THE IMPORTANCE OF ACCIDENT-PRONENESS IN THE AETIOLOGY OF HEAD INJURIES IN CHILDHOOD*

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The term 'accident-proneness' was originally coined by Farmer and Chambers (1926) to describe a concept arising out of the observations of Greenwood and Woods (1919) and Newbold (1926). These workers had studied the distribution of accidents among factory hands and found that a relatively large proportion of accidents was reported from a relatively small proportion of the population at risk. This undue concentration of accidents could not be explained by chance variations or variations in exposure to danger. It was concluded that certain individuals had some sort of personality trait which rendered them more liable to have accidents. This trait (accident-proneness) seemed to be independent of the environment and constant for the individual from year to year.

Accident-proneness is now also used to denote a somewhat similar concept which has arisen from the psychological study of particular case-histories. Groddeck (1923), Menninger (1936) and others have suggested that many accidents are not entirely fortuitous but are in some way caused by the injured persons themselves. The process is said to be unconscious and motivated by complex desires for self-punishment and death. Flanders Dunbar (1943, 1947) attempted to combine both psychological and statistical approaches to the subject.

The existence of accident-proneness is now widely accepted. There is still, however, a considerable difference of opinion on its place in the aetiology of accidental injuries in general. Some workers (Heinrich, 1941; Dunbar, 1947) regard it of major importance but others (Adelstein, 1952; Schulzinger, 1954) think that it is of little significance. A common view, quoted by Schulzinger, is that 'the accident-prone 15% of the population causes 85% of the accidents'. Attempts to predict accident-

proneness have not met with much success (Chambers, 1955).

Little work has been done on accident-proneness in childhood. Ackerman and Chidester (1936) presented a case-history of a girl who had repeated accidents. Bakwin and Bakwin (1948) reviewed the subject. Some individual and social comparisons have been made between children who have had one or more accidents and those who have not. Differences have been found, but it is remarkable how small these are. For instance, 'accident-repeaters' have been found to be more aggressive, impulsive and rebellious (Birnbach, 1948), obstinate, impatient, vigorous, hyperactive, rude and highly-strung (Fuller, 1948), but the meaning of such differences is hard to assess. In children under the age of 5 years, Douglas and Blomfield (1958) found little difference in housing conditions, social class or maternal care between accident and control groups; children with two or more accidents were found to have slightly better physical development and mental ability. Langford, Gilder, Wilking, Genn and Sherrill (1953) found no neurological, ophthalmological or intellectual differences between a small group of accident-repeaters and controls. An increased number of accidental injuries has been reported in the families of injured children compared with the families of control groups (Langford *et al.*, 1953; Backett and Johnston, 1959). This has also been recorded in adults (Dunbar, 1943).

The present work was undertaken in an attempt to see whether accident-proneness plays a significant part in the aetiology of head injuries in childhood.

Material

Two series of observations were made. For the first series the case notes were examined of all children with head injuries admitted to Sheffield Children's Hospital between January 1, 1952 and December 31, 1958. Cases were included on the

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following criteria: (1) The child's age was 13 years or under (but birth injuries were excluded). (2) The child was admitted to hospital because of the head injury or associated injuries. (3) There was a history of an accident which could have caused a head injury or obvious evidence of, for example, a fractured skull. (4) The child had one or more of the following: coma, stupor, drowsiness, confusion, vomiting, convulsions, lacerations of the head or bleeding from the nose or ear. These features were usually the reasons for the child's admission. Most of the children suffered mild or moderate head injuries, according to Symonds' (1949) classification. Seventeen children (11 boys and six girls) had severe injuries and three of these died.

The second series consisted of 30 patients with head injuries admitted to the same hospital between September 1, 1958 and April 30, 1959. These were seen personally and the parents interviewed. Full past and family histories were taken with special reference to accidental injuries, burns, and poisonings. These patients were matched by sex and age (to the year over the age of 2 years and to the quarter year below that), with 30 other patients admitted to the same wards during the same period of time. This control group was made up of acute medical cases, since closed head injuries are admitted to medical wards in this hospital. Eighteen of these children had acute infections (eight of the respiratory tract), three had rheumatic fever, two had anaphylactoid purpura, two chorea and five had other miscellaneous conditions. Similar histories were taken from the parents of these children. The two series overlap to some extent.

This hospital is a general children's hospital serving Sheffield and the surrounding districts. The great majority of the patients came from Sheffield itself.

First Series

Sex and Age. There were 1,180 cases of head injury in the first series of whom 825 were boys and 355 were girls. This is a ratio of 2.3 boys to one girl (Table 1). At all ages there were more boys with head injuries than girls. The number of boys and girls at each year of age in the general population of Sheffield is known from the census of 1951 (Registrar-General, 1951). Using these figures, it can be said that the excess of boys with head injuries is not significant ($\chi^2 = 2.75$; $n = 1$; $0.2 > p > 0.1$) under the age of a year. It becomes significant ($\chi^2 = 3.71$; $n = 1$; $p \approx 0.05$) for the first 2 years of life and highly significant ($\chi^2 = 6.63$; $n = 1$; $p = 0.01$) if the first 3 years of life are taken

TABLE 1

AGE AND SEX DISTRIBUTION OF THE CASES OF HEAD INJURY

Age in years	Boys	Girls	Totals	No. of boys per girl
Under 1	29	18	47	1.6
1—	51	34	85	1.5
2—	52	36	88	1.4
3—	62	38	100	1.6
4—	66	37	103	1.8
5—	69	34	103	2.0
6—	86	31	117	2.8
7—	86	30	116	2.8
8—	82	29	111	2.8
9—	82	21	103	3.9
10—	56	23	79	2.4
11—	42	8	50	5.3
12—	36	11	47	3.3
13—	26	5	31	5.2
	825	355	1,180	2.3

together. In general, after the age of 2 years, the ratio of boys to girls steadily increased with age.

The age and sex distribution of the cases are shown in Tables 1 and 2 and Fig. 1. It can be seen that the total number of cases rose steadily from the youngest age groups to a plateau at 6 to 8 years and thereafter declined. There were nearly four times as many cases at the age of 6, 7, or 8 years than at the age of 13 years.

There was a marked difference in the age distribution of head injuries in boys and girls. The peak frequency for girls was at the age of 3 years, followed by a steady decline with each older age group. The peak frequency for boys, on the other hand, was at the age of 6 to 9 years, and the numbers fell rapidly after that.

Month of the Year. Fig. 2 shows the monthly incidence of cases of head injury for each year of the survey. More cases regularly occurred in the summer than in the winter months. The whole series is summated for one year in Fig. 3, together with the distribution of cases according to sex and age group. Seasonal variations were most marked in the numbers of boys in the 0 to 4, and 5 to 9 year old groups.

TABLE 2

DISTRIBUTION OF CASES OF HEAD INJURY BY SEX AND AGE GROUPS

Age Group (years)	Boys	%	Girls	%	Totals	%	No. of Boys per Girl
0-4	260	22	164	14	423	36	1.6
5-9	405	34	145	13	550	47	2.8
10-13	160	14	47	3	207	17	3.4
	825	70	355	30	1,180	100	2.3

FIG. 1.—Age and sex distribution of all the cases of head injury from the first series.

FIG. 2.—Monthly incidence of the first series of head injuries for each year of the survey.

Day of the Week. Fig. 4 shows the cases distributed according to the day of the week on which the accident occurred. There were only slight daily variations and the differences are not significant ($\chi^2 = 4.15$; $n = 6$; $0.7 > p > 0.5$). The ratio of boys to girls altered very little from day to day in the series as a whole and in the different age groups.

Time of Day. There was enough information in the notes to time the accident to the nearest hour in 649 cases (Fig. 5). There were two peak periods, one at midday and another larger one at 5 to 6 p.m. Each age group showed the same sort of pattern but it was least marked in the 10 to 13 year old group and most obvious in the 5 to 9 year old group.

FIG. 3.—Distribution of the first series of head injuries by month of the year, sex and age-group.

FIG. 4.—Distribution of the first series of head injuries by day of the week, sex and age-group.

FIG. 5.—Distribution of 649 cases of head injury from the first series by time of day, sex and age-group.

FIG. 6.—Distribution of 1,172 cases of head injury from the first series by type of accident, sex and age-group.

The peak frequencies in this latter group were almost entirely made up of boys, whereas the peak frequencies in the 0 to 4 year old group were made up of both boys and girls.

Type of Accident. Precise details of the accident causing the injury were seldom available. There was enough information, however, to classify the accidents into three main types. All accidents involving a moving vehicle were described as road accidents. Falls included falls from a height and falls on the child's own level. The term 'impact' was used for those cases in which the child was struck by or ran into an object. The results are shown in Fig. 6.

Falls were the largest category of accident. Falls were as common in the 0 to 4 year old group as in the 5 to 9 year old group. The 5 to 9 year old suffered more road accidents. There were more boys than girls in each age group of each type of accident.

Accident Repetition. The 1,180 cases were distributed among 1,155 patients. Nineteen children between them had 44 head injuries (Table 3). Put in another way, 1.6% of the children suffered 3.7% of the head injuries.

Fifteen of these accident-repeaters were boys and four were girls. This sex ratio is not significantly different ($\chi^2 = 0.37$; $n = 1$; $0.7 > p > 0.5$) from the rest of the series. At the time of their last injury, four were in the 0 to 4 year old group, 13 were in the 5 to 9 year old group and two were in the 10 to 13 year old group. None of these children sustained a severe injury. Thirty-two of the 44 accidents were falls, seven were road accidents and five were due to impact. This distribution is significantly different from the rest of the series ($\chi^2 = 7.42$; $n = 2$; $0.05 > p > 0.02$) and indicates that repeated head injuries were more often due to falls than to road accidents or impact.

In addition to these 19 children, 57 children had had one or more accidental injuries in the past

requiring medical attention (lacerations, known and suspected fractures, poisoning, etc.). In all, then, a total of 76 children (6.6%) had a past history of accidents at the time of their head injury. Sixty-three of these were boys and 13 were girls. This excess of boys is significant ($\chi^2 = 5.91$; $n = 1$; $0.02 > p > 0.01$) compared with the rest of the series. Sixty-five children had a past history of one accident, eight of two accidents and three of three accidents.

Second Series

The past and family history of children with head injuries was studied more closely for two reasons. In the first place it seemed likely that the past histories in the case notes of the first series were inadequate. In the second place, because of the observations of Langford *et al.* (1953) and Backett and Johnston (1959), a greater incidence of accidental injuries was expected in the families of these children than in a control group.

The patients of the control group were chosen to match the age and sex of the patients with head injuries. The 60 children of these two groups were called the index cases. It was found in retrospect that the two groups were very similar with regard to a number of other general features (Table 4). There were few differences in the informant's kinship to the index cases, the informant's own estimates of their housing conditions or the social class of the children in each group as judged by the occupation of the father.

TABLE 4

COMPARISON OF AGE, SEX, INFORMANTS, HOUSING AND SOCIAL CLASS OF ACCIDENT AND CONTROL GROUPS OF THE SECOND SERIES

	Head Injury Group	Control Group	Totals
Sex:			
Boys ..	20	20	40
Girls ..	10	10	20
Age group:			
0-4 years ..	9	9	18
5-9 years ..	13	13	26
10-13 years ..	8	8	16
Informants:			
Both parents ..	14	14	28
Mother ..	14	12	26
Father ..	2	3	5
Sister ..	0	1	1
Housing:			
Unsatisfactory ..	6	5	11
Satisfactory ..	24	25	49
Social class:			
I and II ..	3	8	11
III ..	15	12	27
IV and V ..	12	10	22

TABLE 3

DISTRIBUTION OF 1,180 CASES OF HEAD INJURY AMONG 1,155 PATIENTS

No. of Head Injuries	Number of	
	Children	Cases
1	1,136	1,136
2	14	28
3	4	12
4	1	4
Totals	1,155	1,180

TABLE 5

COMPARISON OF PAST AND FAMILY HISTORY OF INJURIES IN ACCIDENT AND CONTROL GROUPS OF THE SECOND SERIES

	Head Injury Group	Control Group	Total	Value of	
				χ^2	p
1. Index cases:					
No. of individuals	30	30	60	—	—
No. with past history of injury	13	10	23	0.16	0.7-0.5
No. of injuries incurred	19	18	37	—	—
2. Siblings:					
No. of individuals	66	44	110	4.11	0.05-0.02
No. with past history of injury	6	9	15	2.04	0.2-0.1
No. of injuries incurred	8	10	18	1.46	0.3-0.2
3. Parents:					
No. of individuals	60	60	120	—	—
No. with past history of injury	31	26	57	0.28	0.7-0.5
No. of injuries incurred	46	39	85	0.42	0.7-0.5
4. Close family: (2 and 3)					
No. of individuals	126	104	230	1.92	0.2-0.1
No. with past history of injury	37	35	72	0.33	0.7-0.5
No. of injuries incurred	54	49	103	0.08	0.8-0.7
5. Remote family: (grandparents, parents' siblings, first cousins)					
No. of individuals	528	440	968	5.06	0.05-0.02
No. with past history of injury	42	40	82	0.24	0.7-0.5
No. of injuries incurred	57	50	107	0.02	0.9-0.8
6. Whole family: (1 + 4 + 5)					
No. of individuals	684	574	1,258	9.44	>0.01
No. with past history of injury	92	85	177	0.34	0.7-0.5
No. of injuries incurred	130	117	247	0.24	0.7-0.5

Results

The results are summarized in Table 5. Thirteen of the children with head injuries had a past history of injury, compared with 10 in the control group. The 13 children in the head injury group had had 19 injuries between them, and the 10 children in the control group had had 18 injuries. Neither of these differences is significant. Similar comparisons were made between the siblings of the index cases, their parents, their more distant relatives and combinations of these groups. No significant differences were found in the incidence of past injuries. There were significantly more siblings and relatives in the families of the head injury group.

Over a third of the 60 index children had a past history of injury. Twenty of these children were boys and three were girls. This is significantly ($\chi^2 = 5.38$; $n = 1$; $p \approx 0.02$) more boys than would be expected from the sex ratio of the rest of the series. There was a history of injury in nearly half of the parents, roughly a seventh of the siblings and a twelfth of the remote family.

Discussion

The incidence of head injuries in this series was found to vary with four main factors: sex, age, the month of the year and the time of day. The most important of these appeared to be the child's sex.

There were consistently more boys than girls in all situations that were examined. More boys had head injuries at each year of age, in every month of the year, on each day of the week and at each hour of the day. More boys suffered each particular type of accident. More boys had severe head injuries, repeated head injuries and a past history of other accidental injuries.

The ratio of boys to girls in the first series was 2.3 to 1. This might conceivably be due to an excess of boys over girls in the general population. In Sheffield, however, the ratio of boys to girls is only 1.05 to 1 (Registrar-General, 1951), so that this can only account for a small fraction of the preponderance of boys with head injuries. Others have reported a similar sex incidence (Beekman, 1928; Ireland, 1932; Fabian and Bender, 1947; Rowbotham, Maciver, Dickson and Bousfield, 1954; Harris, 1957).

More boys had a past history of accidental injury than girls. This suggests that, in general, boys are more prone or liable to accidents than girls. This is borne out by mortality figures (van den Berg, 1957), hospital accident series (Simson, 1956), surveys of home accidents (Dennis and Kaiser, 1954) and other community studies (Jacobziner, 1955; Rice, Starbuck and Reed, 1956). This is not necessarily true for every type of injury because, for example, burns are commoner in girls

than in boys (Colebrook, Colebrook, Bull and Jackson, 1956).

A boy's relative proneness to head injury seems to vary with age. The ratio of boys to girls with head injuries steadily increased after the age of 2 years. However, as in other series (Ireland, 1932; Rowbotham *et al.*, 1954; Harris, 1957), the maximum incidence of cases was in the middle years of childhood. These two factors offset one another so that the commonest age for head injuries in boys was 5 to 9 years.

Seasonal variations in the incidence of fatal (van den Berg, 1957; Kanellakis, 1958) and non-fatal (DeCosse, 1953; Jacobziner, 1955) childhood accidents are well recognized. The greatest danger is in the summer months. The present series of head injuries conformed to the same pattern. There were no significant variations in the number of head injuries according to the day of the week, although both DeCosse (1953) and Ehrenpreis (1957) have reported low incidences of accidents in general on Sundays compared with the rest of the week.

Marked variations occurred in the time of day the accident happened. Peak periods were at noon and at 5 to 6 p.m. There were considerable differences between boys and girls and between the age groups in this respect. Most of the variation was due to variations in the numbers of boys. Corresponding variations did occur in the numbers of girls but these were small and only proportional in the 0 to 4 year old group. The most marked variations occurred in the numbers of 5 to 9 year old boys. Similar hourly variations have been noted for childhood accidents in general (DeCosse, 1953; Ehrenpreis, 1957). Ehrenpreis states that, in Sweden, the peak periods correspond to the hours before the main mealtimes and he suggests that more accidents happen because the children are more irritable, hungry and less well supervised. It would be of great interest, in this country, to see if the hourly accident pattern changed if milk were given out in schools in the afternoons instead of in the mornings.

Only a small proportion (1·6%) of children were represented more than once in the first series of head injuries. This, by itself, suggests that accident-proneness was of no great aetiological importance. On the other hand, it might be expected that accident-proneness would express itself differently at different ages. Affected children who have head injuries at the age of 5 to 9 years might have suffered burns, scalds or poisoning earlier in life. If accident-proneness is important in the aetiology of head injuries, one would expect a higher incidence of past injuries in a group of children with head injuries

than in controls. This could show itself in two ways. (1) There could be a greater number of children with a past history of injury. (2) Each group could have the same number of children with a past history of injury, but these children could have incurred a greater total number of injuries (i.e. they are accident-repeaters). No evidence of either of these situations was obtained from the second series of patients.

The second series revealed a high incidence of past injuries among children and their parents in both the accident and control groups. It was also found that the children with head injuries came from slightly larger families than the controls. In contrast to Langford *et al.* (1953) and Backett and Johnston (1959), no significant difference was found in the incidence of accidental injuries in the families of the two groups.

In conclusion, apart from increased liability associated with the male sex, no evidence of accident-proneness was discovered. This does not disprove the existence of accident-proneness nor discount its possible importance in the individual case. It does suggest that accident-proneness is of little significance in the aetiology of the great majority of head injuries in childhood.

Adelstein (1952) has critically reviewed the whole subject of accident-proneness. He points out that much of the confusion is semantic and rests on the interpretation of an 'accident'. This can mean death, a major injury, a minor injury or no injury at all but only damage to property (a mishap). It has been assumed (Newbold, 1926; Heinrich, 1941) that these events are closely related and that, for instance, the causes of mishaps or minor injuries are essentially the same as the cause of major injuries and fatalities. This premise is probably inaccurate. For example, in industry, there is only a very low correlation between minor and major injuries (Farmer and Chambers, 1926; Adelstein, 1952). In childhood, the age distribution of non-fatal accidental poisoning is different from that of fatal accidental poisoning (Clements, 1956). There is little correspondence between the causes of accident morbidity and the causes of accident mortality in childhood (Ehrenpreis, 1957). Observations on one type of accidental result (e.g. mishaps, death or a particular injury) do not necessarily apply to another. Adelstein himself found some evidence of accident-proneness in the aetiology of mishaps but little or none in the aetiology of major injuries.

The outstanding objection to the psychological explanations of accident-proneness is that they are based on such dubious evidence. Theories have largely been built up on the patient's view of the

cause of his accident, weeks, months or years after it has happened.

It has been remarked that preoccupation with accident-proneness may well divert attention from other more rewarding aspects of accident causation. These include not only the effects of age, sex and season but also the means whereby a child learns to avoid accidents (Editorial, *British medical Journal*, 1959).

Summary

Two series of children with head injuries were studied. The first series consisted of 1,180 cases admitted to a children's hospital over a period of seven years. The ratio of boys to girls was 2·3 to 1. The maximum incidence of cases was in the middle years of childhood. More cases occurred in the summer than the winter months. There was no significant variation in the number of cases according to the day of the week. Two peak frequencies occurred during the day, one at noon and a larger one at 5 to 6 p.m. Falls were the commonest type of accident. Only 1·6% of the children had more than one head injury; none had more than four.

In the second series, 30 children with head injuries were matched by age and sex with 30 acute medical cases. No difference was found in the incidence of accidental injuries in the past or family histories of these two groups. A third of the children, and half their parents had a history of accidental injury. The children with head injuries came from slightly larger families.

These findings are discussed. No evidence of accident-proneness was found apart from increased liability associated with the male sex.

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