PEDESTRIAN ACCIDENTS AND INJURIES IN TRIPOLI CITY-LIBYA

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الملخص

تعتبر المشاة من أكثر الفئات العمرية تعرضاً لخطر حوادث المرور على الطرقات في ليبيا. في هذه الدراسة تمت دراسة 442 مترجل تعرضوا لتصادم مع العربات أثناء سيرهم على الطرقات العامة في الفترة مابين 2003-2004. وتشمل هذه الدراسة نوع العربة المسببة للحادث وعمر المصاب وجنسه ومكان الحادث ونوعية الإصابة. كل الإحصائيات تم تجميعهما من مستشفى الحوادث بطرابلس. تم استخدام توزع مربع كأي لتحديد قوة العلاقة بين المتغيرات في هذا البحث.على ضوء هذه الدراسة يتضح أن الأطفال ذوى الفئة العمرية أقل من 15 سنه أكثر تعرضا للحوادث حيث بلغت نسبة هذه الفئة من الإصابات 53.5% ومثلت حوالي 49% من الوفيات. بينما تشكل الفئة العمر 16-60 سنه نسبة 36.4% من الحوادث، بينما كانت النسبة 10% للفئة العمرية فوق 60 سنه. وطبقاً لمقياس الإصابات البسيط (AIS 4-6)، فان 34.1% من الأطفال، 17.5% شباب و37.8% من كبار السن تعرضوا إلى إصابات أدت إلى الوفاة.كما كانت أكثر الإصابات شيوعا في الرأس تليها إصابات الأطراف.

ABSTRACT

Pedestrians in Libya are the more risk group of road users; the present study was intended to study the general characteristics of 442 pedestrians struck by vehicles on Libyan road in 2003 and 2004. Accidents were described in terms of vehicles involved, age and sex of the casualties, the location of impact, and the overall severity of injuries sustained. The pedestrian details were collected from the Accidents hospital in Tripoli. The statistical method of the chi-square test is used to identify whether a significant relationship exists between two categorical variables.

The most vulnerable age groups were children at age less than 15 years who accounted for 53.5%, of all accidents while 49% of pedestrian's death was children, Adult aged 16-60 years accounted for 36.4% and elderly adults aged more than 60 years accounted for 10%. Life threatening or fatal injuries (AIS 4-6) were sustained by 34.1% of the children, 17.5% of adults and 38.7% of the elderly adults. Head injuries were the commonest form of injury for all age group closely followed by limb fractures.

KEYWORDS: Pedestrians; Libya; Road accidents; Injuries.

INTRODUCTION

In Libya motor vehicle crashes in 1996 result in approximately 2,169 pedestrians injured and 496 deaths, 20 per cent of them children under 15 years of age. (11 pedestrian deaths per 100,000 persons) M.O.I. [25]. According to Road Accident Statistics LB, 1996, 46 per cent of Libya RTA deaths were pedestrians, there were 341 fatalities due to road crashes in Tripoli the capital city of Libya, of them 178 (52%) were pedestrians. Libyan pedestrian deaths are more than most developing countries such as, South Africa 45 per cent, Brysiewicz [4] Saudi Ariba 25 per cent, Al-Ghamdi

[1] and developed countries such as G.B for instance 1.7 pedestrian deaths per 100,000 people, HMS [14] which is less than Libyan pedestrians death rate by around seven times.

Downing et al [6] studies in developing countries showed that pedestrians are a high-risk group of road users as they represent a significant proportion of all reported road accident casualties. In African countries, more than 40 per cent of road accident fatalities were pedestrians. In Middle East countries, it was more than 50 per cent. By comparison, in Europe and the United States of America (USA) pedestrians represented only 20 per cent of road accident fatalities. The higher proportion in developing countries may be simply due to more people making walking trips however Jacobs [17] have shown there is some evidence supporting the premise that when pedestrians and vehicle flows were taken into account, pedestrians are more at risk in third world cities than in U.K cities. Downing [6] also showed that approximately 20 per cent of fatalities were of people under the age of 15 years. The equivalent figure for European cities and in the USA was 10 per cent. On average children killed by road traffic accidents represented more than a quarter of all pedestrian road accident deaths in Africa.

According to Ribbens [31] approximately 65 per cent of pedestrian causalities in South Africa occurred when the victim was crossing the road and 20 per cent while walking, standing or playing near the road. Mitigating circumstances that contribute to the accident rate are a lack of proper crossing facilities; footpaths and self contained recreation space or parks.

Pedestrian vehicle collisions are of serious concern because of the severe nature of injuries to those who are struck by vehicles. Past research has established that pedestrians suffer very serious injuries to those who are struck by vehicles. The traditional view of pedestrian traffic safety tends to place the burden of responsibility on the behaviour of pedestrians and emphasizes education as the means to prevent accidents Harruff et al [13]. This view has been investigated by data from developed countries showing that education efforts are less effective than efforts aimed at modifying the physical and social environment of the transportation system, Roberts et al [32].

Only two studies have been published about vehicle accidents on Libyan roads in 1984 and 1978. This is the first ever study about pedestrians accidents and their injury in Libya. In this study, the general characteristics of a sample of 442 pedestrians struck by vehicles in Libyan road in 2003 and 2004 were described in terms of vehicles involved, age and sex of the casualties, the location of impact, and the overall severity of injuries sustained. The general location of the injuries received by severity is noted, and the injury patterns are compared, for each of the main body areas- head, neck, chest, abdomen, arms, and legs. The statistical method of the chi-square test is used to identify whether a significant relationship exists between two categorical variables.

METHODOLGY

Different methods were followed to obtained number of pedestrian accidents and their injuries from Libyan database; unfortunately, no pedestrian accidents database was published since 1996. So that, the injury details of 442 inpatient pedestrians who had been involved in pedestrian accidents between years 2003-2004 were collected from Abu-slime Accident Hospital in Tripoli, the capital city of Libya (population 1,127,118). Tripoli was chosen as a representative sample of Libyan accidents because of the high vehicle population and number of inhabitants. The data included, pedestrian

overall severity of injuries sustained, age and sex of the casualties, and the injury patterns for each of the main body areas- head, neck, chest, abdomen, upper extremes, and lower extremes. Information about pedestrian accident circumstances was obtained from three sources:

- The injured person.
- The accident report obtained from the police station.
- The hospital that treated the injured person.

In the absence of any routine injury coding system in Libya, the doctors in Accident and Emergency Department at Accidents Hospital estimate injury severity, from patient records, using the Abbreviated Injury Severity Scale (AIS) (AAAM, 1990). This was done through converting injury diagnosis and text descriptions of injuries into AIS90 codes AAAM, 1990. Abbreviated Injury Scale (AIS) (AAAM, 1990) has used due to its common use in international accident surveys. It is the most commonly used injury classification system in accident studies. AIS classifies injuries into 7 degrees of severity (from 0 uninjured to 6 immediately fatal) in seven body regions head, face, chest, abdomen, Legs and Arms.

RESULTS

In this study passenger cars and taxis accounted for 70% of the vehicles that struck pedestrians (67% of Libyan fleet; L.N.D [19]). Light goods vehicles, such as pick up truck, accounted for further 21.8%. These categories accounted for 30 per cent of the entire Libyan vehicle population L.N.D [19]. Table (1) gives details of the vehicles striking the 442 pedestrians. Vehicles included in the category (other) were ambulances, tractors, military vehicles, and two wheeled vehicles.

Table 1: Type of Vehicles involved in Pedestrians accidents.

Vehicle Type	Number /%
Car and Taxi	303/69
Goods vehicle	97/21.8
Other	9 /2.1
N.K. *	24/5.7
Total	433 /100

* Not Known.

Age and Sex of Pedestrians

Table (2) gives details of the age and sex of the pedestrians involved. The most vulnerable age groups were the 16- to 30 years old group, which represents 26.5% of the sample population; the 5-to 9 years old group with 19.2%, and the under 4 years old group with 19%.

Table 2: Rate of accident by Age and Sex of pedestrians

Age of Pedestrians	Sex of pedestrians		
	Male	Female	All
	Number/ %	Number/ %	Number/ %
0-4	52 /17.8	32 / 21.3	84/19
5-9	51 / 17.5	34 /22.7	85/19.2
10-15	45/ 15.4	23/ 15.3	68/15.3
16-30	70 / 24	47/ 31.3	117/26.5
31-45	24 / 8.2	7/ 4.7	31/ 7
46-60	9 / 31	4 / 2.7	13 /2.9
≥61.	41 /60	3 /2	44/10
All ages	292/66	150/34	442 /100

Overall, the pedestrian children aged less than 15 years accounted for 53.5% of the all pedestrians, adult aged 16-60 years accounted for 36.4% and elderly adults aged more than 60 years accounted for 10%. However, male casualties were almost two times female for most age groups. The proportion of males however varied with age, 62.5% of them were children, 45% of the adults and 93.2% the elderly adults being males.

Action of Pedestrian

Nearly 61.8% of the pedestrians were crossing the road when struck, probably not in a defined crosswalk. A large proportions of pedestrians were crossing roads 61.8%, 8.8% highway crossing which less commonly for pedestrians to cross very high speed road, unless this road passing through high population area or unprotected from pedestrians. A small number 11.3% were on the pavement when struck. Table (3) gives details of the action of the pedestrian by pedestrian age. A chi-square test was conducted in order to determine whether the there were significant differences between different age groups for crossing road. According to the chi-square test, the age is a contributing factor of the pedestrians action, there was a significant difference between child and adult, at the crossing places $x^2 = 99.177; df = 5; p < 0.05.$

Table 3: Action of the pedestrians by pedestrian age

Action of Pedestrians	Age by years			
	Children 0-14 No/ %	Adult 15-60 No/ %	Elderly ≥ 60 No/ %	All No/%
Crossing road or street	152 /64.2	33 /75	33 /75	273/61.8
On pavement	14 /5.9	5 /11.4	28/6.3	50/11.3
On road not crossing	31/13.1	-	-	31/ 7
Highway crossing	4/1.7	35/21.7	-	39/8.8
Waking near the road (without pavement)	14/5.9	11 /6.8	2 /4.5	27/6.1
Not known	22/9.3	18/11.2	4 /9.1	44/ 10
All	237	161	44	442

Overall Severity of Injury

Table (4) details the overall severity of the injuries sustained by pedestrian of different ages, classifying the injuries using the MAIS (1-6). 28% of the children, 33.5% of adults and 9.1% of elderly adults sustained minor injury or no injuries. Life threatening or fatal injuries (MAIS 4-6) were sustained by 35.2 % of the children, 17.3% of adults and 45.5% of the elderly adults. The statistical analysis chi-squared test revealed that there was strong evidence that age and injury severities are related: ($x^2 = 29.936$, df = 4, $p<0.05$) for Children and adult; ($x^2 = 18.306$, df = 4, $p< 0.05$) for adult and elderly adult. No significant difference between children and elderly adults ($x^2 = 14.758$, df = 6, $p<0.05$).

Table 4: Pedestrians over all injury severity of AIS 0-6

Injury severity (MAIS)	Age			
	0-14	15-59	≥ 60	All
	No/%	No/%	No/%	No/%
No injury	22/9.3	-	1 /2.3	23/5.2
1	44/18.6	54/33.5	3/6.8	101/22.9
2	57/24.1	64/39.8	14/32	135/ 30.5
3	30/12.3	15/9.3	6/13.6	51/11.5
4-5	55/23	11/6.8	7/16	73/16.5
6	29/12.2	17 /10.5	13/29.5	59 /13.4
Total	237/54	161/36	44/10	442

Tables (5a, b, c) show the general location and severity of the injuries sustained by the three age groups: children, adults, and elderly adults. The tables show that the body regions most frequently involved were the head, the face and the lower limbs. Head and lower limbs injuries were dominate for all age groups, 57% of the children sustained head injuries, leg injuries were sustained by 41% and face injuries were sustained by 25%. Leg injuries were received by 52.8% of adults, head 77.6%, and arm injuries accounted for 62.7% of the cases. Head injuries 82%, arm injuries in 89.6%, and leg injuries in 82% of the elderly adult.

Table 5a: Children injury severities AIS (1-6)

Location of Injuries	Age 0-14 AIS 1-6 Ns= 237						
	1	2	3	4	5	6	Total/%
Head	32	25	21	13	20	24	135 /57
Face	22	13	19	5	-	-	59/ 25
Neck	-	2	-	2	-	1	5/2
Chest	4	9	7	2	3	3	28/12
Abdomen	3	4	3	2	5	3	20/9
Pelvis	2	2	1	-	-	-	5 / 2
Upper limbs	15	4	10	-	-	-	29 /12
Lower Limbs	47	32	19	-	-	-	98/ 41

Table 5b: Adult injury severities AIS (1-6)

Location of Injuries	Age 15-59 AIS 1-6 Ns=161						
	1	2	3	4	5	6	Total/%
Head	27	32	32	13	-	21	125 / 77.6
Face	23	3	4	6	-	-	36 / 22.4
Neck	5	1	-	1	-	-	7/ 4.3
Chest	10	5	5	7	1	-	18/ 11.2
Abdomen.	-	2	2	1	-	2	7/ 4.3
Pelvis	-	9	9	-	-	-	18 /11.2
Upper limbs	67	17	17	-	-	-	101 / 62.7
Lower limbs	45	20	20	-	-	-	85/52.8

Table 5c : Elderly adult injury severities AIS (1-6)

Location of Injuries	Age 60+ AIS 1-6 Ns=44						
	1	2	3	4	5	6	Total/ %
Head	13	8	3	3	4	8	36/ 82
Face	12	7	-	-	-	-	19/ 43.2
Neck	1	-	-	-	-	-	1/ 2.3
Chest.	7	4	2	1	-	-	14/ 8.7
Abdomen	4	-	1	-			5 / 3.1
Pelvis	-	1	-	-	-	-	1/ 2.3
Upper limbs	18	12	5	-	-	-	35/79.6
Lower limbs	19	12	5	-	-	-	36/ 82

Fatal Injuries

Tables (6a, b, and c) give details of the injuries sustained by those pedestrians who were killed. Twenty nine children struck by the cars were killed; head injuries were sustained by 97% followed by lower limbs 72.4%. Seventeen adults were killed; head injuries were sustained by 88%, 23.5% chest injuries. Thirteen elderly adults were killed; head injuries were sustained by 92%, 46.2 chest, and abdominal 30.8%. If only

life threatening or fatal injuries were considered then head injuries were sustained by 71%, chest and abdomen injuries were nearly the same.

Table 6a: The injuries sustained by children pedestrians who were killed

Location of Injuries	Age 0-14. AIS 1-6 Ns = 29						
	1	2	3	4	5	6	Total/%
Head	-	2	2	1	3	20	28 /97
Face	-	4	5	7	-	-	16/55.2
Neck	-	4	2	2	5	5	18/ 62
Chest	1	-	2	2	1	7	13/45
Abdomen	-	1	1	1	3	3	9/31
Pelvis	-	1	1	1	-	-	3/10
Upper limbs	3	4	5	-	-	-	12/41.4
Lower limbs.	9	5	7	-	-	-	21/72.4

Table 6b: The injuries sustained by adults pedestrians who were killed

Location of Injuries	Age 15-59 AIS 1-6 Ns =17						
	1	2	3	4	5	6	Total/%
Head	-	-	-	1	2	12	15/88
Face	-	1	2	-	-	-	3/17.7
Neck	-	-	-	2	1	2	5/29
Chest	-	-	1	-	2	1	4/23.5
Abdomen	-	-	1	1	-	2	4/23.5
Pelvis	-	-	1	-	-	-	1/5.9
Upper limbs	2	4	3	-	-	-	9 /52.9
Lower limbs	5	3	6	-	-	-	14/82.4

Table 6c: The injuries sustained by elderly adults pedestrians who were killed

Location of Injuries	Age 60+ AIS 1-6 Ns =13						
	1	2	3	4	5	6	Total /%
Head	-	-	2	-	3	7	12/92
Face	1	1	2	-	-	-	4/30.8
Neck	1	1	-	-	2	1	4/38.5
Chest	-	1	3	-	-	2	6/ 46.2
Abdomen	-	-	1	-	-	3	4/30.8
Pelvis	-	1	1	-	-	-	2/15.4
Upper limbs	-	2	2				4/30.8
Lower limbs	-	2	1				3/23.1

DISCUSSION

In this study female pedestrians were presented at 34% of all pedestrian victims, this finding is in agreement with those of the published Road Accident Statistics in LB M.O.I. [24] where female pedestrian victims were represented by 31%. In this study the number of males was nearly twice that of females and these findings agree with Fontaine et al [9] finding that the male gender was associated with a particularly high risk of death among pedestrians. It should by noted that the small population of female

pedestrian injuries in Libya would be influenced by the traditional Arabic customs that women's main duty is to look after her family and educate children, while the man is the breadwinner. Another reason is that most females walk less, and in the event of visiting relatives, a car is used for transport. The Home Interview survey in Tripoli By Mekky[26] showed that the average rate of daily trip by females was half that of males. 53.5% of pedestrian victims were less than 15 years of age. According to Libyan Road Accidents Statistics (1996) 53% of pedestrian victims were under age 15 years, whereas in G.B 40% of all pedestrian casualties were children HMSO [16]. In the United States 22% of pedestrian injuries were children NSC [29]. The High incidence of school age victims is relates to the fact that most Libyan schools are normally built very close to main roads, and it is easy for children to wander from the school onto the road. Mekky [26] stated that annual numbers of pedestrian's injuries during school months were great in area containing schools. Another factor that might contribute to the number of school age injuries is that, in Libya, parents of younger children allow them the freedom to walk and/or cycle to school without the accompaniment of an adult. Moreover, the increased numbers of pedestrian children casualties on Libyan roads are likely to result from a lack of proper crossing facilities, poor roads design and lighting, and an absence of children's play area. The lack of crossing facilities has been cited in the Libyan Road Accident Statistics (1996) as the main cause of pedestrian collisions during night time in Libya in general. Research studies have revealed that engineering shortcomings contribute to the number of those problems of pedestrian collisions, such as a lack of proper crossing facilities Ribbens [31]. It is surprising that children at age 1-4 years of age accounted for19% of pedestrian accidents, compared with GB in 1998 where only 11% of all pedestrian casualties were of this age group. This percentage may be a result of many factors, firstly parents unaware of road hazards, and secondly, most houses are located on main roads (some houses being 2 or 3 meters from the main road) so that infants can wander on to main roads. The absence of children's playground may also be significant.

In this study 61.8% of pedestrian's victims were struck when crossing roads with no crossing facilities. Many studies agree with this finding, Al-ghamdi [1] studied pedestrian accidents in Saudi Arabia and revealed that 77.1% of pedestrians were probably struck while crossing a roadway. Stutts et al [36] showed that the most common pedestrians contributing factor was pedestrians running into the roads. The problem of pedestrian accidents has been a major concern in many developing countries. A South African study by Baker at el [31] noted that approximately 65% of pedestrian casualties in South Africa occurred while crossing the road, and 20% while waking, standing or playing near the road. The absence of pedestrians education programmes for pupils and parents using crossing facilities in some main roads has greatly contributed to the rising numbers of pedestrian victims in Libya, and, as noted by Farze[8] pedestrian in Karachi, Pakistan, who had Zebra crossing available to them often did not use them.

High incidence of elderly adult pedestrians struck while crossing highway was observed (21.7%). It is a result of motorway in Libya pass through the coastline cities without any guard fences or crossing bridges. Furthermore, many shops are located very close to the main roads.

For all injury groups (children, adults, and elderly adults), head injuries and leg injuries predominated 57% of children, 77.6% of adults, and 82% of elderly adults sustained head injuries; whilst 41% of children, 52.8% of adults, and 82% of elderly

adults received leg injuries. Most pedestrian injury studies are in agreement with this finding. Aston at el [2] found that 54% of hospital pedestrian inpatients received head injuries, 35% leg injuries. Many pedestrian studies have noted high incidence of pedestrian head and limb injuries (Tunbridge et al [37], Jamieson et al [18], Nelson [28], and Ramet [30]). Similar findings were alsoreported by Langwieder [21], who confirmed that children have a high incidence of head injury, and elderly pedestrians were found to have serious/fatal head injuries and also frequent lower limb; Xuejun [38] found that head and lower extremities of children were at risk of higher injury than other body regions.

According to Road Accident Statistics in Libya (1995-1996), children represented 50% of pedestrian deaths. In this study, pedestrian children accounted for only 12.2% of pedestrian deaths (29 children), and head and neck were the most frequent causes of death. Other studies Levy et al [23], Kinny et al [20], and Mullins et al [27], have reported similar finding. It was noted that 31% of children pedestrian victims sustained abdominal injuries; it was mostly likely that most of these causes came from the Al-Zintan city, in which 40% of its vehicle population are light pickups, with very poor mechanical condition Brysiewicz [4]. When pedestrians struck by such vehicle fall to the ground without wrap contact, the casualty could sustain severe abdomen and chest injury by being run over. High incidence of elderly adults killed in this study, 22% of all pedestrians killed, head was the rolling cause of death in this age. Ryan [34] and Xuejun [38], have had similar finding. Most of elderly pedestrians in this study also sustained leg injuries. It is likely that with lower tolerance to injury and with more brittle bones, they are more likely to sustain multiple injuries in an accident than any other group. Harms [12] found that the increased severity of injury in the elderly was attributed to increased fragmentation of the skeletal system as, in old age, the bone become more brittle

CONCLUSIONS

This study illustrated that children have a high involvement rate as pedestrian casualties. Although the elderly have a lower rate than children, more elderly pedestrians were severely injured. Head injuries were the commonest form of injury, closely followed by limb fractures.

The absences of crossing facilities and excessive speed on urban roads were the common causes of accidents with pedestrians. It is considered that improvements in crossing facilities will have a beneficial impact on the accident statistics, as well as supervision at school arrival and departure times. In the long term it is evident that much more drastic measures will be required in order to reduce the incidence of pedestrian injury.

Road safety education can also play a part in reducing pedestrian casualties. Drivers need to learn that lower speeds in residential areas and around schools and playgrounds will increase their chance of stopping in time and will reduce the likelihood of serious injury and death of pedestrians

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