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# Epidemiology of diaphyseal femoral fracture

The incidence of diaphyseal femoral fracture in adults, aged 20 years and older, was determined in Stockholm County using hospital admission rates. The validity of the data was investigated by a study of the medical records of a sample of 277 cases and also by determining the incidence in a subpopulation of 139 cases using an alternative method. The incidence decreased from age 20 to middle age after which it increased into old age. The age-related increase was more pronounced in women and in fractures caused by moderate trauma. From 1972 to 1981, the incidence of diaphyseal femoral fracture caused by moderate trauma increased annually by 10 per cent in women aged 75 years and older.

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The incidence of fracture of the proximal femur (Alffram 1964, Gallagher et al. 1980, Jensen 1980, Zetterberg & Andersson 1982), the pelvis (Knowelden et al. 1964, Melton et al. 1981), the proximal humerus (Horak & Nilsson 1975, Rose et al. 1982), and the distal radius (Alffram & Bauer 1960, Matkovic et al. 1980, Hansson et al. 1982, Falch 1983) is highly age-related. Osteoporosis has generally been claimed to be the main etiologic factor for these fractures, and the trauma associated with fracture at these predominantly cancellous bone sites has usually been reported to be moderate or minimal. An increasing risk of falls in old age and a number of chronic illnesses associated with aging have been suggested to contribute to the high risk of sustaining these types of fractures in elderly people.

The epidemiology of fracture of the diaphyseal femur has attracted much less interest (Knowelden et al. 1964, Wong 1966). The incidence of fracture of the compact bone of the diaphyseal femur is commonly thought to be associated with severe trauma, resulting in a different relationship with age than fractures of cancellous bone. The objective of the present investigation was to determine age- and sex-specific incidence rates of diaphyseal femoral fractures from different types of trauma and to study possible changing trends.

## Materials and methods

All hospitals in Stockholm County treating diaphyseal femoral fracturea are connected to a computerized medical information register, the Inpatient Care Register (ICR), (Peterson 1975). All discharges from inpatient care in the hospitals of Stockholm County are reported to the register. For this study all discharges, 1,612 cases of fracture of the diaphyseal femur (code numbers 821.00 and 821.10) during the period 1972–1981 were selected from the register. Only fractures among Stockholm County residents were included.

To assess the validity of the information in the ICR, the medical records of a sample of 277 cases were retrieved. The diagnostic codes and the code for the external cause of the fracture (E-code) were checked. The E-codes were correct in 252 of 258 cases (98 per cent); in the remaining the E-code was missing. The diagnostic codes were erroneous in 11 per cent of the cases. The majority of the misclassified fractures were proximal femoral fractures, indicating a risk of overestimating the incidence of diaphyseal femoral fracture, especially in old people. Therefore, the error introduced by the misclassified cases was accounted for by using correction factors based on the proportion of misclassified cases in each 10-year age-group from age 20 in both sexes.

The cases, aged 20 years and older, were identified and stratified by sex, 10-year age-group, type of trauma involved, and year of discharge. Age- and sex-specific incidence rates were calculated by dividing the number of cases by the mean of the corresponding population during the observation period. Incidence rates were calculated separately for all types of trauma, severe trauma (traffic accidents and high falls), and moderate trauma (fals on the same levels).

In addition, to investigate the validity of using ICR data, the incidence was also determined in a subpopulation of Stockholm County using an alternative method. From the ICR, all patients with a diagnosis of diaphyseal femoral fracture treated at Huddinge or Södertälje Hospitals between 1972 and 1981 were

selected. The medical records and/or radiographs were examined, and only fractures that definitely passed through cortical bone – defined as the part of the femur between 10 cm distal to the lesser trochanter and 15 cm proximal to the knee-joint line – were considered. One hundred and thirty-nine fractures in 72 men and 67 women fulfilled the criteria of a diaphyseal fracture. The population at risk consisted of the residents of the catchment area of Huddinge and Södertälje Hospitals between 1972 and 1981. Annual census data were obtained from the National Swedish Bureau of Statistics (Statistiska Centralbyrån). Age- and sex-specific incidence rates of diaphyseal femoral fracture were calculated by dividing the number of cases in each age group by the size of the corresponding population. The incidence rates in the subpopulation serve as a check on the validity of the computer-based information. The incidence rates in Stockholm County, not corrected for misclassified cases, and in the subpopulation were compared (Miettinen 1976). For women the methods gave similar results; whereas for men exclusively computer-based data gave higher incidence rates in old age. The 95 per cent confidence limits for the difference in incidence between two populations, however, included the possibility of equal incidence rates in al age groups and in both sexes (Figure 1).

In the study of Stockholm County, multiple registrations caused by transfers between hospitals and departments were avoided by excluding all but the first admission for fracture in hospitals with emergency service. Fractures of the same type occurring more than once in the same person during the study period were therefore not included. This approach may result in a slight underestimation of the incidence rate. In the sample of 277 cases, however, no patient sustained more than one diaphyseal femur fracture during the period under study.

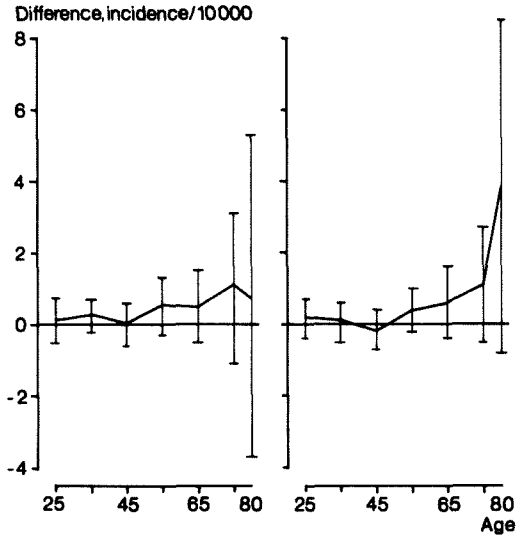


Figure 1. The difference between the incidence of diaphyseal femoral fracture in Stockholm County and the subpopulation of the county. The 95 per cent confidence limits of the difference is indicated and includes the possibility of equal incidence rates in the two populations. Left, men; right, women.

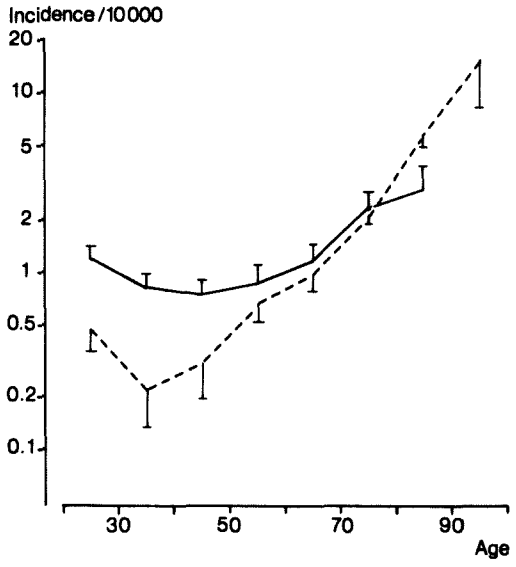


Figure 2. Incidence rate per 10,000 person years of diaphyseal femoral fracture for men and women in 10-year age-groups. Ninety-five per cent confidence limits indicated. —— Men; ---- Women.

To study time trends in the incidence rate of the diaphyseal femoral fracture, differences in age distribution were accounted for with a multiplicative model that corrected for age and compared each year with the first year under study (Alfredsson & Ahlbom 1983). In addition, an exponential regression model was used to estimate the average annual change in the incidence rates based on the multiplicative model. The time trend for fracture caused specifically by moderate and severe trauma was analyzed in those aged 75 years and older. Because the E-code was not reported in 7 per cent of the cases and the unreported E-codes were unevenly distributed over the study period, the analysis was made with a corrected value.

## Results

The incidence of diaphyseal femur fracture decreased from young adulthood to middle age in both sexes. Following this initial decrease, the

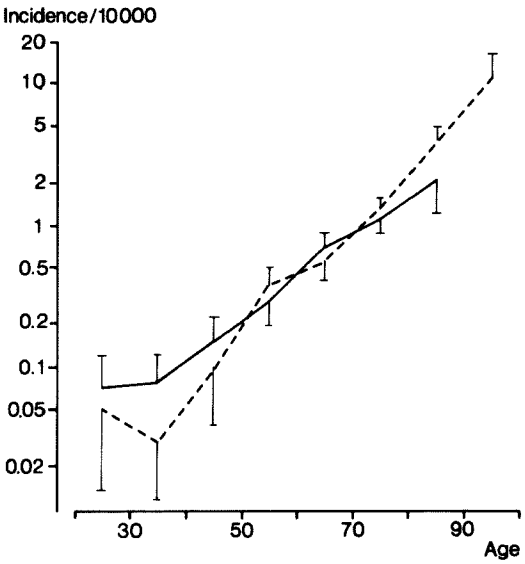


Figure 3. Incidence rate per 10,000 person years of diaphyseal femoral fracture caused by moderate trauma for men and women in 10-year age-groups. Ninety-five per cent confidence limits indicated. —— Men; ---- Women.

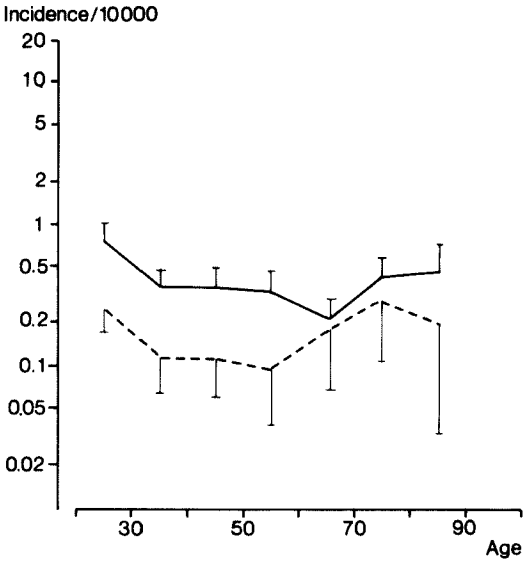


Figure 4. Incidence rate per 10,000 person years of diaphyseal femoral fracture caused by severe trauma for men and women in 10-year age-groups. Ninety-five per cent confidence limits indicated. —— Men; ---- Women.

incidence increased continually with age (Figure 2). The increase was more pronounced in women, and after age 70 the incidence was higher in women than in men.

For men, aged 20–29 years, the incidence was more than twice the incidence found in women, whereas the opposite was found in old age.

The incidence of fractures caused by moderate trauma increased exponentially from age 30–39 years onward in both sexes (Figure 3). For severe trauma the incidence was highest in early adulthood (Figure 4).

In 20 per cent of the 139 cases in the subpopulation study, the fracture coincided with a neuromuscular disorder that was likely to produce disuse osteoporosis of the affected leg (Table 1), or the fracture was located near a bone lesion or a metal implant. Before age 60 years, 9 per cent of the cases were associated with a significant concomitant disease or with a metal implant, whereas after age 60, 33 per cent of the fractures occurred in patients with a significant concomitant disease or an implant.

In the time-trend analysis from 1972 to 1981, the incidence did not change in the 50–74 year-old age group. In those aged 75 years and older, the incidence increased annually by 3.6 per cent (95 per cent confidence limits −2.1; 9.7) and 3.9 per cent (95 per cent confidence limits −0.1; 8.1) for men and women, respectively.

*Table 1. Neuromuscular disorders of probable etiologic significance among 139 cases of femoral diaphyseal fracture*

| | Age | Sex | Trauma | Remarks |
|---|---|---|---|---|
| Sequelae of polio | 61 | M | Hit by car | Fracture at tip of femoral component of hip prothesis |
| | 72 | F | Driver of car | |
| | 81 | F | Rotational trauma in bed | Mb Parkinson |
| Hemiparesis | 64 | F | Torsional trauma while standing | Diabetes melitus |
| | 75 | F | Fall on same level | |
| Muscular dystrophy | 42 | M | Fall on same level | |
| Myelomeningocele | 20 | F | Fall from wheelchair | |
| Multiple sclerosis | 49 | F | Sitting down with legs crossed | |
| Mb Parkinson | 71 | F | Fall on same level | Fracture of Ender-nailed femur |
| | 74 | M | Fall from wheelchair | |

For women aged 75 years and older, fractures caused by moderate trauma increased annually by 10 per cent (95 per cent confidence limits 6.8; 14). For men and for severe trauma, the 95 per cent confidence limits included the possibility of an unaltered incidence.

## Discussion

In our material the incidence of diaphyseal femoral fracture increased with age for both sexes. The general pattern was similar to that for fracture of the proximal femur (Hedlund et al. 1987). In particular, the incidence pattern of fracture caused by moderate trauma resembled that of proximal femoral fractures.

The majority of the misclassified cases in our register were proximal femoral fractures, suggesting a risk of overestimation of the true incidence rate, particularly in old age. Although the introduction of correction factors compensates for the misclassified cases, the incidence rates should be considered as estimates of limited precision of the true incidence. However, it seems proper to conclude that there is an age-related increase of the incidence of diaphyseal femoral fracture.

Compared with the incidence reported by Knowelden et al. (1984), we found a somewhat higher incidence of diaphyseal femoral fracture in both sexes before 60 years of age and a somewhat lower incidence after aged 60. From Singapore (Wong 1966) similar incidence rates have been reported in a mixed Asian population, although the incidence in old men was much higher in Stockholm.

Metal implants act as stress raisers in bone, but are also unspecific indicators of bone disorders, e.g., osteoporosis causing fracture and the need for internal fixation. In one third of the cases aged 60 years and older in the subpopulation, the fracture coincided with a neuromuscular disorder that was likely to produce disuse osteoporosis of the affected leg or the fracture was near a bone lesion or a metal implant. Although there are no data in the general population to relate this proportion to, the data suggest that a substantial proportion of diaphyseal femur fractures in old age are secondary to disorders or implants weakening the bone.

We have previously reported that the incidence of trochanteric fractures over age 75 years increased in Stockholm County during 1972–1981, whereas the incidence for the 50–74 year-old age-group was unaltered (Hedlund et al. 1986). The present study suggests a a similar time trend for diaphyseal femoral fracture, with an increasing incidence of fracture associated with moderate trauma in women aged 76 years and older. In men, however, the 95 per cent confidence limits of the annual change included the possibility of an unaltered incidence.

Riggs & Melton (1983) proposed three types of fracture: Type A (vertebral and distal forearm fractures) characterized by a high women/men ratio early after menopause; Type B (hip, proximal humerus, pelvis, proximal tibia) characterized by an exponential rise in incidence later in life; and Type C (diaphyseal fractures), which shows neither a preponderance for women nor an increase with age. The preponderance for women and the increase with age also for diaphyseal fractures found in the present study do not, however, support the concept of distinct fracture syndromes.

As in the case with trabecular bone, our observations confirm that age-related factors, such as bone loss and deteriorating neuromuscular function, are important risk factors also for fracture of compact bone in old age.

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