Population-based prospective study on the incidence of osteoporosis-associated fractures in a German population of 200 413 inhabitants

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ABSTRACT

Background. A limited body of data is available with regard to the incidence of osteoporotic fractures in Germany. Most of the data published thus far have been derived from hospital records or health insurance settlements. The aim of the present study was to prospectively register four types of fractures in an urban population. The data we obtained were compared with the results of retrospective analysis procedures in order to determine the differences and underlying errors.

Methods. An urban population of 200 413 residents was investigated prospectively with regard to osteoporosis-associated fractures over a period of 12 months. All fractures were recorded and confirmed on radiographs. The results of this analysis were compared with the data from the Statistical Bureau and the International Classification of Disease (ICD) registers of the hospitals.

Results. A total of 979 fractures occurred during the period of investigation. The most common type was the distal radius fracture (395; 197.1 per 100 000). The retrospective detected data of the Statistical Bureau were 31.56% lower than the actual number of fractures. A retrospective analysis of fractures based on the ICD registers of the hospitals revealed an over-registration rate of 26.67%.

Conclusions. Retrospective methods of fracture registration do not provide sufficiently reliable data.

Keywords: fractures, Germany, incidence, osteoporosis

Introduction

An estimated 7.8 million residents of Germany older than 50 years of age suffer from osteoporosis. Of these, at least 300 000 had experienced a fracture.1 One in three postmenopausal women and one in five men older than 50 years of age develop fractures with no significant trauma, associated with a significant increase in morbidity and mortality, and a high economic burden.2,3 In Germany ~5.4 billion Euros were spent in 2003 for the treatment of osteoporosis.1

The incidence of metaphyseal fractures such as those of the head of the humerus, the proximal femur, the distal radius and the thoracolumbar spine vary markedly, depending on age and region.4

Persons older than 60 years of age constituted 14.6% of the German population in 1950, but their proportion rose to 25.6% in 2008.5 This fact and the higher incidence of fractures of the proximal femur (99 141 in 1995; 116 281 in 2004) illustrate the magnitude of the problem.6 Germany
lacks comprehensive registers for systematic documentation of fractures.

In German hospitals, fractures are diagnosed by the treating physician and a radiologist. After treatment has been concluded, the diagnosis is noted in a formal medical report and transformed into a code [International Classification of Diseases ICD]. The clinics pass on these data at regular intervals to the statistical office without mentioning names or dates of birth. The statistical office updates their disease statistics on this basis.

However, the statistical office receives no fracture data from out-patient medical offices of orthopedics or surgery. Thus, one may justifiably conclude that a large number of fractures are not included in these statistics.

Except for a few regional studies, the incidence of osteoporotic fractures has been calculated on the basis of hospital statistics or health insurance settlements.7,8

Retrospective registration of fractures solely on the basis of data from the federal statistical office, health insurance companies or other insurance institutions does not permit the identification of misclassifications or incorrect assignment of codes.

In studies published so far, correction factors were used to obtain an approximate view of actual conditions.6,9

The aim of the present study was to determine, in the population of a medium-sized city with >200,000 inhabitants, the incidence of four types of fractures associated with osteoporosis in advanced age. Fractures that had occurred in a period of 1 year were registered prospectively.

Patients and methods

Patient population

Rostock is a city in north-eastern Germany with 200,413 inhabitants.10

Selection procedure

The following fractures were registered over a period of 1 year (October 2008 to October 2009): proximal humerus, distal radius, proximal femur, clinically evident vertebral body fractures. All residents of Rostock who had experienced one of the investigated fractures during the period of the study and had received out-patient or in-hospital treatment were registered. Residents of Rostock who had experienced a fracture outside the city and had been treated elsewhere could not be considered. Patients whose main place of residence was not Rostock were excluded from the study.

Clinically evident vertebral body fractures were defined as those identified on radiographs (fish, wedge or vertebral crush fracture) in conjunction with acute back pain.

Asymptomatic vertebral fractures confirmed on X rays were not taken into account when the date of the fracture could not be clearly assigned to the period of investigation.

Patients of all ages, both sexes, and ethnic origin were included in the counting.

Data collection

Data were collected prospectively at the two departments of traumatology in Rostock by evaluating surgery reports, ward and admission records. Patients treated on an out-patient basis at the offices of all 16 out-patient surgical offices were registered. Orthopedic surgeons who are not involved into acute fracture treatment were not involved.

All fractures were confirmed on radiographs and were reviewed by qualified radiologists at the hospitals.

Initially patients younger than 45 years and fractures caused by high impact were also included in order to obtain an overview of the incidence of fractures in all age groups. Patients were then divided into different age groups to determine the age-adjusted fracture incidence. We believed this would permit the identification of fractures caused by osteoporosis.

Treatment procedures, the duration of hospital stay, the type of discharge and potential complications were recorded. The location of each fracture was evaluated on X rays, surgery reports and medical reports. Multiple denominations—the same fracture at different health service locations—were ruled out by comparing names.

This was followed by a retrospective analysis of diagnostic codes in the same time period (ICD-10-GM 2009), derived from hospital statistics and data sets of the Statistical Office.

Statistical analysis

The data material was saved and evaluated using Microsoft Office Excel and SPSS 2003.

Incidences have been estimated using the person–year method.

Age-specific incidence rates were determined to obtain detailed fracture data in the individual age groups, while standardized incidence ratios were used (German population) to compare the data with other studies.

The level of significance was set at \( \alpha = 0.05 \), based on the frequency distributions determined by the chi-square test or Fisher’s exact test.
Results

Nine hundred and seventy-nine fractures of the specified types occurred over a period of 1 year. The most common type was the fractures of the distal radius, which occurred in 395 cases (197.1 per 100,000), followed by 242 femoral fractures close to the hip joint (120.8 per 100,000), 190 fractures of the proximal humerus (94.8 per 100,000), and 152 clinically evident vertebral body fractures (75.8 per 100,000) (Table 1).

Women accounted for 71% of the total population affected by fractures.

Among patients aged <45 years, the incidence of fractures was higher among men than among women for all fracture types. In contrast, among residents older than 45 years of age, fractures at the investigated locations occurred more frequently in women than in men. In fact, for fractures of the distal radius the female-to-male ratio was 5.7:1.

Table 1 Age-related incidence rates per 100,000 inhabitants

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Female Male</th>
<th>Inhabitants (m)</th>
<th>Incidence/100000</th>
<th>Fractures Inhabitants (w)</th>
<th>Incidence/100000</th>
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<td>180</td>
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</table>

Age-related Incidence rates per 100,000 subdivided into several types of fractures in men and women

<table>
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<tr>
<th>Age groups</th>
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<th>Radius</th>
<th>Femur</th>
<th>Vertebra</th>
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<tr>
<td>90–99</td>
<td>0</td>
<td>558</td>
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<td>1395</td>
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</tbody>
</table>
Among people older than 60 years, 1.22% of women and 0.61% of men had experienced one of the four fracture types during the period of investigation. Below the age of 70 years, 0.25% had experienced a fracture and above the age of 70 years the percentage was 1.93%.

**Femoral fractures**

In women there was a significant increase in the frequency of femoral fractures from the age of 60 years onward ($P < 0.01$). Around the age of 90 years, the age-related frequency of fractures among female residents was 28.5-fold higher than that among 60- to 69-year olds. The frequency of femoral fractures among men showed a significant increase only after the age of 75 years ($P < 0.01$). The incidence of fractures at the age of 90 years was 17.6-fold higher than that among 70- to 79-year olds. The peak of the incidence of femoral fractures in advanced age exceeded the rates of all other investigated fracture types (Fig. 1).

**Fractures of the radius**

The age-related incidence of fractures of the radius in men showed no significant increase in any age group, but was higher than those in girls and women up to the age of 45 years. Significant increases in fracture rates were noted in women after the age of 50 years ($P < 0.01$), as well as after the age of 70 years ($P < 0.01$). Among 70- to 79-year-old women, it had increased 6.4-fold when compared with those aged 40–49.

**Fractures of the proximal humerus**

Sixty-seven percent of patients with fractures of the humerus were women. The incidence of fractures in women increased until the age of ~80 years and then remained almost constant in higher age groups (Fig. 1).

Fractures of the proximal humerus in men revealed a significant increase from the age of 80 years onward ($P < 0.01$). Proximal fractures of the humerus were the only type of fracture whose incidence in advanced age was higher among men than among women.

**Clinically evident vertebral fractures**

The incidence of vertebral body fractures in women was increased 8-fold among those aged 80–84 years when compared with those aged 65–69 years.

![Comparison of age-related fractures in men](https://academic.oup.com/jpubhealth/article-abstract/35/2/255/1542810)

![Comparison of age-related fractures in women](https://academic.oup.com/jpubhealth/article-abstract/35/2/255/1542810)

**Fig. 1** Comparison of age-related fractures in men and women.
Among male residents, on the other hand, only a minimal rise was noted until the age of 84 years, whereas the incidence rose significantly from the age of 85 onward.

**Fractures registered on an in-patient and out-patient basis (treated by surgery or conservatively)**

Three hundred and six of 395 fractures of the distal radius were registered at one of the hospitals; this amounts to 77.47% regardless of conservative or surgical treatment. One hundred and seventy of 190 patients with a fracture of the proximal humerus (89.47%) and 239 of 242 patients with a femoral fracture were reported at a hospital (98.76%).

**Type of treatment**

Seventy per cent of distal radius fractures were treated by surgery.

Fractures of the proximal humerus treated by surgery comprised 55.5%, while those of the proximal femur were 98.1%.

**Length of hospital stay**

The mean duration of in-hospital treatment after fractures of the proximal humerus was 4 days longer in men than in women (12.5 ± 5.25 versus 8.5 ± 3.49 days). Similar data were obtained for distal radius fractures (8.6 ± 5.43 versus 5.7 ± 1.25 days). The mean duration of the hospital stay after a fracture of the proximal femur showed no significant difference (14.66 ± 2.94 days in men versus 14.29 ± 2.09 days in women), (P > 0.05).

**Complications**

The most common complications after treatment of proximal femoral fractures were anemia requiring transfusion (women 47.6%; men 26.6%), urinary tract infection (9.7% of women; 1.6% of men) and pneumonia (4.1% of women; 10.9% of men). In patients older than 80 years of age, 59.8% of women and 34.8% of men with anemia required transfusion. Complications occurred less frequently after fractures of the distal radius and the proximal humerus than after femoral fractures.

There was a significant (P < 0.01) age-dependent increase in acute hospital mortality after femoral fractures. The maximum mortality rate of 13% was registered in patients older than 80 years.

**Retrospective analysis using ICD codes**

The retrospective analysis of ICD codes comprised 1240 fractures. However, only 979 fractures were confirmed on review of the diagnoses.

Based on the exact number of fractures, incorrect codification had caused an over-registration of 5.62%. Multiple registrations had increased the total number by as much as 21.05%.

Taken together, the purely retrospective analysis revealed an over-registration of 26.67%. This corresponds to a correction factor of 0.73.

**Data from the Statistical Bureau of Mecklenburg-Vorpommern**

The number of fractures of the desired category recorded at the Regional Statistical Bureau for the population of Rostock was 670. Thus, given the 979 prospectively registered fractures, an under-registration of 309 fractures or 31.56% was noted here. Concordence in fracture rates was registered for those of the proximal femur.

Under-registration of 77 fractures was noted for those of the proximal humerus when compared with prospective data. Fractures of the distal radius also revealed a similar deviation: in fact, as many as 192 fewer fractures were registered at the Statistical Bureau.

**Discussion**

**Main findings of this study**

To the best of our knowledge, prospective investigations concerning incidence rates, treatment and complications of these four fracture types are not available in Germany until now. 979 fractures of the specified types occurred over a period of 1 year. The most common type was the fractures of the distal radius.

From the age of 45 onward, women reveal a significantly higher rate of fractures than men (P < 0.01). The difference becomes even more evident from the age of 55 onward. These findings concur with an extension study from Italy in the space of time from 2003 to 2008. The incidence of femoral fractures in advanced age exceeded the rates of all other investigated types. Around the age of 90 years the highest incidence of proximal femoral fractures was observed. Fractures of the proximal humerus were the only type of fracture whose incidence in advanced age was higher among men than among women.

Fractures of the distal radius treated by surgery comprised 75%, while those of the proximal femur amounted to 98.1%. Umberto Tarantino observed hospitalization rates of 93.0% for hip fractures, 36.3% for humeral fractures and 22.6% for forearm/wrist fractures in Italy. Thus, the
percentage of patients treated by surgery in our study was clearly higher in humeral and forearm fractures.

After a fracture of the proximal humerus or the distal radius, the mean duration of the hospital stay was significantly longer in men than in women (P < 0.05).

Particularly, the femoral fractures implicate complications such as anemia and pneumonia that require blood transfusion and antibiotic treatment.

The purely retrospective analysis of the investigated fractures revealed an over-registration of 26.67%. An under-registration of 31.56% was noted in the data from the Statistical Bureau of Mecklenburg-Vorpommern.

What is already known on this topic
Fractures of the femur, the distal radius, the proximal humerus and those of vertebrae are most commonly associated with osteoporosis.\(^1,13\)

The only prospective study we know of, conducted in a population of 82,251 residents, extended from 1987 to 1989 and was solely limited to the incidence of fractures of the femoral neck.\(^8\)

Females were more frequently affected (a crude average annual incidence rate per 100,000: females 291.3; males 110.2).\(^8\)

The number of patients admitted to the hospital at least once for a hip fracture in Germany increased in 1995–2004.\(^6\)

The age-adjusted incidence in Germany ranks third when compared with published international data; higher rates have been reported for Norway and the USA.\(^8\)

In femoral fractures there is a significant age-dependent increase in acute hospital mortality with a maximum in the group of the patients older than 85 years.\(^14\)

Limitations
A specific feature of Rostock is that the proportion of immigrants here is less than that in the entire Federal Republic of Germany (3.2 versus 8.2%).

However, given the limited number of patients investigated in the present study, extreme caution is advised when extrapolating the fracture rates of 200,413 residents to the entire population of Germany.

Residents of the city of Rostock may have experienced fractures outside the city and may have undergone treatment at other institutions than the medical facilities of the city. Fractures were registered at the Departments of traumatology, emergency departments and surgeons’ offices in the city. Clinically evident vertebral fractures, which were diagnosed and treated exclusively at the offices of orthopedic surgeons, were not taken into account.

What this study adds
Knowledge of the existing state is essential for devising health-relevant strategic approaches and making expenditure forecasts in health care.

To our knowledge, our study is the first prospective registration of four types of fractures associated with osteoporosis in a specific population. The difficulties of the various approaches were demonstrated by direct comparison with retrospective analyses of fracture counts. As fractures treated on an out-patient basis in Germany are not reported to the provincial statistical offices of the country, valid statements about fracture incidences cannot be made on the basis of these data. Due to data protection regulations, patients could not be assigned by name to the data of the Statistical Bureau. Thus, it was impossible to exclude multiple registrations.

The present study shows that central registers, guidelines and controls of registration and coding of fractures are needed for exact documentation of fracture incidences. Multiple denominations could be avoided by exact registration of patients. An automated registration procedure for the purpose of documentation would facilitate comprehensive registration.

In persons aged 80–90 years, the age-related incidence of proximal humerus fractures among men was even higher than that among women. This observation does not concur with the numerical preponderance of women experiencing fractures of the humerus in advanced age, as reported in a large number of studies.\(^15–17\) Thus, in contrast to fractures of the radius, those of the humerus do not occur less frequently in men.

The high frequency of fractures in the age group older than 75 years is of paramount importance. This age group, which is prone to frailty, must be given special attention.

References


