Analysis of Accident Data and Evaluation of Leading Causes for Traffic Accidents in Jordan

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ABSTRACT

Road safety is a primary concern and goal of highway and traffic engineers worldwide. The road network in Jordan exhibits relatively high traffic volumes, particularly in urban areas and in the Central Business District (CBD) areas of major cities. Jordan ranks one of the top countries worldwide in terms of having higher numbers of road traffic accidents leading to a relatively high number of fatalities and injuries.

In the past few years in particular, the number of registered vehicles in Jordan has considerably increased. As a result, traffic volumes and Vehicle Miles of Travel (VMT) have significantly increased leading to deteriorating traffic flows and escalating traffic congestions and jams. Consequently, the number of road traffic accidents has also noticeably increased in Jordan in the past decade.

Complete analysis of statistical data obtained for traffic accidents in Jordan was conducted in this study. Evaluation of the possible leading causes of traffic accidents in Jordan was also carried out. Different possible causes along with behaviors of drivers and pedestrians were investigated and correlated with the number of traffic accidents, fatalities and injuries.

Jordan was found to have accident, fatality and injury rates that are considerably higher than those of other countries in the world. Nonetheless, as rates with time, the fatality and injury rates seemed to be moving in the right direction. Yet, the number of traffic accidents, fatalities and injuries looked critical.

Traffic accidents and casualties were observed to be higher in summer times. More than 90 percent of traffic accidents, fatalities and injuries occurred on roads with speed limits between 40 and 60 km/h. Pedestrians composed the highest percentage of the total numbers of fatalities and injuries. The majority of driver casualties and passenger casualties (fatalities and injuries) belonged to the age group of 18-42 years. On the other hand, the highest percentage of pedestrian casualties belonged to the age group of 0-18 years. However, about 80 percent of the casualties in Jordan were males and only 20 percent were females.

"Tailgating" and "not taking safety measurements during driving" were the most two important driver behaviors in terms of traffic accidents. Yet, behaviors of "using wrong lane" and "not taking safety measurements during driving" led to the highest percentages of the total number of fatalities and injuries.

The majority of the pedestrian fatalities and injuries were in fact walking on road during the time of the accident occurrence and about one third of them were walking on sidewalk. Other behaviors of drivers and pedestrians were also important and created traffic complexity and hazardous situations leading to a reduction in saturation flow rates and in capacities and causing bottleneck conditions and traffic jams; hence resulting in traffic safety concerns.

KEYWORDS: Accident data, Accident analysis, Safety, Traffic accidents, Fatalities, Injuries.

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BACKGROUND AND LITERATURE REVIEW

Safety is the main goal for highway and traffic engineers that should be provided for drivers, road users and pedestrians. Road traffic accidents with their end results of fatalities and injuries are significantly related to safety on highways. One of the key measures of safety on a highway is the number of traffic accidents occurring on it. Consequently, records and statistics of traffic accidents should be available at traffic departments and agencies in each country for the country's highway network.

Road traffic accidents get plenty of local attention where and when they occur, especially when they involve fatalities or injuries. Traffic accidents are considered obvious reminders of the harm which vehicles and their users can cause anytime when there is a tragedy.

Globally, traffic accidents on roads are influential. Traffic fatalities and injuries resulting from road accidents are so high worldwide. According to the most recent estimates, road traffic accidents kill 1.2 million victims worldwide and injure 50 million each year. Ninety percent of them occur in developing countries, and more than half of all victims globally are between the ages of 15 and 44. In addition to human suffering which traffic accidents cause, they result in considerable additional costs to societies. This global loss has enormous implications for the security of families. Estimates show that road traffic injuries cost nations as much as two percent of their gross national product (WHO, 2007).

Low-income and middle-income countries account for well over three quarters of the casualties, affecting the most vulnerable groups including pedestrians and other road users. Road traffic accidents are already the fourth leading cause of death for 15–59 years olds in low- and middle-income countries. According to statistics in the year of 2005 by the National Highway Traffic Safety Administration (NHTSA) of the United States (US), the economic cost of the disaster for all age groups in the US is estimated to be between $65 billion and $100 billion per year (NHTSA, 2006).

The annual number of traffic accidents in Jordan is among the highest in the world according to statistics. Jordan ranks one of the top countries in the Arab World for the number of road traffic accidents. According to statistics and reports in Jordan, more than 98,000 road traffic accidents were recorded in 2006, averaging one every 5 minutes and resulting in a death every 10 hours. In 2007, the registered traffic accidents were 110,630 resulting in 992 deaths and 17,969 injuries, apart from the financial cost that exceeded JD280 million.

While in some developed countries, nations lose one citizen in traffic accidents for every 10,000 registered vehicles, Jordan loses 16 citizens annually for a similar number of registered vehicles. Jordanian statistics show that five children die every week in traffic accidents and that there is a traffic accident every 7.5 minutes on average. Numbers like these look terrifying when compared to international road safety standards.

Jadaan (1989) presented a review of the problem of road traffic accidents in Jordan with a special reference made to hospitalized accidents. Analysis of time-series data on road traffic accidents between 1979 and 1985 showed a rising trend. Over three-quarters of accidents occur in urban areas and during daylight while pedestrians constitute over 40 percent of all injuries. A detailed analysis of 1986 road traffic accidents revealed that more accidents occur on Saturdays (the first business day of the week at that time) and during summer months. Three-quarters of injured pedestrians were less than 20 years of age; a group that composes 60 percent of the total population, and 73 percent of the total injuries involved people less than 30 years of age.

In Jordan, the majority of the total number of road traffic accidents is collision accidents. For instance, in the year of 2007, collision accidents composed 94.5 percent of the total number of accidents. Accidents involving pedestrians were 3.8 percent of the total number of accidents in the same year. On the other hand, only 1.7 percent was the contribution of the turnover accidents for the same year (Report from Jordan Traffic Institute, 2008).

Despite the fact that the percentage of pedestrian-involved accidents is considered very low compared to collision accidents, the numbers of fatalities and injuries in this kind of accidents are relatively high due to the direct impact between the vehicle and the pedestrian. For example, according to a final report from Jordan Traffic Institute (2008), in the year of 2007 the fatalities resulting from accidents involving pedestrians constituted about 31 percent of the total number of fatalities, and the injuries from the same type of accidents composed approximately 37 percent of the total number of injuries.

The capital city of Jordan, Amman, perceives the highest number and majority of traffic accidents among the other cities of Jordan. For the year 2007, Amman received about 67 percent of the total number of accidents. Irbid, the second major city in terms of population in the northern part of Jordan, comes second after Amman in the number of traffic accidents. In 2007, Irbid city exhibited approximately 7 percent of the total number of traffic accidents (Report from Jordan Traffic Institute, 2008).

Comparing Jordan to Other World Countries

Jordan is considered one of the world countries that have relatively high accident rates. Several other countries were selected covering a wide range of traffic conditions with a variety of traffic accidents, fatalities and injuries. These countries included the United States of America (USA), Great Britain (GB), Germany, Sweden and Greece.

The Fatality Rate (FR) and Injury Rate (IR) in the past six or seven years were evaluated for these countries and compared to those of Jordan. These two rates were determined with reference to 10,000 registered (licensed) vehicles per year in each country as shown in the equations below. The change with time for these rates was monitored over the specified time period.

$$FR = 10{,}000 \frac{Total\ \ Number\ of\ \ Fatalities\ \ in\ \ That\ \ Year}{Total\ \ Number\ of\ \ Registered\ \ Vehicles\ \ in\ \ the\ \ Same\ \ Year} \quad (1)$$

$$IR = 10{,}000 \frac{Total\ \ Number\ of\ \ Injuries\ \ in\ \ That\ \ Year}{Total\ \ Number\ of\ \ Registered\ \ Vehicles\ \ in\ \ the\ \ Same\ \ Year} \quad (2)$$

where:
FR = fatality rate, and
IR = injury rate.

The traffic statistics data including the number of registered motor vehicles, the number of accident fatalities and the number of accident injuries for these countries were obtained from the following offices:

1. The Bureau of Transportation Statistics (BTS) in the USA, US Department of Transportation, Research and Innovative Technology Administration (RITA), http://www.bts.gov/publications/national_ transportation_statistics/ index. html.
2. The U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA), National Center for Statistics and Analysis Databases, http://www.nhtsa.dot.gov/.
3. The U. S. Department of Transportation, Federal Highway Administration, Highway Statistics, Annual Issues, Washington, D.C., http://www.fhwa.dot.gov.
4. The U. S. Department of Transportation, Federal Highway Administration, Highway Statistics Summary, FHWA-PL-97-009, Washington, D.C., http://www.fhwa.dot.gov.
5. The Department for Transport (DfT) of Great Britain, http://www.dft.gov.uk/.

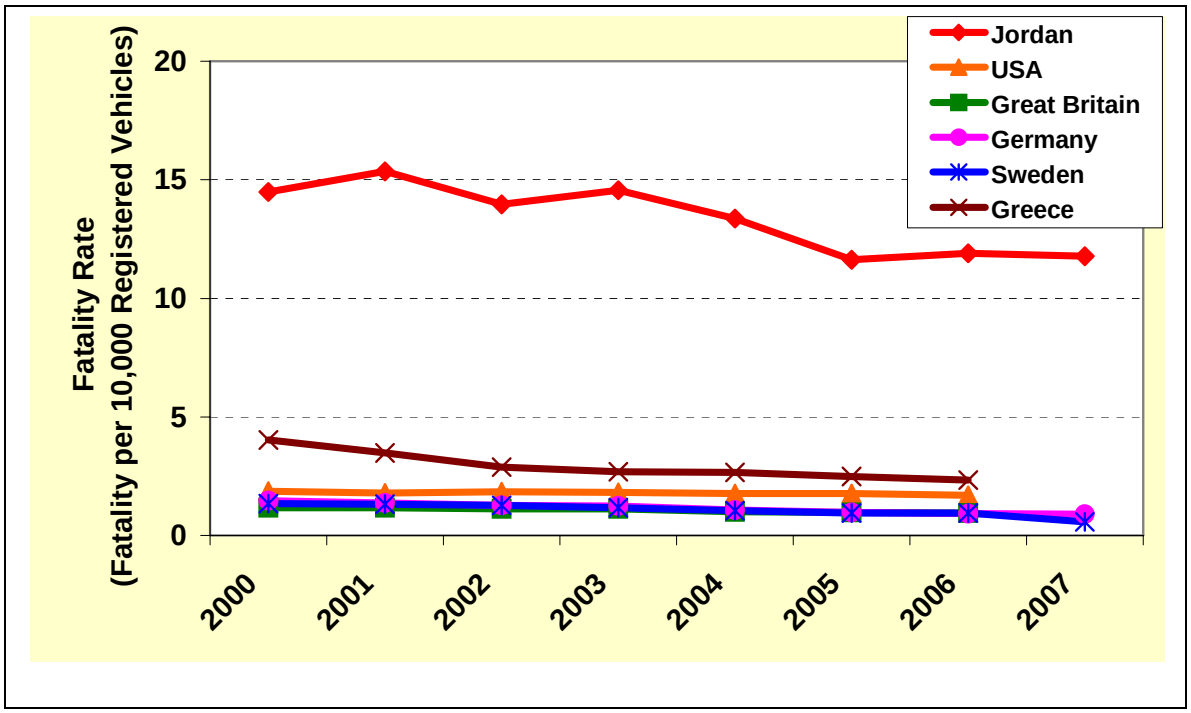

Figure (1): Fatality rate with time

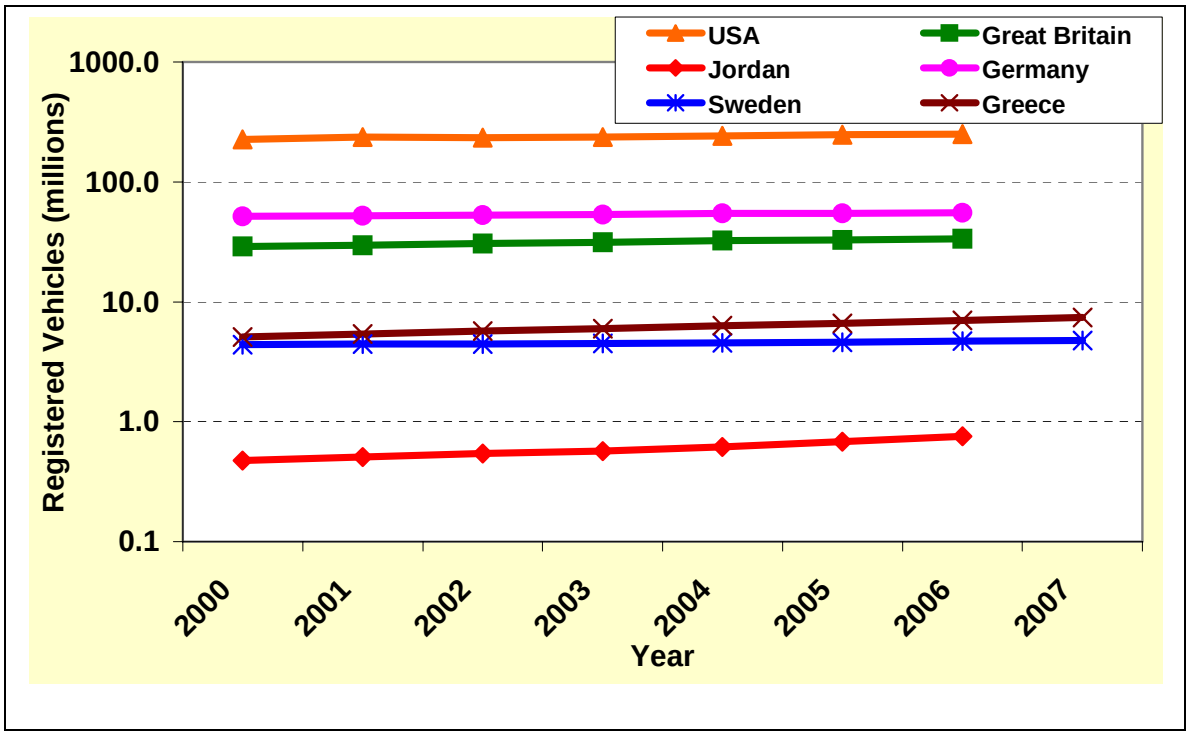

Figure (2): Number of registered vehicles rate with time

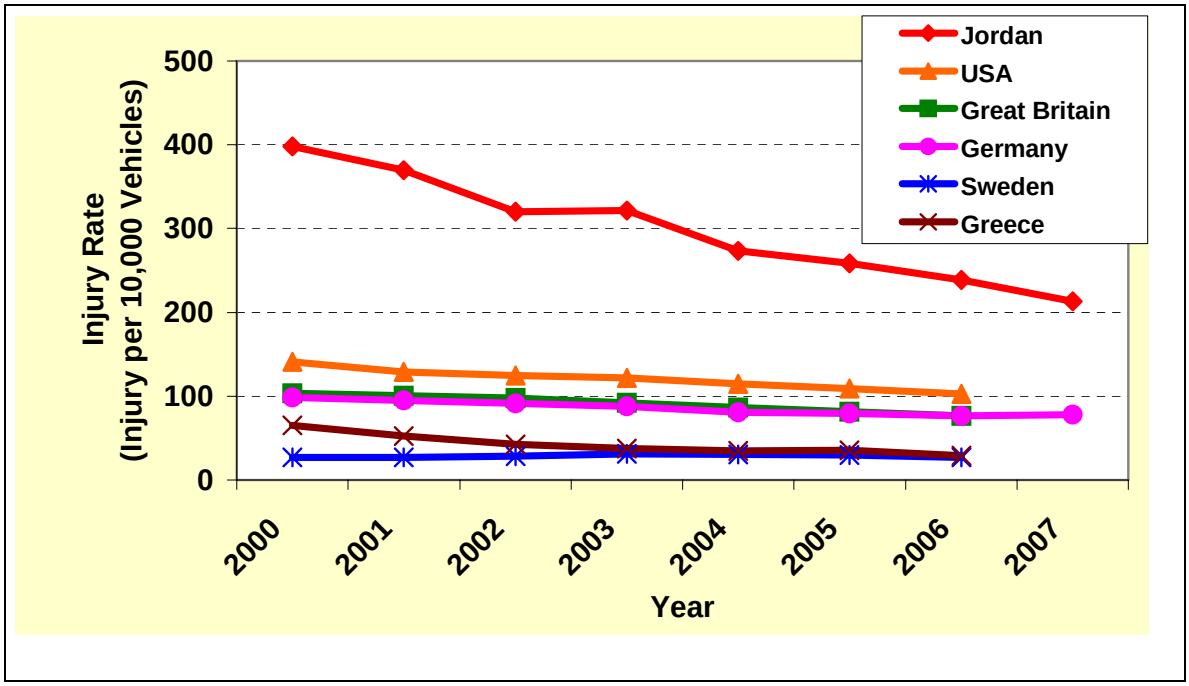

Figure (3): Injury rate with time

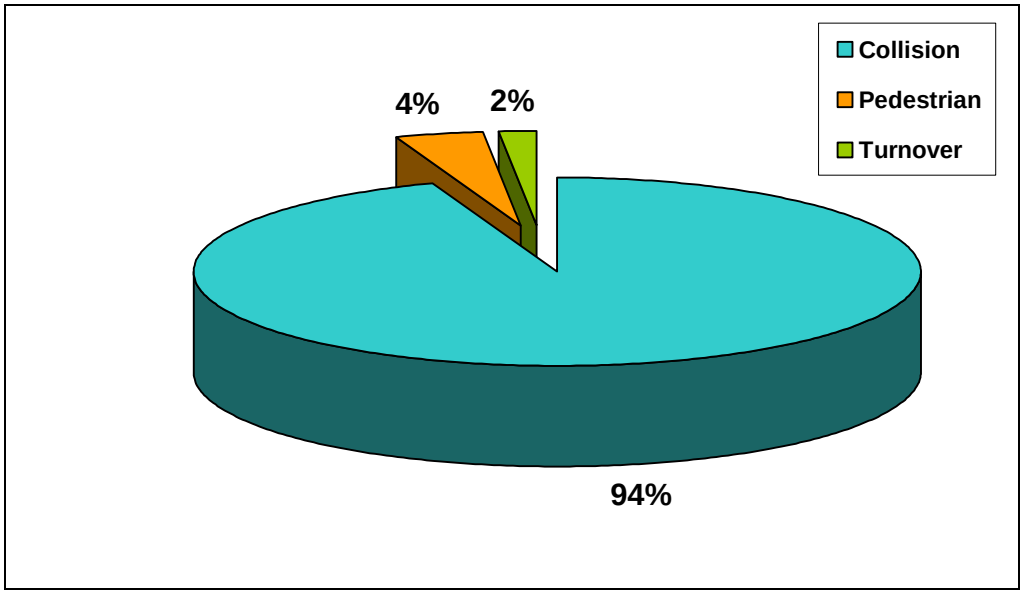

Figure (4): Road traffic accidents in Jordan for the year of 2007

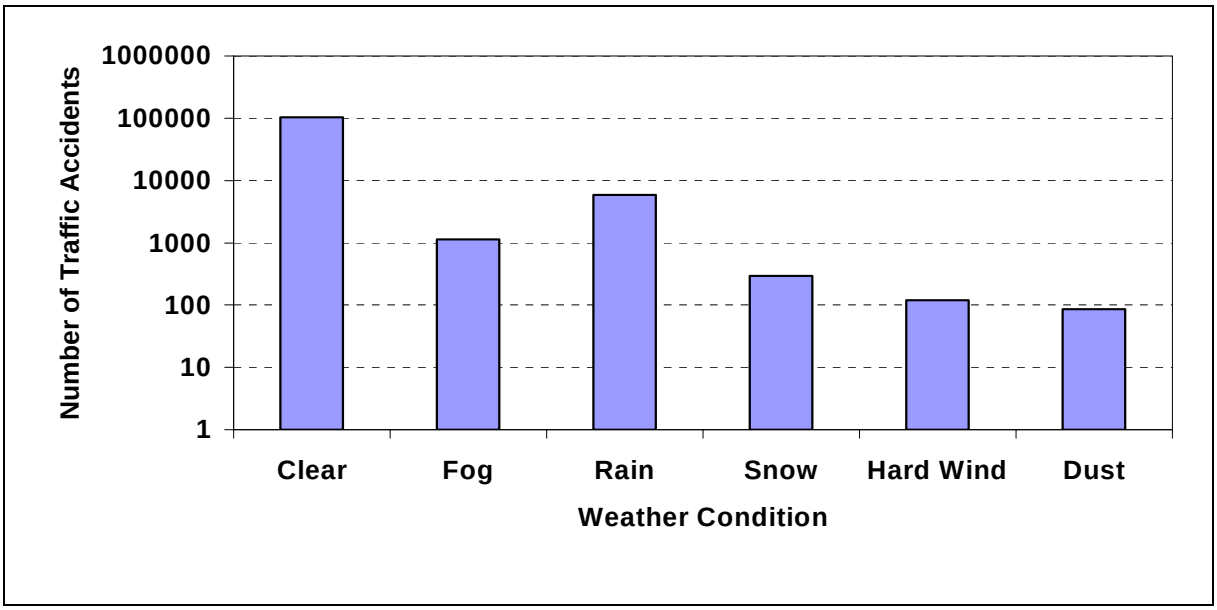

Figure (5): Year 2007 road traffic accidents by weather condition in Jordan

6. The International Road Traffic and Accident Database (IRTAD) Group, the International Transport Forum and the Organization for Economic, Cooperation and Development (OECD), Joint Transport Research Center, http://www.cemt.org/irtad/IRTADPUBLIC/index.htm.
7. The Federal Statistical Office of Germany, http://www.destatis.de/jetspeed/portal/cms.
8. The Federal Highway Research Institute of Germany, http://www.bast.de/EN/e-Home/e-homepage_node.html?_nnn=true.
9. The Swedish Institute for Transport and Communications Analysis, http://www.sika-institute.se.
10. The Swedish National Road Administration, http://www.vv.se/templates/page2_2____13172.aspx?epslanguage= EN.
11. The Official Statistics of Sweden, http://www.scb.se.
12. The National Statistical Service of Greece, http://www.statistics.gr/Main_eng.asp.
13. World Health Organization (WHO), http://www.who.int/violence_injury_prevention/road_traffic/en/.
14. The Department of General Statistics (DGS) of Jordan, http://www.dgs.gov.jo.
15. The Public Security Directorate (PSD) of Jordan, Jordan Traffic Institute, http://www.jti.psd.gov.jo/.

The fatality rate and injury rate in these countries along with the same rates in Jordan over the time period from 2000 to 2006/2007 were determined and plotted with time.

The fatality rate (number of fatalities per 10,000 registered motor vehicles) in Jordan was also compared to those of other countries (Figure 1). An encouraging decline in the fatality rate, when the total number of registered motor vehicles is taken into consideration, is observed. The total number of registered vehicles in Jordan increased rapidly with time compared to other countries (Figure 2). The fatality rate for Jordan declined from the year 2000 to the year 2005 in a relatively good rate of change, particularly when this rate is compared to those rates of other countries. However, the fatality rate is on average about 8 times the fatality rate of the USA, 13 times higher than that of GB and 12 times the fatality rate of Sweden.

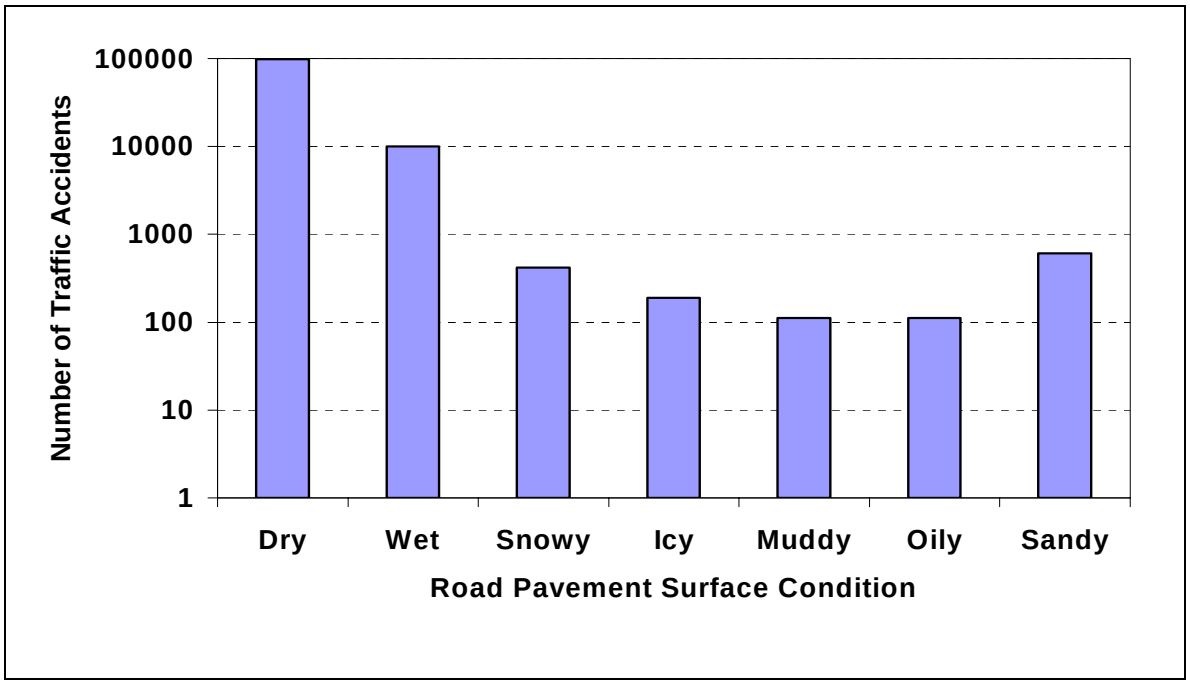

Figure (6): Year 2007 road traffic accidents by road pavement surface condition in Jordan

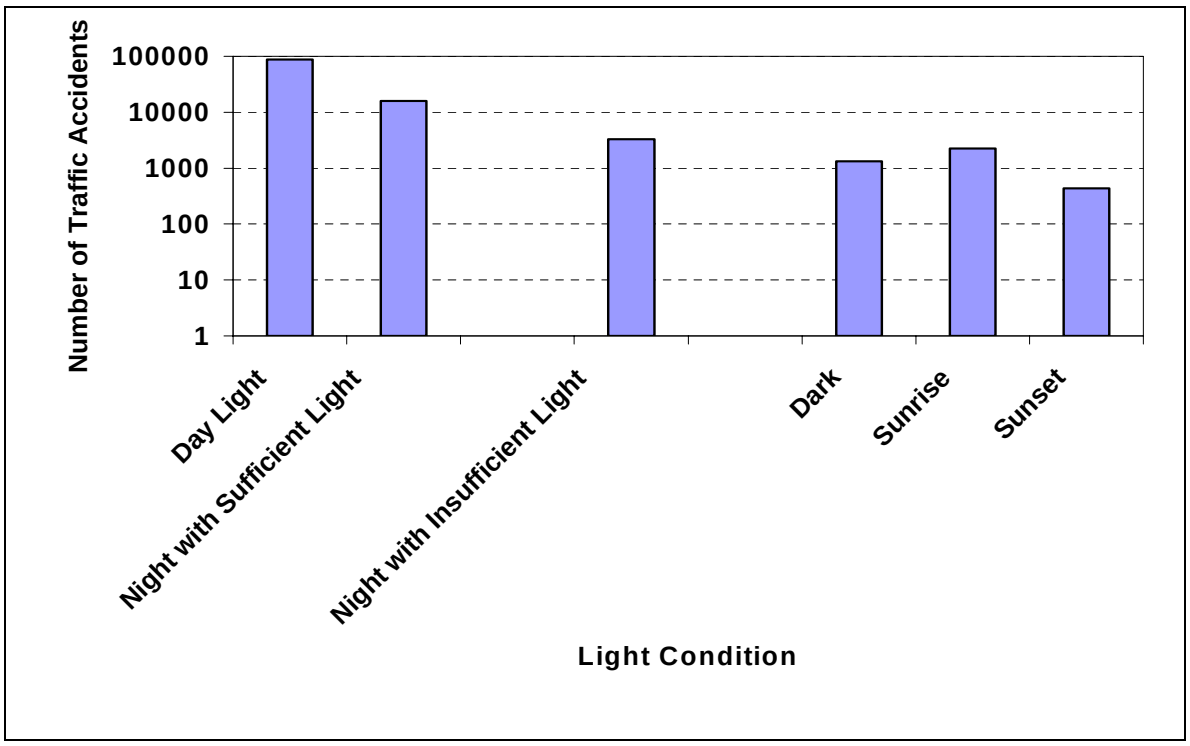

Figure (7): Year 2007 road traffic accidents by light condition in Jordan

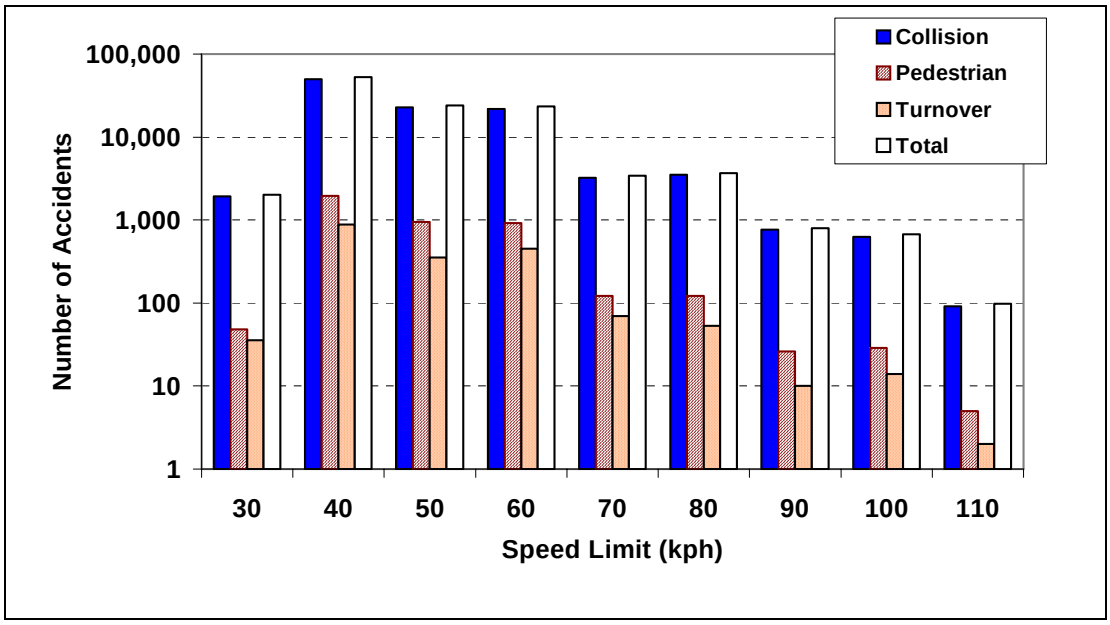

Figure (8): Year 2007 road traffic accidents by speed limit in Jordan

Similar trend was obtained for the injury rate (number of injuries per 10,000 registered motor vehicles) as shown in Figure 3. The figure shows that the injury rate for Jordan consistently decreased from the year 2000 to the year 2006. However, this rate when compared with those of other countries is significantly high. It is on average about 2.5 times higher than that for the USA, 3.2 higher than that for GB, about 11 times the injury rate of Sweden and about 8 times the injury rate of Greece. This rate is considered drastically high compared to the rates of other countries.

In conclusion, Jordan is having fatality and injury rates considerably higher than those of other countries in the world. Nevertheless, as trends with time, at least the fatality and injury rates seem to be moving in the right direction. Yet, traffic and highway engineers as well as responsible authorities are required to work together in order to push harder towards lower numbers of accident fatalities and injuries, more decreasing rates and safer roads in Jordan.

Leading Causes for Traffic Accidents in Jordan

Analysis of traffic data obtained for Jordan shows that the highest percentage of road traffic accidents is that for collision accidents which compose on average about 95 percent of the total number of accidents (Figure 4). Most of these accidents occur during the daytime when weather conditions are normal and the road pavement surface is also dry. This is to conclude that the factor of weather conditions and pavement surface condition in this case is not considered a major cause of road traffic accidents in Jordan.

To investigate the effect of weather conditions on traffic accidents, statistical data over a period of one year (year 2007) were obtained and analyzed. The number of traffic accidents per weather condition was recorded for all possible weather conditions in Jordan including: “Clear”, “Fog”, “Rain”, “Snow, “Hard Wind” and “Dust”. The histogram shown in Figure 5 illustrates the number of traffic accidents occurring under each weather condition. The figure shows that most (approximately 93 percent) of the accidents happened when the weather condition was “Clear”. The weather condition that had the next highest number of traffic accident (5.3 percent) was “Rain” condition and next to that was “Fog” condition (1.0 percent). Consequently,

weather conditions in Jordan do not contribute significantly in the occurrence of road traffic accidents.

In other words, when a traffic accident occurs, there is a low probability that a certain weather condition has caused this accident. But rather, other reasons have led to the accident.

It is commonly known that the road pavement surface condition influences the occurrence of traffic accidents. Subsequently, different pavement surface conditions were considered in this study to investigate the effect of the surface condition on traffic accidents. They included: “Dry”, “Wet”, “Snowy”, “Icy”, “Muddy”, “Oily” and “Sandy”. The number of road traffic accidents per each pavement surface condition was recorded. Figure 6 demonstrates the number of traffic accidents for each surface condition on Jordan roads. In this figure, it is obvious that the highest percentage (about 90 percent) of traffic accidents occurred when the pavement surface condition was “Dry”. The next highest number of traffic accidents (9.1 percent) took place when the surface condition was ‘Wet”. All other pavement surface conditions contributed insignificantly to traffic accidents as shown in the figure.

By investigating the light conditions at the time when traffic accidents occur, the results illustrated in Figure 7 are obtained. The numbers of traffic accidents for six light conditions were recorded. The light conditions included: “Day Light”, “Night with Sufficient Light”, “Night with Insufficient Light”, “Dark”, “Sunrise” and “Sunset”. It was found that approximately 79 percent of the traffic accidents occurred under the “Day Light” condition, and 14.5 percent of the traffic accidents happened under the “Night with Sufficient Light” condition. Other light conditions contributed slightly to traffic accidents as shown in the figure. In other words, the majority of traffic accidents occurring in Jordan are taking place during the daylight.

The total numbers of fatalities and injuries resulting from traffic accidents in Jordan were also in agreement and were directly proportional with the total number of traffic accidents by weather condition, road pavement surface condition and light condition.

In summary, weather conditions, road pavement surface condition and light conditions for the roads in Jordan to a great extent do not have major effect on road traffic accidents. This conclusion is made based upon statistical data obtained for road traffic accidents across the entire road network in Jordan for a wide range of conditions entirely covering those of Jordan.

In general, the highway system is composed of five main components: driver, vehicle, road, environment (weather) and surroundings (light, pedestrians, …etc). Up to this point, the weather conditions, road conditions and light conditions have been considered in the analysis. These conditions are related to road and environment; however, there are still other important components that primarily affect the occurrence of road traffic accidents including the driver, vehicle and pedestrians. It is typically difficult to investigate in a single study all possible causes that could lead or contribute to road traffic accidents. Nonetheless, in this study, great efforts and time were put into investigating the major causes that might have impact on traffic accidents in Jordan.

The time of accident and the speed limit of the roadway where the accident took place were also addressed in this study. It was observed that the number of traffic accidents peaked during the time period from 12:00 pm (noon time) until 5:00 pm having its maximum between 2:00 pm and 3:00 pm (9 percent of the total number of traffic accidents occurred in this period). By also comparing the different days of the week, it was noticed that Sunday and Thursday in the week had the maximum number of traffic accidents. 15.6 and 16.5 percent of the total number of traffic accidents occurred on Sundays and Thursdays, respectively. In Jordan, Sunday is the first day of the week and Thursday is the last day of the week. Therefore, it might be that people on the first business day of the week are normally more nervous and tense than on other days, and on the last business day of the week they rush to go home to do activities and enjoy

their times in the beginning of the weekend. The other fact about Jordan is that the closing time during a business day for most of the government agencies and departments is 3:00 pm and most of the time employees leave earlier than that especially if they started their working day earlier than 8:00 am. In addition, the same closing time applies for some private companies, establishments and agencies, and others end their business day at 2:00 pm. Moreover, government and private schools release their school kids for most grades at the time of 2:00 pm. These facts indicate that the time period between 2:00 pm and 3:00 pm is considered actually a big rush hour for Jordan. Other traffic peak hours in the morning and after 3:00 pm receive a relatively high number of traffic accidents but not the highest. Not all employees travel to their work places and businesses at the same time due to the fact that some offices start work at 8:00 am, others at 9:00 am and some others even later. Additionally, schoolteachers and kids have to be at school normally before 7:30 am or even 7:00 am in some cases.

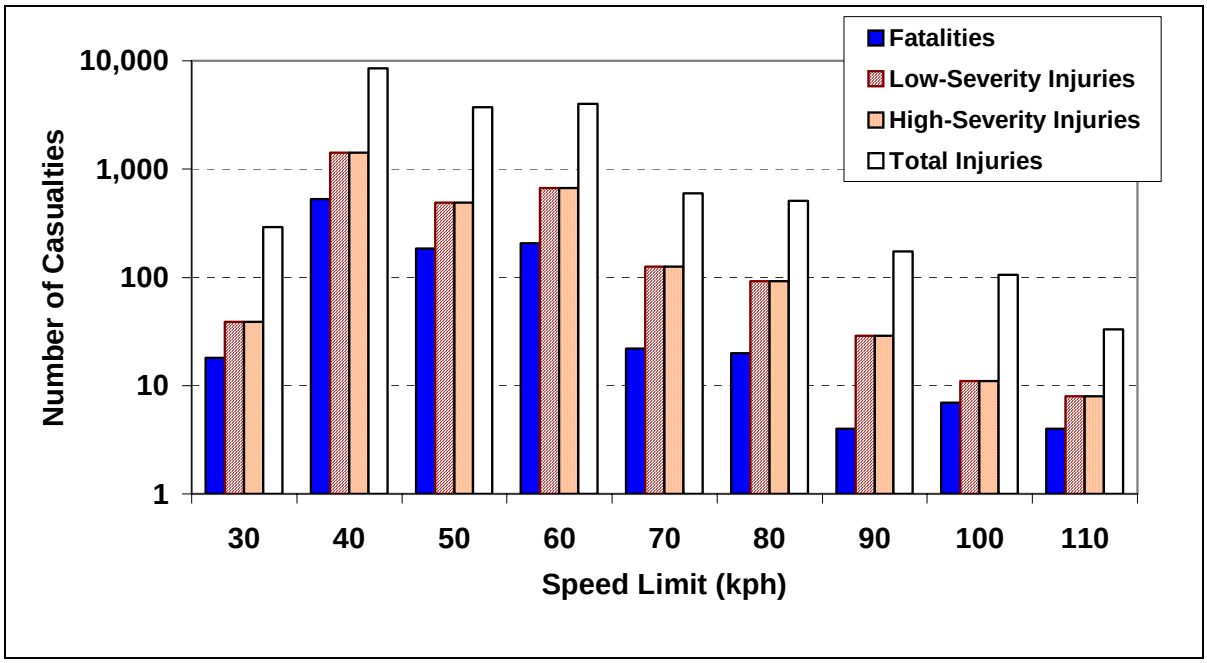

Figure (9): Year 2007 fatalities and injuries of road traffic accidents by speed limit in Jordan

The severity of the traffic accident, number of fatalities and number of injuries by time are also important measures that should be considered when addressing traffic safety. The number of fatalities by time was obtained for the year of 2007. It was found that approximately 20 percent of the total number of fatalities (the highest percentage) occurred between 3:00 pm and 6:00 pm, and about 18 percent of fatalities took place between 12:00 pm and 3:00 pm. Similar results were obtained for the number of injuries by time. About 23 percent of the total number of high-severity injuries and 21.3 percent of the total number of low-severity injuries (the highest percentages) happened in the time period from 3:00 pm to 6:00 pm. In addition, approximately 21 percent of the total number of high-severity injuries and about 21 percent of the total number of low-severity injuries took place in the time period between 12:00 pm and 3:00 pm. In summary, the time period between 3:00 pm and 6:00 pm is considered a critical period in terms of traffic safety in Jordan. The number of fatalities and the number of injuries during rush hours were statistically compared to those during

off-peak hours. A t-test was used to compare the two means in each case. It was found that both the number of fatalities and the number of injuries during peak hours were statistically different (larger) than those during off-peak hours at a significance level of 10 percent.

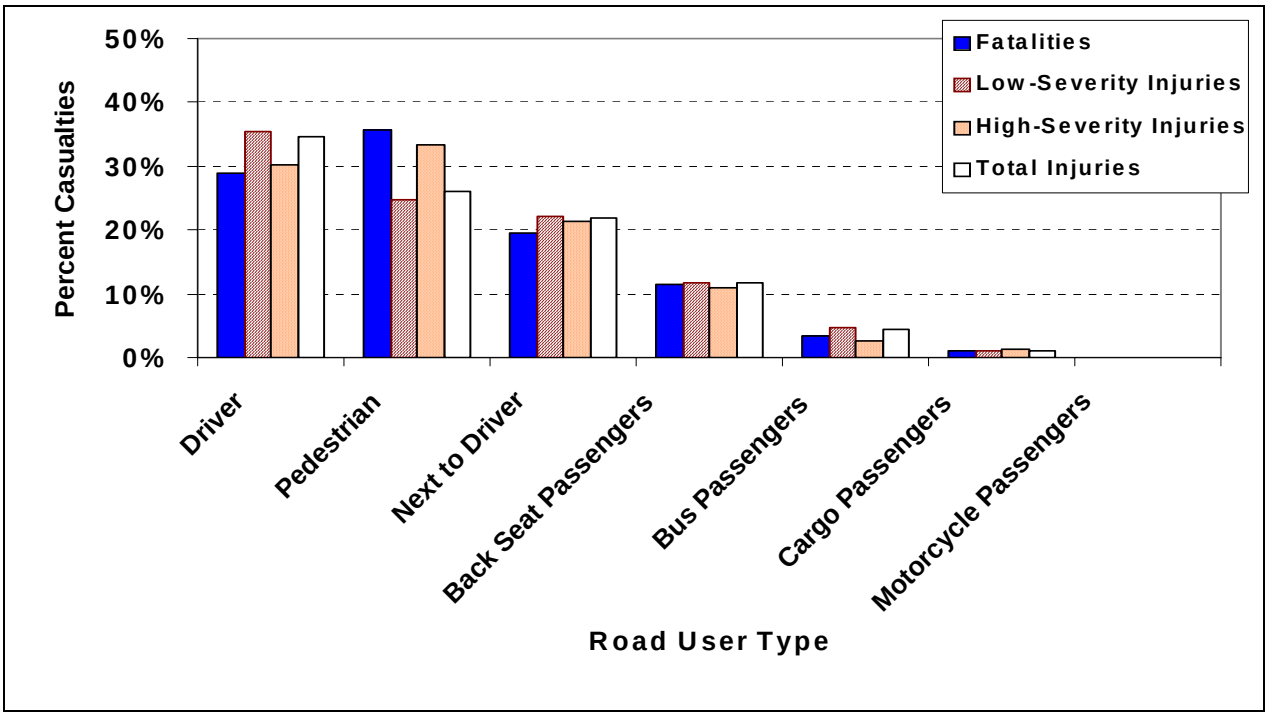

Figure (10): Year 2007 fatalities and injuries of road traffic accidents by type in Jordan

When the day of the week was considered, it was found that about 14.7 percent of the total number of fatalities occurred on Sunday and 15.0 percent of the fatalities occurred on Thursday. However, Friday had the highest percentage of the total number of fatalities. 14.2 percent of the total number of low-severity injuries and 13.1 percent of the total number of high-severity injuries occurred on Sunday. In addition, 16.8 percent of the total number of low-severity injuries and 16.4 percent of the total number of high-severity injuries occurred on Thursday. Friday also had a relatively higher number of injuries; 14.9 percent of the total number of low-severity injuries and 16.2 percent of the total number of high-severity injuries occurred on Friday. Despite that Friday was not a critical day for the number of traffic accidents, but the severity of the accident and the number of fatalities and injuries on this day were highest. However, the number of fatalities and the number of injuries during peak hours were found statistically equivalent to those during off-peak hours at a significance level of 10 percent.

When the month of the year is also considered, traffic accidents data obtained for Jordan shows that the highest numbers of traffic accidents indeed occur during the summer months from July to October. 9.5, 9.6, 9.4 and 9.6 percent of the total number of traffic accidents actually occurred in these months, respectively. On the other hand, 10.3, 9.2 and 12.5 percent of the total number of fatalities occurred in August, September and October, respectively. In other words, about one third of the total number fatalities took place in these three months of the year. Similar results were obtained for injuries. Approximately 9.4, 10.6, 9.2 and 10.2 percent of the total number of low-severity injuries occurred in

the months of July, August, September and October, respectively, i.e. about 40 percent of the total number of low-severity injuries happened during these four months. For high-severity injuries, 11.1, 11.1, 8.8 and 10.7 percent of the total number of these injuries occurred in these months, respectively. In summary, about 42 percent of the total number of high-severity injuries took place in these months. A t-test was conducted on the means of the number of fatalities and also on the number of injuries for the summer months and for the other months of the year. It was found that the number of fatalities and the number of injuries in the summer months were both statistically different (greater) than those in the remaining months of the year at a significance level of 10 percent.

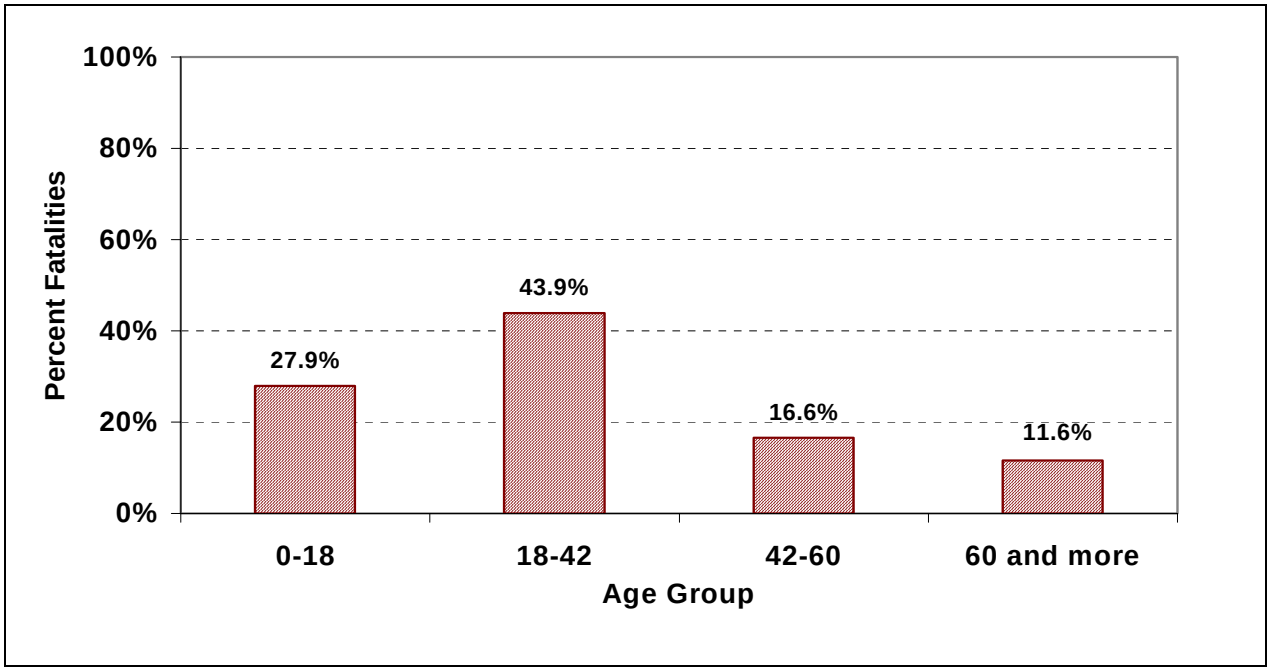

Figure (11): Year 2007 fatalities of road traffic accidents by age group in Jordan

Due to the fact that Jordan is a developing country with limited resources and fair economic conditions, a quite good percentage of Jordan's population work in the neighboring Arabic Gulf Regional Countries such as the United Arab Emirates (UAE), the Kingdom of Saudi Arabia (KSA), Qatar, Bahrain, Oman, …etc to improve their financial state and to raise their living standards. Subsequently, during the summer times in their vacations, most of those working abroad come back home to see their extended families and enjoy their vacations with their loved relatives or friends in Jordan. Most of them drive their own vehicles from these countries back to Jordan. In addition, many residents of these gulf countries visit Jordan and other neighboring countries in the summer times as tourists, particularly because Arabic gulf countries are too hot during the summer. Those tourists also for the major part drive their own vehicles to Jordan when they visit it. For this reason, a driver driving around in any major city of Jordan during the summer time would notice many of these foreign license plates on the back bumper of vehicles. That is to say that the number of operating vehicles during the summer time is typically much higher than in other times of the year. And thus, this could be a good reason behind the highest number of traffic accidents during this time period of the year.

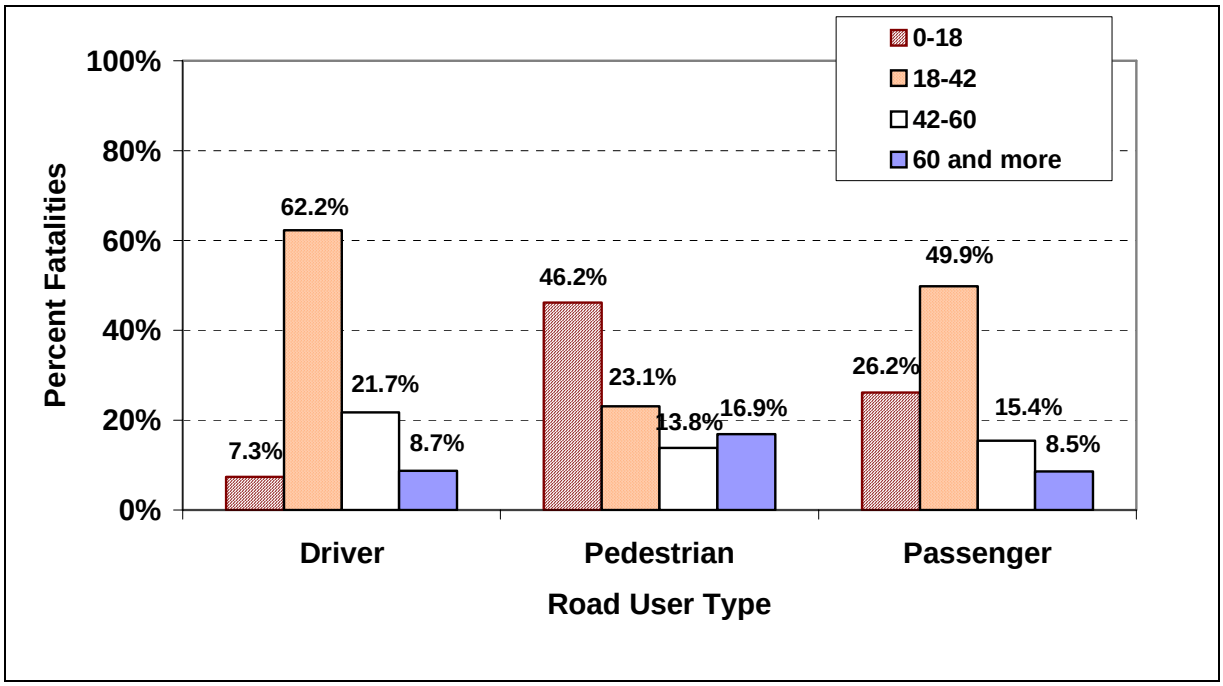

Figure (12): Year 2007 fatalities of road traffic accidents by age group and road user type in Jordan

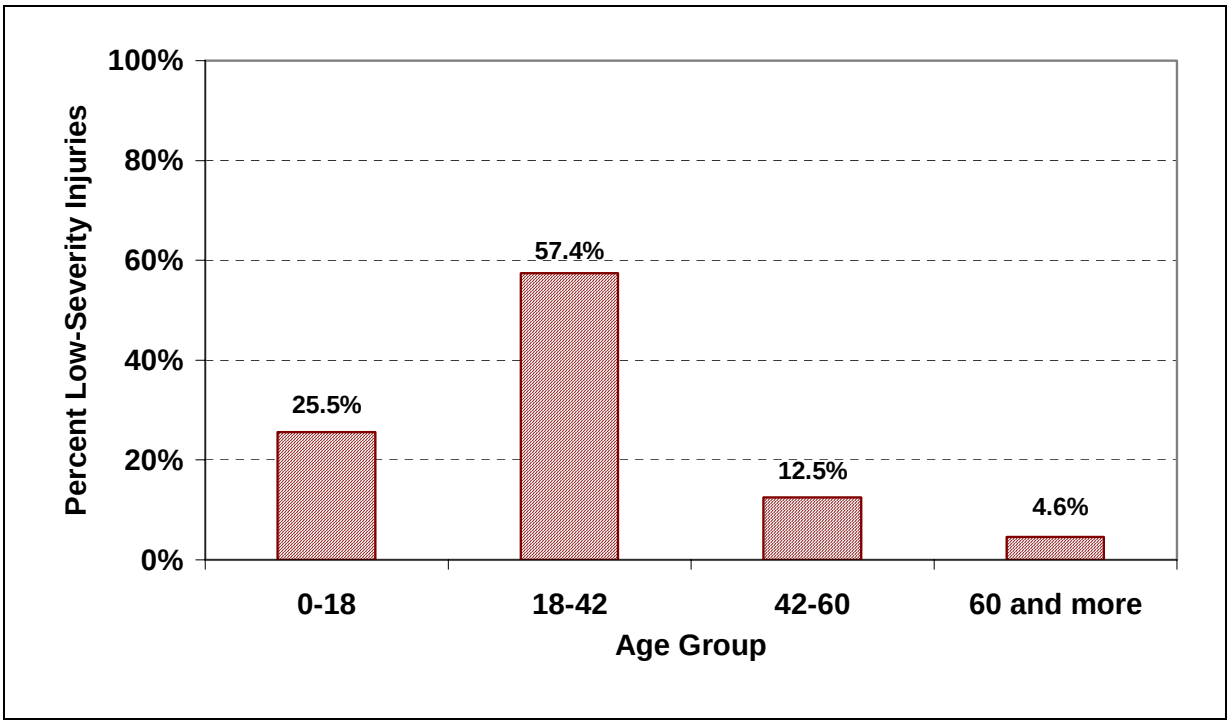

Figure (13): Year 2007 low-severity injuries of road traffic accidents by age group in Jordan

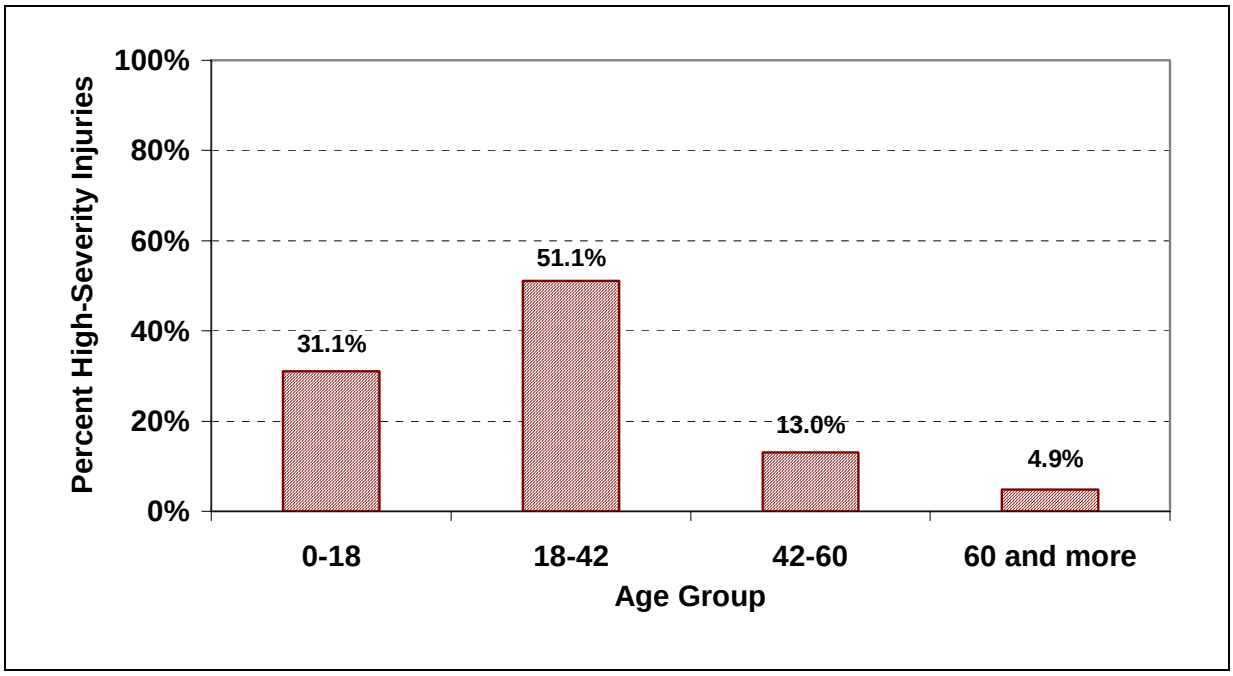

Figure (14): Year 2007 high-severity injuries of road traffic accidents by age group in Jordan

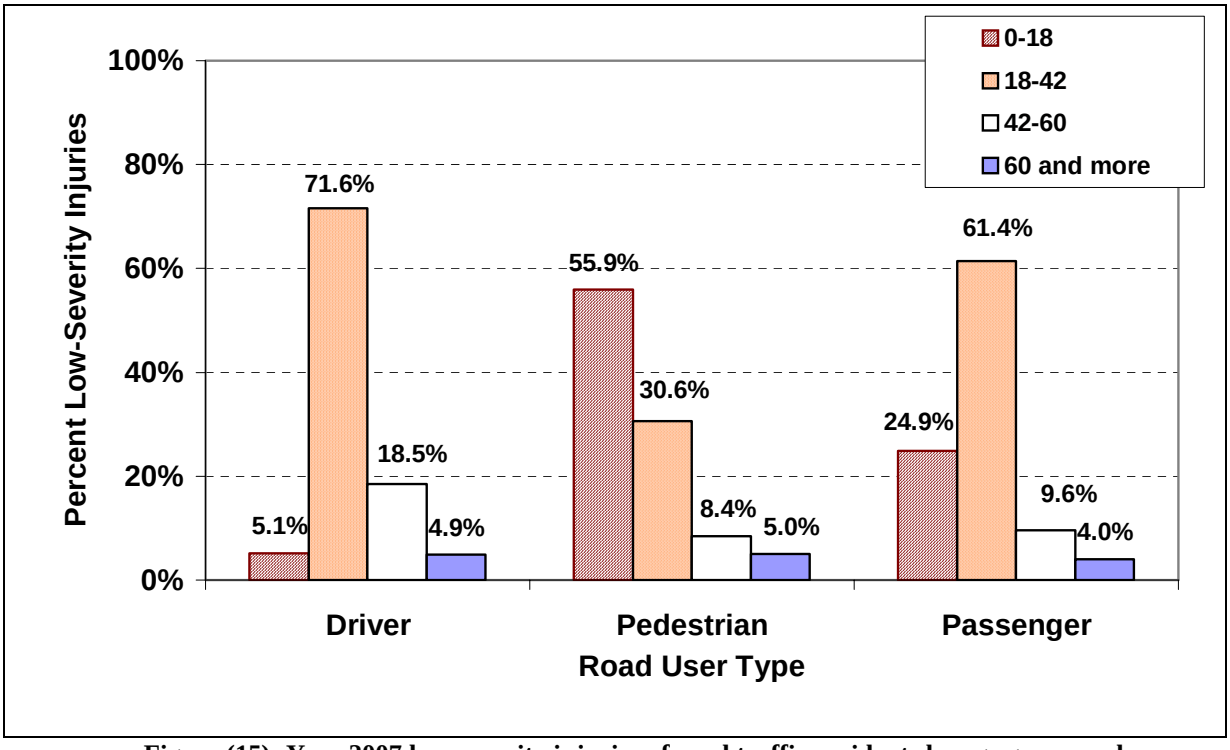

Figure (15): Year 2007 low-severity injuries of road traffic accidents by age group and road user type in Jordan

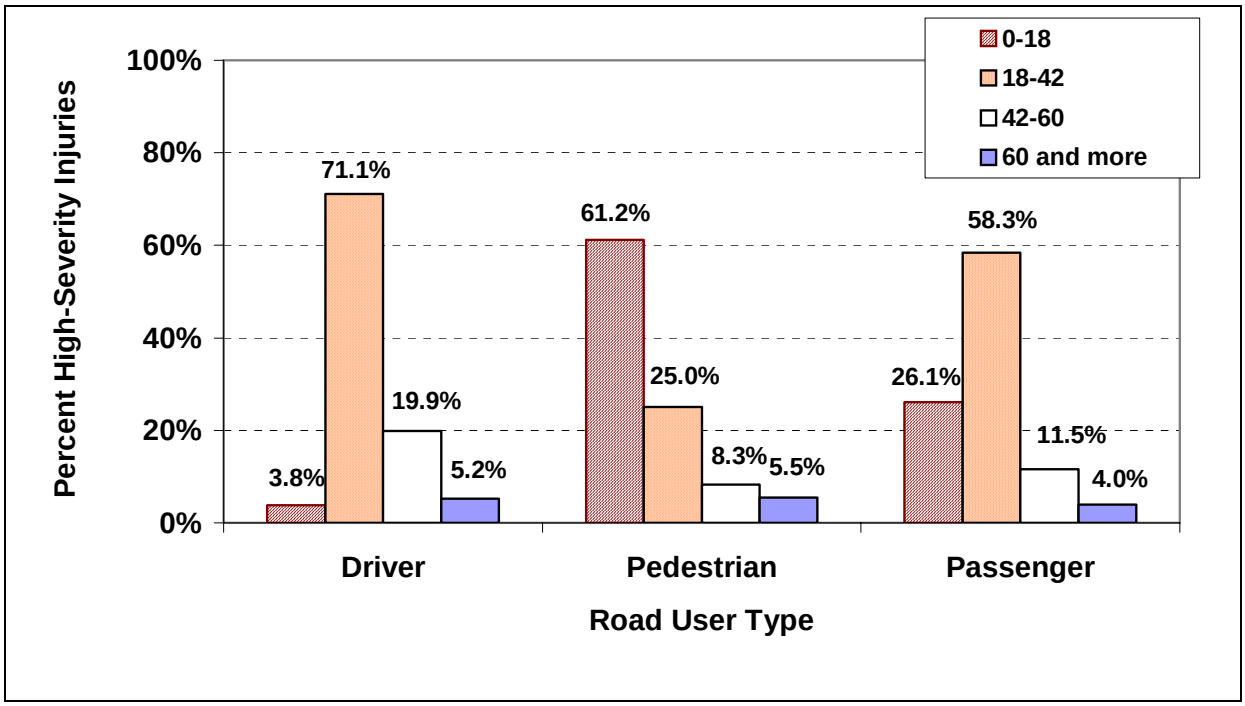

Figure (16): Year 2007 high-severity injuries of road traffic accidents by age group and road user type in Jordan

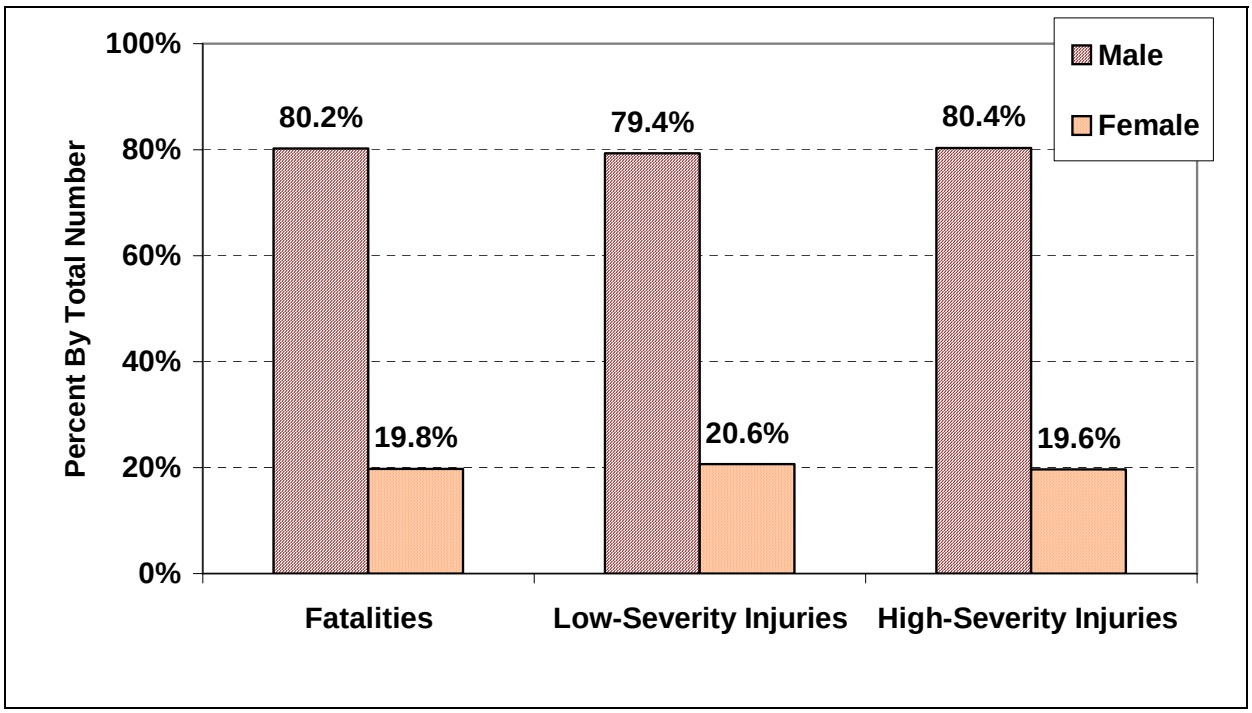

Figure (17): Year 2007 fatalities and injuries of road traffic accidents by gender in Jordan

It is known that there are differences between speed limit, design speed and operating speed. The speed limit of a roadway is the maximum speed allowed by law for road motor vehicles. Speed limits are commonly set and enforced by the legislative bodies of nations or provincial governments. It is determined as the 85^{th} percentile speed on the road, meaning that 85 percent of the vehicles are driving below that speed. The design speed is the maximum speed at which motor vehicles can be operated safely on that roadway under ideal conditions. On the other hand, the operating speed is the speed at which motor vehicles normally operate on that roadway. In this study, road traffic accidents were obtained for roads in Jordan classified based upon the speed limit on that road. The number of traffic accidents by type is presented in Figure 8.

In this figure, the maximum number of traffic accidents occurred on roads with a speed limit of 40 km/h (25 mph). Approximately 47.5, 21.8 and 21.0 percent of the total number of traffic accidents occurred on roads with speed limits of 40 km/h, 50 km/h and 60 km/h, respectively. In other words, 90.3 percent (the majority) of the total number of traffic accidents occurred on roads with speed limits between 40 and 60 km/h (25 and 37 mph). Of course, one cannot correlate between the speed limit and the number of accidents without taking into consideration intercorrelations between the speed limit and other factors. For instance, roads with speed limits below 60 km/h are normally having fair geometric design and facilities. In addition, roads with speed limits below 60 km/h are typically residential roads, minor roads inside the city, some local roads between residential and commercial properties and roads with school zones, …etc. Accordingly, roads of this speed limit generally exhibit higher numbers of pedestrians, have low-quality geometric design and are located in crowded areas. And therefore, the prevailing conditions including those previously mentioned contribute significantly to the road traffic accidents on these roads.

Considering the number of fatalities and injuries by speed limit, it was observed that the highest number of fatalities occurred on roads with speed limit of 40 km/h (25 mph). The same scenario was repeated for the number of injuries (Figure 9). In other words, the highest number of injuries (for both low-severity injuries and high-severity injuries) occurred on roads with speed limit of 40 km/h. Nearly 53.1, 18.5 and 20.8 percent of the total number of fatalities took place on roads with speed limits of 40 km/h, 50 km/h and 60 km/h, respectively. That is to say, 92.4 percent (the majority) of the total number of fatalities occurred on roads with speed limits between 40 and 60 km/h (25 and 37 mph). Also 47.5, 20.8 and 22.2 percent of the total number of injuries happened on roads with speed limits of 40 km/h, 50 km/h and 60 km/h, respectively. In conclusion, about 90.5 percent (the majority) of the total number of injuries occurred on roads with speed limits between 40 and 60 km/h. The outcome of the fatalities and injuries agreed with that of the traffic accidents as shown in Figures 8 and 9. Using the statistical t-test, the number of fatalities and the number of injuries for the speed limit in the range of 40 to 60 km/h were found statistically greater than those for the speed limit outside this range at a significance level of 10 percent.

By taking the road user type (driver, pedestrian, next to driver, backseat passenger, bus passenger, cargo passenger and motorcycle passenger) into consideration, the numbers of fatalities, injuries with low severity and injuries with high severity were obtained. It was found that the highest percentages of the total number of fatalities and the total number of high-severity injuries were from the pedestrian road users (Figure 10). About 35.8 percent (more than one third) of the total number of fatalities was actually from the pedestrians and 33.4 percent (about one third) of the total number of high-severity injuries was also from the pedestrians, despite the fact that pedestrian accidents composed only about 4 percent of the total number of traffic accidents. Regarding the low-severity injuries, drivers had the highest percentage of 35.5 percent and pedestrians had the next value of 24.7 percent. In general, drivers and pedestrians were the most two categories of road users who perceived the highest number of casualties of

traffic accidents in Jordan.

The age group of causalities was also addressed in this study. Age was classified into four main age groups or categories: 0-under 18, 18-under 42, 42-under 60 and 60 years and more. The total numbers of fatalities, low-severity injuries and high-severity injuries were obtained by age group and road user type. Figure 11 shows that the maximum percentage (43.9 percent) of fatalities was from the 18-42 years age group, and the next highest percentage (27.9 percent) was from the 0-18 years age group. In other words, about 72 percent of the total number of fatalities was actually from the youth groups in Jordan. Of course, this is a crucial safety matter for a small country like Jordan. The lowest percentage (11.6 percent) belonged to the 60 years and more age group.

When the road user type was also considered along with the age group, it was noticed that the highest percentage (62.2 percent) of driver fatalities was from the same age group of 18-42 years and a similar scenario applied for passenger fatalities where 49.9 percent of the total number of passenger fatalities was from the age group of 18-42 years (Figure 12). These outcomes are rational since 62.7 percent (about two thirds) of registered drivers in Jordan are indeed young drivers in the age group of 18-42 years adding that some young drivers are commonly reckless and inattentive during driving. On the other hand, the highest percentage (46.2 percent) of pedestrian fatalities belonged to the 0-18 years age group followed by that of the 18-42 years age group with 23.1 percent. Kids under 18 years old in Jordan are normally unattended when they use the traffic system particularly that the majority of this age group go to school.

With regard to injuries and their correlation with age group, it was found that the majority of injuries including low-severity and high-severity injuries belonged to the 18-42 years age group concurring with the results for fatalities. 57.4 percent of the total number of low-severity injuries and 51.1 percent of the total number of high-severity injuries were from this age group (18-42 years) as shown in Figures 13 and 14. The next highest percentage was from the 0-18 years age group where the corresponding percentages were 25.5 and 31.1 percent, respectively. The age group 60 years and more had the lowest percentages; 4.6 and 4.9 percent of the total number of low-severity injuries and total number of high-severity injuries, respectively (Figures 13 and 14).

When both age group and road user type were considered, it was observed that 71.6 percent of the total number of low-severity driver injuries and 71.1 percent of the total number of high-severity driver injuries were in fact from the age group 18-42 years (Figures 15 and 16). And similar findings were obtained for passenger injuries where 61.4 percent of the total number of low-severity passenger injuries and 58.3 percent of the total number of high-severity passenger injuries were also from the same age group (18-42 years) as shown in Figures 15 and 16. On the other hand, the highest percentage of pedestrian injuries was from the age group 0-18 years followed by that of the 18-42 years age group. 55.9 percent of the total number of low-severity pedestrian injuries and 61.2 percent of the total number of high-severity pedestrian injuries were from the age group 0-18 years (Figures 15 and 16). The next highest percentages of the pedestrian injuries belonged to the 18-42 years age group where 30.6 percent of the total number of low-severity pedestrian injuries and 25.0 percent of the total number of high-severity pedestrian injuries were from this age group (18-42 years). These outcomes are in fact in agreement with the results of the fatalities discussed earlier.

It should be noticed herein that about 80 percent of the total number of traffic accident casualties were males and only about 20 percent were females as shown in Figure 17.

CONCLUSIONS

The following conclusions were drawn based on the results of data analysis and evaluation conducted in this study:

1. Jordan was found to have high fatality and injury rates when compared to several countries in the world. Although the fatality and injury rates seemed to be moving in the right direction, the number of fatalities and injuries looked alarming.
2. According to the traffic accident data obtained, weather conditions, road pavement surface condition and light condition were not considered major causes of traffic accidents in Jordan.
3. Collision accidents composed the majority of traffic accidents in Jordan.
4. The time period between 3:00 pm and 6:00 pm in general was found to be a critical period in terms of traffic safety in Jordan.
5. In general, the first business day and last business day of the week were found to have the highest percentages of traffic accidents, fatalities and injuries.
6. Traffic accidents and casualties were observed to be higher in summer times.
7. More than 90 percent (the majority) of the total numbers of traffic accidents, fatalities and injuries occurred on roads with speed limits between 40 and 60 km/h.
8. Pedestrians composed the highest percentage of the total numbers of fatalities and injuries in general. About one third of fatalities were pedestrians and one third of injuries were also pedestrians, despite the fact that pedestrian accidents composed about 3.8 percent of the total number of traffic accidents.
9. The maximum percentage (43.9 percent) of fatalities was from the 18-42 years age group, and the next highest percentage (27.9 percent) was from the 0-18 years age group.
10. The highest percentage of injuries was also from the age group of 18-42 years, where 57.4 percent of the total number of low-severity injuries and 51.1 percent of the total number of high-severity injuries were from the age group of 18-42 years.
11. It was found that 62.2 percent of driver fatalities was from the age group of 18-42 years and 49.9 percent of the total number of passenger fatalities was from the same age group of 18-42 years; these were the highest percentages.
12. On the other hand, the highest percentage (46.2 percent) of pedestrian fatalities belonged to the age group of 0-18 years.
13. The majority of the total number of driver injuries was from the age group of 18-42 years, where 71.6 percent of low-severity driver injuries and 71.1 percent of high-severity driver injuries were in fact from the age group of 18-42 years.
14. Similar findings were obtained for passenger injuries, where 61.4 percent of the total number of low-severity passenger injuries and 58.3 percent of the total number of the high-severity passenger injuries were from the same age group of 18-42 years.
15. Alternatively, the highest percentage of pedestrian injuries was from the age group of 0-18 years, where 55.9 percent of the total number of low-severity pedestrian injuries and 61.2 percent of the total number of high-severity pedestrian injuries were from the age group of 0-18 years.

REFERENCES

Al-Khateeb, G.G., Obaidat, M.T. and Khedaywi, T.S. 2008. *Road Safety Strategies Through Excellence in Services, Awareness and Law Enforcement in Jordan*. Proceedings of the 5th International Safety Conference, Road and Traffic Safety Strategies, Amman, Jordan, April 22-24, 8-22.

Jadaan, K.S. 1989. The Epidemiology of Road Traffic Accidents in Jordan. *The Journal of the Royal Society for the Promotion of Health*, 109 (4): 141-144, 198.

The Bureau of Transportation Statistics (BTS) in the USA. 2007. US Department of Transportation, Research and Innovative Technology Administration (RITA),

http://www.bts.gov/publications/national_transportation_statistics/index.html, Statistics.

The Department for Transport (DfT) of Great Britain. 2006. On-Line Edition, http://www.dft.gov.uk/, Annual Reports and Statistics.

The Department of General Statistics (DGS) of Jordan. 2007. http://www.dgs.gov.jo, Annual Reports.

The Federal Highway Research Institute of Germany. 2007. http://www.bast.de/EN/e-Home/e-homepage__node.html?__nnn=true, Reports.

The Federal Statistical Office of Germany. 2007. http://www.destatis.de/jetspeed/ portal/cms, Statistics.

The International Road Traffic and Accident Database (IRTAD) Group. 2006. The International Transport Forum and the Organization for Economic Cooperation and Development (OECD), Joint Transport Research Center, http://www.cemt.org/irtad/ IRTADPUBLIC/ index. htm, Statistics.

The Official Statistics of Sweden. 2007. http://www.scb.se/, Statistics.

The National Statistical Service of Greece. 2007. http://www.statistics.gr/ Main_eng.asp, Statistics.

The Public Security Directorate (PSD) of Jordan. 2008. Jordan Traffic Institute, http://www.jti.psd.gov.jo/, Annual Reports.

The Swedish Institute for Transport and Communication Analysis. 2007. http://www.sika-institute.se, Reports and Analysis.

The Swedish National Road Administration. 2007. http://www.vv.se/templates/page2213172.aspx?epslanguage= EN, Reports.

The U.S. Department of Transportation. 2006. Federal Highway Administration, Highway Statistics Summary, FHWA-PL-97-009, Washington, D.C., http://www.fhwa.dot.gov.

The U.S. Department of Transportation. 2007. Federal Highway Administration, Highway Statistics, Washington, D.C., http://www.fhwa.dot.gov, Annual Issues.

The U.S. Department of Transportation. 2006. National Highway Traffic Safety Administration (NHTSA), National Center for Statistics and Analysis Databases, http://www.nhtsa.dot.gov/, Statistics.

World Health Organization/WHO. 2007. http://www.who.int/ violence_injury_prevention/ road_traffic/en/, Reports.