# Decreasing incidence of fractures in children

## An epidemiological analysis of 1,673 fractures in Malmö, Sweden, 1993–1994

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The incidence of fractures in children in the city of Malmö, Sweden, almost doubled between 1950 and 1979. To see whether a further increase had occurred, we carried out an epidemiological analysis of fractures among children 0–16 years in Malmö 1993–1994. During the study period, 1,673 fractures occurred in 1,610 children. The commonest fracture location was the distal forearm (26%), followed by the phalanges of the hand (16%) and the clavicle (9%). The annual fracture incidence was 235/$10^4$ in boys, 149/$10^4$ in girls and 193/$10^4$ for both genders. This means a decrease in the annual fracture incidence by 9% since 1975–1979. The decrease was not associated with any specific type of fracture or etiological factor. Fractures of the distal forearm among girls were an exception to the general decline, having increased by one third since 1975–1979, which might be explained by the fact that today girls participate to a greater extent in the same sports as boys.

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Fractures constitute 10–25% of all pediatric injuries (Sibert et al. 1981, Nathorst Westfelt 1982) and are probably a reliable parameter of danger in the lives of children. Landin (1983) found that the incidence of fractures in children in Malmö, Sweden, almost doubled from 1950 to 1979. The increase was due to a higher number of fractures caused by slight trauma, such as sports-related accidents, whereas high-energy trauma, such as traffic accidents, decreased over the period. A fracture incidence similar to that in Malmö for 1975–1979 was found in Nottingham children in 1981 (Worlock and Stower 1986). A higher rate of distal forearm fractures than in Landin's findings 1975–1979 was reported by Kramhöft and Bödtker (1988) in Danish children during 1985, mainly due to more fractures among girls. We have now determined whether there has been a further increase in the incidence of fractures among children in Malmö.

## Patients and methods

In the city of Malmö, population 243,000, virtually all trauma care is provided at the Malmö University Hospital. The radiographic examinations are carried out in the Department of Diagnostic Radiology and classified according to the diagnosis, making it possible to retrieve records of all patients with a fracture. The population at risk, 0–16 years, was 44,479 (1993) and 42,040 (1994), altogether 86,519. The design of this study was identical with the previous study of fracture incidence and fracture patterns among children in Malmö for 1975–1979 by Landin (1983), which made comparisons possible. All records of fractures for 1993 and 1994 were investigated. In cases with an uncertain fracture diagnosis, the radiographs were reviewed. Case records from the Departments of Orthopedics, Hand Surgery, Plastic Surgery and Otorhinolaryngology were examined for additional epidemiological information. Two fractures of the same bone and fractures of, for example, the radius and the ulna in the same arm were recorded as one fracture. Fractures of ribs and teeth were excluded, as also were fractures in non-residents. As in the study by Landin (1983), follow-up of fractures incurred and initially treated outside Malmö were

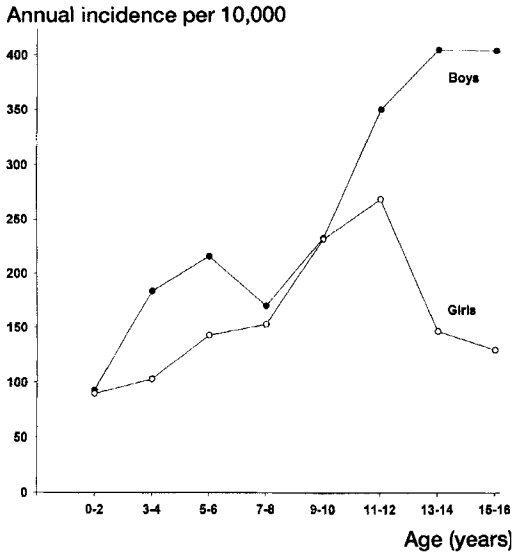


Figure 1. Incidence of fractures in children in 1993–1994.

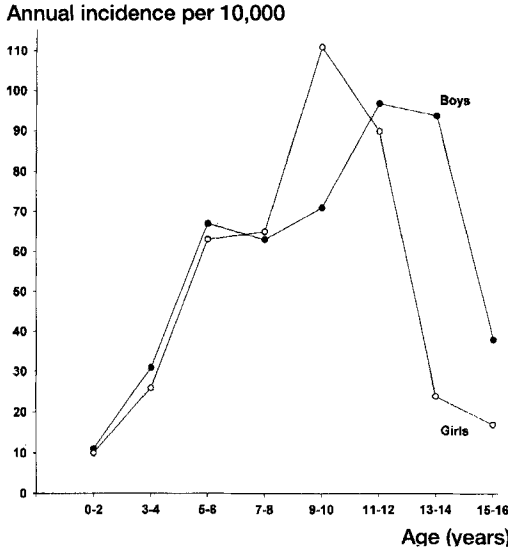


Figure 2. Incidence of distal forearm fractures in children in 1993–1994.

carried out at our institution and thus included in the study. The fractures were categorized according to the child's age, fracture location, the side involved, month of fracture, severity of trauma and environmental aspects. The severity of trauma was classified as slight (fall on ground level, most sports injuries), moderate (fall from a height 0.5–3 m, fall on stairs, bicycle and horse accidents) or severe (fall from a height > 3 m, all other traffic accidents).

The chi-square test was used for the statistical analysis. P-values < 0.05 were regarded as statistically significant.

## Results

During the period of observation, 1,673 fractures were recorded, 1,045 in boys and 628 in girls. The annual fracture incidence was $235/10^4$ in boys, $149/10^4$ in girls and $193/10^4$ for both genders. Based on these figures, the accumulated risk of sustaining a fracture from birth until the age of 16 was 42% for a boy and 26% for a girl. The fracture risk increased with age in both genders, girls reaching their peak at age 11–12 years, boys at age 13–14 years (Figure 1). Boys accounted for 62% of the fractures, identical with the figure for 1975–1979 (Landin 1983). Boys had a significantly ($p < 0.05$–$0.001$) higher incidence than girls in all age groups except 0–2, 7–8 and 9–10 years. The annual fracture incidence had decreased by 9% compared to 1975–1979 ($p < 0.01$). The decrease was a general phenomenon and was not associated with any specific type of fracture or etiological factor. Fracture of the distal forearm was the commonest type of fracture and made the calculation of the age and sex-specific incidence possible (Figure 2). In the age group 9–10 years, girls had a higher incidence than boys ($p < 0.05$) whereas boys dominated in the older age groups. The incidence of forearm fractures in girls has increased by 31% since 1975–1979 ($p < 0.01$), from $35/10^4$ to $46/10^4$, while it has remained virtually unchanged in boys, $53/10^4$. As a consequence, the boy/girl ratio concerning distal forearm fractures in our study was 1.2 compared to 1.7 when all fractures were included.

In the upper extremity, there was a preponderance of left-sided fractures with a left/right ratio of 1.2 ($p < 0.01$). In the lower extremity, the left/right ratio was 0.9 but this difference was not statistically significant.

The frequency of various fracture types is similar to that for 1975–1979, except for an increased rate of forearm fractures among girls (Table 1).

More fractures occurred during April–June and August–October than during the winter months

Table 1. Fracture location. Number of fractures (percentages in brackets). 1993–1994

| | Boys | Girls | All |
|---|---|---|---|
| Facial skeleton | 20 (1.9) | 11 (1.8) | 31 (1.9) |
| Clavicle | 84 (8.0) | 64 (10) | 148 (8.8) |
| Humerus | | | |
| proximal | 17 (1.6) | 32 (5.1) | 49 (2.9) |
| shaft | 12 (1.1) | 8 (1.3) | 20 (1.2) |
| distal | 54 (5.2) | 40 (6.4) | 94 (5.6) |
| Forearm | | | |
| proximal | 21 (2.0) | 15 (2.4) | 36 (2.2) |
| shaft | 46 (2.0) | 19 (3.0) | 65 (3.9) |
| distal | 237 (23) | 195 (31) | 432 (26) |
| Scaphoid | 13 (1.2) | 5 (0.8) | 18 (1.1) |
| Metacarpals | 104 (10) | 19 (3.0) | 123 (7.4) |
| Fingers | 164 (16) | 102 (16) | 266 (16) |
| Femur | | | |
| proximal | 2 (0.2) | 1 (0.2) | 3 (0.2) |
| shaft | 15 (1.4) | 3 (0.5) | 18 (1.1) |
| distal | 5 (0.5) | 1 (0.2) | 6 (0.4) |
| Patella | 10 (1.0) | 1 (0.2) | 11 (0.7) |
| Tibia | | | |
| proximal | 2 (0.2) | 0 (0) | 2 (0.2) |
| shaft | 69 (6.6) | 24 (3.8) | 93 (5.6) |
| distal | 12 (1.1) | 0 (0) | 12 (0.7) |
| Ankle | | | |
| lat. mall | 29 (2.8) | 20 (3.2) | 49 (2.9) |
| med. mall | 7 (0.7) | 3 (0.5) | 10 (0.6) |
| other | 5 (0.5) | 3 (0.5) | 8 (0.5) |
| Metatarsals | 52 (5.0) | 27 (4.3) | 79 (4.7) |
| Toes | 28 (2.7) | 19 (3.0) | 47 (2.8) |
| Other site | 37 (3.5) | 16 (2.6) | 53 (3.2) |
| Total | 1,045 | 628 | 1,673 |

Table. 2 Environmental factors and activities

| Environment | Activity | % |
|---|---|---|
| Home | | 6.6 |
| Day nursery | | 1.4 |
| School | | 3.3 |
| Work | | 0.5 |
| Traffic accidents | | 13 |
| | Bicycle accidents | 8.5 |
| | Pedestrian hit by vehicle | 1.1 |
| | Moped, motorcycle | 1.9 |
| | Car passenger | 0.7 |
| | Other | 0.8 |
| Playing accidents | | 16 |
| | Playground | 6.0 |
| | In-lines, skateboard | 1.8 |
| | Sledge, other "snow" | 1.3 |
| | Other play accidents | 6.9 |
| Fight injuries | | 3.2 |
| Sport accidents | | 23 |
| | Soccer | 5.7 |
| | Other ball-game | 4.9 |
| | Ice-hockey, skating | 3.3 |
| | Gymnastics and athletics | 2.5 |
| | Horse accidents | 2.5 |
| | Wrestling, boxing, etc. | 1.8 |
| | Skiing | 1.1 |
| | Other | 1.2 |
| Unknown | | 33 |

and July ($p < 0.05$). The lowest number of fractures was recorded in December ($p < 0.05$).

The severity of trauma was slight in two thirds and severe in less than 5%. No significant change in trauma severity had taken place comparing 1975–1979 with 1993–1994. Falling on ground level, the commonest type of trauma, occurred in 40% of all fracture accidents.

A difference in sex distribution was noted regarding fractures sustained in fights, where boys dominated greatly (87%), and in horse accidents, where girls were involved almost exclusively (95%) (Table 2).

## Discussion

As pointed out by Wilkins (1996), the incidence of children's fractures varies with age, season of the year, climate, cultural and environmental factors. In order to detect changes in fracture incidence and fracture patterns, we used the same study design as in previous research by Landin (1983). The slight, but statistically significant reduction in the fracture incidence since 1975–1979 requires consideration of some altered and in some respects contradictory conditions since the 1970s. Since the late 1970s, there has been an increasing participation in organized sport activities, but spontaneous playing activities have decreased considerably (Engström 1996): almost half of 15-year-old Swedish teenagers in 1992 had a level of physical activity less than jogging or a corresponding physical effort at least once a week. Findings in other studies also show that children in the 1990s are less physically active than previously. The bone mineral content (BMC) is influenced by activity and Düppe et al. (1992) found a decrease of 9% in the BMC in women, 20 years old, in Malmö from 1970–1972 to 1988–1990. Another indication of reduced physical activity is the finding by Rasmussen and Johansson (1997) that the number of 18-year-old men with a body

mass index (BMI) > 25 has increased by 63% from 1981 to 1995. Although these findings are not direct proof, they can be regarded as circumstantial evidence for the recorded reduction in fracture incidence. Another explanation of the decline in fracture incidence could be the general safety awareness that has developed in Sweden over recent decades. Expressions of this are the use of more protective equipment in sports, bicycle helmets and safety-belts in the back-seats of cars. The decline in fractures caused by severe trauma found in our study may also be a result of an increased safety awareness, especially with regard to the traffic situation. This is supported by the threefold decrease in children killed in traffic accidents annually that has occurred between 1975–1979 and 1993–1994 (Swedish National Road Administration 1998). The frequency of distal forearm fractures among children ranges from 20% in Winnipeg (Reed 1977) to 36% in Nottingham (Worlock and Stower 1986). In Malmö, the frequency has increased from 23% in 1975–79 (Landin 1983) to 26%, in our study, due to an increase in fracture rate among girls. Girls now seem to have an activity pattern similar to boys, resulting in an increasing incidence of fractures of the distal radius in girls, which also was found by Kramhöft and Bödtker (1988) in Denmark, where the weather conditions are similar to those in southern Sweden.

Bailey et al. (1989) noted a correlation between the peak incidence of distal radius fractures and the peak velocity of growth in Canadian children. Both occurred between the ages of 11.5–12.5 years in girls and 13.5–14.5 years in boys. Hagino et al. (1990) compared the fracture incidence and bone mineral density of the distal radius in Japanese children. The age at peak fracture incidence, 11 years in girls and 13 years in boys, coincided with the age at which the metaphyseal/diaphyseal density ratio was the lowest. Both these studies suggest that distal forearm fractures are partly due to a temporary osteopenia of the metaphysis during rapid growth. Our results did not confirm this hypothesis, the peak fracture incidence being reached already by the age of 9–10 years in girls and 11–12 years in boys.

A slight but significant preponderance of left-sided fractures in the upper extremity has been observed in several other studies—for example, Iqbal (1974), Reed (1977) and Landin (1983). It has been suggested by Mortensson and Thonell (1991) that this may depend on a general tendency to break a fall with the left arm.

The seasonal variation we observed probably reflects the amount of outdoor activity among children in southern Sweden. Winter months are dark and rainy with snow only occasionally. Masterson et al. (1993) have found a strong positive correlation between monthly sunshine hours and fracture admissions. The extremely low number of fractures in December was unexpected. The relatively low number of fractures during July, the main holiday month in Sweden, may indicate that children's activity level is higher when they are at school. Another possible explanation is that some children leave the city during vacation so that minor fractures, not requiring follow-up, are not checked in Malmö and therfore not recorded. However, Landin (1983) found that even fractures treated with reduction and therefore followed up in Malmö had the same seasonal variation.

Although the fracture incidence in children reflects trends in our society, some features seem to be constant, such as the predominance of boys, the seasonal variation and left-side preponderance of fractures of the upper extremity.

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