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Traffic Accidents in Jordan

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ABSTRACT

In Jordan, traffic accidents constitute a major health problem. They are considered the second leading cause of death. This paper investigated the characteristics of traffic accidents in Jordan and evaluated the safety impact of policy measures undertaken in 2008, including intensification of police enforcement and implementation of traffic law with stiff penalty levels. To accomplish these objectives, accidents' data of 1998 through 2007 were obtained from Jordan Traffic Institute and other related sources.

Results of analysis revealed that Jordan has experienced huge human and economic losses as well as social and emotional negative impacts. Children, young and elderly have been exposed to an elevated pedestrian accident risk. Young drivers of ages less than 25 years and elderly of ages over 60 years are over-involved in accidents. Carelessness and aggressive driving behavior were the major causes of traffic accidents. The results of analysis also indicated that motorization level can be used to explain variations in traffic accidents and fatalities. Furthermore, intensifying of traffic enforcement and implementing traffic law with stiff penalty levels were found to have a strong positive safety impact on accidents and fatalities. Finally, it is recommended to restructure and empower the Higher Council for Traffic Safety to be able to draw a comprehensive strategy with clear vision and rational safety policies to tackle the traffic accidents' problem.

KEYWORDS: Traffic accidents, Safety measures, Jordan.

INTRODUCTION

Traffic accidents are increasingly being recognized as a major cause of death and a growing health problem. They kill 1.2 million people each year and injure or disable as many as 50 million people more. According to the World Health Organization (Toroyan and Peden, 2007), traffic accidents are the second leading cause of death globally among children and youth people. In addition to pain, grief and social suffering, these accidents cost countries 1% to 2% of their gross national products (Peden et al., 2004). Thus, the reduction of accidents and their consequences is of great importance to all countries.

Traffic accidents are a complex phenomenon. They are caused by a multitude of factors, including roadway and its environment, road users' behavior and vehicle aspects. Accident analysis revealed that traffic risk is a function of exposure, probability of involvement and probable severity. Exposure to vehicular and other conflicts that are susceptible to accident occurrences depends on motorization level, land use and road planning. There have been several studies relating accidents to these exposure measures (Mittal, 2008; Al-Masaeied and Suleiman, 2004; Brindle, 2001; Al-Masaeied et al., 1997). Road users' behavior, vehicle speed and vehicle and roadway conditions affect the likelihood of involvement. Studies indicated that young

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age and inexperience drivers contribute to a high level of risk involvement. Recently, studies conducted in France and Finland (Constant et al., 2008; Rijkka and Mikko, 2008) pointed out that intensification of speed control with stiffer penalties resulted in significant reduction of injury and lethal accidents. Other studies (McLean and Kloeden, 2002) reported that an increase of 5 km/hr above the speed limit of 60 km/hr in rural areas would double the risk of accident involvement. Also, the improvement of road conditions and its environment and the implementation of low-cost measures have a great impact on lowering accident involvement rates or severity (Harkey et al., 2008; Elvik and Vaa, 2004; Al-Masaeid, 1997). Finally, in-vehicle protection devices; such as seat-belt, air-bag and child constraint, are very effective in reducing accident severity.

Realizing traffic accidents as a preventable problem, developed countries have implemented different policies and measures to reduce this problem (Jorgesen, 2002). These include enforcement, education, training and engineering improvements. Unlike developed countries, the problem of traffic accidents in developing countries is still considered as a matter of fate or unavoidable cost of development. Without remarkable efforts to enhance traffic safety in developing countries, the number of deaths due to traffic accidents is expected to increase by 80% between 2000 and 2020 (Jacob and aeron-Thomas, 1999). Thus, developing countries are required to analyze the problem and determine appropriate measures to revert the upward tendency in the number and severity of traffic accidents.

In Jordan, traffic accidents constitute a major health problem. Although previous studies (Al-Suleiman and Al-Masaeid, 1992; Al-Masaeid and Nelson, 1996; Al-Masaeid, 1998) have addressed accident characteristics in Jordan, these characteristics might change with time due to change in motorization, infrastructure development, legislation and educational levels. It is worth mentioning that the government of Jordan has applied a new traffic law and intensified police activities in 2008. Thus, periodic investigation of accident characteristics is vital to define target groups for further actions and measures, and to help decision makers set rational policies and strategies to curb this problem.

The main objectives of this paper were: First; to quantify the accident problem in Jordan and its characteristics, including involvement rates of pedestrians, drivers and vehicles. Second; to estimate the socio-economic impact of 2008 policy measures, and suggest guidelines for improving road safety in Jordan. To accomplish these objectives, data on traffic accidents were collected from the annual reports of Jordan Traffic Institute (1998-2008). Involvement rates were computed based on the data of 2005 through 2007, while statistical relationships were developed using the data of 1998 through 2007.

BACKGROUND

Jordan is located in the Middle East region, with an area of 90 thousand sq. km and a population of about 5.8 million people. The problem of traffic accidents started to appear as a serious issue in the mid 1980s. In 2007, traffic accidents were considered the second leading cause of death in Jordan. During the past 20 years, the number of accidents increased from 15884 accidents in 1987 to 110630 accidents in 2007. For the same period, the number of population and the number of vehicles increased only by approximately 2 and 3 folds, respectively. Obviously, this situation is not surprising, because Jordan has not yet applied a comprehensive strategy to reduce this problem (Katamine, 1999).

At the end of January 2008, as a result of the drastic increase in traffic accident casualties and after a horrific bus accident on Irbid-Amman highway, his majesty King Abdullah II instructed the government to draw a comprehensive strategy to curb accidents and casualties in Jordan. Chairing a meeting of the Higher Council for Traffic Safety, the King said that the strategy on traffic safety should be implemented in line with a timetable and a clear program. Also, the Monarch stressed the importance of drafting a law to activate the Council's role, tasks and duties. Accordingly, the previous traffic law (No. 49, 2001) was substituted by a new temporary

traffic law (No. 52, 2007) which imposed stiffer penalties. Concomitantly with the application of the new law, traffic police activities were intensified and targeted drivers' errors, particularly excessive speeds. After four months, the new traffic law was relaxed, and a less restrictive permanent traffic law (No. 49, 2008) was issued in July 2008 and applied since August 2008. However, police enforcement activities continued at the same level or even more up to the present time. Starting from Feb. 2008, the Higher Council for Traffic Safety, under the chairmanship of the prime minister, has met once a month to follow road safety issues.

Table (1): Population, Vehicle Ownership, Accidents and Fatalities in Jordan.

Year	Population (thousand)	Vehicle Ownership (thousand)	No. of Accidents (thousand)	Fatalities
1998	4755.8	389.20	43.343	612
1999	4900.0	418.43	50.330	676
2000	5039.0	473.34	52.796	686
2001	5182.0	509.83	52.662	783
2002	5329.0	542.81	52.913	758
2003	5480.0	517.50	62.115	832
2004	5350.0	612.33	70.266	818
2005	5473.0	679.73	83.129	790
2006	5600.0	755.48	98.055	899
2007	5728.0	841.93	110.630	992

TRAFFIC ACCIDENTS ANALYSIS

Quantification of the Problem

Table (1) presents the growth of population, vehicle ownership, traffic accidents and fatalities between 1998 and 2007. As shown in the table, there are dramatic increases in traffic accidents and the resulting fatalities over the past ten years. Also, Table (1) indicates that traffic fatalities have grown faster than the population. For Jordan, Figure (1) illustrates that fatality risk continued to rise. In contrast, fatality risks for different developed countries actually decreased with time. According to 2007 statistics, the fatality rate in Jordan was 12 compared with 1.6 fatalities per 10000 registered vehicles in USA. Considering both of fatality risk and rate for Middle East and North Africa region, MENA, Jordan ranked number five. Similar to some countries in the region (Abdulmajid, 2007; Bener and Crundall, 2005; Ansari et al., 2000), traffic accidents are considered the second leading cause of death in Jordan. Thus, Jordan faces a serious accident problem.

Study of fatality distribution indicated that children and youth under the age of 25 years account for 41% of those killed in traffic accidents in Jordan. Though about 5% of the population is over 60 years of age, they accounted for nearly 12% of all traffic fatalities. Further investigation of all traffic accident casualties revealed that children and young people are exposed to a high level of risk. For example, children and young people represented more than 43% of those killed or seriously injured in accidents, while the corresponding worldwide percentage is only 30% (Toroyan and Peden, 2007).

In addition to the magnitude and severity of the accident problem in Jordan, traffic accidents are very costly for a country having limited resources. Al-Masaeid et al. (1999) indicated that the costs of fatal, injury and property damage only accidents are JD 63851, 4155 and 1400, respectively. Based on these estimates, traffic

accidents costed the country JD 220, 258 and 281 millions in 2005, 2006 and 2007, respectively (JD 1=US$ 1.42).

Table (2): Total Traffic Accidents, Pedestrian Accidents and their Casualties in Jordan (2005–2007).

Year	No. of Traffic Accidents	No. of Pedestrian Accidents	Pedestrian Casualties		All Accident Casualties	
			fatal	injury	fatal	injury
2005	83129	4866	305	4844	790	17579
2006	98055	4826	319	4837	899	18019
2007	110630	4178	276	4193	992	17969

Table (3): Causes of Traffic Accidents (2005 – 2007).

Cause	Percentage
Carelessness	22.5
Close following or tailgating	17.0
Disregarding traffic priority	14.6
Using incorrect lane	14.1
Bad turn	10.5
Incorrect reversing	9.2
Disregard traffic signs	2.8
Excessive speed	1.5
Disallowing pedestrian priority	1.2
Wrong overtaking	0.8
Wrong turn	0.7
Others	5.1

Pedestrian Involvement Rates

Table (2) shows total road accidents, pedestrian accidents and their casualties in Jordan during the period 2005-2007. Despite the fact that pedestrian accidents constitute about 5% of the total traffic accidents, they resulted in about 34% and 26%of the total traffic fatalities and injuries, respectively. The corresponding percentages for pedestrian fatalities in Europe and USA were 20% and 11%, respectively (Jacobs et al., 2000; NHTSA, 2007). This result is not unexpected because pedestrians are not given sufficient consideration in transport and urban planning. For example, Al-Masaeied et al. (1994) pointed out that many rural towns were developed along and on both sides of Jordanian major roads without any advanced planning. Furthermore, many schools were located adjacent to main roads. This situation creates hazards to local and through traffic as well as to residents.

Figure (2) shows the relative involvement rate for pedestrians killed or seriously injured during the years 2005-2007. The relative involvement rate was computed as a percentage of the number of pedestrians killed or seriously injured for a given age group to the population

of that age group in thousands. This figure indicates that child age group (5-10 years) and elderly age group over 60 years have the highest level of pedestrian risks. Although children and elderly accounted for nearly 37% and 5% of Jordan's population, children and elderly fatalities represented about 45% and 15% of all pedestrian fatalities. Thus, these age groups should be the target for accident prevention measures. Conversely, the (25-45) age group has the lowest level of risk.

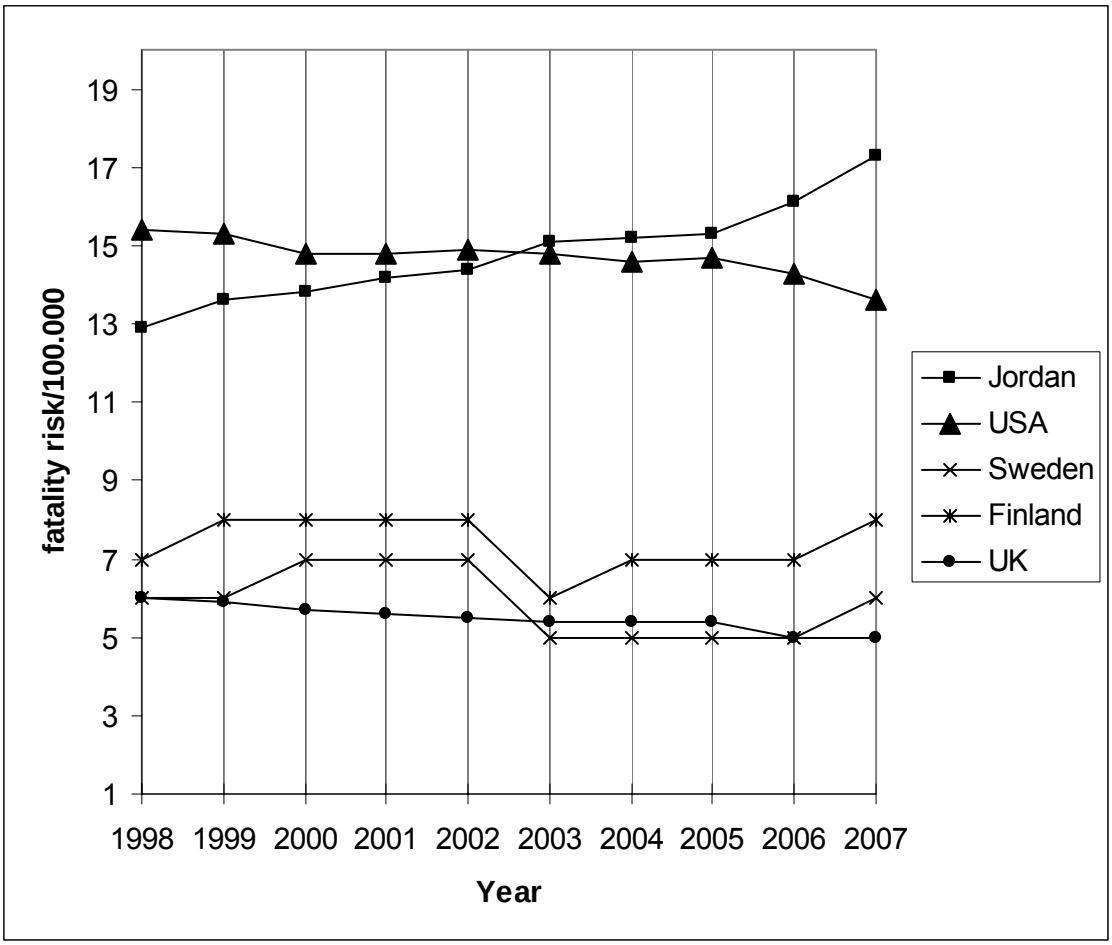

Figure (1): Fatality Risk for Different Countries.

Drivers' Involvement Rates

Figure (3) shows drivers' involvement rates for the period 2005-2007. Drivers' involvement rates were computed as a percentage of the involved drivers for a given age group to the population of divers in the same age group. The figure illustrates that drivers aged less than 30 years were over- involved in traffic accidents. Also, young aged drivers with ages less than 25 years are the most dangerous drivers. They are over-involved in traffic accidents by a factor of 1.6 to 2.5 when compared with the overall average. These results are compatible with the findings of previous studies, which reported that young and inexperienced drivers contribute to a high level of risk (Peden et al., 2004). In contrast, drivers aged 40 to 60 years were found to have the lowest involvement rate. Compared to 40-60 age category, Figure (3)

indicates that the level of involvement increased for drivers aged more than 60 years.

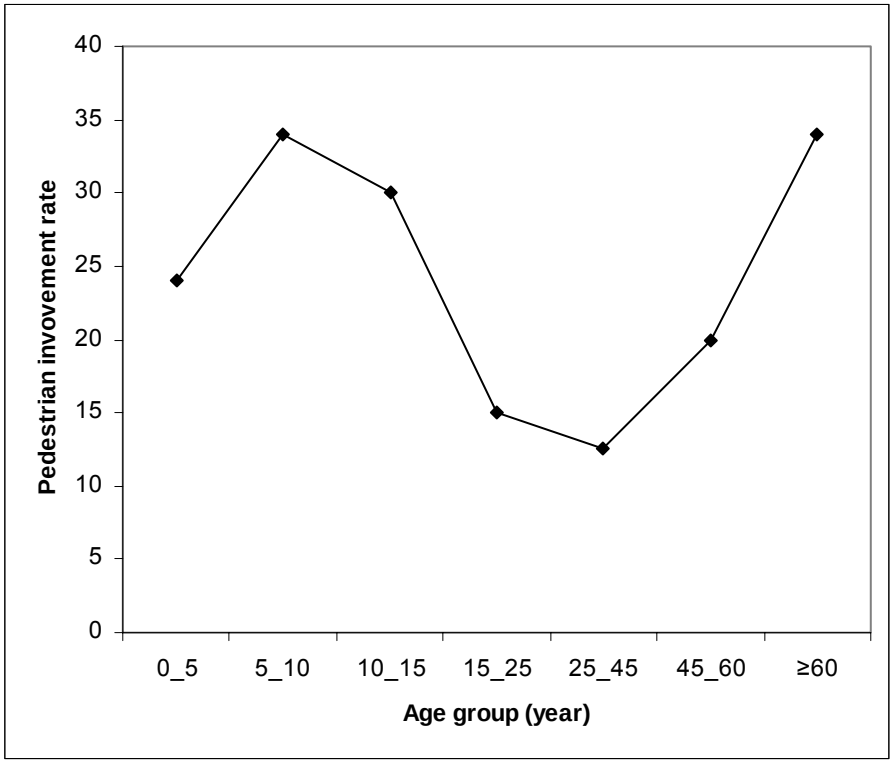

Figure (2): Pedestrian Involvement Rate for Different Age Groups.

Field observations and accident records reveal that most of traffic accidents in Jordan are caused by drivers' errors and their aggressiveness. The major causes of traffic accidents in Jordan during 2005-2007 are detailed in Table (3). The largest single cause of an accident was carelessness of drivers, contributing to 22.5% of all accidents. Close following or tailgating took the second rank, accounting for 17% of the accidents. Other causes were disregarding traffic priority, using incorrect lane, bad turn and reversing. Excessive speed took the eighth rank, causing about 1.5% of the accidents. Aggressive behavior, including tailgating, disregarding traffic priority or pedestrians, disregarding traffic signs and excessive speed, contributed to about 40% of accident causes. According to accident pattern, accidents are classified into vehicle-vehicle collision, vehicle-pedestrian accident and run-off-road accident. Although the run-off-road accidents constituted about 2% of the total traffic accidents in Jordan, they resulted in more than 20% of the fatalities. In fact, most of these accidents could be attributed to speeding, especially on rural roads.

Vehicles' Involvement Rates

Involvement rates of different vehicle types in traffic accidents for the period 2005-2007 are shown in Figure (4). In all years investigated, the highest involvement rates were found for buses or coaches and mini-buses. In general, more than 50% of the registered buses and mini-buses were involved in accidents. In fact, most of buses and mini-buses are used as public transport or for tourism purposes. As such, they normally experience traveling longer distances with excessive speeds. On the other hand, approximately 25% of registered cars, trucks and dual purpose vehicles were involved in accidents.

Involvement of motorcycles was found to decrease with time. Finally, construction and agricultural vehicles do not appear to be a major problem in Jordan, where only 4% and 2%, respectively, of these vehicle types are involved in accidents.

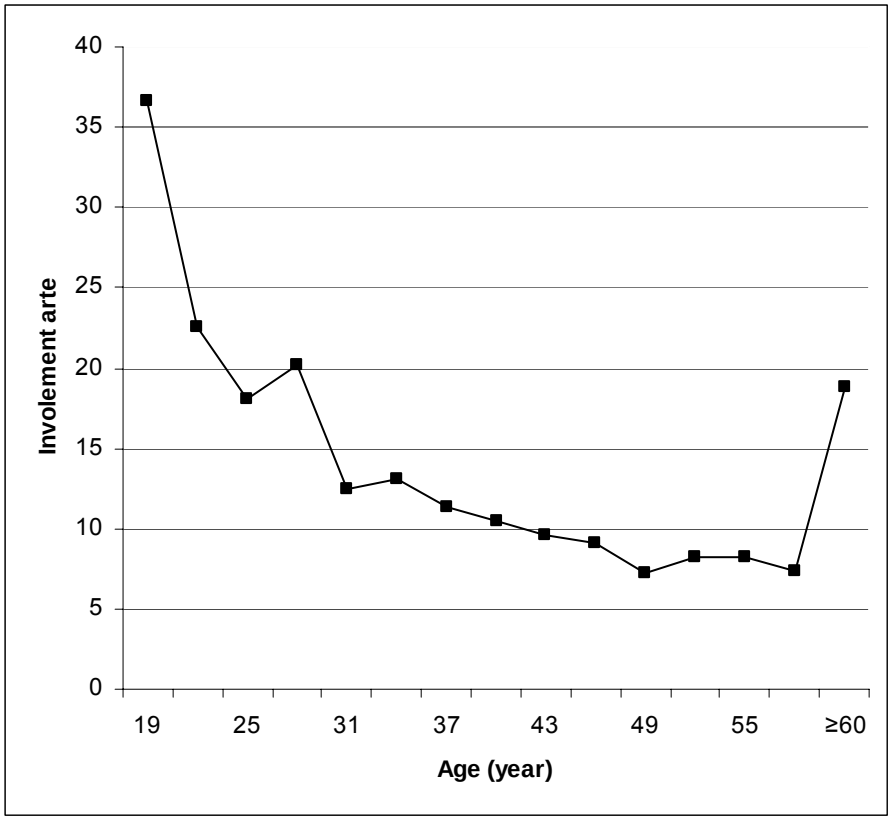

Figure (3): Drivers' Involvement Rate *versus* Driver Age.

Although involvement rates for buses and mini-buses are very high, they resulted in only 11% of the total traffic fatalities. In contrast, traffic accidents involving cars resulted in about 60% of all traffic fatalities.

DEVELOPMENT OF ACCIDENT AND FATALITY MODELS

Using the data in Table (1), two types of descriptive models were developed. In the first type, a model was developed to describe the relationship between the number of accidents and motorization level in vehicles per one-thousand of population. Motorization level was found to vary from 82 vehicles per one-thousand of population in 1997 to 147 vehicles per one-thousand of population in 2007. Based on regression analysis carried out in this study, the following equation was developed:

$$ACC = 37.68\ M^{1.60} \quad (1)$$

where:

ACC = number of traffic accidents per year.

M = motorization level, number of registered vehicles per one-thousand of population.

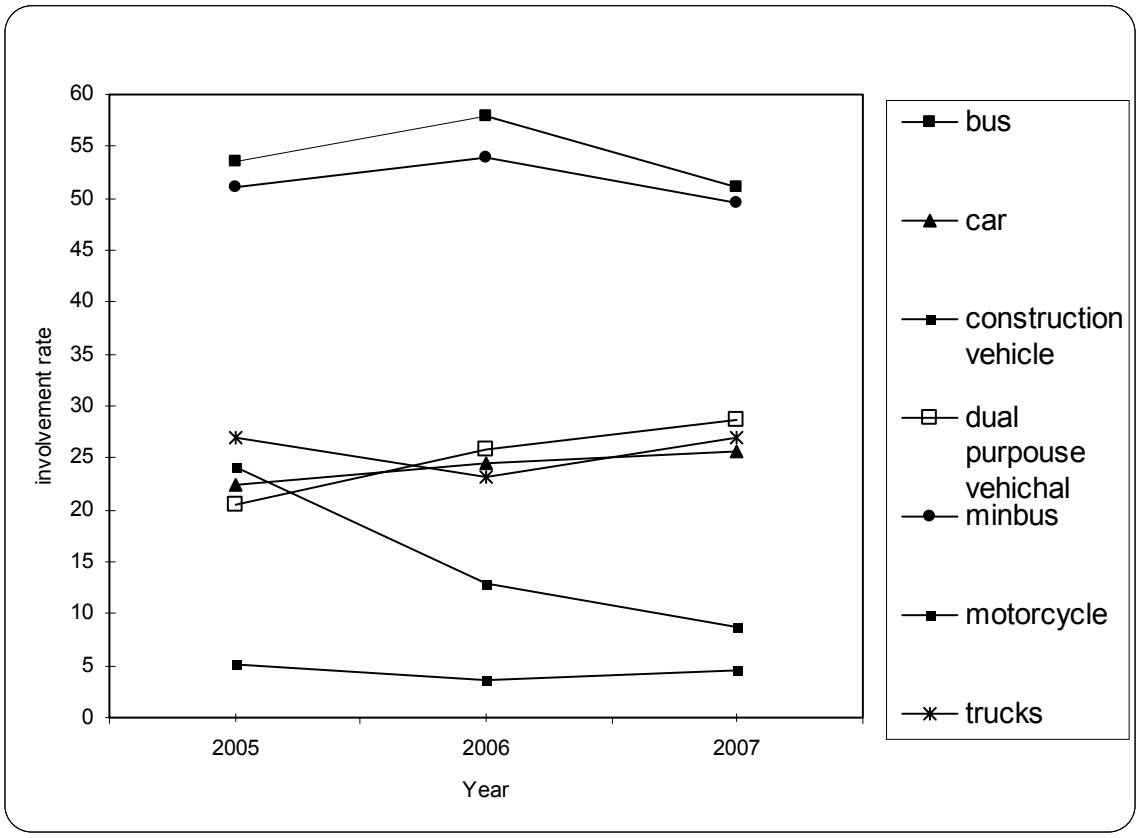

Figure (4): Involvement Rate for Different Vehicle Types.

The above model equation and its parameters were found to be significant at 95% confidence level (N=10, R^2=0.96, F=148.9). The coefficient of determination (R^2) was 0.96, which means that the model explained 96% of the variations in traffic accidents.

The second type of models was developed to estimate fatalities as a function of motorization level. The following equations were obtained:

$$F = 31.34\ M^{0.69} \quad (2)$$

$$F/V = 22.5\ M^{-0.60} \quad (3)$$

where:

F = traffic accident fatalities per year.

V = number of registered vehicles in thousands.

Equation (2) was found highly significant, with a coefficient of determination of 0.87 (N = 10, R^2 = 0.87, σ =0.055, F=51.34). Similarly, equation (3) and its parameters were found to be highly significant, with a coefficient of determination of 0.88 (N = 10, R^2 = 0.88, σ =0.045, F=58.55). Compared with the model equation (2), model equation (3) has a lower standard error and higher coefficient of determination and F-value. Furthermore, equation (3) is consistent in form with the well-known Smeed's formula (Smeed and Jeffcoate, 1970). Therefore, equation (3) was recommended and adopted for subsequent applications.

Evaluation of 2008 Traffic Safety Policies

As stated before, two safety policies were implemented since the start of February 2008. The first one was the application of the temporary law (No. 52, 2007), which imposed stiffer penalties on drivers'

violations, particularly speeding. Due to drivers' complaints, this law was relaxed by the end of May, 2008 and substituted by a less restrictive permanent law (No. 49, 2008). The second safety policy was the intensification of traffic police enforcement; which continued up to the present time. The number of fines increased to 2.14 millions in 2008, compared with 1.36 millions in 2007. The most important was the increase in number of fines for excessive speeding, which increased from 144 thousands in 2007 to nearly 180 thousands in 2008. The positive combined effect of these policy measures was a decline in the number of accidents and fatalities.

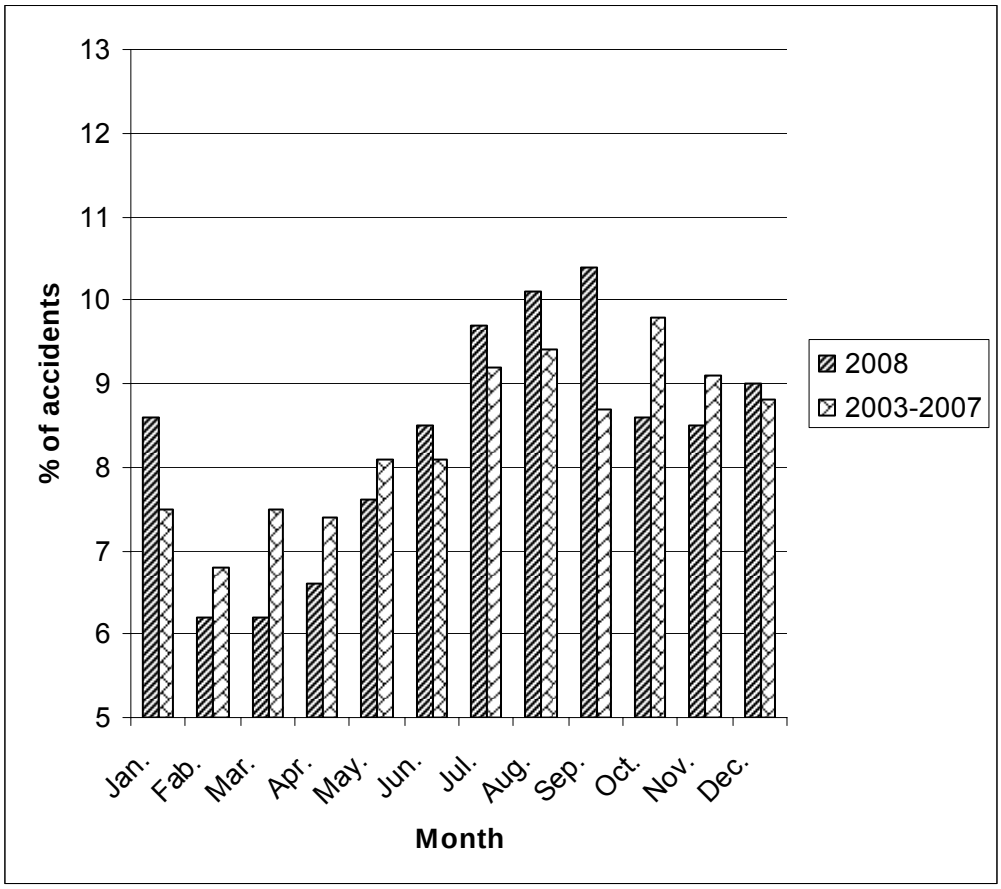

Figure (5): Comparison of Accident Percentages of 2008 and (2003-2007) Period.

In the evaluation, it was assumed that the developed equations in this study are applicable in the absence of any effective safety measures. In 2008, there were 905592 registered vehicles and a population of 5850 thousands. Using equation (1) with motorization level of 154.8, the expected number of accidents for 2008 is 117500; while the actual observed number of accidents was 101066. At 95% confidence level, a significant decline of about 14% in the total number of accidents could be concluded. Furthermore, traffic accidents of 2008 resulted in 740 fatalities compared with an estimated 995 fatalities, computed using equation (3). Similarly, a 25.63% reduction in the number of fatalities in 2008 was found to be significant at 95% confidence

level. Thus, the applied policies were found to be effective in reducing the total number of accidents and the resulting fatalities.

Despite the fact that the combined effect of the new traffic law and increasing enforcement level had an overall positive influence in reducing accidents and fatalities, the application of law with stiffer penalties was the most effective measure. Figure (5) shows the percentage of accidents by month for 2008 and the average of percentages during the period 2003-2007. For February, March, April and May, the percentage of accidents in each month of 2008 was found to be significantly lower than the corresponding average for the same month in the 2003-2007 period. It is worth mentioning that the temporary law with stiffer penalties was only applied during these months. Thus, the implementation of an intensive enforcement accompanied with higher penalty levels may create greater positive impact on traffic safety.

In addition to the reduction in number of accidents and fatalities, the applied measures had economical benefits. According to the estimated and actual observed accidents in 2008, the saving in accidents was about 16434 accidents. Therefore, the anticipated economic saving is approximately JD 42 millions (US$ 60 millions).

DISCUSSION OF RESULTS

This paper presents the extent of traffic accident problem in Jordan. The problem is serious and alarming. It is considered as the second leading cause of death in Jordan. Children and youth under the age of 25 years and elderly of ages over 60 years were found to be overrepresented in accident fatalities. Child age group (5-10) years and elderly age group (over 60) years were exposed to the highest level of pedestrian accident risk. In fact, children's behavior in this age group is less disciplined and their physical and cognitive skills are not fully developed. Also, young and elderly drivers were significantly over-involved in traffic accidents. In addition to the lack of driving experience, young drivers often underestimate the level of risk. Aggressive driving behavior was the major cause of accidents. Previous studies concluded that self-assertion and territorial attitude among Jordanians lead to aggressive driving behaviors (Suliman and Awad, 2003). Similar to other Middle East countries, carelessness was the first single cause of accidents (Bener and Crundall, 2005). Compared with developed and a number of developing countries, Jordan has experienced excessive human and economic losses as well as social and emotional impacts as a result of this problem.

Safety policy measures undertaken in 2008, including intensification of police enforcement and improvement of traffic laws, were found to be effective in reducing total traffic accidents and fatalities by 14% and 25.63%, respectively. This result is compatible with findings of previous studies, which revealed that changing of attitudes or traffic law towards safety is an effective mean to improve drivers' behavior (Pelsmacker and Janssens, 2007). Such changes can be achieved through education and enforcement of laws. In France, a dramatic increase in law enforcement over the 2001-2004 period reduced traffic fatalities by about 32% (Constant et al. 2008). Similarly, intensification of speed enforcement in Finland reduced the number of fatal accidents by 13% (Rijkka and Mikko, 2008). For a given enforcement level, however, the results of this study suggested that a traffic law with stiffer penalty level would be more effective on traffic safety.

Realizing traffic accidents as preventable and multidiscipline problem, safety measures implemented in Jordan are not enough to tackle this problem. The Higher Council for Traffic Safety should be an independent body and empowered by technical committees constituted at lower operational levels. Such committees are responsible of planning, conducting studies, problem identification, policy formulation and follow-up with the Council and implementation bodies. In fact, many developed countries have adopted safety policies and achieved successful stories like Sweden, Japan, United Kingdom, among others. For example, Sweden adopted 'vision zero' in 1997, Netherlands adopted 'sustainable road safety' in

1991 and England adopted 'tomorrow's roads safety for everyone' in 2000. According to the Britain strategy, a reduction of 50% in the number of children killed or seriously injured should be achieved by 2010, compared with the average for 1994-1998. However, a reduction of 55% in the number of children killed or seriously injured was achieved by the end of 2007 (National Statistics, 2008, 2009).

In Jordan, the political will and commitment to reduce the problem of traffic accidents exist. The Higher Council for Traffic Safety should be restructured as an independent entity empowered by specialized staff. Safety measures dealing with road users, roadway and its environment and vehicles should be developed. Children often underestimate the level of risk in crossing or playing in streets. Thus, education and mass media programs are necessary for this age group. Also, well structured training programs are vital for drivers. Although black-spot and low-cost safety improvements are cost-effective, road and urban safety audits, in planning and design stages, are much more preferable for accident prevention. It is worth mentioning that vehicle-vehicle collisions constituted more than 93% of traffic accidents in Jordan. Thus, widening of roadways and implementation of medians to separate traffic are recommended, especially for roads subjected to high traffic volumes. Vehicle investigation programs shall be established to ensure that vehicles are in good mechanical conditions and equipped with safety devices. Finally, enforcement of traffic laws and improvement of rescue medical services are considered as an essential part of safety policies (Al-Masaeid and Zubai, 2005).

CONCLUSIONS

Based on the results of this study, the following points were concluded:

1. Jordan faces a serious and alarming traffic accident problem. Compared with developed and a number of developing countries, Jordan has experienced excessive human and economic losses as well as social end emotional impacts as a result of this problem.
2. Child age group (5-10) years and elderly age group (over 60) years are exposed to the highest level of pedestrian accident risk.
3. Young drivers of ages less than 25 years and elderly of over 60 years are overrepresented in traffic accident involvement.
4. While the first single cause of accidents in Jordan is carelessness, aggressive driving behavior is believed to be the major contributory factor in traffic accidents.
5. Public transport means, including buses and mini-buses, are over-involved in traffic accidents.
6. Forecasting exponential models, using motorization level as an independent variable, successfully explains the variations in traffic accidents and fatalities.
7. Intensification of traffic enforcement accompanied by implementation of traffic law with stiff penalty levels would have a great positive influence on traffic safety.
8. Although political will and commitment to reduce the problem of traffic accidents exist, Jordan shall implement a comprehensive strategy with a clear vision and rational policies to curb this problem.

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