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ORIGINAL ARTICLE

Young patients with hip fracture: a population-based study of bone mass and risk factors for osteoporosis

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Abstract
Introduction Hip fracture in young patients is rare. The present study was aimed to clarify the comorbidity pattern and reveal relevant risk factors for osteoporosis and fracture in this patient group.
Materials and methods Using electronic diagnosis registers and lists of the operating theatres for the Oslo hospitals, patients with new hip fracture during two 1-year periods from May 1994 through April 1995 and from May 1996 through April 1997 were identified. All patients age 20–49 years at the time of fracture were included (n=49), and a detailed medical history was recorded. Thirty-two of the patients volunteered for examination and completed a questionnaire and interview to reveal risk factors for osteoporosis. Data from the Oslo Health Study served as reference material. Bone mineral density (BMD) was measured using dual x-ray absorptiometry, and Z-scores were calculated using healthy subjects from Oslo as reference.
Results Of the patients identified, the median age was 40 years (range 25–49), and 63% were men. In 65% of the patients, the fracture occurred after a fall at the same level, in 16% it occurred after a fall from a higher level, and in 18% it occurred in a traffic accident. Twenty percent of the patients had a history of alcohol or drug abuse, 39% had neuromuscular diseases, and 12% had endocrine diseases. The patients examined had significantly more risk factors for osteoporosis than the reference population. The BMD expressed as Z-score for L2-4 was −1.0±0.9 (mean ± SD; $p<0.001$), for femoral neck was −1.5±1.0 ($p<0.001$), and for total body was −1.3±1.1 ($p<0.001$). BMD was significantly lower than in controls for patients sustaining low- and high-energy trauma. There was a negative correlation between the total number of risk factors and BMD for lumbar spine ($r=-0.35$, $p<0.05$), femoral neck ($r=-0.37$, $p=0.04$), and total body ($r=-0.55$, $p=0.001$), respectively.
Conclusions The majority of the young patients with hip fracture have a history of low-energy trauma, comorbidity predisposing for falls or decreased bone strength, as well as several risk factors for osteoporosis. The BMD was significantly lower than in the reference population regardless of the trauma mechanism.

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Introduction

Hip fractures are commonly seen with osteoporosis in the elderly and represent an important cause of morbidity and mortality in this age group, with implications for treatment capacity and healthcare system economics [1–3]. Among the high number of patients with hip fracture is a small group of patients less than 50 years old [4, 5]. Few studies are available on these young patients, possibly due to the low incidence that complicates the inclusion of a sufficient number of patients within an acceptable time period. It has been presumed that high-energy trauma is the major cause of hip fracture in young patients [6–8]. However, subgroups with concomitant diseases and/or abuse problems have been identified, and fractures may also result from low-energy trauma [9, 10]. Correspondingly, low bone mineral density (BMD) has been demonstrated by quantitative computed tomography (QCT) of the spine in a limited number of young hip fracture patients (n=20), indicating early osteoporosis [10].

In the adult population in general, several risk factors for osteoporosis and hip fracture have been identified in numerous studies [11–13], but for the low-incidence group of young patients, no studies on risk factors are available. Such knowledge, however, is particularly important in the young to allow improved identification of individuals at high risk for osteoporosis and fracture and to provide a clinical strategy for referring selected young subjects to bone densitometry. Because the incidence rate of hip fracture in Oslo, Norway, exceeds all those previously reported [4], this area offers an opportunity to conduct studies on young patients with hip fracture within a limited time period.

The aim of the present study was to explore the epidemiology of hip fracture in young patients, with a focus on comorbidity pattern and risk factors. Furthermore, it was aimed to clarify, by determining BMD by dual x-ray absorptiometry (DXA), whether these young patients have early osteoporosis.

Materials and methods

Study population

Using data from a study reporting the incidence of hip fracture in Oslo, Norway [4], all resident patients age 20–49 years with a hip fracture during the period from 1 May 1996 through 30 April 1997 were identified and included in the present study (n=21). In addition, all resident patients age 20–49 years with a hip fracture admitted to the two largest hospitals in Oslo (treating more than 90% of the relevant fractures, based on data from Lofthus et al. [14]) from 1 May 1994 through 30 April 1995 were included (n=28). The patients were identified using the electronic diagnosis registers and lists of the operating theatres of the hospitals, and the diagnoses were verified by reviewing the medical records.

In April 1999, patients still alive (n=46) were invited to participate in an interview and examination, and 32 of them volunteered and gave their written informed consent.

The study was approved by the regional ethics committee.

Medical records

Medical history, date of hip fracture, type and side of hip fracture, type of treatment, place and mechanism of trauma, and previous hip fractures were recorded from the medical records in all 49 identified patients. Data on medical history were classified into neuromuscular diseases, endocrine diseases, and abuse of alcohol or drugs.

Questionnaire and structured interview

To elucidate the risk factors for osteoporosis and fracture, the 32 patients volunteering for participation completed a questionnaire and went through a structured interview by two of the authors. The questions concerned the trauma mechanism; marital status; educational level; employment and social security benefits; smoking, alcohol, and drug habits; diet; height; weight; physical activity; long-term immobilisation; diseases (asthma/chronic obstructive pulmonary disease, diabetes mellitus, mental disorders, and hyperthyroidism or hypothyroidism); previous fractures; and regular medication. Women were also asked about menstrual history. All questions concerned the situation before the fracture.

Mechanism of trauma was classified as low-energy (fall at the same level) or high-energy (fall from a higher level and traffic accident). The reported consumption of milk and yoghurt was used as an indicator of dietary calcium intake, and the calcium content of these sources was based on figures from the Norwegian food composition table [15]. Mental disorders were defined as mental problems requiring professional help.

Data from questionnaires and interviews were compared with reference material from age- and gender-matched controls from the Oslo Health Study, including 4,762 men and 5,950 women aged 30, 40, and 45 years [16]. Mean and standard deviation (SD) or percentage for the risk factors were calculated for each gender- and age-specific group of the controls, and a weighted mean based on the age distribution of the patient group was calculated for each sex.

Clinical and densitometric measurements

Body height and weight were measured while the patients were wearing light indoor clothing and no shoes, and body mass index (BMI) was calculated. The results were compared with data from the Oslo Health Study.

BMD was determined by anterior-posterior DXA of the lumbar spine (L2-L4), the unfractured femoral neck, and the total body using a Lunar DPX-l (Madison, WI, USA). In two male patients, BMD of the femoral neck was not measured because of the presence of surgical devices in both hips. The results of the BMD measurements were compared with reference data for 385 healthy subjects from Oslo [17] and the results presented as *Z*-scores (the number of SDs from the mean value of age- and gender-matched controls).

The coefficients of variation for the DXA measurements were 1.0% for the lumbar spine, 2.5% for the femoral neck, and 0.7% for the total body.

Statistical analyses

The Mann-Whitney test, chi-square test, Fischer's exact test, and one-sample *t*-test on summarised data were applied to compare characteristics of the patients and of patients versus controls. One-sample *t*-test on summarised data, chi-square test, and Fischer's exact test were applied for comparison of data from questionnaires and interviews. For the BMD analyses, one- and two-sample *t*-tests and linear regression were applied.

The Spearman correlation technique was applied when relevant, including evaluation of the association between the number of risk factors for osteoporosis and BMD. The variables from questionnaires and interviews that were significantly different from those of the controls were classified as risk factors, and correlation analyses between the total number of these risk factors in each patient and the Z-scores of the BMD measurements were performed. Low body weight was defined as weight and BMI <90% of controls [11]. In addition, corresponding correlation analyses were performed using risk factors for osteoporosis according to Boden et al. [10].

The level of statistical significance was set at 0.05. Results are given as mean ± SD unless otherwise stated.

Results

Of the 49 patients identified, 63% were men. There were no significant differences between examined and unexamined patients for age, trauma mechanism, or medical history except for the frequency of low-energy trauma in women, which was lower in those examined (Table 1). In men and women, 65% and 67% had a history of low-energy trauma, respectively. Of the patients sustaining low-energy trauma, 72% had a history of neuromuscular disease, endocrine disease, or abuse of alcohol or drugs, whereas the corresponding number for high-energy trauma was 29% (p=0.004).

Data from questionnaires and interviews revealed that the male patients had significantly lower body weight and higher frequency of a low educational level, sickness and social security benefits, physical inactivity, daily smoking, previous fracture of the forearm, diabetes mellitus, and regular medication compared with controls (Table 2). Similar trends were found for women. Characterising these variables as risk factors for osteoporosis and fracture, all of the male patients and nine of 10 female patients had one or more of these risk factors. There was no significant difference in total number of risk factors between patients sustaining high-energy and low-energy trauma. A history of previous fracture(s) was reported in 77% and 40% of the male and female patients, respectively. In the patients with previous fracture(s), the mean number of fractures was 2.1 (range 1–6).

Time from fracture until examination was 4.0±1.3 years. Height at time of examination was 179.2±8.6 cm in male patients compared with 180.6±7.2 cm in male controls (p=0.44), whereas corresponding values for women were 168.1±5.2 cm and 167.3±8.4 cm, respectively (p=0.64). BMI at time of examination was 24.2±3.0 in male patients compared with 26.4±3.7 in male controls (p<0.005), whereas corresponding values for women were 23.9±4.0 and 24.7±4.3, respectively (p=0.54). BMD expressed as *Z*-score for L2-4, femoral neck, and total body were significantly lower in male and female patients compared with controls (Fig. 1). All patients had negative *Z*-scores at one or more of the sites measured. *Z*-score was below −1 SD in 86% and 50% of the male and female patients, respectively, and below −2 SD in 50% and 20%, respectively. Adjusting for BMI did not reduce the differences in *Z*-score between patients and controls. Both for patients sustaining high-energy trauma and for those sustaining low-energy trauma, BMD was significantly lower than in the controls at all sites measured (Fig. 2). Patients with low-energy trauma had significantly lower BMD than those with high-energy trauma, except for the lumbar spine.

There was a significant negative correlation between the number of risk factors identified by questionnaire and interview and BMD for the lumbar spine (r=−0.35, p<0.05), femoral neck (r=−0.37, p=0.04), and total body (r=−0.55, p=0.001), respectively (Fig. 3). Using the same risk factors for osteoporosis as Boden et al. [10],

Table 1 Characteristics of the study population

	Men		Women	
	Patients examined (*n*=22)	Patients not examined (*n*=9)	Patients examined (*n*=10)	Patients not examined (*n*=8)
Median age in years (range)	42 (25–49)	33 (32–49)	39 (27–49)	43 (26–49)
Trauma mechanism				
Fall at same level	55%	89%	40%	100%[a]
Fall from higher level	18%	0	40%	0
Traffic accident	27%	11%	20%	0
Medical history				
Neuromuscular diseases	36%	44%	30%	50%
Endocrine diseases	14%	11%	20%	0
Abuse of alcohol/drugs	27%	33%	0	13%

[a] p=0.01 for women examined vs. not examined

corresponding analyses revealed similar correlations between the number of risk factors and BMD for the femoral neck (r=−0.43, p=0.02) and total body (r=−0.47, p=0.007), respectively. No significant correlation was found between total number of previous fractures and BMD.

Table 2 Risk factors for osteoporosis and fracture

	Men			Women		
	Patients (*n*=22)	Controls (*n*=4,762)	*p*-value	Patients (*n*=10)	Controls (*n*=5,950)	*p*-value
Mean age (years)	40.6	40.2	0.79	38.4	38.5	0.97
Mean weight (kg)	74.9	85.4	<0.001	62.4	68.8	0.04
<12 years of school attendance	63.6%	26.7%	<0.001	60.0%	25.2%	0.02
Recipient of sickness or social security benefits	31.8%	8.5%	0.002	0	13.1%	0.38
Physical inactivity	59.1%	21.2%	<0.001	40.0%	22.4%	0.25
Smoker, daily	68.2%	29.3%	<0.001	30.0%	32.5%	1.0
Number of cigarettes (mean)	13.3	13.9	0.83	24.7	11.2	0.05
Alcohol >4 times a week	18.2%	6.7%	0.06	0	3.6%	1.0
Cups of coffee (mean)	4.6	3.4	0.10	2.0	2.6	0.43
Mean intake of calcium (mg/day)[a]	327.3	236.1	0.07	187.5	162.4	0.71
Cod liver oil[b]	59.1%	49.6%	0.39	50.0%	45.4%	1.0
Vitamin supplements[b]	45.5%	44.5%	0.94	60.0%	55.1%	1.0
Previous fracture of forearm	40.9%	19.8%	0.03	20.0%	13.0%	0.63
Diseases						
Asthma/COPD[c]	4.5%	9.7%	0.72	0	11.8%	0.62
Diabetes mellitus	9.1%	0.8%	0.02	0	1.1%	1.0
Mental disorders	18.2%	12.3%	0.34	10.0%	20.5%	0.70
Hyperthyroidism/hypothyroidism[b]	4.5%	0.5%	0.22	10.0%	3.5%	0.34
Regular medication						
Systemic corticosteroids[b]	0	0.8%	1.0	0	1.4%	1.0
Prescription analgesics	31.8%	2.9%	<0.001	20.0%	5.1%	0.09
Hypnotics	13.6%	2.3%	0.02	0	2.8%	1.0
Tranquilisers	18.2%	2.0%	0.001	0	2.0%	1.0
Antidepressants	13.6%	2.5%	0.02	0	4.3%	1.0
Antiepileptics	18.2%	1.0%	<0.001	0	0.8%	1.0
Systemic oestrogens	–	–		20.0%	3.7%	0.05

[a] Based on milk and yoghurt consumption
[b] n=504 for male and n=501 for female controls (supplementary questionnaire)
[c] *COPD* chronic obstructive pulmonary disease

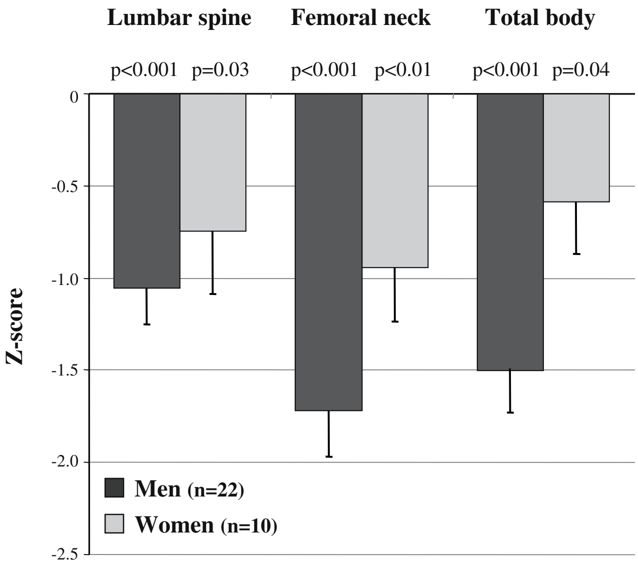

Fig. 1 Bone mineral density (BMD) expressed as *Z*-score for the lumbar spine (L2-L4), femoral neck, and total body in male and female patients, respectively. At all sites, the BMD was significantly lower in patients than in controls. Mean values are given, and error bars denote standard error (SE)

There was no significant correlation between BMD and time from fracture until examination or between BMD and patient age at the time of examination.

Discussion

The present study demonstrates that young patients with hip fracture have reduced BMD regardless of trauma mechanism. Furthermore, the majority have a history of low-energy trauma, comorbidity predisposing for falls or decreased bone strength, as well as several risk factors associated with osteoporosis and fracture.

The present study confirms that hip fracture is more frequent in young men than in young women and that low-energy trauma predominates among young patients [5, 10]. More than half (57%) of the patients had a history of endocrine or neuromuscular disease or previous or current abuse of alcohol or drugs, which demonstrates that these patients have a high degree of comorbidity. This finding corresponds with previous reports on hip fracture in the young [5, 9]. Although comorbidity is also an important fracture determinant in older patients with osteoporotic fractures [18, 19], the present and previous findings [20, 21] indicate that young patients with osteoporotic fractures represent a deviant part of the population, characterised by clustering of risk factors for reduced BMD. Because the femoral neck is stronger in younger people [22], several risk factors contributing to fracture are probably needed.

The risk factors for osteoporosis and fracture in the young identified in the present study are similar to those in the adult population in general [11, 12, 23], and hence confirm the importance of several risk factors for osteoporosis. Except for school attendance and sickness and social security benefits, all risk factors identified in the present study are well recognised and classified as high or moderate in the review of risk factors for osteoporotic fractures by Espallargues et al. [11]. The present findings indicate that low socioeconomic status is an additional important risk factor for osteoporotic fractures in the young. A previous study among the elderly in Oslo, Norway, that reported an increased risk for hip fracture in those with low education [24], indicates that low socioeconomic status may also be a risk factor in the general population.

All the risk factors identified in the present study were significantly different from the reference population for the male patients, whereas fewer differences were observed in female patients despite similar trends in the results. This was probably due to a lower number of women included, resulting in a type II error that was particularly noticeable for variables with a low frequency in the controls (e.g. regular medication). Differences in alcohol consumption between patients and controls did not reach statistical significance. This may be explained by the high frequency of patients with drug or previous alcohol abuse. Most of these patients reported no alcohol consumption at the time of fracture, thereby reducing the frequency of recorded abuse.

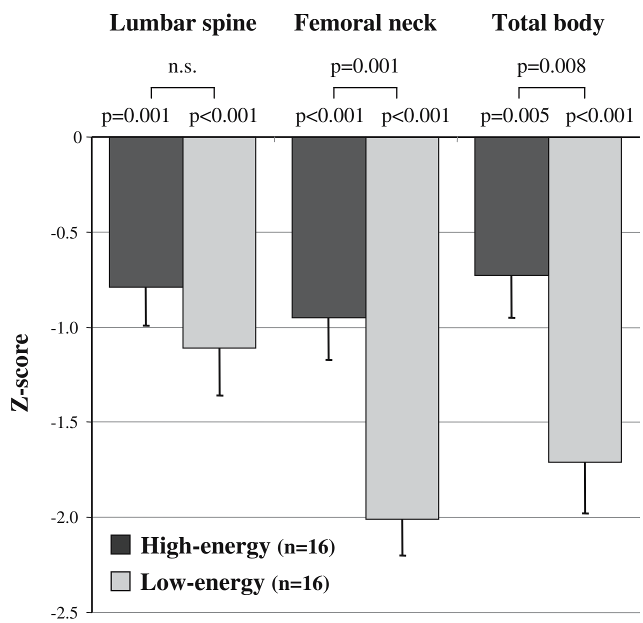

Fig. 2 Bone mineral density (BMD) expressed as *Z*-score for the lumbar spine (L2-L4), femoral neck, and total body in patients sustaining high- and low-energy trauma, respectively. At all sites, the BMD was significantly lower in patients than in controls irrespective of trauma mechanism. Furthermore, the patients sustaining low-energy trauma had significantly lower BMD at the femoral neck and total body compared with those sustaining high-energy trauma. Mean values are given, and error bars denote standard error (SE)

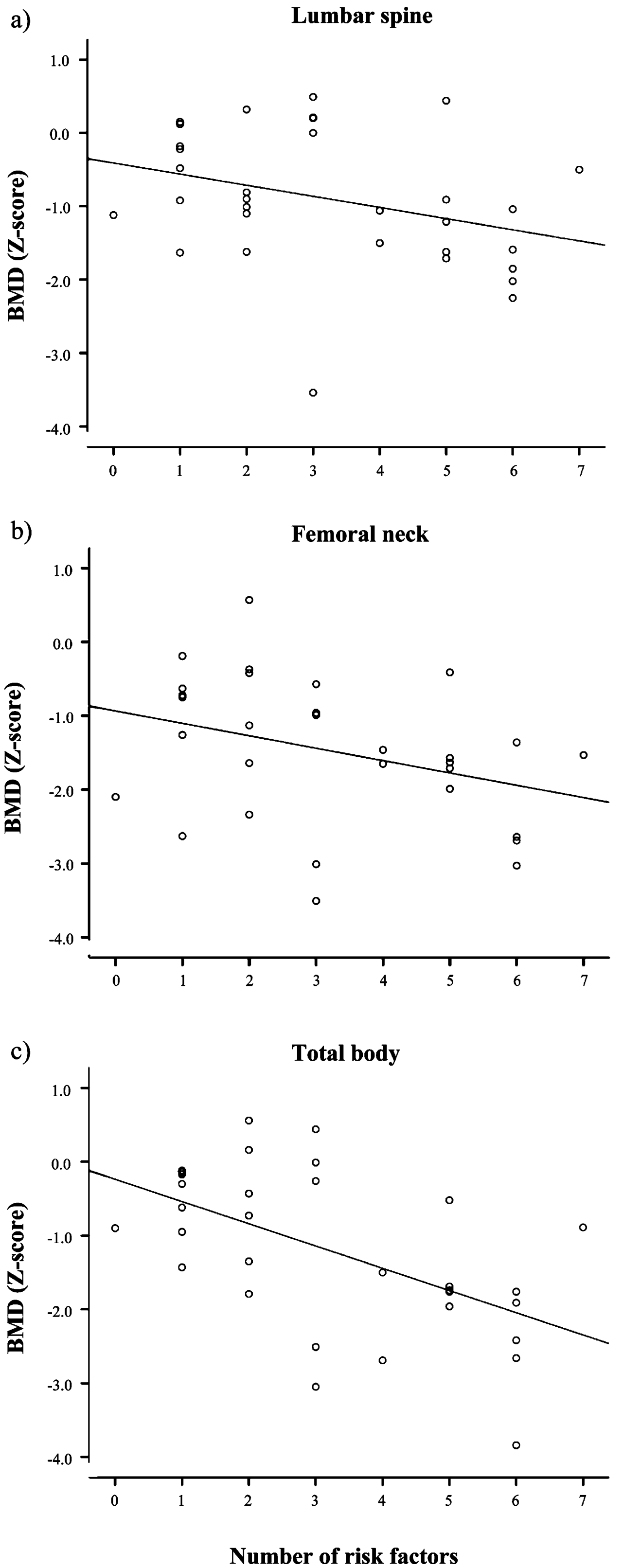

Fig. 3 Correlation between the total number of risk factors for osteoporosis identified in the present study and bone mineral density (BMD) expressed as *Z*-score at **a** the lumbar spine (r=−0.35, p<0.05), **b** the femoral neck (r=−0.37, p=0.04), and **c** the total body (r=−0.55, p=0.001), respectively

Hip fracture in the young could be a result of a high-energy trauma sufficient to cause a fracture in normal bone. However, the present results demonstrate that young patients with hip fracture have a lower BMD than expected regardless of trauma mechanism and that the number of risk factors was unrelated to the trauma mechanism. Boden et al. reported similar findings after performing QCT in young hip fracture patients, although BMD was measured only at the lumbar spine [10]. Because environmental factors influence peak bone mass [25, 26], it may be speculated whether a low peak bone mass might explain, at least in part, the low BMD of the present patient group. It is likely that many of the patients had a life style in adolescence and early adult life that negatively influenced this variable. Concerning the significant correlation found between the number of risk factors and BMD, it should be emphasised that the correlation coefficients ranging from −0.35 to −0.55 imply that the identified risk factors explain the low BMD only to a limited extent.

In the present study, BMD was presented as *Z*-score and not *T*-score. *T*-score was originally developed for diagnosing osteoporosis in postmenopausal Caucasian women [27] and was therefore not regarded as relevant in the young population of the present study [28]. At present, there is no consensus on a definition of osteoporosis in the male segment of the population [29, 30], and for premenopausal women a *Z*-score of less than −2 SD has been proposed as a definition of low bone mass/osteoporosis [31, 32]. If this definition is applied to the patients in the present study, 41% of them would have been classified as osteoporotic, and medical treatment should therefore have been considered.

The information on risk factors in young individuals provided by the present study can be used by the clinician when considering referral to bone densitometry. If BMD in young patients is measured mainly in those with significant risk factors, this may result in a reduced number of negative tests, with consequences for capacity and healthcare costs. The advantages of using risk factors as a prescreening procedure are well recognised [33, 34].

The present results of the clinical examination and the BMD measurements could have been biased if only the healthiest subjects had volunteered for participation. However, except for trauma mechanism in women, there were no differences between the patients who participated and those who did not. It is noteworthy that the patients with a history of alcohol or drug abuse participated to the same extent as those with no abuse problems.

Risk factors prior to the fracture were recorded by questionnaire and interview about 4 years after the fracture. This could represent a methodological problem, and the retrospectively reported risk factors were therefore compared with those in the medical records at the time of fracture. This comparison demonstrated agreement between the sources, showing that the recording of risk factors was consistent. Also BMD was measured 4 years after the fracture. None of the examined patients reported diseases resulting in long-term immobilisation or changes in habits that would significantly affect bone mass following the fracture. Furthermore, no correlation was found for BMD versus time elapsed from fracture until BMD measurement was performed and BMD versus age. It is thus likely that the recorded BMD reflects the BMD at the time of fracture.

In conclusion, the present study shows that young patients with hip fracture have low BMD regardless of trauma mechanism, demonstrating signs of early osteoporosis. The patients exhibited a high degree of comorbidity, thereby representing a deviant part of the population. Furthermore, low educational level and achievement of sickness or social security benefits were identified as additional risk factors compared with those of the general population. The present findings indicate that BMD measurements should be performed in young patients with hip fracture to identify those in whom medical treatment may be necessary. In addition, the identified risk factors can be used as a prescreening procedure to identify young subjects in whom BMD measurement should be considered.

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