Children's fractures: a population based study

Ronan A Lyons, Annie M Delahunty, Debbie Kraus, Martin Heaven, Mike McCabe, Howard Allen, Pam Nash

Abstract

***Objective*—To measure the incidence of childhood fractures in a defined population.**

***Setting*—Accident and emergency (A&E) departments covering the Swansea and Neath Port Talbot areas of South Wales in 1996.**

***Methods*—Linkage of data from A&E departments with population data to produce fracture incidence rates by anatomical site and cause in children aged 0–14 years.**

***Results*—During 1996, 2463 new fractures occurred in 2399 residents yielding a fracture rate of 36.1/1000 children. Fractures were more common in boys than girls and increased with age in both groups. Sports and leisure activities accounted for 36% of fractures, assaults for 3.5%, and road traffic accidents 1.4%. Fractures of the radius/ulna were most frequent (36%).**

***Conclusions*—The fracture rate in South Wales children is twice the rate reported in previous studies. Further research is required to elucidate the reasons behind this high rate. Many fractures could be prevented by the use of safer surfaces in school playgrounds, and wrist protection in in-line skaters and possibly in soccer players.**

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Collaboration in Accident Prevention and Injury Control, Welsh Combined Centres for Public Health, University of Wales College of Medicine
R A Lyons

Department of Public Health, Iechyd Morgannwg Health, Swansea
A M Delahunty
D Kraus
M Heaven

Accident and Emergency Department, Morriston Hospital, Swansea
M McCabe
H Allen

Casualty Department, Neath General Hospital, Neath
P Nash

Correspondence to: Dr R Lyons, Welsh Combined Centres for Public Health, 41 High Street, Swansea SA1 1LT, UK (e-mail: ronan.lyons@morgannwg-ha.wales.nhs.uk).

Despite considerable improvement injury remains the principal cause of death in children and young people in Europe, North America, and Australasia.[1–4] Considerably less is known about trends and the incidence of non-fatal injuries, data on which are usually collected by surveys or emergency department surveillance systems. Surveys can estimate the total incidence of injuries but are subject to recall bias, particularly when children are involved, and suffer from a lack of standardisation in definitions of injury site, diagnosis, and severity. Data on medically attended injuries from surveillance systems are not prone to the same biases and can be used as a proxy for injury incidence once issues relating to access are understood. Non-fatal injuries to children are extremely common. Each year more than one fifth of the childhood population attends an accident and emergency (A&E) department as a result of an injury.[5 6]

The importance of injury prevention has been identified by the UK government as one of four areas that needs to be tackled in the recent white paper *Our Healthier Nation*.[7] A target of a 20% reduction has been set in the rate of occurrence of accidents by the year 2010 from the 1996 baseline.[7] The monitoring of progress towards the targets is by way of annual surveys of the population.[8] While this is a welcome development, the sample size of the annual survey will not provide sufficient data to identify small areas with higher rates where preventative strategies could be targeted. For this to happen, larger data sets on injury occurrence are required. In 1993 we developed an injury database with information fed in from the A&E departments of the three local hospitals covering a defined geographical area of South Wales comprising the City and County of Swansea and Neath Port Talbot County Borough Council areas.[6]

Analysis of the data revealed a fall-off in attendance rate with increasing distance from a hospital for all injuries with the exception of fractures, indicating that fracture incidence is the best indicator of injury occurrence in surveillance systems using A&E databases.

Following on from this work we initiated a prospective study of childhood fractures during the 1996 calendar year in a defined geographical area. This paper provides details on the causes and incidence of childhood fractures in South Wales.

Methods

Details of the operation of the database are included in an earlier publication.[6] Data on all A&E and casualty attendances at three hospitals serving the defined catchment area are amalgamated with census data at the Department of Public Health. Only two of the hospitals treat fractures and all fractures, whether initially treated at these or other hospitals, access the fracture clinic through the A&E departments. A weekly computer listing of all fractures was produced by both hospitals. Mapping of postcodes of residence with the Royal Mail postcode address file was used to determine residency within the geographical area.[9] A special stamp was included in the A&E records of all children attending during 1996 which asked for details on where the injury occurred, what the person was doing at the time of injury, what went wrong, and on what did the person injure themselves. These items were coded using the Scandinavian NOMESCO system of classifying injuries.[10] Fractures were classified using the *International Classification of Diseases*, ninth revision (ICD-9) system and by grouped anatomical site, as is standard practice in A&E departments.[11]

Where data were missing, parents and children were followed up via telephone calls by two of the doctors involved in the study. The

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Table 1 Distribution of fractures by ICD-9 code (n=2463)

ICD-9 code	*Area of body*	*No*
800-801, 803	Skull	49
802	Facial bones	77
805-806	Vertebral column	2
807	Ribs and sternum	6
808	Pelvis	7
810	Clavicle	152
811	Scapula	5
812	Humerus	175
813	Radius and ulna	888
814	Carpal bones	132
815	Metacarpals	195
816-817	Phalanges	351
820-821	Femur	22
822.0	Patella	6
823	Tibia and fibula	70
824	Ankle	90
825-826	Foot bones	220
818-819, 827	Multiple fractures	16

same study design has been used in districts in Norway, Finland, Sweden, Latvia and Croatia, but data on comparative fracture rates are not yet available.

Results

The childhood population (0–14 years) of the City and County of Swansea and Neath Port Talbot is 68 231. During 1996, 2463 new fractures occurring in 2399 residents were registered at the hospitals, yielding a crude rate of 36.1 fractures/1000 children. There were more fractures in male children 44.4/1000 (1545) than in females 27.5/1000 (n=918). The majority of children suffered only one fracture in an incident, but 2.7% had two or more separate fractures.

Table 1 gives a frequency breakdown of ICD-9 codes for the entire group.

Fractures of the radius and ulna were most common (36%), followed by fingers (14%), carpals and metacarpals (13%), and humerus (7.1%); skull fractures accounted for just under 2% of the total.

Table 2 shows the number of fractures grouped into anatomical areas and the incidence rate per 1000 children by sex and five year age group. Fracture rates in younger children are similar for boys and girls, but after the age of 10 rates in boys are more than twice those in girls.

Table 3 Distribution of areas where fractures occurred (first injuries n=2455)

Type of area	*No (%)*
Transport area	386 (15.7)
Residential area	735 (29.9)
Production and working areas	14 (0.6)
Commercial premises	19 (0.8)
Schools and public premises	362 (14.7)
Sports areas	417 (17.0)
Parks and amusement areas	217 (8.8)
Open countryside	89 (3.6)
Sea, lakes, and rivers	5 (0.2)
Other and unspecified	211 (8.6)

The majority of injuries were unintentional; 85 fractures (3.5%) occurred as a result of acts of violence and five (0.2%) from self harm. The majority of violence related fractures occurred in older boys (80%), but were rarely related to sporting activities (4.8%). Thirty eight per cent of violence related fractures occurred on school premises. The most common fractures were metacarpal fractures in assailants (52%) and nasal bones (17%) in recipients.

Table 3 shows the distribution of the types of areas where the fractures occurred. Among the fractures occurring in residential area, the most common sites were the living room/bedroom (n=230), the garden (n=230), followed by the stairs (n=94). Forty five per cent of fractures occurring in schools happened in the playground. Three quarters (108/140) of the fractures occurring in school playgrounds occurred while running, with half of the injuries (n=71) resulting from contact with hard ground surfaces.

The majority of sports area fractures occurred in general sports grounds and halls; 15 occurred at skiing facilities, and 14 in indoor ice and skating rinks. Playgrounds (n=186) were the most common site for fractures occurring in parks and amusement areas.

A total of 865 (36.1%) children were involved in sport and leisure activities when the incident resulting in the primary fracture

Table 2 Age and sex specific incidence rates of fractures per 1000 children (numbers)

	Male age groups			*Female age groups*				
All fractures	*0–4*	*5–9*	*10–14*	*0–4*	*5–9*	*10–14*	*All*	*% Of all fractures*
Skull	1.19 (14)	0.81 (9)	0.59 (7)	1.15 (13)	0.26 (3)	0.28 (3)	0.72 (49)	1.99
Face/nose	0.68 (8)	1.70 (19)	2.26 (27)	0.53 (6)	1.14 (13)	0.37 (4)	1.13 (77)	3.12
Vertebra	— (0)	0.09 (1)	— (0)	— (0)	0.09 (1)	— (0)	0.03 (2)	0.08
Scapula	— (0)	0.09 (1)	0.08 (1)	0.09 (1)	0.09 (1)	0.09 (1)	0.07 (5)	0.20
Ribs/sternum	— (0)	— (0)	0.34 (4)	— (0)	— (0)	0.19 (2)	0.09 (6)	0.24
Clavicle	2.22 (26)	2.86 (32)	3.61 (43)	1.42 (16)	1.83 (21)	1.31 (14)	2.23 (152)	6.17
Humerus	1.62 (17)	3.40 (38)	3.10 (37)	1.86 (21)	3.32 (38)	2.06 (22)	2.56 (175)	7.11
Radius/ulna	5.46 (64)	16.65 (186)	22.72 (271)	5.85 (66)	14.07 (161)	13.11 (140)	13.01 (888)	36.05
Carpal	— (0)	1.16 (13)	5.62 (67)	0.18 (2)	0.79 (9)	3.84 (41)	1.93 (132)	5.36
Metacarpal	0.34 (4)	1.97 (22)	12.16 (145)	0.18 (2)	0.61 (7)	1.41 (15)	2.86 (195)	7.92
Fingers	1.62 (19)	4.92 (55)	11.65 (139)	1.59 (18)	4.11 (47)	6.84 (73)	5.14 (351)	14.25
Pelvis	— (0)	— (0)	0.42 (5)	— (0)	— (0)	0.19 (2)	0.10 (7)	0.28
Femur	0.17 (2)	0.18 (2)	0.42 (5)	0.71 (8)	0.26 (3)	0.19 (2)	0.32 (22)	0.89
Patella	— (0)	— (0)	0.42 (5)	— (0)	— (0)	0.09 (1)	0.09 (6)	0.24
Tibia/fibula	1.28 (15)	0.90 (10)	1.59 (19)	0.97 (11)	0.44 (5)	0.94 (10)	1.03 (70)	2.84
Ankle	0.43 (5)	1.16 (13)	3.19 (38)	0.18 (2)	0.79 (9)	2.15 (23)	1.32 (90)	3.65
Tarsus/metatarsus	1.53 (18)	1.08 (12)	3.94 (47)	0.27 (3)	0.44 (5)	3.18 (34)	1.74 (119)	4.83
Toes	0.26 (3)	0.90 (10)	4.36 (52)	0.18 (2)	1.05 (12)	2.07 (22)	1.48 (101)	4.10
Multiple sites	0.17 (2)	0.36 (4)	0.59 (7)	— (0)	— (0)	0.28 (3)	0.23 (16)	0.65
Total	199	427	919	171	335	412	2463	100
Population at risk	11 728	11 170	11 926	11 287	11 444	10 676	68 231	
Crude rate	16.97	38.23	77.06	15.15	29.27	38.59	36.10	

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Table 4 Type of sports and leisure activities preceding fracture

Type of activity	*No (%)*
Athletics	17 (2.0)
Gymnastics	40 (4.6)
Sport with racket/bat	29 (3.4)
Team sport with ball	367 (42.4)
Combat sports	30 (3.5)
Wheel sports	302 (34.9)
Animal sports	25 (2.9)
Winter sports	23 (2.7)
Water and air sports	10 (1.2)
Other and unspecified sports	22 (2.6)

occurred. Table 4 shows the distribution of the main types of activities involved. Ball sport related injuries and wheel sports accounted for the majority of injuries (42.4% and 34.9%, respectively). Most ball sport related injuries occurred during soccer and rugby (86%). Soccer was the most common individual sporting activity resulting in fractures (n=197) and distal radial fractures the most common fracture (n=70) associated with the game. Cycling accounted for the majority of fractures occurring during wheel sports (63%, n=189), with rollerskating/skateboarding accounting for most of the remainder (37%, n=112). The majority of fractures resulting from rollerskating/skateboarding involved the distal radius (63%, n=70).

Road traffic accidents were an uncommon cause of fractures, accounting for only 1.4% (35) of all fractures. In the majority of cases the child was either a pedestrian (54%) or cyclist (31%).

Discussion

This study shows that children's fractures are extremely common, with 4.55% of boys and 2.79% of girls suffering a fracture in 1996; thus by a child's 15th birthday almost two thirds (63.7%) of boys and nearly half (39.1%) of girls can expect to have fractured a bone.

With an injury rate so high one might expect to find a large number of other papers on this topic, yet the number of reports in the literature is extremely small. There are quite a few papers detailing the distribution of children's fractures at individual centres, but these do not define the population at risk and so cannot accurately estimate incidence rates. To accurately estimate the incidence of fractures in a population it is necessary to collect data from all the treatment centres where members of the population might seek attention after an accident.

In the area where this study was carried out it is known from activity data collected for financial purposes that attendances of residents of the districts involved in the study to A&E departments outside the district are very infrequent and amount to about 1% of the in district attendances (personal communication). As the majority of fractures are referred to fracture clinics in the district of residence for follow up, and the only method of accessing the fracture clinics is through the A&E departments, these fractures are recorded in our data.

A small number of reports appear to have defined a population at risk.[12–15] A study of children's fractures in Malmö, Sweden, where one hospital covers the entire area, reported annual incidences of childhood fractures of 25.7/1000 and 16.5/1000 in boys and girls respectively, aged 0–16 years in the 1970s.[12]

However, the effect of attendances at other hospitals does not seem to have been fully taken into account, and the author suggested that the reduction in monthly rates during June and July might have occurred because many families leave the city for a summer vacation. In our study and previous studies the pattern of fracture increases substantially from January/February to peak in the summer months.[13 14]

A study of fractures in children from Nottingham, England during the first six months of 1981 reported an estimated fracture rate of 16/1000 children per year up to the age of 12 years.[14] Fractures in children where non-accidental injury was suspected were excluded, and the yearly rate was estimated by doubling the rate for the six months of the study.

A population based study of fractures in children aged 0–12 years in Rogaland County in Norway between 1992 and 1995 has recently been published.[15] The paper reported an annual incidence of 12.8 fractures/1000 children but gives limited details of fracture site as the main emphasis of the paper is on associated activity restriction. The fracture rate for children aged 0–12 years in this study was 33.9/1000.

The pattern of fractures in the present study is similar to the Swedish and Nottingham studies, and this would not support the hypothesis that the higher rate of fracture in South Wales is due to more complete reporting of fractures which occasionally go unreported (for example digits).

In this study fractures of the radius accounted for 36% of all fractures reported compared with 45% in Nottingham and 27% in Malmö; fractures of hand phalanges accounted for 14%, 15%, and 19% respectively; skull fractures accounted for 1.9%, 3.6%; and 1.8% respectively, and femoral fractures accounted for 1%, 1.2%, and 1.6% respectively.

The lower percentage of skull fractures in our study compared with the Nottingham study is likely to be partially due to the different age distributions as the incidence of skull fractures falls sharply with age (table 2) The rate of skull fractures in this study of 0.72/1000 children per annum is slightly higher than the rate of 0.64 reported from a study in Edinburgh focusing specifically on skull fractures.[16]

While differences in age groups reported, and the potential for minor levels of under-reporting in the Nottingham and Swedish studies, might explain some of the discrepancies in fracture rates, there cannot be an explanation for the more than doubling of rates seen in the South Wales study.

Some of the difference might reflect an increased incidence over time as the other studies were carried out in the 1970s and early 1980s. The Swedish paper comments on

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changes in fracture incidence over time and reports a doubling in the risk of fracture from 1950 to 1979, which would support this idea.[12] However, the limited data from the 1992–95 Norwegian study and preliminary data from the other European districts in this study indicate that the South Wales fracture rates are substantially higher (personal communication).[15]

The reasons for the higher levels of fractures in the South Wales population are unclear. Landin reported a fivefold increase in fractures between 1950 and 1979 due to sports and equipment related playing activities, and that such activities accounted for 21% of fractures in 1979.[12]

In our study, sport and leisure related activities accounted for 36% of all fractures and so it is clearly plausible that the increased availability of leisure facilities might have contributed to this phenomenon. However, even a doubling of sports related fractures in the 1980s and 1990s would not explain a rate of fractures that is twice as high as previously reported in the literature. As the distribution of fractures is similar to that in previous studies it would appear that the higher rate of fractures in South Wales is real and not an artefact of reporting.

Implications for prevention

Whether the higher rate of fractures in South Wales children is due to a greater exposure to risky pursuits or a tendency towards fracturing bones at lower levels of trauma is unknown. Further research is required before specific causes can be elucidated. However, a sizeable proportion of fractures occurred in children running and falling on hard surfaces in school playgrounds. It is likely that many of these injuries could be prevented by the use of impact absorbing surfaces such as used in modern children's playgrounds.[17]

The commonest fractures in this study were those involving the radius or ulna (36%). Many of these may not be preventable but there is evidence that the majority of distal radial fractures occurring in rollerskaters can be prevented by wrist guards.[18] In this study none of the 70 children with fractures of the radius occurring during rollerskating/skateboarding were recorded as wearing wrist guards at the time of injury, indicating a considerable potential for prevention. A similar number of distal radial fractures occurred during soccer. As the majority of these were due to falls on outstretched hands this raises the intriguing prospect of the potential use of wrist protectors to prevent these injuries.

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