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Research Article

Motor-Vehicle Accidents Victims in Khartoum-Sudan; Identification and Analysis of Related Risk Factors, Safety Measures, and Injury Severity

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Abstract

Background: Road traffic accidents in Khartoum have been increasing dramatically along with tremendous rise in deaths in the previous past years, unfortunately with a simultaneous continuous increase in the import of vehicles.

Objective: The general aim of this study is to provide a reliable analysis of Motor Vehicle accidents in Khartoum, Sudan.

Methodology: A Hospital based descriptive cross-sectional study conducted at different centers in Khartoum State. The study sample was 385 patients exposed to traffic accidents. Data was collected using a Data Sheet filled between April 2020 and March 2021.

Results: The mean injury severity score was 7.6 ± 8.9 with 230(59.7%) fall within not severe range (< 8) and 155(40.3%) (≥8). The reported most common causes in terms of human errors, mechanical causes, obstruction by others and accidental, were excessive speeding 121(31.4%), mechanical defects 17(4.4%), improper overtakes/cuts 57(14.8%) and other recklessness or negligence by drivers 49(12.7%) respectively. Effective seat belt where available for only 43.6% of the victims, yet only 4.9% of these victims applied it. Effective air bags were available for only 26% of the victims.

Conclusion: Significant association was found between injury severity score and variables of age, gender, class, occupation, seat, conditions of the accident, location, time, causes and availability of belts ($P < 0.05$).

Keywords: Road Transport; World Health Organization; Motor-Vehicle

Introduction

Traumatic injuries are considered one of the leading causes of death among young adults in the western world, and are imposing an increasingly severe burden on the health infrastructure of the developing world. The use of motor vehicles is growing worldwide; which is a particular concern in emerging nations where increasing urbanization, overcrowding and scant regard for the 'rules of the road' are the norm [1]. Road transport is the basic mode of transportation for good and passengers in most of the low-income regions in the world, including Sudan; catering 90% of National freight tonnage and 95% of the transport volume. In developing countries, the trend has reached an alarming state, but very little attention is paid to the problem (Odero., *et al*. 1997). Survivors from death often have to struggle with the resultant disability and its cost [2]. In developing countries the proportion of serious injured and killed casualties are higher than in the developed countries. An analysis of cross-sectional data on road traffic related deaths has shown that the poorest countries have highest road traffic related mortality rates [3]. In this analysis, many industrialized countries appear to have introduced interventions that reduced the incidence of road traffic injuries and improve survival of those injured. In developing countries there are some peculiarities regarding the accident profiles [3].

In Sudan, the marked rise in the capital population, and the continuous increase of the number of motor-vehicles imported annually, both do contribute in the dramatic elevation of the number of accidents per year. It was stated that road traffic accidents are the most frequent cause of injury-related disabilities and deaths worldwide [4]. In general the importance of injuries and disabilities as public health problems is yet, not well recognized in many developing countries [5]. The World Health Organization reported that, almost 16000 people die daily worldwide from all types of injuries representing 12% of the global burden of diseases and among all category of injuries, road accident related is the most. The report admits that estimating annual road deaths vary due to some limitations; it is believed that over 3000 lives are lost daily worldwide. The driver's characteristics contribute to the high per-

centage in cases of road traffic accidents [6]. The Russian President, Dimity Medvedev declared at the Lunch of United Nation Decade of Action for Road Safety 2011-2020, (May 11, 2011) in a statement: "Experts estimate that more than a million people die on the roads each year one in five of whom is a child. More than 50 million people are hurt or seriously injured. And in a key note address at the same occasion, David Cameroon, the U.K Prime Minister phrased it by adding a time dimension: "Every six seconds someone is killed or seriously injured on the world's roads". It was revealed in the conference that by 2020, 1.9 million lives will be lost annually if nothing is done to curb road accidents worldwide [7]. World Health Organization strategy of 2001 reports that currently road traffic injuries are the leading cause of deaths and injuries, the 10th leading cause of all deaths and 9th leading contributor to the burden of disease worldwide based on disability adjusted life years. The numbers of deaths resulting from road traffic crashes have been projected to reach 8.4 million in the year 2020 [8].

Disease or Injury 1998	Disease or Injury 2020
1. Lower respiratory infections	1. Ischaemic heart disease
2. HIV/AIDS	2. Unipolar Major depression
3. Perinatal Conditions	**3. Road Traffic Injuries**
4. Diarrhoeal diseases	4. Cerebrovascular disease
5. Unipolar Major depression pulmonary disease	5. Chronic obstructive
6. Ischaemic heart disease	6. Lower respiratory infections
7. Cerebrovascular disease	7. Tuberculosis
8. Malaria	8. War
9. Road Traffic Injuries	9. Diarrhoeal diseases
10. Chronic obstructive pulmonary disease	10. HIV/AIDS

- Source: WHO, Evidence, Information and Policy Report 2000

Figure a: Disease burden for 10 leading causes of death.

Over 1.2 million people died and 50 million were injured or disabled in road accidents worldwide; and that majority of these deaths (90%) occur in developing countries which have only 48% of the world's vehicles, with little or no safety measures in place [9,10]. The table below gives credence to the above assertion nine years ago.

Odero and his colleagues pointed that „A dramatic increases in both, the proportion and absolute number of traffic injuries fatalities in a number of developing countries; Annually, 74% of all road traffic injuries and deaths in the globe are occurring in developing countries [2]. It was stated in absolute numbers by the Global Road Safety Facility (2012), that the road related mortality rate per capital in Africa is the highest in the world with an incidence of 28.3 deaths per 100,000, not mentioning injuries at an estimated cost of US$ 3.7 billion [11]. Iteke and colleagues, stated that avoidable road traffic accidents among other accidents have continued to add to morbidity and mortality in most sub-Saharan African countries and that; there have been many cases of road traffic accidents (RTAs) resulting from low construction standards and poor road maintenance in Sub-Saharan African countries [12]. A study performed by Piece and Maunder (1998) listed six possible causes of the increase in the rate of accidents in the developing countries as: 1. Rapidly urbanization process in these countries. 2. High growth rates 3. Poor road conditions 4. Reckless driving 5. Non-adherence to the traffic regulation by motorists and traffic officers. 6. The majority of the people in developing countries are dependent on public transport for their daily movement. However, the minibuses have a higher accident risk in developing countries than in the developed world [13]. Other more specific causes such as alcohol and substance intoxication were included in a lot of studies, and considered risk factors for drivers, pedestrians, and even passengers!.

	Number	Rate Per 100,000 Population	Proportion Of Total (%)
Low-Income and Middle-Income Countries	1 065 988	20.2	90
High-Income Countries	117504	12.6	10
Total	1183492	19.0	100

Source: WHO Global burden of disease project 2002

Figure b: Estimated global road traffic injury – related deaths.

According to the World Report on Road Traffic Injury Prevention, traffic accidents account for about 3000 daily fatalities worldwide. Statistical projections show that during the period between 2000 and 2020, fatalities related to traffic accidents will decrease within about 30% in high income countries. The opposite pattern is expected in developing countries, where traffic accidents are expected to increase at a fast rate in the years to come [14]. Road traffic accidents may result in any type of injury due to the unlimited ways to impact. It was illustrated in a study by McCoy GF Johnstone RA, Nelson IW, Kenwright J, and Duthie RB that in a frontal collision, the unrestrained occupant of a vehicle continues to move forward as the vehicle comes to an abrupt stop. This forward motion is arrested as the patient connects with the, by now, stationary vehicle chassis. The initial impact point is often the lower extremities, resulting in fracture or dislocation of the ankles, knee or hip dislocations and femoral fractures. As the body continues moving, the head, cervical spine and trunk impact with the windshield and steering apparatus. In a lateral impact, the victim is accelerated away from the side of the vehicle. Compressive pelvic injuries, pulmonary contusion, intra-abdominal solid organ injury and diaphragmatic rupture are common. Rear impacts also accelerate the victim; if head restraints are incorrectly fitted, the inertia of the head makes the cervical spine vulnerable to injury. Ejection

from a vehicle is associated with a significantly greater incidence of severe or critical injury [15].

Deceleration/acceleration injuries are other possible morbid and lethal patterns. They occur when differential movement occurs between adjacent structures as Rivara FP Grossman DC, and Cummings P (1997) described; for example, the distal aorta is anchored to the thoracic spine and decelerates much more quickly than the relatively mobile aortic arch.

Shear forces are generated in the aorta by the continuing forward motion of the arch in respect to the distal thoracic aorta. Similar situations occur at the renal pedicles, the junction of the cervical with the thoracic spine and also between the white and grey matter within the brain [1]. It was stated by Pathirana and colleagues (2013) that pattern and severity of fractures following RTA varies according to the category and age of the victim, the nature of the accident and following of the basic safety protocols [16]. Studies conducted in 1996 by the American National Highway Traffic Safety Administration In purely frontal MVAs, showed that air bags provide a reduced risk of fatality of approximately 30%. In all crashes the reduction in risk of death has been estimated at 11% [17].

Literature Review

Introduction

The first true motor vehicle was constructed by Nicholas-Joseph Cugnot of Lorraine, France. It was huge, steam-powered tricycle and the 1769 model is said to have run for 20 minutes at 3.6 kilometers per hour with a capacity to carry four passengers. It got enough steam to move again after resting for 20 minutes. Carl Benz of Germany is considered the pioneer contributor to the modern petrol engine motor vehicle. Benz ran his first car in 1885 at a speed of ten kilometers per hour. Gottlieb Daimler, also of Germany, ran his in 1886. Since then, motor vehicles manufacturing has undergone a tremendous evolution with the modern models able to cruise at speeds in beyond 300 kilometers per hour, in addition to the development and upgrading of the Acceleration and Brake systems along with other accessories [19]. The first human fatality associated with a motor vehicle was a pedestrian killed in 1899. While then the patterns of injury from man's interaction with the motor car may have been somewhat modified by crash protection devices, including helmets, seat belts and air bags [1].

Definitions

World health organization has defined accidents as "an unpremeditated event resulting in recognizable damage" [20].

Spectrum of accidents are Road traffic accidents, industrial accidents, domestic and peri-domestic, railway accidents, agricultural accident, intentional or suicidal injuries, etc. But the epidemics of road traffic accidents are leading cause of mortality and morbidity. The alarming increase in mortality and morbidity owing to road traffic accidents has been a matter of great concern globally [21]. According to Mackie [22] the United Nations Cost Benefit Analysis of Transport Infrastructure Projects (2003) classified accidents as follow:

- A damage-only accident is one in which there are no casualties.
- A fatal accident is one in which there is at least one fatality.
- A serious accident is one in which there is at least one serious casualty but no fatalities.
- A slight accident is one in which there is at least one slight casualty but no serious injuries and no fatalities" [22].

Road traffic accidents (RTA) are "hidden epidemic" which though a priority has received much less attention [23]. Advances made in health and health related sciences have paid with dividends in bringing down the mortality and morbidity due to communicable diseases. This has resulted in longevity of the people. At the same time Globalization has improved the socio-economic status of the people resulting in changes in the lifestyle of the people. The longevity of life and changes in the life styles has brought the entire spectrum of non-communicable disease and accidents to the forefront of health care delivery system [24]. RTAs occur when one vehicle collides with another vehicle or a pedestrian, animal or other object; this may occur in a public or private location, and may be unintentional. The results of RTAs vary from minor damage to a vehicle to serious injury or death for the people involved [25,26].

All the same, the World Health Organization's (WHO) World Report on Road Traffic Injury Prevention [27] defines a road traffic injury as fatal or nonfatal injuries occurred as a result of a road traffic crash. A road traffics crash can be also defined as a collision or incident that may or may not lead to injury, occurring on a public road and involving at least one moving vehicle. This implies that, RTA can be defined as an accident that occurred on a way or street open to public traffic; resulting in one or more person's being killed or wounded, and at least one stirring vehicle was intricate. Therefore, RTA is a smash between vehicles; between vehicles and pedestrians; between vehicles and animals; or between vehicles and geographical or architectural obstacles.

Causes and related factors

In General Reasons for RTAs involving trucks are multifactorial. They include human causes; (driver, passenger, or pedestrian faults) such as chronic illness, tiredness/lack of concentration, in-

toxication, speed and time, plus inappropriate behavior [28-30], in addition to vehicle related causes, sudden obstruction, and accidents. The impact of the individual driving style is still being considered [31-33].

Ethiopia as a Regional example, as in Sudan, and specially Khartoum, Ethiopia is considered similar in many aspects related to RTAs. In addition to that, it underwent a process of rapid urbanization and suffered of a lot of the negative consequences. The Ethiopian National Road Safety Coordination Office (NRSCO) [34] states that Based on a five-year average record in Ethiopia of the personal injury accidents, 81% are caused due to drivers' error, 5% due to vehicle defect, 4% due to pedestrian error, 1% due to road defects and 9% due to other problems.

Research studied the road traffic accidents in China for the period 2000-2005 concluded that the driver experience, the classification of the road, and the level of urban development surrounding the road are the main factors that characterize the accidents‟ fatalities in China. In addition, there are other reasons that include: cultural issues such as drunk driving, poor road performance that is due to limited funding, overloaded heavy trucks because of expensive toll, resulting in more sever fatalities and lack of safety. It suggested allocating fund for investments in transportation infrastructure that is not only beneficial to traffic but also to the national GDP (gross domestic product). Furthermore, the road traffic safety system in China needs to be enhanced [35,36].

Specific causes and related factors

Urbanization and migration: Peng., *et al*. [37] considered the traffic accidents in urban areas in China, where the population growth is causing higher frequency of traffic accidents, which is markedly happening in Khartoum when comparing it to the other Sudanese states. They utilized a database that includes historical data regarding road traffic accidents in Shanghai. The data were studied in order to determine the relationship between traffic accidents and the road parameters.

Driver's behavior

A driver‟ work/live in generally unhealthy environments, with a dearth of healthy options, and a resulting high prevalence of associated diseases can be found. This is related to both the occupational framework and sometimes personal risk-taking behavior patterns. Nevertheless, there is a substantial deficit of prevention and medical care (the latter especially) on the road [38].

A study conducted in Mekele City, Northern Ethiopia; revealed personal behavioral factors which are distractive and leading to more serious accidents. Majority of the study subjects 233 (66.6%) had risky driving behaviors which is Significant number. More than a quarter 100 (28.6%) had less knowledge about basic traffic signs. Significant percent of them 148 (42.3%) had a habit of using mobile phone while driving vehicle and 28 (9.7%) had experience of driving after drinking alcohol. 97(62.6%) house car and 58(37.4%) taxi unfasten their seat belt while driving. Majority 303 (86.6%) followed the recommended speed limit of driving. About 66 (18.9%) of them had experience of punishment or warning by traffic polices in the previous 1 year and 77 (22%) ever had car accident while driving. Drivers of secondary education and with high average monthly income were more likely to have risky driving behavior [39]. Seeing it from another perspective, most of truck drivers have to fulfill strict timetables and are therefore neglecting their fatigue and a lack of concentration [40,41]. In 2003 a questionnaire amongst truck drivers was performed. Of the participants, 20% reported to be dissatisfied with route planning and scheduling [42]. Moreover, it was shown that the driving performance of truck drivers is sleep dependent. Unfortunately, studies revealed that truck drivers often do not recognize their sleepiness, or, if they do, continue driving regardless [43]. In a multinational survey, almost 30% of truck drivers admitted to having had at least one near miss experience in the last three months due to fatigue [42]. The attitude of the drivers was examined through surveying 2,614 drivers in Norway. The questionnaire results indicated that behaviors such as speeding and rule violations, careless driving, attitude towards drinking and driving are among the most important behaviors that impact the involvement in accidents. It was also concluded that age and gender are significant factors that impact the variations of drivers‟ attitude [44].

Age

The effect of driver's age on traffic accidents in Florida US has been studied by Abdel-Aty., *et al*. [45]. These models considered the relationship between the driver's age and several factors that impact traffic accidents, such as traffic volume, severity of the injury, types of collision, road type, and speed distribution.

Environmental effect on light and heavy MV

As a result of a study on the rural Sweden roads, it was mentioned that the presented data should consider many factors such as environmental issues, and the type of the traffic flow, for instance, to be homogeneous (light vehicles only) or nonhomogeneous (light and heavy vehicles). The study developed empirical models describing the relationships between accident frequency and traffic flow. The results concluded that the consideration of homogeneous or nonhomogeneous traffic has a significant impact on the accidents‟ trends [46].

Number of vehicles involved in the RTA:

A study used regression analysis to evaluate the traffic accident data in Jordan and the UAE from 1990 till 2004, and Qatar till 2006. The study results indicated that exponential models showed the best fit to predict the relationship between number of fatalities and the population or number of vehicles. The models showed an acceptable average absolute error of 20.9% for Qatar, 10.9% for Jordan and 5.5% for the UAE [47].

The status of the vehicle just before the accident:

Defective braking systems - anti skid braking system (ABS)

An effective (ABS) is very important for any vehicle as it helps the driver to control and steer the car while braking, and also prevents skidding [48].

Defective head or rear lights If cars are driven less at night, then a third of motorcycle accidents could be avoided and 10% of car accidents would be prevented [49].

Defective tires

Defective tires lead to the driver losing control of the vehicle. There are many causes of defective tires, such as low air pressure, the overloading of vehicles and tire manufacturing defects. The New Zealand Land Transport Safety Authority underlines this, indicating that 40% of fatal accidents in this country result from faulty tires [50]. Similarly, in Australia in 2000, 15 fatal accidents and 110 injury accidents were the result of defective tires.

Using mobile phone while driving or crossing roads

The results of the study made it clear that using mobile phone while driving or crossing roads either as a driver or pedestrian is one of the most reported forms of risky behavior in Abu Dhabi and a high percentage of respondents admitted to this practice.

Alcohol consumption and substance intoxication

Many of the reasons for accidents that have been reported in the literature are applicable to Khartoum, such as speeding, rule violations, and careless driving. However, some of the most common reasons for accidents in China and Europe are not very common in Khartoum, such as drunk driving. For example, in France the number of fatalities was reduced by 4% after lowering the limit to 50mg of alcohol in per 100 ml of blood. In China the number of drink and driving cases decreased in the area of stricter law enforcement. It is very important to inform and educate people about the penalties of drink-driving. Substance intoxication also can reduce and impair driving as suggested in a study done in Melbourne, Australia. The inclusion of one story in the newspapers on the danger of drink-driving may reduce the number of people who drink alcohol and drive illegally.

Literature's list of causes

In able to organize these causes collectively, their list, in addition to the age and unusual seat in the vehicle will include all causes, suggested by the above given literature, lying under one of the following categories:

- **Human error:** Excessive Speeding-Inattention, confusion of lack of judgment of driver-Drivers careless at road junction and cutting corners-Improperly overtaking or cutting in-Inexperience of driver-Intoxication/alcohol consumption-Other recklessness or negligence by drivers- Over loading.
- **Mechanical fault:** Mechanical Defects-Defective Lights-Dazzling lights
- **Obstruction by others:** Abandon truck on the road-Tree or mounting close to the road.
- **Accidental:** Falling object on the road-Passengers Faults-Pedestrian on the way-Animals not under control-Weather.

Harm distribution

According to (Abegaz., *et al*. 2014), who conducted a study targeting Addis Ababa – Hawassa main road to evaluate the improved road safety applied by the Oromiya national regional state showed 4053 crashes were registered and among these 1193 (29.4%) were fatal and 24.2% injury crashes and almost half (1880 (46.4%)) were property damage, resulted in 1.2 deaths and 1.8 injuries per crash, of all deaths more than half 800(57.5%) were pedestrians, 32% vehicle occupants and the rest 147(10.5%) were drivers ; vehicle occupants were more vulnerable for injury crash 55.% (965) followed by pedestrians 614 (35.1%) and the rest drivers are equally at risk for injury like deadly crash accounting 9.7% (170). Regarding the type of crashes reported in the study area, 40.6% (1,645) were crashing with other vehicles, followed by pedestrian collision 32.9% (1,335), rollover crashes accounted 16% (651) and the rest 6% (238), 4.5% (184) crash with fixed object and others including animal vehicle crash respectively. Another study carried in Kenya revealed that of all fatalities reported, pedestrians comprised 42%, passengers 38%, drivers 12% and cyclists 8%. Vehicle-Pedestrian collisions were most severe and had case fatality rate of 24% while only 12% of injuries resulting from vehicle accidents were fatal [50].

Mechanism of injury

Motor vehicle-related injuries can be arbitrarily divided into: • Collision between the occupant and the external environment (the vehicle, or a stationary object if the occupant has been ejected). • Acceleration or deceleration forces acting on the patient's internal organs.

Collisions

- **Frontal Collision**: In a frontal collision, the unrestrained occupant of a vehicle continues to move forward due to inertia as the vehicle comes to an abrupt stop. This forward motion is arrested as the victim connects with the, by now, stationary vehicle chassis. The initial impact point is often the lower extremities, resulting in fracture/dislocation of the ankles, knee, hip or femur. As the body continues moving, the head, cervical spine and torso impact on the windscreen and steering column.
- **Lateral Collision:** In a lateral impact, the victim is accelerated away from the side of the vehicle. Compressive pelvic injuries, pulmonary contusion, intra-abdominal solid organ injury and diaphragmatic rupture are common. Rear impacts also accelerate the victim; if head restraints are incorrectly fitted, the inertia of the head makes the cervical spine vulnerable to whip-lash injury. Ejection from a vehicle is associated with a significantly greater incidence of severe or critical injury. Other injuries after impact are due to explosions leading to bums. When a car hits an adult, front bumper usually strikes first, hitting the victim at or just below the knee level either on the front or side of the legs. Primary injury on the thigh or hip will be due to the radiator grill, lamps or bonnet (hood) striking the body. If the vehicle is large e.g. truck or bus primary injuries maybe higher affecting chest, arms or head. Even at low speeds the body might be thrown violently away and at higher speeds (60-100 k/h) the victim may be projected up into air and travel a considerable distance before striking the ground or an obstruction giving rise to scooping-up injuries. These cause secondary injuries especially on head, chest and pelvis. Running over injuries occur when a wheel passes over the body. It causes great distortion if on the head, chest, pelvis or abdomen. Tire marks are impressed by intradermal bruising. Where a motor wheel rotates against a body on the ground, large areas of skin and subcutaneous tissue may be ripped off giving rise to flaying injury [1].
- **Deceleration/acceleration injuries:** Such injuries occur when differential movement occurs between adjacent structures; for example, the distal aorta is anchored to the thoracic spine and decelerates much more quickly than the relatively mobile aortic arch. Shear forces are generated in the aorta by the continuing forward motion of the arch in respect to the distal thoracic aorta. Similar situations occur at the renal pedicles, the junction of the cervical with the thoracic spine and also between the white and grey matter within the brain [1].

The principal fatal sequel

The principal fatal sequel to injury include hemorrhage, fat embolism due to long bone fractures, pneumonia (especially following thoracic or abdominal which interfere with respiratory movement and serious head injuries), pulmonary embolism and cardiovascular sequel (endocardial hemorrhages, endocardial fibrosis and hypertrophy, arrhythmias) [46].

Patterns of injury

At the time of inception of this study, no study had been carried out to document the pattern of injures that occur in fatalities arising from road traffic accidents in Khartoum. In the western world the most common causes of death include: Head injury 60%; Thoracic injury 20-25%; Aortic injury 15%. In addition, tracheobronchial injuries contribute to a small number of patients admitted to trauma centers. While the spleen is the most commonly injured visceral organ [34].

A study at Nairoby city, carried at the Kenyatta Hospital showed that fractures were the most common form of injury recorded in emergency surgical admissions was fractures of long bones and pelvis followed by head injury. Fractures contributed to 48.4% of the total injuries recorded while head injuries contributed to 22.8%. The most common fractures seen were those of the femur (15%), combined fractures of the tibia and fibula (10.6%) and pelvic fractures (6.1%). There was a 9.2% mortality rate with 75% of them being due to head injury. Pedestrians accounted for 50% of the deaths followed by passengers at 40%. Five (5%) of the drivers died while motorcyclists and cyclists contributed 2.5% respectively. The recorded cases of death were due to either head injury or hemorrhagic shock with the former being the leading cause of death (75%).

Scoring of injuries

Importance of scoring/triage and documentation

Research conducted in The Indian Subcontinent; showed that 23% of RTA deaths were felt to be preventable, 41% possibly preventable, and the rest not preventable. The majority of preventable deaths resulted from a failure to diagnose or manage a treatable injury, what shows the importance of the Clinically Systematic Approach and its documentation. Documentation's important is often surpassed by the hard physical work, and tackled by the poverty of resources as shown in another study carried among patients who attended Nairobi Hospital which may have go similar circumstances which revealed that trauma documentation was poor with less than 30% accuracy in most cases seen at the Nairobi Hospital Accident and Emergency Department.

Scoring systems

Scoring systems were designed initially to categorize patients with single, specific diagnoses into risk and prognosis groups. Clinical assessment of severity of illness is an essential component of medical practice. It is intuitive to consider whether patterns and severity of physiological disturbance can predict patient outcome. Scoring may allow collection of data more accurately and consistently, costs may be reduced, clinical research is facilitated, epidemiologic analysis is possible, the time course of illnesses can be documented (organ dysfunction etc.) earlier determination of a problem.

Scoring systems for use in emergency room patients have been introduced and developed over the last 30 years. They allow an assessment of the severity of disease and provide an estimate of in-hospital mortality. This estimate is achieved by collating routinely measured data specific to a patient. A weighting is applied to each variable, and the sum of the weighted individual scores produces the severity score. Various factors have been shown to increase the risk of in-hospital mortality after admission to hospital, including increasing age and severity of acute illness, certain pre-existing medical conditions (e.g., malignancy, immunosuppressant, and requirement for renal replacement therapy), and emergency admission to ICU. Severity scoring systems allow generation of a score that reflects the severity of the condition resulting in ICU admission. The scores allow the factors that influence outcome and those differ between patients to be taken into account and can be standardized to allow comparison between patients. A systematically organized approach to trauma evaluation and management has been shown to reduce mortality, morbidity, and length of hospital stay. Injury scoring systems are used to determine the potential for someone having sustained a serious injury. They are useful in situations where there is more than one casualty, as they allow emergency services and ED personnel to prioritize the more severely injured patients.

Abbreviated injury severity system

The Abbreviated Injury Scale (AIS) was first introduced in 1969 as an anatomic scoring system to categories automobile victims for epidemiological purposes. It underwent revision in 1990, and body regions for the AIS were identified as follows: head, face, neck, thorax, abdomen and pelvic content, spine, upper extremities, lower extremities, and unspecified. In this revised version, external injuries are dispersed across body regions, and the AIS provide a reasonably accurate way of ranking the severity of injury by body regions. With the AIS, injuries are ranked on an ordinal scale ranging from 1 to 6, with 1 being considered a minor injury or least severe, 5 being a severe injury or survival uncertain, and 6 being an un-survivable injury. An AIS score ≥3 is considered serious. The AIS correlates well with the degree of injury but suffers as a prognostic tool because it does not take physiologic derangements or chronic health into account.

New injury severity score

NISS is defined as the sum of the squares of the AIS scores of a patients three most severe injuries. It is more straightforward to calculate than ISS, because the location of the injuries does not have to be considered¨†the three highest AIS scores are used regardless of body region.

Advantages and disadvantages of NISS

Once the AIS severity codes are available, NISS is straightforward to calculate. It does take account of multiple injuries in the same region; however, it does not discriminate between injury severities in different locations. Its performance compared to ISS seems to depend to some extent on the characteristics of the database studied.

Modified injury severity scale in pediatric

The MISS is a trauma scoring system for pediatrics patients. It operates along similar lines to the ISS but with five body regions (neurological, face and neck, chest, abdomen and pelvic contents, extremities and pelvic girdle) scored from 1 (minor) to 5 (critical with uncertain survival). As with the ISS, the total score is the sum of the squares of the three most severely injured body regions. For MISS scores greater than 40 mortality is 50%, and for scores greater than 50 mortality is 75%. In this case a GCS of 14 would give a neurological score of just 1, so the three most severely injured regions are face and neck, extremities, and abdomen, giving a MISS of 42 + 32 + 22 = 29.

International examples

The European Efforts the EU is considered as a leading school in this subject. Taking for example the UK as a legislating member, in which, and according to the EU Road Safety Project, two traffic safety strategies were developed. One is the Strategic Framework for Road Safety and is used in Great Britain. The other is the Road Safety Strategy used in Northern Ireland. The Strategic Framework for Road Safety in Great Britain aims to reduce traffic fatalities 37% to 1,770 by 2020. -The Road Safety Strategy in Northern Ireland has the objective of reducing traffic fatalities to 60% to 418 by 2020. According to the Department for Transport in 2012, the UK had a lower RTA death rate in comparison with all the other European Union countries except Malta. In contrast, the USA had four times the number of deaths in RTAs compared to the UK.

The North America module

Canada's road safety vision has the title of the "safest roads in the world". Their vision was intended to result in Canada achieving a rate of five fatalities per 100,000 people. Since this vision was proposed, the roads have become much safer; in 2007 there were 2,767 fatalities and therefore the fatality rate was 8.4 per 100,000 people. Not far down to the south of the American continent, in the United States of America, Road safety strategy was aimed at reducing the fatality rate to 1.05% per 100 million vehicles for each mile. This strategy also had the objective of reducing fatalities resulting from drink-driving to 32% and lessening fatalities from motorcycle accidents to 14%.

The Australian aims

The Australian National Road Safety Strategy 2011–2020 aims at lowering the number of fatalities and serious injuries by 30% every year.

Strategies around the Arabian Peninsula

Qatar's National Strategy for Traffic Safety aims to reduce deaths through RTAs from the present number of 220 to 130 and it is hoped the rate of serious injuries will be reduced to 300 compared to a present rate of 550 injuries per year. The Strategic Traffic Safety Plan aims to reduce the number of road traffic fatalities and injuries in the city of Riyadh by 30% of the expected number of road accidents for the year 2014. After applying this strategy, the number of fatalities should be reduced to 266 deaths with an average of 22 deaths per month, compared to the average of 26 deaths per month during 2013.

African strategic targets

The Africa Decade Plan of Action of the African Union has the goal of reducing road traffic fatalities by 50% in 2020 and it is also aimed at preventing about one million severe injuries per year. According to the Kenya Roads Board (KRB), the road safety vision is: "An efficient road network for a prosperous Nation". This can be achieved through increasing the funds available for road safety projects, developing the maintenance of the road network and improving the coordination between stakeholders for road safety.

Justification

Road traffic accidents in Khartoum have been increasing dramatically along with tremendous rise in deaths in the previous past years, unfortunately with a simultaneous continuous increase in the import of vehicles. Survivors of this tragic way of death often have to struggle with the resultant disability. Healthy manpower is the base of the pyramid of nations development throughout the whole history of mankind. On the other hand, deaths and disabilities due to road traffic injuries, which can be considered relatively preventable, have got a major impact on medical, social, and economical pillars of national development, not to mention that both are considered as leading causes of poverty. RTAs are considered as a public health problem which needs to be addressed as a preventable non-communicable epidemic with annual morbidities and fatalities, only surpassed by Wars, and generally their profile should be raised.

Objectives

General objective

The general aim of this study is to provide a reliable analysis of Motor – Vehicle accidents in Khartoum, Sudan.

Specific objectives

- To identify the causes contributing to motor vehicle accidents in Khartoum State.
- To identify risk factors related to motor vehicle accidents in Khartoum State.
- To analyze the relation between the causes and related factors of road traffic accidents, and victims Injury Severity.
- To assess the availability and application of basic safety measures, in means of seat-belts and Air-bags.
- To analyze the relation between victims' application of basic safety measures and road traffic Injury Severity.

Materials and Methods

Study design

A Hospital based descriptive cross-sectional study.

Study area

Trauma and Orthopedic Surgery Units in Khartoum North Teaching Hospital, Ibrahim Malik Teaching Hospital, Altamaiyuz Centre for Trauma, and Omdurman Teaching Hospital, which are governmental hospitals that resemble the main Trauma and Orthopedic Surgery departments in Khartoum, in addition to other private hospitals, given their permission.

Study population

All drivers and passengers whom sustained non-fatal injuries as a result of transporting by a four wheeled motor-vehicle road traffic accident in Khartoum State encountered during the period of the study. Despite their contribution in the road transport in Khartoum state, motorized Rickshows were excluded as there are no safety measures, nor apparatus designated or developed for such vehicles yet.

Sample size and sampling technique

The total population is more than 100,000, so the sample size (N) was calculated by the Fischer's Exact Test. The formula used

for sample size determination was calculated as follows: n = Z21-α/2 PQ/d2 Where n = required sample size, α = level of significance (0.05), Q = 1-p, Z21-α/2 = standard normal deviate within 95% confidence interval (1.962), P = assumed proportion of the sample, and d = level of precision at 5% (standard value 0.05). n = (1.962x0.5x0.5) ÷ 0.052.

Sample Size = n = 385.

Data collection

Data collection procedure and methodology was based on both quantitative and qualitative methodologies. That was accomplished by conducting interviews with accidents victims during the field work period using an interview guided Data Sheet, containing questions covering the relevant quantitative and qualitative variables which are divided into four parts as follows; the 1st part is concerned with the victims' demographic variables which are age, gender, occupation, class during the accident, seat position, alcohol and substance intoxication. The 2nd part is about the severity of the injury which will be measured using the Injury Severity Score. The 3rd part is regarding the accident's variables, which are the time of the accident, the location of the accident (within the city or in the highway), and the reason which is suspected to cause the accident (human error, mechanical fault, obstruction, and accidental). The last part deals with the availability, and application of the basic safety measures.

Data analysis

All data was computerized and statistical analyses were performed using the 16th version of the Scientific Product and Service Solution statistical software (SPSS).

Ethical clearance

This thesis proposal was submitted to the Council of Traumatology and Orthopedic Surgery and the Ethical Committee of the Sudan Medical Specialization Board for approval. Serious injured casualties were not interviewed due to their situation. And those who were able still depended on their consent to participate.

For ethical and confidentiality purposes names of the subjects whom participated in this study were not included in the data collection instruments. Each participant was acknowledged that filling this questionnaire is optional, and its results will not be used in purposes other than research works.

Results

The mean age was 29.8 ± 14.2 years and the highest percentage of the patients 209(54.3%) aged between 20-39 years (Figure 1). Males were 288(74.8%) and females were 97(25.2%); male to female ratio was 2.9: 1 (Figure 2).

The highest percentage of the patients 141(36.6%) were in civil service (Figure 3). The class of 308(80%) of the patients was passenger and 77(20%) was driver (Figure 4). Intoxication of alcohol or substance abuse was reported in only 6(1.6%) of the patients (Figure 5).

As shown in Table (1) 138(35.8%) of the patients on unusual seat, followed by 133(34.5%) on front seat, 66(17.1%) on passenger seat, 39(10.1%) back seat and 9(2.3%) mother's lap.

In the majority of the cases 283(73.5%) the time at which the accident was happened was during the weeks work-days and in other 102(26.5%) during the weekend (Figure 6).

The majority of accidents 280(72.7%) occurred within the city and 105(27.3%) along the highway (Figure 7).

The most common human error that caused the accident was excessive speeding 121(31.4%) and to lesser extent improperly overtaking or cutting 57(14.8%) in addition to other recklessness or negligence 49(12.7%). Other causes related to human errors are shown in Table (2).

Mechanical causes were mechanical defect 17(4.4%), defective heights 9(2.3%) and dazzling lights 1(0.3%) (Table 3).

The only one cause related to obstruction was tree or mounting close to road reported in 7(1.8%) of the cases (Table 4).

Accidental causes were pedestrian on the way 29(7.5%), animals not under control 22(2.9%), passenger fault 14(3.6%) and weather 11(2.9%) (Table 5).

Available of effective seat-belt confined to seat was reported in 168(43.6%) and not available in 217(56.4%) of the cases (Table 6).

Effective airbags confined to the seat was available in 101(26.2%) of the cases and not available in 284(73.8%) (Table 7).

Application of victim's seat belt was reported in 19(4.9%) of the cases and not applied in 366(95.1%) of the cases (Table 8).

The mean injury severity score was 7.6 ± 8.9 with 230(59.7%) fall within not severe range (> 8) and 155(40.3%) (≥8) (Figure 9).

Significant association found between injury severity score and variables of age, gender, occupation, conditions of the accident, location, time, causes and availability of belts and airbags ($P < 0.05$) (Tables 9-13).

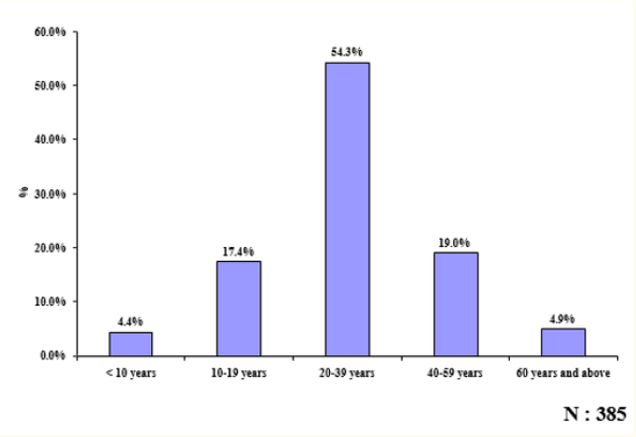

Figure 1: Distribution of the patients according to age group.

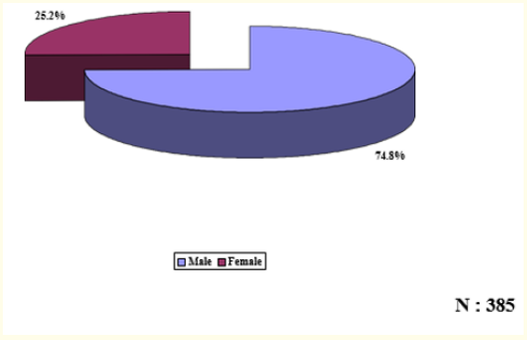

Figure 2: Distribution of the patients according to gender.

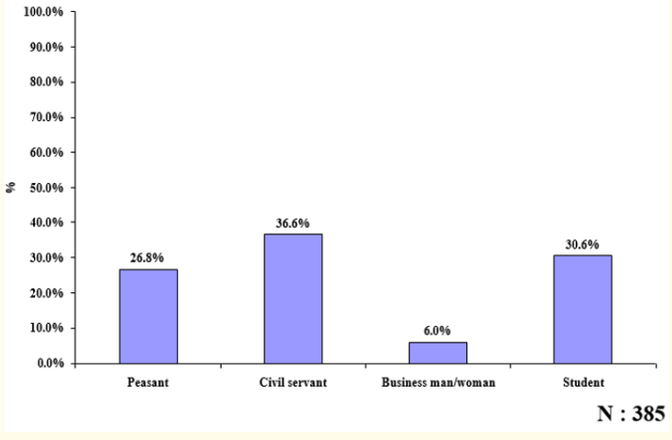

Figure 3: Distribution of the patients according to occupation.

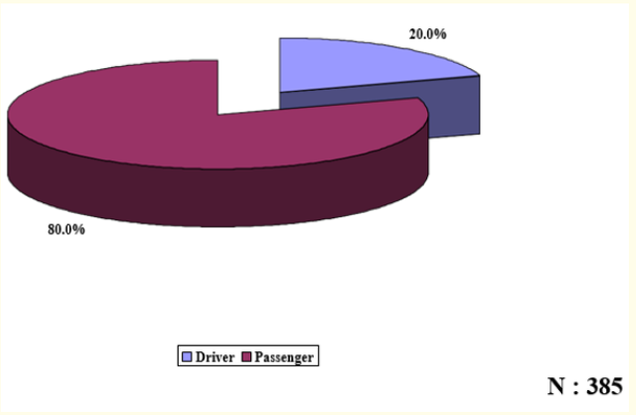

Figure 4: Distribution of the patients according to the class of the victim.

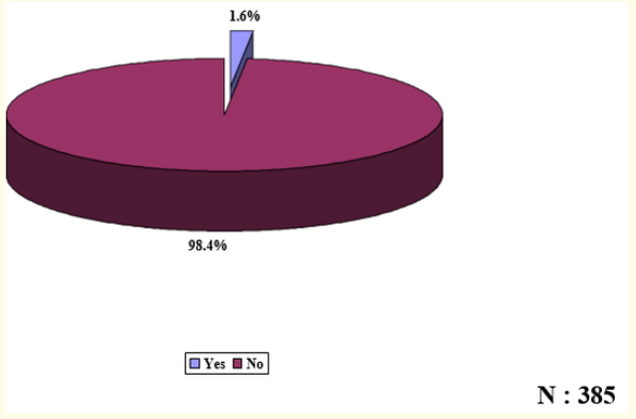

Figure 5: Distribution of the patients driver intoxication (of alcohol and/or recreational substances).

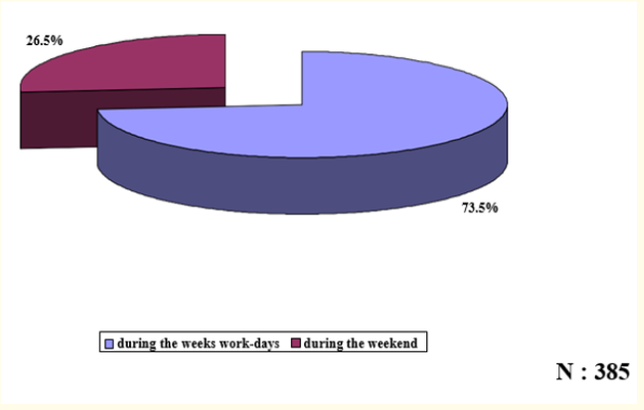

Figure 6: Distribution of the patients according to the time of the accident.

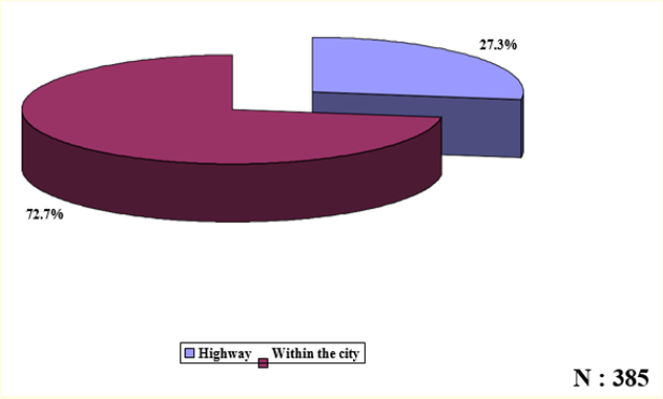

Figure 7: Distribution of the patients according to location of accident.

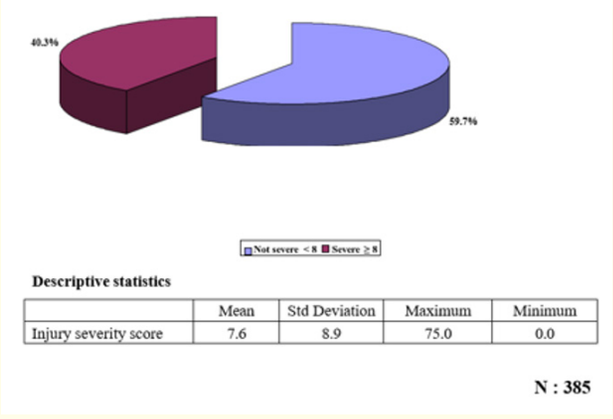

Figure 8: Distribution of the patients according to the Injury Severity Score.

Seat	N	%
Front seat	133	34.5
Back seat	39	10.1
Passenger seat	66	17.1
Mother's lap	9	2.3
Unusual seat (pick-up box, roof-top, etc.)	138	35.8
Total	385	100.0

Table 1: Distribution of the patients according to seat of the injured passenger (N: 385).

Human errors	N	%
None	112	29.1
Excessive speeding	121	31.4
Inattention, confusion of lack of judgment of driver	16	4.2
Drivers careless at road junction and cutting corners	24	6.2
Improperly overtaking or eating	57	14.8
Inexpedience of driver	2	0.5
Intoxication/alcohol consumption	4	1.0
Other recklessness or negligence by driver	49	12.7
Total	385	100.0

Table 2: Distribution of the patients according to causes of accident (N: 385).

Mechanical fault	N	%
None	358	93.0
Mechanical defects	17	4.4
Defective heights	9	2.3
Dazzling lights	1	0.3
Total	385	100.0

Table 3: Distribution of the patients according to causes of accident mechanical errors (N: 385).

Obstruction by others	N	%
None	378	98.2
Tree or mounting close to the road	7	1.8
Total	385	100.0

Table 4: Distribution of the patients according to causes of accident (N: 385).

Accidental	N	%
None	309	80.3
Passengers faults	14	3.6
Pedestrian on the way	29	7.5
Animals not under control	22	5.7
Weather	11	2.9
Total	385	100.0

Table 5: Distribution of the patients according to causes of accident (N: 385).

Availability of effective seat-belt confined to seat	N	%
Available	168	43.6
No available	217	56.4
Total	385	100.0

Table 6: Distribution of the patients according to availability of effective seat-belt confined to the seat (N: 385).

Availability of effective airbags which are confined to the seat	N	%
Available	101	26.2
No available	284	73.8
Total	385	100.0

Table 7: Distribution of the patients according to availability of effective airbags which are confined to seat (N: 385).

The victims application seat belt	N	%
Applied	19	4.9
Didn't applied	366	95.1
Total	385	100.0

Table 8: Distribution of the patients according to the victims application of seat belt (N: 385).

		Severity of the injury		
		Not severe < 8	Severe =>8	P value
Age group	< 10 years	13	4	0.021
	10-19 years	37	30	
	20-39 years	129	80	
	40-59 years	44	29	
	60 years and above	7	12	
Sex	Male	174	114	0.015
	Female	56	41	
Occupation	Peasant	50	53	0.019
	Civil servant	95	46	
	Business man/ woman	14	9	
	Student	71	47	

Table 9: Distribution of the patients according to relationship between injury severity score and basic information of the patient (N: 385). P > 0.05.

		Severity of the injury		
		Not severe < 8	Severe =>8	P value
Class of the injured person	Driver	50	27	0.24
	Passenger	180	128	
Driver intoxication of alcohol or substance	Yes	4	2	0.113
	No	226	153	
Seat	Front seat	71	62	0.019
	Back seat	31	8	
	Passenger seat	43	23	
	Mother's lap	6	3	
	Unusual seat	79	59	

Table 10: Distribution of the patients according to relationship between injury severity score and condition of the accident (N: 385). P > 0.05

		Severity of the injury		
		Not severe < 8	Severe =>8	P value
Time of accident	During the weeks work-days	183	100	0.001
	During the weekend	47	55	
Location of accident	Highway	49	56	0.001
	Within the city	181	99	

Table 11: Distribution of the patients according to relationship between injury severity score and time and location of accident (N: 385). P > 0.05

		Severity of the injury		
		Not severe < 8	Severe =>8	P value
Hyman errors	None	64	48	0.014
	Excessive speeding	68	53	
	Inattention, confusion of lack of judgment of driver	11	5	
	Drivers careless at road junction and cutting corners	15	9	
	Improperly overtaking or eating	34	23	
	Inexpedience of driver	0	2	
	Intoxication/alcohol consumption	2	2	
	Other recklessness or negligence by driver	36	13	

Mechanical fault	None	214	144	0.016
	Mechanical defects	12	5	
	Defective heights	4	5	
	Dazzling lights	0	1	
Obstruction by others	None	227	151	0.017
	Tree or mounting close to the road	3	4	
Accidental	None	186	123	0. 025
	Passengers faults	11	3	
	Pedestrian on the way	15	14	
	Animals not under control	10	12	
	Weather	8	3	

Table 12: Distribution of the patients according to relationship between injury severity score and causes of accident (N: 385). P > 0.05.

		Severity of the injury		
		Not severe < 8	**Severe =>8**	**P value**
Availability of effective seat-belt confined to seat	Available	99	69	0.012
	No available	131	86	
Availability of effective airbags which are confined to the seat	Available	51	50	0.18
	No available	179	105	
The victim's application	Applied	17	2	0.014
	Didn't applied	213	153	

Table 13: Distribution of the patients according to relationship between injury severity score and availability of belts (N: 385). P > 0.05.

Discussion

This chapter is aimed to highlight the findings of the study and discuss the results with their specific strengths and limitations, and was divided into four categories as follows; A part is concerned with the victim's variables which are age, gender, occupation, class during the accident, seat position, alcohol and substance intoxication. Another part is about the severity of the injury which will be measured using the Injury Severity Score. A third part is regarding the accident's variables, which are the time of the accident, the location of the accident (within the city or in the highway), and the reason which is suspected to cause the accident (human error, mechanical fault, obstruction, and accidental). A fourth part deals with the availability, and application of the basic safety measures. The most common age group involved in this study was found to be between 20 and 39 years (54.3%). On other hand, injury severity was significantly associated with older ages (above 60 years); (P = 0.021 < 0.05). This shows that the people of the most active and productive age group are involved in the trauma, which adds a serious economic loss to the community. This finding is similar to another study which was conducted in India, as Jha N., *et al*. [26] in their study of injury pattern among road traffic accident cases in a tertiary hospital in south India found that more than 53% of the victims were in the age group between 20 – 40 years.

Other studies have found the similar outcomes, while some others found the age group of 25-34 to be the most common involved group, this shows that the people in the most active and productive years of life are involved in RTAs, which amounts to a serious economic and emotional loss to their families and community as well. It was noted that below and above the age of 20 and 49 years, the proportion of accidents was low.

This may be because children are generally taken care of by elders and comparatively less use of vehicles in the adolescent age group. A lower incidence of RTAs in people aged 60 years and above may be due to generally less mobility of these people [26].

According to this study, accident rates were higher in males than in females in the ratio of 3.7:1, other studies also indicate similar ratios moreover, females tend to sustain more severe injuries than males (P 0.015 < 0.05), which is a known case regarding a

lot of musculoskeletal injuries. However, this can be justified by a lot of soft tissue morphological differences – in addition to better equilibrium and proprioceptive abilities of males owed to their different lifestyles.

Distributing the study population showed no significance except for the Business man/woman which was noted in only 6% of cases, which seems to be a very low figure when compared to other classes, namely; Civil servants, Peasants, and Students which were found to be 36.6%, 26.8%, and 30.6% respectively. However, this can be attributed to their high income, rendering them the ability to be treated in private hospitals, leading to fewer cases presented to the governmental hospitals, which were most of the data sheets for this study were filled. Peasants showed significant increase ($P = 0.019 < 0.05$) in injury severity when compared to civil servants, business men/women and students as severe injuries occurred in more than 50% of the injured peasants. Among the injured patients whom participated, one fifth of the victims were Drivers and the other 80% were found to be passengers. No apparent significance was noted when comparing injury severity between drivers and passengers ($P = 0.24 > 0.05$).

Comparing this result with other studies conducted in nearby regions marks a lower Passenger/Driver presentation which was found to be 2/1 in a study carried in Ethiopia, and also 2/1 in another study took part in Kenya. Only 1.6% of the drivers whom participated in the study were driving under the heaviness of alcohol or recreational substance intoxication, which away far below the results of studies in other countries. However, this was actually anticipated as it is far harder to admit being drunk or intoxicated by a recreational substance in a society like the Sudanese society. This is most probably due to religion, and social causes. Alcohol and intoxication were not found to be related to the injury severity in this study ($P = 0.133 > 0.05$), due to the fact that the number of victims reported alcohol and substance intoxication was very low (6) [44]. Atypical seats shape their self when the Typical seats are filled. The majority of the victims were using atypical or unusual seats during their transportation at the time of accident, constituting about 34.5% of the total sample when compared to front seats, back seats, and passenger seat. This can be owed to the poor system of transportation in Khartoum, which is failing to meet the marked rise in population. Front seats occupants and occupants of atypical or unusual seats tended to suffer more severe injuries when compared to other seats occupants while back seats occupants showed significantly less severe patterns than the other seats occupants ($P = 0.019 < 0.05$).

Compared to the other days of the week, more victims sustain their injuries in the weekend (26.5%). What changes during the weekend is the pattern of Traffic Flow. It was suggested by other studies that changing in the type of the traffic flow is the reason for the marked increase when compared to other week days. The time and location of the accident were found to be strongly related to injury severity as severe injuries accounted for about 54% of injuries sustained during weekend, while only 35% of severe injuries were sustained during week days ($P = 0.001 < 0.05$) [46]. As concluded by previous studies regarding the site of accident, "within the city" appeared in 72.7% of the Data Sheets, compared to 27.3% "on a highway". On the other hand, 53.3% of accident that occurred along highways were severe, nevertheless only 35.3% of accidents which took place within the city showed severe injuries. That may be attributed to the high speed used while driving along highways, leading to more severe patterns of accidents [37]. The reported most common causes in terms of human errors, mechanical causes, obstruction by others and accidental, were excessive speeding 121(31.4%), mechanical defects 17(4.4%), improper overtakes/cuts 57(14.8%) and other recklessness or negligence by drivers 49(12.7%) respectively. Significant association found between injury severity score and causes of the accidents ($P < 0.05$), which fell in most of the cases under the umbrella of "human errors". Moreover, injury severity was found to be markedly high when associated with some of the causes, namely injuries caused by speeding were found to be severe in 37.5% of cases. As concluded by all the studies that analyzed the causes, human errors were ranked in the first place. A good example to compare with, is a study conducted in Mekele City, Northern Ethiopia, as there, the demographic circumstances look a lot like Khartoum. The study revealed that 233 (66.6%) of the subjects of the research had risky driving behaviors [39].

Under the same category, accidents caused by improper overtaking or cutting showed severity in 40.2% of victims. Although inexperience and alcohol or abuse of recreational substances are hard to admit as mentioned, even the little number of victims whom confessed showed significant relation as the injuries were severe in 100% and 50% respectively for the two causes. Victims of accidents which were caused by Mechanical faults, namely defective or dazzling lights showed severity in 55.5% and 100% ($P = 0.016$). However, victims of both collectively were 10 subjects. Of the causes that were classified under the category of Accidental, pedestrians on the way and animals not under control, there was significant increase in severity. Both act in the same way on the driver with less anticipation of response from animals by drivers. 50% of injuries caused by pedestrians were found to be severe, while 60% of those which were caused by animals were severe ($P = 0.025$). Effective seat belt where available for only 43.6% of the victims, yet only 4.9% of these victims applied it. Strikingly this is

one of the easiest factors to control, not only by checking the application but the effectivity as the presence of an ineffective belt is the same as its absence. The study showed that the percentage of severe injuries among seat belt appliers was 11.7% while among victims who didn't apply seat belt, injury severity was found to be about 42% indicating significant differences (P = 0.012 < 0.05 availability and 0.014 for application). Effective air bags were available for 26% of the victims only, and this is a very low percentage regarding the number of victims involved in this study. The availability of effective air bag showed no significant relation to the sustained injury severity as the results showed that mild and severe injuries were almost equal among victims who occupied seats with air bags (P value = 0.18 > 0.05).

Strengths and limitations of the study

Strengths

Most of the earlier studies focused on hospital-based finding and this research tries to conduct a multifactorial analysis in Khartoum which included correlation of these factors in addition to basic safety measures, with the resulted injury severity.

Considering multiple factors for the assessment of each victim is also strength of this study.

Limitations

Universally, it's hard to admit lack of experience by drivers as a cause of the accident, while in Sudan, which is considered as an Islamic country, admittance of drinking alcohol or abusing re-creational substances is even harder to admit, put aside admitting that it was a cause of an accident.

Lack of community based and/or similar studies locally and most of literatures were hospital based which made the comparison extremely difficult.

Recommendations

Road safety measure needs to be taught as a part of a suitable subject in primary school. This is because large number of people ends with that level of education.

Strict enforcement of traffic laws and rules to control speed, use of safety belts and roadworthy vehicles should be enhanced especially on major highways.

Modern equipment such as alcohol breathalyzers proved effectiveness globally and need to replace the current widely used test, in which, the result depends on the personal judgment of the policeman after sniffing the suspect's throat.

In addition to convicting suspects, video and speed cameras can aid analyzing causes, mechanisms, and patterns of RTA‟s correlating them with the resultant damage.

Road traffic injuries should be considered as a public health issue. More than half the people killed in traffic crashes are young adults aged between 15 and 44 years often the breadwinners in a family. Public health sector can play an important role in taking the lead in advocacy and support; it can add value to epidemiology and information systems, among others.

Hospitals with trauma units should be built along major highways for quick access for post-crash victims. For example, Soba University Hospital is situated in an ideal location for victims whom sustained their injuries along the highway that connect Khartoum State to State of Gezira, Algabal Hospital, Ombadda T.Hospital, and Algaily Hospital share the advantage of their locations too, but yet, none of them can be considered as a Trauma Center. Unfortunately, in Soba University Hospital there is no Emergency Department or set-up, or even a Trauma Unit.

Road maintenance The Government under responsible ministries should make sure road signs are repaired and replaced periodically and every time when needed especially in highways and in high population areas.

The construction of new roads especially highways must consider traffic separation to harmonize all road users and facilitate traffic safety.

Development of a specialized body under the lead of either the Central Ambulance Administration, or the Civil Defense Police for rapid deployment of pre hospital service at the scene and possible integration with traffic police department.

The awareness should be raised regarding insurance and its benefits, and as the current bottom level is the 3rd party Insurance, Total Coverage type of insurance need to be encouraged, and the cost-effectiveness of it have to be well addressed to drivers and owners of vehicles.

Use of all available broadcasting technologies, the classic and modern, papers and Media to create greater levels of awareness, commitment and informed decision making at all levels government, industry, international agencies and nongovernmental organizations so that strategies scientifically proven to be effective in preventing road injuries can be implemented.

To add the NISS - which is easily calculated - to the admission sheets in hospitals, as it showed to be of a great value not just in the clinical process, but even to make such studies easier to conduct.

Further studies can be made on the area of traffic accidents by considering more details and accurate information on various variables. For example, if the causes and consequences of an accident are recorded in detail instead of broad categories results could be more accurate and efficient.

To research more and more in the subject, enable to make it possible to run a Meta-Analysis, in the sake of accurately sizing the problem.

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