, exactly like other lifestyle factors, may be associated with bone density and the risk for fracture resulting from osteoporosis. Diet is important, both because it is necessary to have a sufficient supply of energy and nutrition and because poor dietary habits may cause deficiencies in vitamins and minerals. Nutritional deficiencies are common among the elderly with illness. A Swedish study found that 28 per cent of the patients who were admitted to a geriatric department were undernourished. This also applied to 38 per cent of the patients with hip fracture and 8 per cent of stroke patients.

Is total dietary intake important for bone mass and fracture risk?

A certain intake of energy and nutrition is necessary so that the supply of nutritional substances is sufficient and that protein is not burned off as energy. Low-weight individuals have a different hormone balance and a lower content of important growth factors. A slim individual also has little tissue to cushion falls. Undernourishment and low weight increases the risk for osteoporosis and fractures caused by osteoporosis (Evidence Grade 2).

What ingredients in food are particularly important for bone mass and fracture risk?

Protein is needed for the continuous formation of bone tissue and is important for achieving maximum bone mass. Hence, protein is of special importance prior to and during puberty. However, no

research findings have demonstrated the effect that protein content in the diet has on bone loss and fractures caused by osteoporosis (Evidence Grade 3).

The vitamins which have been studied in conjunction with osteoporosis include A, C, D, and K. High content of vitamin A in food is associated with reduced bone density in the femoral neck and increased risk for hip fracture in both men and women (Evidence Grade 2).

Vitamin K is required in normal amounts so the body can form a sufficient amount of the protein osteocalcin (binds calcium and is found in bone tissue). The impact of vitamin K deficiency on bone tissue is unknown. High content or high intake of vitamin K in the diet is associated with reduced risk for hip fracture (Evidence Grade 2).

Vitamin C is important to allow the normal formation of collagen in the skeleton. Reports on the effects which vitamin C supplements have on the risk for fracture are inconsistent.

Vitamin D is necessary so that sufficient amounts of calcium can be taken up in the intestine and so that minerals can be stored in the skeleton. The risk for vitamin D deficiency is high among those who are elderly and sick. Studies that specifically investigate the correlation between osteoporosis and vitamin D in the diet are lacking.

Calcium. The skeleton contains 99 per cent of the body's calcium. Calcium salts make the skeleton strong. They are released from the skeleton if intake from the diet is insufficient. Some studies suggest that increased intake of calcium, mainly from milk products, increases bone density in children and teenagers. Increased calcium intake prior to menopause is thought to be important. These positive effects may, however, be a consequence

of a generally good nutritional status (Evidence Grade 2).

Documentation is insufficient to show general co-variation between calcium intake in the diet and bone density or osteoporosis-related fractures. There may be an effect between calcium intake (more than 1500 mg/day) and bone density in postmenopausal women (Evidence Grade 3). Documentation on the relationship between the dietary content of calcium and the risk for fracture is insufficient. Other minerals in the diet have not been sufficiently studied

What role does diet play in the formation of bone mass during growing years?

The studies which have analyzed the importance of diet during childhood and adolescence clearly suggest that good dietary habits involving sufficient intake of protein, calcium (milk products), and necessary vitamins is important for developing maximum bone mass (Evidence Grade 2).

Is diet important in treating individuals with low bone density?

A randomized controlled trial shows that six months of protein supplements in patients with osteoporosis and recent hip fracture resulted in a leveling out of bone mineral loss and fewer new vertebral fractures (Evidence Grade 2). Further studies are needed.

Pharmacotherapy

Pharmacotherapy for osteoporosis involves the use of calcium, vitamin D, and three types of substances that impede the degradation of bone tissue. The three substances include estrogen agents of moderate potency, selective estrogen receptor modulators (SERM), and bisphosphonates. Agents are available in other countries which stimulate bone formation, eg, parathormone (PTH). This agent is expected to be approved in Sweden in the near future.

Most treatment studies of these drugs have examined their

effects on bone density or biochemical markers. This report prioritizes studies addressing the most important outcome measure, namely the risk for fracture. Most studies are conducted on middle-aged and elderly women. Only a few studies involve men. Some studies address osteoporosis caused by cortisone in men and women. Most studies have been under way for three years. Isolated studies have examined safety and tolerance up to seven years.

Calcium and Vitamin D

There is no solid evidence that treatment with calcium alone or vitamin D alone reduces the risk for osteoporosis-related fractures. Possibly, treatment in selected groups at high risk for calcium and/or vitamin D deficiency would provide more positive results.

The combination of calcium and vitamin D reduces the risk for hip fracture and other fractures, with the exception of vertebral compression, in elderly women (Evidence Grade 1).

Treatment with 1-alpha-hydroxylated vitamin D may possibly reduce the risk for vertebral fracture in postmenopausal women (Evidence Grade 3).

Calcium in combination with different types of vitamin D counteracts the decline in bone density in men and women treated with cortisone (Evidence Grade 1).

Estrogen

An earlier SBU report on estrogen treatment concluded that evidence shows that estrogen agents of moderate potency can prevent bone loss (Evidence Grade 1) and reduce the number of fractures (Evidence Grade 2). Several studies have been presented since publication of the SBU report, mainly the Women's Health Initiative (WHI) addressing primary prevention. Part of the study showed that estrogen combined with progesterone reduces the risk for hip fracture and other fractures. The study was discontinued prematurely due to increased incidence of breast cancer and cardiovascular diseases. However the evidence for fracture reduc-

tion is good (Evidence Grade 1). The applicability of treatment is limited by its undesirable effects. There are no controlled studies of fractures during estrogen treatment in women at high risk for osteoporosis fractures.

SERM

A large study has shown a reduced risk for vertebral fractures in postmenopausal women with osteoporosis (Evidence Grade 1). Data are lacking for other fractures.

Bisphosphonates

Currently, three bisphosphonates are registered in Sweden for treatment of osteoporosis: alendronate, etidronate, and risedronate. There are several large studies of alendronate and risedronate in women with osteoporosis. All of these studies show a lower fracture prevalence. The best effects concern vertebral fractures and all peripheral fractures (Evidence Grade 1). There is also a significant reduction in the risk for hip fractures among elderly women with osteoporosis (Evidence Grade 2). Isolated studies suggest that these agents also have preventive effects for bone mass and vertebral compression in men (Evidence Grade 3). Risedronate prevents the loss of bone mass in cortisone-treated patients (Evidence Grade 1). The evidence is insufficient for determining the effects on fracture risk in cortisone-treated patients.

Parathormone (PTH) – unregistered drug

Daily subcutaneous injections of PTH have shown positive effects on the skeleton. A large study reported reduced risk for vertebral fracture in osteoporotic elderly women with at least one previous vertebral fracture. The study was discontinued prematurely due to uncertainty in animal studies. PTH increases bone density in the back and hip in elderly women with postmenopausal osteoporosis and reduces the risk for vertebral fractures (Evidence Grade 1).

Economic Aspects of Osteoporosis and Preventive Fracture Treatment

A feature common to all economic calculations is the use of models to estimate the cost effectiveness of different treatments. Osteoporosis treatment influences the risk of disease for extended periods, motivating the use of models. Uncertainty about the costs and effects in the studies requires one to interpret with caution the conclusions of the cost effectiveness of various treatments. Future economic assessments require further knowledge about the effects and risks of treatment, mortality, quality of life, and cost in various ages and risk groups.

Estrogen

Reliable conclusions cannot be drawn regarding the cost effectiveness of hormone treatment in preventive intervention of fractures in asymptomatic women.

Bisphosphonates

Clinical studies have shown that bisphosphonates protect against fractures in elderly women with osteoporosis. Economic studies suggest that treatment with bisphosphonates is cost effective in elderly women with elevated fracture risk. Assessing this with greater certainty would require further studies to analyze the effects of treatment on fracture risks in these patient groups during and following treatment.

Calcium + Vitamin D

Studies of treatment with calcium and vitamin D have shown a reduced prevalence of fractures in elderly women with osteoporosis. Since the costs are moderate, the treatment of elderly women with calcium/vitamin D is cost effective.

Pain and Pain Treatment

Nothing would suggest that osteoporosis alone causes acute or chronic pain. Symptoms appear following acute fractures, or as after-effects of previously incurred fractures. Many patients with osteoporosis may also experience other back problems, eg, degenerative changes that cause back pain without the presence of vertebral compression. In older people, both degenerative changes and osteoporosis with vertebral fractures are common, but the prevalence varies in different populations. The literature review focuses on vertebral compression and back pain. Fracture-related pain and conditions resulting from peripheral fractures are not addressed since they are oriented more toward orthopedics.

Does vertebral compression cause back pain?

Pain from vertebral fractures is most pronounced when the fracture occurs and in the weeks directly thereafter. Vertebral fractures that appear in an x-ray image may have occurred a long time prior to the examination since the x-ray does not distinguish fresh fractures from old fractures. The more vertebral compressions found, the greater the probability that the patient has, or has had, back pain (Evidence Grade 1). Vertebral compression is not a common cause of back pain in younger, healthy individuals, but is often a cause of back pain in elderly women and patients treated with cortisone (Evidence Grade 2).

Do antiosteoporotic agents relieve pain?

Two types of agents have been studied, ie, calcitonin and bisphosphonates. Calcitonin has an analgesic effect which is superior to placebo and mild pain relievers (eg, paracetamol) in acute vertebral fractures (Evidence Grade 2). However, there is no scientific evidence that calcitonin is more effective than conventional pain relievers (eg, NSAIDs, codeine, dextropropoxyphene, opiate analgesics) in alleviating pain for vertebral fractures. There is no evidence that bisphosphonates reduce pain.

Is orthopedic surgery using vertebroplasty and kyphoplasty effective against back pain in osteoporosis?

The methods have been tested since the mid 1990s and involve injecting bone cement into the vertebral body. In vertebroplasty and kyphoplasty, bone cement is injected to relieve pain and stabilize the vertebrae. In kyphoplasty, the compromised vertebral body is initially expanded to restore, either fully or partially, the height of the vertebrae. Only recent vertebral fractures can be treated since fracture healing occurs within two months, rendering the procedure more difficult. Several published case reports suggest that vertebroplasty and kyphoplasty provide rapid and effective pain relief in selected patients with fresh vertebral fractures (Evidence Grade 3). Randomized controlled trials have yet to show that this invasive treatment has a better effect than conventional pain relief, and that it is effective and safe in long term followup in unselected patient groups.

Corsets and supportive treatment

Corsets are used for different types of back disorders. There is insufficient evidence to show when treatment with corsets or other back support devices is helpful, and whether these devices provide effective pain relief in acute or chronic back pain resulting from vertebral fracture.

Physiotherapy

Isolated, well-execute studies suggest that physiotherapy involving exercise of muscle strength and balance in women with fresh vertebral fractures provides favorable effects, such as lower experience of pain, reduced use of pain relievers, and improved quality of life (Evidence Grade 3).

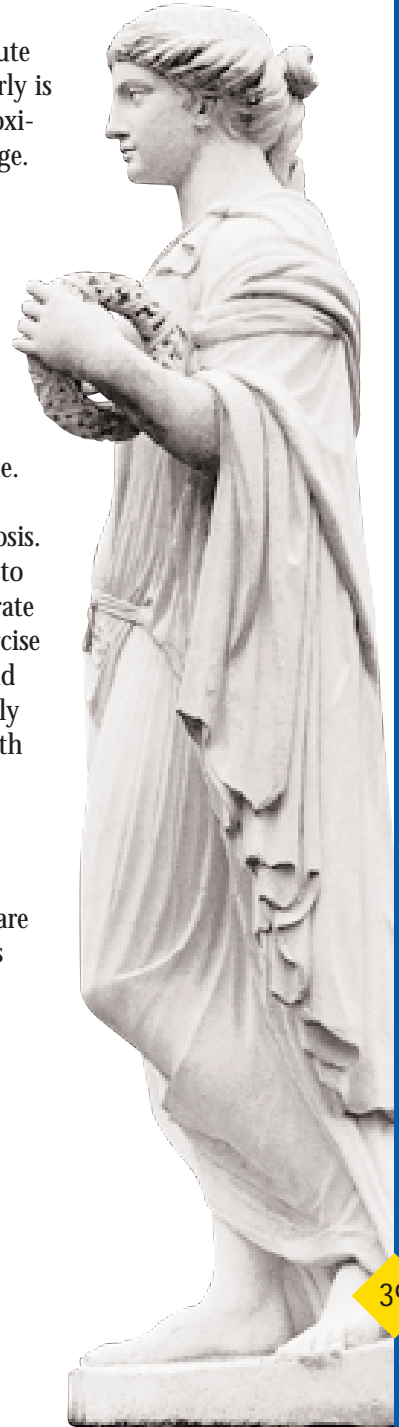
Falls and Preventing Falls

Falls are common and are increasing in absolute numbers, mainly because the number of elderly is increasing. During a year, falls occur in approximately 30 per cent of those over 65 years of age.

Two thirds of the individuals in nursing homes fall during a year, half of them more than once. Several factors may, alone or in combination, cause falls. Causes may include age-related changes in balance, joints and muscle problems, vision problems, dizziness, general weakness, undernourishment, medication, and hazards that cause falls inside and outside of the home. All falls do not lead to fractures, but the risk increases if the person who falls has osteoporosis.

Several studies address exercise programs to improve balance. In summary, there is moderate scientific evidence that walks and aerobic exercise improve balance, oxygen uptake, strength, and quality of life (Evidence Grade 2). Individually designed training programs for muscle strength and balance have been shown to reduce the number of falls (Evidence Grade 2).

Also, interventions to reduce the risks at home can result in reducing number of falls (Evidence Grade 2). However, interventions are less successful in reducing the number of falls among individuals with impaired cognitive function (Evidence Grade 3). There is no evidence showing that interventions to prevent falls will reduce the number of fractures.



Hip Protectors

Falling laterally on the upper part of the femur often causes a hip fracture. Hip protectors are intended to reduce the impact of the fall on this particular area. Hip protection devices usually consist of an undergarment with fixed or removable plastic shields covering the hip. Hence, they are effective only for the upper part of the femur. Elderly people who live in institutions or their own home have been studied. Hip protectors appear to reduce the risk for hip fracture after falls in the elderly who live in nursing homes or institutions (Evidence Grade 2). A problem is compliance, as identified in a study where no difference in the fracture rate was observed among those who used hip protectors and the control group. The participants did not use the protectors during the night, and falls occurred when they got out of bed. The use of hip protectors requires motivating not only the individual but also the staff.

Studies of hip protectors suggest that they can protect against fractures in selected elderly, high-risk patient groups in nursing homes. In these groups, hip protectors can be cost effective. To reliably assess cost effectiveness, more studies are needed to investigate the costs and effects in different age groups and living situations.

Rehabilitation Following Osteoporosis Fractures

The goal of rehabilitation is to return the individual to his/her previous functional level. The previous functional level and type of living situation often have a greater impact on the outcome of rehabilitation than the injury itself. Those who experience fragility fractures are often older women with several concurrent diseases, poor nutritional situation, less ability to perform activities of daily living, impaired mobility, and a limited social contact network.

Hip Fractures

Rehabilitation in geriatric, orthopedic, or multidisciplinary care is equivalent with regard to outcome measures such as mortality, institutional living, and function (Evidence Grade 1).

Different types of intensive exercise interventions by physiotherapists and occupational therapists, eg, more frequent exercise, specific methods for exercising walking skills, or neuromuscular stimulation, do not shorten the rehabilitation phase nor do they improve the outcome in cognitively intact patients (Evidence Grade 2).

Most studies exclude patients with impaired cognitive function. A few studies suggest that these patients may benefit from more intensive rehabilitation (Evidence Grade 3). Knowledge about patients with severe cognitive disorders is inadequate.

Early mobilization and discharge to the patient's home, with rehabilitation provided in primary care for patients assessed to be sufficiently functional, has been a practice in Sweden for many years. Given the appropriate selection of patients and sufficient resources in primary care, this treatment yields results equal to those from inpatient rehabilitation services (Evidence Grade 1).

Since a high percentage of the patients admitted with hip fractures are undernourished, providing energy rich diets and extra proteins can shorten the rehabilitation phase. Mortality is not influenced. (Evidence Grade 2)

The diagnosis of osteoporosis is seldom reported either during admission or discharge of patients with hip fractures. Few patients receive adequate treatment with drugs or other interventions to prevent new fractures (Evidence Grade 2).

Wrist Fractures

Intensive exercise under the leadership of a physiotherapist or treatment, eg, with ultrasound, does not shorten the rehabilitation phase or yield an outcome superior to early exercise on one's own following instruction (Evidence Grade 2).

Vertebral Fractures

Exercise under the guidance of a physiotherapist can result in less pain, a lower use of painkillers, and improved quality of life in patients with new fractures (Evidence Grade 3). Continuing to exercise is important to prevent new fractures and reduce pain (Evidence Grade 3).

Quality of Life Related to Osteoporosis and Fractures

Quality of life is a more important measure of well being in patients with osteoporosis and fractures than bone density values or the number of fractures. Quality of life has been studied using general tests and tests specific to osteoporosis patients. The association between osteoporosis and quality of life is unclear.

Does osteoporosis without fractures reduce the quality of life?

Osteoporosis alone, without fractures, does not appear to impair function or reduce the quality of life (Evidence Grade 3).

Do hip fractures and vertebral fractures substantially reduce the quality of life?

Hip fractures lead to long-term impairments in functional capacity and quality of life in a large percentage of those affected (Evidence Grade 1). Pronounced and multiple vertebral fractures impair the quality of life in women following menopause (Evidence Grade 1). The situation in men has not been sufficiently studied, but available studies suggest findings that are similar to those in women (Evidence Grade 3). It is uncertain whether single, moderate vertebral deformities detected by x-ray examination lead to a lower quality of life (Evidence Grade 3).

Ethical and Social Aspects – Priorities

According to a parliamentary decision, priorities in health care should be based on an ethical platform consisting of three principles: the principle of human value, the principle of need, and the principle of cost effectiveness. Health services should also adhere to the decision concerning four priority groups. Furthermore, all interventions in health care should be based on four principles: to do good, to do no harm, to respect autonomy, and to be just.

The healthcare conditions caused by osteoporosis, ie, fractures in conjunction with low energy trauma, belong to priority group I. The same group includes care of individuals having lower autonomy – among osteoporosis patients, this involves all elderly patients with dementia. A large number of patients need rehabilitation after the acute fracture phase and therefore belong to priority group II. Even primary prevention, which is an important aspect of prevention in osteoporosis, belongs to priority group II.

There is no scientific evidence to show that general population screening programs for osteoporosis are of value. Hence, this is not ethically justified.

The treatment of patients with osteoporosis appears to follow accepted ethical principles. An exception concerns undertreating patients who have experienced fractures. Rehabilitation is judged to be the same from an ethical standpoint. However, there is some uncertainty as regards hip fracture patients with moderate to severe cognitive disorders.

With all types of fragility fractures, social rehabilitation is a necessary complement to pain relief, physical skills training, and interventions to prevent new fractures.

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SBU Evaluates Health Care Technology

The Swedish Government has given SBU the following responsibilities:

- SBU shall evaluate the methods used in health care by systematically and critically reviewing the scientific evidence in the field.
- SBU's assessments shall cover the medical aspects and the ethical, social, and economic consequences of disseminating and applying medical and dental technologies.
- SBU's assessments shall be compiled, presented, and disseminated in such a way that all affected parties have access to the information.
- SBU shall contribute, through informational and educational initiatives, toward ensuring that the knowledge gained is used to rationally utilize available resources in health care.
- SBU shall draw on national and international experience and research findings in the field and shall serve as a focal point for health technology assessment in Sweden. This effort shall be managed in a way that secures success and respect for the organization, both domestically and internationally.

Osteoporosis – Prevention, Diagnosis and Treatment

The SBU report, “Osteoporosis – Prevention, Diagnosis and Treatment”, is based on a systematic and critical review of the scientific literature. It is one of a series of scientific reports published by SBU (The Swedish Council on Technology Assessment in Health Care).

The Summary and Conclusions of the report, presented in this booklet, have been approved by the SBU Board of Directors and the SBU Scientific Advisory Committee.

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