# Epidemiology of ankle fractures

## A prospective population-based study of 212 cases in Aalborg, Denmark

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We studied the epidemiology of ankle fractures prospectively during 1 year in a population of about 200,000. The overall incidence rate was 107 fractures per $10^5$ person-years. Below the age of 50, ankle fractures were commonest in men. After this age, females became predominant and the age-specific incidence rates decreased in both sexes. The main cause of fracture was falls (87%), on the ground, on stairs or from a height. 137 fractures (55%) occurred in sports, play or other leisure activities. Most patients (64%) were walking, running or jumping at the time of injury. Alcohol and slippery surfaces were each involved in nearly a third of the cases. The distribution of the fractures according to both the Lauge-Hansen and the AO Weber classification systems were within the limits of previous series. Nearly half the patients were hospitalized and the fractures were operated on with osteosynthesis. Our findings indicate that ankle fractures are mainly caused by substantial trauma sustained during physical activity. Osteoporosis seems to be of minor importance.

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Studies focusing on the epidemiology of ankle fractures are few. In 1969, the age- and sex-specific incidence rates were described in the population of Malmö (Nilsson 1969) and later the changes in incidence over 30 years were studied in the same population (Bengnér et al. 1986). A third study described the incidence and various other epidemiologic data in a population from the United States (Daly et al. 1987). These studies were all retrospective.

We prospectively analyzed the epidemiology of ankle fractures in a geographically well-defined population.

## Patients and methods

The casualty department in Aalborg Hospital serves an area consisting of the 5 surrounding municipalities. On 1 January 1995, its population was 198,603. These residents were defined as the population at risk and formed the basis of the study.

Data were obtained prospectively from each patient who was treated for an ankle fracture in the casualty department during the period 1 September 1994 to 31 August 1995. All patients with a radiographically verified ankle fracture were included, except patients with physeal fractures, isolated small avulsion fractures or Pilon fractures. Visitors and tourists who sustained an ankle fracture during their stay in the area studied were included (18 fractures), while inhabitants of the area who sustained an ankle fracture elsewhere were excluded. The patients included were all interviewed by the doctor on duty, using a specially designed questionnaire.

Based on the primary radiographs, the fractures were classified according to both the Lauge-Hansen (1942) and the AO Weber (Müller et al. 1979) classification systems. Data concerning the hospital stay were obtained from the hospital's computerized registration system.

Calculations of incidence rates were based on official Danish population statistics. The 95% confidence intervals (CI) around the incidence rate were estimated using an approximation to the normal distribution. The $\chi^2$ test with Yates' correction was used for statistical comparisons; a probability less than 0.05 (two-tailed) for differences occurring by chance was considered significant.

## Results

211 patients sustained 212 ankle fractures. The overall incidence rate was 107 fractures per $10^5$ person-years (95% CI 87–127). The age-adjusted incidence rates for the two sexes were equal. The age- and sex-

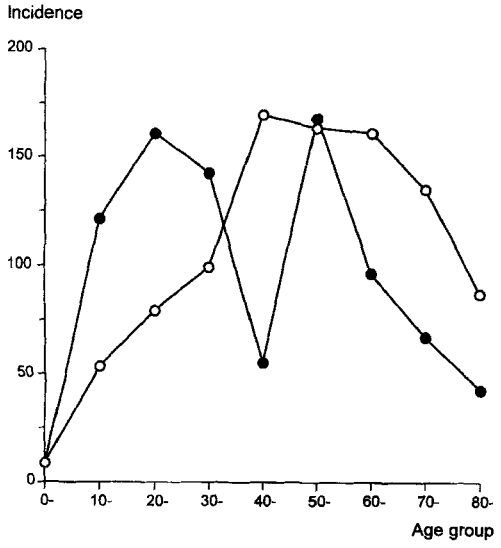


Figure 1. Age- and sex-specific incidence of ankles fractures per $10^5$ person-years. ● men, ○ women.

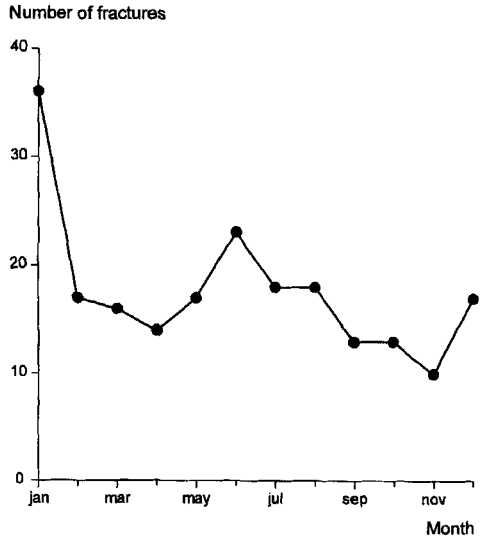


Figure 2. Frequency of ankle fractures according to the month of occurrence, n 212.

specific incidence rates, however, showed pronounced variations; the incidence in young men was double that of young women (Figure 1). The fracture incidence varied throughout the year with peaks in January and June (Figure 2). The numbers of fractures per day were nearly equal for the first 5 days of the week and increased slightly during weekends. Fractures occurred most frequently in the afternoon and early evening.

All fractures were caused by accidents, as distinct from acts of violence or spontaneous fractures. Nine tenths of the fractures were due to falls, on the ground, on stairs or from a height (Table 1). More than half of the fractures occurred in sports, play or other leisure activities (Table 2). The commonest sports activity was soccer (17). The proportion of injuries related to sports were significantly higher among men (26%) than women (10%).

In most cases (202), the patients walked normally before the accident. Two thirds of the patients were walking, running or jumping at the time of injury (Table 3). One tenth of the fractures occurred in traffic accidents, most often during cycling. 59 (28%) patients stated that the ground was slippery at the time of the accident. In January alone, more than two thirds of the fractures occurred on icy ground. At the time of injury, one tenth of the patients were wearing high-heeled shoes or clogs; the remainder were wearing shoes with a flat sole or no shoes. 62 patients (29%) stated that they had consumed alcohol within 4 hours before the accident.

There was a significant association between the age of the patient and the Lauge-Hansen staging, as one third of fractures in the age group below 50 were pronation fractures but only one tenth in older patients (Table 4). According to the AO Weber classifi-

**Table 1. Mechanism of injury in 212 ankle fractures**

| | No. | % |
|---|---|---|
| Stumbling or slipping on ground | 118 | 56 |
| Falling on stairs | 32 | 15 |
| Falling from height | 34 | 16 |
| Direct trauma | 26 | 12 |
| Unknown | 2 | 1 |

**Table 2. Activity at the time of injury in 212 ankle fractures**

| | No. | % |
|---|---|---|
| Playing and other leisure activities | 79 | 37 |
| Sports activities | 39 | 18 |
| Work | 25 | 12 |
| Vital activities [a] | 10 | 5 |
| Other or unknown activity | 59 | 28 |

[a] Eating, bathing, resting, sleeping, etc.

**Table 3. Movement pattern at the time of injury in 212 ankle fractures**

| Movement pattern | No. | % |
|---|---|---|
| Walking, running, jumping | 136 | 64 |
| Standing, sitting, lying down | 27 | 13 |
| Moving (vehicle) | 19 | 9 |
| Pulling, pushing, lifting | 4 | 2 |
| Other or unknown movement pattern | 26 | 12 |

Table 4. Radiographic classification of 212 ankle fractures according to Lauge-Hansen, number (%)

| Stage | Supination-adduction | Supination-eversion | Pronation-abduction | Pronation-eversion |
|---|---|---|---|---|
| 1 | 25 (12) | 0 | 17 (8) [a] | |
| 2 | 1 | 69 (33) | 3 (1) [a] | |
| 3 | – | 2 (1) | 1 | 17 (8) |
| 4 | – | 65 (31) | – | 12 (6) |
| All | 26 (12) | 136 (64) | 50 (24) | |

[a] Pronation-abduction and pronation-eversion fractures stages 1 and 2 are indistinguishable on radiographs.

cation system, 24 fractures were type A, 139 were type B, and 29 were type C. 20 fractures could not be classified radiographically in this system because the fracture only involved the medial malleolus. Fewer fractures were type A or B, and more were type C in patients younger than 50, compared to older patients, but the difference was not significant ($p = 0.06$).

In 20 cases, the fracture was accompanied by injuries in other anatomic regions: 10 minor wounds or abrasions, 5 fractures, 2 contusions, 2 sprains, and 1 brain concussion.

The average delay from accident until treatment at the casualty department was 17 hours (10 min–24 days). 94 patients (45%) were hospitalized: 91 because the fractures were operated on, 3 because of other injuries. The average length of the hospital stay was 6 (1–50) days.

## Discussion

The overall incidence rate compares well with the incidence rates previously reported from Scandinavia: 114 (Lindsjö 1981) and 107 (Bengnér et al. 1986) fractures per $10^5$ person-years. Daly et al. (1987) found in a study from the United States 184 fractures per $10^5$ person-years but these included physeal fractures and small avulsion fractures, which to some extent may explain the difference.

In the younger age groups, ankle fractures were commoner among men, probably because of greater physical activity. In women, the incidence rate gradually increased to reach a maximum between 40 and 70 years of age and it then became higher than among men. This could be explained by the reduced bone quality occurring in some postmenopausal women. Unlike the continued increase in well-known fragility fractures, such as hip fractures (Johnell et al. 1984), the incidence of ankle fractures decreased for both sexes after the age of 60–70. The trauma involved, the substantial physical activity at the time of injury, and the low prevalence of disabling diseases in the locomotor system indicate that ankle fractures should not be characterized as fragility fractures.

Nine tenths of the fractures were the result of indirect trauma, i.e., stumbling on the ground, falling on stairs or falling from a height. The mechanisms of injury involved were the same as found in a study concerning ankle sprains (Hølmer et al. 1994). Comparing that study to ours, patients sustaining ankle fractures are generally older than patients sustaining ankle sprains. This may be due to an age-dependent change in the ratio of bone and ligament strength.

The distributions according to the Lauge-Hansen and the AO Weber classification systems are within the range of previously reported series, although differences exist (Lindsjö 1981, Daly et al. 1987). These may be explained by a large interobserver variation in both classification systems (Nielsen et al. 1990, Thomsen et al. 1991). Our results support previous observations of a relationship between age and the nature of the fracture (Daly et al. 1987); the reason for this relationship is unknown.

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