original article

Causes and patterns of adult traumatic head injuries in Saudi Arabia: implications for injury prevention

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BACKGROUND AND OBJECTIVES: Data on the epidemiology of traumatic head injuries (THI) is essential for any organized prevention program. Such data are few in the developing world. Our primary goal was to study the causes, descriptive features, and outcomes of THI in adults in Saudi Arabia.

DESIGN AND SETTINGS: The present study is a retrospective review.

METHODS: This retrospective review included all consecutive cases of adults with THI (>18 years) who were admitted to a major trauma centre in Riyadh, Saudi Arabia, from May 2001 to July 2010. Patients were identified through a trauma database, which includes cases that required hospital admission or died in the emergency department.

RESULTS: A total of 1870 patients met the inclusion criteria with a mean age of 32.6 years and a male predominance (91.2%). Most injuries were secondary to motor vehicle collisions (MVC; 69.4%). Pedestrian injuries were second (16.8%) and had 40% risk of mortality (odds ratio 0.62, 95% CI 0.48-0.8). Most patients (56.7%) had a severe THI (Glasgow coma score, GCS < 8). The overall mortality rate was 30%. Mortality was significantly associated with older age (*P*=.0001), lower GCS (*P*=.0001), and a higher injury severity score (ISS; *P*=.0001).

CONCLUSION: The most common causes of hospital admission following injury were MVC and pedestrian injuries. Both were also the most common causes for injury-related deaths. Safety on the roads should be the primary target for any organized injury prevention programs to be successful.

Traumatic head injury (THI) is a major cause of morbidity and mortality between the ages of 15 and 44 years in most countries.[1-3] Affected individuals may experience severe disabilities including physical and cognitive difficulties, personality changes, epilepsy, and speech impairment.[4,5] Rehabilitation of THI patients is a burden on the family, society, and health services.[4-6] Additionally, the cost to society is high. In the United States (US), the cost due to loss of productive years to death and disability secondary to THI was estimated as $9.2 billion and $51.2 billion, respectively.[3]

The incidence and prevalence of THI varies according to study location, included population (hospitalized or general public), and the grade and severity of included head injuries. The incidence of THI in the US between 2002 and 2006 was 1.7 million cases per year. Out of those, 1.4 million were discharged from the emergency department, 275 000 required hospital admission and discharged alive, and 52 000 were dead.[7] In Australia, the incidence of THI was 322 per 100 000 population.[8] European estimates of THI were 235 cases per 100 000 and around 7 775 000 cases in 10 years. Their average mortality rate was 15 per 100 000 and case fatality rate was 11 per 100 cases.[9] Regional variability in the number of traumatic brain injuries is evident when comparing some areas in Italy to others in France with an annual incidence of 24.4 and 5.2 per 100 000, respectively.[10,11]

The role of THI as a leading cause of morbidity and mortality in the developing world has been increasingly reported.[12,13] In Al Ain city, United Arab Emirates, THI affected 42 per 100 000 inhabitants and accounted for about two-third of trauma-induced deaths.[12] Another study from Qatar showed a THI incidence rate of about 4.2 to 4.9 per 10 000 population.[14] Similar studies about demographics of THI are lacking in Saudi Arabia. Our aim was to study causes and pattern of THI in a major trauma center. Such data is valuable to guide injury prevention programs and provide an aid for resource management and discharge planning.

METHODS

Study design and study population

The present study is a retrospective review. It included all consecutive cases of adults (>18 years) with THI in a major trauma center in Riyadh, Saudi Arabia, from first of May 2001 to July 2010. Patients were identified through King Abdulaziz Medical City Trauma Registry (KAMC-TR). KAMC-TR is a prospectively recorded database. A full-time data registrar is responsible about collecting the data and following patients from admission until discharge. An annual audit of 5% of the data is performed through medical records for quality assurance purposes. The database includes patients who died in the Emergency Department (ED), or required hospital admission. The cases that were discharged from the ED without admission were not included. The missing data was collected and verified from the hospital medical records. Ethics approval for the present study was obtained from the Institutional Review Board prior to study commencement.

Study setting

Riyadh's population is around 5.8 million residents, constituting 24.1% of the Saudi population.[15] Major traumas are transferred to trauma centers based on the geographic location of the accident. KAMC, where the study was performed, is one of the largest trauma centers in the country.

Data variables

Descriptive patient and injury-related data were obtained. It included patient's age, gender, use of protective devices, date, time, and injury mechanism and place. The severity of injury was assessed using Injury Severity Score (ISS). The validity of ISS in predicting mortality and hospital length of stay has been validated in several studies.[16,17] The severity of THI was assessed using Glasgow Coma Scale (GCS), which is a valid method to predict disability and mortality in patients with head injury.[18] Both ISS and GCS were assessed at presentation to the ED. Other variables pertaining to intervention and outcome of injury including the need for surgical intervention, length of hospital stay, and patient's final disposition following discharge were also analyzed.

Statistical analysis

Statistical analysis was performed using SPSS, version17.0 (SPSS, Chicago, IL, USA). Descriptive statistics in the form of mean, median, and standard deviation were included. Student t test was utilized for continuous variables. Chi-square test was used for categorical variables. ANOVA was calculated for multiple groups with continuous variables. The level of significance was set at *P* value <.05.

RESULTS

Patient and injury characteristics

A total of 1870 patients satisfied the inclusion criteria. The details of patients and injury characteristics were illustrated in **Table 1**. The mean age was 32.6 years (±14.7). Males (1706; 91.2%) were more affected than females (164; 8.8%). Drivers constituted the majority of admitted cases (79%). Associated spine fractures were present in 20.6% of cases; mostly affecting the cervical spine (50%, **Table 1**). The most commonly associated body injury was in the thoracic area (46.6%) followed by extremity injuries (39%).

Motor vehicle collision (MVC) was the most common mechanism of injury (69.4%) followed by pedestrian injury (16.8%) among all age groups (**Figure 1**).

Injury severity

The mean ISS was 26.44. Higher impact injuries (ISS 16 and above) affected 60% of the study population and had a higher mortality rate (99.5%). Only 3 patients (0.5%) with an ISS below 16 died (*P*=.0001). The mean GCS was 8.3. Most patients (56.7%) had a severe THI (GCS 3-8) followed by 30.3% with mild THI (GCS13-14); then 13% with moderate THI (GCS 9-12). Patients admitted with severe THI constituted 93.2% of the total mortality rate.

Injury outcome

The mortality rate was 30% (555 cases) of the total study sample. MVC was responsible for 68.3% of deaths (**Table 2**) followed by pedestrian injuries (21.8%). Mortality was significantly associated with older age (*P*=.0001), car drivers (*P* =.02), a lower GCS (mean of 4, *P*=.0001), and a higher ISS (mean of 53.6, *P*=.0001). In Addition, there was a low percentage of skull fractures in the mortality group (mean 18.7%, *P*=.0001) and only 6.8% had craniotomy. Gender was not a significant factor in association with mortality (*P*=.258). Among individual mechanisms of injuries, pedestrian injuries had more deaths (40%, OR of 0.62, 95% CI 0.48-0.8). Within the groups of MVC and falls, mortality rate was 29.2% and 18.2%, respectively. Transfer out of the ED was mostly to the intensive care unit (36%). A total of 68% were discharged home.

DISCUSSION

The present study is the largest to address the demographics of THI in adults in Saudi Arabia. MVC was the main mechanism of THI, which was similar to other studies in neighboring countries such as United Arab Emirates and Qatar.[12,19] In contrast, reports from the developed world, like the US, identified fall and assaults as the main causes of THI.[7] However, motor vehicle–traffic injuries in the US remained the leading cause of THI-related deaths.[7] The increased THI rate among males compared to females (10.4 to 1, respectively) is higher than other studies in the developed world and neighboring countries. It could be a reflection that women do not drive cars in Saudi Arabia.[12,19]

Pedestrian injuries were the second common cause (17%) of THI. The alarming figure of mortality within this group (40%) is different from those reported in the developed world. For instance, in Europe and the US pedestrian mortality among THI patients reached 20% and 14% respectively.[20] Although developed countries reported less pedestrian injuries, 5000 people die and 60 000 are injured as pedestrians in the US annually. Comparative fissures from the European Union indicate that out of 50 000 annual road traffic deaths, 8500 were pedestrians.[21,22]

THI secondary to falls represents a challenge in most developed countries. Figures from Europe showed falls to be responsible for about 15% to 61% of THI (in Ravenna and Finland, respectively).[9,23] In the US, falls were responsible for 35% of THI and resulted in the greatest number of THI-related ED visits (523 043) and hospitalizations (62 334).[7] The relatively lower percentage of falls in the current study (6%) could be related to the young average age of Saudi population. The median age in Saudi Arabia is 21 years and people under the age of 24 comprise 48.6% of the population.[24] In United Arab Emirates, where population age distribution is similar, a comparable percentage of falls was reported (11.9%) among patients with THI.[12]

The severity of THI is one of the most important predictors for mortality in hospitalized trauma patients.[25,26] Internationally, the reported mortality rate among THI patients was 15 per 100 000 individuals in

Table 1. Patient and injury characteristics.

	Total (n=1870)	Alive (n=1315)	Dead (n=555)	*P* value
Age	32.61 (14.66)	31.58 (14.07)	35.06 (15.72)	.0001
Gender				
Male	1706 (91.2%)	1206 (91.7%)	500 (90.1%)	.258
Female	164 (8.8%)	109 (8.3%)	55 (9.9%)	
Vitals on admission				
HR	98.08 (31.45)	100.98 (24.17)	87.62 (48.14)	.0001
RR	21.42 (7.92)	22.26 (6.47)	18.36 (11.24)	.0001
SBP	129.74 (38.35)	135.66 ± 26.53	108.36 (60.51)	.0001
GCS (mean)	8.30 (5.95)	10.12 (6.045)	4.0 ± 2.48	.0001
Mild	561 (30.3%)	546 (41.9%)	15 (2.7%)	.0001
Moderate	241 (13.0%)	219 (16.8%)	22 (4.0%)	
Severe	1049 (56.7%)	539 (41.3%)	510 (93.2%)	
ISS (mean)	26.44 (22.95)	14.80 (10.02)	53.57 (21.64)	.0001
Below 16	739 (40%)	736 (56.9%)	3 (0.5%)	.0001
16 and above	1109 (60%)	557 (43.1%)	552 (99.5%)	
Type of injury				
Blunt	1840 (98.4%)	1300 (98.9%)	540 (97.3%)	.003
Penetrating	27 (1.6%)	12 (1.1%)	15 (2.7%)	
MVC position[a]				
Driver	312 (79.2%)	248 (775%)	64 (86.5 %)	.02
Front passenger	48 (12.2%)	46 (14.4%)	2 (2.7%)	
Rear passenger	34 (8.6%)	26 (8.1%)	8 (10.8%)	
Skull fracture				
Yes	571 (30.5%)	467 (35.5%)	104 (18.7%)	.0001
No	1299 (69.5%)	848 (64.5%)	451 (81.3%)	
Spine fractures				
Cervical	191 (10.2%)	158 (12.0%)	33 (5.9%)	.0001
Thoracic	101 (5.4%)	78 (5.9%)	23 (4.1%)	.118
Lumbar	94 (5.0%)	80 (6.1%)	14 (2.5%)	.001
Associated injuries				
Face and neck	482 (25.8%)	413 (31.4%)	69 (12.4%)	.0001
Thorax	872 (46.6%)	637 (48.4%)	235 (42.3%)	.016
Abdomen	457 (24.4%)	309 (23.5%)	148 (26.7%)	.145
Extremity	728 (38.9%)	571 (43.4%)	157 (28.3%)	.0001
Others	188 (10.1%)	147 (11.2%)	41 (7.4%)	.013
Craniotomy				
Yes	175 (9.4%)	137 (10.4%)	38 (6.8%)	.015
No	1695 (90.6%)	1178 (89.6%)	517 (93.2%)	
Hospital LOS (d)	37.74 (79.21)	50.10 (88.8)	8.44 (35.07)	.0001

HR: Heart rate, RR: respiratory rate, SBP: systolic blood pressure, GCS: Glasgow Coma Scale, mild head injury: GCS 13-15, moderate head injury: GCS 9-12, severe head injury: GCS 3-8, ISS: injury severity score, MVC: motor vehicle collision, LOS: length of stay.

[a]MVC position is related to where the injured person was seated in the car.

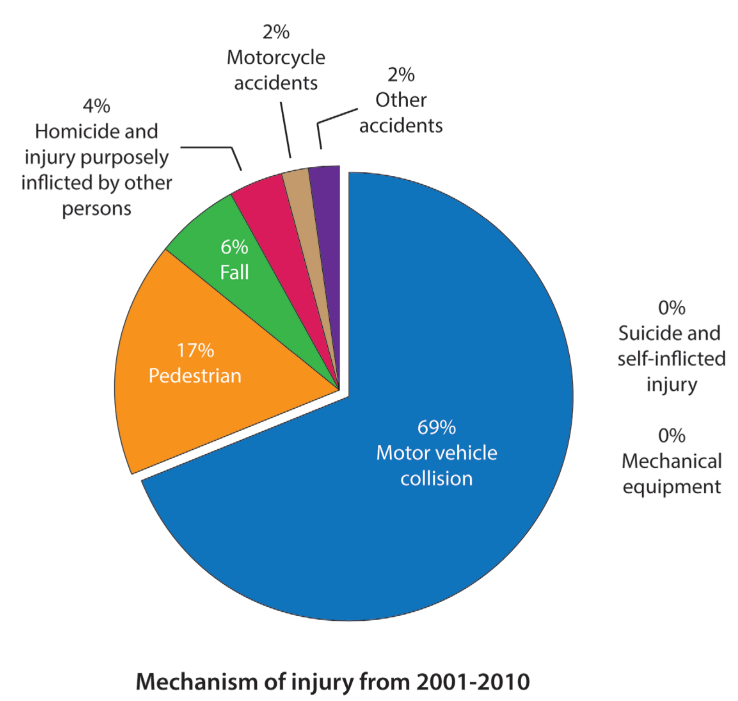

Figure 1. Mechanism of head injury in all age groups.

Table 2. Distribution of mechanism of injuries related to the outcome.

Mechanism of injury	Total (n=1870)	Alive (n=1315)	Dead (n=555)
Motor vehicle collision	1298 (69.4%)	919 (70.8%)	379 (29.2%)
Pedestrian	315 (16.8%)	194 (61.6 %)	121 (38.4%)
Fall	110 (5.9%)	90 (81.8%)	20 (18.2%)
Homicide and injury purposely inflicted by Other persons	75 (4.0%)	54 (72%)	21 (28%)
Motorcycle accident	34 (1.8%)	34 (100%)	0
Suicide and self-inflicted injury	2 (0.1%)	2 (100%)	0
Mechanical equipment	1 (0.1%)	1 (100%)	0
Other accidents	35 (1.9%)	21 (60%)	14 (40%)

Europe and 17.8 per 100 000 individuals in the US.[9,27] The death rate of 30% in the current study was higher than the overall mortality in the United Arab Emirates (6%) and Qatar (8%).[12,19] However, comparison may not be accurate since our study sample included only admitted patients with THI where most of them had a severe head injury (mean GCS of 8.3). Among different mechanisms of injuries included in the current study, most deaths occurred within the pedestrian group (40%) followed by MVC (29.2%). This raises a serious public health concerns and calls for an action to prevent such fatal injuries.

The current study should be interpreted within its retrospective design limitations. It is a hospital-based study where all included patients required hospital admission. There were few details available on the location of the injury, restraining devices such as seatbelt and helmets, and detailed neurological status at discharge. Nonetheless, it illustrates an alarming percentage of deaths secondary to admitted patients with THI. It also identified MVC and pedestrian injuries as the main causes that require appropriate public health measures and preventive programs.

Various injury prevention programs were effective in reducing morbidity and mortality worldwide. Preventive programs in Sweden resulted in a significant reduction of road traffic injuries.[28] The use of protective equipment like seatbelts and helmets for motorcyclists and bicyclists can reduce the incidence of cranial and non-cranial injuries.[29,30] The current study could be used as an impetus to develop more safety regulations on the roads particularly street-crossing rules and driving regulations. There is also a need for collecting trauma data on a population scale to identify the major causes of injury and design-targeted prevention programs.

In conclusion, MVC was the main mechanism responsible for THI admission and mortality followed by pedestrian injuries and falls. The current study calls for the need of a countrywide data collection program and the development of organized injury prevention strategy.

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