

# THE EFFECTS ON ACCIDENTS OF THE COMPULSORY USE OF DAYTIME MOTORCYCLE HEADLIGHTS IN SINGAPORE

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**ABSTRACT** - *This paper examines the effectiveness of the 'ride-bright' legislation in Singapore that was implemented in November 1995. The odds ratio test is used to investigate if there is any significant difference in the number of daytime motorcycle accidents by severity before and after the implementation of the legislation. The findings indicate that though there is insignificant change for the number of serious injury and slight injury accidents, the legislation is effective to reduce the number of fatal accidents.*

## 1 INTRODUCTION

A review of the road casualties and motor vehicle population statistics in Singapore revealed the following observations:

- As at June 1997, the motor vehicle population (inclusive of public buses and taxis) in Singapore is 656,552. Out of this population, motor cars made up the highest proportion (57.09%; 374,852) followed by motorcycles and scooters (20.00%; 131,319).
- In 1996, the total number of road casualties is 7,853, out of which motorcyclists and their pillion riders is the most vulnerable group of motorists, accounting for 49.90% (3,919) of the total number of fatalities and casualties.
- Motorcyclists and their pillion riders also sustained the highest number of injuries in terms of the following degree of injuries:

Degree of Injury	Total Casualties	Motorcyclists & Pillion riders	% of Total Casualties
Fatal	225	94	41.78
Serious injury	420	220	52.38
Slight injury	7,208	3,605	50.01
Total	7,853	3,919	49.90

Source: Road Traffic Accidents Statistical Report Singapore 1996

The above observations show that motorcycles are the most accident-prone type of vehicles on the road in Singapore. In November 1995, the Singapore Traffic Police made it compulsory for all motorcyclists to switch on their motorcycle headlights during the daytime. The objective of this legislation is to increase the conspicuity of the motorcyclists, and in turn reduce the number of motorcycle accidents.

This paper examines the effectiveness of compulsory use of daytime motorcycle headlights in Singapore as an accident countermeasure. Next section, we review the researches done overseas in this area. The methodology adopted in the study is introduced in section three. The last two sections present and discuss the results, discussion and conclusions.

## **2 LITERATURE REVIEW**

In the United States, Hurt et al. (1981) found that conspicuity of the motorcycle is a critical factor in multiple vehicle accidents. Many accidents were the result of drivers not being aware of the approaching bike (Donne 1990). As a result, several investigations of the efficacy of headlamps and daytime running lights as aids to frontal conspicuity are being done. Olson *et al.* (1979) reported promising conspicuity response effects from the use of modulated headlamps on motorcycles, with the modulated high-beam headlamp being the most effective daytime conspicuity aid evaluated. In addition, Jenkins and Wigan (1985) proposed a coherent code of flashing signals for the traffic environment that encompasses and extends their applications to allow for the use of a modulated light device in order to enhance the conspicuity of motorcyclists. This is to accommodate the use of modulation devices to enhance motorcycle conspicuity without any detrimental effect on the current use of flashing signals by highway authorities. Another advantage of using a unique code for motorcycles is that it will readily identify them as a specific class of vehicle.

In the United States, Zador (1985) found that states requiring daytime motorcycle headlight use had substantially fewer daytime motorcycle fatalities. In the United Kingdom, the use of two daytime running lights was found to be by far the most effective method of increasing the conspicuity of all two-wheeled motor vehicles. Use of the more powerful headlamp normally fitted to standard motorcycles, or of a single running light, or of a fluorescent jacket were found to be significantly less effective than two daytime running lights, but still of value (European Conference of Ministers of Transport, 1980).

### 3 DATA AND METHODOLOGY

The source of the motorcycle accident data is the cases of accidents reported to the Singapore Traffic Police from the years 1992 to 1996. To assess the effectiveness of this legislation, odds ratio tests are conducted to investigate if there is any significant difference in the number of daytime motorcycle accidents by severity before and after the implementation of the legislation. The odds ratio test is used in retrospective case-control studies. A two by two table similar to Table 3.1 should be first set up.

**Table 3.1** General representation the results of a retrospective study  
as a 2×2 table

	Before	After	Total
Yes	A	B	A + B
No	C	D	C + D
Total	A + C	B + D	A+B+C+D

A/C is called the odd of the outcome in the first column in Table 3.1 and B/D is called the odd of the second column in the table. The ratio of the two odds gives the odds ratio (OR), that is,  $OR = (A \times D) / (B \times C)$ . The sampling distribution of  $(\log_e OR)$  is approximately the normal distribution, so the 95% confidence interval for the log of the odds ratio is given as follows:

$$\log_e OR - N_{0.975} \times SE(\log_e OR) \text{ to } \log_e OR + N_{0.975} \times SE(\log_e OR)$$

where  $N_{0.975}$  is the appropriate value from the normal distribution and  $SE(\log_e OR)$  is the standard error of the  $(\log_e OR)$  which can be calculated by using the following formula

$$SE(\log_e OR) = \sqrt{\frac{1}{A} + \frac{1}{C} + \frac{1}{B} + \frac{1}{D}}$$

The confidence interval for the odds ratio is obtained by antilogging these values. If 1 lies within this confidence interval, it can be concluded that the difference between the two odds ratios is insignificant. In other words, there is no significant difference in the number of daytime motorcycle accidents before and after the implementation of the legislation in this study.

In order to identify the direction of the effect, we also construct upper-95% confidence interval for the one-sided odds ratio test. If 1 is not in the interval, then it can be concluded that the odds in the first column is in fact larger than the odds in the second column in Table 3.1. In this study, if 1 is not in the upper 95% confidence interval, it implies that the number of daytime motorcycle accidents before the implementation of the legislation in this study is more than the number after implementing the legislation. In other words, the legislation is effective.

The odds ratio tests in this study covered the years 1992 to 1996. The period January 1992 to October 1995 constitutes the before period whereas the period November 1995 to December 1996 constitutes the after period. For the purpose of the tests, daytime is defined as the period of time from 7.00 a.m. to 7.00 p.m. The tests consider only daytime multiparty motorcycle accidents (accidents between moving vehicles and accidents between motorcycle and pedestrian). This is because conspicuity is not a problem in single-party motorcycle accidents, and the inclusion of such accidents may distort the findings.

#### **4 RESULTS AND IMPLICATIONS**

Table 4.1 summarizes the odds ratio test results for all multiparty motorcycle accidents. It can be seen that the odds ratio of 1, which indicates that the proportion of all daytime motorcycle accidents to all nighttime motorcycle accidents is the same before and after the implementation of the 'ride-bright' legislation, lies within the confidence interval at the 5% level of significance. Thus, it can be concluded that the implementation of the 'ride-bright' legislation has insignificant effect on the total number of daytime multiparty accidents.

**Table 4.1 Odds ratio test for all multiparty motorcycle accidents**

	<b>Before Implementation</b>	<b>After Implementation</b>
Daytime multiparty motorcycle accidents	5,320	1,780
Nighttime multiparty motorcycle accidents	3,258	1,067
Total	8,578	2,847
Odds ratio (OR)	0.98	
The 95% Confidence interval for the odds ratio	(0.898, 1.070)	

However, the above result is inconclusive on its own. The ‘ride-bright’ legislation may be effective in reducing a specific severity of daytime multiparty motorcycle accidents (fatal, serious injury or slight injury). This effectiveness may be obscured in the above analysis. Thus, it is necessary to look at the effect of the ‘ride-bright’ legislation on the severity types of daytime multiparty motorcycle accidents separately.

Table 4.2 summarizes the odds ratio test results for fatal multiparty motorcycle accidents only. It can be inferred that the implementation of the ‘ride-bright’ legislation has effect for reducing the number of fatal daytime multiparty motorcycle accidents. This is because the odds ratio of 1, which indicates that the proportion of fatal daytime multiparty motorcycle accidents to fatal nighttime multiparty motorcycle accidents is the same before and after the implementation of the ‘ride-bright’ legislation, does not lie inside of the 95% upper confidence interval.

**Table 4.2 Odds ratio test for fatal multiparty motorcycle accidents**

	<b>Before Implementation</b>	<b>After Implementation</b>
Fatal daytime multiparty motorcycle accidents	145	25
Fatal nighttime multiparty motorcycle accidents	133	37
Total	278	62
Odds ratio (OR)	1.61	
The upper 95% Confidence interval for the odds ratio	(1.011, + ∞)	

Table 4.3 shows that the 'ride-bright' legislation has no significant effect on the number of daytime multiparty motorcycle accidents for serious injury only. This conclusion is based on the finding that the odds ratio of 1 lies within the 95% confidence interval and the 95% upper confidence interval as well.

**Table 4.3 Odds ratio test for serious injury multiparty motorcycle accidents**

	<b>Before Implementation</b>	<b>After Implementation</b>
Serious injury daytime multiparty motorcycle accidents	335	98
Serious injury nighttime multiparty motorcycle accidents	276	97
Total	611	195
Odds ratio (OR)	1.20	
The 95% Confidence interval for the odds ratio	(0.869, 1.657)	
The upper 95% Confidence interval for the odds ratio	(0.9168, + ∞)	

Finally, Table 4.4 tests the effectiveness of daytime headlights with respect to daytime multiparty motorcycle accidents for slight injury only. In this case, the ‘ride-bright’ legislation again is not no significant, as the odds ratio of 1 lies within the 95% confidence interval and the 95% upper confidence interval.

**Table 4.4 Odds ratio test for slight injury multiparty motorcycle accidents**

	<b>Before Implementation</b>	<b>After Implementation</b>
Slight injury daytime multiparty motorcycle accidents	4807	1657
Slight injury nighttime multiparty motorcycle accidents	2837	933
Total	7644	2590
Odds ratio (OR)	0.95	

The 95% Confidence interval for the odds ratio	(0.866, 1.042)
The upper 95% Confidence interval for the odds ratio	(0.879, + ∞)

## 5 CONCLUSION

This study examines the effectiveness of the compulsory use of daytime motorcycle headlights (“ride-bright” legislation) in Singapore. The findings indicate that the legislation is effective in reducing the number of fatal accidents which is consistent with the results by Zador (1985), but there is little change on the number of serious injury and slight injury accidents. This may signal that having headlights on during daytime does improve the conspicuity of motorcycles, as the beam from the headlight stand out well under daytime conditions.

One possible reason why headlights have successfully reduced fatal accidents can be due to the early signal that they give time to the other parties to slow down. It may be reasonable to assume that if the other parties can be alerted earlier, one can start applying the break earlier and will have a longer distance to travel before hitting the motorcyclist deadly, seriously or slightly. However, the time required in avoiding a slight/serious injury accident is longer than the time required to avoid a fatal accident, given the same speed of traveling. In short, the headlight can only give the drivers a lead time long enough to avoid a fatal accident but not long enough to avoid slight/serious injuries. If this is the case, one way to make headlights more effective is to make them more conspicuous e.g. say use of “multiple”, “more powerful” headlights so that they will be able to send a warning signal even earlier to avoid accidents.

The possibility cannot be ruled out that enhanced conspicuity leads to behavioural adaptation. Drivers may drive faster or otherwise adopt reduced safety margins, once they come to rely on the sight of headlights as the main clue to identification of a motor vehicle (Elvik, 1993). This could be one of reasons why the total number of multiparty accidents in the daytime was not reduced after implementing the regulation. One inherent limitation of the study is the use of only 14 months' data for the after implementation period in the evaluation of the effectiveness of the 'ride-bright' legislation. This may be too short a period for the effects of the legislation to surface. Thus, the same tests done in the future with more years' data may come up with different conclusions.

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