Osteoporosis and fractures: the size of the problem

Stavroula J Theodorou, Daphne J Theodorou, David J Sartoris

The public health impact of osteoporosis-related fractures is enormous, with important economic implications. Government agencies and health-care providers must recognize the importance of early diagnosis of osteoporosis, implement policies for the prevention of disease, and develop effective payment policies for densitometry examinations.

Osteoporosis is a systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue with a consequent increase in susceptibility to fracture (Consensus Development Conference, 1993). Osteoporosis and its complications are primarily related to age and menopause, and so the disease occurs more commonly in women than in men. Osteoporosis is often not recognized until a person develops a fracture from minimal trauma.

Osteoporotic fractures are generally recognized as a wide problem in the developed world, causing considerable morbidity and mortality in the elderly population. Because osteoporosis results in low bone density, bone mass measurement can help physicians to confirm the diagnosis of osteoporosis and assess the relative risk of future osteoporotic fracture. Indeed, bone mass is a key determinant of the risk of fracture. Advances in methods allowing measurement of bone density (bone densitometry) have revolutionized the diagnosis, monitoring and subsequent therapy of osteoporosis, and have proved helpful in the prevention of disease and its disabling complications.

Despite important developments in bone densitometry, however, there is no consistent strategy for the prevention of disease, both in individuals and populations. The magnitude and consequences of osteoporosis should encourage health-care providers to inform individuals of their relative risk of future osteoporotic fracture, and to manage patients with established osteoporosis and fractures. This would provide significant improvements in health-related costs and cost savings from fracture reduction owing to early diagnosis and treatment of osteoporosis. Effective strategies for the management of osteoporosis should ensure the following:

1. Public education to raise awareness of disease and address the role of lifestyle factors in its prevention
2. Medical education to improve understanding of the disease, with implications of its early diagnosis, treatment and effective prevention
3. Availability of specialist expertise on treatment of established osteoporosis
4. Use of bone densitometry to evaluate patients with osteoporosis or patients at risk of developing the disease, determine individual future fracture risk and assess outcome of treatment.

OSTEOPOROSIS AND THE PUBLIC HEALTH PROBLEM MAGNITUDE

Osteoporosis constitutes a major and increasing public health problem (Cooper et al, 1992a,b). In osteoporosis, the greatest burden in both morbid and economic terms is imposed by fractures. Over 8 million Americans suffer from osteoporotic fractures (Repa-Eschen, 1993). The most common fracture sites are the lumbar spine, femoral neck, distal radius and proximal humerus (Consensus Development Conference, 1993). Each year in the USA approximately 500 000 vertebral fractures, 250 000 femoral neck fractures, and 240 000 distal radius fractures are attributed to osteoporosis (Consensus Development Conference, 1993).

Elderly patients have a propensity to suffer osteoporotic fractures from seemingly minor trauma. In patients with osteoporosis, most fractures are associated with falls. Biomechanically, the mechanism of injury associated with a fall relates considerably to the resulting type of fracture. Falls to the side are most likely to result in hip fractures (*Figure 1*), falls onto an outstretched hand are most commonly responsible for wrist fractures, and forces in the spine generated by activities such

Dr Daphne J Theodorou and **Dr Stavroula J Theodorou** are Musculoskeletal Radiologists, and **Professor David J Sartoris** is Professor of Radiology in the Department of Radiology, School of Medicine, University of California, San Diego, California

Correspondence to: Dr SJ Theodorou

Figure 1. Radiograph of the right hip in a 76-year-old man receiving corticosteroid medications shows femoral neck fracture with external rotation of the femoral shaft.

Figure 2. Anteroposterior radiograph of the lumbar spine in a 65-year-old woman with osteoporosis and back pain shows compression fractures involving the L1–L3 vertebral bodies.

TABLE 1.
% Lifetime fracture risk (LFR) in 50-year-old Caucasian women and men

	% LFR for skeletal site		
Gender	Hip	Spine	Distal forearm
Women	17	15	16
Men	6	5	3

From Melton et al (1992)

as lifting, coughing or stepping down a curb usually result in a vertebral fracture (*Figure 2*).

The lifetime fracture risk in 50-year-old Caucasian women has been estimated as 17% for hip, 15% for vertebral, 16% for distal forearm, and 40% for any of these three types of fracture, with lower comparable figures for men: 6%, 5%, 3% and 13% (Melton et al, 1992) (*Table 1*). A woman's risk of hip fracture approximately equals her combined risk of breast, uterine and ovarian cancer, whereas in men it is similar to the lifetime risk of prostate cancer (Riggs, 1991). It has been calculated that 6.7% of women who sustain an osteoporotic fracture become dependent in basic activities of daily living and only 33% of those with a hip fracture return to their pre-fracture health state (Chrischilles et al, 1991; US Congress Office of Technology Assessment, 1995). Overall, 10% of women who sustain a hip fracture become functionally dependent in the activities of daily living (US Congress Office of Technology Assessment, 1995).

Ultimately, a third of the patients sustaining a hip fracture may be totally dependent, which makes the risk of institutionalization quite high (Jensen and Bagger, 1982). Furthermore, 24% of patients with an osteoporosis-related hip fracture aged 50 years and over die in the year after the fracture (US Congress Office of Technology Assessment, 1994), and another 13% of these patients die in the next year. Hip fracture patients who do not die within 18 months of the fracture, however, have a mortality rate similar to that of the never fractured (White et al, 1987).

Most increased mortality occurs during the 6–12 months after the hip fracture (Magaziner et al, 1989; US Congress Office of Technology Assessment, 1994). Excess mortality after a hip fracture is higher in men and black people (Jacobsen et al, 1992). The rate of hip fractures is 2–3 times higher in women than men, but 1-year mortality following a hip fracture is nearly twice as high for men than women (Kellie and Brody, 1990; Graves, 1995). Cummings et al (1989) estimated that white women in the United States have 31% chance of dying of coronary heart disease, compared with 2.8% risk of dying of hip fracture, 2.8% risk of dying of breast cancer and 0.7% risk of dying of endometrial cancer, indicating that women's risk of dying of a hip fracture is equal to that of dying from breast cancer (Elffors, 1998).

OSTEOPOROSIS-RELATED HIP FRACTURES

More than 90% of all hip fractures are reportedly associated with osteoporosis (Riggs and Melton, 1995). Hip fractures are among the most serious

complications of osteoporosis as they are associated with more deaths, disability and medical costs than all other types of osteoporotic fractures combined (Phillips et al, 1988; Chrischilles et al, 1991). Femoral neck and intertrochanteric fractures are the most common types of hip fracture in osteoporosis patients. It has been estimated that more than 95% of osteoporosis-related hip fractures require surgery and lengthy hospitalization (Graves, 1995), and that each year in the USA half (160 954 hospital admissions) of the hospitalizations resulting from osteoporotic fractures are related to hip fractures. According to Phillips et al (1988) 3.4 million hospital bed-days are attributed to this particular type of fracture.

In England, patients with a hip fracture occupy one-fifth of all orthopaedic beds (Hoffenberg et al, 1989). In addition, 2.3 million outpatient services are related to osteoporotic fractures, of which hip fractures account for 10%. The average length of hospitalization of patients sustaining a hip fracture ranges between 20 and 30 days (Magaziner et al, 1989). In 1983, the implementation of the Prospective Payment System for inpatient services in the USA contributed to an overall decrease of the length of hospitalization from 21.9 days before the system to 12.6 days after its implementation (Fitzgerald et al, 1987). It is noteworthy that shorter hospital stays led to increased morbidity and mortality in some but not all studies (Fitzgerald et al, 1987; Ray et al, 1990).

Hip fractures result in more than 7 million days of restricted activity and 60 000 admissions to nursing homes annually in the USA (74% of nursing home admissions relating to osteoporosis; Holbrook et al, 1984; Phillips et al, 1988), and 8% of all nursing home residents have a hip fracture (Holbrook et al, 1984). Because the majority of hip fractures occur after the age of 65 years, lost years of life and earning capacity are lower than in patients with heart disease, stroke or breast cancer (Melton, 1993). About half of the health-care costs associated with hip fractures are attributable to nursing homes (Phillips et al, 1988; US Congress Office of Technology Assessment, 1994). Some 19% of patients with a hip fracture require long-term nursing home care, compared with 1.9% of patients with vertebral fracture(s) and none of the patients with wrist fracture (Chrischilles et al, 1991).

CONSEQUENCES OF OSTEOPOROTIC FRACTURES

Hospitalization and associated health-care costs

Because of the growing population of older persons around the world, a dramatic increase in the number of osteoporosis-related fractures is expected in coming years. There are somewhat in excess of 325 million people aged 65 years or more in the world, and this is expected to increase to more than 1500 million people by the year 2050 (Cooper et al, 1992b). Increases in the number of elderly persons will be more prominent in Asia, Latin America, the Middle East, and Africa (from 190 million people estimated in 1990 to 1271 million people in 2050).

Estimates indicate that osteoporosis is associated with three-quarters of distal radius fractures in adults (Cooper et al, 1992a). The incidence of osteoporotic distal radius fractures in American women increases rapidly during the menopause, and reaches a plateau at about 700 per 100 000 person-years after the age of 60 years (Melton and Riggs, 1985). The reason for the plateau is unclear, but it may relate to the rate at which elderly women fall forward on an outstretched hand (Melton and Riggs, 1985). Interestingly, distal radius fractures lead to over 6 million restricted-activity days annually (Holbrook et al, 1984). Less than 1% of patients with an osteoporotic distal radius fracture become dependent, although nearly 50% of these patients report fair or poor functional outcomes at 6 months (Chrischilles et al, 1991). Mortality related to distal radius fractures is not increased and the costs associated with this particular type of fracture may reach $140 million each year (Holbrook et al, 1984; Cooper et al, 1993).

OSTEOPOROSIS-RELATED VERTEBRAL FRACTURES

Osteoporotic vertebral fractures are a common and often debilitating complication of osteoporosis (Theodorou et al, 2002). The incidence of vertebral compression fractures is usually underestimated because most of these fractures never come to medical attention, but are found incidentally on a radiograph taken for some other reason (Cooper et al, 1992b). Only about one third of vertebral fractures are diagnosed on the basis of clinical evaluation (Cooper et al, 1992a). Unlike fractures in the appendicular skeleton where there is usually a distinct split in the bone, vertebral fractures involve a wide range of deformities.

Patients with multiple vertebral body compression fractures may develop kyphosis, which can be associated with significant complications including pulmonary compromise and gastrointestinal tract dysfunction (Theodorou et al, 2002). Furthermore, altered biomechanics in the spine, owing to the kyphotic deformity, may result in an increased risk of falls and development of new fractures or may impose overload on adjacent vertebrae causing them to fracture (Theodorou et al, 2002). Only 1 in 3 vertebral deformities identi-

fied on radiographs are treated, and approximately 1 in 10 of such abnormalities result in hospitalization of the patient (Cooper et al, 1992a).

Vertebral fractures in patients aged 65 years or older account for 150 000 hospital admissions in the USA each year, 161 000 physician office visits, and more than 5 million restricted-activity days for those 45 years old and over (Holbrook et al, 1984). Only 4% of patients with a vertebral fracture become completely dependent in the activities of daily living, but the negative emotional impact of this type of fracture plays a more important role in the reduced quality of life (Chrischilles et al, 1991; Cook et al, 1993). The mortality among patients with osteoporotic vertebral fractures is increased, which may be related to comorbid conditions associated with an increased risk of death rather than to complications of the fracture itself (Cooper et al, 1993). The 5-year survival rate following a vertebral fracture is about 81% (Cooper et al, 1993).

ECONOMIC COSTS

Among persons aged 45 years or older with vertebral or wrist fractures, 25–39% of patients with vertebral fracture(s) and 8–10% of patients with a wrist fracture are hospitalized (Chrischilles et al, 1994). The number of hospitalized patients with wrist fractures increases with age to as much as 76% for women older than 85 years (Kanis and Pitt, 1992). The annual cost of osteoporosis in the USA may reach $20 billion (Praemer et al, 1992). Much of the cost is attributed to the large number of osteoporotic fractures, more than 1.5 million annually, and the expensive and protracted care often required (Consensus Development Conference, 1993). Direct medical expenditure for osteoporotic fractures was estimated at $13.8 billion in 1995 (3% of all Medicare costs) (Ray et al, 1990). The highest expenses were accrued in inpatient ($8.6 billion) and outpatient medical services ($1.3 billion), and nursing home care ($3.9 billion).

These economic costs are likely to increase as the demographics in the USA continue to shift toward an older population. Specifically, in the USA the number of people aged 65 years and older is expected to rise from 32 million in 1990 to 69 million in 2050, whereas the number of people aged 85 years and over will rise from 3 million to 15 million. As the incidence of hip fracture rises exponentially with ageing, the number of patients sustaining this particular type of fracture, which is the worst and most costly osteoporotic fracture, and its associated costs are expected to double or even triple by 2040 (Cummings et al, 1990; Schneider and Guralnik, 1990).

As with hip fractures, the incidence of vertebral fractures rises exponentially with age (Ross et al, 1995). However, the ageing population in the USA has been growing faster than predicted and the number of people aged 65 years and over in the year 2040 could be 22% higher than initially anticipated with 840 000 resulting hip fractures (Schneider and Guralnik, 1990).

Worldwide, the number of hip fractures is expected to rise to 6.26 million by 2050 with 4.43 million fractures (71%) occurring in Asia, Latin America, the Middle East, and Africa (Cooper et al, 1992b). The incidence of other types of osteoporotic fractures such as those in the distal radius, ankle, proximal humerus, proximal tibia, and possibly vertebral fractures, is also increasing (Bengner et al, 1988). Most direct economic costs of osteoporotic fractures are attributed to treatment of women aged 65 years and older (Ray et al, 1990). Indeed, 87% of patients with a hip fracture are 65 years of age or older, and 75% of these patients are women (Brody, 1985). The rate of hip fracture among white women in the USA approximately doubles every 5 years after the age of 50 years (Farmer et al, 1984). Overall, about 55% of all hip fractures occur among those aged 80 years and older and 33% in those aged 85 years and older (US Congress Office of Technology Assessment, 1994).

Quality of life following an osteoporotic fracture

In patients sustaining a hip fracture most of the recovery in the ability to walk and perform activities of daily living occurs within 6 months of the fracture (Magaziner et al, 1990). In particular, patients resume the abilities of daily living such as bathing (65% of patients), eating (90%), dressing (72%), transferring (75%), toileting (80%) and grooming (82%) within 6 months. Factors including old age, dementia, postsurgical delirium, depression and rehospitalization are associated with poor recovery of various abilities, whereas contact with a social network is associated with better recovery (Magaziner et al, 1990). Preexisting comorbidities which are present in about 90% of patients with a hip fracture, such as deep vein thrombosis, urinary tract infections, pneumonia and pressure sores, contribute to the decreased functional status of these patients (Melton, 1993). The decreased physical function that follows a hip fracture also leads to increased risk of falls, fear of falling and trauma, which creates a vicious circle of further activity restriction.

Decreased quality of life is common for patients with vertebral fracture(s). Vertebral fractures may initially be asymptomatic, but with

increasing severity and number of fractures, patients (mostly women) are more likely to report back pain, disability and physician visits for treatment of back pain (Eisman and Riggs, 1995). It has been estimated that 60–87% of women with a vertebral fracture report problems with activities such as carrying, lifting, walking, house cleaning, shopping, dancing and sports (Cook et al, 1993).

CONCLUSION

The most dreaded clinical manifestation of osteoporosis is fractures, which may cause considerable disability and possible death. Osteoporosis-related fractures involve enormous costs to the individual and the society. Radical measures must be taken now for osteoporosis prevention, targeting both the population and the individual. It is imperative that health-care providers develop effective strategies to treat people with osteoporosis, and prevent development of this condition in those at risk. HM

Conflict of interest: none.

Bengner U, Johnell O, Redlund-Johnell I (1988) Changes in incidence and prevalence of vertebral fractures during 30 years. *Calcif Tissue Int* **42:** 293–6

Brody J (1985) Prospects for an aging population. *Nature* **315:** 463–6

Chrischilles E, Butler C, Davis C, Wallace R (1991) A model of the lifetime osteoporosis impact. *Arch Intern Med* **151:** 2026–32

Chrischilles E, Shireman T, Wallace R (1994) Costs and health effects of osteoporotic fractures. *Bone* **15:** 377–86

Consensus Development Conference (1993) Diagnosis, prophylaxis and treatment of osteoporosis. *Am J Med* **94:** 646–50

Cook D, Guyatt G, Adachi J et al (1993) The multicentre vertebral fracture study group. Quality of life issues in women with vertebral fractures due to osteoporosis. *Arthritis Rheum* **36:** 750–6

Cooper C, Atkinson E, O'Fallon W, Melton L (1992a) Incidence of clinically diagnosed vertebral fractures: A population-based study in Rochester, Minnesota, 1985-1989. *J Bone Miner Res* **7:** 221–7

Cooper C, Campion G, Melton L (1992b) Hip fractures in the elderly: a world-wide projection. *Osteoporos Int* **2:** 285–9

Cooper C, Atkinson E, O'Fallon W, Melton L (1993) Population-based study of survival after osteoporotic fractures. *Am J Epidemiol* **137:** 1001–5

Cummings S, Black D, Rubin S (1989) Lifetime risks of hip, Colles' or vertebral fracture and coronary heart disease among white postmenopausal women. *Arch Intern Med* **149:** 2445–8

Cummings S, Rubin S, Black D (1990) The future of hip fractures in the United States: numbers, costs, and potential effects of postmenopausal oestrogen. *Clin Orthop* **252:** 163–6

Eisman J, Riggs B (1995) Session VII, osteoporosis 2: overview. *Bone* **17S:** 85–6

Elffors L (1998) Osteoporotic fractures due to osteoporosis. Impacts of a frailty pandemic in an aging world. *Aging (Milano)* **10:** 191–204

Farmer M, White L, Brody J, Bailey K (1984) Race and sex differences in hip fracture incidence. *Am J Public Health* **74:** 1374–80

Fitzgerald J, Fagan L, Tierney W, Dittus R (1987) Changing patterns of hip fracture care before and after implementation of the Prospective Payment System. *JAMA* **258:** 218–21

Graves E (1995) National hospital discharge survey: annual summary, 1993. National center for health statistics. *Vital Health Stat* **13**(121): 1–63

Hoffenberg R, James O, Brocklehurst J et al (1989) Fractured neck of femur: prevention and management: summary and recommendations of a report of the Royal College of Physicians. *J R Coll Physicians Lond* **23:** 8–12

Holbrook T, Grazier K, Kelsey J, Stauffer R (1984) *The Frequency of Occurrence, Impact and Cost of Selected Musculoskeletal Conditions in the United States.* American Academy of Orthopedic Surgeons, Chicago, Il: 1–187

Jacobsen S, Goldberg J, Miles T et al (1992) Race and sex differences in mortality following fracture of the hip. *Am J Public Health* **82:** 1147–50

Jensen J, Bagger J (1982) Long-term social prognosis after hip fractures. *Acta Orthop Scand* **53:** 97–101

Kanis J, Pitt F (1992) Epidemiology of osteoporosis. *Bone* **13S:** 7–15

Kellie S, Brody J (1990) Sex-specific and race-specific hip fracture rates. *Am J Public Health* **80:** 326–8

Magaziner J, Smonsick E, Kashner T et al (1989) Survival experience of aged hip fracture patients. *Am J Public Health* **79:** 274–8

Magaziner J, Simonsick E, Kashner T et al (1990) Predictors of functional recovery one year following hospital discharge for hip fracture: a prospective study. *J Gerontol A Biol Sci Med Sci* **45:** 101–7

Melton L (1993) Hip fractures: a worldwide problem today and tomorrow. *Bone* **14S:** 1–8

Melton L, Riggs B (1985) Risk factors for injury after a fall. *Clin Geriatr Med* **1:** 525–39

Melton L, Chrischilles E, Cooper C et al (1992) How many women have osteoporosis? *J Bone Miner Res* **7:** 1005–10

Phillips S, Fox N, Jacobs J et al (1988) The direct medical costs of osteoporosis for American women aged 45 and older, 1986. *Bone* **9:** 271–9

Praemer A, Furner S, Rice D (1992) *Musculoskeletal Conditions in the United States.* American Academy of Orthopaedic Surgeons, Park Ridge, IL

Ray W, Griffin M, Baugh D (1990) Mortality following hip fracture before and after the implementation of the Prospective Payment System. *Arch Intern Med* **150:** 2109–14

Repa-Eschen L (1993) Prevention and treatment of osteoporosis in our health care delivery system. In: Avioli L, ed. *The Osteoporotic Syndrome.* Wiley-Liss, New York, NY: 197

Riggs B (1991) Overview of osteoporosis. *West J Med* **154:** 63–77

Riggs B, Melton L, eds (1995) *Osteoporosis: Etiology, Diagnosis, and Management.* 2nd edn. Raven Press, New York, NY: 239

Ross P, Fujiwara S, Huang C et al (1995) Japanese women in Hiroshima have greater vertebral fracture prevalence than Caucasians or Japanese-Americans in the U.S. *Int J Epidemiol* **24:** 1171–7

Schneider E, Guralnik J (1990) The aging of America. Impact on health care costs. *JAMA* **263:** 2335–50

Theodorou DJ, Theodorou SJ, Duncan T, Garfin S, Wong W (2002) Percutaneous balloon kyphoplasty for the correction of spinal deformity in painful vertebral body compression fractures. *Clin Imaging* **26**(1): 1–5

US Congress Office of Technology Assessment (1994) *Hip Fracture Outcomes in people age 50 and over: Background paper.* OTA-BP-H-120. US Government Printing Office, Washington, DC: 95

US Congress Office of Technology Assessment (1995) *Effectiveness and Costs of Osteoporosis Screening and Hormone Replacement Therapy. Vol II: Evidence on Benefits, Risks and Costs.* OTA-BP-H-144. US Government Printing Office, Washington, DC

White B, Fisher W, Laurin C (1987) Rate of mortality for elderly patients after fracture of the hip in the 1980s. *J Bone Joint Surg* **69-A:** 1335–40

KEY POINTS

- Osteoporosis is a major public health problem associated with serious and often debilitating complications.
- Osteoporosis and its related fractures involve enormous individual and community care costs.
- Measurement of bone density plays a key role in determination of the future risk of fracture.
- Implementation of a clear policy on the prevention of osteoporosis and its related fractures, both in individuals and populations, is a high priority requirement justified on public health and cost grounds.