

The pattern of traumatic brain injuries: A country undergoing rapid development

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(Received 9 March 2009; revised 16 November 2009; accepted 20 November 2009)

Abstract

Background: Traumatic brain injuries (TBIs) remain an important public health problem in most industrial developed and especially in developing countries. This may also result in temporary or permanent disability.

Objective: The aim of this study was to examine the trends in the distribution of traumatic brain injuries by gender, age, severity of injury and outcome and describe the incidence in the injury patterns.

Design: This is a retrospective, descriptive, hospital-based study that included all cases of TBI during the period from January 2003 to December 2007.

Patients and methods: This study is a retrospective analysis of 1919 patients with traumatic brain injury attended and treated at the Accident and Emergency Department of the Hamad General Hospital and other Trauma Centers of the Hamad Medical Corporation. Details of all TBI cases were extracted from the database of the Emergency Medical Services (EMS). Severity of TBI was assessed by Glasgow Coma Scale (GCS).

Results: This study was based on 1919 patients suffering from traumatic brain injury, where 154 died and 97 (5.1%) of them died in the intensive care unit. The number of TBI cases increased remarkably in 2007 by 69.7%. However, the incidence rate was nearly stable across the years (4.2–4.9/10 000 population). Of the total TBI cases, the majority of them were non-Qataris (72.7%) and men (88.6%). There was a significant increase in number of TBI cases between 2003 and 2007 in terms of age group ($p = 0.003$), nationality ($p = 0.004$) and severity of injuries ($p = 0.05$). The highest peak rate of TBI cases was observed among the population over 65 years old, followed by 15–24 year olds. Falls caused most TBIs in the 1–14 years age group, road traffic accidents in the age group 15–24 years and sports and recreation in the age group 25–34 years.

Conclusion: The present study findings revealed that traumatic brain injury is a major public health problem, especially among young adults and older people. Although there was a sharp increase found in the number of TBI cases, the incidence rate of TBI took a stable trend during the study period.

Keywords: Epidemiology and incidence, traumatic brain injury, morbidity, rehabilitation, mortality

Introduction

Traumatic brain injuries (TBIs) remain one of the main public health problems in developing and developed countries; although the frequency of

brain-related pathologies reported in different countries vary considerably. TBI is a leading cause of death and disability around the globe and presents a major worldwide social, economic and health problem [1]. TBI plays the leading role in disability due

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ISSN 0269-9052 print/ISSN 1362-301X online © 2010 Informa Healthcare Ltd.
DOI: 10.3109/02699050903508192

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to trauma and is the leading cause of brain damage in children and young adults [2]. TBI can cause a host of physical, cognitive, emotional and behavioural effects and outcome can range from complete recovery to permanent disability or death. Some severe TBI victims can be left in long-term unresponsive states (coma or brain damage) or become paralysed. Long-term rehabilitation and treatment is often necessary to maximize function. The 20th century has seen critical developments in diagnosis and treatment of TBI which have decreased death rates and improved outcome.

Epidemiological data shows that TBI often occur in children and elderly and its incidence for males is twice that of females [3, 4]. TBI is a critical public health problem affecting more than 10 million people worldwide and is set to surpass many diseases as the leading cause of mortality and morbidity by the year 2020 [5]. In the US, every year 270 000 people experience a moderate or severe TBI and 70 000 people die from head injury [6]. Mortality rates due to head injury ranges from 7–30 per 100 000 according to data available from the US, UK, Australia, Spain and France [6, 7].

Causes of TBI include falls, vehicle accidents and violence. Over the past decade, rapid economic development and consequent urbanization, which tend to accompany dramatic increases in vehicles and high buildings, have resulted in alteration of life style, and such changes may have increased the risk of traffic accidents and high level falls. Also, the state of Qatar has witnessed progressive development in infrastructure and economy during the last decade. Qatar is located halfway along the western coast of the Arabian Gulf. The country is a peninsula extending towards the north of the gulf with a set of islands. The estimated population of the State of Qatar during the year 2008 was 1 448 449 (75.7% males and 24.3% females) with expatriates composing 70% of the total population [8]. The majority of the population is non-Qataris who are residing in Qatar as temporary residents under work visas for employment. Qatar is not divided into urban and rural areas because resources of primary health care have been distributed equitably in such a way so as everyone has access for immediate treatment for common diseases and injuries. Hence, Qatar is divided into urban and semi-urban areas. Nevertheless, a few studies done by Bener et al. [9, 10] in Qatar reported that there has been a dramatic increase in the incidence of head injuries and Qatar took the highest fatality rate from road traffic crashes among the developed and developing countries. Hence, it is important to investigate the pattern of TBIs in Qatar. Despite the fact that TBI is a leading cause of morbidity and mortality worldwide, there is a

paucity of good quality research and higher level of evidence in this area. To the authors' knowledge, there are no published regional studies describing the national trends in TBI. This is the first study in this region which took the initiative to examine the trends in the distribution of TBIs and describe the incidence in the injury patterns.

Patients and methods

The present study is a retrospective hospital-based study that included all cases of mild, moderate and severe TBI who were treated in the Accident and Emergency Department of the Hamad General Hospital and another eight Trauma Centres of the Hamad Medical Corporation during the period from January 2003 to December 2007. This study included 1919 patients suffering from TBI, of whom 154 died and 97 of them (5.1%) died in the intensive care unit.

Hamad Medical Corporation acts as the tertiary healthcare centre in Qatar and all injuries and fatal cases are treated in this hospital. The study was based on the Emergency Medical Services (EMS) registry which is an electronic database in Qatar. This registry records complete information of the patients who had TBI from road traffic accidents, falls and violence. The details of these victims were collected regularly by EMS staff using a standard questionnaire in the Accident and Emergency Department and Trauma Centres from the register and the medical record files of the victims. The questionnaire included variables such as age, sex, nationality, type of accident, the time of injury, type of injury, severity of injury and outcome of treatment. Outcome of treatment is classified as 'improved' if patients are back to normal state, 'partially improved' if not recovered completely, while 'severe/vegetative' means totally bedridden and death. Medical records of the victims were thoroughly reviewed in the event of any missing information.

The definition of traumatic brain injury (TBI) [10, 11] encompasses brain concussion, skull fracture, brain damage with clear neurological deficits and clinically observable cognitive deficits, post-traumatic amnesia, neurological sequelae and any evidence of intracerebral haemorrhage. The present data did not include TBIs from fights and assaults. Also, all TBI cases were doubly checked through the hospital discharge records and included any one of the following codes of the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) [11] in the diagnosis fields: 800.0–801.9, 'fracture of the vault or base of the skull'; 803.0–804.9, 'other unqualified and

multiple fractures of the skull'; or 850.0–854.1, 'intracranial injury, including concussion, contusion, laceration and haemorrhage'.

Severity of TBI was assessed by Glasgow Coma Scale (GCS) [4, 12] and classified as follows: severe is a score of 3–8, moderate is a score of 9–12 and mild is a score of 13–15. The Glasgow Coma Score is a tool for measuring the degree of unconsciousness and is thus a useful tool for determining severity of TBI. The GCS score of patients was taken at scene and, for the intubated patients, the score was taken prior to intubation.

Data are expressed as mean and standard deviation (SD) unless otherwise stated. Student *t*-test was used to ascertain the significance of differences between mean values of two continuous variables like mean age vs gender. The Fisher exact and Chi-square test for trend were used to compare frequencies between two or more than two categories. The level $p < 0.05$ was considered as the cut-off value for significance.

Results

Table I shows the trend in number of TBI cases during the period from 2003–2007. The number of TBI cases increased remarkably in 2007, by 69.7% compared to the year 2003. However, the incidence rate was nearly stable during the study period (4.1–4.9/10 000 population). Across the years, the majority of the TBI cases were non-Qataris (66–78%) and men (86–90.5%). There was a significant increase in the number of TBI cases between 2003 and 2007 in terms of age group ($p=0.003$), nationality ($p=0.004$) and severity of injuries ($p=0.048$). Also, a significant difference was observed in the mean age \pm SD of the studied TBI patients between men (29.2 ± 12.5) and women (17.3 ± 6.8) ($p < 0.001$). There was a sharp increase in TBI cases between 2003 and 2007 in the age groups 15–24 years by 132% and 25–34 years by 118%. Also, severe and moderate TBIs increased considerably in 2007 by 154% and 165%, respectively. Most of the

Table I. Trend in the number of TBIs during the study period 2003–2007 ($n=1919$).

Variable	2003 (%) <i>n</i> = 304	2004 (%) <i>n</i> = 314	2005 (%) <i>n</i> = 366	2006 (%) <i>n</i> = 419	2007 (%) <i>n</i> = 516	Variance %	<i>p</i> -value
<i>Age group</i>							
0–14 years	85 (28.0)	96 (30.6)	88 (24.0)	84 (20.0)	85 (16.5)	0	0.003
15–24 years	56 (18.4)	64 (20.4)	83 (22.7)	83 (19.8)	130 (25.2)	132	
25–34 years	67 (22.0)	60 (19.1)	96 (26.2)	127 (30.3)	146 (28.3)	118	
35–44 years	48 (15.8)	47 (15.0)	47 (12.8)	56 (13.4)	80 (15.5)	67	
45–54 years	21 (6.9)	23 (7.3)	29 (7.9)	39 (9.3)	37 (7.2)	76	
55–64 years	12 (3.9)	11 (3.5)	13 (3.6)	18 (4.3)	16 (3.1)	33	
≥65 years	15 (4.9)	13 (4.1)	10 (2.7)	12 (2.9)	22 (4.3)	47	
<i>Gender</i>							
Male	264 (86.8)	270 (86.0)	323 (88.3)	379 (90.5)	464 (89.9)	76	0.248
Female	40 (13.2)	44 (14.0)	43 (11.7)	40 (9.5)	52 (10.1)	30	
<i>Nationality</i>							
Qatari Male	71 (23.4)	83 (26.4)	82 (22.4)	94 (22.4)	91 (17.6)	28.2	0.011
Qatari Female	19 (6.3)	24 (7.6)	18 (4.9)	20 (4.8)	22 (4.3)	15.8	
Non-Qatari Male	193 (63.5)	187 (59.6)	241 (65.8)	285 (68)	373 (72.3)	93.3	
Non-Qatari Female	21 (6.9)	20 (6.4)	25 (6.8)	20 (4.8)	30 (5.8)	42.9	
<i>Type of accident</i>							
RTA	162 (53.3)	163 (51.9)	204 (55.7)	219 (52.3)	236 (45.7)	46	0.162
Fall	94 (30.9)	102 (32.5)	103 (28.1)	136 (32.5)	177 (34.3)	88	
Sports and recreation injuries	48 (15.8)	49 (15.6)	59 (16.1)	64 (15.3)	103 (20.0)	114	
<i>Time of week</i>							
Week days	93 (30.6)	99 (31.5)	113 (30.9)	127 (30.3)	156 (30.2)	68	0.996
Weekend	211 (69.4)	215 (68.5)	253 (69.1)	292 (69.7)	360 (69.8)	70	
<i>Severity of injuries</i>							
Severe (3–8)	22 (7.2)	26 (8.4)	35 (9.6)	41 (9.9)	56 (10.8)	154	0.048
Moderate (9–12)	46 (15.1)	58 (18.5)	78 (21.2)	91 (21.8)	122 (23.7)	165	
Mild (13–15)	236 (77.7)	230 (73.1)	253 (69.2)	286 (68.3)	338 (65.5)	43	
<i>Outcome of injury</i>							
Non-fatal	285 (93.8)	291 (92.7)	335 (91.5)	382 (91.2)	472 (91.5)	66	0.708
Fatal	19 (6.3)	23 (7.3)	31 (8.5)	37 (8.8)	44 (8.5)	132	
Incidence rate/10 000 population (overall)	4.2	4.1	4.6	4.9	4.2	0	

TBIs occurred during weekends throughout the study period, with a stable trend (69–70%).

Table II examines the mechanism of TBIs by type of accidents during the period from 2003 to 2007. More than half of the TBI patients were the victims of road traffic accidents (51.3%), followed by injuries from falls (31.9%). Most of the TBI patients were non-Qataris (72.7%) and in the age group 25–34 years (25.8%). The highest peak of the TBI from road traffic crashes was in the age group 15–24 years (31.1%), then from falls in the age group 1–14 years (38.9%), and from sports and recreational injuries in the age group 25–34 years (33.4%). Only 44.8%

of the TBI patients returned to normal after the treatment.

Figure 1 shows the incidence rate of TBIs by age group and year during the 5-year study period. The highest peak rate of TBI per 10 000 population was recorded among the above 65 year old population, followed by 15–24 years across the study period.

Figure 2 shows the proportion of TBIs by mechanism of injury and age group during the 5-year study period. Falls caused most of the TBIs in the age group 1–14 years and then road traffic accidents caused most TBI in the age group 15–24 years and sports and recreation in the age group 25–34 years.

Table II. Mechanism of TBIs by type of accidents during the period from 2003 to 2007 ($n=1919$).

Variable	Road traffic accident ($n=984$)		Falls ($n=612$)		Sports and recreation injuries ($n=323$)		Total ($n=1919$)		<i>p</i> -value	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
Gender										
	Male	893	90.8	512	83.7	295	91.3	1700	88.6	0.001
	Female	91	9.2	100	16.3	28	8.7	219	11.4	
Nationality										
	Qatari	324	32.9	154	25.2	46	14.2	524	27.3	0.001
	Non-Qatari	660	67.1	458	74.8	277	85.8	1395	72.7	
Age group										
	1–14 years	151	15.3	238	38.9	49	15.2	438	22.8	0.001
	15–24 years	306	31.1	60	9.8	50	15.5	416	21.7	
	25–34 years	241	24.5	147	24.0	108	33.4	496	25.8	
	35–44 years	136	13.8	67	10.9	75	23.2	278	14.5	
	45–54 years	66	6.7	57	9.3	26	8.0	149	7.8	
	55–64 years	40	4.1	23	3.8	7	2.2	70	3.6	
	≥65 years	44	4.5	20	3.3	8	2.5	72	3.8	
Outcome of treatment										
	Improved (normal state)	435	44.2	188	30.8	137	42.5	761	38.4	0.001
	Partially improved	264	26.8	65	10.6	54	16.7	383	25.0	
	Severe/vegetative	188	19.1	326	53.2	108	33.4	621	22.6	
	Death	97	9.9	33	5.4	24	7.4	154	8.00	

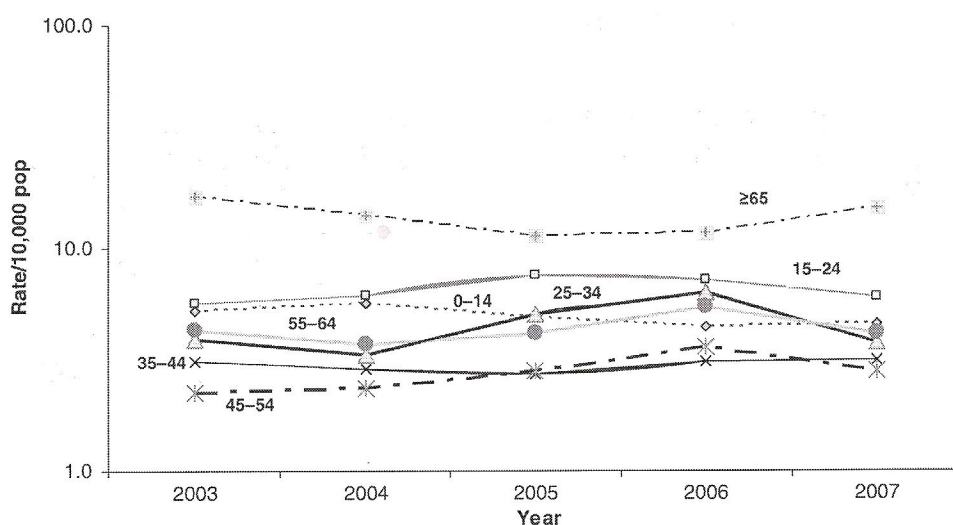


Figure 1. Incidence rate of TBIs by age group and year during the 5-year study period.

Discussion

This is an important study which provides epidemiological data on incidence, mortality, severity and patterns of TBIs for a 5-year period (2003–2007). The devastating personal, social and financial consequences of TBI are compounded by the fact that most people with TBI are young and previously healthy. There has been very few population-based epidemiological studies conducted on TBI in developed countries. This is the first study in the State of Qatar, even in the gulf region, that examined the trends in the distribution of TBI by gender, age, nationality, mechanism and severity of injury.

The incidence of TBI varies by age, gender, region and other factors [13]. In the State of Qatar, it was observed that the incidence rate of TBI was 4.2 per 10 000 population in 2007, which is lower than most developed countries. The yearly incidence of TBI per 10 000 people was 18–25 in the US; 28.1 in France; 26.1 in South Africa; 32.2 in Australia [14] and 43 in England [15]. There was a remarkable increase in TBIs between 2003 and 2007, of 69.7%, although the incidence pattern remained stable. Comparing to the overall incidence rate coverage of 20 per 10 000 population for developed countries [16], the incidence rate of TBI in Qatar is very low. The possible explanation for the lower incidence could be under-reported TBI cases. It is difficult to comment about the under-estimate because there are no published studies in the gulf region to compare the incidence pattern of TBIs.

In this investigation, it is alarming to observe that men suffer from TBI ~8-times more than women (7.8:1). Furthermore, non-Qataris were more often affected by TBI (72.7%). This explains that the

non-Qatari labour force in Qatar is at high risk for TBI. The Qatar population pyramid shows a high proportion of non-Qatari men in the age group 20–40. However, in a study by Hardman et al. [18], it was reported males prevailed over females with a ratio of 2:1 and had a 4-fold risk of fatal head injury. During the study period, 88.6% of the TBI victims were men. A similar proportion was found in a study done in Brazil [19], where 83% were males with the most frequent age group being 21–30 years. In contrast, among Mexicans [20] who were hospitalized as a result of TBI every year, only 68% of them were males.

The present study revealed a highest peak incidence rate of TBI among the old population above 65 years old, followed by 15–24 years. In another study, it was documented the age groups most at risk for TBI are children and the highest rates of mortality and hospitalization due to TBI are in people over 65 years old [21]. However, the peak incidence in younger children is not found in this study, indicating that it is likely to be due to falls, which is quite evident in the graph that proportion of falls in the age group 1–14 years took the highest peak (38.9%). Similar to these results, a higher incidence peak of TBI was reported in the 15–24 years population in Brazil [19].

Of the TBI cases studied, more than half of the injuries were from road traffic crashes (51.3%), with the highest peak in the age group 15–24 years (31.1%). A study of Baldo et al. [22] in Italy also confirms road traffic crashes as a major cause of TBIs (48.5%) with a higher rate among 16–25 year old [21]. Also, in China [23], traffic accidents (60.9%) were the major cause of TBI in all age

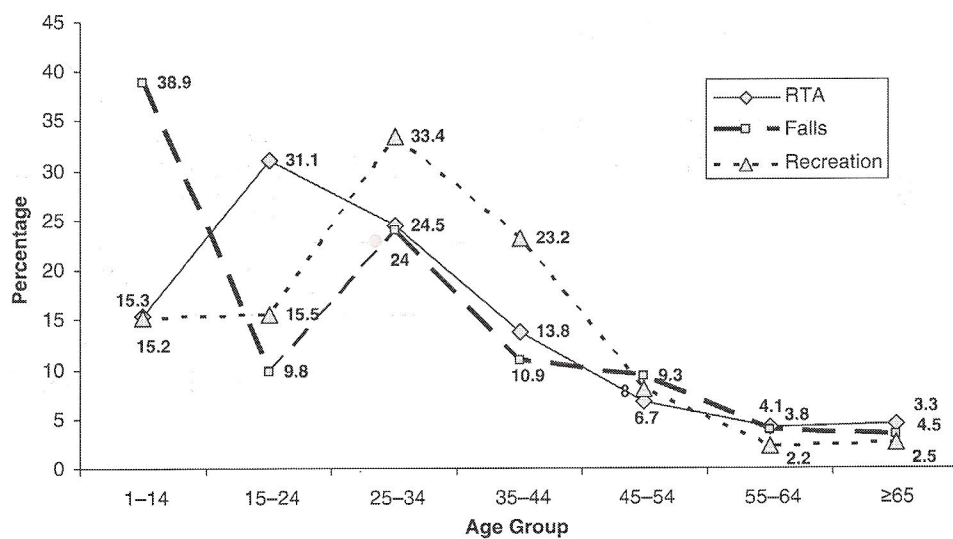


Figure 2. Proportion of TBIs by mechanism of injury and age group during the 5-year study period.

groups, but TBI patients in the age group 35–44 years were the most vulnerable for traffic accidents. Over 70% of TBIs in Taiwan are caused by traffic accidents, a percentage higher than in the stated countries [24]. These study findings support each other in that traffic accidents were the first leading causes of TBI. This may be due to the rapidly increasing number of vehicles during the past decade in developing and developed countries.

In the present study, falls were found to be the second leading cause of TBI (31.9%) and the main cause of TBI in children of 1–14 years (38.9%). Falls, which represent the most frequent cause of TBI in the youngest were observed in many studies. In China, falls were the third leading cause of TBI, with a lower proportion (13.1%) and in Brazil (24%) [18].

Among the studied TBI patients, the proportion of severe and moderate injuries has been increasing across the study period, whereas there was a constant decline in the proportion of mild injuries in 2007. It was found that moderate and severe injuries each account for on average 9.4% and 20.5%, with the rest mild injuries. A US study [25] also found a similar proportion, 10% of TBIs was for severe and moderate injuries each. Another study done in France reported a higher proportion of severe injuries (20%) and moderate injuries (18%) with 62% mild injuries [26].

Considering the treatment outcome, only 44.8% of the TBI cases came back to a normal state, leaving 27.2% in the severe or vegetative state and 20% in partial improvement. It is interesting to note that among the victims of TBI, number of falls resulting in severe injuries or vegetative state contributed a higher proportion (36.9%) than TBI from car accidents (19.1%). The higher proportion of brain injuries from falls is due to the high proportion of non-Qatari male labour force in Qatar. In Qatar, a large number of non-Qatari men are working in the construction and industrial field who do not own any vehicles. These men are the high risk group for falls rather than car accidents. This shows that special efforts should be made to reduce the number of TBIs from falls involving young people. This highlights the importance of having cost-effective programmes for people living with TBI addressing acute care, rehabilitation and specific welfare programmes to reduce the risk of falls and to restrict functional impairment in the elderly.

The TBI pattern in the current study provides some useful information for emergency physicians who deal with severe trauma. Since most of the pathologic process that determines outcome is fully active during the first hours after TBI, the decisions of emergency care providers may be crucial. The stable pattern of the incidence of TBI in Qatar

shows the magnitude of TBI in Qatar and requires public health measures to reduce the rate. As TBIs are largely preventable, public awareness and prevention programmes targeting the high risk groups are of great importance.

Conclusions

The present study findings revealed that TBI is a major public health problem, especially among young adults and older people. Although there was a sharp increase found in the number of TBI cases, the incidence rate of TBI took a stable trend during the study period. TBI rates are higher in males compared to females. The highest peak rate of TBI was observed among the population over 65 years old, followed by 15–24 years. Falls were found to be the main cause of TBI in children and road traffic accidents prevailed as the leading cause of TBI in adults. In the future, it would be good to establish a national TBI registry for reliability.

Declaration of interest

The authors declare that there are no competing interests.

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