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The risk and burden of vertebral fractures in Sweden

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Abstract The aim of this study was to determine the risk and burden of vertebral fractures judged as those coming to clinical attention and as morphometric fractures. Incidence and utility loss were computed from data from Malmo, Sweden. Clinical fractures accounted for 23% of all vertebral deformities in women and for 42% in men. The average 10-year fracture probability for morphometric fractures increased with age in men from 2.9% at the age of 50 years (7.2% in women) to 8.4 at the age of 85 years (26.7% in women). As expected, probabilities increased with decreasing T-score for hip BMD. Cumulative utility loss from a clinical vertebral fracture was substantial and was 50–62% of that due to a hip fracture depending on age. When incidence of fractures in the population was weighted by disutility, all spine fractures accounted for more morbidity than hip fracture up to the age of 75 years. We conclude that vertebral fractures have a major personal and societal impact that needs to be recognised in algorithms for assessment of risk and in health economic strategies for osteoporosis.

Keywords Burden of fracture · Osteoporotic fracture · Utility · Vertebral fracture

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Introduction

We have previously characterised the morbidity in the population of Sweden that arises from osteoporotic fractures. In that study fracture risk was weighted according to the morbidity associated with each osteoporotic fracture [1]. The unit of morbidity used was the cumulative loss of quality of life (disutility). The purpose was to devise a methodology to compute intervention thresholds where the multiple outcomes of different fractures and the different consequences were reduced to a single metric. Since then data have become available that suggest that the incidence and consequences of vertebral fracture may have been considerably underestimated. Whereas our previous study focused on the probability of a clinical vertebral fracture and its attendant morbidity, it is now evident that morphometric fractures that do not come to clinical attention have significance, since they are not all asymptomatic [2, 3]. Moreover, the risk of further fractures is increased [4]. With respect to clinical fractures, recent estimates suggest that the loss of quality of life is very significant, and far greater than hitherto appreciated [5, 6, 7, 8]. Indeed, the loss of quality of life in the 1st year after clinical fracture may be of the same order of magnitude as that for a hip fracture [9].

The aim of the present study was to determine the risk of both morphometric and clinically diagnosed fractures. For this purpose the first vertebral fracture was documented so that 10-year probabilities of fracture could be computed. A further aim was to characterise the burden of both morphometric and clinical fractures as judged by cumulative disutility.

Materials and methods

Incidence of vertebral fracture

Vertebral fractures may be clinically overt (i.e., coming to clinical attention), clinically silent or asymptomatic. Collectively, they are termed morphometric fractures. For the purposes of this paper we

wished to estimate the incidence burden and long-term probability of both morphometric fractures and clinical fractures. A clinical fracture in this context is one that comes to hospital attention through in-patient or outpatient attendance or one diagnosed radiographically by the general practitioner.

For the incidence of clinically diagnosed vertebral fracture we used data from Malmo 1993/1994 [10], and a Poisson model was used to smooth the published function with age. For the incidence of morphometric fractures we computed the incidence in Europe from the EVOS/EPOS [11] and the Rotterdam study [12]. Both studies measured morphometric deformities prospectively using an identical algorithm [13]. A Poisson model was used to estimate the incidence of morphometric fractures in the two studies. The un-weighted β coefficients (i.e., unweighted by sample size) were used to merge the data and compute the incidence in Europe. The incidence was revised upward to take account of the higher age and sex-specific incidence in Sweden compared with rates in Europe [11]. For men, rates were multiplied by 1.28 and for women by 1.654. These estimates together with the disutility (see later) were used to determine the burden of vertebral fractures at specific ages in both men and women.

For the computation of the probability of a first vertebral fracture, it was necessary to determine the incidence of a first vertebral fracture. In the case of clinically diagnosed fractures, this has previously been assessed directly from patients in Malmo [10] by accessing the in-patient, out-patient and radiology records from 1993 and 1994. Patients with prior vertebral fractures were excluded to compute incidence of a first vertebral fracture. The ratio of the incidence of a first fracture to the unadjusted incidence of vertebral fracture was 0.75 in men and 0.73 in women, and relatively constant with age. In the Rotterdam study, the estimate is very similar for morphometric fractures, being 0.79 in men and 0.69 in women [12]. For the present purposes we took the ratio of 0.74 and assumed that the same ratio was also applicable to morphometric fractures. For comparative purposes we used data on the incidence of hip and other osteoporotic fractures from a previous publication [1].

Probability of fracture

The 10-year probability of vertebral fracture was calculated using a Poisson model from the incidence of the first fracture with age and the mortality estimates by age in 5-year intervals. Vertebral fractures included those coming to clinical attention and all morphometric fractures. The 10-year probabilities were computed by previously published methods from the hazard of first fracture and the death hazard [14, 15].

In order to determine the fracture probability according to BMD, we used the published data from the 3rd National Health and Nutrition Examination Survey (NHANES III, 1998–1994) as the reference values for BMD at the femoral neck [16]. Cut off values to categorize individuals as having low bone mass or osteoporosis utilised the WHO criteria, so that osteoporosis was defined as a T-score of < -2.5 SD and low bone mass denoted a T-score of -1 to -2.5 SD [17]. Cut-off values were chosen in young women based on the age range 20–29 years. The threshold for low bone mass was 0.740 g/cm^2 and 0.577 g/cm^2 for osteoporosis. We chose the same thresholds for men since the incidence of hip and vertebral fracture in men is similar to that in women for the same BMD [18, 19, 20, 21, 22]. The risk of fracture at the spine was assumed to increase 1.8-fold for each standard deviation decrease in bone mineral density (95% CI 1.1–2.7), as estimated by a previous meta-analysis [23]. Probability by age was expressed as the risk of an individual at a given T-score for BMD [14].

Quality of life

Quality of life following a clinical vertebral fracture was taken from a study in which this was assessed prospectively in 40 patients attending the Accident and Emergency Department at Malmo [7, 9]. The EQ-5D was administered at 14 days and 6, 9 and 12 months after the fracture event. Each patient was asked to fill in the questionnaire on the health status experienced at the time of the interview. Interviews were conducted in 43 patients at week 2, and complete information obtained on 40 patients. The EQ-5D was also administered to 86 patients with hip fracture, 126 patients with a distal forearm fracture and 40 patients with a fracture at the proximal humerus.

Health state values obtained from areas under the curve with time did not differ between men and women, but decreased somewhat with age. Age and sex-specific social tariff values for Sweden [24] were used to calculate the utility loss associated with each fracture type. For a clinical vertebral fracture this was a loss of 0.260, which was greater than that for hip fracture (0.149), fracture of the proximal humerus (0.153) and forearm fracture (0.017). Age and specific utility losses were used to compute the multiplier that could be used to determine utility losses for vertebral fracture and other fracture types at any age (Table 1).

The utility losses for vertebral fracture obtained above were those coming to clinical attention. The utility loss after a morphometric deformity not coming to clinical attention is not known. Patients with sub-clinical fracture are reported to have impaired activities of daily living (ADLs) that are about one-third to one-half of the ADLs in patients with a clinical fracture [2, 3]. On this basis we assumed that the utility loss of a sub-clinical fracture was one-third that of a clinically overt fracture, since a proportion of the decrement observed may have resulted from co-morbidity. From the ratio of clinical to non-clinical fractures (42% in men and 23% in women), the utility loss from all vertebral fractures was calculated for the 1st year. In men, this was:

$$(0.42 \times 0.260) + (0.58 \times 0.260/3) = 0.159 \tag{1}$$

This gave a multiplier of 0.777 in men for the 1st year.
In women, the utility loss in the 1st year was:

$$(0.22 \times 0.260) + (0.78 \times 0.260/3) = 0.125 \tag{2}$$

This gave a multiplier of 0.820.

For the quality of life in the 2nd year after a clinical fracture we used a multiplier of 0.909 (a utility loss of 0.100), calculated from a case control study of patients enrolled into the MORE study with vertebral fractures (both symptomatic and asymptomatic) [25]. Fracture occurred at an unknown time prior to assessment. The value closely matches unpublished information from the CaMos study in Canada (A Tenenhouse, personal communication, 2002). We assumed that the utility loss in the 2nd year after a non-clinical morphometric fracture was one-third that of a clinical fracture. Thus, for the second year after a fracture (clinical and non-clinical) the utility loss in men was:

$$(0.42 \times 0.1) + (0.58 \times 0.033) = 0.061 \tag{3}$$

This gave a multiplier of 0.912.

Table 1 Health state utility values according to site of fracture

Fracture site	Multiplier for utility		Multiplier for utility loss	
	1st year	2nd year	1st year	2nd year
Spine (clinical)	0.626	0.909	0.374	0.091
Spine (all morphometric) men	0.777	0.912	0.223	0.088
Spine (all morphometric) women	0.820	0.913	0.180	0.087
Ribs	0.977	0.999	0.003	0.001
Pelvis	0.794	0.815	0.206	0.185
Humerus	0.794	0.973	0.206	0.027
Clavicle, scapula, sternum	0.977	0.999	0.003	0.001
Hip	0.792	0.813	0.208	0.187
Other femoral	0.792	0.813	0.208	0.187
Tibia	0.794	0.926	0.206	0.074
Forearm	0.977	0.999	0.003	0.001

In women the loss was:

$$(0.22 \times 0.1) + (0.78 \times 0.033) = 0.048 \qquad (4)$$

This gave a multiplier of 0.931 for the 2nd year in women.

For comparative purposes the utility loss for hip fracture, distal forearm fracture and fractures of the proximal humerus were taken from the study above. The utility loss after a rib, scapular, clavicular and sternal fracture was assumed to be similar to that of a distal forearm fracture [1, 26]. Femoral fractures other than the hip had a loss equivalent to a hip fracture. For pelvic and leg fractures the utility loss was equivalent to a humeral fracture as previously assumed [1].

The quality of life in the 2nd year after a fracture varied according to fracture type. For hip fracture this was assumed to be 90% of that of a healthy individual [27, 28], and the same assumptions were used for other femoral fractures and for pelvic fractures. For other sites of fracture, health state values were assumed to improve after the 1st year by a proportion equal to that previously assumed by the NOF [26] and by ourselves [1]. Health state utility values are given in Table 1 for each fracture site.

Burden of vertebral fracture

Loss of utilities after the 2nd and subsequent year were assumed to decrease by 10% per year. The cumulative loss of utility (disutility) was calculated for each age and fracture in men and women over the remaining life-time. These disutilities were then weighted by the social tariff values for each and sex and used to calculate the incidence-adjusted morbidity, as previously described [1].

Results

Incidence of fracture

The incidence of all morphometric and clinical vertebral fractures by age and sex is shown in Table 2. The ratio of clinical to morphometric fractures was higher in men than in women and in both sexes increased slightly with age. Approximately 42% of vertebral fractures in men came to clinical attention, and in women the proportion was 22%.

Ten-year vertebral fracture probability

The average 10-year probability of morphometric and clinical spine fractures is shown in Table 3. As expected,

Table 3 Average 10-year probability (%) of vertebral fracture according to age

Age (years)	Morphometric spine fracture		Clinical spine fracture	
	Men	Women	Men	Women
50	2.9	7.2	1.1	1.4
55	3.7	9.4	1.5	2.0
60	4.6	12.3	1.9	2.8
65	5.6	15.9	2.5	3.8
70	6.8	20.1	3.2	5.1
75	7.8	24.2	3.8	6.4
80	8.5	26.8	4.2	7.4
85	8.4	26.7	4.3	7.5

probabilities of morphometric fractures were substantially higher than for clinical fractures, and both increased with age up to the age of 80 years. Thereafter, the 10-year probability plateaued or decreased because of the competing effects of fracture and death hazards. As expected, probabilities were higher in women than in men.

The probability of vertebral fracture by age, sex and T-score is shown in Fig. 1. Fracture probabilities increased with decreasing T-score and increasing age, up to the age of 70 years. Above this age, probabilities plateaued or decreased slightly (Tables 4 and 5). Thus, up to the age of 70 years, age provided an independent element of risk not captured by BMD. Over a 4-SD interval of BMD (+1 to −3 SD), the risk of a vertebral fracture increased approximately 9-fold in men and 12-fold in women.

Disutility

The cumulative loss of utility (disutility) due to fractures of different types is shown in Table 6 by age and sex. As expected, average disutility was greatest in the case of hip fractures over all ages, intermediate for vertebral fractures and lower for humeral and Colles' fracture. Disutility values were higher in the younger age groups due to the higher life expectancy and higher population tariff values. The higher tariff values for the younger healthy population and the use of a multiplier to compute disutility mean that the absolute (rather than

Table 2 Incidence of all morphometric and clinically evident vertebral fractures and the first morphometric and clinical fracture (per 100,000 per year) by age in men and women

Age range (years)	Any fracture				First fracture				Ratio (%)	
	Morphometric		Clinical		Morphometric		Clinical		Clinical/ morphometric	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
50–54	365	874	153	190	244	577	81	104	33	19
55–59	462	1,164	193	253	311	762	111	148	36	20
60–64	592	1,562	248	339	392	1,021	155	215	39	21
65–69	767	2,115	322	459	511	1,376	215	303	42	22
70–74	1,011	2,891	424	628	666	1,880	296	422	44	23
75–79	1,348	3,986	566	865	888	2,583	407	599	46	23
80–84	1,820	5,544	744	1,204	1,191	3,574	562	844	47	24
85–89	2,485	7,776	1,043	1,688	1,613	4,995	777	1,184	48	24

Fig. 1 Ten-year probabilities (%) of a morphometric or clinical vertebral fracture in men and women by T-score and age

Probability (% at 10 years)

Men   *Women*

Age (years)
50 60 70
Clinical ✱ ■ ▲
Morphometric ☐ △ ○
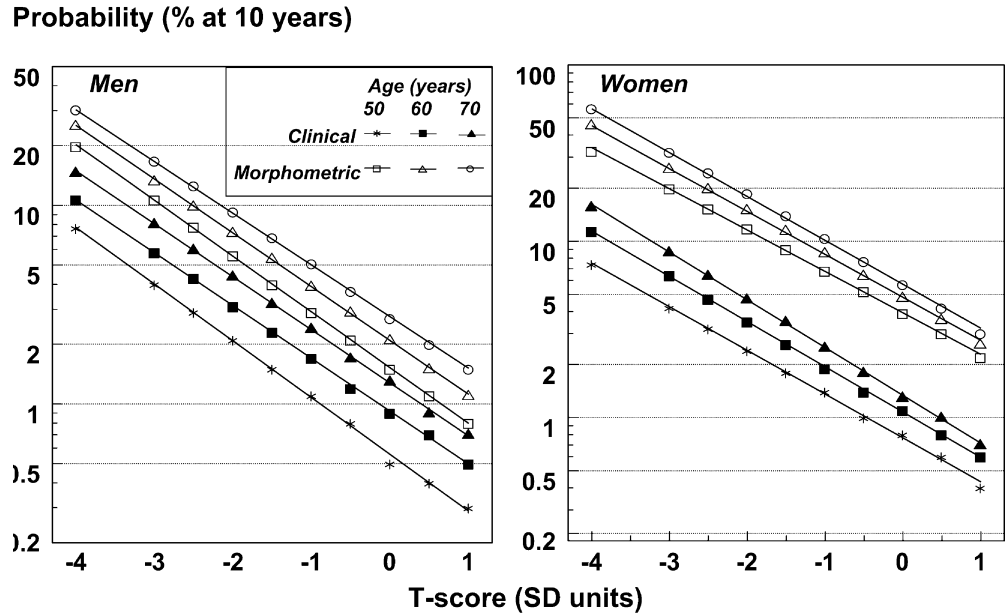
T-score (SD units)

Table 4 Ten-year probability of vertebral fracture according to age and T-score at the femoral neck in men

Age (years)	+1	+0.5	0	−0.5	−1.0	−1.5	−2.0	−2.5	−3.0	−4.0
(a) Morphometric										
45	0.7	0.9	1.3	1.8	2.4	3.4	4.6	6.4	8.7	16.1
50	0.8	1.1	1.5	2.1	2.9	4.0	5.6	7.8	10.7	19.9
55	0.9	1.2	1.7	2.4	3.4	4.7	6.6	9.2	12.8	24.0
60	1.1	1.5	2.1	2.9	3.9	5.4	7.3	9.9	13.3	23.5
65	1.5	2.0	2.6	3.5	4.6	6.2	8.1	10.7	14.1	23.8
70	1.5	2.0	2.7	3.7	5.1	6.9	9.3	12.6	16.8	28.9
75	1.4	1.9	2.7	3.8	5.3	7.4	10.3	14.1	19.3	34.0
80	1.6	2.2	2.9	3.9	5.3	7.1	9.5	12.7	16.8	28.1
85	1.7	2.2	2.9	3.8	4.9	6.4	8.4	10.8	14.0	22.6
(b) Clinical										
45	0.2	0.3	0.4	0.6	0.8	1.1	1.5	2.1	3.0	5.6
50	0.3	0.4	0.5	0.8	1.1	1.5	2.1	2.9	4.0	7.7
55	0.3	0.5	0.7	0.9	1.3	1.9	2.7	3.7	5.3	10.3
60	0.5	0.7	0.9	1.2	1.7	2.3	3.1	4.3	5.8	10.7
65	0.7	0.9	1.2	1.6	2.1	2.8	3.7	4.9	6.5	11.4
70	0.7	0.9	1.3	1.7	2.4	3.2	4.4	6.0	8.1	14.7
75	0.7	0.9	1.3	1.8	2.5	3.6	5.0	7.0	9.7	18.3
80	0.8	1.1	1.4	1.9	2.6	3.5	4.8	6.4	8.6	15.2
85	0.9	1.1	1.4	1.9	2.5	3.2	4.2	5.5	7.2	12.2

Table 5 Ten-year probability of vertebral fracture according to age and T-score at the femoral neck in women

Age (years)	+1	+0.5	0	−0.5	−1.0	−1.5	−2.0	−2.5	−3.0	−4.0
(a) Morphometric										
45	2.1	2.7	3.6	4.6	6.0	7.8	10.1	12.9	16.6	26.7
50	2.2	3.0	3.9	5.2	6.8	9.0	11.8	15.3	19.9	32.5
55	2.3	3.1	4.1	5.5	7.5	10.0	13.3	17.6	23.2	38.5
60	2.6	3.6	4.8	6.4	8.6	11.5	15.1	19.9	25.9	42.2
65	3.1	4.2	5.6	7.4	9.9	13.1	17.2	22.3	28.9	45.9
70	3.0	4.2	5.7	7.7	10.4	14.0	18.7	24.6	32.1	51.3
75	2.7	3.8	5.3	7.4	10.2	14.1	19.1	25.6	33.8	54.5
80	2.8	3.9	5.4	7.4	10.2	14.0	18.8	24.9	32.6	51.6
85	2.6	3.6	5.0	6.8	9.2	12.5	16.7	22.0	28.7	45.4
(b) Clinical										
45	0.4	0.5	0.6	0.8	1.1	1.4	1.9	2.4	3.2	5.4
50	0.4	0.6	0.8	1.0	1.4	1.8	2.4	3.2	4.2	7.4
55	0.5	0.6	0.9	1.2	1.6	2.2	3.0	4.0	5.4	9.7
60	0.6	0.8	1.1	1.4	1.9	2.6	3.5	4.7	6.4	11.4
65	0.7	1.0	1.3	1.7	2.3	3.1	4.2	5.6	7.5	13.1
70	0.7	1.0	1.3	1.8	2.5	3.5	4.7	6.4	8.7	15.7
75	0.7	0.9	1.3	1.8	2.5	3.5	4.9	6.8	9.5	17.8
80	0.7	1.0	1.3	1.9	2.6	3.6	4.9	6.8	9.3	17.3
85	0.7	0.9	1.3	1.7	2.3	3.2	4.4	6.0	8.2	14.9

proportional) utility loss after fracture is higher in younger individuals. The consideration of all vertebral fractures rather than clinical spine fractures alone decreased the average disutility of vertebral fractures by 15–30% depending on age. At the age of 50 years, a clinical spine fracture incurred a disutility of 62% of that for a hip fracture in men and women, and was substantially higher than the loss incurred from humeral fractures by 63%.

The overall burden of vertebral fracture is compared with incidence in Table 7. In men at the age of 50 years, clinical fractures accounted for 18% of osteoporotic fractures between the ages of 50 and 55 years, but for 51% of the total morbidity. With advancing age the morbidity from clinical vertebral fractures exceeded that for hip fracture until after the age of 64 years. When morphometric fractures are considered these comprised, as expected, a higher proportion of the total number of fractures, and because of the additional consequences for morbidity, the population morbidity from morphometric spinal fractures exceeded that of hip fracture until after the age of 75 years.

The results were qualitatively similar for women except where morphometric fractures are concerned. These accounted for a greater proportion of the total number of fractures since a greater number of morphometric

Table 6 Disutility for different fracture types by age adjusted for the population tariffs using a discount of 10% per annum

Type of fracture	Age range (years)							
	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89
(a) Men								
Morphometric spine	0.877	0.800	0.757	0.713	0.714	0.557	0.420	0.350
Clinical spine	1.026	0.938	0.895	0.850	0.768	0.687	0.538	0.472
Humerus	0.383	0.353	0.339	0.327	0.301	0.277	0.228	0.212
Hip	1.643	1.491	1.402	1.304	1.148	0.980	0.701	0.943
Forearm	0.010	0.009	0.009	0.009	0.008	0.007	0.005	0.005
(b) Women								
Morphometric spine	0.857	0.640	0.621	0.733	0.622	0.545	0.444	0.321
Clinical spine	1.053	0.751	0.734	0.917	0.790	0.706	0.594	0.460
Humerus	0.392	0.282	0.278	0.349	0.305	0.279	0.243	0.200
Hip	1.692	1.193	1.149	1.430	1.202	1.041	0.829	0.570
Forearm	0.011	0.007	0.007	0.009	0.008	0.007	0.006	0.004

fractures were not clinically apparent. The disutility occasioned by morphometric deformities outstripped that resulting from hip fracture, except from the age of 80 years onwards.

Discussion

In this paper we have characterised the risks and burden of vertebral fracture in Sweden using two definitions of vertebral fracture. The first is a clinically overt fracture from which we have previously made estimates for incidence and burden, albeit with different utility values [1]. In the present paper we additionally evaluated morphometric fractures, which include those vertebral deformities that do not come to clinical attention. The reason they are included is that they may still be of clinical significance. Firstly, they are of prognostic significance in that the risk of further fractures is significantly increased [4, 29]. Thus, they are useful to consider in a case-finding strategy, for which purpose

information on fracture probability is required. A second reason is that morphometric deformities not coming to clinical attention are not without symptoms [2, 3]. It is difficult to be sure to what extent the decrement in quality of life associated with a clinically silent fracture is related to the fracture itself or to co-existing morbidity. For this reason we chose relatively conservative assumptions concerning the ongoing morbidity, so that the impact of their consideration is relatively modest in men. In women, nearly twice as many vertebral deformities are clinically covert than in men, so that the impact even of conservative estimates on disutility of non-clinical fractures is quantitatively greater.

In this paper we describe 10-year probabilities for vertebral fractures. Such data require documentation of the first fracture at a particular site. Second or subsequent fractures are common, particularly at the spine [10]. The overestimate from unadjusted data on vertebral fracture incidence is approximately 36% (see Table 2), so that the use of unadjusted data overestimates long-term risks. For this reason we used the incidence of first fracture. By contrast, long-term risks are underestimated when no account is taken of future mortality. For the 10-year time span that we used in this paper, the effect is small, but the data are nevertheless adjusted.

It should be noted that the estimates of risk that we provide are modelled from measurements made at the femoral neck with BMD using DXA. The probabilities computed would differ from those derived from measurements made with other techniques or with the same technique, but at other sites. We also assume that the increase in risk of fracture is the same in women as in men. Though the data are scanty, the available evidence would suggest that this is so [18, 19, 20, 21, 22].

A further limitation of these estimates is that they apply to a Swedish population and used data from Malmo, Sweden. For fractures other than vertebral fractures, data from Malmo appear to be representative for Sweden [10, 30]. A strength of the use of Swedish data is the accuracy of information on fracture rates and on mortality. A disadvantage is that fracture rates are

Table 7 The proportion of fractures (%) due to vertebral, hip and other osteoporotic fractures by age, sex and the definition of vertebral fracture (*left hand panels*) compared with the burden (disutility adjusted incidence; *right hand panels*)

Sex	Definition of vertebral fracture	Site of fracture	Age range (years)							
			Incidence based				Disutility based			
			50–54	60–64	70–74	80–84	50–54	60–64	70–74	80–84
M	Clinical	Spine	18	22	17	10	51	44	30	18
		Hip	5	12	20	27	22	37	52	67
		Other	77	66	63	63	27	19	18	15
M	Morphometric	Spine	34	40	33	22	68	61	48	32
		Hip	4	9	16	23	15	26	38	56
		Other	62	51	51	55	17	13	16	12
F	Clinical	Spine	17	21	17	13	48	40	25	17
		Hip	4	11	22	37	16	33	50	65
		Other	79	68	61	50	36	27	25	18
F	Morphometric	Spine	49	55	48	41	77	72	55	41
		Hip	2	6	14	25	7	15	30	46
		Other	49	39	38	34	16	13	15	13

high and mortality is low compared to many other regions of the world. Thus, the probabilities we report are not necessarily applicable to other areas, particularly in the developing world. In addition, the pattern of probability with age may differ between countries. Short-term risks increase progressively with age until the short-term risk of death outstrips the fracture risk. Thereafter, the probability falls with age. For 10-year probabilities this break point occurred at the age of 75 to 85 years, but would occur sooner in countries with a higher mortality.

A significant finding from the present study is the high morbidity consequences of vertebral fractures arising from the high utility losses. Quality of life was measured throughout the 1st year following a clinical vertebral fracture to assess quality-adjusted life years (QALYs). With this technique health states are valued between 0 (death or the worst health state imaginable) and 1 (perfect health). The loss of utility in the 1st year after vertebral fracture was 37% that of an individual in perfect health. This estimate is markedly greater than those previously used by ourselves and by the National Osteoporosis Foundation [1, 26]. These estimates (5% utility loss) were based on expert opinion in the absence of empirical data. Subsequent studies, including our own, have shown these losses to be seriously underestimated [5, 6, 7, 8]. The validity of our findings is further supported by the health state values we derived in the same study for hip fracture and for forearm fracture, which are very close to other empirical estimates [31, 32, 33].

It may be relevant that these health states were taken from patients originally attending the orthopaedic department and may not be representative of all clinically overt fractures. Comparison of the incidence rates over all clinically evident fractures (Malmo 1993–1994) and hospitalised fractures (Swedish patient register 1996) suggests that approximately 25% of men and women are hospitalised. In the patients in whom we assessed quality of life, 42% were hospitalised, suggesting that bias cannot be excluded.

The high morbidity from clinical vertebral fractures is most marked in the first 6 months after the fracture event and thereafter attenuated with time similar to observations of Tosteson et al. [8]. Nevertheless, the utility loss in the 1st year was at least as great as that noted for hip fracture. In subsequent years we assumed that utility loss diminished in keeping with other observations that studied patients well after fracture events [8, 25]. Thus, when utility loss was cumulated over remaining life-time, disutility was less than for hip fracture, since the impairment of quality of life is more marked in 2nd and subsequent years for hip fracture compared to clinical vertebral fracture. At the age of 50 years the disutility from clinical vertebral fracture was 1.053 in women compared with 1.692 for hip fracture (see Table 6). Thus, a clinical vertebral fracture occasions 62% of the morbidity expected from a hip fracture at that age. In an earlier study where the NOF estimates of utility loss were used [26], we estimated that the utility loss from a clinical vertebral fracture was only 24% that of a hip fracture [1].

Greater uncertainties surround the disutility associated with clinically silent fractures, since a greater proportion of the utility loss computed may be related to pre-existing comorbidity compared to clinical fractures. The disutility assumed is, however, modest and has a small impact on the expected disutility at any age. For example, in women aged 50 years the average utility loss from a clinical spine fracture was 1.053 and 0.857 for all vertebral fractures combined (see Table 6). Since costs of asymptomatic morphometric fractures are also likely to be lower than for clinical fractures, the consideration of all fractures or clinical fractures in health economic analysis is likely to have little impact on estimates of cost effectiveness and thus on intervention thresholds.

The undervaluation of vertebral fracture morbidity compared to that of a hip fracture has consequences for practice guidelines that are based on health economic assessment. Hip fractures occur most often in advanced age and intervention becomes more cost-effective, therefore, with advancing age. Vertebral fractures (and other osteoporotic fractures) by contrast occur earlier in the natural history of osteoporosis. The omission of these fractures or undervaluation of the morbidity in turn undervalues the cost-effectiveness of interventions, particularly in younger patients with osteoporosis. Thus, higher intervention thresholds arise if health economic estimates are made on hip fracture risk alone, particularly in younger individuals.

We conclude that the morbidity arising from vertebral fractures has been considerably underestimated using values derived from expert opinion. Empirical data suggest a very substantial impact of clinical vertebral fractures that incur a disability that is approximately 62% of that incurred by a hip fracture over the remaining lifetime of individuals. The large societal impact, particularly in mid-life, needs to be accounted for in health economic strategies for osteoporosis.

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