

# Head trauma among children in Reykjavík

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The incidence of head trauma (ICD9 850–854) among children in the Reykjavík area, aged 0–14 years, was studied over a 5-year period, 1987–1991, using hospital records. On average, 72 children with head trauma were admitted to hospital each year, indicating an annual incidence of 1.70 per 1000 population. Fourteen percent of children admitted to hospital with head trauma suffered the more severe forms of brain injury (ICD9 851–854) (annual incidence of 0.28 per 1000). Seven children died from brain injury, indicating an annual death rate of 0.03 per 1000. Falls were the most common cause of head trauma (62%), followed by traffic accidents (19%). On average, one to two severely brain-injured children received rehabilitation each year. □ *Brain, causes, child, incidence, injury, rehabilitation, trauma*

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Head trauma is a major cause of morbidity and mortality in children in the western world (1). In the USA it is estimated that the annual incidence of head trauma among children is 2–3 per 1000 population, and approximately 10% of these are severe injuries. It is estimated that 0.10 per 1000 children die each year of brain trauma (2).

Recent research indicates that Iceland is no exception when it comes to pediatric injuries. During the period 1974–1991, the annual incidence of accidents among children aged 0–14 years in Reykjavík was 299 per 1000 children (3), which is high compared with neighboring Scandinavian countries Norway (4) and Sweden (5). During the 5-year period, 1987–1991, the annual incidence of head or spinal trauma among 0–14-year-old children diagnosed at the Emergency Unit of Reykjavík City Hospital was 11 per 1000 (data from hospital records), which is similar to Sweden (5) and France (6).

Guðmundsson (7) studied head trauma among children in Reykjavík during the period 1973–1980. On average, 84 children aged 0–14 years were admitted to hospital each year diagnosed with head trauma (diagnostic numbers 850–854 according to the *International Classification of Diseases, ninth edn* (ICD9) (8)), indicating an annual incidence of 2 per 1000 population. Twenty-four percent of children were 0–4 years old, 44% were 5–9 years and 32% were 10–14 years. Twenty percent of all children were admitted to the Intensive Care Unit, Reykjavík City Hospital, with severe brain injury.

There have been many social and economic changes in Iceland over the past decade involving, among other things, a greater number of motor vehicles and traffic

accidents (data from Icelandic Traffic Commission, 1993). At the same time, there has been increased emphasis on preventive measures with regard to childhood accidents, and in 1988 the use of seat belts in cars was made obligatory by law. The hypothesis of this research was that in spite of an increase in the number of car accidents, with and without injuries, protective measures had led to a reduction in the number of the more severe forms of head trauma among children needing hospital admission and intensive care.

In the present study, we focused on the incidence and causes of head trauma (ICD9 850–854) among children admitted to hospital in Reykjavík during the 5-year period 1987–1991. The study did not deal with population estimates but with all cases. Because of the limited size of the Icelandic population and an advanced health care system with reliable recording methods, it is possible to identify and follow-up virtually all Icelandic individuals with a specific diagnosis or treatment during a defined period of time. In the case of head trauma, the work is made easier still by the fact that only one emergency unit, located at Reykjavík City Hospital, serves the Greater Reykjavík Area. The same hospital houses the only neurosurgical ward in the whole of Iceland.

## Patients and methods

The study included all 359 new cases of head trauma (ICD9 850–854) among children aged 0–14 years admitted to hospital in Reykjavík during the 5-year period 1987–1991. All children were admitted to a

Table 1. Number of 0–14-year-old children with head trauma, by age, sex and ICD9 number, admitted to the three hospitals in Reykjavik (Reykjavik City Hospital, National University Hospital and Landakot Hospital) during the 5-year period 1987–1991.

| Diagnosis (ICD9)                      | Age (years) |        |        |        |        |       | Total | %   |
|---------------------------------------|-------------|--------|--------|--------|--------|-------|-------|-----|
|                                       | 0–4         |        | 5–9    |        | 10–14  |       |       |     |
|                                       | Boys        | Girls  | Boys   | Girls  | Boys   | Girls |       |     |
| Concussion/commotio cerebri (850)     | 60          | 38     | 69     | 56     | 58     | 28    | 309   | 86  |
| Cerebral laceration/contusion (851)   | 2           | 3      | 8      | 1      | 6      | 1     | 21    | 5   |
| Hemorrhage in cerebral meninges (852) | 6           | 1      | 3      | 2      | 3      | 2     | 17    | 5   |
| Other intracranial hemorrhage (853)   | 3           | 1      | 1      | 0      | 1      | 0     | 6     | 2   |
| Other intracranial injury (854)       | 1           | 1      | 0      | 0      | 3      | 1     | 6     | 2   |
| Total (%)                             | 72(20)      | 44(12) | 81(23) | 59(16) | 71(20) | 32(9) | 359   | 100 |

hospital ward for at least overnight observation, following medical evaluation at an emergency unit. A diagnosis was made by a neurosurgeon or a child neurologist. Care was taken not to double-count children who were transferred from one hospital to another. Data on cause of accident, injuries and incidence were obtained through the archives of the three hospitals in Reykjavik: Reykjavik City Hospital, National University Hospital and Landakot Hospital.

The severity of head trauma was estimated by medical diagnosis according to the *International Classification of Diseases, ninth edn* (ICD9) (8). While ICD9 850, concussion, denotes a relatively milder form of trauma, the ICD9 codes 851–854 indicate severe injuries. ICD9 851 = cerebral laceration and contusion; ICD9 852 = subarachnoid, subdural and extradural hemorrhage following injury; ICD9 853 = other and unspecified intracranial hemorrhage following injury; and ICD9 854 = intracranial injury of unspecified nature.

Information was obtained regarding the number of brain-injured children receiving rehabilitation during the period 1987–1991. This was done by examining length of hospitalization and by counting the number

of brain-injured children receiving services at every rehabilitation centre in and around Reykjavik.

## Results

During the five year period 1987–1991, 359 (224M (62%), 135F (38%)) children aged 0–14 years were admitted to hospital in Reykjavik, diagnosed with head trauma (ICD9 850–854); that is an average of 72 children each year, or an annual incidence of 1.70 per 1000 population in the Reykjavik area. The number of children by age, sex and ICD9 number is shown in Table 1. The 5–9-year-old age group was the largest, followed by the youngest age group (0–4 years old). Fourteen percent of children had the more severe forms of head trauma (ICD9 diagnoses 851–854). The annual incidence of severe head trauma (ICD9 851–854) was 0.28 to 1000. A relatively high percentage (16%) of children in the youngest age group suffered the more severe forms of head trauma. Only 17 (5%) children were admitted to the intensive care unit.

During the 5-year period, 7 Icelandic children died from brain injury, indicating an annual death rate of

Table 2. Causes of head trauma (ICD9 850–854) by age and sex, among 0–14-year-old children in the Reykjavik area during the 5-year period 1987–1991.

| Cause             | Age (years) |       |      |       |       |       | Total (%) |
|-------------------|-------------|-------|------|-------|-------|-------|-----------|
|                   | 0–4         |       | 5–9  |       | 10–14 |       |           |
|                   | Boys        | Girls | Boys | Girls | Boys  | Girls |           |
| Falls             | 56          | 40    | 55   | 40    | 20    | 11    | 222 (62)  |
| Traffic accidents | 10          | 3     | 14   | 9     | 26    | 7     | 69 (19)   |
| Accidental blows  | 5           | 1     | 8    | 7     | 12    | 5     | 38 (11)   |
| Sport             |             |       | 1    |       | 7     | 7     | 15 (4)    |
| Assaults          | 1           |       |      | 2     | 1     | 1     | 5 (1)     |
| Other             |             |       | 3    | 1     | 5     | 1     | 10 (3)    |
| Total             | 72          | 44    | 81   | 59    | 71    | 32    | 359       |

Table 3. Results from studies in Iceland and six other countries regarding the incidence of trauma among children.

|                     | Annual incidence per population of 1000 |                               |                                  |                    | Death due to brain injury |
|---------------------|---|-------------------------------|----------------------------------|--------------------|---------------------------|
|                     | Trauma at EUs                           | Head and spinal trauma at EUs | Head trauma admitted to hospital | Severe head trauma |                           |
| Reykjavík 1973–1980 | 299 <sup>a</sup>                        |                               | 2.00 <sup>b</sup>                | 0.40 <sup>b</sup>  | 0.03 <sup>b</sup>         |
| Reykjavík 1987–1991 | 264 <sup>c</sup>                        | 11.0 <sup>d</sup>             | 1.70 <sup>d</sup>                | 0.28 <sup>d</sup>  | 0.03 <sup>d</sup>         |
| USA                 |   |                               | 1.85 <sup>e</sup>                | 0.27 <sup>e</sup>  | 0.10 <sup>e</sup>         |
| Israel              |   |                               | 1.71 <sup>f</sup>                | 0.26 <sup>f</sup>  | 0.03 <sup>f</sup>         |
| Norway              | 125 <sup>g</sup>                        |                               | 2.34 <sup>h</sup>                |                    |                           |
| Sweden              | 143 <sup>i</sup>                        | 9.8 <sup>i</sup>              | 2.62 <sup>i</sup>                |                    |                           |
| France              |   | 11.7 <sup>k</sup>             |                                  |                    |                           |
| Denmark             |   |                               |                                  | 0.30 <sup>l</sup>  |                           |

<sup>a</sup> Reykjavík City Hospital, Emergency Unit 1974–1991 (3); <sup>b</sup> Reykjavík City Hospital, Neurosurgical Ward 1973–1980 (7); <sup>c</sup> Reykjavík City Hospital, Emergency Unit 1991 (3); <sup>d</sup> Present study; <sup>e</sup> San Diego County 1981 (1); <sup>f</sup> Israel 1970–1976 (9); <sup>g</sup> Norway 1992 (4); <sup>h</sup> Norway 1989 (10); <sup>i</sup> Göteborg 1975–1976 (5); <sup>j</sup> Sweden 1988 (11); <sup>k</sup> France 1981 (6); <sup>l</sup> Denmark 1990 (12).

0.03 per 1000. Six of these children were younger than 10 years of age, and five were girls.

Table 2 shows the causes of head trauma. With increasing age, there was a reduction in the number of head traumas caused by falls, while there was an increase in the number of injuries from other causes, such as traffic accidents, accidental blows and sport.

On average, one to two children were referred to rehabilitation each year.

## Discussion

Table 3 compares the results of studies conducted in Iceland with six other countries on the incidence of childhood injuries and pediatric head trauma. In spite of the high incidence of childhood injuries diagnosed at emergency units in Iceland, the annual incidence of hospitalizations due to head trauma (ICD9 850–854), the incidence of severe head trauma and the annual incidence of deaths due to brain injury reported in the present study were all similar to other countries.

During the 8-year period 1973–1980, on average 84 children were admitted to hospital in Reykjavík each year diagnosed with head trauma (ICD9 850–854). Twenty percent of these children were admitted to the Intensive Care Unit, Reykjavík City Hospital, with severe brain injuries. The present study showed, that during the 5-year period 1987–1991, on average 72 children were admitted to the three hospitals in Reykjavík each year diagnosed with head trauma, and only 5% of these received intensive care. The reduction in hospital admissions due to pediatric head trauma in Reykjavík is not statistically significant. However, the decrease in the number of children admitted to the intensive care unit of the City Hospital is significant ( $p < 0.005$ ), indicating a reduction in the incidence of severe brain injuries among Icelandic children. As traffic becomes heavier and as the number of traffic accidents with and without injuries increases

in Iceland (information from Icelandic Traffic Commission, 1993), the decrease in hospital admissions due to pediatric head trauma may be attributed to greater emphasis on protective measures which have been adopted in recent years, such as the increased use of child restraints in cars, and protective helmets and high visibility reflectors for pedal cyclists and horse riders. These preventive measures seem to have been especially effective in reducing the incidence of head trauma among older children. However, a relatively high incidence of head trauma and severe brain injuries among young children (0–4 years) is of particular concern. For preventive purposes it is important to note that in this age group 83% of head traumas are caused by falls.

Admission to intensive care, diagnosis according to ICD9 or number of individuals receiving rehabilitation may not encompass all cases of severe head trauma among Icelandic children. Studies in other countries have suggested that mild and moderate head trauma can, in some cases, have considerable short- and long-term effects on the child and the child's family (13, 14). Deficits caused by head injuries are not limited to physical factors. Pediatric brain injury may also lead to deficient cognitive and academic functioning, social and emotional difficulties, behavioral disturbances, poor self-control, reduction in adaptive abilities and lack of concentration and initiative (14). All these factors can affect the maturing and developing child in many ways. The harmful effects of pediatric brain injury may not be fully recognized until later, even in late adolescence. Studies indicate that two out of every three children with severe brain injury will need prolonged support and special services (13). Long-term follow-up is therefore indicated.

The sex ratio in the present study (38% girls and 62% boys) was comparable to previous studies on pediatric head trauma in Iceland and in other countries (1, 7). Of the 50 children suffering from the more severe forms of head trauma, only 13 (26%) were girls. However, more

girls than boys died from brain injury during the study period. The reason for this is not clear; most likely it is a random effect in a small group.

On average, only one to two children were referred for rehabilitation each year. Rehabilitation was reserved for children who had suffered the most severe injuries and showed signs of serious physical and mental deficits. Rehabilitation was limited to short-term physical therapy. A broad-based, long-term rehabilitation program and support for brain-injured children and their families are not available in Iceland.

In Denmark it has been estimated that 283 children per year may be in need of support or rehabilitation due to deficits caused by head injuries (12). By simple arithmetic this would imply 19 Icelandic children each year, indicating that the rehabilitation effort in Iceland does not match the need.

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