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The epidemiology of fractures in children

Louise Rennie [a], Charles M. Court-Brown [b,*], Jacqueline Y.Q. Mok [a], Thomas F. Beattie [a]

[a] *Royal Hospital for Sick Children, Sciennes Road, Edinburgh EH9 1LF, United Kingdom*
[b] *Royal Infirmary of Edinburgh, Old Dalkeith Road, Edinburgh EH16 4SU, United Kingdom*

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Summary A retrospective study of all paediatric fractures presenting to hospital in Edinburgh, Scotland in 2000 was undertaken. It showed that the incidence of fractures was 20.2/1000/year and that 61% of children's fractures occurred in males. Analysis of paediatric fractures shows that there are six basic fracture distribution curves with six fractures showing a bimodal distribution but most having a unimodal distribution affecting younger or older children. The incidence of fractures increases with age with falls from below bed height (<1 m) being the commonest cause of fracture.

The majority of fractures in children involve the upper limb. Lower limb fractures are mainly caused by twisting injuries and road traffic accidents. The incidence of fractures in cyclists and pedestrians remains relatively high whereas the incidence in vehicle occupants is low suggesting that road safety programs have been successful. Similar programs should be instituted for young cyclists. The importance of accident prevention programmes in the home is also highlighted.

Introduction

Injuries are common in childhood with studies showing that on average about 25% of children are injured each year.[12,11] It has been shown that fractures account for 10—25% of childhood injuries[5] and that the effects of paediatric fractures are considerable with significant restriction of activity.[3] Despite this the epidemiology of paediatric fractures is poorly understood. Landin[4] documented the epidemiology of fractures in children in Malmö in Sweden and showed that the incidence of fractures almost doubled between the 1950s and the 1970s. However, there have been comparatively few studies since then and there has been recent debate[12,5,7,6] about the incidence of fractures in children. We analysed all paediatric fractures presenting to hospital in Edinburgh, Scotland in 2000 to ascertain their incidence, demonstrate which fractures were most common and investigate the causes of fracture in different age groups. We also set out to examine the

* Corresponding author. Tel.: +44 1312423516.
E-mail address: courtbrown@aol.com (C.M. Court-Brown).

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fracture distribution curves of all fractures to see if there was a reproducible set of curves, which would encompass all fractures.

Materials and methods

A retrospective analysis of all paediatric fractures in the council areas of the city of Edinburgh, Midlothian and East Lothian in Scotland was undertaken. All in-patient and out-patient fractures in children aged less than 16 years of age were examined. These patients are all treated in two hospitals, the Royal Hospital for Sick Children in Edinburgh and the Royal Infirmary of Edinburgh. There are no other paediatric trauma units in the area.

Both hospitals keep prospective databases of all in-patient and out-patient fractures. All the relevant databases in the year 2000 were analysed to provide epidemiological information about the fractures presenting in this year. In all cases X-rays were reviewed to exclude incorrect diagnoses and soft tissue injuries. All the X-rays were reviewed by one author (LR) to avoid inter-observer error. Where there was debate about the presence of a fracture an opinion was obtained from an experienced paediatric radiologist. Parameters that were recorded from the databases and X-rays included age, gender, date of injury, mechanism of injury, site of fracture and involvement of a physis.

The site of fracture was recorded using standard anatomical sites. All fractures were listed individually with multiple fractures recorded separately. However, multiple fractures of the finger and toe phalanges, metacarpals, metatarsals and vertebrae were recorded as one fracture. In 2000, the practice of routine skull X-rays for minor head injuries ceased and skull fractures would be missed. For these reasons, skull and rib fractures were excluded from our analysis.

Seven basic mechanisms of injury were recorded. These were twisting injuries, falls from below bed height (<1 m), falls down stairs or slopes, falls from above bed height, blunt trauma, sports injuries and road traffic accidents. Fractures occurring as a result of road traffic accidents were subdivided into those occurring in cyclists, motorcyclists, pedestrians and vehicle occupants. Stress, insufficiency and pathological fractures were combined together but there were insufficient numbers to permit meaningful analysis.

The population was divided into four age ranges. These were infants (0—1 years), pre-school children (2—4 years), school children (5—11 years) and adolescents (12—16 years). All patients from outwith Edinburgh, East Lothian and Midlothian were excluded from analysis but patients from the area who had their initial treatment elsewhere were included. Fracture incidence was calculated from the relevant figures from the 2001 census. Data was manipulated in Excel spread sheets and statistical analysis was performed using SPSS.

Results

The population of patients in Edinburgh, Midlothian and East Lothian aged less than 16 years at the 2001 census was 108,987 with a gender ratio of 51:49% males to females. During the year 2000 there were 2198 fractures in 2168 patients. Twenty-seven patients (1.2%) presented with more than one fracture, 24 patients sustained 2 fractures and 3 patients had 4 fractures. The overall incidence was 20.2 fractures/1000/year and the overall average age was 9.7 years. Analysis of gender showed that 61.4% of patients were males with an average age of 10.3 years (median 11.3) and an incidence of 23.9/1000/year. 38.6% were females with an average age of 8.9 years (median 9.5) and an incidence of 15.7/1000/year. A review of fracture location showed that 82.2% were in the upper limb, 17.3% were in the lower limb and 0.5% were in the pelvis or spine. Only 0.7% of fractures were open and 14.8% were physeal.

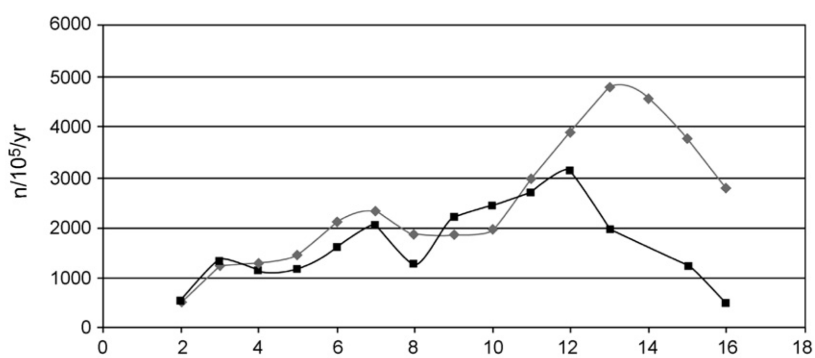

Figure 1 Overall fracture incidence curves. (◆) Boys and (■) Girls.

Table 1 The basic epidemiology of paediatric fractures in Edinburgh in 2000

Fracture	%	Age (year)	Male: female (%)
Distal radius/ulna	32.9	9.9	55:45
Finger phalanges	15.3	10.6	66:34
Metacarpus	7.6	12.5	85:15
Distal humerus	7.4	6.8	56:44
Clavicle	7.3	8.3	71:29
Radius/ulna diaphysis	5.4	7.8	64:36
Metatarsus	4.8	10.0	56:44
Ankle	3.5	10.9	58:42
Toe phalanges	3.0	10.9	51:49
Proximal radius/ulna	2.8	8.5	42:58
Tibia and fibula diaphysis	2.5	8.5	67:33
Proximal humerus	1.8	9.5	36:64
Distal tibia	1.7	10.0	66:34
Scaphoid	1.3	12.7	79:21
Femoral diaphysis	0.7	6.3	69:31
Humeral diaphysis	0.4	10.7	75:25
Distal femur	0.3	6.6	83:17
Proximal tibia	0.2	11.2	100:0
Patella	0.2	9.8	75:25
Pelvis	0.2	8.8	75:25
Talus	0.1	10.9	67:33
Calcaneus	0.1	11.2	100:0
Midfoot	0.1	9.3	67:33
Thoracic spine	0.1	8.0	67:33
Cervical spine	0.1	13.4	100:0
Proximal femur	0.1	10.3	100:0
Lumbar spine	0.05	9.2	0:100

The prevalence of different fractures together with the average age and gender ratio of the patients is shown.

The overall fracture incidence curves are shown in Fig. 1. These demonstrate that fractures in both boys and girls have a bimodal distribution with the early peak being at 6—7 years and the later peak at 13—14 years. Generally the incidence of fractures in girls is slightly less than in males up to the age of 12 years after which the incidence in boys is significantly greater. The prevalence of the different fracture types together with the average age and gender distribution of the patients is shown in Table 1. This demonstrates that fractures of the distal radius and hand account for 57.1% of all paediatric fractures. The top 10 fractures listed in Table 1 account for 90% of all fractures and it is apparent that fractures of the hindfoot, midfoot, pelvis, proximal femur and spine are very rare.

Analysis of the fracture incidence curves for each of the 16 commonest fractures shown in Table 1 demonstrates that fractures can be divided into six basic incidence curves. These are shown in Fig. 2a—f. The Type I curves follow the overall paediatric distribution curves shown in Fig. 1 with a bimodal distribution in both boys and girls but with a higher incidence in boys. These fractures all occur in the lower limb with fractures of the tibia and fibula diaphysis, distal tibia and metatarsals showing a Type I curve. Type II curves also show a bimodal distribution in boys but a unimodal distribution in girls with the highest female incidence usually being between 4 and 6 years of age after which the incidence declines. Examples are fractures of the clavicle, radius and ulna diaphysis and femoral diaphysis. The remaining fracture curves have a unimodal distribution. In Type III curves there is a gradual increase in incidence up to the age of 12—14 years in both sexes with a later decrease in incidence, particularly in girls. In the five fractures that showed a Type III distribution fractures of the distal radius, proximal humerus, proximal radius and ulna and toe phalanges had a greater incidence in females under 12 years whereas in finger phalangeal fractures it was boys under 12 years who had the greater incidence. Above 12 years all fractures had a greater male incidence except for fractures of the proximal radius and ulna. These fractures were also different in that the peak occurred in 9—10-year-old children.

In Type IV fractures there is a high incidence of fractures in older children with very few being seen in younger children. The best example is the scaphoid fracture, which did not occur in any child younger than 11 years but ankle fractures and humeral diaphyseal fractures show a similar distribution. The incidence is higher in boys than girls but declines after the age of 14 years. The Type V fracture curve was seen only in the distal humerus. There is a unimodal distribution affecting younger boys and girls. After the age of 6—7 years the incidence declines but the overall incidence is similar in both sexes. The Type VI curve was only seen in metacarpal fractures. In this fracture there is a strong male predominance and very few occur before the age of 10 years. This fracture type is different from the Type IV fracture in that the male incidence does not decline after 14 years of age but continues to increase into adulthood. The curves shown in Fig. 2 are diagrammatic and not all fractures show exactly the same pattern but the curves do represent the overall distribution of paediatric fractures.

Table 2 shows the different epidemiological characteristics and the five most common fractures in each age group. It demonstrates that the incidence of fractures rises as children age and that the lowest incidence of fractures is in the infant group. As children age the pattern of fractures changes. In young children clavicle and distal humeral fractures are most common but with increasing age fractures of the distal radius and hand are more commonly seen.

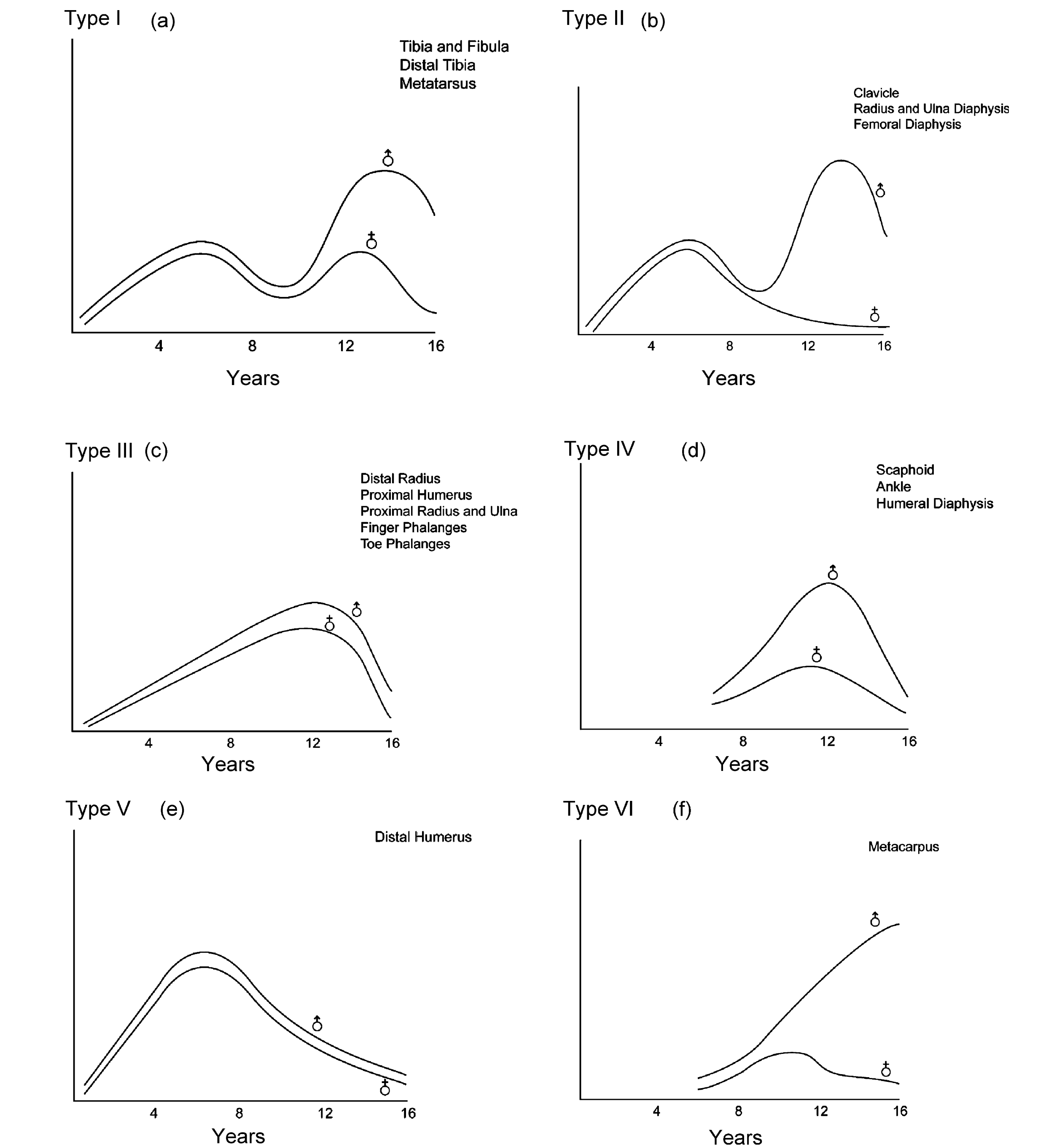

Figure 2 Sub-parts (a—f) are diagrammatic representations of the fracture patterns.

The epidemiological characteristics and the five most common fractures for the different mechanisms of injury are shown in Table 3. It can be seen that the commonest cause of paediatric fractures is a simple fall from below bed height. These usually cause upper limb fractures with about 50% involving the distal radius. Blunt trauma accounts for almost 20% of all fractures. These injuries are more common in older children and again usually cause upper limb fractures. The term 'blunt trauma' covers a number of different mechanisms of injury but it became clear that in addition to a number of heterogeneous causes there were four better defined causes of blunt trauma—assaults, crush injuries, direct blows and hyperflexion/extension injuries. Assaults are rare and the four patients in this series included two confirmed non-accidental injuries. However, crush injuries, direct blows and hyperflexion/extension injuries are commoner. They tend to cause upper limb fractures with fractures

Table 2 The basic epidemiology of fractures in children of different ages, with the five commonest fractures in each age group

Age group (year)	Prevalence (%)	Incidence/ 1000/year	Male: female (%)	Upper:lower limb (%)	Five commonest fractures
0—1	2.1	3.6	47:53	78:22	Clavicle (22.2%) Distal humerus (22.2%) Distal radius (11.1%) Radius/ulna diaphysis (11.1%) Tibia & fibula (8.9%)
2—4	11.6	12.9	53:47	76:24	Distal humerus (22.0%) Distal radius (21.3%) Clavicle (15.0%) Radius/ulna diaphysis (9.5%) Finger phalanges (7.1%)
5—11	51.3	23.2	54:46	85:15	Distal radius (40.3%) Finger phalanges (14.4%) Distal humerus (7.5%) Radius/ulna diaphysis (5.9%) Metacarpus (5.3%)
12—16	33.8	26.6	77:23	79:21	Distal radius (28.0%) Finger phalanges (20.3%) Metacarpus (14.3%) Clavicle (7.0%) Metatarsus (5.3%)

of the metacarpus and finger phalanges being particularly common. The epidemiological characteristics and the five commonest fractures associated with these mechanisms of injury are shown in Table 4.

Falls from above bed height (>1 m) account for about 17% of fractures. They tend to occur in younger children and mainly cause upper limb fractures. Sports injuries cause about 12% of paediatric fractures. Sports injuries are a mixed group of twisting injuries, fall, direct blows and other causes. There were 27 different sports in the series but football, skiing and rugby accounted for 65% of sports fractures. The epidemiological characteristics of the top 10 sports are shown in Table 5, which shows that they are commoner in older children and that, with the exception of ice-skating and horse-riding it is mainly boys who are affected. Sledging injuries are less common but they affect younger children and it is interesting to note that 33.3% of the fractures were in the tibia and fibula and 16.6% were in the lumbar spine indicating the severity of sledging accidents. The five commonest fractures in football, skiing and rugby are shown in Table 6. These are mainly upper limb fractures but fractures of the tibia and fibula are not uncommon.

Road traffic accidents account for about 7% of fractures. Predictably they tend to be more severe and there is a high prevalence of lower limb fractures. The four types of road traffic accidents were analysed and are presented in Table 7. About 70% of all fractures in road traffic accidents occur in cyclists with about 24% occurring in pedestrians. Motorcyclists are unusual in this age group and it was interesting that only four patients sustained fractures as a result of being vehicle passengers. They had six fractures and Table 7 shows their relative severity with 50% of the fractures being lower limb long bone fractures. Table 7 also shows that pedestrians are also often seriously injured with the five commonest fractures involving the tibia and fibula, distal tibia, femoral diaphysis, pelvis and humeral diaphysis. Cyclists usually present with less severe upper limb fractures. The two remaining mechanisms of injury, twisting injuries and falls down slopes or stairs, are less frequent. However, Table 3 shows that twisting injuries are unusual in that they usually cause lower limb fractures and falls down stairs or slopes often involve younger children.

We applied the fracture distribution curves shown in Fig. 2a—f to the different mechanisms of injury. Twisting injuries and road traffic accidents show the bimodal distribution illustrated in Fig. 1. In road traffic accidents the early peak is between 5 and 6 years and in twisting injuries it is between 7 and 9 years. Both have a later peak affecting both sexes although in road traffic accidents the incidence of fractures in older boys is much higher than

Table 3 The basic epidemiology for each mechanism of injury, with the five commonest fractures for each mechanism

Mechanism of injury	Prevalence (%)	Mean age (year)	Male: female (%)	Upper:lower limb (%)	Five commonest fractures
Fall below bed height	37.4	8.7	64:36	93:7	Distal radius (50.3%) Clavicle (9.0%) Distal humerus (7.9%) Finger phalanges (7.3%) Radius/ulna diaphysis (5.7%)
Blunt trauma	18.8	10.9	71:29	81:19	Finger phalanges (43.1%) Metacarpus (22.1%) Toe phalanges (12.7%) Distal radius (9.1%) Metatarsus (3.2%)
Falls from above bed height	17.2	7.8	62:38	83:17	Distal radius (37.7%) Distal humerus (21.4%) Radius/ulna diaphysis (9.1%) Clavicle (7.0%) Metatarsus (5.3%)
Sports	12.1	12.4	78:22	82:18	Finger phalanges (28.6%) Distal radius (26.7%) Clavicle (11.3%) Metacarpus (8.6%) Tibia and fibula (5.6%)
Road traffic accidents	6.7	10.2	69:31	70:30	Distal radius (30.6%) Tibia and fibula (11.0%) Finger phalanges (6.8%) Femoral diaphysis (5.4%) Metacarpus (5.4%)
Twist	4.2	10.6	53:47	14:86	Ankle (40.2%) Metatarsus (39.1%) Finger phalanges (4.3%) Tibia and fibula (3.3%) Metacarpus (3.3%)
Falls down stairs or slopes	2.4	7.6	48:52	69:31	Distal radius (32.7%) Clavicle (13.5%) Metatarsus (11.5%) Radius/ulna diaphysis (11.5%) Distal humerus (9.6%)
Stress, insufficiency or pathological fractures	0.5				
Unknown cause	0.5				

in girls. Falls from below bed height have a Type III distribution curve (Fig. 2c). There is a steady increase in incidence until 11—13 years following which the incidence falls in both sexes. Falls down stairs or slopes and falls from a height show a Type V (Fig. 2e) distribution with an early peak in incidence followed by a gradual decline. Fractures caused by blunt trauma show a Type IV (Fig. 2d) distribution with relatively few fractures earlier than 7—8 years. The later peak shows an increased incidence in boys. Sports related fractures have a Type VI (Fig. 2f) distribution with a small late peak in girls and a significantly higher late peak in boys that extends into adulthood.

An analysis of the seasonal variation of fractures in children showed an increase in fractures in the warmer months of the year. This applies to both boys and girls and a review of the 10 most common fractures listed in Table 1 also showed that it applied to these fractures.

Table 4 The basic epidemiology for each type of blunt trauma, with the five commonest fractures for each mechanism

Type of blunt trauma	Prevalence (%)	Mean age (year)	Male: female (%)	Upper: lower limb (%)	Five commonest fractures
Crush	20.3	7.9	59:41	84:16	Finger phalanges (75.9%) Toe phalanges (9.6%) Metacarpus (6.0%) Metatarsus (3.6%) Distal radius (2.4%)
Flexion/extension	16.4	11.3	69:31	93:7	Finger phalanges (70.1%) Distal radius (11.9%) Metacarpus (9.0%) Toe phalanges (4.5%) Metatarsal (3.0%)
Direct blow	11.3	10.5	76:24	78:22	Metacarpal (23.9%) Finger phalanges (21.7%) Distal radius (13.0%) Radius/ulna diaphysis (10.9%) Toe phalanges (8.7%)
Assault	0.5	7.3	75:25	50:50	Distal femur (25.0%) Proximal humerus (25.0%) Clavicle (25.0%) Metatarsus (25.0%)

Discussion

Fractures in children show epidemiological characteristics, which are different from fractures in adults. A review of fractures in adult patients in Edinburgh in the year 2000 was also undertaken[1] and the basic epidemiology is shown in Table 8. This shows that fractures in children have almost twice the incidence of fractures in adults. Equal numbers of male and female adults are affected but in children there is a strong male predominance. More adults present with multiple and open fractures. The other striking difference is that children present mainly with upper limb fractures and have relatively few lower limb fractures. Fractures of the spine and pelvis are uncommon in both adults and children.

The incidence of fractures in children has been debated in recent years. The classic study of Landin[4] showed an incidence of 21.2/1000/year in Malmö, Sweden in 1975—1979. Similar incidences have been reported from England,[13] Greece,[9] various parts of Scandinavia[7] and the USA.[8] The only study to have reported radically different results was from South Wales where an incidence of 36.1/1000/year was recorded.[6] The reasons for this difference remain unclear although it is interesting to note that the same group also recorded a much higher incidence of fractures in adults than seen in Edinburgh[1] (Table 8). Their data was collected by analysis of Accident and Emergency Department records and not apparently checked by orthopaedic surgeons. X-rays were apparently not reviewed and thus a number of 'possible' fractures recorded by junior doctors may have been

Table 5 The basic epidemiological characteristics for the 10 commonest sports that cause fractures in children

Sport	Prevalence (%)	Average age (year)	Male:female	Upper:lower limb
Football	31.6	12.6	94:6	75:25
Skiing	20.7	11.5	29:71	85:15
Rugby	12.4	13.5	97:3	76:24
Basketball	4.5	13.4	58:42	100:0
Snowboarding	3.4	12.8	89:11	89:11
Sledging	2.6	9.5	71:29	62:38
Ice skating	2.6	10.7	43:57	84:16
Horse riding	2.6	12.1	14:86	100:0
In-line skating	2.3	13.8	100:0	100:0
Karate	1.9	13.4	60:40	100:0

Table 6 The five commonest fractures associated with football, skiing and rugby

Football	
Distal radius	38.1%
Finger phalanges	14.3%
Metacarpus	11.9%
Tibia and fibula	5.9%
Ankle	5.9%
Skiing	
Finger phalanges	43.6%
Distal radius	25.4%
Clavicle	9.1%
Tibia and fibula	7.3%
Metacarpus	5.5%
Rugby	
Clavicle	36.4%
Finger phalanges	18.2%
Metacarpus	9.1%
Metatarsus	9.1%
Tibia and fibula	6.1%

included and increased the incidence. It seems unlikely that the incidence of fractures in South Wales will differ markedly from Edinburgh, Scotland or Nottingham, England. There is also some confusion in the literature as different papers analyse different age groups. Our overall fracture incidence in the 0–12 year group was 18.9/1000/year with 19.8/1000/year being recorded in the 0–14 year group. These are similar to other published results for these age groups.

Table 8 Comparative epidemiological data on paediatric and adult fractures

	Children	Adults
Incidence/1000/year	20.2	11.1
Male:female (%)	61:39	50:50
Isolated fractures (%)	94.4	98.8
Open fractures (%)	0.7	3.1
Lower limb (%)	17.3	39.1
Upper limb (%)	82.2	58.7
Spine and pelvis (%)	0.5	2.2

The adult data was collected in Edinburgh in 2000.[1]

Our results show that about a third of boys and girls can expect to have a fracture before 16 years of age but the fractures vary with age. In children less than 1 year of age clavicle fractures are most common. Between 1 and 3 years of age distal humeral fractures are most commonly seen but between 4 and 14 years of age distal radius fractures are the most common fracture to present to surgeons. Between 15 and 16 years fractures of the metacarpus are most commonly seen. We also showed that diaphyseal fractures of the radius and ulna decrease with increasing age whereas fractures of the metacarpus and finger phalanges increase in frequency.

The overall frequency of the different fractures seen during the study shows that fractures of the distal radius and ulna are by far the most common fracture. The highest age and sex related incidences are seen with this fracture with an incidence of 14.7/1000/year in 12–13 year old boys and 14.4/

Table 7 The basic epidemiology and the five commonest fractures for the different types of road traffic accident

Type of road traffic accident	Prevalence (%)	Mean age (year)	Male: female (%)	Upper:lower limb (%)	Five commonest fractures
Cyclists	67.3	10.5	69:31	89:11	Distal radius (41.4%) Proximal humerus (10.1%) Metacarpus (8.1%) Finger phalanges (7.1%) Proximal radius/ulna (5.0%)
Pedestrians	23.8	9.0	69:31	13:87	Tibia and fibula (34.3%) Distal tibia (14.3%) Femoral diaphysis (11.4%) Pelvis (8.6%) Humeral diaphysis (8.6%)
Motor cyclists	6.1	12.6	100:0	78:22	Clavicle (22.2%) Finger phalanges (22.2%) Distal radius (22.2%) Tibia and fibula (11.1%) Radius/ulna diaphysis (11.1%)
Passengers	2.7	9.7	25:75	50:50	Femoral diaphysis (33.3%) Proximal humerus (33.3%) Distal humerus (16.6%) Tibia and fibula (16.6%)

1000/year in 11—12 year old girls. These fractures together with those of the finger phalanges and metacarpus comprise 56% of all paediatric fractures. The figures shown in Table 1 are not dissimilar to those of Landin[4] from the late 1970s and Worlock et al.[13] who examined paediatric fractures in Nottingham, England in 1981. This suggests that the current rate of change of fracture epidemiology is less in children than in adults, presumably because changes in paediatric epidemiology depend mainly on social and environmental conditions rather than on age-related changes in bone density as in the adult population. Landin[4] highlighted that in the late 1970s the incidence of paediatric fractures had almost doubled since the 1950s. However, it would seem that the rate of change has now slowed.

It is always difficult to accurately separate fractures according to their mechanism of injury as children do not always remember or admit to the exact circumstances of the injury. A fall may include a twisting injury as well. Blunt trauma is particularly difficult to define and sports injuries are an amalgam of different mechanisms occurring under particular circumstances. However, our results show that, compared with other mechanisms of injury, falls account for 57% of all fractures and that it is younger children who are involved. Crush injuries mainly affect the hands and feet. Younger children tend to be injured in crush injuries and assaults. The relative frequency of fractures in the younger age groups suggests that education in fall prevention in particular may be worthwhile, highlighting injury prevention in the home.[10]

It could be argued that some of the fractures in younger children were the result of non-accidental injury. This study focussed on children who presented to the A&E department with injuries, which were X-rayed. Chest and skull X-rays were rarely done and fractures could have been missed. There were only four assaults in this cohort, two of which were confirmed non-accidental injuries. Within Lothian, clear procedures are followed by staff in the A&E department when there is a suspicion of non-accidental injury, and a referral made to the Child Protection paediatric team for a multi-agency investigation. However, none of the features of inflicted trauma were present in the cohort studied except in two children—the majority of the incidents were witnessed, a clear and plausible account was given of the mechanism and medical attention was sought appropriately. By way of comparison, 57 children aged 2 years and under were referred to the Child Protection team in the same year because they were suspected to be victims of physical abuse. The majority presented with bruises. The true incidence of non-accidental fractures in children remains unknown.

It is self evident that fractures caused by road traffic accidents are more severe. Fortunately they are comparatively rare with only 6.7% of paediatric fractures being caused by road traffic accidents. A review of the type of road traffic accident indicates two principal problems—the number of cyclists injured in road traffic accidents and the relatively low average age of pedestrians who present with fractures. Cyclists are particularly at risk. Although most of the fractures sustained were upper limb fractures and not generally life threatening it would seem that better provision for cyclists is required in terms of improved protective clothing and cycle paths. The high prevalence of severe fractures in young pedestrians also suggests that improved educational programs in road safety are required. It is however gratifying to observe that only four children sustained fractures in 2000 from being a vehicle occupant indicating that improved car safety, speed control and driver awareness measures have been successful.

Sports injuries obviously vary between countries and between different regions in one country. Landin[4] pointed out the dangers associated with skiing in a cold climate but even in Edinburgh skiing resulted in a large number of fractures. These are attributable to a local dry ski slope and increasing affluence allowing more children to visit the European and North American ski centres. In the United Kingdom it would be expected that football and rugby would also cause significant numbers of fractures but the literature[7,6,2] indicates that in recent years there has been an increased number of fractures associated with snowboarding and in-line skating. This is reflected in our findings. Generally sports fractures are not too severe but our results highlight that football, skiing and rugby are all associated with a relatively high number of fractures of the tibia and fibula.

We believe that the use of fracture distribution curves as shown in Fig. 2a—f is helpful in displaying fracture patterns throughout childhood. Landin[4] published curves for different fractures but analysis of all of the different curves shows that a number of fractures have very similar curves and can be grouped together. They illustrate the essential difference between fractures such as the distal humerus where the peak is 5—7 years and the scaphoid where were no children under 11 years of age and the peak is between 12 and 14 years. The curves also illustrate that the common fractures seen in young male adults actually start to increase in incidence in childhood. These are mainly fractures of the hand caused by direct blows and are frequently associated with the various hormonal and behavioural changes of adolescence!

A number of fractures such as those of the proximal tibia, patella, pelvis, talus, calcaneus, midfoot, proximal femur and spine are very rare in childhood and distribution curves cannot be constructed without a much larger study. However, we have shown that these fractures are commoner in older boys and we believe it likely that they have a Type IV or Type VI distribution and are uncommon in younger children. We believe that this is important when considering the spectrum of fractures caused by non-accidental injuries. Unusual fractures such as those mentioned above and the humeral diaphyseal fracture which occur in older children after high-energy injuries should be considered to be non-accidental in younger children until proven otherwise.

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