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A State-Wide Analysis of Pre-Hospital Injuries and Fatalities Resulting From Motorcycle Road Traffic Accidents in Queensland

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Abstract

The present study aimed to examine the prevalence and characteristics of pre-hospital injuries and fatalities involving motorcycle riders in Queensland. A retrospective analysis was undertaken of all motorcycle road traffic crashes that were attended by the Queensland Ambulance Service (QAS) over a five year period (1999-2003). A total of 6145 motorcycle-related incidents were recorded by the QAS during the study period, of which 113 incidents involved a deceased rider. Importantly, there was a 34% increase in the total number of motorcycle injury-related cases over the 5 year period, as well as an increase in the number of pre-hospital deaths. A further comparative analysis revealed some level of disparity between QAS data and corresponding official motorcycle injury records that are predominantly utilised to inform motorcycle policy. The reasons for this discrepancy and the implications of the findings will be further examined in the paper.

Keywords: *motorcycle, pre-hospital, injury, fatalities.*

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INTRODUCTION

The Present Context

Road Traffic Crashes (RTC) are a major source of injury worldwide, and are expected to become the third leading cause of death and disability by 2020 (WHO, 2004). In Australia, traffic accidents are responsible for a substantial number of deaths and injuries each year, with the resultant loss of life and functioning representing a significant economic and social cost in terms of productive life-years lost, medical and rehabilitative expenses, and ensuing legal compensation claims.

One group of road-users who are disproportionately represented in crash statistics are motorcycle riders. For instance in 2002, Australian road traffic crash statistics recorded a rate of 6.3 motorcyclist deaths per 10,000 registered motorcycles, which compares poorly to a comparatively much lower rate for motor vehicles of 1.2 motorist deaths per 10,000 registered vehicles (AAA, 2003). This figure represents a more than 5 times greater risk of death associated with motorcycles as compared to motor vehicles. A further concern is that Australia's motorcyclist fatality rates compare poorly with other OECD nations, which record on average 5.1 motorcycle-related deaths per 10,000 (ATSB, 2002). Furthermore, given the high risk of fatality associated with motorcycles, it is of concern that national and international data trends indicate a significant increase in motorcycle-related deaths in more recent times (ATSB, 2002; Queensland Transport, 2002).

In addition to the familial impact of deaths, motor accident insurance claim records provide a proxy measure of the extent of financial burden that motorcycle-related injuries present to the community. The NSW Motor Accidents Authority report on Third Party Insurance claims indicates that the average and median costs for motorcycle rider and passenger injury claims are higher than for any other road user type (MAA, 2001). The combined effect of the disproportionate representation of motorcyclists in road traffic crashes, along with the costly nature of the resultant injuries, reinforces this issue as one of significant economic and social impact for communities.

Official Queensland road accident statistics show a similar pattern of motorcyclist overrepresentation to the national statistics, with motorcycles being involved in 12% of all fatal crashes, but comprising only 3% of total vehicle registrations within the state (Queensland Transport, 2003). In 2002, there were 7.3 fatalities per 10,000 registered motorcycles compared to 1.3 fatalities per 10,000 motor vehicles (Queensland Transport, 2003). In 2003, there was also a 6% increase in millions hospitalised due to motorcycle crashes (Queensland Transport, 2003).

Underreporting of Incidences

It should be noted that caution must be observed when comparing official crash statistics from 2001 onwards with previous years. Since 1991 Queensland Transport has been responsible for producing the official road traffic crash statistics for Queensland. The data for these reports is derived from Queensland Police Service Traffic Incident Report System (TIRS) as well as coroner's reports and other sources. Prior to October 2000, a motor accident insurance claimant in a road crash involving an injury was not required

under the *Motor Accident Insurance Act (MAIA) 1994* to report the crash to police. In October 2000, an amendment was passed to the Act in order to change reporting requirements in line with the *Transport Operations (Road Use Management – Road Rules) Regulation 1999*, requiring that all motor vehicle accidents involving injury be reported to the police. As a result, there was a significant increase in the number of reported crashes in the categories of minor injury, medical treatment and hospitalised from 2001 onwards, making comparison of official crash statistics prior to and following this date potentially misleading (Queensland Transport, 2001).

Whilst official counts of the number of motorcyclists killed or hospitalised each year are already substantial, it is suggested that they are likely to be underestimating the true incidence of injury resulting from motorcycle accidents. For instance, official road traffic crashes (RTC) statistics in Australia are primarily compiled from the details of police and coroner reported crashes, and thus exclude emergency department presentations by motorists themselves or others, such as self-administration to hospital. For example, research indicates that many traffic-related injuries are never reported to the police (Aptel et al., 1999; Rosman & Knuiman, 1994). Most studies investigating the level of reporting to police of fatal injuries show rates of between 85-100% (Aptel et al., 1999), however reporting rates for injuries resulting in hospitalisation appear to be far lower (Alsop & Langley, 2001). For example, a Western Australian study found that despite local laws requiring that all RTCs involving injury be reported, overall only 54% of hospital admission cases had a matching police report (Rosman, 2001). Importantly, the study also noted that the level of reporting to the police decreased with a decrease in the severity of injuries. The likely magnitude of underreporting of RTC-related injuries is particularly concerning with regards to motorcycles, as this group have been identified as having a particularly low reporting rate when compared to accidents involving other motor transport types (Alsop and Langley, 2001; Diamantopoulou et al., 1997). These inherent problems in police sourced data result not only in the total incidence of injuries being underrepresented in official statistics, but also the profile of severity of injury being heavily skewed to the more severe end of the spectrum. Taken together, a need remains for comprehensive and reliable research injury data to inform and improve prevention activities. This cannot be effectively achieved by only examining a subset of all injury cases, so it is essential to shift the focus from looking only at fatal or serious injuries to include all injuries of all severities.

As a result, an improved data collection process maybe needed in order to obtain more accurate and reliable state-wide data on the incidence and severity of injuries resulting from motorcycle-related accidents in Queensland, Australia. It is the contention of this paper that by using data routinely collected by the Queensland Ambulance Service regarding persons treated for injury following involvement in a motorcycle accident, the QAS is in a unique position to provide a valuable adjunct to existing data sources. Ambulance data is available for all levels of severity of cases treated, and can thereby facilitate a more accurate representation of the true scope and nature of motorcycle-related injuries. The examination of case details, such as injury severity and the timing of death, will allow conclusions to be drawn regarding the potential for improved pre-hospital

treatment to result in increased survival. As a result, this current study aims to examine QAS databases to identify the incidents and characteristics of motorcycle-related accidents in order to help inform injury prevention and mitigation strategies. The study has three main aims which are:

- a) Determine the number of injuries and pre-hospital fatalities resulting from road traffic crashes involving motorcycles in Queensland attended by the QAS for the period 1999-2003;
- b) Examine the characteristics of these injuries and fatalities in order to identify potential risk factors for the targeting of road safety initiatives; and
- c) Investigate whether differences exist between QAS motorcycle injury data and official incident databases.

METHOD

This study is a population based, retrospective analysis of all Road Traffic Crashes (RTC) involving a motorcycle that were attended by Queensland Ambulance Service (QAS) over a five-year period (1 January 1999 - 31 December 2003). The data was retrieved from QAS Ambulance Integrated Management System (AIMS), which records data collected via a standardised Ambulance Report Form (ARF) that is completed by attending Paramedics for each ambulance response in Queensland. Details are routinely collected concerning the patient's demographic profile, clinical treatment details and other case specific information. AIMS was interrogated for all cases of RTC involving a motorcycle, that were attended by QAS between 1 January 1999 and 31 December 2003. Cases were excluded where the patient was a Pedestrian struck by a motorcycle but the data did include pillions.

RESULTS

Incidence of Motorcycle Injuries and Fatalities

The first aim of the study was to identify the total number of motorcyclists injured during the study period and determine whether fluctuations were evident during this time period. As shown in Table 1, the QAS recorded a total of 6145 cases of motorcycle-related road traffic injuries attended between 1 Jan 1999 and 31 Dec 2003. In 91% of cases treated, the patient was the rider/driver of the motorcycle. A helmet was worn at the time of the incident in 83% of cases, and 58% of patients were ejected from the motorcycle at the time of the accident. More specifically, 113 (1.8%) were deceased prior to reaching hospital. Over the study period, there was a 34% increase in the total number of motorcycle injury-related cases between 1999 and 2003 ($\chi^2(4) = 130.4$, $p < .001$). In addition, the number of cases of pre-hospital deaths increased significantly across the time period ($\chi^2(4) = 10.27$, $p < .05$), with the highest rate recorded in 2002.

INSERT TABLE ONE HERE

Characteristics: Gender and Age Distribution

The vast majority of all persons treated were male (82.1%), as only 813 of the 6145 patients were female (17.9%). A significant difference was identified between males and females on age of riders, as females were on average two years older (33.7 vs 31.4 yrs) than males [$t(2) = 53.53$; $p < .001$]. However, given the relatively small age gap, this difference is unlikely to be of any clinical importance. Additionally, there was a significant effect of gender on rider status, with only 3.2% of male patients being the passenger on a motorcycle, compared to 33.2% of female patients attended ($\chi^2(6) = 932.09$, $p < .001$).

Chi-square tests revealed a significant effect in the age distribution of motorcyclists, with the vast majority (74%) of all cases involving persons 39 years of age and under ($\chi^2(6) = 3481$, $p < .001$). Figure 1 displays the age distribution of all patients analysed by 10-year age categories. Firstly, the greatest proportion of individuals injured in motorcycle accidents were between the ages of 20 to 29. However, when cases were split into two groups by age (≤ 39 years and ≥ 40 years), a statistically significant trend was evidenced across the five year period, with accidents in the ≤ 39 years group increasing by 24.5% compared to a much greater increase of 66.2% in the ≥ 40 years age category ($\chi^2(4) = 11.09$; $p < .05$). When the overall increase in the rate of injuries is taken into account, this represents a proportional decrease of 5.4% in the ≤ 39 years age group (e.g., 77.6% in 1999; 72.2% in 2003), whilst the proportion of cases in the ≥ 40 years of age increased from 22.4% in 1999 to 27.8% in 2003.

INSERT FIGURE ONE HERE

Time and Day of Injury

An examination of time and day of injuries revealed there was a significant overrepresentation of weekend days in the accident data ($\chi^2(6) = 285$, $p < .001$). For example, 37% ($n = 2310$) of all injuries occurred on either a Saturday or Sunday, equating to a proportional 31% overrepresentation of weekend days compared to week days. Whilst, the peak time of day for accidents amongst all age groups was between 1pm-6pm, with 49.4% of incidents occurring during this period, there was a further significant effect evident between time of day of the incident and age of the patient ($\chi^2(18) = 123.38$, $p < .001$). The proportion of accidents occurring in the morning hours (7am-12pm) increased with increasing age, whilst the proportion of accidents at night (7pm-12am) decreased with increased age (Figure 2).

INSERT FIGURE TWO HERE

Injury Profile

According to the Patient Status code which details patient case severity on route to hospital, 1.6% of patients were deceased, whilst 17.9% of patients were grossly unstable

or had potentially life-threatening injuries. Comparatively, 68% of injuries treated were not classed as being of an immediately life threatening nature. The non-critical nature of the majority of cases of motorcycle-related injury is corroborated by the recorded Glasgow Coma Scores (GCS) for the cases analysed. The vast majority of patients (93%) were fully alert with a GCS score between 13 and 15.

Location

In regards to location of injuries, multiple/general injuries were recorded as the primary injury site in 38.8% of cases, followed by Lower limbs (23.0%) and Upper limbs (12.8%) as the next most predominant injury locations. The Head and Neck (9.7%), Chest (5.7%), Spine (3.7%) and Abdomen/Pelvis (3.7%) were the least common locations for primary injuries. A secondary injury location was recorded for 1105 patients, and of these cases, Lower limbs (27.3%), Multiple/General (24.5%) and Upper limbs (22.7%) were again the most commonly recorded injury sites.

When examining the pre-hospital fatality cases separately, 65% (n = 74) of all pre-hospital fatalities were recorded as being Dead On Arrival of the ambulance service. A further 15 patients died at the scene of the incident. The most predominant body locations of injuries in these cases were Multiple/General (75.2%) and Head/Neck (17.7%) regions. There was no significant age effect (≤ 39 years vs ≥ 40 years) on the proportion of fatal cases ($\chi^2(1) = .24, p > .05$).

Incidence Rates

The third aim of the study was to investigate whether a disparity exists between QAS motorcycle injury data and official incident databases. An investigation into official statistics of the number of motorcycle-related injuries in Queensland were also available for the period 1999-2002 (Queensland Transport, 2006), and a total of 4384 injuries were recorded in Queensland. For the same period, QAS recorded attendance at 4711 motorcycle-related injury cases, which equates to a 7.5% increase in the total number of injury cases captured using ambulance records compared to Queensland Transport data.

DISCUSSION

This study aimed to investigate the state-wide incidence of pre-hospital injuries and fatalities resulting from motor-cycle accidents in Queensland. In addition, the study endeavoured to identify the demographic characteristics of individuals most likely to be involved in such accidents and explore whether disparities may exist between QAS data and official statistical databases utilised to influence policy.

Firstly, in regards to the prevalence of accidents, the QAS recorded a total of 6145 cases of motorcycle-related injuries attended between 1 Jan 1999 and 31 Dec 2003. In 91% of cases treated, the patient was the rider/driver of the motorcycle. An examination of accidents by gender revealed that the predominance of male involvement in motorcycle crashes (82%) is consistent with worldwide findings (Roudsari, Sharzei & Zargar, 2001).

An interesting aspect from a public health perspective was the prevalence of females as motorcycle passengers, with women being passengers on a motorcycle at a rate of 10:1 with men. The gender difference suggests that whilst public campaigns regarding riding safety should be aimed primarily at males, countermeasures to increase pillion safety should target females to have a practical impact for the safety of passengers (Christie & Harrison, 2001).

In regards to age, persons aged 39 years and younger in the current study were overrepresented within the injury database, as this group accounted for 74% of all cases. This phenomenon is well documented both nationally and internationally with respect to motorcycle-related accidents, as individuals fatally injured in motorcycle crashes tend to be younger (Haworth et al., 1997; Krige, 1995). However, a significant trend was also identified that indicated an increasing proportion of accidents among the 40 years and older age group. Whilst the total number of injury cases increased in all age groups from 1999 to 2003, proportionally, the numbers of injuries within 40 years and older group increased by 5.4%, whilst accidents amongst the 39 years and younger group decreased proportionally. This is corroborated by data from the Australian Transport Safety Bureau (2002), which found in the decade from 1991 to 2001, fatalities among 17-25 decreased by approx 6%, whilst fatalities amongst those 40 years and over increased by 77% (ATSB, 2002). These increases may in part result from an exposure factor given the increasing number of riders over 40 years of age either commencing or recommencing motorcycling after a break of a number of years. A change in the age distribution of motorcyclists has also been identified in the United States, as fatalities in the 20-29 year old group have decreased while the 40+ age groups have increased over the past ten years (NHTSA 2003). The trend in the QAS injury data provides evidence of a continuing shift in the age profile of motorcycle-related injuries in Queensland and has direct implications for intervention and safety strategies. Many of these motorcyclists are riders returning to riding after an extended absence which may be an extension of the “empty nest” syndrome. That is, many of these motorcyclists may have previously ridden motorcycles in their earlier years, however stopped motorcycling during the child raising years, before returning to riding in the absence of dependents. Furthermore, these returning motorcyclists that may have ridden motorcycles 20 or more years ago are now returning to motorcycling with motorcycles that have advanced in technology along with the vastly different road conditions and congestion.

In regards to time, an examination into the weekly distribution of crashes revealed that weekend crashes were overrepresented in the data for all age groups. This data may once again suggest that a particular group of riders (e.g., pleasure riders), who ride on weekends rather than being regular motorcycle commuters, are at a greater risk of crash involvement. Thus, road safety initiatives that target this specific population demographic may require consideration. The most common time of day for accidents, across all age groups, was in the afternoon (1-6pm). This is perhaps a proxy measure of both exposure to motorcycling and risk, as this time period is generally the busiest time on the roads for all forms of vehicles. For example, during this time period there are not only likely to be more motorcyclists riding, but also an increase in the risk of injury due to the increased

number of other vehicles on the road. The distribution of accidents by age also serves to confirm exposure to riding as a determinant of risk of injury, as a strong effect was evidenced by age. For example, older riders (aged 40 and over) had more accidents in the morning hours (7am-12pm) than the younger age group, which may perhaps indicate that older riders tend to set out earlier in the day. Conversely, younger riders (39 years and under) were involved in a greater proportion of night-time accidents (7pm-12am) than the older riders, as again more younger riders may be more likely to be out on the roads at night.

Injury Profile

In contrast to fatalities, the majority of patients (68%) treated by QAS for motorcycle-related injuries were of a non-critical nature. The greater part of the sample were alert (93%), and only 1.8% of cases attended resulted in death prior to hospital arrival. Even accounting for the official Queensland statistic of 205 motorcycle-related fatalities for the period 1999-2003 (Queensland Transport, 2006), this equates to an approximate survival rate of 97%¹. This is a favourable result considering that internationally motorcycling has been documented to be a very high risk form of transport. Additionally, Australia's strict helmet regulations are likely to have had a significant impact upon the survival rate, with a helmet being documented as being worn at the time of the accident in 83% of cases. American research, where helmet regulations vary between states, has estimated a 20% lower mortality rate in states where motorcycle helmet wear is enforced (Branas & Knudson, 2001). This is further supported by the relatively low rate of primary injuries to the Head and Neck region (9.7%) in the QAS cases. Another notable finding was the proportion of injuries to the head and neck region was higher in the recorded fatal QAS cases (17.7%), but was not predominant, as most fatal cases also suffered multiple trauma injuries (65%).

A closer examination of the data revealed that a considerable proportion of the patients had suffered multiple/general injuries (38.8%), and upper and lower limb injuries (35.8%). This is also a common finding amongst motorcycle injury-related research (Peek et al., 1994). Third Party Insurance claims data also confirms the predominance of lower limb injuries, in association with skin injuries, amongst motorcycle riders and passengers (MAA, 2001). Importantly, limb injuries often do not lead to hospitalisation, but rather the injured person attended to presents at hospital Accident and Emergency departments, thereby not being recorded in official RTC hospitalisation statistics. Despite this, as asserted by Peek et al. (1994), and confirmed by the Motor Accidents Authority data (2001), the high rate of these injuries and potentially costly nature of treatment makes these injuries an important public health issue. This data suggests that community campaigns to promote wearing of protective clothing, particularly for upper and lower limbs, would be an effective countermeasure against such injuries (Wyatt et al., 1999). Furthermore, manufacturers should consider the need to develop, manufacture and promote user friendly protective clothing designed to not only provide protection to these

¹ It should be noted that not all fatal cases would be attended by QAS and so are not included in the total QAS cases, possibly resulting in a slight underestimation of the survival rate.

parts of the body but also be suitable for the climatic conditions experienced in states such as Queensland.

Trend Over Time

Examination of the stability of the events across time revealed that ambulance service records show a 35.7% increase in the total number of cases treated over the period 1999-2002. This finding is comparable with hospitalisation data for the same period which recorded a 40.3% increase in hospitalisations (Queensland Transport, 2006). When the increase in recorded hospitalisations resulting from motorcycle accidents is considered as a proportion of the road toll for all vehicles, the increase is in proportion with the general increase in all transport-related hospitalisations. In 1999, motorbikes represented 14% of the total road toll, and in 2002 they accounted for 17% (Queensland Transport, 2006). Thus, while there was an alarming increase in the number of motorcycle-related injuries recorded during the study period, the increase in pre-hospital cases of motorcycle-related injuries is comparable with the increase of all RTC injuries in the Queensland population.

However, in regards to fatalities, a notable finding was that there was a large and disproportionate increase from 1999 to 2003 in the number of motorcycle-related fatalities that occurred in the pre-hospital environment. Specifically, QAS recorded a 127% increase in fatalities prior to hospital, while for the same period ATSB (2006) recorded only a 2.6% increase in the total number of motorcycle-related deaths in Queensland. From this, it is recommended that ambulance service data be monitored to ascertain whether this is a statistical anomaly, indicative of a need to alter pre-hospital treatment protocols, or a true effect representative of an increase in the number of cases with unsurvivable injuries. Research performed by Wyatt et al. (1999), examining motorcycle accidents in South-East Scotland found that most deaths of motorcyclists occurred upon or shortly after impact. This suggests a limited ability for pre-hospital services to improve current survival rates, and highlights the importance of injury prevention strategies to impact upon this figure. If the increase of pre-hospital deaths evidenced in Queensland does prove in the future to correspond to an increase in the proportion of cases suffering major trauma injuries, then this phenomenon is of importance for the formulation and targeting of injury-prevention strategies.

Database Disparity

Interestingly, analysis of Queensland Ambulance Service (QAS) data concerning persons treated for motorcycle-related injuries showed that ambulance records of pre-hospital deaths accounted for 55% (113 cases) of the total 205 fatalities reported by official road crash statistics for Queensland between 1999 and 2003. The difference in number of recorded deaths between the two sources is likely to be accounted for in either coroner's cases, where the ambulance was not called to attend cases of obvious death, as well as in-hospital deaths. A greater difference was evidenced between ambulance and official reporting source accounts of total number of motorcycle-related injury cases. Official statistics of the number of hospitalisations for motorcycle-related injuries in Queensland are available for the period 1999-2002 (Queensland Transport, 2006). According to these,

a total of 4384 medically treated cases were recorded in Queensland. For the same period, QAS recorded attendance at 4711 motorcycle-related injury cases, representing a 7.5% increase in the total number of injury cases captured using ambulance records, as compared to police and hospital sourced data. These results suggest that some motorcycle injury cases are being treated by QAS and subsequently are not requiring hospitalisation either due to treatment onsite or due to sustaining injuries that upon presenting at hospital are not serious enough to require hospitalisation.

Whilst minor injuries resulting from motorcycle accidents are often not comprehensively analysed, their impact upon the health system and community should not be ignored. These minor injuries still consume healthcare resources in regards to treatment in pre-hospital setting or hospital Accident & Emergency departments. Additionally, such incidents impact upon productivity in terms of absence from work. For example, a study by McClure and Douglas (1996), suggests that the magnitude of impact that minor non-hospitalised injuries have over a lifetime is greater in terms of Quality Adjusted Life Years (QALYs) than for injuries resulting in death or hospitalisation. From a public health perspective, minor injuries are an important group of interest for injury prevention and health promotion strategies.

Some limitations of the study were identified. The data presented in the current study is over six years old, however more recent statistics also indicate a similar level of motorcycle injury rates. The study also required ambulance officers to (at times) make decisions and record data within high stress situations, and thus some level of measurement error may exist within the database. However given the large number of cases within the data set, it is unlikely that the number of errors in data recording account for the anomaly between QAS and other data sources.

Despite such limitations, this study provides strong evidence for the value of using ambulance service data as a useful adjunct to traditional data sources for road traffic crash statistics. The inclusion of pre-hospital data serves to provide a more accurate data set that captures and profiles the full extent of injuries resulting from motorcycle-related accidents. This additional detail is useful in estimating the true economic and social impact of motor cycle-related injuries, and is vital to inform the design and targeting of effective injury prevention strategies. Additionally, the value of supplementing police and hospital sourced records with ambulance service data is equally applicable for monitoring all forms of transport-related accidents thus providing a more accurate indication of the injuries sustained from all crashes requiring medical treatment within the road user community.

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Table 1. *Number of motorcyclists attended by QAS and number of pre-hospital deaths as a result of motorcycle accidents: 1999-2003*

Year	Frequency	Pre-hospital Deaths
1999	1071	11
2000	1037	16
2001	1150	22
2002	1453	39
2003	1434	25
Total	6145	113

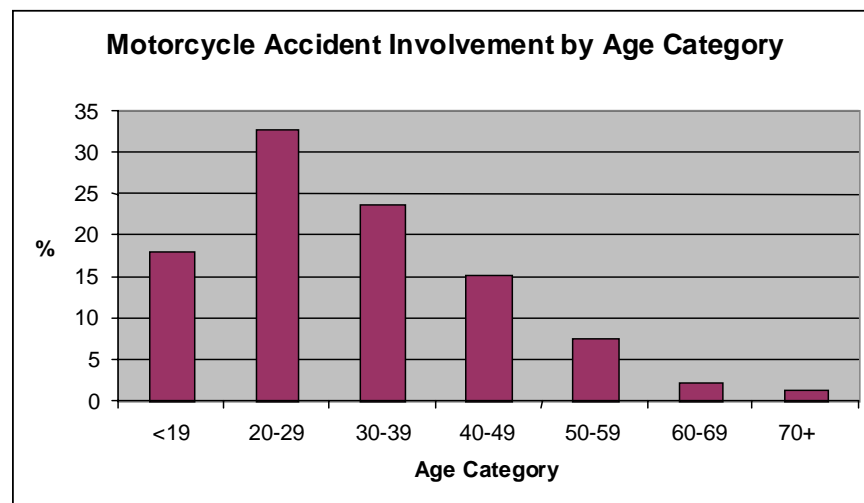


Figure 1. Patient age distribution by 10-year age category

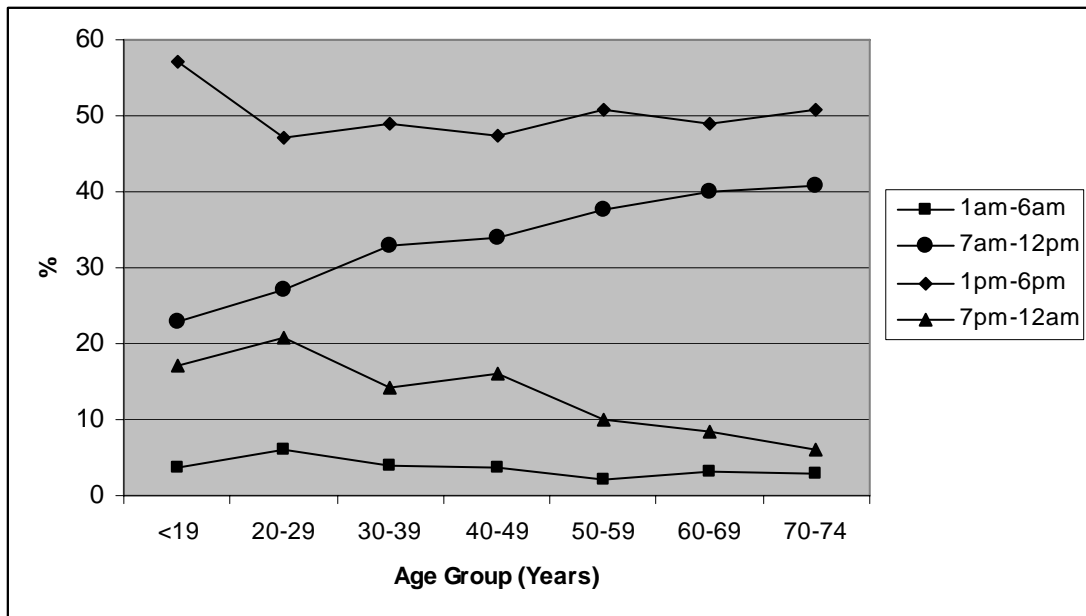


Figure 2. Relationship between time of day of the incident and age of the rider.