ORIGINAL ARTICLES

Injury prevention programmes in primary care: a high risk group or a whole population approach?

Denise Kendrick, Patricia Marsh

Abstract

Objective—To examine the relationship between risk factors for childhood unintentional injury and injury outcome and to assess the feasibility of using risk factors to identify children at high risk of injury.

Setting—One general practice in Nottingham, UK.

Method—A postal questionnaire survey to all parents of children registered with the practice (n=771) to obtain data on risk and sociodemographic factors. All children still registered with the practice one year later were followed up for occurrence of a medically attended injury.

Results—The response rate was 78%. The injury rate over the follow up year was 246 injuries per 1000 children. Previous medically attended injury was associated with each of the injury outcomes (odds ratio (confidence interval) for all attendances, 2.33 (1.37 to 4.05); for accident and emergency attendances, 2.27 (1.15 to 4.4); and for primary health care team attendances, 2.58 (1.33 to 5.0)). Male sex was associated only with accident and emergency department attendance (odds ratio 2.13 (1.06 to 4.2)). Maternal age and previous injury were associated with a higher number of injuries in the subsequent year on univariate and multivariate analyses. The sensitivity and positive predictive value of the risk factors were low, except for previous injury and male sex. The number of children needing an injury prevention intervention to prevent one injury as identified by the risk factors was not significantly different from that required if a whole population approach were to be used.

Conclusion—Primary care based injury prevention programmes, at present, should not be targeted at children identified as being at 'high risk' of injury. Nevertheless, a larger study using a wider cross section of the population is needed to address this issue further.

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Keywords: primary care; injury prevention programme; preventive strategy.

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This paper presents the results of a study undertaken at one general practice in the UK as part of the process of planning an injury prevention intervention study. As part of planning the study, it was important to consider whether the interventions should be offered to all children or only to children identified as being at high risk.

Many factors have been identified as being associated with an increased risk of unintentional injury in childhood, such as male sex, family size and structure, previous medically attended injury, young maternal age at birth of first child, and various measures of socioeconomic status.[1-10] Over recent years there have been suggestions, including the governments health strategy for the UK,[3 4 11 12] that injury prevention programmes should be targeted at children at high risk of injury.

Several workers have discussed the difficulties of doing this. The Child Health and Education Study found that case definition was important in determining which factors were associated with injury. So, for example, the risk factors associated with having one or more medically attended injuries differed from those associated with admission to hospital for an injury.[10] A second problem is that the sensitivity and positive predictive value of some factors in predicting which children will have injuries has been found to be low. This suggests that only a small proportion of injuries could be prevented by targeting injury prevention at children identified by this method.[2]

The alternative to targeting injury prevention to those at high risk, is to use a population approach. This is feasible in primary care in the UK, where all children aged under 5 years see a general practitioner or practice nurse at least once a year.[13] A programme of primary care based child health surveillance currently exists, and has been found to reach children at high risk of injury.[14] This could be used to offer systematic age specific anticipatory injury prevention as described by The Injury Prevention Program (TIPP).[15]

This study, therefore, examines the relationship between risk factors and injury outcomes and assesses the feasibility of using risk factors to identify children at high risk. The findings inform the decision regarding using a whole population or a targeted approach in a primary care intervention study.

Methods

A postal questionnaire was sent to all parents and older children (age 12–16 years) registered with the practice in 1993 (n=771). Nonresponders were reminded by telephone after

two weeks and sent a further questionnaire if requested. Non-responders without a telephone were sent a second questionnaire. The questionnaire contained two sections; the first concerned age specific questions on safety practices and safety equipment possession and use, the results of which were not used for this study. The second section contained questions about risk factors for unintentional injury as identified from the published literature[1-10] and sociodemographic details. The reliability of the questionnaire was assessed by a test-retest procedure on a sample of 34 mothers from a child health clinic in a location with a similar socioeconomic profile to that of the study population. Consistency of responses was assessed by calculating κ coefficients. The responses to four questions (age, sex, postcode, previous medically attended unintentional injury) were validated from the medical records of a systematic one in 10 sample of children of responders still registered with the practice one year after the survey. Where a child had left the practice the next child on the list was used. κ Coefficients were calculated to assess the degree of agreement between the responses on the questionnaire and the data in the medical records.

One year later, all children still registered with the practice were followed up for the occurrence of injuries, by a manual and computer search of the primary care records and a computer search of the hospital records at the only local hospital with an accident and emergency department. Injury severity was calculated using the 1990 version of the abbreviated injury scale (AIS).[16] Non-responders to the questionnaire who were still registered with the practice were followed up in the same way. The outcomes used for this study were primary care and accident and emergency attendances and hospital admissions for unintentional injury.

The data were analysed using χ^2 tests for categorical data. As the number of injuries by each risk factor was skewed to the left, comparisons were made by transforming the data using $\sqrt{x+1}$ for the number of injuries and by undertaking unpaired t tests. Multivariate analyses, using logistic regression, were conducted with the outcomes of any attendance at any health care facility for unintentional injury or not, primary health care team attendance or not, accident and emergency department attendance or not, or hospital admission or not. Multiple linear regression analysis was used to adjust for confounding factors for the number of injuries. All data were analysed using the SPSS-PC package. The estimated number of children needing an injury prevention intervention to prevent one injury was calculated using the numbers needed to treat method described by Sackett *et al*[17] based on an estimated 10% reduction in injury frequency achievable by a primary care based intervention.[18 19]

Results

Altogether 587 questionnaires were returned, giving a response rate of 78%. Twenty one of the questionnaires used for reliability testing were returned (62%). Twelve questions had identical responses on both questionnaires and a κ coefficient of 1.00. The remaining two questions had κ coefficients of 0.94 and 0.87.

The age, sex of the child, and postcode recorded on the questionnaires were identical to that recorded in the notes for all 58 children. The κ coefficient for medically attended injuries was 0.81.

The age distribution of children for whom questionnaires were completed did not differ significantly from that of the non-responders (χ^2=6.1, 4 degrees of freedom, p=0.19), but significantly fewer parents of girls responded (χ^2=9.6, 1 degree of freedom, p=0.002). Over the one year follow up period, 47 children left the practice. Of the 540 children still registered, 96 children had a total of 133 injuries, accounting for 141 attendances at a health care facility. Seventy of these attendances were treated by the primary health care team, 67 at the accident and emergency department, and four children were admitted to hospital after injury. The injury rate was 246 injuries per 1000 children per year, that for non-responders was 357 per 1000 (χ^2=3.27, 1 degree of freedom, p=0.07). The AIS scores of all injuries ranged from 1–3, with 87% having a score of one. Not surprisingly, with such little variation in scores, there were no significant associations between injury severity and any of the risk factors.

Based on univariate analyses, only a history of a previous medically attended injury was significantly associated with attendance at any health care facility, attendance at the accident and emergency department, and at the primary health care team. Male sex was significantly associated with attendance at the accident and emergency department only. None of the other factors showed any significant association with any injury outcome.

The relative risk and 95% confidence interval (CI) for each injury outcome by each risk and sociodemographic factor are shown in table 1. Logistic regression models were fitted for each outcome variable. Models were built using forward and backward stepwise selection and by entering all variables on one step. Each method produced identical models for each outcome. The final model for all injury attendances and for primary health care team attendances included only previous injury (odds ratio (OR) 2.33, 95% CI 1.37 to 4.05 and OR 2.58, 95% CI 1.33 to 5.00, respectively). The final model for accident and emergency attendances included male sex (OR 2.13, 95% CI 1.06 to 4.20) and previous injury (OR 2.27, 95% CI 1.15 to 4.40). These models were used to estimate the probability of each injury outcome based on the presence or absence of the significant factors. A history of previous medically attended injury increased the probability of a medically attended injury over the next year from 0.26 to 0.43, and that of primary health care team attendance from 0.16 to 0.27. Being male and having a history of previous medically attended injury increased

Table 1 Relative risk of primary health care team attendance, accident and emergency department attendance at any health care facility for unintentional injury, by univariate analyses of risk and sociodemographic factors (95% CI)

Risk or sociodemographic factor	No of children with risk factor*	Primary health care team attendance	Accident and emergency department attendance	All attendances
Male sex	292	1.08 (0.65 to 1.79)	1.68 (1.01 to 2.80)	1.19 (0.82 to 1.74)
Age <5 years	187	1.00 (0.59 to 1.70)	0.80 (0.49 to 1.29)	0.97 (0.66 to 1.41)
≥4 children in family	62	1.29 (0.64 to 2.62)	1.30 (0.67 to 2.53)	1.18 (0.69 to 2.00)
Single parent family	57	1.95 (0.98 to 3.87)	0.92 (0.41 to 2.04)	1.06 (0.59 to 1.88)
Non-owner occupier	62	1.27 (0.63 to 2.58)	0.44 (0.14 to 1.36)	0.92 (0.50 to 1.69)
No access to car	37	1.05 (0.40 to 2.77)	0.73 (0.24 to 2.23)	0.77 (0.33 to 1.80)
Ethnic group non-white	22	†	0.40 (0.06 to 2.74)	0.25 (0.04 to 1.69)
Receipt of means tested benefit	79	1.39 (0.74 to 2.59)	0.66 (0.26 to 1.49)	0.99 (0.57 to 1.67)
Maternal age ≤20 years at birth of first child	35	0.79 (0.26 to 2.43)	0.70 (0.23 to 2.19)	0.80 (0.34 to 1.85)
Previous medically attended injury	239	1.79 (1.06 to 3.02)	1.64 (1.01 to 2.68)	1.52 (1.04 to 2.21)
Overcrowding	28	1.70 (0.73 to 3.98)	0.65 (0.17 to 2.55)	1.01 (0.44 to 2.32)
Unemployment	20	1.43 (0.48 to 4.25)	0.47 (0.07 to 3.21)	1.11 (0.44 to 2.77)
Townsend score >0	97	1.28 (0.71 to 2.31)	1.01 (0.84 to 1.90)	1.07 (0.67 to 1.71)

* n=540. Cases with missing data on a particular variable have been excluded.
† No children with an ethnic origin classified as non-white had an unintentional injury leading to a primary health care team attendance over the follow up year.

Table 2 Univariate analyses of the mean number of injuries by risk and sociodemographic factors

Risk or sociodemographic factor	No of children*	Mean (SD) No of injuries	t	df	p (two tailed)
Male	292	1.06 (0.28)	−0.38	534	0.70
Female	246	1.06 (0.22)			
Age (years)					
<5	187	1.05 (0.26)	0.81	538	0.41
≥5	353	1.07 (0.24)			
No of children in family					
<4	474	1.06 (0.24)	−0.96	72	0.34
≥4	62	1.10 (0.30)			
Ethnic group					
White	489	1.06 (0.25)	2.04	39	0.05
Non-white	22	1.02 (0.09)			
No of parents					
Single	57	1.10 (0.32)	0.91	64	0.37
Two	465	1.06 (0.24)			
Access to car					
No	37	1.04 (0.28)	0.54	525	0.60
Yes	490	1.07 (0.25)			
Home ownership					
Owner occupier	466	1.06 (0.25)	0.03	526	0.98
Non-owner occupier	62	1.06 (0.25)			
Receipt of benefits					
Yes	79	1.07 (0.31)	0.22	96	0.83
No	445	1.06 (0.24)			
Maternal age (years)					
≤20	35	1.05 (0.35)	−2.60	468	0.01
>20	435	1.10 (0.25)			
Employment					
No	20	1.09 (0.30)	1.22	538	0.22
Yes	520	1.07 (0.25)			
Overcrowding					
Yes	28	1.08 (0.35)	0.22	28	0.83
No	511	1.06 (0.24)			
Residency					
Non-deprived area	394	1.07 (0.24)	1.02	127	0.31
Deprived area	97	1.04 (0.30)			
Previous injury					
Yes	239	1.10 (0.28)	2.77	445	0.006
No	289	1.04 (0.22)			

* n=540. Cases with missing data on a particular variable have been excluded.
df=degrees of freedom.

Table 3 The sensitivity, specificity, and positive predictive value of risk and sociodemographic variables for predicting future injury and the number of children in each risk factor group needing to be targeted for injury prevention to prevent one injury*

Risk or sociodemographic factor	Sensitivity (%)	Specificity (%)	Positive predictive value	No of children to target per injury prevented (95% CI)
Male sex	59.4	46.8	19.5	38 (24 to 52)
Age <5 years	35.4	65.5	18.2	38 (27 to 49)
≥4 children in family	13.7	88.9	21.0	27 (21 to 33)
Single parent family	11.6	89.2	19.2	25 (19 to 31)
Non-owner occupier	10.7	88.0	16.1	43 (36 to 50)
No access to car	5.3	92.6	13.5	33 (28 to 38)
Receipt of benefits	14.9	84.9	17.7	30 (23 to 37)
Ethnicity	1.1	95.0	4.5	25 (17 to 33)
Maternal age ≤20 years	5.8	92.2	14.2	34 (29 to 39)
Previous medically attended injury	57.4	57.4	22.6	29 (20 to 38)
Overcrowding	5.3	94.8	17.9	54 (49 to 59)
Unemployment	4.2	96.4	20.0	50 (46 to 54)
Townsend score >0	21.1	80.5	19.6	34 (26 to 42)
Whole population				38 (18 to 58)

* Estimated 10% reduction in injury frequency as result of injury prevention intervention.[18 19]

the probability of accident and emergency attendance over the next year from 0.28 to 0.52.

Using the number of injuries as the outcome measure, previous medically attended injury and young maternal age at birth of first child were associated with a significantly higher number of injuries (table 2). Multiple linear regression produced identical results as the univariate analyses. The predicted number of injuries in the subsequent year, based on the final regression equation for a child with a mother aged over 20 at the birth of her first child who has had at least one previous medically attended injury is 1.11, whereas a child with a mother aged 20 or under at the birth of their first child who has not had a previous medically attended injury has a predicted number of injuries in the subsequent year of 0.99.

The number of children and the number of injuries occurring to children in each risk factor group is shown in table 3, along with the sensitivity, specificity, and positive predictive value for each factor in predicting which children will suffer future injury. These results demonstrate that the sensitivity and positive predictive value is low for most factors; thus the number of children needed to be targeted for injury prevention does not differ significantly from the number who would need to receive an intervention if a population approach was used.

Discussion

It has not been possible in this study to replicate the associations previously found between risk factors for childhood injury and many injury outcomes. It is important to consider the possible explanations for this because the implications of this finding are that such risk factors should not be used for targeting primary care based interventions. Chance, bias, confounding, or a true lack of association are all potential explanations which need to be considered.

A posteriori sample size calculations indicate that the study was sufficiently powerful (80% power, 5% significance level) to detect a relative risk of a medically attended injury of less than 2 for male sex, four or more children

in family, non-owner occupation, receipt of means tested benefits, and previous medically attended injury. As attendance at the primary health care team and at the accident and emergency department were less common outcomes, the study was only able to detect larger relative risks for these outcomes. Previous studies have found relative risks of this magnitude (that is 2 or less) for child age, maternal age, single parenthood, previous medically attended injury, sex, and socioeconomic disadvantage.[1 2 3 5 12 20-24] Therefore, it seems unlikely that a type II error can explain the lack of association found between most risk factors and having at least one medically attended injury.

Previous work suggests that responders to postal questionnaires often differ from non-responders in terms of demographic and socioeconomic factors such as age, sex, social class, ethnicity,[25 26] and single parenthood.[27 28] A response bias has been demonstrated in which girls and older children with a history of previous medically attended injury were under-represented among the responders. Also, the unintentional injury rate over the follow up year was higher in children of non-responders. Previous studies in primary care and accident and emergency settings have found injury rates similar to that of children of responders found in this study,[13 29 30] so it is unlikely that response bias will have had a major effect on the results. Furthermore, assuming that all children of non-responders had a history of previous injury and experienced the injury rate for non-responders found in this study, the relative risk for a future injury in those with a history of previous injury would increase from 1.79 to 2.05, which would not substantially alter the results.

Much of the work on risk factors for unintentional injury originated from the Child Health and Education Study, which commenced 25 years ago, based on a population comprising all children born in one week in England and Wales. It is possible that the variables used in this study have not been able to identify a group of children at high risk of injury because of changes in social structure over time or because of the relatively affluent population used in this study.[31] Some variables are directly comparable betweeen the two studies: the Child Health Education Study had less than 5% of their study population with four or more children in each family,[7] compared with 11.8% in this study; fewer than 5% of the children came from single parent families[9] compared with 9.7% in this study, and 8.6% of mothers whose first child was born before the age of 20 years[8] compared with 6.5% in this study. Over the last 25 years single parenthood has become more prevalent and single parents are an increasingly heterogeneous socioeconomic group.[32] Maternal age at birth of first child has risen over the same period.[33] The children of such single parents or young mothers today may therefore have differing risks of injury than they did at the time of the Child Health and Education Study. The use of a relatively affluent population

may influence the utility of the risk factors for identifying children at high risk of injury. The experience of poverty or disadvantage cannot be separated from social context, hence variables used to describe socioeconomic status may reflect different life experiences in a relatively affluent area than in a deprived area. For example, non-owner occupation in an affluent area may be a qualitatively different experience than non-owner occupation in a deprived area where other facilities such as safe play or leisure areas are less likely to be available. The risk factors may therefore be more discriminating in terms of injury risk in a less advantaged population.

A further difficulty with some of the risk factors used in this study is that their presence may be less important than their duration. For example, long term unemployment is likely to reflect different socioeconomic-economic circumstances than short term unemployment, such as increasing financial difficulty, increasing frequency of stressful life events, decreasing quality of the home environment, increasing social isolation and reduced self esteem,[24] all of which may be important in preventing injury. This study did not measure duration of indicators of socioeconomic disadvantage, but it may be useful for future work in this area to do so.

Confounding factors such as proximity to hospital, maternal inexperience in dealing with injury and non-accidental injury are unlikely to explain the observed results. The practice area is geographically small and located close to the accident and emergency department. Children with older mothers were found to suffer a greater number of injuries than children with younger (and possibly more inexperienced) mothers. This is contrary to what would be expected if maternal inexperience was a confounding variable. At present none of the children registered with the practice are on the child protection register, so non-accidental injury is unlikely to be a plausible explanation.

It is possible that factors relating to health service utilisation are confounding the relationship between risk factors and injury occurrence because the majority of injuries in this study were minor. This suggestion is supported by the findings of the Walsh and Jarvis who examined cases of moderate (injury severity score (ISS) $\geqslant 4$) or severe injury (ISS $\geqslant 9$) and death and found a significant association between socioeconomic status (measured by Townsend index) and injury.[35] The gradient was steepest for fatal injuries and least steep for more minor injuries. The preponderance of minor injuries does mean that the results of this study cannot be generalised to more severe injuries, and that where strong associations exist between severe or fatal injuries and risk factors, targeting injury prevention may be worthwhile. Even then, it will only be an effective strategy if the majority of injuries occur in the high risk group.

Insufficient power, bias, and confounding therefore do not provide adequate explanation for the lack of an association between the risk factors and the injury outcomes. Three recent

studies of attendances at accident and emergency departments for unintentional injury have also failed to find associations between area based measures of deprivation and attendance[12 36 37] supporting the hypothesis that for more minor injuries some of the previously demonstrated associations may no longer exist. A case-control study undertaken in Glasgow in 1995 found only previous injury and male sex to be significantly associated with such attendances after unintentional injury, with similar ORs to those found in this study, but no association between an area based deprivation score or ethnicity and attendance for injury.[12] Lyons and colleagues, in a larger accident and emergency department based study using the Townsend index of deprivation, suggested that their failure to find an association may be explained by the ecological fallacy where the association at an aggregate level does not necessarily represent the association found at the individual level.[36] This may occur if the Townsend index does not describe homogenous areas, in which case data at the level of the individual will be more useful than aggregate data. The lack of any associations between the individual components of the index and any of the outcomes does not support this hypothesis, but further work is needed with a larger sample size to examine the relationship between individual measures of deprivation and injury outcome before stronger conclusions can be drawn about the ecological fallacy.

Implications for prevention

The failure to find significant associations between risk factors and a range of injury outcome measures suggests that, at present, primary care injury prevention programmes should not be targeted using these risk factors. Such a strategy should await further work to confirm or refute this finding in a larger population with a wider cross section of socioeconomic status. The low sensitivity and positive predictive value for each of the factors (except male sex and previous injury) means that for most risk factors the factor will miss most of the children who will have an injury in the subsequent year, because they are not in the high risk group. At the same time it will identify a large proportion of children as being at high risk who will not have an injury. The high specificity for most factors means they will correctly identify most of the children who will not have an injury. The number of children needed to treat to prevent one injury does not differ significantly using the targeted or population approach, but only the population approach has the potential to prevent all injuries.
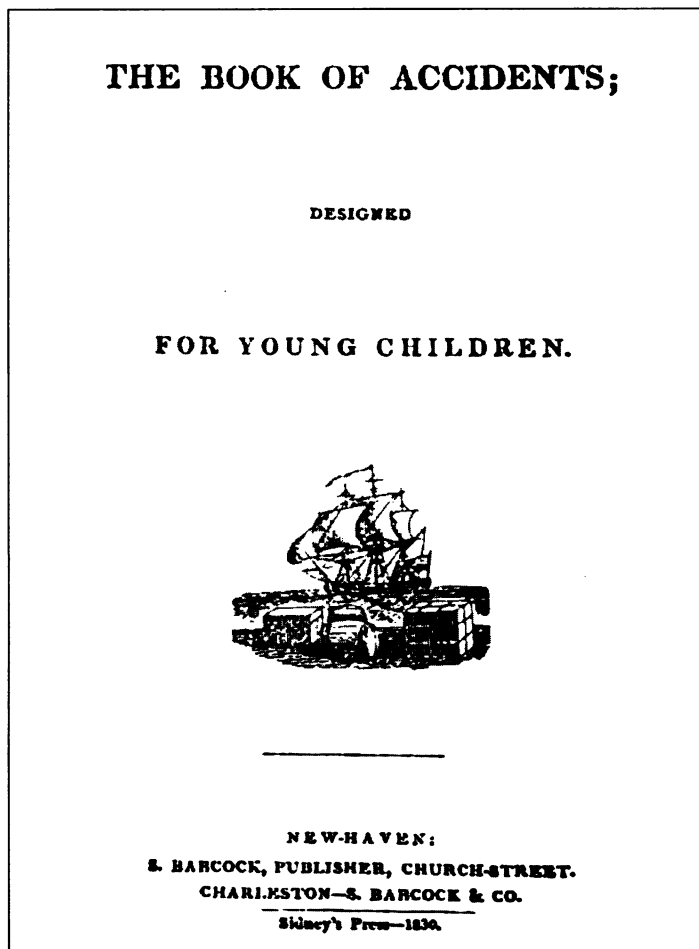
This study, therefore, supports previous suggestions that targeting injury prevention at groups of high risk children is not efficient in terms of the number of children that would have to be targeted and the potential number of injuries prevented. Instead, as children have repeated contacts with members of the primary health care team, especially in the first five years of life and as injury prevention programmes, such as TIPP, do exist which could be incorporated into these contacts it is suggested that primary care injury prevention programmes should use a population approach.

In terms of prevention in settings other than primary care and in populations suffering more severe injuries, more work is needed assessing the efficiency of targeted versus population strategies.

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THE BOOK OF ACCIDENTS;

DESIGNED

FOR YOUNG CHILDREN.

NEW-HAVEN:

S. BABCOCK, PUBLISHER, CHURCH-STREET.

CHARLESTON—S. BABCOCK & CO.

Sidney's Press—1830.

Book of Accidents

This issue includes the first in a series of illustrations from *The Book of Accidents; Designed for Young Children* published in New Haven in 1830. Neither the writer nor illustrator is known. I discovered these pictures when Dr T E Cone (now of Massachusetts) arranged for their publication in *Pediatrics* in 1981. I am grateful to Dr Cone and to *Pediatrics* for allowing us to reproduce them. Apart from the delightful drawings, I wanted to share them with our readers because both the somewhat unfortunate title and the admonitory text accompanying most of the illustrations, so clearly reveal what was believed about injuries and their prevention a century ago. As you will discover, the onus is placed squarely and excusively on the child or parents, and it is clearly 'accidents' that these, largely middle and upper class families, are depicted as trying to prevent, mostly by giving advice to their children. I wonder how much most of society's attitudes have changed since then.

I B PLESS

Editor