

Characteristics and Factors Associated With Injuries Sustained By Motorcycle Occupants Admitted To Teaching Hospital, Karapitiya, Sri Lanka from 2010 To 2014

Rathnaweera RHAI^{1*}, Gunarathna EGUN²

¹Department of Forensic Medicine, Faculty of Medicine, University of Ruhuna, Sri Lanka

²Office of the Judicial Medical Officer, Base hospital, Balapitiya, Sri Lanka

Abstract

Introduction: Motorcycle related accidents account for nearly 40% of total road traffic accidents (RTA) reported in Sri Lanka annually. The objective of this study was to investigate the characteristics of motorcycle accidents and to describe and compare injury patterns of the riders and pillion riders who are admitted to the Teaching Hospital Karapitiya,

Materials and Methods: A cross-sectional retrospective study was conducted retrospectively on motorcycle occupants admitted from 1st January 2010 to 31st December 2014.

Results: The total number of motorcycle occupants was 812 with a male to female ratio of 5.9:1. Out of that 68% were riders and the highest percentage of (39.8%) of the victims were belonging to the age group of 21-30 years. Sixty-seven percent (n=540) of the accidents were reported during the period of 06.00 hours to 18.00 hours. For both the rider (75%) and the pillion rider (56%), lower extremity was the commonest site of injury. Forty percent of the population had lower limb fractures and 15% had upper limb fractures. The commonest bone to fracture was Tibia (12%). Fifty-four percent of the riders and 52% of the pillion riders had grievous injuries.

Conclusion: The young adult males in their productive age group are the most vulnerable group. Injuries to extremities and the head and face are the frequent sites of injury. Both the riders and the pillion riders were found to have similar injury patterns and risk factors. A slightly higher risk for more severe injuries is present for riders. In order to reduce the number of accidents as well as to reduce the severity of injuries, strict enforcement of traffic laws, administration of new guidelines on protective gear and monitoring blood alcohol concentrations of all the motorcyclists admitted to hospitals following accidents are recommended.

Keywords: Motorcycle accidents, injury pattern, risk factors

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Introduction

Road traffic accidents (RTA) are a major global public health problem associated with significant morbidity and mortality rates.^[1] This problem is increasing at a fast rate all over the world and is expected to become the third most important global health issue by the end of 2020.^[1] It is estimated that, by the end of the year 2020, road traffic accidents

will be the 6th leading cause of death worldwide.^[2] According to the World Health Organization, over one million deaths and 20 to 50 million injuries are caused by road traffic accidents every year globally.^[3] Out of that, more than 75% of road traffic accidents occur in low and middle-income countries.^[3] Vulnerable road users (pedestrian, cyclist, and motorcyclist) make up around 70% of

road traffic accident deaths in the South-Asian region alone.^[3] The Sri Lankan situation is also similar. According to traffic police statistics of Sri Lanka, a significant increase in road traffic accidents was noted in the recent past. During the 2009-2015 period, the total number of road traffic accidents increased by 15% while deaths increased by 17%.^[4]

Motorcycle riding has gained wider popularity globally over the past decade. Motorcycles have become an increasingly popular mode of transportation in the United States with more than 8.1 million registrations in a single year.^[5] In Finland, motorcycle usage has constantly increased from 60 000 in 1991 to 91 000 in 2001.^[6] The use of motorcycles has grown more rapidly in Asia. Pakistan has reported a significant rise in motorcycle usage from 100,000 in use per year in 2000 to 2 million in 2019.^[7] As in most developing countries in the South-Asian region, motorcycles are one of the popular modes of transport among the Sri Lankans. Apparently, 55% out of the total registered vehicles are motorcycles with nearly 400,000 new motorcycles getting registered annually.^[8]

Motorcyclists involved in RTA tend to receive more injuries due to a lack of safety measures such as seat belts, airbags, and limb protection. Because of that, these riders are facing three times higher risk of injury than car occupants and a 16 times higher tendency to die in the event of a fall or crash.^[7] This problem is more marked in developing countries due to various reasons including overcrowded and poor-quality roads, poor traffic regulations and law enforcement, reckless driving, and substance abuse.^[9] Even in developed countries with low morbidity and mortality rates from motorcycle injuries, the risk of dying from a motorcycle accident is 20 times higher than from a motor vehicle accident.^[10,11] According to statistics from the Department of Environment, Transport, and the Regions of the United Kingdom, motorcycle riders and passengers had a casualty rate nearly fifteen times that of car occupants.^[12]

It is estimated that Motorcycle related accidents account for nearly 40% of total RTA reported in Sri Lanka annually and these figures are rising at a very rapid rate.^[13] Even with this high prevalence rate, the available literature sources regarding motorcycle accidents in Sri Lanka are minimal. The objective of this study was to identify the characteristics of motorcycle accidents and to describe and compare injury patterns of the riders and pillion riders who are admitted to the Teaching Hospital Karapitiya, Sri Lanka during the study period.

Methodology

A cross-sectional descriptive study was conducted retrospectively on motorcycle occupants admitted to Teaching Hospital Karapitiya with a history of a motorcycle accident. The victims were examined by the authors, from 1st January 2010 to 31st December 2014. As the primary source, medicolegal examination forms (MLEF) of all the subjects were used and as secondary sources, bed head tickets, imaging data, police records, and other relevant medical reports were used. The severity of the injury was determined and categorized as non-grievous, grievous, endanger the life, or fatal in the ordinary cause of nature. Patients with incomplete medical records and those who met with railway accidents were excluded from the study. The total sample size was composed of 812 motorcycle occupants which include both riders and pillion riders. A pre-coded data collection form was used to record socio-demographic data and medico-legal aspects of injuries sustained by the occupants. The data was analyzed to study the patterns of injuries and associated factors.

Informed written consent of all the patients was obtained during the clinical examination to use the collected necessary information in scientific communications. This study was carried out within the ethical standards set up by the Department of Forensic Medicine, Faculty of Medicine, University of Ruhuna.

Results

A. Age and gender

The total number of motorcycle occupants was 812 with a male to female ratio of 5.9:1 (male 85%, n=694 & female 15%, n=118). Out of that 68% (n=558) were riders and the remaining 32% (n=254) was pillion riders. Out of the motorcycle riders, 93% were males (n=522) and 7% were females (n=36) (male: female 13:1). Out of the pillion riders 68% were males (n=172) and 32% were females (n=82) (male: Female 2.1:1).

The highest percentage of (39.8%, n=323) the victims were belonging to the age group of 21-30 years, followed by 31-40 years (24.3%, n=198). The highest percentage of riders (40%) and the pillion riders (39%) were also from the age group of 21-30 years. (Figure 01). Seventy seven percent (n=432) of the riders were below the age of 40 years. The youngest victim was a 4-year-old boy and the eldest victim was an 83-year-old male. The mean age of the study sample was 28 years.

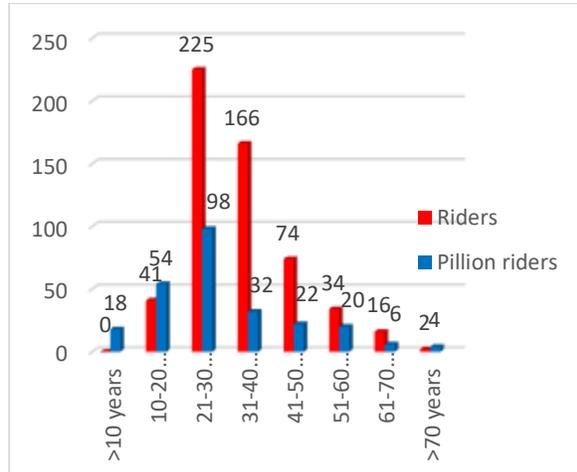


Figure 01: Age distribution of the riders and pillion riders

B. Occupation, educational background

The occupational status of motorcycle riders showed that only 7% (n=44) were professionals. Sixty-one percent (n=340) were working as unskilled (23%) or semiskilled (38%) workers. Five percent (n=29) were unemployed and 27% (n=145) were working as skilled workers. When considering the level of education of the motorcycle riders, only 23% (n=128) had studied beyond the ordinary level and out of that only 3% (n=16) had a degree.

C. Time of the incident

Most accidents were reported from April to June (35%) followed by October to December (27%) and July to September (23%). The lowest number of accidents were reported from January to March (15%). When considering the day of the week, the highest number of accidents (24%) were reported on Fridays. However, the average number of accidents for a weekday was 126 whereas, for weekends it was 89. (Figure 02).

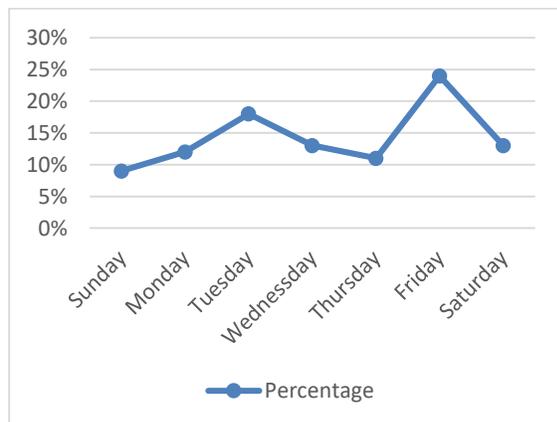


Figure 02: Day of the week of the reported accident

Sixty-seven percent (n=540) of the accidents were reported during the time from 06.00 to 18.00 hours. (Figure 03). The highest number of accidents were reported from 15.00 to 17.59 hours (30%, n=238).

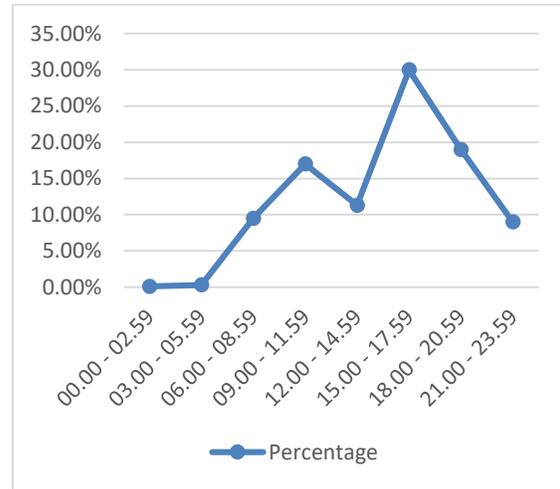


Figure 03: Time of the day of the reported accident

D. Risk factors

Three categories of associated factors were identified; environment-related, rider related, and vehicle related (Table 01). Sixty-seven percent of the accidents occurred during the daytime and the highest percentage (55%) of accidents happened on straight roads. Forty-two percent of the accidents happened on tarry roads and 65% of accidents occurred in dry weather. Risky overtake accounted for 27% of accidents followed by risky turning across the road (20%). High speed accounted for 09% of the accidents. Eleven percent of the riders were found to be under the influence of alcohol at the time of the accident and 09% haven't got a valid driving license. Nine percent of the accidents were due to worn off or punctured tires and 03% were due to defective breaking.

Table 01. Associated factors of injuries sustained by the motorcycle occupants

a. Environment-related		
Factor	Environmental factors	N=812 % (n)
Lighting condition	Day light	67 (546)
	Night with street light	22 (178)
	Night without street light	11 (88)
Road characteristics	Straight road	55 (443)
	Curve / bend	10 (81)
	Roundabout	03 (25)
	Cross junction	08 (65)
	T/Y junction /by-road	24 (198)

Road condition	Carpeted	38 (309)
	Tar	42 (341)
	Concrete	12 (97)
	Gravel	08 (65)
Weather condition	Dry	61 (495)
	Rainy	33 (268)

b. Rider related

Factor	% (n)
N=812	
High speed (>60 km/h)	09 (51)
Risky overtake	27 (148)
Risky turning across the road	20 (110)
Risky entering into the road	18 (98)
Turn without signal	12 (68)
Under influence of alcohol/drugs	11 (64)
Not having a valid driving license	09 (48)

c. Vehicle related

Factor	% (n)
N=812	
Defective breaking	03 (17)
Punctured / worn off tires	09 (48)
Mechanical problems	02 (11)

Eighty-eight percent (n=494) of the riders and 79% (n=201) of pillion riders were found to be wearing a helmet at the time of the accident. When considering the number of occupants at the time of the collision, only the rider was present in 25% (n=207) of the time whereas in 73% (n=591) of the time, there were two occupants. In 02% (n=14) of the time, there were more than two occupants.

E. Type of crash

The most common type of accident was collision with another motor vehicle (37%) followed by crash with another motorcycle (25%). The most common motor vehicle collision was with three-wheelers (14%). (Table 02).

Table 02. Type of accident met with by the motorcycle occupants

Accidental fall	20 (166)
Collision with an object	07 (60)
Collision with an animal	05 (42)
Collision with a pedestrian	03 (26)
Collision with a three-wheeler	14 (112)
Collision with another motor cycle	25 (204)
Collision with a car / van / jeep	12 (98)
Collision with a bus / lorry / truck	11 (92)
Collision with a foot cycle	02 (14)

Out of the total collisions with motor vehicles (n=506), 45% (n=228) were side-on collisions followed by head-on (39%, n=147) and rear end (15%, n=76) collisions. There were 05 (1%) tail gaiting accidents also.

F. Injury pattern

For both the rider (75%) and the pillion rider (56%), the lower extremity was the commonest site of injury (Figure 04). This was followed by upper extremity (61%) and head and face (52%) for riders and head and face (36%) and upper extremity (33%) for pillion riders. Injuries over multiple body regions were observed in 74% of the riders and 77% of the pillion riders. Abrasion was the commonest type of injury for both the rider (73%) and the pillion rider (52%) (Figure 05).

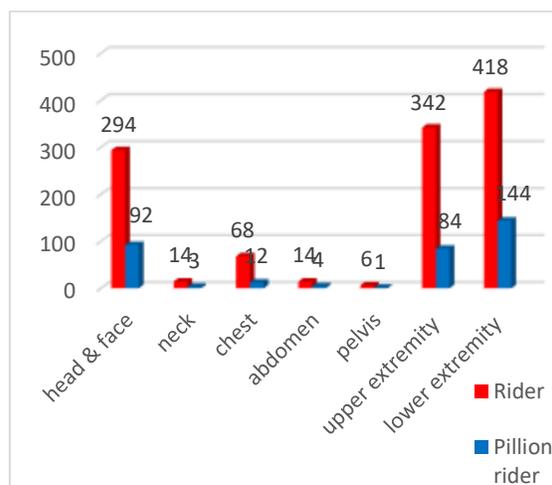


Figure 04. Site of injury of the motorcycle occupants

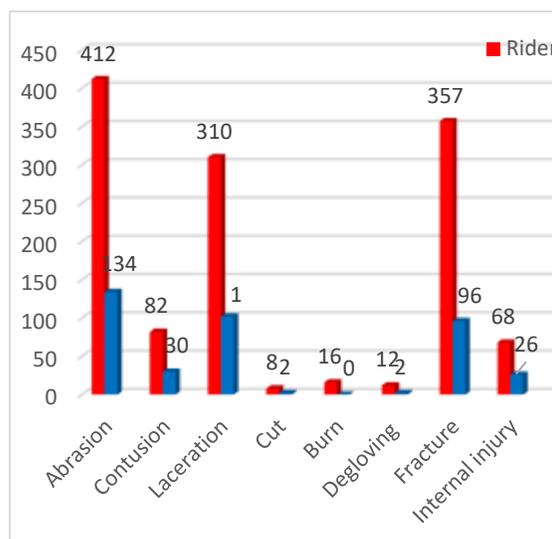


Figure 05. Type of injury of the motor cycle occupants

Fifty-six percent of the population had fractures and out of that lower limb fractures were the commonest (40%), followed by upper limb fractures (15%) (Figure 06). The commonest bone fractured was the tibia (12%). Fractures of the tibia (11.4%) and fibula (11%) were the commonest type of fractures for the riders followed by facial (9.3%) and radial (8.6%) fractures. For the pillion riders' tibial fracture (12.5%) was the commonest followed by the fractures of femur (7.5%) and the fibula (07%).

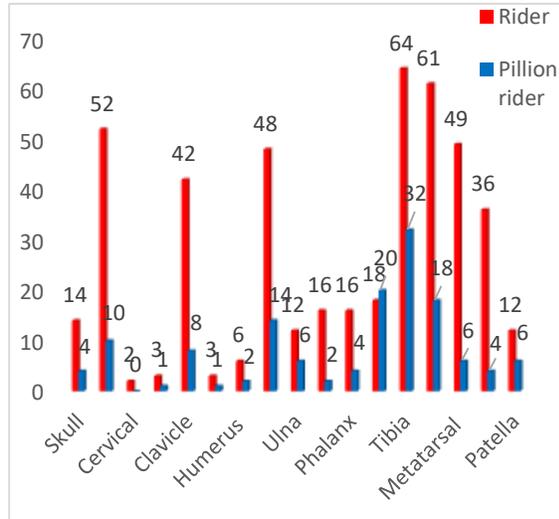


Figure 06 - Type of bones fractured

Only 4.3% (n=35) of the population had internal injuries and out of that, the riders (5.1%) had a slightly higher number in comparison to pillion riders (2.3%). The intracranial injury was the commonest internal injury among both the riders (4.3%) and the pillion riders (2.3%). None of the pillion riders had intra-abdominal or internal chest injuries whereas for the riders, 0.5% had internal chest injuries and 0.3% had intra-abdominal injuries.

Fifty-four percent of the riders and 52% of the pillion riders had grievous injuries. Five percent of the riders and 2.3% of pillion riders had endangering life type of injuries (Figure 07).

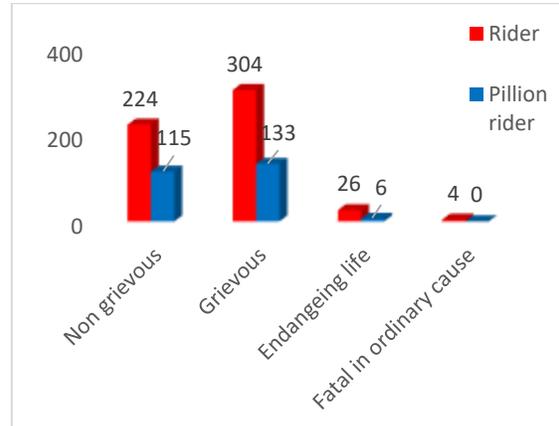


Figure 07 - Category of hurt of the motor cycle occupants

Discussion

In Malaysia approximately 35-40% of all RTA involve motorcyclists, and 50-60% of deaths due to motor vehicle accidents involve motorcyclists.^[14] Similar rates are observed in Singapore.^[15] Motorcyclists account for about 5 % of all injured patients in Finland.^[6] According to Indian statistics, about 20% of deaths in RTA are due to motorcycle crashes.^[2] In recent years, there has been a significant increase in the number of motorcycle collisions in Sri Lanka in parallel with increasing popularity of motorcycles as a method of transport. This has resulted in an increasing number of casualty admissions to hospitals with an increased the burden on the health sector. However, despite this burden, the responses to this problem by the authorities is very minimal, probably because of the lack of local data.

In this study, the overall male to the female ratio observed was 5.9:1. However, it was 13:1 for the riders and 2.1:1 for the pillion riders. Some of the studies done in other countries have shown similar figures however, some other studies have shown higher and lower figures too. In a study done in Turkey, the reported male: female ratio was as high as 25:1.^[16] In studies done in Pakistan, Egypt, and England, the observed ratio was 9:1.^[7,9,12] Lower ratios were observed in studies done in Cameroon (1.09:1) Nigeria (3.9:1), and Tanzania (2.3:1).^[17,18,10] In a study done in Karachi, the observed ratio was 5.7:1, which is much similar to the overall ratio observed in this study. Even though the ratios are high for motorcycle riders in our country, it is very low for the pillion riders. Many people are choosing a motorcycle as a family vehicle because of the low cost and easy maintenance. This has resulted in an increased number of female motorcycle occupants as well as an increased number of female victims following motorcycle crashes.

According to the literature, the typical age group for motorcycle accidents is between 20 to 40 years.^[20,21,22,23] In studies done in India and Malaysia, the highest percentage (40%) of motorcycle accidents were reported from the age group of 21-30 years.^[2,19] Mean age of the victims of motorcycle accidents was 25.6 years in Finland and 36 years in Turkey.^[6,16] According to a study done in Kurunegala, Sri Lanka, the commonest age group of motorcycle victims was 21-30 years (32.5%) followed by 31-40 years (31.1%).^[4] Similar observations were made during this study with the highest percentage of 39.8% of the victims were from the age group of 21-30 years, followed by 31-40 years (24.3%). According to a study done in Nigeria, 70% of the riders were less than 40 years of age.^[18] Similar percentages were observed in this study too. However, 28% of the pillion riders in this study were less than 20 years. In comparison, in other studies, only 10.37% and 5.9% of the victims were found to be below 20 years.^[2,4] This high percentage observed in this study could mainly be due to the fact of parents of school children using the motorcycle as their preferred transport method, which is quick and ideal for narrow Sri Lankan roads in traffic situations. Most of these victims were on their way to school or private classes at the time of the accident.

Of the motorcycle riders, only 23% had studied beyond the ordinary level and only 6.5% were professionals. According to literature, riders of low socioeconomic states face accidents 2.5 times more than the others.^[16] This could be due to two reasons; either those who are well educated and have better jobs use other safer modes of transport or when they are using a motorcycle, they follow road rules and take precautions to prevent accidents. Moreover, drug and alcohol abuse is higher in lower socioeconomic groups, which increases the possibility of accidents.^[16] However, a more detailed study in this aspect is needed in the future to come to more broad-based conclusions.

When considering the day of the week, most studies revealed a higher percentage of accidents happening on weekends when compared to weekdays.^[7,14,17] However, in this study the highest percentages were reported during the weekdays. This could be due to the fact that in our country, most people use motorcycles to go to work on weekdays and the roads are busier during these periods. In comparison, on weekends the roads are less busy and the number of people on motorcycles also less resulting in a lesser number of accidents. Several studies have reported seasonal trends associated with motorcycle

accidents. According to available literature, rates are higher in summertime when compared to the winter season.^[7,14,24] In this study, the highest number of cases were reported from April to June (35%) followed by the period of October to December (27%). As April and December are widely recognized as festive months with a lot of cultural events, the traffic situation is far worse during these periods. The increased number of vehicles in narrow Sri Lankan roads could well be the reason for this peak in the number of accidents during these times of the year.

According to available literature, most of the motorcycle crashes happens in the day time though some studies suggest otherwise. In a study done in Cameroon, 63.7% of motorcycle crashes were reported during the night time (6.00 pm to 6.00 am).^[17] However, according to crash statistics of the National Highway Traffic Safety Administration, the majority of fatal motorcycle accidents occur between the hours of 3.00 pm and Midnight.^[24,25] The risk for accidents is more than the double between the hours of 3.00 pm and 9.00 pm.^[24] In a study done in Karachi, 37% of the accidents were reported during the time period of 01.00 pm to 6.00 pm.^[14] In another study done in Pakistan, 36.6% of the motorcycle accidents were reported during the period of 12.00 noon to 06.00 pm.^[7] Similar findings were observed in this study. Sixty-seven percent of the motorcycle accidents occurred during the day time (06.00 am to 06.00 pm) and the highest percentage (30%) of accidents occurred during the period of 3.00 pm to 6.00 pm. This period is known for the high level of traffic congestions as well as increased human activities due to workers leaving their work stations. These rush hours therefore can be very risky for motorcyclists. There was another minor peak during the hours of 09.00 am to 12.00 noon, which is difficult to explain. This could be the time where most of the workers who are late rushing at the roads facing accidents. A detailed analysis is needed to explore the real situation.

The underlying causes for motorcycle accidents are multifactorial and a special emphasis is needed to be given on this. Out of all the causes, human error is probably the most common reason for the majority of accidents. [26] For motorcycle occupants, the exposure and subsequent absorption of the kinetic energy from their whole-body following trauma make them extremely vulnerable to injuries. [26] Speeding makes them more prone to get injured. According to available literature, the greatest number of reported motorcycle crashes occurs at speeds of 50 – 60 km/h (6,26). At greater speeds, riders have less time to react and have less control of

the vehicle with the need for longer distances to stop. [19] In this study, only 9% of the riders admitted high speeds in excess of 60 km/h. However, the reliability of this given speed is questionable as there was no way of accurately tracing this. Risky overtake, risky turning across the road and risky entering into main roads were the main identified human errors in this study. On busy roads, these errors can be fatal with the resultant loss of many lives. Driving under the influence of alcohol is another well-identified risk factor for motorcycle crashes. [28] Alcohol consumption can cause carelessness, loss of concentration, and high speeding with the resultant fatal accident. [29] Studies have shown that around 9% of motorcycle riders were found to have taken alcohol within 6 hours before the collision. [17] In this study, the percentage of the riders who were found to have consumed alcohol was 11%. The diagnosis of alcohol consumption was based mainly on the clinical signs present on admission to the hospital. The accuracy of such methods is questionable as many cases can get underreported. Better accuracy can be achieved with the usage of modern non-invasive devices in future studies. Usage of protective equipment is another important factor in the prevention of injuries in motorcycle accidents. The available protective equipment includes helmets, gloves, boots, and protective clothing. Usage of a helmet ranges from 6.5% to 67% in motorcycle occupants.[2,7,10,26] In this study 85% of the occupants were found to be wearing a helmet at the time of the accident. This probably reflects the compliance of safety helmet usage among the motorcyclists in Sri Lanka. However, none of the riders were wearing gloves or protective boots. Having a valid driving license is another important factor analyzed. In this study, it was interesting to note that, 91% of the riders who met with collisions had a valid driving license. Probably the other errors of the riders such as speeding and careless overtaking are more predisposing to accidents than a valid license. According to Norghani et al, young riders, in general, have poor attitudes towards road safety and obeying the road traffic law. [30] As the majority of the riders found in this study were young males, this also could be true in most instances. With regard to the crash circumstance, around 65% of the crashes occurred at straight or curved roads (non-junction sites). This could be due to the higher speeds of the motorcycles on straight roads than at junctions. Especially in busy and narrow roads of Sri Lanka, high speeding could be very risky irrespective of the road condition. In this study, the majority of the motorcycle crashes (61%) occurred in clear weather conditions. This again could be due to the associated high speeding in dry weather

conditions. Thirty-one percent of the accidents occurred in rainy weather was mainly due to slippery road conditions and poor light.

In the present study, a collision between a motorcycle and other motor vehicles was the most common type of accident (37%), followed by crashes against other motorcycles (25%) and slip and fall (20%). Collision against pedestrians was only 03% out of total accidents. In a study done in Tanzania, the commonest type of collision was motorcycle against another motor vehicle (52%) followed by collision against pedestrians (26%).^[10] Crash against motorcycles accounted for only 4.7%. Similar observations were made in other studies as well.[18,30,31] Out of the motor vehicle crashes, collision against the motor car was the commonest in many studies.^[7,26] However, in the present study, a three-wheeler was the commonest motor vehicle responsible for collisions. The higher percentage of motorcycle-motorcycle and motorcycle-three-wheeler collisions reported in this study is a special situation in comparison to other studies. This could be due to the increased use of such vehicles in Sri Lanka compared to developed countries. The Low percentage of pedestrian accidents could be due to the fact of availability of more pedestrian paths and pedestrian crossings. When considering the collision type, side-on collision was the commonest type observed in this study followed by head-on collisions. Similar observations were made in other studies as well.^[2,19]

Motorcycle accidents continue to be a source of severe injuries. In this study, 69% of the motorcycle occupants had injuries to their lower extremities followed by upper extremities (52%) and head & face (47%). Both the riders and the pillion riders were found to have an almost similar type of injury patterns. According to available literature, similar patterns were observed in many studies, though with lesser frequencies.^[6,7,17,26,32] The high rate of involvement of extremities and the cephalic region observed in this study most probably due to the lack of or poor quality of protective gears used by the motorcyclist in this country. The other possibility is the extreme speeds of the motorcyclists causing injuries to multiple regions of the body after the primary impact. Abrasion (67%) was the commonest type of injury observed in this study followed by fractures (56%) and lacerations (50%). Both the riders and the pillion riders were found to have almost similar type of injury types. Abrasion was the commonest type of injury observed in other studies as well. [2,17,26] However, contusions were also observed frequently in other studies.^[26] The lower occurrence of contusions in this study could be

mainly due to the difficulty in observing contusions in dark-skinned patients. In two of the studies, the observed frequency of fractures was 22.9% and 15.8% respectively.^[17,26] In comparison, a very high percentage of fractures was observed in this study. This could again be due to the high-speed riding as well as lack of or poor-quality protective gear worn by the motorcycle occupants. Long bone fractures are a common occurrence in motorcycle accidents.^[33,34,35] In this study, the lower limb fractures (40%) were found to be commoner than upper limb fractures (15%) and out of all the fractures, tibial fracture (12%) was the most frequent fracture. Similar observations were made in other studies as well.^[7,13,14,17] In comparison, riders and the pillion riders both had a higher percentage of lower limb fractures (43% & 38%) in comparison to upper limb fractures (17% & 11%). Riders had a slightly higher tendency to have both lower and upper limb fractures than the pillion riders. Intracranial injuries were the most frequent internal injury type observed in many previous studies. In a study conducted by Fouda et al, 44.3% of the sample had combined intracranial lesions.^[9] In another study conducted by Alicioglu et al intracranial lesions were observed in 48.5% of the cases.^[16] In this study also the intracranial lesions were the most frequent internal injury type, however, the observed frequency was low (5.1%) in comparison to the other studies. Intra-abdominal and chest injuries were observed in lesser frequencies in previous studies. In a study conducted by Fouda et al, 9% of the population had variable chest injuries and 9.5% had intra-abdominal injuries.^[9] Alicioglu et al had observed chest injuries in 7.1% of the population and intra-abdominal injuries in 2.8% of the population.^[16] In this study, the intra-abdominal (0.3%) and chest (0.5%) injury frequencies were low in comparison to previous studies. One of the reasons for this low percentage of internal injuries observed in this study could be due to the fact of many who had severe internal injuries may have passed away without getting admitted to the Emergency Department. In this study, both the rider and the pillion rider had a very similar percentage of serious injuries. Even though minimal, riders had a slightly higher tendency to have serious injuries than the pillion rider. This is in accordance with some of the studies done in other countries.^[36,37]

In this study, the analyzed group of patients was selected from a single tertiary care hospital. Because of that, the results may not represent the situation in other parts of the country. The accuracy of some of the facts obtained from the patients may not be reliable. However, despite these limitations, the findings of this study will hopefully help prevention and intervention strategies in the near future.

Conclusion

The young adult males in their productive age group are the most vulnerable group for such accidents. Injuries to extremities and the head and face are the frequent sites affected predisposing these patients to prolonged hospitalization and morbidity, greatly affecting many families in the long run. Both the riders and the pillion riders were found to have similar injury patterns and risk factors. A slightly higher risk for more severe injuries is present for riders. In order to reduce the number of accidents as well as to reduce the severity of injuries, the following recommendations are made: (i). Strict enforcement of traffic laws and regulations with a 24-hour surveillance system to monitor motor-vehicle activities, (ii) Administration of new guidelines on protective gear, including reinforced footwear and leg protection, (iii) Monitoring blood alcohol concentrations, using non-invasive techniques, of all the motorcyclists admitted to hospitals following accidents.

Disclosure statement

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Competing Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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