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ORIGINAL ARTICLES

Annual incidence of unintentional injury among 54 000 children

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Abstract

***Objective*—To enhance the case definition of unintentional injuries in childhood by applying an objective severity measure to fatal and non-fatal cases.**

***Design*—A descriptive prospective epidemiological study of a defined resident childhood population (<16 years of age) for a one year period, 1990.**

***Setting*—Newcastle upon Tyne, England. Child population estimate for 1990 was 54 400.**

***Subjects*—Resident children who died, were admitted to local hospitals, or attended local accident and emergency departments.**

***Outcome measures*—Using recognised severity scoring systems (for example the injury severity score, trauma score) injuries were classified as severe, moderate, or mild.**

***Results*—There were six deaths, 904 admissions, and 11 682 accident and emergency department attendances. All deaths, 25% of admissions, and 1% of accident and emergency attenders were classified as severe. The underlying determinants of severe injuries are different than those for all other injuries (for example age, social class).**

A comparison with a local survey in 1986 showed a 26% rise in hospital admissions, but no significant rise in the frequency of severe or moderately injured children. Comparisons with other international data showed higher rates of injury admissions and attendances for England, but no significant differences in the frequency of severe injuries.

***Conclusions*—Objective severity scoring enhances the case definition of unintentional injuries in childhood by allowing for the identification, and, therefore, the more reliable ascertainment of severely injured children. This more completely ascertained set of population cases increases the accuracy of comparisons of injury frequency over time and by place, and, in addition, enhances our basic understanding about the epidemiological characteristics of childhood unintentional injury.**

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Unintentional injury is the leading cause of death of children after the age of 1 year, accounting for one third of all deaths in those 1–15 years.[1,2] It is also a major cause of ill health because deaths represent only the 'tip of the iceberg' of the spectrum of morbidity.

Although there has been a welcome increase in the medical literature on the epidemiology of non-fatal childhood injuires,[3-5] few British studies have measured the total frequency of unintentional injury among a cohort of children over a fixed time period. This type of information is essential because injury prevention programmes are not just aimed at fatal cases, but also are intended to reduce the impact of non-fatal injuries.

In a previous publication, based on retrospective data, we highlighted the epidemiological difficulties in attempting to use health service based data (for example hospital admissions) as a direct measure of the population frequency and distribution of non-fatal childhood injuries.[5] Such difficulties relate to 'selection biases'—that is factors that influence hospital attendance or admission. We argued that these selection biases function primarily at the 'mild' end of the injury spectrum and could be avoided by focusing attention on the more 'severe' injuries. This paper, based on a prospective study, examines the epidemiology of unintentional injury in a cohort of children, using a variety of data sources to measure the frequency of injury at different levels of severity.

Methods

The study population was children under the age of 16 years resident in Newcastle upon Tyne in 1990; this was estimated at 54 400 children.[6] All deaths, all admissions to local hospitals, and a sample of attendances at local accident and emergency departments of resident children as a consequence of unintentional injury during 1990 were studied. An earlier retrospective sample study had shown no outward flow of Newcastle resident children for hospital admission of injuries,[5] and it is likely that accident and emergency attendance would follow the same pattern.

Deaths were identified from the local coroner's files and hospital inpatients were identified from examination of the admission books. Thereafter, the relevant inpatient case notes were obtained from the medical records departments. A 20% random sample of accident and emergency department attenders was drawn from monthly listings of resident children who visited the two local departments serving Newcastle upon Tyne. Where casualty cards were found on examination not to concern unintentional injuries, or were missing, a further random substitute was drawn.

The records of all eligible children were studied by one of the authors (SSMW). Epidemiological and injury severity data were extracted onto a standard sheet and subsequently transferred to computer.

Injury severity was based on the injury severity score (ISS)[7] and the revised trauma score[8] as previously described.[5] Cases were then classified: all, moderate (ISS >3), or severe injuries (ISS >8 or equivalent).[5] Scoring and classification was done by a single trained observer (SSMW) and without knowledge of the sociodemographic assignment (see below). Injury type and cause were classified using main groupings from the *International Classification of Diseases*.[9]

The postcoded home address of injured children was used to identify which census ward children resided in. Rates of injury were calculated for each ward, using the best local estimates for current ward populations. For the ecological study, the measure of social deprivation used was the Townsend deprivation score for each ward.[10]

Statistical analysis was undertaken using the Statistical Package for Social Sciences.[11] Because some children may have sustained more than one accident, the results pertain to actual episodes (admission/attendance) rather than children.

Results

During 1990, there were six deaths, 904 hospital admissions, and 11 682 accident and emergency department attendances for unintentional injuries among children under the age of 16 years from addresses in Newcastle upon Tyne. All the deaths were identified, 97% of the case notes for inpatients were examined, and the 2400 accident and emergency department cases represent an almost exact one in five random sample of available record cards.

All of the deaths were a result of severe injuries (ISS >8). Only 226 (25%) admissions had severe injuries, and 407 (45%) had moderate injuries (ISS >3). For accident and emergency attenders, 34 out of 2400 (1%) had severe injuries, and 265 (11%) had moderate injuries. Only eight out of the 34 children who presented to the accident and emergency department with injuries judged severe were not admitted to hospital. All had minimally displaced long bone fractures.

Tables 1 and 2 give the leading types and causes of injury that resulted in admission and accident and emergency attendance. Minor soft tissues injuries (for example sprains and contusions) are the most common type for attendances, while fractures are the leading type for hospital admission. Within both data sets, falls are the main cause of injury.

The six deaths consisted of three road traffic accident victims who sustained multiple injuries, and three house fire victims who suffered burns and smoke inhalation.

Figure (A), using admission data, displays the relationship between age and injury frequency at different levels of severity. Children 0 to 4 years have the highest rate of admission. However, if the admission group is refined by including only those with moderate injuries a different pattern emerges. Children 5 to 9 years have the highest rate of injury — a fact that remains evident even if the group only includes children with severe injuries. Children 10 to 15 years have rates of moderate and severe injuries just below those of 5 to 9 year olds.

Figure (B) examines the same relationship, using accident and emergency data. The oldest age group, namely, 10 to 15 year olds, have the highest rate of attendances. This holds even if only moderate injuries are included. However, there is still an apparent over-representation of slight injury attendances among children under 5 years. It appears that injury frequency is directly related to increasing age. The presence of a high proportion of preschool children among admissions and attendances would seem to be a product of selection biases.

The potential for selection bias may also have a geographical component. Mapping the rates of injury across the 26 census wards in Newcastle reveals different patterns depending on which case definition of injury is used. For instance, of the six wards with the highest accident and emergency attendance rates only two reappear in the top six for rates of admission for severe injuries. Although these rates are significantly rank correlated ($r = 0{\cdot}34$, $p < 0{\cdot}05$), it is clear that targeting of preventive interventions by locality will lack precision if crude attendance rates are used.

Converting this geographical analysis into an ecological analysis enabled us to correlate

Table 1 Type of injuries: hospital admissions and attendances at accident and emergency departments, 1990

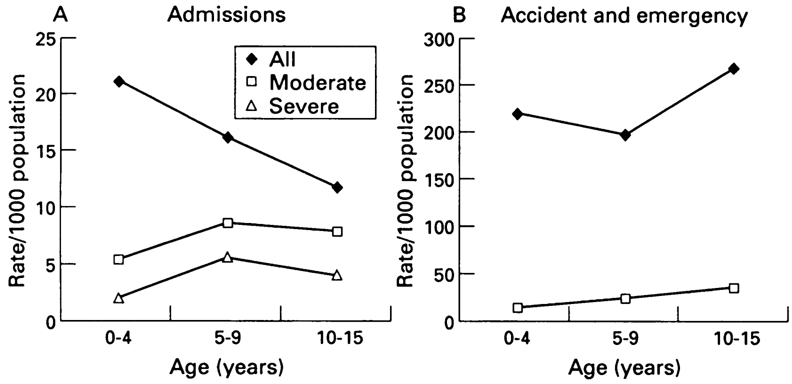
	Admissions	*Attendances* (95% CI)*
Head injury	255	2510 (2336 to 2684)
Fractures/dislocation	264	1450 (1310 to 1590)
Poison	108	245 (184 to 306)
Burn	67	270 (206 to 334)
Lacerations	136	2430 (2258 to 2602)
Foreign body orifice	36	380 (305 to 455)
Soft tissue (sprains etc)	–	4115 (3913 to 4317)
Other	38	282 (217 to 347)

*Attendances are estimates of the annual total based on 1:5 sample (see methods). CI = confidence interval.

Table 2 Causes of injuries: hospital admissions and attendances at accident and emergency departments, 1990

	Admissions	*Attendances* (95% CI)*
Fall	343	4430 (4224 to 4636)
Struck by	115	2645 (2468 to 2822)
Poison	108	245 (184 to 306)
Burn	67	270 (206 to 334)
Road traffic accident	85	320 (251 to 389)
Foreign body orifice	36	380 (305 to 455)
Pedal cycle (not a road traffic accident)	61	435 (355 to 515)
Piercing/cutting	55	800 (693 to 907)
Animal bites	7	465 (382 to 548)
Twisting/inversion/strain	–	950 (834 to 1066)
Crush	–	465 (382 to 548)
Other	27	277 (213 to 341)

*Attendances are estimates of the annual total based on a 1:5 sample (see methods). CI = confidence interval.



Rates of (A) admissions and (B) accident and emergency attendances by age and severity.

Table 3 Relationship between rates of injury and Townsend deprivation scores for wards (n = 26)

	No	Spearman's R (95% CI)
All accident and emergency attendances	2400*	0·51 (0·15 to 0·75)
Accident and emergency attendances with moderate injuries	266*	−0·02 (−0·4 to 0·37)
All admissions	904	0·75 (0·51 to 0·88)
Admissions		
With moderate injuries	407	0·64 (0·34 to 0·82)
With severe injuries	226	0·30 (−0·1 to 0·62)

*One in five sample. CI = confidence interval.

injury rates for wards by differing levels of severity with the Townsend social deprivation score for the same wards. Table 3 gives details of the rank correlations between injury rates and social deprivation scores for the 26 census wards of Newcastle upon Tyne. Using both admission and attendance data, the strong relationship between injury rates and social deprivation appears to weaken progressively through the severity spectrum. However, the rates for children with moderate injuries who are admitted still have a statistically significant relationship with deprivation. This is not evident among the moderately injured children attending accident and emergency departments, and reasons for this are given.

Using data from our previous report we compared admission rates over time (between 1986 and 1990). Table 4 demonstrates the admission rates at different levels of severity between the two years. Although there has been a 36% rise in total, the changes for moderate and severe injuries are insignificant. This implies that the increased admission rates have occurred chiefly at the level of milder injuries.

Comparing these data with population based data from America,[12] Sweden[13] and Australia[14] (table 5) demonstrates that, although all four countries have similar mortality rates for unintentional injury, the rates for admissions and attendances are highest and equal highest respectively in this English study. For the reasons given above these potentially important international comparisons are impossible to interpret.

However, because the Swedish study used a severity assessment method similar to the present study, it is possible to compare frequency figures at different levels of severity. This required some modification to our data to bring them in line with the Swedish severity system (see table 6). The results show that the rate of severe injuries was virtually identical in both countries, even though the attendance rate was 144/1000 in Sweden and 214/1000 in Newcastle.

Table 4 Admission rates/1000 population (95% confidence interval) in two different years by severity of injury

	1986	1990
All	12·2 (10·1 to 14·4)	16·6 (15·5 to 17·7)
Moderate injuries	7·3 (5·6 to 9·2)	7·7 (6·9 to 8·6)
Severe injuries	3·5 (2·3 to 4·9)	4·3 (3·7 to 4·9)

Table 5 International comparisons of unintentional injury rate/1000 children (95% confidence interval)

	Deaths	Admission	Attendance
Sweden			
(Gothenburg 1976)	0·15 (0·73 to 0·25)	11·3 (10·6 to 12·1)	143·9 (141·3 to 146·5)
United States			
(Massachusetts 1979–82)	0·17 (0·092 to 0·29)	7·7 (7·1 to 8·3)	216·0 (209·8 to 222·2)
Australia			
(Melbourne 1989)	0·11 (0·054 to 0·16)	8·1 (7·6 to 8·5)	54·5 (53·3 to 55·6)
England			
(Newcastle 1990)	0·11 (0·037 to 0·24)	16·6 (15·6 to 17·7)	214·9 (211·0 to 218·8)

Table 6 Unintentional injury in childhood rates/1000 population (95% confidence interval) in Sweden and England

	Gothenburg 1976	Newcastle 1990
Total attendances	143·9 (141·3 to 146·5)	214·9 (211·0 to 218·8)
Severe injuries	5·3 (4·8 to 5·8)	5·2 (4·6 to 5·8)

Discussion

Unintentional injury still remains one of the chief threats to the health of children and is the main preventable cause of death of children aged 1–15 years.[15] However, because child death is an increasingly rare event, the scientific focus is now on non-fatal cases as a source for constructing and evaluating preventive measures.

New methods for the surveillance of non-fatal unintentional injury among children are required. The natural data sources for such surveillance still remain within health services, but accident registration systems need also to be population based.[16] A method to improve the reliability of hospital based data and to ensure that they reflect the true underlying population rates must overcome the selection biases that operate to determine attendance or admission.[17] These selection biases appear to apply mostly at the milder end of the severity spectrum, and can be largely avoided by severity scaling.

The ISS remains the methods of choice for this severity assignment.[18] The ISS allows immediate scoring of injuries without reference to treatment and is valid and reliable in the paediatric population.[19] Discussion concerning the interobserver reliability of ISS[20 21] is largely confined to more severely injured cases than those included in the present report. Furthermore, a single highly trained observer was responsible for scoring in both this and our prior study.

Previously we had shown the selection bias of young children (under 5 years) with milder injuries gaining hospital admission at a lower threshold than older children. The present study again demonstrates this point, and is given further weight by the observation of a similar phenomenon operating among children attending accident and emergency departments. This amplifies the need for injury prevention work to target older children, as both inpatient and accident and emergency attendance data, when disaggregated by severity, indicate they have the highest population rate.

The relationship between social class or social deprivation and accident and emergency attendance, injury admissions, or injury mortality is well documented.[5 22 23] The relationship between fatal injury and social class is strong.[23] The present study only examined this relationship using a small area based approach, with the inherent problems of 'ecological fallacy'. None the less, it is interesting that although attendance and admission rates are strongly linked with deprivation, this relationship progressively weakens for the more severe injuries. It must be remembered that children with severe injuries represent all population cases of such injuries, while crude attendance and admission data sets are prone to selection biases. These results, therefore, support the hypothesis that the child's social class is a strong independent influence in determining which population cases attend or are admitted to hospital.

This is reinforced by the group of children with moderate injuries. We would expect all population cases with moderate injuries to attend the accident and emergency department for attention. Within the accident and emergency data set these moderate injuries appear not to be related to social deprivation. However, a subset of such cases are admitted, and because the relationship between deprivation and moderately severe injury admissions is still strong, we infer that social factors are largely responsible for selective admission among this group of children.

Some of these findings seem to conflict with those from our previous work where we reported that severe injury had a steeper social gradient than crude admission rates.[5] It should be noted that in the intervening five years a major shift in admission thresholds (as described below) may have altered these relationships. This is a fertile area for more detailed studies to examine the relative severity, types, and circumstances of injuries occurring among children living in differing neighbourhoods.

The value of a severity criterion for comparing injury rates over time is also evident. Our results show a 36% rise in local child injury admission rates between 1986 and 1990. The important question is, has there been a 36% rise in these rates within the population? The lack of any corresponding rise among the more unbiased data sets (that is moderate and severe injuries) suggests the answer is 'No'. Other studies have shown recent increases in general paediatric admission rates associated with shorter 'lengths of stay'.[24] Our results suggest that because of greater bed availability, or changes in clinical policy, in 1990 a greater proportion of children presenting with milder injuries were admitted.

As most prevention programmes need to be able to measure changes over time accurately, this type of analysis is crucial.

We contend that injury prevention must be shown to reduce the frequency and/or the severity of injury in whole populations. A severity based case definition is essential to the measurement of both the true frequency of injury and to assessing any change in the severity spectrum.

Variations in event frequency by place are potentially important in understanding the aetiology of any disease.[25] The comparison of unintentional injury frequency between four countries, as shown in this study, might imply that Britain had the highest population rates of unintentional injury leading to hospital admission. The fact that mortality and severe injury rates are similar suggests, however, that such differences by country are particularly prone to 'selection biases' associated with differing service utilisation practices. Thus, the true population rates of injury may well be similar in all four countries.

Finally, it is important to emphasise the sheer numbers of children who suffer unintentional injury.[26 27] In Newcastle, as elsewhere, more than one in five children require medical attention for an injury each year, and of these 10% are admitted to hospital. Epidemiologists and policy makers must provide more time, energy, and funding to prevention programmes to reduce this modern epidemic.

Key points

- Injury prevention requires accurate injury surveillance data for defined populations
- Admission rates alone do not reflect underlying population rates of injury
- A more accurate method is to use case definitions based on injury severity
- Such case definitions change our understanding of the determinants of injury (for example age, social class)
- They can also profoundly change the interpretation of differences in injury frequency by time and place

IMPLICATIONS FOR PREVENTION

Surveillance data based on local registers and using severity related case definitions are essential to the implemention, planning, and evaluation of preventive interventions intended to reduce the major cause of mortality and morbidity among our children — injuries.

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Getting over an accident

Eight year old John was knocked down by a car when crossing a road. He was badly bruised and broke a leg, but he recovered well from his injuries. Unfortunately, this was not the end of an unpleasant experience for John. He started to have nightmares, dreaming about monsters coming to hurt him. He became very nervous in traffic and refused to cross roads. He found it difficult to concentrate in school and he shrank at the sound of loud noises.

Survivors of the Zeebrugge ferry disaster and recent coach or train crashes would immediately realise that John was suffering from post-traumatic stress. But unlike them, children who show distress after an accident are not always helped to overcome their fears and anxieties. Yet, each year in the UK about 700 children die, 120 000 are admitted to hospital and 2 000 000 attend accident and emergency departments as the result of an accident.

Provisions to help children and their families overcome the psychological effects of accident and injury are patchy and disconnected. The lessons learned from supporting the survivors of disasters have not been more widely applied. Nurses are often among the first people to get into contact with children and their families after an accident. Many will have developed ways of diminishing the distress, but they don't always benefit from those experienced in counselling and debriefing. Most importantly, the extent of support provided is unclear and it is uncertain which methods are the most effective.

The Child Accident Prevention Trust has recently started a project that aims at the nationwide collection of information about the provision of support for children and their families after an accident. The project will also gather information about the various methods of support used and their effectiveness. A report will be produced at the end of the study which will make recommendations as to how to ensure that children and their families receive adequate support after an accident. In order to gather as much information as possible, the trust would like to hear from anyone who has experience of providing support after an accident or who have views on ways in which support should be given. Please write to: Dr Ellen Heptinstall, Child Accident Prevention Trust, 18–20 Farringdon Lane, London EC1R 3AU, UK.