Epidemiology of femoral fractures in children in the West Midlands region of England 1991 to 2001

We have attempted to describe the epidemiology of femoral fractures in children in the West Midlands region of the National Health Service in England. Our source of data was the Regional Hospital Episode Statistics database for the years 1991-2 to 2001-2. Cases were defined as emergency hospital admissions in patients aged under 16 years, with a diagnostic code of femoral fractures in any field, and resident in the West Midlands.

Between 1991-2 and 2001-2, 3272 children aged under 16 years with femoral fractures were admitted to hospital. The crude incidence during this period decreased from 0.33 to 0.22 femoral fractures/1000/year. Those caused by traffic accidents decreased by 43%, and by falls by 29%. The peak age-gender-specific incidence (0.91/1000/year) was in two-year-old boys, and this was 50% higher than in the next highest age-gender group. In the first year of life, the incidence in boys and girls was the same. Thereafter the rate in boys exceeded that in girls, varying from 1.6 times at 11 years to 4.7 times at 14 years. Falls accounted for 49% of the fractures, varying from 77% in one-year-olds to 26% in eight-year-old children. Traffic accidents were responsible for 26% of fractures varying from 55% in ten-year-old to 2% in one-year-old children. Maltreatment was recorded in 1.3% of all cases, and in 8.5% of children under one year. Twice as many fractures were seen in May to August than in January (winter). The rates of fractures were associated with deprivation for all age-gender groups. Fractures of the shaft accounted for 58% of all fractures, varying from 70% in three-year-old to 34% in 13-year-old children.

Our findings show that there has been a decrease in the incidence of femoral fractures during the 1990s and early 2000s. Two-year-old boys had twice the rate than any other single-year age-gender group. More deprived areas had much higher rates which suggests the potential for greater prevention. A relatively low rate of maltreatment was recorded compared with that in some other studies.

Accidents are the major cause of death in children in England and accounted for 15% of deaths in one- to-four-year olds and 24% of deaths in 5- to-14-year-old children in the year 2000. Fractures are a common consequence of accidents and femoral fractures are the most frequent major fracture of long bones. Femoral fractures constituted 1.7% of all fractures in children under 16 years of age in a population-based series of 4621 fractures ascertained from archived radiographs in Malmo between 1950 and 1979.

A review of the management of femoral fractures in children has identified variable, often conflicting, recommendations, and no randomised controlled trials. We were interested in the epidemiology of these fractures in relation to consideration of the feasibility of a randomised, controlled trial of surgical interventions for such injuries. We found very few population-based epidemiological studies in the UK. We therefore undertook this study in order to describe the epidemiology of femoral fractures in children in our region, the West Midlands of England.

Patients and Methods
The West Midlands Region of the National Health Service (NHS) of the UK has 5.3 million residents and 28 general hospitals. The data for our study were the NHS Hospital Episode Statistics (HES) collected by the Department of Health and the study was carried out under the terms and conditions of the HES data protocol of the Department of Health in regard to patient confidentiality and data security.

A femoral fracture in a child was defined as follows: a finished first consultant episode in a hospital admission; date of first episode occurring between April 1, 1991-2 and March 31,
The mid-year population estimates for 1991 to 2001, all based on the 1991 national census, were used as denominators to calculate annual incidence rates. Overall factor-specific incidence rates were calculated during the 11-year period. We describe the incidence of fractures by financial year (April 1 to March 31), age and gender, month, external cause of fracture, and anatomical site. External cause codes used were ICD9 from 1991-2 to 1994-5 and ICD10 from 1995-6 to 2001-2. Since there is no standard way of grouping external causes, we grouped them once we had seen the distribution of codes used in femoral fractures (Table I). Causes were grouped into ‘human’ when a fracture occurred as a result of physical contact by another person such as assault and not specified as maltreatment and ‘struck’ when it occurred from contact with an object which was falling or thrown etc, but not specifically stated to be by a human. The anatomical site of the fracture was aggregated into four groups (Table II).

The association between femoral fracture and deprivation was investigated by the deprivation scores of Townsend, Phillimore and Beattie. These scores are based on: the percentage of economically active residents aged 16 years and over who are unemployed; the percentage of households with more than one person per room; the percentage of households who do not own a car; the percentage of households which are not owner-occupied derived for electoral wards from the results of the 1991 Census. An electoral ward for a person was derived from their postcode. The higher the score is the more materially deprived the area. The rates were calculated for each Townsend percentile. Populations were not available for 15-year-old children by deprivation and therefore rates have been calculated for five-year age bands up to and including 14-year-old children.

Results
There were 3272 femoral fractures (3203 children) recorded in the 11 years between 1991-2 and 2001-2002, 2243 (68.5%) in boys and 1029 (31.5%) in girls. Apart from the first year of life when the rates in boys and girls were nearly the same, the rate in boys (0.29 (0.23 to 0.35/...
The incidence of femoral fractures has significantly declined from 0.33/1000/year (0.31/1000/year to 0.35/1000/year) in 1991-2 to 0.22/1000/year (0.21/1000/year to 0.24/1000/year) in 2001-2 (Fig. 2). Over the period, femoral fractures caused by traffic accidents decreased by 43% from 103 to 59 fractures per year (from 0.09 to 0.05/1000/year), and those caused by falls by 29% from 168 to 119 fractures per year (from 0.15 to 0.11/1000/year) (Fig. 3).

The peak overall age-specific incidence rate was in two-year-old boys (rate of 0.91/1000/year (0.80 to 1.00/1000/year, n = 293), and this was 50% greater than the next highest age-specific rate. The lowest overall age-specific incidence rate was in 14-year-old girls (rate 0.08/1000/year, n = 23).

When variation in the incidence of fracture was considered by month, it peaked at 328 to 345 fractures per month during the 11-year-period in the months of May, June, July and August (Fig. 4). The minimum number of fractures was 171 (5.2%), recorded in January. This seasonal pattern of elevated levels in the months of March to September and lower levels in October to February was seen across each of the 11 years.

External cause codes were ascribed in 92.9% of cases. Falls were recorded as the cause in 49.4% of children with an intra-age range from 76.7% in one-year-old to 26.2% in eight-year-old children. Traffic accidents were the external cause in 28.0% of children, and this varied from 54.1% in ten-year-old to 2.2% in one-year-old children. Maltreatment was recorded as the external cause in 1.17% of all children, and 7.8% in children aged less than one year (Fig. 5).
The incidence of fractures of the shaft was 57.5% of the total overall, varying from 70.3% in three-year-old to 34.0% in 13-year-old children (Fig. 7). A fractured neck of the femur accounted for 3% to 6% of femoral fractures in children up to the age of nine years, and 14% to 26% from 11 years of age and above. The mean hospital length of stay was 23.4 days (SD 19.6). Only 13 (0.4%) patients died in hospital and 261 (7.9%) were recorded as having multiple injuries.

The incidence of femoral fractures was associated with deprivation for both boys and girls in the 0 to 4-year and 5 to 9-year age groups but not in the 10 to 14-year age groups (Table III). For traffic-related injuries, there was a significant relationship (not overlapping CIs) to increasing deprivation. Only the involvement of an animal appeared to have any numerical relationship to affluence (Table IV).

Validity. We assumed that patients were managed in an NHS hospital although it is theoretically possible that a few in the very youngest age group may have been managed on an outpatient basis, and that the clinical coding at hospitals is accurate. The quality of the HES data has been systematically reviewed and the coding accuracy observed to be high. However, to date, there has been no investigation of the quality of injury and cause of injury coding. The accuracy of the data used in our study could be validated by recourse to patient records, if resources were available.

Discussion
This is the only large study of femoral fractures in children that we are aware of in the UK, and is the largest reported study. It provides new epidemiological information based on 3293 fractures in children aged from 0 to 15 years.
admitted to hospital in the West Midlands of England in the 11 years between April 1, 1991 and March 31, 2002. We found a decrease of incidence of such fractures during this period. This decrease was seen in both fractures caused by falls and by traffic accidents.

Another notable finding was that the rate of fracture was 50% higher in two-year-old boys than in the next highest age-gender group. Other observations included an incidence in boys twice that in girls 0.44 ((0.42 to 0.45)/1000/year) compared with 0.21 ((0.20 to 0.22)/1000/year), approximately twice as many in summer as in winter, approximately half caused by a fall and approximately a quarter by a traffic accident, nearly double the rate of fractures in the most deprived quintile than the most affluent, and most involving the femoral shaft.

The decrease in femoral fractures during the 1990s is a new finding (Fig. 2). We can only speculate on the reasons. Improved road safety appears to be a major contributing factor. The reduction may reflect reduced exposure during periods of play either by improved safety in schools and play areas, or in the reduced levels of physical activity and play time outside the home in recent years. No significant change in incidence was seen in Sweden between 1972 and 1981.

Most studies on femoral fractures in children consider treatment, and involve relatively small numbers of cases. Epidemiological studies are rare. We are aware of two large studies of fractures of the femoral shaft. Hinton et al., in Maryland, USA, studied 1485 children aged 0 to 17 years with such fractures recorded in the hospital discharge database of Maryland Health Services Cost Review Commission for 1990 to 1996.

Hedlund and Lundgren studied 851 children aged from 0 to 17 years with fractures of the shaft of the femur recorded in the Inpatient Care Register in Stockholm between 1972 and 1981. The incidence of fractures of the shaft of the femur in the early years of our study was similar to the rate of 0.19/1000/year reported from Maryland, USA, between 1990 and 1996 and from Stockholm, Sweden in children aged 0 to 19 years between 1972 to 1981. An incidence of 0.22 per 1000 children aged from 0 to 15 years (n = 131) was reported from Kuopio Province, Finland, between 1976 and 1985.

In contrast to other types of fracture in children in which the incidence increases with age to peak in the early teens, in femoral fractures the peak incidence was in young children (Fig. 1). The incidence of fractures in two-year-old boys was 50% more than in the next highest age group. In most studies single-year age bands are not described. A peak incidence in two-year-old boys was observed in Maryland, USA and in Aarhus, Denmark. The incidence in two-year-old boys in our study is higher than that in the USA (0.91 vs 0.36/1000/year). In Stockholm, where two-year age bands were used, the highest incidence in both sexes was in two- to three-year-old children. In Oregon, the first year of life was the modal year. The high rate of fractures in two-year-old boys requires further explanation, but may relate to the increased activity of children of this age, combined with a lack of awareness of dangers.

No gender difference in the incidence of fractures was observed for the first year of life, but then the greater risk for boys varied between 1.6 times the risk for girls at 11 years, to 4.7 times at 14 years (Fig. 1). Studies in Maryland, USA, Finland and Sweden have all reported two or three times more fractures in boys than in girls. This reflects the excess risk for boys for fracture for all sites. There has been much speculation as to why boys have a higher risk of fractures, but no convincing evidence for the reason has been reported.

Up to the age of four falls were the predominant cause of fractures, and thereafter traffic accidents. This is consistent with observations from Denmark, Sweden and the USA. Maltreatment was rarely ascribed as a cause, although in children under one year of age it was ascribed in 8.5% of fractures. This is in contrast to some other studies. In 74 children aged five years or younger in Oklahoma, 50% of fractures were considered to be caused by child protection Committee to have been caused by child abuse, and in 30% of 80 cases in children under four years of age in Portland, Oregon were considered to be caused by child abuse. Trogan et al. studied 57 children under six years of age with femoral fractures in Greece on their Emergency Department Injury Surveillance System, and found that none was coded with abuse. They considered it likely that there was under-ascertainment, but recognised the societal difficulties of study in this area. We speculate that at least some of the difference in rates of maltreatment will be from the case definitions and methods of ascribing a cause between routine hospital statistics and special studies. The coding of the cause in the HES is reliant on the patient or witnesses accurately recounting what happened, the clinician recording it and the coder interpreting the chain of events accurately. It is likely that within this process some biases and inaccuracies are likely to occur. Therefore, in circumstances in which there are conflicting accounts of the exact nature of the event that caused the injury, for example was the child pushed or did he or she slip, the results should be regarded with caution. In our study, this is pertinent to maltreatment, human action, being struck and a fall. Further research is needed.

The risk of fracture is consistently higher for the most deprived Townsend quintile across all age-gender groups and for most causes. Given the possibility of mis-recording these results may need to be treated with caution. However, the association with deprivation is consistent with previous studies of trauma, and of fractures of the femoral shaft in Maryland, USA. Femoral fractures from road-traffic accidents were three times more common in the most deprived areas than the most affluent. Falls were 1.5 times more likely to occur in the most deprived than in the most affluent areas. This suggests the opportunity for preventative...
measures, such as improved design and engineering of residential areas in regard to risk from traffic and in play areas.

We conclude that this is the largest reported study of the epidemiology of femoral fractures in children that we are aware of. The descriptive epidemiology will provide useful information for those planning interventional studies of the treatment or prevention of femoral fractures in children, or those planning services. Further research is warranted in several areas, for example the high rate in two-year-old boys, the higher rate in boys than in girls, the lower rates of maltreatment than in other areas, and the reduction of the inequality of health between deprived and less deprived areas.

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References