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TITLE Preliminary analysis of motorcycle accidents: short - term impacts of the running headlights campaign and regulation in Malaysia

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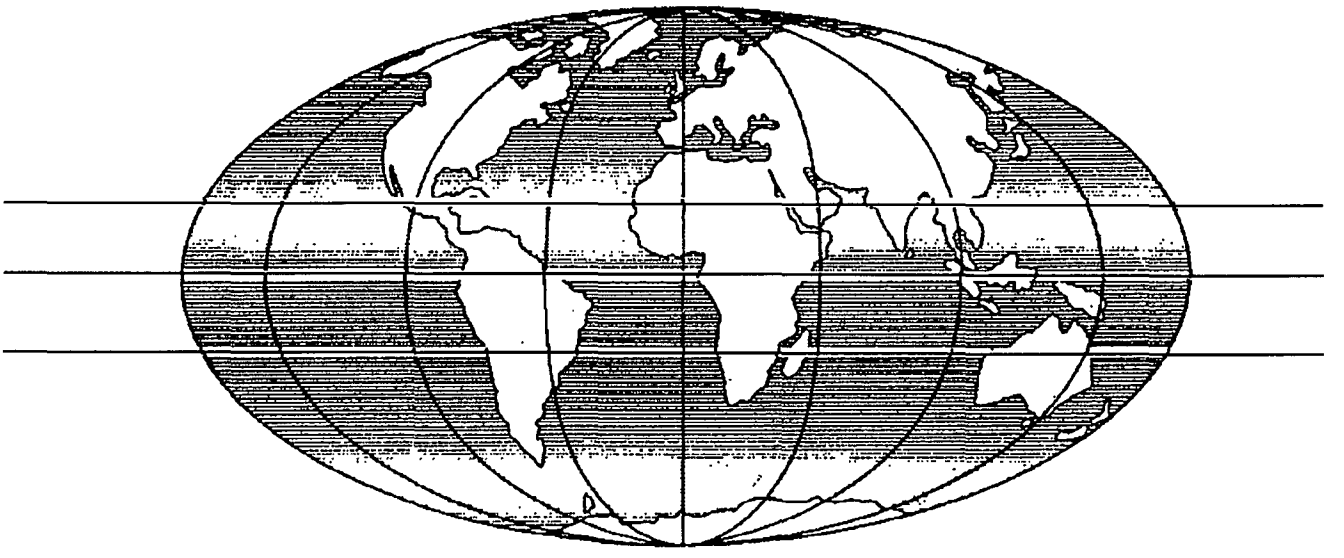

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Preliminary Analysis of Motorcycle Accidents: Short–Term Impacts of the Running Headlights Campaign and Regulation in Malaysia

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Radin Umar RS, Mackay GM, Hills BL. Preliminary Analysis of Motorcycle Accidents: Short–Term Impacts of the Running Headlights Campaign and Regulation in Malaysia. J Traffic Med 1995;23:17–28.

A preliminary investigation of motorcycle fatalities showed that riding a motorcycle is 17 times more dangerous than driving a passenger car. About 50 per cent of motorcycle accidents in this country occur at junctions and 38 per cent of the incidents involve other vehicles crossing motorcycle's paths. In most cases, motorcycles are found to be moving straight ahead. Daytime accidents constitute about 73 per cent of the motorcycle accidents and about two thirds of the riders involved in multiple accidents are on their right–of–way. Based on this analysis, improved motorcycle conspicuity was proposed, and a nation–wide "running headlight" Campaign and Regulation were implemented in July and September, 1992, respectively. Detailed analysis on the impact of running the headlight campaign and regulation in the districts of Seremban and Shah Alam revealed that there had been a sizeable drop (6.9%) in multiple vehicle–day time motorcycle accidents in the study areas. The percentage of riders switching on their lights increased sharply just after the campaign and remained at about 82 per cent by the end of 1992. Conspicuity–related accidents while motorcycles are going straight ahead or turning on the right of way, MSTOX, were found to have dropped significantly immediately after the campaign by about 22 per cent. Statistical tests done before and after the campaign confirmed that the running headlight Campaign and Regulation had a significant impact ($p < 0.005$) in reducing MSTOX accidents in the study areas.

Keywords: motorcycle accidents, injury index, colliding mechanisms, conspicuity–related accidents, conspicuity, running headlight, impacts

INTRODUCTION

Motorcycles are one of the major modes of personal transport in Malaysia. About 60 per cent of the registered vehicles in this country are motorcycles and their proportions on the road

Figure 1. Registered Motorised Two-Wheelers in Malaysia [Royal Malaysian Police]

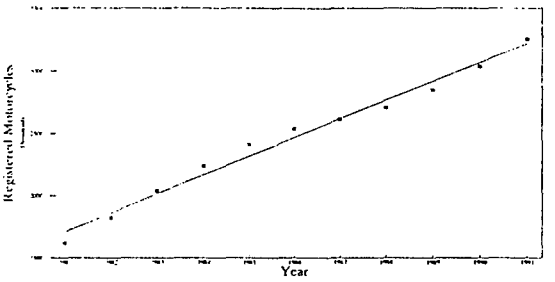
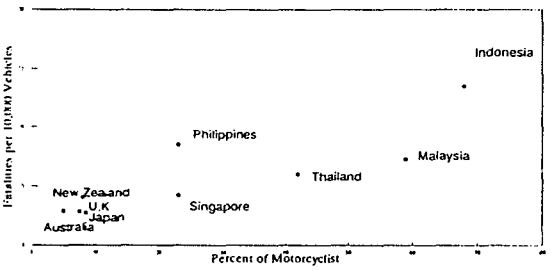


Figure 2. Motorisation and Death Rates (1987) [1]



varies between 30 to 60 per cent, according to locations. The number of the motorized two-wheelers (motorcycles and scooters) registered has been increasing tremendously in past years with an average increase of about 12 per cent per year in the last 10 years as shown in Figure 1. Consequently, casualties among motorcyclists form a large portion of the traffic injury problem (Figure 2) and are placed among the top [1] in comparison to other countries. This is primarily because the vehicle itself offers little protection to the riders and pillion passengers in the event of collision with other vehicles. Thus, research on motorcycle safety is essential so that appropriate measures can be taken to reduce the casualty and mortality rates among motorcyclists. This paper presents the analysis of motorcycle accidents and the impact of the recent "running headlight Campaign and Regulation" in the pilot project areas, Seremban and Shah Alam, Malaysia.

HYPOTHESIS

The characteristics of motorcycle accidents, especially those involving riders travelling straight ahead on their right-of-way, can be used to test the hypothesis that the majority of motorcyclists are victims of traffic accidents because they are not seen by other road users. Improvement in their conspicuity may result in reducing their exposure to accidents. Consequently, detailed analyses of collision mechanisms involving motorcycles were studied and the impacts of the national Ride-Bright Campaign and Regulation were carried out.

DATA COLLECTION AND ANALYSIS

This study was based primarily on a specially created police accident form POL27(Pin 1/91). The form was designed for easier completion and fully compatible with a customised version of TRLs Microcomputer Accident Analysis Package, MAAP[2]. National accident data from the mainframe computer system at the Police Headquarters, Bukit Aman, were downloaded using a specially designed transcription program MALMAINF [3] for the overall analysis of the accident patterns, while the up-to-date Pilot Project data in the districts of Seremban and Shah Alam [4] was used for the evaluation of the campaign and regulation. In both cases, special working files containing all motorcycle accidents were created separately for each data set for further analysis.

Detailed collision types involving motorcycle accidents were reclassified and recoded based on sketch diagrams and written police descriptions available on the last page of the form. A total of 193 collision mechanisms dividing into 37 colliding groups were identified as summarised in Figure 3. The colliding group was classified according to the road geometry, vehicle manoeuvres and the riders' right way with the notations S to represent all Straight directions on the right-of-way, T for either Turning left or right on the right-of-way and X for crossing manoeuvre on losing the right-of-way. Collision types were also identified by the impact directions with notations F, B and D for the front, rear and side collisions, respectively. These recoded records were then manually updated into MAAP.

Figure 3. The 37 Collision Groups Defined for Motorcycle Accidents

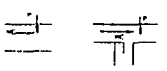
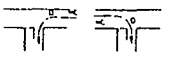
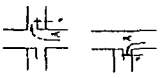
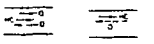
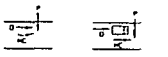
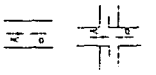
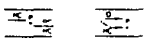
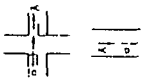
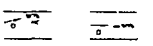
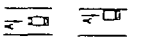
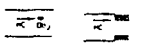
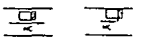
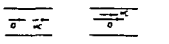
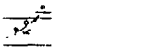
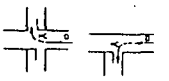
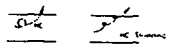
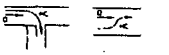
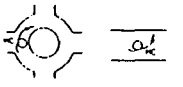
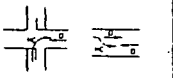
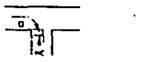
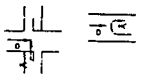
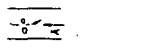
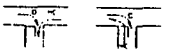
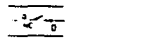
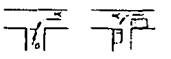
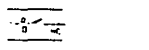
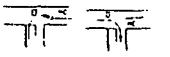
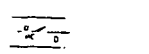
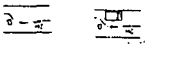
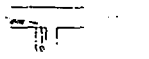
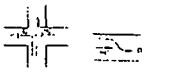
Notation	Colliding Mechanism	Examples	Notation	Colliding Mechanism	Examples
MCSPX	Motorcycle Straight Pedestrian Cross		MBOTB	Motorcycle Backing Other Turn Rear-End Collision	
MCTPX	Motorcycle Turn Pedestrian Cross		MSOSD	Motorcycle Straight Other Straight Side-Swipe Collision	
MSPOB	Motorcycle Straight Pedestrian Obscured		MSOSF	Motorcycle Straight Other Straight Head-On Cillision	
MSPMR	Motorcycle Straight Pedestrian Middle of Road		MBOSB	Motorcycle Backing Other Straight Rear-End Collision	
MSPWA	Motorcycle Straight Pedestrian Walk Along Road		MEOSB	Motorcycle Park/Stop Other Straight Rear-End Collision	
MSPWO	Motorcycle Straight Pedestrian Walk Opposite Direction		MSOEB	Motorcycle Straight Other Park/Stop Rear-End Collision	
MSHOJ	Motorcycle Straight and Hit Objects		MSOED	Motorcycle Straight Other Park Side Collision	
MCSHA	Motorcycle Straight and Hit Animals		MSORF	Motorcycle Straight Other Reverse Front Collision	
MCSHB	Motorcycle Straight and Hit From Back		MCYHP	Motorcycle Yaw/Fall and Hit Pedestrian	
MCTHB	Motorcycle Turn and Hit From Back		MYOFF	Motorcycle Yaw/Fall Off the Road	
MCXHB	Motorcycle Cross and Hit From Back		MYONR	Motorcycle Yaw/Fall On the Road	
MCXHF	Motorcycle Cross and Hit From Front		MQOTF	Motorcycle Queue at Stop Line Other Turn Hit From Front	
MCXHD	Motorcycle Cross and Hit From Side		MSOYF	Motorcycles Straight Other Yaw Head-On Cillision	
MCTHD	Motorcycle Turn and Hit From Side		MYOSF	Motorcycle Yaw/Fall Other Straight Head-On Collision	
MCTHF	Motorcycle Turn and Hit From Front		MSOYB	Motorcycle Straight Straight Other Yaw Rear-End Collision	
MSOXD	Motorcycle Straight Other Vehicles Cross Side Collision		MYOSB	Motorcycle Yaw/Fall Other Straight Rear-End Collision	
MSOXF	Motorcycle Straight Other Vehicles Cross Front Collision		MEOTB	Motorcycle Park Other Turn Rear-End Colision	
MSOXB	Motorcycle Straight Other Vehicle Cross Rear-End Collision				

Table I Injury Risk for Occupants of Motorised Vehicles in Malaysia

Vehicle Type	Injuries			Vehicle Involved	Index (per 1000 vehicles)			Relative Risk		
	Fatal	Serious	Slight		Fatal	Serious	Slight	Fatal	Serious	Slight
Car	227	522	2057	63674	3.6	8.2	32.3	1.0	1.0	1.0
Van	100	187	541	11324	8.8	16.5	47.8	2.5	2.0	1.5
Motorcycle	1255	4153	8162	20810	60.3	199.6	392.2	16.9	24.3	12.1
Lorry	109	169	520	13119	8.3	12.9	39.6	2.3	1.6	1.2
Bus	14	30	77	4837	2.9	6.2	15.9	0.8	0.8	0.5

RESULTS

Injury Risk for Occupants of Motorised Vehicles in Malaysia

The accidents and injuries involving motorised vehicles successfully downloaded from the mainframe computer throughout Malaysia in 1992 are shown in Table I. Motorcycle casualties constitute about 76 per cent (13,570 cases) of the total casualty injuries of motorised vehicles. This is followed by about 16 per cent (2806 injuries) passenger car casualties and about 5 per cent (828 cases) and 5 per cent (798 cases) for the passenger van and commercial vehicle casualties respectively.

The relative risk of injuries for the occupants of different classes of vehicle involved in accidents were calculated from the ratio of the injury index per 1000 vehicles of a particular type of vehicle over the injury index of a passenger car. These confirmed further the fact that the chance of injury amongst the motorcyclists are much higher than other types of motorised vehicles. This is illustrated in the last column of Table I with the relative risk being 17 and 24 times greater than passenger cars for (i) motorcycle fatalities and (ii) serious injuries respectively. This is followed by passenger vans and commercial lorries both with fatality indices of about 3 compared with passenger cars.

Collision Mechanisms With Motorcycles

The severity of accidents against collision group as coded in Figure 3 is shown in Figure 4. Crossing accidents while motorcycles are travelling

Figure 4. Collision Mechanisms With Motorcycles

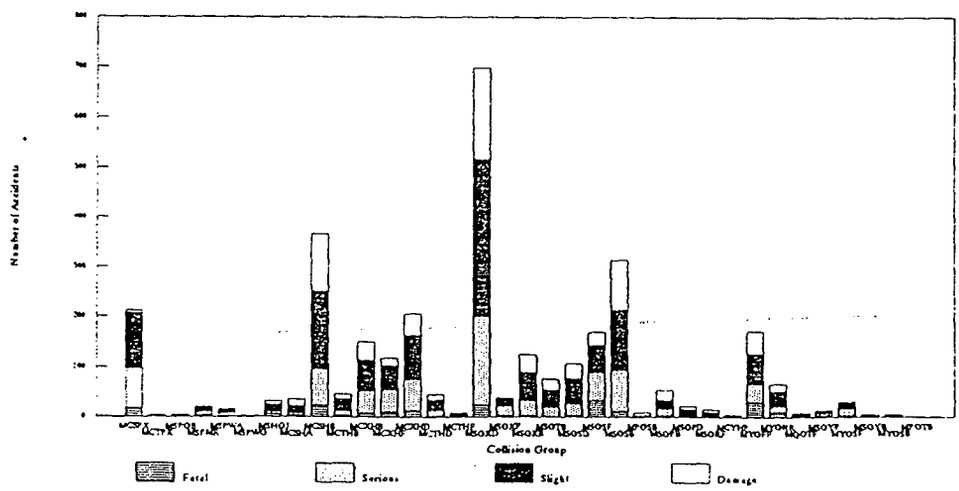
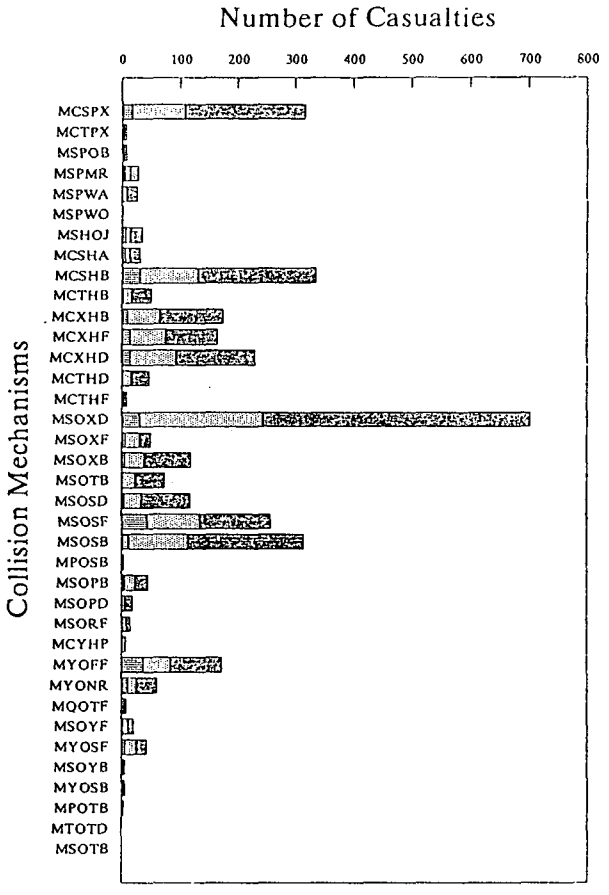


Figure 5. Colliding Mechanisms and Casualty Injuries With Motorcycles

Collision Mechanism	Number of Casualties Fatal	Serious	Slight	Total
MCSPX	17	91	208	316
MCTPX	1	2	4	7
MSPOB	0	2	5	7
MSPMR	4	9	15	28
MSPWA	0	8	19	27
MSPWO	0	0	1	1
MSHOJ	6	8	21	35
MCSHA	5	8	19	32
MCSHB	30	100	205	335
MCTHB	2	15	34	51
MCXHB	9	55	111	175
MCXHF	14	61	90	165
MCXHD	14	79	137	230
MCTHD	1	15	31	47
MCTHF	0	3	5	8
MSOXD	31	211	460	702
MSOXF	5	25	20	50
MSOXB	5	34	81	120
MSOTB	0	23	50	73
MSOSD	4	29	85	118
MSOSF	44	90	123	257
MSOSB	12	102	200	314
MPOSB	1	0	3	4
MSOPB	4	19	22	45
MSOPD	0	5	14	19
MSORF	2	6	7	15
MCYHP	1	4	2	7
MYOFF	37	47	89	173
MYONR	10	15	35	60
MQOTF	0	4	4	8
MSOYF	2	9	10	21
MYOSF	5	20	18	43
MSOYB	2	1	3	6
MYOSB	0	2	4	6
MPOTB	1	0	2	3
MTOTD	0	0	0	0
MSOTB	0	0	0	0
TOTAL	269	1102	2137	3508



straight ahead and other vehicles cross their travelling paths (MSOXD) constitute about 22 per cent (699 cases) of accidents investigated. This is followed by about 12 per cent (367 cases) rear–end collisions with motorcycles [motorcycles moving straight ahead and struck from the back (MCSHB)]. Another 10 per cent (315 cases) of the accidents are rear–end collisions with other vehicles [motorcycle backing other straight (MBOSB)] and about 7 per cent (213 cases) is the pedestrian–motorcycle accidents while motorcycles are moving straight ahead (MCSPX).

The analysis of the injuries to motorcyclists for the 37 collision groups is shown in Figure 5. Although the figures of casualties are generally higher than the number of accidents, the proportion of casualties according to the collision mechanisms are quite comparable to the proportion of accidents. Casualties resulted from crossing accidents while motorcycles are

Table II Collision Group and Conspicuity-Related Accidents

Collision Group with Motorcycles	Priority	Fatal	Serious	Slight	Damage	Total	Conspicuity Relevant
Motorcycles With Pedestrians and Other Vehicles						2502	
Motorcycle Straight/turn other vehicles cross	Motorcycles	38	254	421	238	951	Yes
Motorcycle Straight/turn Pedestrians cross	Motorcycles	22	100	133	6	261	Yes
Motorcycle Straight/turn Struck from Back	Motorcycles	28	85	179	129	421	No
Motorcycle Cross Main Paths	Others	30	156	196	94	476	No
Motorcycle hit other vehicles from Back	Others	12	105	154	122	393	No
Single Motorcycle Accidents						431	
Motorcycle yaw/skid/fall	NA	46	69	105	63	283	No
Motorcycle Hit Animal/Object	NA	14	32	56	46	148	No
Others	NA	40	83	111	64	298	NA
Total		230	884	1355	762	3662	

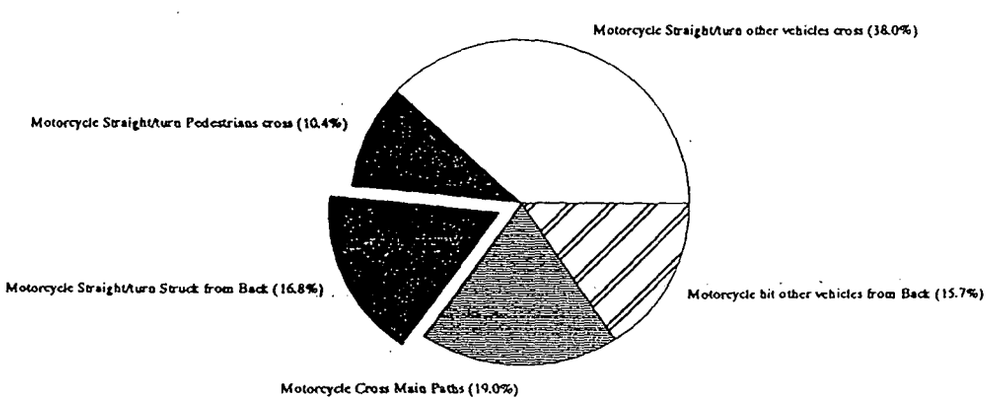
travelling straight ahead and other vehicles cross their travelling paths (MSOXD) still ranked the highest (701 cases) followed by rear-end casualties with motorcycles [motorcycles moving straight ahead and struck from the back (MCSHB)] (335 cases) and the pedestrian casualties (316 cases).

Conspicuity-Related Accidents

To understand the collision characteristics further, the 37 collision groups were classified into two collision types known as "motorcycle to pedestrians and other vehicles accidents", (MPVA) and "single motorcycle accidents", SMA. These are shown in Table II and Figure 6. The former group was further classified into two categories known as "conspicuity-related" accidents and "non conspicuity-related" accidents. The "conspicuity- related accidents" consists of all accidents involving motorcycles moving straight or turning with the right of way when pedestrians and other vehicles cross their paths. The above classifications are necessary to differentiate between accident situations in which running headlights could have potentially improved safety and those in which they probably would have been irrelevant.

"Motorcycle with pedestrians and other vehicle" accidents, MPVA, constitute about 77 per cent of accidents investigated (2502 cases) while less than one quarter of the investigated

Figure 6. Collision Groups With Motorcycles



accidents constitutes the single motorcycle accidents, SMA. A total of 951 cases (38 per cent) of the MPVA accidents occurred when motorcycles were travelling straight or turning on their right-of-way and collided with other vehicles. An additional 261 cases (about 10 per cent) were motorcycle-pedestrian accidents and another 421 cases (17 per cent) involved rear-end collisions with motorcycles.

Of the 2502 MPVA cases, a total of 1633 (about 65 per cent) involves motorcyclists who were on their right-of-way and colliding with either pedestrians or other vehicles. Out of those accidents, a total of 1212 (about 74 per cent) of motorcycles involved in the conspicuity-related accidents. It was noted also that one-third of the MPVA were the results of the direct riders' negligence crossing the paths of other vehicles or backing too close to the front vehicles in the rear-end situations.

Daytime Running Headlight Campaign and Regulation

There is a widespread belief that motorcycles are more difficult to detect in traffic than other motorised vehicles. Studies of individual collisions involving motorcycles [5], indicate that drivers who violate motorcyclists' right-of-way often claim not to have seen them before the collision ("looked but failed to see"). The conspicuity of motorcyclists has been of concern for many years and has resulted in a number of "Running Headlights" campaigns in which motorcycle headlights are switched on in the daytime. These have been shown to reduce motorcycle collisions in selected countries [5,6,7,8].

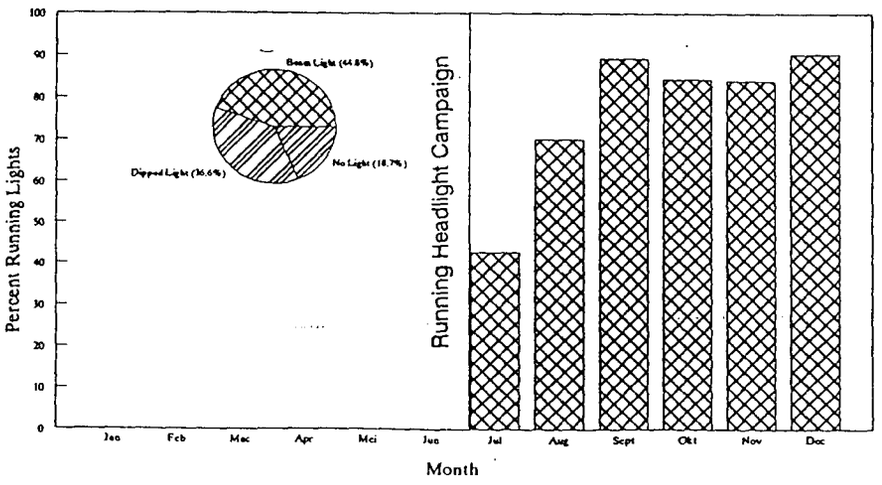
In view of the high proportion of motorcycles in Malaysia, it was anticipated that a campaign to improve the conspicuity of motorcycles would have a clearer impact than in developed countries when there is a smaller proportion of motorcycles. Since the majority of the accidents occurred while motorcycles had the right-of-way and particularly while they were travelling straight ahead or turning, it can be concluded that in the majority of traffic accidents in which they are involved, motorcyclists tend to be the victims of errors made by other road users.

With the above evidence that improving the conspicuity of motorcycles reduces accidents, a nation-wide "Daytime Running Headlight" campaign was proposed and this was launched in July 1992. This was followed by the compulsory use of headlights regulation in September 1992.

Rate of Compliance for Running Headlights

The percentage of motorcycles complying to the running headlights campaign during the day time in the districts of Seremban and Shah Alam is shown in Figure 7. Samples of at least 100 motorcyclists, each at eight sampling points in

Figure 7. Rate of Compliance for Daytime Running Headlights



Seremban and Shah Alam, were taken each month starting from June 1992. The percentage of motorcyclists riding with lights switched on increased sharply just after the campaign and by the end of 1992, it stood at 82 per cent. The proportion of all riders using their main beam or dipped light was consistently maintained at about 45 and 37 per cent, respectively, throughout the campaign and regulation periods.

Multiple-Day and Night Accidents With Motorcycles

The pattern of day and night time multiple accidents with motorcycles in Seremban and Shah Alam is as in Table III. The cumulative plot of accidents before and after the campaign and the respective projected mean on the basis of data six months before the campaign against time are shown in Figure 8.

By comparing the predicted mean trend line with the actual cumulative number of the multiple-day time accidents, it can be seen that there is a distinct separation for the cumulative number of multiple-day accidents just after the campaign in July 1992. The upward or downward curvature of the cumulative plot indicates a corresponding short term trend and changes in slope indicate long term changes in the rate of occurrence of the accidents investigated [9]. In contrast, the number of all motorcycle accidents and multiple-night accidents lie close to the straight lines of corresponding cumulative means, implying that these types of accidents fluctuated very closely about a steady average over the same period.

Table III Multiple-Day and Night Time Accidents With Motorcycles

Collision Types	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
All Motorcycle Accidents	141	124	181	130	130	156	135	149	122	152	129	164
Cumulative												
All Motorcycle Accidents	141	265	446	576	706	862	997	1146	1268	1420	1549	1713
Mean All Motorcycle Accidents	141	285	428	572	716	860	1003	1147	1291	1434	1578	1722
Multiple-Day Accidents	102	82	121	89	92	104	82	93	79	94	91	110
Cumulative												
Multiple-Day Accidents	102	184	305	394	486	590	672	765	844	938	1029	1139
Mean Multiple-Day Accidents	102	200	299	397	495	594	692	790	889	987	1085	1184
Multiple-Night Accidents	17	16	28	11	15	20	23	22	13	21	17	26
Cumulative												
Multiple-Night Accidents	17	33	61	72	87	107	130	152	165	186	203	229
Mean Multiple-Night Accidents	17	35	53	70	88	106	124	142	160	177	195	213

Figure 8. Cumulative Plot of Multiple-Day and Night Time Motorcycle Accidents Against Month of Year

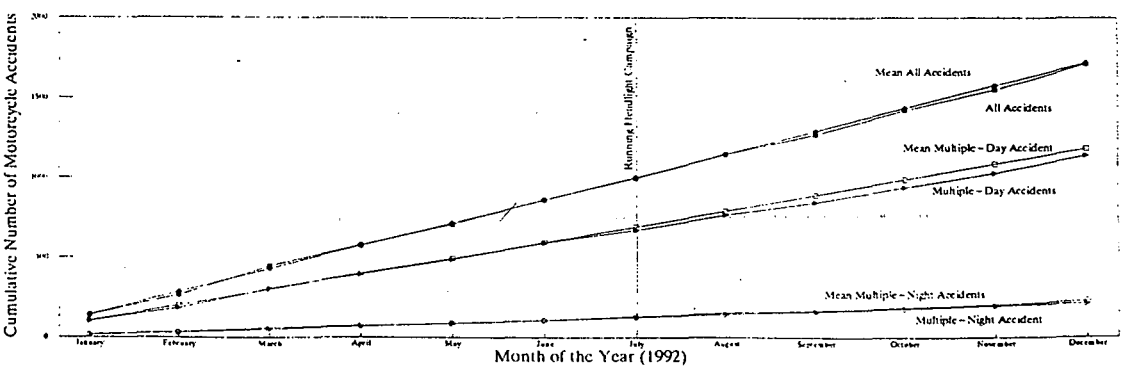
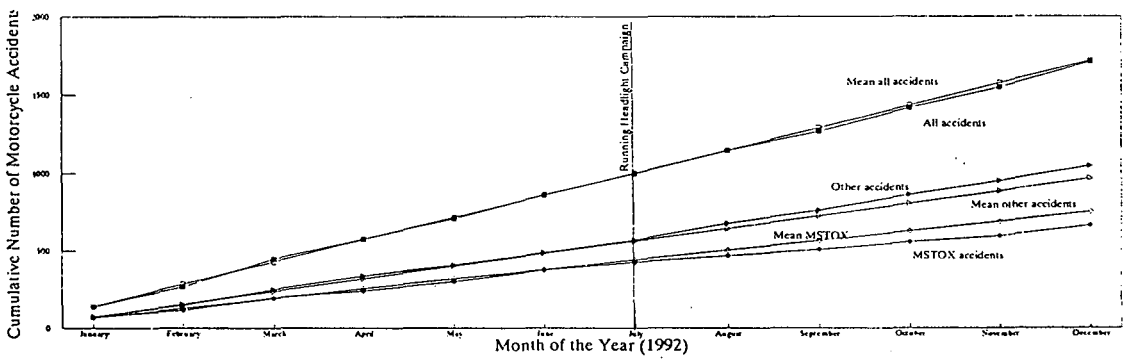


Table IV Right of Way Accidents With Motorcycles

Collision Types	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
All Motorcycle Accidents	141	124	181	130	130	156	135	149	122	152	129	164
Cumulative												
All Motorcycle Accidents	141	265	446	576	706	862	997	1146	1268	1420	1549	1713
Mean All Motorcycle Accidents	141	285	428	572	716	859	1003	1147	1290	1434	1578	1721
MSTOX Accidents	68	48	79	44	61	73	53	43	38	49	40	68
Cumulative												
MSTOX Accidents	68	116	195	239	300	373	426	469	507	556	596	664
Mean MSTOX Accidents	68	130	192	255	317	379	441	503	565	628	690	752
Other Types of Accidents	73	76	102	86	69	83	82	106	84	103	89	96
Cumulative												
Other Type of Accidents	73	149	251	337	406	489	571	677	761	864	953	1049
Mean Other Types Accidents	73	155	236	318	399	481	562	644	725	807	888	970

Figure 9. Cumulative Plot of MSTOX and OTHER Accidents Against Month of the Year



Conspicuity-Related Accidents (MSTOX)

Table IV and Figure 9 show the number and the cumulative plots of motorcycle accidents with respect to the riders' manoeuvres, collision types and the right-of-way respectively. The number of accidents involving motorcycles moving straight or turning when other vehicles or pedestrians cross their paths (MSTOX) dropped sharply with an overall drop of about 22 per cent (see Table V) six months before and after the campaign.

A similar trend was also noticed on the cumulative plot. The clear downward diversion for the MSTOX accidents just after the campaign in July 1992, indicates the positive changes in the rate of occurrence of MSTOX accidents. Conversely, the number of other types of motorcycle accidents were found to increase steadily after the campaign while the overall accidents lie close to the straight lines of corresponding cumulative means, inferring that the overall accidents fluctuated very closely about a steady average over the observation period. Since the number of multiple accidents while motorcycles are moving straight or turning on the right-of-way is decreasing and there has been an upward toll on the other types of collisions it can be deduced that the campaign and regulation resulted in a reduction to the MSTOX accidents in the study areas.

Before and After Analysis

The number of different types of motorcycle accidents and injuries six months before and after

Table V Before and After Analysis on Motorcycle Accidents

Campaign & Regulation	Motorcycle Accidents			Motorcycle Injuries	
	Multiple-Day	MSTOX	All	MSTOX	All
Before Period (January-June)	590	373	862	303	635
After Period (July-December)	549	291	851	239	676
Chi Square (df=1)	2.06	9.19		11.7	
Probability	p <0.2	p <0.005		p <0.001	

the campaign and regulations are shown in Table V. The total motorcycle accidents and corresponding injuries within the same areas are also presented for the control data. Based on the Chi Square values, it can be concluded that there has been a significant effect on the reduction on motorcycle accidents and injuries involving MSTOX (motorcycles moving straight or turning and other vehicles or pedestrians crossing their paths). The computed Chi Square values for accidents and injuries for one degree of freedom are 9.19 ($p < 0.05$) and 11.7 ($p < 0.001$) respectively. The drop in multiple–day time accidents however was only indicative ($p < 0.2$) at 0.2 level of significance.

DISCUSSION

It was anticipated that the running lights campaign for motorcycles could only improve multiple vehicle accidents with motorcycles. No improvement was expected in the multiple–night time accidents since almost all motorcycles are using their headlights for the night riding. The biggest impact expected in this exercise however, was the change in the right–of–way accidents involving motorcycles. This is because about two thirds of multiple motorcycle accidents occurred while the motorcyclists had the right–of–way and collided with either pedestrians or other vehicles.

The time series analysis showed a sizeable drop in the number of multiple–day accidents with motorcycles (6.9%), comparing six months before and after the campaign. Nationally, this will result of saving about 13,177 motorcycle accidents in 1992. This reduction is indicated by the downward diversion of the cumulative curve. On the other hand, the number of night–time and overall accidents lies very close to the mean values of the computed accidents over the same period of observation. These results support the conclusion that the campaign and regulation reduced multiple motorcycle accidents during the day time.

The biggest impact anticipated from this campaign and regulation was the reduction of conspicuity–related accidents, MSTOX. The overall drop for this type of collision six months before and after the campaign and regulation was about 22 per cent. Since the number of multiple accidents while motorcycles are moving straight or turning on the right–of–way is decreasing, while there has been a continuing upward trend of other types of collisions, it can be concluded that the campaign and regulation must have given a significant reduction to the motorcycle accidents in the study areas. This conclusion is further supported by the 'before' and 'after' analyses which showed highly significant reduction for MSTOX accidents.

Although there has been some drop in the multiple vehicle–day time accidents it is still not conclusive that the campaign and regulation have changed these particular types of accidents, significantly. However, at 0.005 level of significance, it is certain that the reduction in the multiple accidents and the associated injuries, particularly for motorcycles travelling straight ahead or turning on the right–of–way and other vehicles or pedestrians crossing their travelling paths, does not occur by chance. Therefore, it is concluded that the "running headlight" campaign and regulation has been successful in improving motorcycle safety in this country.

Whilst an overall benefit was predicted, it can also be anticipated that the campaign and regulation might reduce the safety of those remaining motorcyclists who continue to travel without their lights on. Pedestrians and drivers of other vehicles who become used to the running headlights may not be expecting motorcyclists travelling without their lights on. This could result in a higher risk of accident for those motorcycles not complying with the regulation. Motorcycles without their lights could be due to riders forgetting or choose not to switch on their lights or to faulty lighting systems or blown bulbs.

To overcome these problems, it is recommended that passive measures, such as the use of headlights which automatically turn on when the engine is started, be made available by the manufacturers. A panel indicator to indicate any failure of lighting system and spare bulb facility should be considered for the future motorcycle design. In addition, riders should be encouraged to use their high beams during the daytime and should be informed about the advantages of this. Police enforcement should also be carried out regularly to improve further the rate of compliance.

CONCLUSIONS

The following conclusions can be drawn:

i. Casualties among motorcyclists form the largest part of road traffic casualties in Malaysia. The rate for motorcycle fatalities was found to be 17 times higher than for passenger cars. Serious attention to this group is thus strongly justified.

ii. Crossing accidents while motorcycles are travellingstraight ahead and other vehicles cross their travelling paths (MSOXD) constitute the highest type of collision mechanisms investigated. Further grouping based on the riders' right–of–way revealed that about two thirds of motorcyclists involved in multiple accidents were on their right–of–way and their travelling paths were intercepted by other vehicles and pedestrians. Since the majority of the accidents happened while motorcyclists were following their right–of–way, it can be concluded that the majority of these motorcyclists are the victims of the situations and additional attention to this problem is required.

iii. Detailed evaluation of the campaign and regulation revealed that there has been a decreasing trend on multiple– day time accidents in the study areas. A larger drop was found for multiple motorcycle accidents in which motorcycles are moving straight or turning with right–of– way, MSTOX. Although the statistical analysis of the multiple vehicle–daytime accidents is only indicative, a highly significant ($p < 0.005$) reduction in MSTOX accidents was found and it is concluded that daylight use of headlights should be encouraged as one of the best ways to improve motorcycling safety in Malaysia.

In view of the increasing number in motorcycles in developing cities, it is proposed that these positive findings be seriously taken into consideration in drawing up low–cost countermeasures to reduce motorcycle accidents and injuries in the developing countries.

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