

Epidemiological and risk predictors of severity of school injuries

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عوامل التكهّن الوبائية بمدى وخامة إصابات المدارس

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خلاصة: الحوادث هي السبب الرئيسي للمراضة والوفيات بين تلاميذ المدارس. ولقد تمت دراسة عوامل التكهّن الوبائية بمدى وخامة الإصابات بين سائر الإصابات المدرسية التي تقدّمت إلى مستشفى الطلبة بالإسكندرية خلال العام الدراسي 1996-1997. وكان إجمالي عدد التلاميذ الذين شملهم المسح 3422 مصاباً. وتبيّن أن السن وطبيعة الإصابة ومكان الإصابة المدرسية وكيفية حدوثها، وطريقة الإحالة، كانت عوامل جوهرية للتكهّن بضرورة المعالجة داخل المستشفى. كما أن السن وطريقة الإحالة وطبيعة الإصابة، كانت عوامل تكهّن جوهرية بالحاجة إلى الإحالة للخدمات الصحية المتخصصة. وأمكن التكهّن إلى حد كبير بدرجة خطورة الإصابة، عن طريق وجود مرض حاد في وقت وقوع الإصابة، ومكان الإصابة وكيفية حدوثها، إلى جانب توافر الإسعاف الأولي وطريقة الإحالة ووقتها.

ABSTRACT Accidents are the leading cause of morbidity and mortality among schoolchildren. Epidemiological and risk predictors of injury severity were investigated among all school injuries presenting at the Students' Hospital in Alexandria during the scholastic year 1996-97. In all, 3422 injured pupils were surveyed. Age, nature of injury, place and mechanism of school injury and referral method were significant risk predictors for hospitalization. Age, referral method and nature of injury were significant predictors of referral to specialized health services. Injury severity score was significantly predicted by the presence of acute disease during time of injury, place and mechanism of injury as well as by provision of first aid and referral method and time

Facteurs prédictifs de gravité des blessures sur le plan de l'épidémiologie et du risque dans les établissements scolaires

RESUME Les accidents sont la principale cause de morbidité et de mortalité chez les écoliers. On a procédé à l'examen des facteurs prédictifs de gravité, sur le plan de l'épidémiologie et du risque, pour tous les cas de blessures en milieu scolaire qui se sont présentés à l'Hôpital universitaire d'Alexandrie durant l'année scolaire 1996/1997. En tout, 3422 écoliers blessés ont été examinés. L'âge, la nature de la blessure, le lieu et le mécanisme de la blessure ainsi que la méthode d'orientation-recours étaient d'importants facteurs prédictifs du risque d'hospitalisation. L'âge, la méthode d'orientation-recours et la nature de la blessure étaient d'importants facteurs prédictifs de l'orientation vers des services de santé spécialisés. La présence d'une maladie aiguë au moment de la blessure, le lieu et le mécanisme de la blessure ainsi que les premiers soins dispensés, la méthode d'orientation-recours et le moment d'intervention permettaient de prédire l'indice de gravité de la blessure de façon significative.

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Introduction

Accidents are the most significant cause of mortality and morbidity among children attending school. Although considerable attention has been focused on accidents affecting children at home, comparatively little attention has been devoted to accidents that affect children at school [1-5]. This might be because the vast majority of school accidents results in injury rather than death [1]. Nonetheless accidents are still the leading cause of death among school-age children [6,7].

In a 1983 study by McFayden et al. the number of injuries per child ranged from 0 to 3 with 73 injuries recorded among 983 children during 1 year; none of the injuries was severe [8]. McFayden et al. also recorded 9695 school absences with a range of 0-65 absences per child [8]. Fraser estimated that in the United States 4 505 000 adolescents from 10 years to 17 years old experienced an injury during 1988 [9].

Accidents are the leading cause of death among young people in all industrialized countries and in a growing number of developing countries. The greatest proportion of all deaths due to injury occurs in children and young adults. Injury is the main cause of death among children aged 0.5-15 years [10]. Infants have been found to have the highest injury death rates; and pre-school children have the second highest injury death rates [10]. In the United Kingdom, accidental injury kills 700 children every year [4]. In Egypt, between 1975 and 1979, deaths due to accidents accounted for 7.6% of deaths among boys aged 5-14 years, a rate of 14.7 per 100 000 persons in that age group [11].

Previous studies have focused on risk factors leading to injuries. Very few have been designed to study which factors can predict the severity of injury. We studied

the epidemiological patterns of injury and its severity and identified risk factors that predicted severity of school injuries.

Subjects and methods

A complete description of the adopted methodology is presented in a report submitted to the World Health Organization in 1998 about the patterns of school injuries in Alexandria (Kamel MI et al., unpublished report, 1998). The descriptive approach was selected and a prospective survey was conducted. The inference population was pupils enrolled in all stages of education at governmental and nongovernmental schools and technical schools during the scholastic year September 1996-June 1997 (808 021 pupils) in Alexandria, Egypt. The unit of observation was considered to be each injured pupil attending at the Emergency Department of the Students' Hospital.

Data were collected with a standard interviewing form from injured pupils or from parents. The interview form requested: personal variables including age, sex, presence of acute or chronic disease during the incident; injury variables including nature, mechanism and place of injury; medical services rendered including school first aid and person providing first aid; and referral time and method. It also requested dependent variables related to hospital admission, duration of admission and time in intensive care unit, operative intervention and outcome of injury.

To calculate the injury severity score, the abbreviated injury severity score was assigned to each injury [12]. It was calculated as the total of squares of the score for the most severe three injuries [12].

School injury was defined as an injury occurring while going to or coming from

school, while inside the school or because of school activities. Injury severity indicators included hospital admission, duration of admission, referral to specialized health service and injury severity score.

Epi-Info was used for tabulation and statistical analysis. Descriptive statistics were used to identify predictors of severity of injury. Multivariate analysis techniques, i.e. stepwise multiple regression and multiple logistic regression, were used to predict significant risk factors. Dependent variables, including injury severity score and duration of hospitalization, used for multiple regression, were first tested for normality. Because they were found to be right skewed, logarithmic transformation to base 10 was used to normalize their distribution. The transformed log variables were then used for statistical analysis.

Results

During the scholastic year 1996–97, 3422 injured pupils attended the Emergency Department of the Students' Hospital in Alexandria. The overall injury rate was calculated as 4.25 per 1000 pupils per scholastic year.

Injured pupils were 5–24 years of age with a mean age \pm standard deviation of 12.93 ± 2.958 years. Boys (76.9%) were more likely to present with an injury than girls (23.1%). Only 13.4% of the pupils had a chronic health problem, the most common being refractive errors. Acute respiratory infection was the most common acute ailment (Table 1).

The greatest proportion of injuries occurred inside school buildings (37.1%) and on playgrounds (35.5%). The remainder (27.4%) occurred outside schools, which, except for very few incidents, took place in the streets. The most frequent mechanisms

of injury were falling (49.2%) and being struck by or against objects (25.2%). The most common injuries were contusion (51.6%) and fracture (23.0%). In 79.1% of cases first aid was not provided. When first aid was provided, physicians (15.4%) and nurses (4.4%) were the most likely

Table 1 Injury characteristics

Characteristic	Percentage
<i>Chronic disease</i>	
None	86.6
Sense organs	9.8
Debilitating	3.6
<i>Acute disease</i>	
None	98.6
Present	1.4
<i>Place of injury</i>	
Street	27.4
Playground	35.5
School building	37.1
<i>Mechanism of injury</i>	
Struck by or against an object	25.2
Falling	49.2
Slipping	3.2
Traffic	11.9
Violence	6.0
Other	2.6
<i>Nature of injury</i>	
Contusion	51.6
Cut or laceration	14.1
Fracture	23.0
Joint dislocation	1.3
Scratch	1.4
Sprain or strain	5.1
Brain concussion	2.8
Burn or electrocution	0.1
<i>First aid provided</i>	
None	79.1
Teacher or pupil	2.1
Nurse	4.4
Physician	15.4
<i>Referral method</i>	
Ambulance	3.8
Other	96.2

Table 2 Predictors of referral for school injuries using multiple logistic regression

Variable	Coefficient (B)	Level of significance	Exp (B)
Age	-0.1904	0.0290	0.8266
Referral method	1.5426	0.0113	4.6768
Nature of injury			
Contusion	-0.3112	0.9541	0.7326
Cut or laceration	0.6266	0.9077	1.8712
Fracture	-0.1437	0.9788	0.8622
Joint dislocation	2.2139	0.6848	9.1517
Scratches	-5.2029	0.8762	0.0055
Strain or sprain	-5.0081	0.7862	0.0067
Burn or electrocution	4.8581	0.3750	128.7831
Constant	-5.2934	0.3351	-

Model correct classification: 90.47%

persons people to give such care. Teachers only provided care in 2.0% of cases and pupils in only three cases (0.1%) (Table 1).

One-third of the injured pupils were referred within 30–45 minutes and 29.98% within 15–30 minutes of the injury event. An ambulance was used for only 3.8% of the injured pupils. The most common means of transportation were public transportation (52.7%) and taxi cabs (30.5%).

Of the injured pupils, 12.5% required hospitalization and only a minority (3.5%) needed care in specialized clinics. The rest received treatment and were discharged immediately. Duration of hospitalization ranged from 1 day to 46 days with a mean of 2.88 ± 5.06 days and a median of 1 day. Nine children were admitted to the intensive care unit with a mean hospitalization duration of 2.78 ± 1.97 days and a median of 2 days. Of the 428 hospitalized pupils, 63.8% had some sort of operative intervention. Most of these had closed bone reduction.

The mean injury severity score was 1.8773 ± 1.5367 . Of the 428 hospitalized pupils, only two suffered from partial per-

manent disability (leg amputations). None of the hospitalized died. No significant difference was observed between scores of boys (1.8502 ± 1.4950) and girls (1.9672 ± 1.6660) (Mann-Whitney $Z = 0.0411$). However, a significant negative correlation ($r = -0.0741$) was observed between age and the score for injury severity. Injury severity also differed significantly with place of injury (Kruskall-Wallis $\chi^2 = 51.6498$) in that pupils injured in streets had a higher score (2.2369 ± 1.9024) than those injured in school playgrounds (1.7199 ± 1.3592).

Significant predictors of injury severity are given in Table 2. Of the variables evaluated, age, referral method and nature of injury were significant. Of the types of injury considered, burn or electrocution was the most important predictor of severity followed by joint dislocation.

Significant predictors of hospitalization were age, sex, referral time and use of ambulance as well as nature and mechanism of the injury (Table 3). Of mechanisms of injury, traffic was the most important predictor of hospitalization. There were several predictors of injury severity score,

Table 3 Predictors of hospitalization for school injuries using multiple logistic regression

Variable	Coefficient (B)	Level of significance	Exp (B)
Age	-0.0846	0.0001	0.9189
Sex (male)	0.1512	0.0474	1.1633
Referral time	0.0092	0.0007	1.0093
Referral method (ambulance)	1.0693	0.0000	2.9133
Nature of injury			
Contusion	-2.1668	0.0000	0.1145
Cut or laceration	-0.3831	0.0878	0.6817
Fracture	0.7150	0.0003	2.0442
Joint dislocation	0.2664	0.4834	1.3052
Scratches	-0.5437	0.2491	0.5806
Strain or sprain	-0.8544	0.0078	0.4255
Burn or electrocution	0.2452	0.8182	1.2778
Mechanism of injury			
Struck by or against object	-0.1789	0.2471	0.8362
Falling	-0.1464	0.2766	0.8638
Slipping	-0.1714	0.5576	0.8425
Traffic	0.9397	0.0000	2.5591
Constant	-2.1438	0.0000	-

Model correct classification: 89.68%

Table 4 Predictors of injury severity score for school injuries using stepwise multiple regression

Variable	Coefficient (B)	Student t-test	P-value
Nature of injury	0.1149	70.388	<0.0001
Referral method	0.0704	4.505	<0.0001
Mechanism of injury			
School first aid	0.0145	5.154	<0.0001
Place of injury	0.0297	4.078	<0.0001
Time of referral	-0.0087	2.303	0.0213
Constant	0.0004	2.459	0.0140
Constant	-0.4104	15.480	<0.0001

$r = 0.78677$; $F = 924.7627$; $P < 0.0001$
 Log base 10 of the injury severity score was used as the dependent variable.

including presence of acute disease, place of injury, mechanism of injury, school first aid, referral method and time of referral (Table 4). Age, nature of the injury, place and mechanism of the injury as well as referral method and time were significant predictors of duration of hospitalization (Table 5). However, the model had a relatively moderate correlation ($r^2 = 0.4842$) and regression ($F = 174.3389$).

Discussion

Research into injury remains a priority. However, a prerequisite for the study of injury is the acquisition of sufficient data from which to develop priorities and make decisions on further research.

Table 5 Predictors of duration of hospitalization for school injuries using stepwise multiple regression

Variable	Coefficient (B)	Student t-test	P-value
Referral method	0.0145	10.186	< 0.0001
Time of referral	0.0020	3.652	0.0003
Nature of injury	0.1585	25.012	< 0.0001
Place of injury	-0.0763	5.285	< 0.0001
Mechanism of injury	0.0406	3.752	< 0.0001
Age	-0.0162	4.22	< 0.0001
Constant	-2.7859	27.201	< 0.0001

$r = 0.4842$; $F = 174.3389$; $P < 0.0001$
 Log base 10 of duration of hospitalization was used as the dependent variable.

Among the school population (808 021 students) during the scholastic year 1996–97, 3422 injured pupils attended the Emergency Department of the Students' Hospital. The mean injury severity score for injured pupils was low (1.877 ± 1.543), which is reflected in the low duration of hospitalization (median of only 1 day). This is lower than that reported by a study by Fraser in which the median was 3.2 days [9]. Of the 428 hospitalized injured pupils, 63.8% required operative procedures.

The majority of injured pupils (76.9%) were boys. Gender difference has also been reported by other researchers [1,2,13–16]. Boys were not only more prone to injury, but were also more likely to have severe injury. Being male was a significant predictor of hospitalization. The risk-taking behaviours of the boys may be responsible for their susceptibility to both injury and hospitalization as a result of injury [15]. Also hormone factors and greater freedom allowed to boys might explain why boys are more likely to have injuries [17].

The mean age of injured pupils was 12.93 ± 2.958 years. In 1996, Stark et al. reported a peak of injury incidence rate at age 10–12 years [18]. We found that age was a significant predictor of severity of injury as it was not only a predictor of hospitalization but also of its duration.

Injury prevention programmes for children should be based on an understanding of the patterns of each mechanism of injury. This is important as we found that the mechanism of injury was a significant predictor of injury severity score, hospitalization and duration of hospitalization. Falling was the most common cause of injury (49.2%), followed by being struck by or against an object (25.2%). Nearly similar proportions (52% and 25%) were reported by Jones and Olam in 1995 in Sydney [19]. Road traffic injuries ranked third (11.86%), which suggests the need for road traffic education programmes. Violence ranked fourth (8.0%). Violence has been reported by other authors as an important mechanism [15,20,21]. It indicates the need for proper supervision and improving teacher–pupil and pupil–pupil relationships.

The place of injury predicted the injury severity score as well as the duration of hospitalization. We found 72.4% of injuries occurred inside school premises, which suggests the need for closer supervision. In 1998, Kamel et al. demonstrated a significant association between place of injury and mechanism as well as with the nature of injury (Kamel MI et al., unpublished report, 1998). Both were significant predictors of severity, hospitalization and duration of admission.

The three most common injuries were contusion (51.6%), fracture (23.0%) and cut or lacerated wound (14.1%). The nature of the injury was a predictor of referral of school injuries in that burn or electrocution, joint dislocation and cut or lacerated

wounds were more likely to be referred. The nature of the injury was also a significant predictor of hospitalization in that children with fracture, joint dislocation and burns were more likely than those with other injuries to be hospitalized.

Medical care provided to injured pupils should be assessed. First aid was given to only 20.5% of the injured pupils, although 79.1% of injuries occurred inside the school. The majority received first aid from a physician or from a nurse. Moreover, 14.88% of referrals of injured pupils took

1 hour or more. This indicates the importance of replanning medical care provided to injured pupils, particularly since delays in providing care may lead to complications. It has been reported that delay of medical care after 60 minutes of injury occurrence is related to a risk of major injury [22]. In our study, the referral time was a significant predictor of severity and hospitalization as well as a predictor of referral.

The findings of our study could be used to plan school injury prevention and control programmes.

References

- Schelp L, Ekman R, Fahl I. School accidents during a three-school-years period in a Swedish municipality. *Public health*, 1991, 105:113-20.
- Lenaway DD, Ambler AG, Beaudoin DE. The epidemiology of school related injuries: new perspectives. *American journal of preventive medicine*, 1992, 2:193-8.
- Gratz RR. School injuries: what we know, what we need. *Journal of pediatric health care*, 1992, 6:256-62.
- Levene S. Preventing accidents. *Practitioner*, 1992, 236:776-8.
- Santer LJ, Stocking CB. Safety practices and living conditions of low income urban families. *Pediatrics*, 1991, 88:112-8.
- Feldman KW. Prevention of childhood accidents. Recent progress. *Pediatrics review*, 1980, 97:75-82.
- Lovejoy FH, Chafee-Bahamon C. The physician's role in accident prevention. *Pediatrics review*, 1982, 4:53-60.
- McFadyan SC et al. Injuries, absences and visits to the nurse among children in alternative schools. *Journal of school health*, 1988, 58(10):406-9.
- Fraser Jr JJ. Nonfatal injuries in adolescents: United States, 1988. *Journal of adolescent health*, 1996, 19(3):166-70.
- Baker SP, Waller AE. *Childhood injury state by mortality facts*. Baltimore, Maryland, Johns Hopkins University School of Public Health, 1989.
- Mohan D, Romer CJ. Accident mortality and morbidity in developing countries. In: Manciaux M, Romer CJ, eds. *Accidents in childhood and adolescence: the role of research*. Geneva, World Health Organization, 1991.
- Civil ID, Schwab CW. The abbreviated injury scale, 1985 version: a condensed chart for clinical use. *Journal of trauma*, 1988, 28:87-90.
- Fothergill NJ, Hashemi K. Two hundred school injuries presenting to an accident and emergency department. *Child care, health and development*, 1991, 17:313-7.
- Stone DH. Research on injury prevention: time for an international agenda. *Journal of epidemiology and community health*, 1996, 50:127-30.

15. Cobb BK et al. A longitudinal study of the role of sociodemographic factors and childhood aggression on adolescent injury and "close calls". *Journal of adolescent health*, 1995, 17(6):381-8.
16. Gallagher SS. *Facts sheet: school injuries*. Boston, Massachusetts, National Pediatric Trauma Registry, October 1988-April 1993.
17. Pulkkinen L. Behavioural precursors to accidents and resulting physical impairment. *Child development*, 1995, 66:1660-79.
18. Stark C et al. Two years of school injuries in a Scottish education subdivision. *Public health*, 1996, 110(4):229-35.
19. Jones J, Olam L. Injuries at school. *Injury issues*, 1995, a3:1-5.
20. Hammarstrom A, Janlert U. Epidemiology of school injuries in the northern part of Sweden. *Scandinavian journal of social medicine*, 1994, 22:120-6.
21. Boulton MJ. Proximate causes of aggressive fighting in middle-school children. *British journal of educational psychology*, 1993, 63:231-44.
22. Hajar Medina MC et al. Mother's work and severity of accidental injuries in children. *Salud publica de Mexico*, 1995, 37(3):197-204.

Globally, injuries are responsible for one in six years lived with disability. Injuries have, nevertheless, often been a neglected area of public health policy. More attention therefore needs to be focused on dealing with the growing problem of injuries, through more comprehensive prevention, improved emergency and treatment services, and better rehabilitation.

Source: The World Health Report, 1999. Geneva, World Health Organization, 1999. Page 19.