

Analysis of Pedestrian Accidents in Irbid City, Jordan

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Abstract: The numbers of people who are walking and bicycling continues to increase all over the world and pedestrian accidents are becoming a serious problem in the developed and developing countries. However, the problem is more severe in the developing countries, such as Jordan where pedestrians represented 32.5% of all traffic accident fatalities and 23.8% of all traffic accident injuries during the year 2010. This study aims at analyzing pedestrian accidents in Irbid city, as an example for urban areas in Jordan, based on a total of 1090 pedestrian accidents that have occurred in the City during the three years period (1999 - 2001). The analysis was based on pedestrian characteristics, driver characteristics, accident time, accident location, weather, road surface condition, illumination condition, vehicle characteristics, speed limit, accident severity, pedestrian faults, and driver faults. Geographic Information System (GIS) tool was used to locate all pedestrian accidents over the study area. The results of the study showed that the majority of pedestrian accidents have occurred at non-intersection locations, during clear and sunny weather, on dry surface, during daylight, and at low speed limits. Also, more pedestrian accidents have occurred during the afternoons, on Thursdays, and during July. The majority of involved drivers in pedestrian accidents were males, with private license type, driving private vehicles and committed the fault of "not giving priority to pedestrians". The majority of pedestrian victims were males, children less than 15 years old, and hit by vehicles while crossing the road.

Keywords: Pedestrian, accidents, driver, vehicle, speed.

INRODUCTION

Statistics reported by the Jordan Traffic Institute [1] indicated that 140,014 traffic accidents have occurred during the year 2010, which have resulted into a total of 670 deaths and 17,403 injuries. Pedestrians were involved during the same period in 4091 traffic accidents that have resulted into 218 fatalities and 4140 injuries. It was noticed that the majority of pedestrian accidents in Jordan have occurred in urban areas.

Irbid city was selected as an example for urban areas in Jordan to investigate the characteristics of pedestrian accidents based on pedestrian characteristics, driver characteristics, accident time, accident location, weather, road surface condition, illumination condition, vehicle characteristics, speed limit, accident severity, pedestrian faults, and driver faults. Irbid City has the second largest metropolitan population in Jordan after the capital city, Amman, with a population of around 300,000 (becomes 650,000 if the Greater city area is considered), and is located about 70 km to the north of Amman. The city is a major ground transportation hub between Jordan and Syria in the north. Irbid region is also home to several colleges and universities, the two most prominent being Jordan University of Science and Technology and Yarmouk University. The study area used in the investigation was the main city area as shown in Fig. (1).

This research aims at analyzing pedestrian accidents in Irbid city based on pedestrian characteristics (age and gender), driver characteristics (age, gender, and license type), accident time (hour, day, and month), accident location (midblock, intersection & bus terminal), weather, road surface condition, illumination condition, vehicle characteristics, speed limit, accident severity, pedestrian faults, and driver faults.

The characteristics of pedestrian accidents were investigated for the three years period (1999-2001). Data on traffic accidents were obtained from traffic directorate, public security headquarters, Jordan. Each pedestrian accident was located on Irbid streets map, using geographic information system (GIS) software to relate the accidents with their location characteristics.

LITRATURE REVIEW

The number of people who are walking and bicycling continues to increase all over the world and are currently forming around 12 percent of trips in the United States [2]. As a result, pedestrian accidents are becoming a serious problem in the developed and developing countries.

Pedestrians represented 32.5% of all traffic accident fatalities and 23.8% of all traffic accident injuries in Jordan [1] during the year 2010. The problem is worse in some other developing countries like Egypt where around 75% of the traffic injuries are related to accidents involving pedestrians [3].

These are considered high figures as compared to the developed countries. Based on (2007-2009) statistics,

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ANALYSIS OF PEDESTRIAN ACCIDENTS IN IRBID CITY, JORDAN

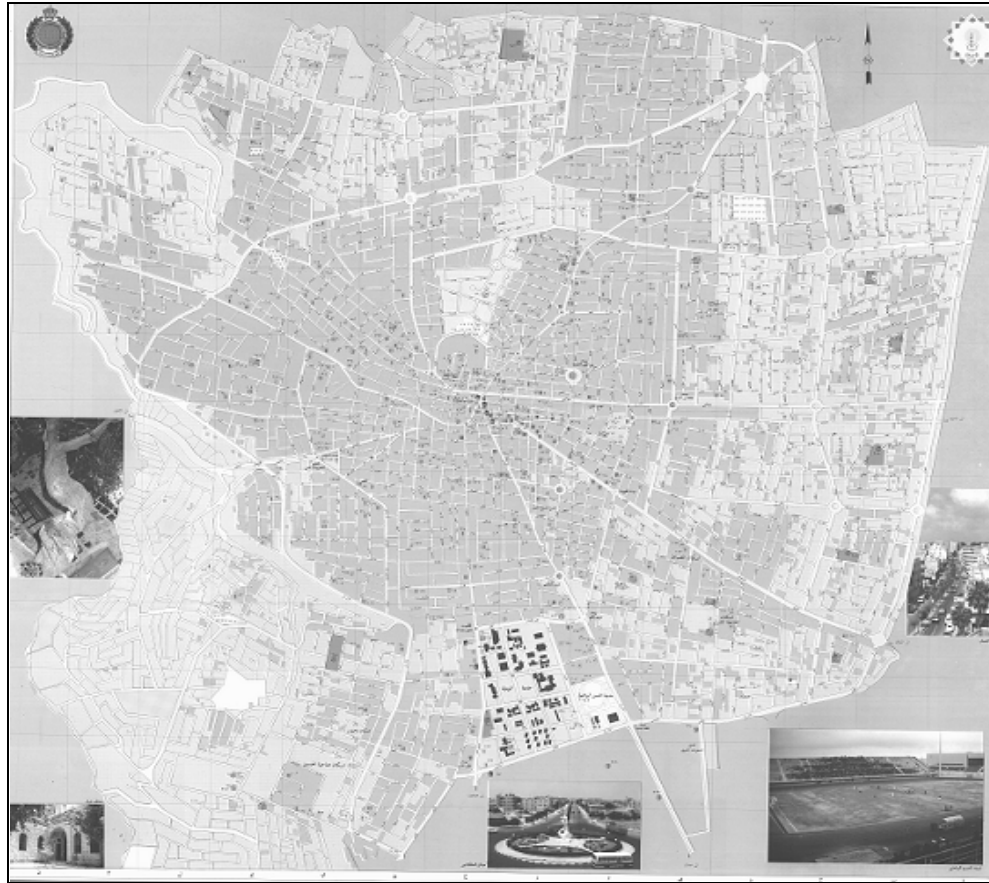


Fig. (1). Irbid City study area (Source: Irbid Municipality).

pedestrians represented 20% of all road deaths across the EU countries ranging from around 9% in the Netherlands to 37% in Romania [4]. In USA [5], a total of 4,280 pedestrians were killed (13% of all traffic fatalities) and 70,000 were injured (3% of all traffic injuries) during the year 2010. This could be explained by the fact that, in the developed countries, almost every pedestrian is a driver that makes him/her more familiar with the traffic environment [6]. On the other hand, in most of the developing countries, there is a low auto ownership, so more journeys are made on foot resulting in more likelihood of people being on the streets facing the risk of being hit by vehicles.

WHO states that around 90% of the global road traffic mortality occurs in low- and middle-income countries [7]. Zegeer and Bushell [8] indicated that pedestrians are more susceptible to traffic crashes in countries where traffic laws are poorly enforced and that pedestrians are most at risk in urban areas due to the large amount of vehicle and pedestrian activities. Wickramasinghe *et al.* [9] have noticed that in developing countries, even when there are sufficient pedestrian road crossing facilities, pedestrians take the risk and follow illegal road crossing patterns increasing their exposure to traffic accidents.

Several studies investigated the characteristics of pedestrian accidents. For example, LaPlante *et al.* [10]

investigated the characteristics of pedestrian accidents in Michigan and found that young pedestrians ages 5 to 24 are more likely to be involved in crashes, and that pedestrian crashes occur more often after dark than during daylight hours. Viola *et al.* [11] investigated the characteristics of crashes resulting in pedestrians killed or seriously injured in New York and found that nearly 36% were due to driver inattention, 79% involved private automobiles, and 80% involved male drivers. Nieuwesteeg and McIntyre [12] found that injured pedestrians are usually not at fault when crossing at intersections, but mostly at fault when crossing the road mid-blocks in Victoria. Truong, and Somenahalli [13] have used the GIS tool for the analysis of pedestrian-vehicle crash data for identification and ranking of unsafe bus stops in Australia.

DATA COLLECTION AND REDUCTION

Data on pedestrian traffic accidents were obtained from traffic directorate, public security head quarters, Irbid. After reviewing the traffic accident reports for the three years period (1999-2001), a total of 1090 pedestrian accident reports were separated from around 10,000 traffic accident reports that included all types of traffic accidents [14]. The following are the major data items that existed in the traffic accident report and might be used in analyzing pedestrian traffic accidents:

1. Location of the accident, based on a written description and a sketch.
2. Pedestrian age, gender and action (disregarding pedestrian traffic light, crossing from an incorrect location, crossing in front of a parked vehicle, working, playing, walking on the road, pushing a carriage, crossing at a zebra crossing, waiting to ride, getting in or out of a vehicle, crossing a pedestrian traffic light, getting in or out of a school bus, walking on sidewalks, riding a bicycle, off road, crossing the road, and walking inside a bus terminal).
3. Driver age, gender, license type, and fault (driving opposite to traffic direction, incorrect overtaking, exceeding speed limit, using incorrect lane, incorrect bending and turning, driving under the influence of alcohol, tail gating, incorrect parking, failing to comply with obligatory signs, disregarding a traffic light signal, not giving priority to vehicles, not giving priority to pedestrians, and incorrect reversing).
4. Vehicle category (motor cycle, agricultural vehicle, construction vehicle, small passenger car, minibus, bus, truck, dual-purpose vehicle, and special purpose vehicle) and vehicle type (foreign, government, private, public, and recreation).
5. Road surface condition (dry, wet, snowy, and icy), illumination condition (daylight, night with sufficient light, night with insufficient light, and dark) and weather condition (clear, fog, rain, snow, strong wind, and dust).
6. Accident severity (slight injury, medium injury, severe injury, and fatal).
7. Time of the day, day of the week, and month of the year.
8. Speed limit.

The Geographic Information System (GIS) has been used for the analysis and recording of pedestrian traffic accidents. Using GIS, the locations of traffic accidents were drawn as points on Irbid city map. After locating the accidents at the proper locations, each year had a separate layer (theme) over the base layer (the map). After that, all other characteristics of the accidents were added.

ANALYSIS AND RESULTS

To increase the efficiency of pedestrian's traffic safety improvement programs, the traffic safety officials need to focus on pedestrian and driver categories and consider the conditions that are directly related to pedestrian accidents. This requires more understanding of the relationship between pedestrian accidents and pedestrian characteristics, driver characteristics, accident time, accident location, weather, road surface condition, illumination condition, vehicle characteristics, speed limit, accident severity, pedestrian faults, and driver faults.

According to age groups. The highest relative involvement of the pedestrian casualties (by age groups and per 100,000 population within each age group) was for the age groups (6-10), (0-5), (11-15), & (56-60) respectively as shown in Table 1. Children below 15 years old who formed

43% of the city population, accounted for around 64% of pedestrian accidents. Similar results were found for Jordan by Al-Masaeid [16].

Table 1. Pedestrian Casualties by Age Group and Per 100000 Population

Age Group	Population	Pedestrian Casualties	Relative Involvement Per 100,000 Population
≤ 5	38528	269	698.19
6 - 10	35986	285	791.97
11 - 15	33251	172	517.28
16 - 20	30525	102	334.15
21 - 25	27696	73	263.58
26 - 30	21475	68	316.65
31 - 35	15091	41	271.69
36 - 40	10501	24	228.55
41 - 45	7870	11	139.77
46 - 50	6917	19	274.69
51 - 55	6401	14	218.72
56 - 60	5295	19	358.83
> 60	41284	33	79.93
All	280820	1130	402.39

According to accident location. Accident locations were divided into intersections, mid blocks, and bus terminals. Intersection accident location was defined as the one that has occurred within 20 m of an intersection [15]. The majority of pedestrian accidents (69.4%) have occurred at mid blocks, and a total of 26.8% have occurred at intersections. The rest of pedestrian accidents 3.8% have occurred inside bus terminals. Mid blocks are at more risk because of higher speeds, on street parking, and interruptions to both drivers and pedestrians. The unorganized traffic at terminals has caused a considerable number of pedestrian accidents.

According to road surface condition. Higher accident rates have occurred on dry surface conditions (95.5%) as compared to wet surface conditions. This was expected because pedestrians tend to avoid walking on the streets under rainy conditions.

According to illumination condition. The majority of pedestrian accidents (82.1%) have occurred during daylight condition, a bout 15.6% have occurred during nighttime with sufficient light, 2.0% have occurred during nighttime with insufficient light and only 0.3% have occurred during dark condition. These results are expected because this study was conducted for the urban area of the city where most of pedestrian trips end with the sunset. A study in Saudi Arabia presented similar results and showed that for most cities, the majority of accidents occurred during the day time [17].

According to accident severity. Pedestrian traffic accidents have resulted into 73.5% of slight injuries, 18.7% of medium injuries, 5.1% of severe injuries and 2.7% of fatalities.

According to pedestrian gender. Males accounted for about 72.3% of pedestrian involvements in traffic accidents. This is due to higher mobility of the male population in the Middle Eastern countries. In Kuwait, more than 80% of pedestrian victims were males [18].

According to time of the day. It was found that accidents are more frequent during (12:00 – 3:00) PM with 28.3% followed by (3:00 – 6:00) PM with 23.9% as shown in Table 2. These time intervals represent the peak traffic and pedestrian activities in the City. It should be noted that the interval (1:00 – 2:00) PM had the highest pedestrian accidents rate because it is the end of the working hours for most of public agencies and schools in Jordan.

Table 2. Pedestrian Accidents by Time of the Day

Time of Day	% of Pedestrian Accidents
00:00-03:00	1.28
03:00-06:00	0.27
06:00-09:00	8.72
09:00-12:00	14.59
12:00-15:00	28.26
15:00-18:00	23.85
18:00-21:00	15.87
21:00-24:00	7.16
Total	100.00

According to day of the week. It was found that pedestrian accidents are more frequent during Thursdays 16.5%, and Sundays 16.1% as shown in Table 3. These two days represent the end and the start of the working days before and after the weekend in Jordan. These two days are characterized by more traffic and pedestrians activities.

Table 3. Pedestrian Accidents by Day of the Week

Day	% of Pedestrian Accidents
Saturday	14.86
Sunday	16.06
Monday	14.50
Tuesday	15.05
Wednesday	13.21
Thursday	16.51
Friday	9.81
Total	100.00

According to month of the year. Monthly distribution of pedestrian accidents indicated that July is the peak month (11.8%) as shown in Table 4. This agrees with Al-Momani [19] study for Amman City in Jordan. This summer month with long, warm, and active days, and with school holiday, in addition to the presence of large number of visiting

Jordanian expatriates, have more pedestrian and vehicle activities.

Table 4. Pedestrian Accidents by Month of the Year

Month	% of Pedestrian Accidents
January	8.81
February	7.71
March	9.91
April	6.88
May	7.43
June	8.53
July	11.83
August	8.81
September	7.89
October	5.78
November	8.90
December	7.52
Total	100.00

According to weather condition. The majority of pedestrian accidents (94.2%) have occurred during clear weather condition and only 4.6% of pedestrian accidents have occurred during rainy conditions.

According to vehicle category. The majority of pedestrian accidents (73.4%) are caused by small passenger cars, followed by dual-purpose vehicles (12.0%) and then trucks (7.8%) as shown in Table 5. This was expected because small passenger cars form the largest component of the traffic fleet in Jordan especially in urban areas.

Table 5. Pedestrian Accidents According to Vehicle Categories

Vehicle Category	% of Pedestrian Accidents
Motorcycle	0.28
Agricultural Vehicle	0.09
Construction Vehicle	0.09
Small Passenger Car	73.36
Minibus	5.74
Bus	0.65
Truck	7.77
Dual Purpose Vehicle	12.02
Total	100.00

According to vehicle license type. Private vehicles were involved in 61.4% of total pedestrian accidents while public vehicles were involved in 32.9%.

According to driver license type. Drivers with private license type were involved in 45.6% of pedestrian accidents while drivers with public license type or higher were

involved in 50.3% of pedestrian accidents. It should be noted that unlicensed drivers were involved in 4.1% of pedestrian accidents showing that more enforcement is needed for this category in the city.

According to speed limit. The majority of pedestrian accidents have occurred at low speed limits of 40 km/hr (65.2%) and 50 km/hr (27.8%) as shown in Table 6. However, drivers tend to show more noncompliance at lower speed limits. Koushki [18] reported that high speed caused 17% of pedestrian accidents, and speed was cited as the major cause for pedestrian fatalities in Kuwait. Knowles *et al.* [20] found that around 90% of fatal pedestrian collisions on London's roads during the period 2006-2010 have occurred on roads with speed limits of 48 km/hour or lower. Jensen [21] found that the proportion of pedestrians killed in crashes increases in step with the speed limit.

Table 6. Pedestrian Accidents According to Speed Limit

Speed Limit	% of Pedestrian Accidents
30	3.15
40	65.16
50	27.76
60	2.95
70	0.59
80	0.39
≥ 90	0.00
Total	100.00

According to pedestrian actions. The majority of pedestrians (59%) were hit by vehicles while crossing the road as shown in Table 7. Without clear and marked crosswalks, which is the case at most Irbid streets, pedestrians cross the streets randomly resulting in more pedestrian accidents.

According to driver faults. The major identified driver fault was "not giving priority to pedestrians" with 37% followed by "incorrect reversing" with 4.6%, and then "exceeding speeding limit" with 2.3% as shown in Table 8.

According to driver gender. Male drivers accounted for 97.5% of pedestrian accidents. This was expected since female drivers constitute a small proportion of Jordanian drivers.

According to driver age. A high proportion of involved drivers in pedestrian accidents refer to young drivers (18-30 years old) with about 48% as shown in Table 9.

CONCLUSIONS

Based on the results of the analysis for pedestrian accidents in Irbid City - Jordan, it can be concluded that:

- Children less than 15 years old, accounted for the highest pedestrian accident rate as compared to other age groups.

Table 7. Pedestrian Accidents According to Pedestrian Actions

Pedestrian Action	% of Pedestrian Accidents
Crossing the Road	59.00
Crossing In front of a Parked Vehicle	4.66
Working on the Road	0.81
Playing on the Road	3.05
Pushing or Towing a Carriage	0.32
Walking on the Road	5.14
Crossing at A Zebra Crossing	0.17
Getting in or out of a Vehicle	1.45
Walking on Sidewalks	0.97
Riding a Bicycle	2.73
Off Road	2.09
Walking inside a Bus terminal	6.27
Crossing from an Incorrect Location	1.93
Others	11.41
Total	100.00

Table 8. Pedestrian Accidents According to Driver Faults

Drivers' Faults	% of Pedestrian Accidents
Not Giving Priority to Pedestrians	37.02
Exceeding Speed Limit	2.30
Using Incorrect Lane	2.29
Incorrect Bending and Turning	0.95
Driving Under the Influence of Alcohol/Drugs	0.19
Failing to Comply with Obligatory Traffic Signs	0.57
Not Giving Priority to Vehicles	0.76
Incorrect Reversing	4.58
Others	51.34
Total	100.00

- The majority of pedestrian accidents occurred at midblock locations, during clear and sunny weather, on dry surface, and during daylight conditions.
- Most of pedestrian accidents have resulted into slight and medium injuries.
- Males accounted for higher number of pedestrian accidents as compared to females.
- Pedestrian accidents were more frequent during the time period 12:00-3:00 PM, on Thursdays, and during July.

Table 9. Pedestrian Accident Causalities According to Driver Age Groups

Age Group	% of Pedestrian Accident Causalities
< 18	0.74
18 - 20	2.50
20 - 25	20.87
25 - 30	22.63
30 - 35	15.58
35 - 40	12.43
40 - 45	7.98
45 - 50	6.96
50 - 55	4.08
55 - 60	3.06
60 - 65	1.77
> 65	1.40
Total	100.00

- Small passenger cars and dual-purpose vehicles were involved in the majority of pedestrian accidents.
- Private cars accounted for higher number of pedestrian accidents as compared to public cars.
- Drivers with private license type were involved in the majority of pedestrian accidents.
- The majority of pedestrian accidents have occurred at low speed limits of 40 and 50 km/hr.
- The majority of pedestrians were hit by vehicles while crossing the road and the driver fault "not giving priority to pedestrians" was responsible for the highest percentage of pedestrian accidents.
- Male drivers accounted for higher number of pedestrian accidents as compared to female drivers.
- The majority of involved drivers in pedestrian accidents were young drivers (18-30 years old).

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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