

# Young Adults and Riding Position: Factors that Affect Mortality Among Inpatient Adult Motorcycle Casualties: A Major Trauma Center Experience

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## Abstract

**Background** In Singapore, road traffic accidents (RTAs) are the second most common cause of deaths in trauma. Motorcycle casualties account for 54% of all fatalities. Studies have shown that the mean age of motorcycle casualties is significantly younger than that of other RTA victims. **Methods** We reviewed the mortality of all motorcycle casualties  $\geq 16$  years admitted to an acute hospital as emergencies from January 2004 to December 2006. To determine the impact of age on mortality, we divided our patients into two groups, one  $\leq 21$  years (younger group) and another  $> 21$  years (older group). A subset analysis based on riding position (driver versus passenger) was performed to determine the inpatient mortality rate in these two groups.

**Results** There were 96 (14%) patients in the younger group and 586 (86%) patients in the older group. The mortality rate for younger motorcycle casualties was significantly higher (14.6% versus 8%;  $p = 0.04$ ). Also, there were significantly more passengers in the younger group (25% versus 8.4%;  $p = 0.0001$ ). The mortality rate among young passengers was significantly higher than that among young drivers (29.2% versus 9.7%;  $p = 0.019$ ). Likewise, the mortality rate of the young passengers was also significantly higher than that among older passengers (29.2% versus 10.2%;  $p = 0.04$ ).

**Conclusions** Young motorcycle casualties have a significantly higher mortality rate than older motorcycle casualties. Young passengers have the highest mortality

rate and contribute significantly to the death rate among young motorcycle casualties.

## Introduction

Injuries are the fifth leading cause of death and the leading cause of hospitalizations in Singapore today [1, 2]. Trauma is the most common cause of death among patients under 40 years of age [3]. Road traffic accidents (RTAs) are the second most common cause of deaths from injuries, suicide being the leading cause [2]. In 2006, there were 799,373 motor vehicles registered in Singapore, 141,881 (18%) of which were motorcycles or scooters; Singapore is a city-state with a population of 4.5 million [4]. Among passenger-carrying vehicles, motorcycles registered the second highest accident rate, after cars [5], yet motorcycle accidents accounted for the highest number of road casualties [5]. In 2006, 190 persons died and 9,706 persons were injured in RTAs; motorcycle drivers and passengers accounted for 102 (54%) of the fatalities and 4,943 (51%) of the injuries [5]. A comparison of the overall incidence of deaths among motorcycle drivers and motorcar drivers reveals that the relative risk of mortality for a motorcycle driver is 18.8% [6]. The use of helmets has been shown to decrease severe head injuries and fatal injuries among motorcycle casualties [7–9], and in Singapore, it is mandatory for motorcycle drivers and passengers to wear helmets [10]. This law is strictly enforced and compliance approaches 100%. Nevertheless, head injury remains the most significant cause of death for both motorcycle drivers and passengers [6]. Studies have shown that the mean age of motorcycle casualties is significantly younger than that of other RTA victims [6, 11, 12].

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In this retrospective study, we reviewed the mortality rates of adult motorcycle casualties who were admitted to an acute public hospital as emergencies. The aim of the study was to determine whether the mortality rate in a major trauma center was higher among younger motorcycle casualties than older motorcycle casualties following road traffic accidents. A secondary aim was to determine the impact of riding position on mortality.

## Patients and methods

From 1 January 2004 to 31 December 2006, all patients 16 years of age and older who came to the emergency department (ED) in our 1,200-bed institution after a motorcycle accident were enrolled in the study. A 24-h ED attendance log was checked to ensure enrolment of all eligible patients. A trained research nurse extracted and stored relevant data of all eligible patients into a computerized database. The extracted data included patient demographics, riding position, Injury Severity Scores (ISS), and outcome (survival or death). The ISS was computed according to the method described by Baker et al. [13] and given in the Abbreviated Injury Scale (AIS) 1990 edition. It is calculated as the sum of squares of the highest AIS scores in the three most severely injured body regions.

Statistical analysis was performed with the chi-squared test for nominal variables. The 2-sample *t*-test was used to compare the continuous data from independent samples, and the Mann–Whitney *U*-test was used to determine the significance of the differences in median values for continuous variables. Analyzed with Stata 10.0 (StataCorp, College Station, TX), all statistical test were conducted at 5% level of significance.

To determine the impact of age on our motorcycle casualties, we performed an analysis based on age. Casualties aged 21 years of age and younger (younger group) were compared with casualties over 21 years of age (older group). A subset analysis based on riding position (drivers versus passengers) was later carried out to determine the effect of riding position on mortality.

## Results

Of the 682 patients in the study, 96 (14%) were in the younger group, compared with 586 (86%) patients in the older group. All of the patients were wearing protective helmets at the time of their accident. The median age was 20 (range: 16–21) years in the younger group and 37 (range: 22–79) years in the older group. The median ISS for the younger group was 13.5 (8–75), and that for the older group was 10 (4–75), a difference that was not statistically significant ( $p = 0.09$ ). There were 14 deaths in the younger group, giving a mortality rate of 14.6%, which is statistically significant, compared to 47 deaths and a mortality rate approaching 8% in the older group ( $p = 0.04$ ). These results are summarized in Table 1.

Of all the casualties entered into this study, 609 were motorcycle drivers, and their median ISS was 10 (4–75). In the younger group, motorcycle drivers made up 75% (72) of all admitted motorcycle casualties; in the older group that percentage was 92% (537), a difference that was statistically significant ( $p < 0.0001$ ). The median age of the younger motorcycle drivers was 20 (16–21) years compared to the median age of 37 (22–79) years in the older group. Among the young motorcycle drivers, there was only 1 underage rider at 16 years of age. The median ISS for the younger and older motorcycle drivers was 13 (8–75)

**Table 1** Demographics of motorcycle casualties

Characteristic	Total, <i>n</i> = 682	Group ≤21 years, <i>n</i> = 96	Group >21 years, <i>n</i> = 586	<i>p</i> Value
Sex (M/F)	608/74	78/18	530/56	
Median age (years)	33 (16–79)	20 (16–21)	37(22–79)	
Race				
Chinese (%)	417 (61)	49 (51)	368 (62)	0.03
Malay (%)	186 (27)	38 (40)	148 (25)	
Indian (%)	71 (10)	8 (8)	63 (11)	
Others (%)	13 (2)	1 (1)	1 (1)	
Median ISS	10 (4–75)	13.5 (8–75)	10 (4–75)	0.09
Death (%)	61 (9)	14 (14.6)	47 (8)	0.04
Riding position				
Driver (%)	609 (89)	72 (75)	537 (91.6)	0.0001
Passenger (%)	73 (11)	24 (25)	49 (8.4)	

ISS Injury Severity Score

**Table 2** Mortality of motorcycle casualties based on age and riding position

Age	<21 years		<i>p</i> Value	>21 years		<i>p</i> Value
	Driver	Passenger		Driver	Passenger	
Riding position						
Numbers (%)	72 (75)	24 (25)	0.019	537 (92)	49 (8)	0.557
Mortality (%)	7 (10)	7 (29)		42 (8)	5 (10)	

and 10 (4–75), respectively, and that difference was not significant. Among the 72 motorcycle drivers in the younger group, there were 7 deaths, resulting in a mortality rate of 9.7%. The mortality rate for motorcycle drivers in the older group was 7.8%, with 42 mortalities. This difference was not statistically significant.

The number of motorcycle passengers in the study was 73, with a median ISS of 10 (4–57). Passengers made up 25% (24) of all admitted motorcycle casualties in the younger group, compared to 8% (49) in the older group. This difference was statistically significant ( $p < 0.0001$ ). The median age of the younger motorcycle passengers was 19 (16–21) years, compared to the median age of 40 (22–67) years in the older group. The median ISS for the younger and older motorcycle passengers was 13 (9–57) and 10 (4–50), respectively. The difference was not statistically significant. Among the 24 motorcycle passengers in the younger group, 7 died, resulting in a mortality rate of 29.2%, whereas in the older group the mortality rate for motorcycle passengers was 10.2% (5 deaths). This difference in mortality was statistically significant ( $p = 0.04$ ).

When we compared the mortality rates of younger passengers (29.2%) with younger drivers (9.7%), the difference was significant ( $p = 0.019$ ). However, when we compared the mortality rates of older passengers with older drivers, the difference was not statistically significant (Table 2).

## Discussion

The median age of the patients in our study is 33 years, which is similar to another reported series in Singapore [11]. In Singapore, the minimum age for obtaining a riding licence or driving licence is 18 years. Despite the strict traffic laws in Singapore, 1 motorcyclist was underage and therefore did not possess a riding licence. Studies have shown that motorcycle drivers with less than 1 year of experience had a higher ISS than more experienced drivers [12]. When we compared the ISS between casualties from the younger group and older groups, we found a trend ( $p = 0.09$ ) suggesting that younger motorcycle casualties present to the hospital with a higher ISS. The higher ISS may be an indicator of a more hazardous riding pattern among the younger drivers, resulting in the higher

mortality rate demonstrated in this study. When the mortality rates of the two age groups were analyzed, the difference was statistically significant. This is the first study to report an association between younger age and death among inpatient motorcycle casualties. Age, however, is not the sole factor affecting mortality; riding experience [12] and the use of helmets have also been shown to have an effect. Other possible factors that may have an impact on mortality, such as riding speed at the time of impact and risk-taking behaviors are often difficult to ascertain when accident victims arrive at the hospital. Hence these elements were not included in the analysis.

According to the Singapore census of population for the year 2000, 4.8% of the population rides a motorcycle as the primary mode of transport. The typical motorcyclist is young, comes from a low-income household, lives in public housing, and is a blue collar worker [1]. These findings are consistent with the demographics of our study, in which we noticed a difference in the composition of the two groups of motorcycle casualties, as well as a higher number of passengers in the younger group than in the older group.

On subset analysis of the motorcycle casualties, when we compared young passengers with young drivers and young passengers against older passengers, the young passengers had the highest mortality rate, and the differences were statistically significant. On further analysis, the mean ISS for young passengers was 20.9. This incidence of high ISS among young passengers caused a significant skew from the median ISS of 13, indicating that the data are not normally distributed. In fact, the ISS in the 75th centile for young passengers was 34, and the six patients whose ISS was above the 75th centile all died. The finding that young motorcycle passengers were most vulnerable to death after a road traffic accident showed that those fatalities contribute significantly to the high mortality rate (43%) among the young motorcycle casualties. A possible explanation for the higher ISS among young passengers could be that passengers have less reaction time to break the fall, unlike motorcycle drivers, who may have more time to react before the accident occurs.

One of the limitations of this study is the lack of data for the group of motorcyclists and passengers who died at the scene and hence were never sent to the hospital. In Singapore, a total of 292 motorcycle drivers and passengers

died between 2004 and 2006 [5]. Up to 42% of all road traffic deaths occurred at the scene [5]. Although ours is the busiest trauma center in Singapore, our data captured only 36% of all inpatient deaths that occurred in Singapore during the study period. Therefore our inpatient results may not be an accurate reflection of the true results in the entire nation. Another interesting revelation is that a disproportionate number of deaths among the young motorcycle casualties represented young passengers. An ideal study would match and analyze the outcomes of all injured motorcycle drivers and their corresponding passengers to determine if the outcomes differed. This was not possible in our study because not all motorcycle drivers were admitted with their passengers as one or the other may have been pronounced dead at the accident scene.

### Conclusions

Motorcycle casualties will continue to contribute significantly to the incidence of road traffic deaths, and trauma surgeons should be prepared to meet this challenge. The mortality rate is significantly higher among inpatient young motorcycle casualties than among older motorcycle casualties. Of all motorcycle accident casualties, young passengers have the highest mortality rate, with an incidence that is significantly higher than that among young motorcycle drivers, and that contributes significantly to the death rate among young motorcycle casualties. Legislation prohibiting young drivers from carrying passengers may

reduce the overall death rate among young motorcycle casualties.

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