Outcome of Head and Other Injuries among Israeli Children: Physical Limitations and Stress Symptoms

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Abstract

Background: Head injuries, especially in young children, are frequent and may cause long-lasting impairments.

Objectives: To investigate the outcome of head and other injuries caused by diverse mechanisms and of varied severity.

Methods: The study population consisted of Jews and Arabs (n=792), aged 0–17 years old, hospitalized for injuries in six hospitals in Israel. Caregivers were interviewed during hospitalization regarding circumstances of the injury and sociodemographic variables. Information on injury mechanism, profile and severity, and length of hospitalization was gathered from the medical files. Five months post-injury the caregivers were interviewed by phone regarding physical limitations and stress symptoms.

Results: Head injuries occurred in 60% of the children, and of these, 22.2% suffered traumatic brain injury with loss of consciousness (type 1). Among the rest, 22% of Jewish children and 28% of Arab children remained with at least one activity limitation, and no statistically significant differences were found among those with head or other injuries. The odds ratio for at least two stress symptoms was higher for children involved in transport-related injuries (OR 2.70, 95% confidence interval 1.38–5.28) than for other mechanisms, controlling for injury profile. No association was found between stress symptoms and injury severity.

Conclusions: Most children had recovered by 5 months after the injury. Residual activity limitations were no different between those with head or with other injuries. Stress symptoms were related to transport-related injuries, but not to the presence of TBI or injury severity.

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Head injuries, especially in young children, are among the most frequent type of injuries and may have long-term consequences. In the United States, about one-third of the 1.4 million people suffering traumatic brain injury are 0–14 year old children, with rates disproportionately high compared with other age groups [1]. In England and Wales, head injuries accounted for 30% of deaths in the same age group [2], and presentations to accident and emergency departments are more frequent due to this cause among children under the age of 10 than in other age groups [3].

The consequences of TBI are of a physical and neurobehavioral nature [4,5], all having an impact on the functioning of the child at school and at home, and on the family [6]. While the outcome of severe TBI is not disputed, and among survivors up to 69% remain with permanent disabilities [7], there is no consensus on the permanence of the disabilities among those with milder injuries [8]. The discussion regarding the outcome of head injuries centers on the plasticity or vulnerability of the brain [9] and its relation to the severity of the injury, how generalized the cerebral trauma is, and the age of the child. That the plasticity of the brain allows younger children to overcome injury damage is now contested, and there is growing evidence that younger children may also sustain long-lasting impairments that appear as the child develops and is unable to learn new skills or function as expected for their age [10]. However, conclusions are difficult to reach, given that studies use different methodologies, case definition, length of follow-up and outcome measures.

Mental health sequelae are also to be expected after an injury, in the form of stress symptoms or post-traumatic stress disorder. This has been studied mostly following transport-related injuries [11,12], and these symptoms may appear regardless of whether a TBI has occurred [12] or whether physical recovery has ensued.

Most of the studies on injury outcomes have focused on a specific profile, for example head injuries, or on a specific mechanism (i.e., motor vehicle) and for severe cases. In the present study we report on injuries caused by diverse mechanisms and of varied severity among Jewish and Arab Israeli children. The population of 0–17 year olds in Israel comprises 69% Jews and 31% Arabs [13]. The injury incidence in this age group as measured by emergency room attendance is 1.6 higher in Jewish than Arab children, but the hospitalization rates are similar in both population groups [14], indicating a higher severity in the latter group. The aim of this study was to investigate the mechanisms and severity of head and other injuries among hospitalized Jewish and Arab Israeli children, and the consequent physical outcomes and stress symptoms 5 months after the injury.

Subjects and Methods

The study population consisted of 792 children, citizens of Israel, aged 0–17 years, from an original sample of 924 subjects, who were included in this study based on the existence of information about mechanisms and type of injury in the medical file. They were hospitalized for injuries in six hospitals across the country including four hospitals with trauma centers level I (located in major cities, and providing the full range of trauma care daily, and 24 hours availability of in-house surgeon, including specialties such as neurosurgery and burn units), and two regional centers (which do not provide the above-mentioned services).

OR = odds ratio
TBI = traumatic brain injury

The sample size selected allows detection of a difference of 10% in a given characteristic, with a ratio of sample sizes of Arabs and Jews of 1.5:1, a significance level of 0.05 and a power of 0.80 [15].

Data collection

The study was approved by the ethics committees of the hospitals. Baseline data were collected from 1 April to 31 October 2001, based on information obtained on hospitalized children from the recorded disposition in the emergency room logs. To assess representativeness of the sample, data from this study were compared with data from the trauma registries in four of the hospitals during the study period. This comparison showed, in both population groups, a similar proportion of admissions across days of the week, age and gender distribution, and injury severity.

During the selected days, caretakers were interviewed in the hospital, after providing informed consent, using a standard questionnaire in Hebrew or Arabic. Caretakers answered questions on the mechanisms of the injury and provided sociodemographic information, including population group (Jew or Arab), the child's age and gender, number of children in the family, and parents' age, education, and working status. Data on the mechanism, type and severity of the injury, as well as the length of hospitalization, were extracted from the medical file to a specially designed form.

Follow-up

Five months after the injury the caretakers were contacted by phone regarding the physical outcome of the injury and stress symptoms. Data were obtained for 549 of the participants who constitute a response rate of 69%. There were no differences in sociodemographic characteristics between respondents and non-respondents. There was a lower response rate among those with an Injury Severity Score [16] of 1 (67.1% among Jews and 63.1% among Arabs) but it was higher among those with an ISS of 16+ (75.0% and 81.2% respectively).

Definition of variables

Injury mechanism was classified according to the International Classification of Diseases (ICD-9-CM) [17]. The mechanisms were as follows: transport-related (E-codes 800-848), falls (E-codes 880-888), burns (E-codes 890-899, E-924), and other mechanisms, excluding misadventures of medical treatment (E-870-879), late effects (E-929), adverse effect of treatments (E-930-949), assaults (961-969), legal interventions (970-978), and war operations (E-990-999). The severity of the injury was classified according to the ISS derived from the Abbreviated Injury Scale (AIS-90) [16]. The AIS ranges in severity from 1 (minor) to 6 (major). The ISS is the sum of the squares of the most severe injuries in three body regions (head/neck, face, chest, abdomen, extremities/pelvic girdle, and external) and ranges from 1 to 75. Injuries were classified according to their anatomic profile based on the Barell Matrix [18] which groups the ICD-9-CM codes according to their body location and nature of injury. They were classified as: TBI definite type 1 (with loss of consciousness): 800, 801, 803, 804 (0.1-0.4, 0.6-0.9), (0.03-0.05, 053-55), 850 (0.2-0.4), 851-854, 950 (0.1-0.3), 995.55; definite TBI type 2 (with brief or unspecified loss of consciousness): 800, 801, 803, 804 (0.00, 0.02, 0.06, 0.09), (0.50, 0.52, 0.56, 0.59), 850 (0.0, 0.1, 0.5,0.9); possible TBI (with no loss of consciousness): 800, 801, 803, 804, (0.01, 0.51); other head injuries (including face and neck), and other injuries (spine/back, torso, extremities, system wide/other).

The outcomes studied were of a physical nature (mobility, participation restriction in life situations, limitation in activities) [19] and stress symptoms. Mobility was assessed according to whether the children were bedridden or homebound following the injury. Participation restriction in life situations was questioned with regard to kindergarten/school, performing sports, daily activities, and doing homework. For children aged 4 years and older, activity limitations were assessed according to the validated seven-item disability scale [20], which includes walking, running, getting up/lying down, movement in bed, going to the toilet, bathing/keeping personal hygiene, and getting dressed. The scale was dichotomized into "no limitations" and "limitations in executing at least one activity." The symptoms related to stress [21] (for children 4 years of age and older) were: difficulty in falling asleep or staying asleep, irritability, angry outbursts, difficulty in concentrating, hyper-vigilance, and exaggerated startle response (Cronbach's α, 0.90). This variable was dichotomized into less than one, and two or more symptoms.

Data analysis

Data were analyzed by SPSS [22]. Cross-tabulations were done to study the association of independent variables with the outcome, and tested for significance by chi-square test. Logistic regressions were performed to determine the unique contribution of the independent variables to the outcome (length of hospitalization, 1–6 and $\geq$ 7 days), at least one limitation in the performance of activities, and the presence of at least two stress symptoms. Independent variables introduced into the models were those associated with the respective outcomes at the $\alpha < 0.05$ level.

Results

Of the 792 children, 472 (60%) experienced head injuries. Of these, 105 children (22.2%) presented with definite TBI type 1. Seventy-five percent of children with head injuries and 95% with other injuries (mostly limb fractures) presented with single injuries.

The injury profile by age and population group is presented in Table 1. The proportion of head injuries was higher among 0–4 year olds than among other age groups, and among them the proportion of definite type 1 or 2, and possible TBI, accounted for about half of the injured in each population group. Other injuries were more common in older age groups. No differences in injury profile were found when analyzing by the child's gender or parents' education.

ISS = Injury Severity Score
AIS = Abbreviated Injury Scale

Table 1. Injury profile by age and mechanism of injury among Jews and Arabs (%)

	Jews					Arabs				
	Definite TBI type 1	Definite TBI type 2 and possible TBI	Other head injuries	Other	Total 100.0 n	Definite TBI type 1	Definite TBI type 2 and possible TBI	Other head injuries	Other	Total 100.0 n
Total	13.5	25.4	20.6	40.5	311	13.1	31.4	15.2	40.3	481
Age (yrs)										
0–4	13.7	37.3	28.4	20.6	102	14.2	38.7	18.2	28.9	225
5–9	12.2	22.4	18.4	46.9	98	10.8	25.9	12.2	51.1	139
10–14	14.0	15.1	14.0	57.0	86	12.8	25.6	15.4	46.2	78
15–17	16.0	24.0	20.0	40.0	25	15.4	20.5	7.7	56.4	39
P	< 0.001					< 0.001				
Mechanism of injury										
Pedestrian	23.8	33.3	14.3	28.6	21	23.4	21.3	12.8	42.6	47
Travel in car	9.1	22.7	40.9	27.3	22	26.1	34.8	8.7	30.4	23
Bicycle/motorcycle/scooter	13.6	31.8	22.7	31.8	22	10.3	41.0	12.8	35.9	39
Other transport related	(15.4)	(15.4)	(7.7)	(61.5)	(13)	(40.0)	(0)	(20.0)	(40.0)	(5)
Fall from heights	18.8	36.5	18.8	26.0	96	19.2	48.5	11.4	21.0	167
Fall on same level	12.0	22.0	8.0	58.0	50	5.0	43.3	6.7	45.0	60
Other	7.1	11.9	27.4	53.6	84	3.0	6.7	25.9	64.4	135
P	<0.001					< 0.001				

Numbers in parenthesis for denominators < 15

Table 2. Injury profile by injury severity score among Jews and Arabs (%)

	Jews: Injury Severity Score					Arabs: Injury Severity Score				
	1	2–8	9–15	16+	100.0 n	1	2–8	9–15	16+	100.0 N
Definite TBI type1	0	2.4	42.9	54.8	42	0	3.2	31.7	65.1	63
Definite TBI type 2 and Possible TBI	20.3	65.8	11.4	2.5	79	21.2	49.0	19.9	9.9	151
Other head	60.9	21.9	14.1	3.1	64	60.6	26.8	7.0	5.6	71
Other	23.8	51.6	23.8	0.8	122	30.5	48.9	15.3	5.3	190
Total	27.4	42.3	21.2	9.1	307	28.2	39.4	17.7	14.7	475
P	< 0.001					< 0.001				

Regarding the mechanism of injuries among Jews [Table 1], pedestrians, those riding on two-wheeled vehicles and those falling from heights presented with the greatest proportion of any type of TBI, while among the Arabs the greatest proportion of TBI were among those falling from heights and traveling in cars.

The odds ratio of definite TBI type 1 was highest for those falling from heights (OR 2.68, 95% confidence interval 1.25–5.71) and injured as pedestrians/riding two-wheeled vehicles (OR 2.45, 95%CI 1.07–5.59), relative to those who fell on the same level, controlling for the age of the child and the population group by logistic regression.

About two-thirds in both population groups (69.7% and 67.6% among Jewish and Arab children respectively) experienced injuries with an ISS of 1–8 [Table 2]. More than half of the Jewish children who experienced definite TBI type 1 had injuries with an ISS of 16+, while the proportion was even higher among the Arab children (65.1%).

CI = confidence interval

Intensive care and length of hospitalization

Eight percent of the Jewish children and 19% of the Arab children were hospitalized in pediatric intensive care wards. The proportions were greater among those suffering TBI of any type, as compared with other injuries (15.9% and 2.8%, $P < 0.001$, among the Jews and 30.5% and 10.3%, $P < 0.001$, among the Arabs). The proportion of children hospitalized for ≥ 7 days was significantly higher among Arabs (24.6%) than among Jews (14.8%). The OR of being hospitalized for ≥ 7 days was not significantly different for head injuries relative to injuries other than head injuries (OR 0.89, 95%CI 0.41–1.61), controlling for the age of the child, the mechanism and severity of the injury, and population group. Those with an ISS of 9 and above had higher OR of being hospitalized for ≥ 7 days relative to those with lower severity (OR 3.98, 95%CI 2.50–6.32).

Table 3. Proportion of homebound and bedridden after the injury, participation restriction in life situations and limitation of activities, and stress symptoms 5 months after the injury by injury profile among Jews and Arabs

		Jews						Arabs					
		Definite TBI type 1	Definite TBI type 2 and possible TBI	Other head injuries	Other	Total	*P*	Definite TBI type 1	Definite TBI type 2 and possible TBI	Other head injuries	Other	Total	*P*
Homebound	n	25	55	44	102	226	0.02	45	96	44	129	314	0.03
	%	64.0	58.2	63.6	79.4	69.5		75.6	57.3	63.6	73.6	67.5	
Bedridden	n	25	55	44	102	226	0.03	45	96	44	127	312	0.01
	%	12.0	14.5	6.8	25.5	17.7		17.8	12.5	22.7	29.9	21.8	
Participation restriction in													
Kindergarten/	n	26	43	42	97	208	0.82	35	68	32	112	247	0.10
School activities	%	3.8	7.0	7.1	4.1	5.3		20.0	10.3	28.1	13.4	15.4	
Sports	n	26	42	37	98	203	0.47	35	64	33	113	245	0.04
	%	15.4	16.7	27.0	21.7	22.7		51.4	32.8	24.2	27.4	31.8	
Daily activities	n	29	49	43	102	223	0.79	50	99	46	131	326	0.29
	%	3.4	6.1	4.7	7.8	6.3		26.0	15.2	13.0	19.8	18.4	
Doing homework	n	19	24	25	66	134	0.51	24	53	27	92	196	0.53
	%	5.3	4.2	8.0	1.5	3.7		33.3	26.4	29.6	20.7	25.0	
Limitation in at least one activity	n	26	29	28	86	169	0.21	27	50	24	93	194	0.28
(4+ year olds)	%	19.2	10.3	17.9	27.9	21.9		25.9	24.0	16.7	34.4	28.4	
At least two stress symptoms	n	25	32	28	86	171	0.34	27	47	23	93	190	0.45
(4+ year olds)	%	16.0	28.1	25.0	15.1	19.3		48.1	38.3	26.1	36.6	37.4	

n=number of children in each category of injury profile; proportions are calculated within each category of the injury profile

Physical outcome

A large majority of the caretakers in both population groups [Table 3] reported that their children were homebound following the injury. Among Jews the proportion was higher for those with injuries other than head injuries, while among Arabs the proportions were similar for those who experienced definite TBI type 1 (75.6%) and those with other injuries (73.6%). The proportion of children who were bedridden after being released from the hospital was greater among those suffering from other injuries than among those with TBI. Restriction participation in activities was reported in higher proportions for sports than for other activities in both population groups. The proportion of parents who reported that their children were restricted in school activities or in doing homework was greater among Arab than among Jewish children. The proportion of children who were limited in at least one activity was also higher among Arab children. In both population groups there were no statistically significant differences in activity limitation or participation restriction by injury profile, also controlling for the age and gender of the child, and the mechanism and severity of the injury.

Stress symptoms

The proportion of children who were reported to have experienced at least two stress symptoms was greater among Arab (37.4%) than among Jewish (19.3%) children, although in neither group were there differences according to the injury profile [Table 3]. In the multiple logistic regression, only injury mechanism (namely being injured as a pedestrian or while riding two-wheeled vehicles) presented with a higher and significant OR for at least two stress symptoms (OR 2.70, 95%CI 1.38–5.28) relative to other mechanisms, when controlling for the profile and severity of the injury, age of the child, and population group. There was no association with injury severity.

Discussion

This study presents data on outcomes among children hospitalized for injuries of varied severity. Unlike other studies on children, which usually only deal with specific injury mechanisms or TBI, this study covered all mechanisms and profile of injuries.

Our results showed that a great proportion of children in this sample presented with head injuries, half of them with TBI. Strong determinants of these injuries were related to the mechanism of the injury, with pedestrians, or riders of two-wheeled vehicles (mostly non-motorized), and those falling from heights, exhibiting the highest OR for definite TBI type I. The significance of falls among younger children and traffic injuries among older ones in the causation of TBI has been shown [1]. The increase in head injuries among adolescents noted by others [1] was not as marked in our study, which included youngsters up to the age of 18. Other studies used an upper age limit of 19, thus including a greater proportion of young car drivers with head injuries. The ethnic differences observed in the injury profile in our study can be attributed to a certain extent to the differing use of protective devices. Activities promoting the use of car restraints have been extensive across the country. However, there might be differential compliance with use and less availability of car seats in the Arab population. The use of bicycle helmets has been adopted more slowly across both population groups. For other mechanisms, such as being injured as a pedestrian or falling from heights, prevention measures require more intensive efforts focusing on environmental modifications and enforcement of regulations.

Regarding length of hospitalization, there were no differences in hospitalization for ≥ 7 days whether the child had a head injury or other type of injuries. In a country like Israel with universal access to hospitalization, also in the case of injuries, it appears that injury severity is a strong determinant of length of hospitalization. This contrasts with health-care systems where large sectors of the pediatric population are uninsured and where longer hospitalizations may be related to malfunctions in the system, especially with respect to under-served populations [23]. Still, given that our study found that a higher proportion of Arab children had longer hospitalizations than Jewish children, it might be that, besides the severity or nature of the injury, children remain in hospital for other reasons – e.g., conditions in the home or the availability and use of rehabilitation care. This requires further research, especially into the social and cultural issues that affect the use of services.

Regarding physical outcome, our study found that by 5 months after the injury most of the children had recovered, and that there was no difference in the proportion of children who remained with limited functioning whether they suffered TBI or other injuries. It appears that other injuries, such as limb fractures, can be as limiting as head injuries, in particular with respect to physical functioning. This was also found in a study that followed children aged 6–12 with TBI or orthopedic injuries for up to 4 years [9]. The proportion of children with residual limitations was lower in our study than among hospitalized 5–15 year old children with TBI in a hospital in a National Health Service Trust in England [7], who were followed for a mean period of approximately 2 years, and among whom half presented with moderate disabilities. In that study, unlike ours, residual disabilities were related to the severity of the injury, although no threshold was identified in which children would be free of sequelae. These residual limitations have an impact on the health and functioning of children in their daily lives, at home and in educational and social settings. However, the needs of these children are not always met [24] and sequelae of TBI are not always recognized by those in close contact with the children, because of poor follow-up by the hospital and poor transfer of information between the health-care system and educational frameworks [25].

With regard to stress symptoms, our study covered all mechanisms of injury, unlike most studies that concentrated on transport-related injuries. The prevalence of stress symptoms in our study did not vary according to whether the child had a TBI or not, nor by injury severity, but did vary by injury mechanism, specifically by transport-related injury. Studies reporting on post-traumatic stress disorder have shown an incidence of 29–86% among children involved in transport-related injuries [12,13]. This wide range expresses differences in target populations, in age limits (from a lower age limit of 6 or 7 years to 18 years), in lengths of follow-up (4 weeks to 13 weeks), and in type of instrument of ascertainment. The severity of the injury does not appear to influence the prevalence of stress symptoms [12].

There are some limitations in this study regarding the ascertainment of physical outcome and stress symptoms, which were subjectively made. It cannot be ruled out that the differences found between the two population groups may stem from a differential understanding of the questions (even though they were asked in the subjects' main language, i.e., Hebrew or Arabic). It is also plausible that the differences reflect a dissimilar appraisal of the problem, perhaps based on different reactions to health issues. The response rate in the follow-up interview was relatively low. The fact that there was a higher response rate among the most severe cases does not affect the findings of a lack of association with activity limitations and with stress symptoms, although some residual misclassification may exist.

In conclusion, TBI was frequent in the study population, and most of the children recovered after 5 months. However, for those who remained with limited function, the proportion among those with TBI was no different than among children with other injuries. Stress symptoms were frequent and were mostly related to the mechanism of the injury and not to its severity or profile. Health and other professionals need to be aware of the long-term effects of the injury, in particular those related to the mental health of the children regardless of the injury profile and its severity, so as to ensure a better reintegration into family life and into educational and social settings.

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