Injury, Int. J. Care Injured xxx (2008) xxx–xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Factors affecting anatomical region of injury, severity, and mortality for road trauma in a high-income developing country: Lessons for prevention☆

Hani O. Eid [a], Peter Barss [b], Shehabeldin H. Adam [a], Fawaz Chikh Torab [a,c], Karl Lunsjo [a,c], Michal Grivna [b], Fikri M. Abu-Zidan [a,c,*]

[a] Department of Surgery, Faculty of Medicine & Health Sciences, UAE University, Al Ain, United Arab Emirates
[b] Department of Community Medicine, Faculty of Medicine & Health Sciences, UAE University, Al Ain, United Arab Emirates
[c] Department of Surgery, Al Ain Hospital, Al Ain, United Arab Emirates

ARTICLE INFO

Article history:
Accepted 10 July 2008

Keywords:
Traffic safety
Injury prevention
Hospitalisation
Mortality
Trauma registry
Severity
Epidemiology

ABSTRACT

Objectives: To study the factors affecting anatomical region of injury, severity, and mortality among road users in United Arab Emirates so as to improve preventive measures.
Methods: Data of the Trauma Registry of Al Ain city were collected prospectively over 3 years (2003–2006) at the main trauma hospital. For traffic injuries, the following were assessed: gender, nationality, road user type, anatomical region(s) of injury, systolic blood pressure on admission, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), and mortality. Analysis included frequencies, cross-tabulations, and logistic regression.
Results: There were 1070 patients, 89% male, 25% UAE nationals, and with a mean age of 31 years. Expatriates, mainly from non-Arabic speaking, low-income countries, accounted for 88% of injured pedestrians, whilst nationals were overrepresented among vehicle occupants (29%), and motorcyclists 37%. Injuries of the extremities and head were frequent among pedestrians, motorcyclists, and bicyclists, whilst head and spine injuries were most common among front and rear vehicle occupants and drivers. The median ISS was five for pedestrians and four for all other road user types, including rear vehicle occupants. The mean hospitalisation was 9.7 days; 13% of patients were admitted to ICU with mean stay of 6.5 days. Overall mortality was 4%; pedestrians accounted for 61% of deaths. Predictors of mortality were GCS ($p < 0.001$), ISS ($p < 0.01$) and systolic blood pressure on admission ($p < 0.03$).
Conclusions: Head injury was a major factor affecting mortality, followed by injury severity and hypotension. To reduce injury incidence and severity, legislation and education are needed to ensure use of seat belts by all vehicle occupants including rear passengers, high-visibility devices by other road users, helmets by motorcyclists and bicyclists, protective clothing and boots for motorcyclists, and traffic engineering for pedestrians.

Introduction

Road traffic injuries are a global public health problem, with an estimated 1.2 million deaths and 50 million non-fatal injuries per year.[38] In the United Arab Emirates (UAE), unintentional injury is the leading cause of death among people younger than 45 years, and possibly at all ages. Road traffic injuries accounted for 77% of unintentional injury deaths in 2003.[32] Whilst road traffic death rates are among the highest in the world, crash rates have been decreasing; however, severity of injury and deaths per crash have been increasing,[14] probably due to modern high speed roads. We aimed to study the factors affecting anatomical region of injury, severity, and mortality among road users in United Arab Emirates so as to improve preventive measures.

Methods

Al Ain, with a population of about 450,000 inhabitants at the time of the study, is the largest city in the eastern district of Abu Dhabi Emirate, and one of the four largest in the country.

A Trauma Registry was established in 2003 at Al Ain Hospital, one of two major hospitals in Al Ain city. During the study period,

☆ This paper was presented as an oral presentation at: 1st Joint Congress of European Association of Trauma and Emergency Surgery (EATES) and European Trauma Society (ETS) (May 23–26, 2007, Graz, Austria).

* Corresponding author at: Department of Surgery, Faculty of Medicine & Health Sciences, PO Box 17666, Al Ain, United Arab Emirates. Tel.: +971 3 7137579; fax: +971 3 7672067.
E-mail address: fabuzidan@uaeu.ac.ae (F.M. Abu-Zidan).

0020–1383/$ – see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.injury.2008.07.012

Table 1
Hospitalised road traffic injury patients by nationality and road user type Al Ain, United Arab Emirates 2003-2006 ($n = 1058$)[a].

Nationality	Road user type									
	All road users		Occupant[b]		Motorcyclist		Bicyclist		Pedestrian	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Emirati	269	25	199	73	27	10	16	6	27	10
Non-Emirati	789	75	479	61	46	6	64	8	200	25
Pakistani	234	22	125	49	18	8	12	5	79	34
Indian	135	13	77	57	11	8	17	13	30	22
Bangladeshi	99	9	42	42	5	5	17	17	35	35
Omani	60	6	49	82	2	3	3	5	6	10
Egyptian	56	5	38	68	2	4	3	5	13	23
Other Arab	145	14	113	78	3	2	9	6	20	14
All others	60	6	35	58	5	8	3	5	17	28
Total	1058	100	678	64	73	7	80	8	227	21

[a] Data unknown for 12 patients (1% of 1070); percents may be 99 or 101 due to rounding.
[b] Includes drivers, front and rear passengers.

Al Ain Hospital treated more than 80% of the severe trauma cases in Al Ain city, compared to Tawam Hospital, which is a tertiary referral specialised centre for oncology, vascular surgery and neurosurgery. Data were collected prospectively over 3 years from March 2003 to March 2006. Patients were included in the registry if they stayed in hospital more than 24 h, died in the Emergency Department, or died after admission. The following factors were recorded for patients with road traffic injuries: age, gender, nationality, road user type, anatomical body part(s) injured, Intensive Care Unit admission, systolic blood pressure on admission, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), and mortality. Data were unavailable for wearing of seat belts and helmets. Statistical analysis included Fisher's exact test, Mann–Whitney *U*-test or Kruskal–Wallis test, as appropriate. Logistic regression was used to define factors affecting mortality. Interactions between age, gender, nationality and road user type were tested to determine their effect on the model. A *p*-value of <0.05 was considered significant. Data were analysed with the Statistical Package for the Social Sciences (version 14, SPSS Inc.).

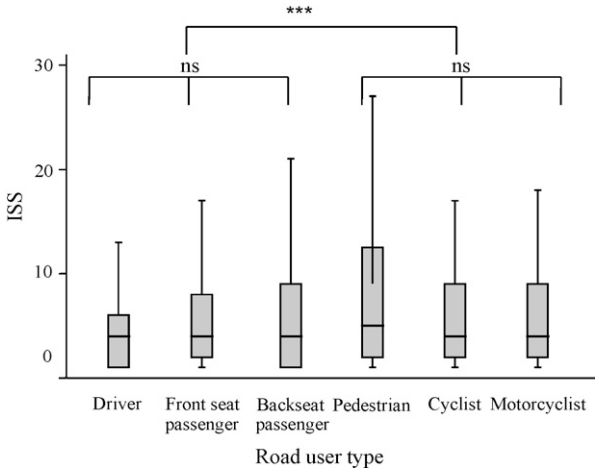

Fig. 1. Hospitalised road traffic injury patients by road user type by Injury Severity Score, Al Ain, United Arab Emirates 2003–2006 ($n = 1070$) $^{***}p < 0.001$, Mann–Whitney *U*-test, ns = non-significant, Kruskal–Wallis test.

Results

There were 1070 patients, 956 males and 114 females. Mean age was 31.1 years (range 3 months–80 years). There were 25% UAE nationals and 75% expatriates (Table 1). Road user types included 63% vehicle occupants including drivers, front and rear seat passengers, 36% non-occupants, pedestrians, cyclists, and motorcyclists, so-called "vulnerable road users", and 1% unknown (Table 2).

Injury severity as measured by ISS was higher for non-occupants (Fig. 1), especially pedestrians, who also accounted for most deaths (Table 2). The profile of body part(s) injured by road user type showed significant differences (Table 3), especially between vehicle occupants and non-occupants (Table 4). Rear seat passengers were as severely injured as front passengers and drivers. Overall, lower extremity and head injuries were most frequent, especially among non-occupants; however, about a third of occupants also had head and facial injuries. Neck and other spinal injuries were higher among occupants than non-occupants; among occupants, neck injuries were more frequent among drivers. Many motorcyclists and cyclists sustained upper extremity injuries.

The mean hospital stay was 9.7 days (range 1–130); 143 (13%) patients were admitted to ICU—of them 17 (12%) died. Mean ICU stay was 6.5 days (range 1–35). Overall mortality was 44 (4%). The

Table 2
Hospitalised road traffic injury patients by road user type by median Injury Severity Score, inter-quartile range, and deaths, Al Ain, United Arab Emirates 2003–2006 ($n = 1070$).

Road user type	All patients				Deaths		
	n	%	ISS		Overall		In user category
			Median interquartile	Range	*n*	%	%
Vehicle occupants	678	63	4	1–41	7	16	1
Driver	395	37	4	1–6	5	11	1
Front passenger	153	14	4	2–8	2	5	1
Rear passenger	130	12	4	1–9	0	0	0
Vulnerable road users	382	24	4	1–43	32	73	8
Motorcyclist	73	7	4	2–9	5	11	7
Cyclist	80	8	4	2–9	0	0	0
Pedestrian	229	21	5	2–12	27	61	12
Unknown	10	1	18	10–22	5	11	50
Total	1070	100			44	99[a]	

[a] Percentage may not add to 100 due to rounding.

Please cite this article in press as: Eid HO, et al. Factors affecting anatomical region of injury, severity, and mortality for road trauma in a high-income developing country: Lessons for prevention. Injury (2008), doi:10.1016/j.injury.2008.07.012

Table 3
Hospitalised road traffic injury patients by road user type by anatomical body part(s) injured, Al Ain, United Arab Emirates 2003–2006 ($n = 1070$).

Body region	Road user type												p[a]
	Driver		Front seat passenger		Rear seat passenger		Pedestrian		Cyclist		Motorcyclist		
	$n = 395$	%	$n = 153$	%	$n = 130$	%	$n = 229$	%	$n = 80$	%	$n = 73$	%	
Head	143	36	45	29	39	30	100	44	32	40	29	40	0.042
Face	111	28	45	29	36	28	46	20	17	21	22	30	0.16
Neck	28	7	5	3	5	4	2	1	2	3	0	0	0.001
Spine	49	12	22	15	16	12	19	8	2	3	5	7	0.02
Thorax	125	32	44	29	36	28	73	32	16	20	15	20	0.15
Abdomen and pelvis	24	6	9	6	16	12	26	11	7	9	4	6	0.07
Upper extremity	124	31	48	31	41	31	80	35	36	45	38	52	0.005
Lower extremity	107	27	43	28	40	31	133	58	44	55	33	45	0.001

[a] p = Fisher's exact test.

multiple logistic regression model was significant ($p < 0.001$); clinical predictors for mortality included lower GCS, followed by ISS and low systolic blood pressure on admission (Table 5). Age, gender, and nationality were not significant, nor were individual road user types. Interactions that were not significant: age and gender ($p = 0.78$), age and nationality ($p = 0.93$), gender and nationality ($p = 0.98$), and nationality and mechanism of injury ($p = 0.78$). These interactions were not included in the final model.

Discussion

In the UAE at present, road traffic victims are predominantly male. UAE nationals are overrepresented, since they constitute only 22% of the total population and 14% of those 20 and older,[31,33] whilst accounting for 25% of all injured road users, 29% of all vehicle occupants, 30% of rear seat vehicle occupants, and 37% of motorcyclists. On the other hand, 88% of injured pedestrians were non-Emirati, mainly from low-income countries where the main language is neither Arabic nor English.

As for road user types, there are relatively few motorcyclists, bicyclists, and pedestrians in the UAE compared with less prosperous countries, so they are undoubtedly overrepresented among the victims. Unexpectedly, there were nearly as many injured rear seat passengers as front seat passengers, and the severity of injury by ISS was similar, suggesting non-wearing of seat belts in the rear. Current seat belt legislation does not cover rear seat occupants, so whilst use is low among front occupants it is nearly zero among rear occupants in Al Ain city.[4]

After drivers, pedestrians were the second most frequent group among the injured and had the highest median ISS and the most severe and fatal injuries. The majority of injured pedestrians were from low-income non-Arabic speaking countries.

Table 4
Hospitalised road traffic injury patients, comparing vehicle occupants and non-occupants by anatomical region(s) injured, Al Ain, United Arab Emirates 2003–2006 ($n = 1070$).

Body region	Vehicle occupants[a]		Vulnerable road users[b]		p*
	$n = 678$	%	$n = 382$	%	
Head	227	34	161	42	0.005
Face	192	28	85	22	0.035
Neck	38	6	4	1	0.0001
Spine	87	13	26	7	0.0025
Thorax	205	30	104	27	0.32
Abdomen and pelvis	49	7	37	10	0.16
Upper extremity	213	31	154	40	0.004
Lower extremity	190	28	210	55	<0.0005

[a] Includes drivers, front and rear passengers.
[b] Includes pedestrians, motorcyclists, and bicyclists.
* p = Fisher's exact test.

As for the nature of the injuries, vehicle occupants sustained more neck and other spinal injuries, about one-fifth, than vulnerable road users. Whilst head injuries were more frequent among all categories of vulnerable road users, head, face, thoracic, and extremity injuries were seen in nearly a third of all vehicle occupants, including drivers, front, and rear passengers, suggesting overall low use of restraints. Not surprisingly, lower extremity injuries occurred in more than half of vulnerable road users, especially pedestrians. Many vehicles in the UAE are heavy four-wheel drive sports utility vehicles with pedestrian unfriendly high bumpers, and often bull bar protectors.

The most significant clinical predictors of mortality were the GCS, followed by ISS and systolic blood pressure on admission. Whilst it is not unexpected that a low Glasgow Coma Scale and low blood pressure on admission, indicative of more severe injury, were predictors of mortality in our study, it has also been shown elsewhere that the most important predictor of mortality was low GCS.[20] This could be because hypotension may be more reversible when detected early than severe head injury. Furthermore, GCS may be low in hypotensive patients due to brain hypoxia. This indicates that hypotension and GCS are interdependent. Nevertheless, patients with normal blood pressure and low GCS may have severe head injury.

In motor vehicle collisions, head injury is the main cause of hospitalisation and mortality.[39] Vehicle occupants who are unrestrained or motorcyclists and bicyclists riding without a helmet are main factors predicting risk of death or disability in road crashes. Hence head injury is generally a reflection of low usage of safety equipment by vehicle occupants, motorcyclists, and cyclists.[12]

Vehicles in the UAE are predominantly modern and supplied with seat belts as required by the Ministry of Economy for imported vehicles; however, although wearing a seat belt has been mandatory for front occupants since 1999, compliance is low. An observational study in Al Ain city in 2003–2004 showed that only 29% of drivers, 14% of front adult passengers, and 2% of rear passengers were wearing a seat belt, whilst less than 4% of children were restrained.[4]

Appropriate seat belt laws for all vehicle occupants, including infants and children, together with vigorous primary enforcement improve compliance and decrease injury severity, hospital admissions and mortality.[9,10] Legislation should include rear passengers since research has shown that unrestrained rear passengers pose a serious risk to other vehicle occupants as well as themselves.[17] As for protection of children, free or discounted booster seats in conjunction with education are effective.[11]

For motorcyclists and bicyclists, collision with a motor vehicle is a major cause of head injury and death. Among motorcyclists, helmets reduce the risk of head injury by 69% and of death by 42%;

Please cite this article in press as: Eid HO, et al. Factors affecting anatomical region of injury, severity, and mortality for road trauma in a high-income developing country: Lessons for prevention. Injury (2008), doi:10.1016/j.injury.2008.07.012

Table 5
Hospitalised road traffic injury patients by variables potentially affecting mortality: logistic regression analysis, Al Ain, United Arab Emirates 2003–2006 (n = 44 deaths, 1070 total).

Variable	B	p	Adjusted odds ratio	95% CI for adjusted odds ratio
Age	0.05	0.08	1.05	0.99–1.12
Gender[a]	−2.21	0.13	0.11	0.006–1.91
Nationality[b]	0.58	0.61	1.78	0.26–12.30
Road user type[c]		0.61		
Driver	−1.3	0.19	0.27	0.04–1.88
Front passenger	−0.5	0.70	0.59	0.04–8.85
Rear passenger	−18.3	0.995	<0.0001	–
Motorcyclist	1.0	0.39	2.71	0.28–26.23
Bicyclist	−16.7	0.997	<0.0001	–
GCS	−0.41	<0.001	0.66	0.54–0.81
ISS	0.12	0.004	1.1	1.04–1.23
Systolic blood pressure[d]	−0.03	0.04	0.96	0.93–0.99

[a] Male as the reference.
[b] Emirati as the reference for comparison against non-Emirati.
[c] Pedestrian as the reference for comparison, first p is overall for road user type.
[d] On arrival.

facial injuries are also reduced,[21] with full-face helmets providing greater protection. For bicyclists, risk of head injury is reduced by 63–88% and of upper and mid-face by 65%.[1,28] An observational study of behaviour of bicyclists on the main roads of Al Ain city found helmet use prevalent among only 0.5%[2] and a prospective study among 1%.[13]

Whilst research in Germany suggests that if a motorcycle collides with a car, motorcycle airbags together with protective knee pads help project the rider up onto the roof of the car, rather than his smashing head (and neck) into the side of the vehicle[8]; airbags would probably be less effective in the UAE, where many vehicles are very high.

Many legislative and non-legislative interventions for increasing use of bicycle helmets have been reviewed.[23,27] Legislation, as well as provision of free helmets, is efficacious. Since most cyclists in UAE are low-income workers and lack education and money, legislation in conjunction with education and free distribution of helmets and/or supply by employers should be helpful.

Studies elsewhere have also emphasised the importance of prevention for head injuries. In China, 67% of road fatalities were due to head injuries and 84% of victims were non-occupants.[39] In Greece, it was reported that in all deaths, car occupants were unbelted and motorcyclists unhelmeted.[22]

Several studies have documented the frequency and severity of lower limb injuries among motorcyclists, including disabling open fractures of the tibia and severe disruption of bones of the foot, as well as fractures of the distal radius.[19,37] As helmet use increases, lower extremity fractures become the most frequent cause of hospitalisation of motorcyclists.[3] Currently effective measures to prevent or minimise damage from limb injuries are high-quality padded suits made of resistant materials, together with high boots and gloves.[25,26] Even if fractures are not always prevented, severe damage to skin and underlying tissues, as well as heavy contamination are minimised.[16] Hence, motorcyclists should be required to wear not only an approved helmet but also boots, gloves and protective ventilated clothing suitable for the hot climate. Protective bars have mixed reviews, since whilst preventing lower limb injuries[16] they may shift injuries higher to the femur or even to the head,[24] although collapsible plastic leg protectors on motor scooters that absorb the energy of impact have shown promise.[15]

Research and appropriate legislation could help to ensure that all motorcycles in the UAE are sold with high-visibility features, such as an automatic daytime headlight.[6,16] Helmets should be white since this may be the only portion of the rider visible to a driver seated on the opposite side of a high sports vehicle, whilst clothing needs to be reflective or fluorescent.[36] Similarly, for bicyclists visibility can be improved by appropriate helmets and clothing.[18,29] Since many motorcyclists and bicyclists are low income employees doing deliveries, their employers should be required to supply such safety devices. Another issue is that many drivers use high sports utility vehicles fitted with dark tinted glass,[4] endangering not only themselves but also making it even more difficult than usual to see motorcyclists, cyclists, and pedestrians. Severe penalties for hitting motorcyclists and bicyclists who are using mandated visibility measures could make vehicle drivers more vigilant when driving in mixed urban traffic.

The most affordable, effective and cheapest way to reduce the burden of injury is prevention.[30] A research strategy to support prevention should be implemented.[7] An epidemiological approach to injury prevention provides a structured means of surveillance, investigation, and prevention of traffic injuries.[5] Research must be linked to suitable interventions to enhance preventive measures for different road user types.

We established an interdisciplinary Trauma Research Group in our faculty, combining preventive and clinical approaches. Fundraising was successful for establishment of a Road Traffic Collision Injury Registry involving the main two hospitals in our city. This facilitated evaluation of care of injured road users, definition of risk factors, and recommendation of appropriate interventions. Furthermore, a Roadway, Transportation and Traffic Safety Research Centre was established in 2004 by members of the university engineering and community medicine departments, in collaboration with Monash University of Australia. This centre serves the UAE University objectives of traffic research, training and consultation, including injury incident analysis and prevention.

The Ministry of the Interior has taken action to improve pre-hospital care. A police Emergency Medical Service was established a few years ago. Trained pre-hospital doctors and nurses are deployed with their ambulances to the trauma scene. There are still no reliable published data to study the effectiveness of improved pre-hospital care on trauma victims; however, the number of victims of traffic collisions transported to our hospital by ambulances, rather than private cars, rose from less than 25–75% in the past 3 years. In 2008, the Traffic Department increased fines for violations and implemented a black point system in order to reduce crash rates[34]; a driving license can be confiscated if black points reach the limit. A decrease in serious collisions was reported after this federal law was publicised.[35]

Please cite this article in press as: Eid HO, et al. Factors affecting anatomical region of injury, severity, and mortality for road trauma in a high-income developing country: Lessons for prevention. Injury (2008), doi:10.1016/j.injury.2008.07.012

Limitations of our study include the fact that the number of deaths was small. The mortality analysis could have been affected by selection bias, since not all crash victims who died immediately, such as motorcyclists, may have been brought to hospital. Moreover, some injured patients may have been treated at other small hospitals. Another limitation was that the data did not include information about use of safety devices.

In summary, motor vehicle collisions are a major cause of head, spine, and extremity injury and death in the UAE. Head injuries are frequent among both vehicle occupants and vulnerable road users. Head injury was a major factor affecting mortality, followed by injury severity and hypotension. Rear vehicle occupants were frequent among the injured, with severity no less than among front occupants. Emirati citizens are overrepresented among injured vehicle occupants; including rear passengers, and motorcyclists, whilst non-citizens from low-income countries account for the vast majority of pedestrian injuries.

Conflict of interest

None.

Acknowledgments

This study was supported by Individual University Grant (# 01-07-8-11/03), Faculty of Medicine Research Grants (NP/03/11, 2003; and NP/04/28, 2004) and an Interdisciplinary Grant (#02-07-8-1/4).

References

1. Abu-Zidan FM, Nagelkerke N, Rao S. Factors affecting severity of bicycle-related injuries: the role of helmets in preventing head injuries. Emerg Med Australas 2007;19:366–71.
2. Abu-Zidan FM, Talib MA, Suhail AA, Bener A. Behavior of bicyclists in Al-Ain City United Arab Emirates: an observational study. Emirates Med J 2004;22:31–3.
3. Agnihotri AK, Joshi HS. Pattern of road traffic injuries: one year hospital-based study in Western Nepal. Int J Inj Control Saf Promot 2006;13:128–30.
4. Barss P, Al-Obthani M, Al-Hammadi A, et al. Prevalence and issues in non-use of safety belts and child restraints in a high-income developing country: lessons for the future. Traffic Inj Prev 2008;9:256–63.
5. Barss P, Smith GS, Baker SP, Mohan D. Injury prevention: an international perspective. Epidemiology, surveillance & policy. New York: Oxford University Press; 1998. p. 12–25.
6. Bednar F, Billheimer JW, McRea K, et al. Motorcycle Safety. Washington, DC, USA: Transportation Research Board, Committee on Safety Data, Analysis, and Evaluation, pubsindex.trb.org. A3B05, Accession Number: 00783644, 2000, p. 1–7. Available from URL: http://www.onlinepubs.trb.org/onlinepubs/millennium/00075.pdf [Accessed May 27, 2008].
7. Bener A, Abu-Zidan FM, Bensiali AK, et al. Strategy to improve road safety in developing countries. Saudi Med J 2003;24:603–8.
8. Berg FA, Bilrkle H, Schmidts F, Epple J. Analysis of the passive safety of motorcycles using accident investigations and crash tests. Available from URL: http://www-nrd.nhtsa.dot.gov/pdf/nrd-01/Esv/esv16/98S10O11.PDF [Accessed May, 27 2008].
9. Carpenter CS, Stehr M. The effects of mandatory seatbelt laws on seatbelt use, motor vehicle fatalities, and crash-related injuries among youths. J Health Econ)2007;(December) [Epub ahead of print].
10. Durbin DR, Chen I, Smith R, et al. Effects of seating position and appropriate restraint use on the risk of injury to children in motor vehicle crashes. Pediatrics 2005;115:305–9.
11. Ehiri JE, Ejere HO, Magnussen L, et al. Interventions for promoting booster seat use in four to eight year olds traveling in motor vehicles. Cochrane Database Syst Rev 2006;1. CD004334.
12. Eid HO, Abu-Zidan FM. Biomechanics of road traffic collision injuries: clinician's perspective. Pictorial Essay. Singapore Med J 2007;48:693–700.
13. Eid HO, Bashir MM, Muhammed OQ, Abu-Zidan FM. Bicycle-related injuries: a prospective study of 200 patients. Singapore Med J 2007;48:884–6.
14. El-Sadig M, Norman JN, Lloyd OL, et al. Road traffic accidents in United Arab Emirates: trends of morbidity and mortality during 1977–1998. Accid Anal Prev 2002;34:465–76.
15. How CK, Megat Ahmad MM, Radin Umar RS, et al. Crash simulation of lower limb with motorcycle basket. Med J Malaysia 2001;56:77–81.
16. Huang B, Preston J. A Literature Review on Motorcycle Collisions Final Report. Oxford, UK: Transport Studies Unit, Oxford University, mpi.mb.ca, 2004, p. 1–47. Available from URL: http://www.mpi.mb.ca/PDFs/MotorcycleRiskStudy/Appendix%205.2%20Oxford%20Univ.pdf [Accessed May 27 2008].
17. Ichikawa M, Nakahara S, Wakai S. Mortality of front-seat occupants attributable to unbelted rear-seat passengers in car crashes. Lancet 2002;359:43–4.
18. Kwan I, Mapstone J. Interventions for increasing pedestrian and cyclist visibility for the prevention of death and injuries. Cochrane Database Syst Rev 2006;(October):4. CD003438.
19. Lateef F. Riding motorcycles: is it a lower limb hazard? Singapore Med J 2002;43:566–9.
20. Li YM, Hu SC, Fu CC. Mortality from motor vehicle crash injuries in eastern Taiwan—a 5-year follow up study. Tzu Chin Med J 2006;18:23–8.
21. Liu BC, Ivers R, Norton R, et al. Helmets for preventing injury in motorcycle riders. Cochrane Database Syst Rev 2008;1. CD004333.
22. Markogiannakis H, Sanidas E, Messaris E, et al. Motor vehicle trauma: analysis of injury profiles by road-user category. Emerg Med J 2006;23:27–31.
23. Macpherson A, Spinks A. Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. Cochrane Database Syst Rev 2007;2. CD005401.
24. Rogers NM, Zellner JW. An overall evaluation of UKDS motorcyclist leg protectors based on IS0 13232. Available from URL: http://www-nrd.nhtsa.dot.-gov/pdf/nrd-01/Esv/esv16/98S10O13.PDF [Accessed May 27, 2008].
25. De Rome L. The injury reduction benefits of motorcycle protective clothing. Motorcycle Safety Forum, National Transport Safety Board, 2006, Available from URL: http://www.ntsb.gov/Events/symp_motorcycle_safety/Rider%20-Protective%20Equipment%20Panel/Liz%20de%20Rome%20-%20LdeR%20Consulting/Liz%20de%20Rome%20-%20LdeR%20Consulting%20(paper).pdf. [Accessed May 27, 2008].
26. De Rome L, Stanford G, Wood B. Survey of motorcyclists and their safety initiatives. LdeR Consulting & Motorcycle Council of NSW. Available from URL: http://www.rsconference.com/pdf/RS040158.pdf?check=1 [Accessed May 27, 2008].
27. Royal ST, Kendrick D, Coleman T. Non-legislative interventions for the promotion of cycle helmet wearing by children. Cochrane Database Syst Rev 2005;2. CD003985.
28. Thompson DC, Rivara FP, Thompson R. Helmets for preventing head and facial injuries in bicyclists. Cochrane Database Syst Rev 2000;2. CD001855.
29. Thornley SJ, Woodward A, Langley JD, et al. Conspicuity and bicycle crashes: preliminary findings of the Taupo Bicycle Study. Inj Prev 2008;14:11–8.
30. Trunkey DD. Trauma. Sci Am 1983;249:20–7.
31. United Arab Emirates Census. Population Preliminary results 2005 by age and nationality. Adapted from: Preliminary Results of the General Census for Population, Housing and Establishments, 2005, United Arab Emirates. Available from URL: http://www.zu.ac.ae/library/html/UAEInfo/documents/CensusResults2005.pdf [Accessed May 27, 2008].
32. United Arab Emirates Ministry of Health. Abu Dhabi, UAE: Preventive Medicine Sector. Annual Statistic Report 2004, 213–4.
33. United Arab Emirates Ministry of Information and Culture web site, United Arab Emirates Yearbook 2008. Available at URL: http://www.uaeinteract.com/uaeint_misc/pdf_2008/index.asp. Accessed May 29, 2008.
34. United Arab Emirates Ministry of Interior web site, New traffic law and black points. Available at URL: http://www.adpolice.gov.ae/traffic-laws/en/subjects.htm [Accessed April 15, 2008].
35. United Arab Emirates Ministry of Interior web site, Police News, Black points—Decline in accidents. Available at URL: http://www.adpolice.gov.ae/en/?T=4&ID=4851 [Accessed April 15, 2008].
36. Wells S, Mullin B, Norton R, et al. Motorcycle rider conspicuity and crash related injury: case–control study. BMJ 2004;328:857.
37. Wick M, Müller EJ, Ekkernkamp A, Muhr G. The motorcyclist: easy rider or easy victim? An analysis of motorcycle accidents in Germany. Am J Emerg Med 1998;16:320–3.
38. World Health Organisation. World report on road traffic injury prevention, 2004. Available at: http://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/en/index.html [Accessed June 20, 2007].
39. Yan-Hong L, Rahim Y, Wei L, et al. Pattern of traffic injuries in Shanghai: implications for control. Int J Inj Control Saf Promot 2006;13:217–25.

Please cite this article in press as: Eid HO, et al. Factors affecting anatomical region of injury, severity, and mortality for road trauma in a high-income developing country: Lessons for prevention. Injury (2008), doi:10.1016/j.injury.2008.07.012