



NHMRC ROAD ACCIDENT RESEARCH UNIT
THE UNIVERSITY OF ADELAIDE



GN

1/1990/3

COMPARATIVE STUDY OF MOTORCYCLE ACCIDENTS

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Research report 2/90

**Sponsored by the World Health Organization
Western Pacific Regional Office**



**WHO COLLABORATING CENTRE IN THE PREVENTION
AND CONTROL OF ROAD TRAFFIC ACCIDENTS**

WORLD HEALTH ORGANIZATION
WESTERN PACIFIC REGION

REGIONAL COMPARATIVE STUDY OF
MOTORCYCLE ACCIDENTS
WITH SPECIAL REFERENCE TO
LICENSING REQUIREMENTS

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INFORMATION RETRIEVAL

McLEAN AJ, CHEN PCY, WONG TW, UKAI T (1990) : REGIONAL COMPARATIVE STUDY OF MOTORCYCLE ACCIDENTS WITH SPECIAL REFERENCE TO LICENSING REQUIREMENTS. Adelaide: NHMRC Road Accident Research Unit, The University of Adelaide.

KEYWORDS : accident/ Australia/ driving licence/ experience (human)/ injury/ Japan/ moped*/ motorcyclist/ motorcycle/ Malaysia/ rider training*/ Singapore

* non IRRD keyword

ABSTRACT : A co-ordinated study of motorcycle accidents during 1986 and 1987 was carried out in Adelaide (South Australia), Kuala Lumpur (Malaysia), Singapore, and Suifu (Japan). The object was to investigate the effect of licensing requirements for motorcyclists on the risk of serious injury in the first year of riding compared to subsequent years. Riders operating on a learner's permit were found to have the highest risk of injury followed by those in their first year of riding. It was clear that more effective training procedures for motorcyclists should be developed.

The views expressed in this publication are those of the authors and do not necessarily represent those of the National Health and Medical Research Council, The University of Adelaide, the World Health Organization, the University of Malaya, the National University of Singapore or the Senri Critical Care Medical Centre.

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ISBN 0 908204 17 5

March 1990

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PREFACE

This is the final report of a study of motorcycle accidents carried out in Adelaide (South Australia), Kuala Lumpur (Malaysia), Singapore, and Suita (Japan) in 1986 and 1987. The study was carried out with the support of the World Health Organization, Western Pacific Regional Office, Manila.

ACKNOWLEDGEMENTS

A study of this type involves many people. Those listed on the title page were each responsible for the conduct of the study in one of the centres and A.J. McLean was the initiator and overall coordinator and prepared the final report. However the following persons also contributed significantly to the successful completion of the study:

Professor W.O. Phoon, the initial principal investigator in Singapore, now Professor of Occupational Medicine at Sydney University.

Ms. Jane S. Heyworth, now with the South Australian Health Commission, assisted in the early stages of the study in Adelaide.

Dr. J.M. Barker, NHMRC Road Accident Research Unit, carried out the study of the control group in Adelaide and performed the data processing and analysis on which the report is based.

Mrs. J.H. Chan, Department of Social and Preventive Medicine, University of Malaya.

Dr. Naotaka Shinfuku, Regional Adviser in Mental Health, Regional Office for the Western Pacific, World Health Organisation, Manila, who encouraged and supported the project.

SUMMARY

The effect of licensing requirements for motorcyclists on the risk of serious injury in the first year of riding compared to subsequent years was investigated in this study. The study was based on two centres where learner's permits were issued, Adelaide and Kuala Lumpur, and on two other centres, Singapore and Suita, where off-road rider training to the stage of full licensure was compulsory.

Riders operating on a learner's permit had the highest risk of injury followed by those in their first year of riding. It was not possible on the basis of this study to show that off-road rider training, as operating in Japan and Singapore, results in a meaningful reduction in the relatively high risk of injury experienced by the novice motorcyclist. It is therefore clear that there is a need for more effective training procedures for motorcyclists.

Recommendations are made relating to the investigation of ways to enhance the effectiveness of off-road rider training schemes, and of the reasons for differences in the average level of injury severity among riders injured in the four centres. It is also recommended that, because of their relatively high risk of accident involvement, novice riders should be prohibited from carrying a pillion passenger.

OBJECTIVES

Motorcycling can be an economical form of personal transport but motorcycle riders and passengers have little protection against injury in the event of an accident. Consequently casualties among motorcyclists form a large part of the traffic injury problem in many countries. For example, motorcyclists are the most commonly injured class of road user in Singapore. In Peninsular Malaysia motorcycle riders and pillion passengers account for almost half of the total number of fatally injured road users. In Australia and Japan the percentages are much lower (about 11 per cent and 16 per cent) but in all four countries the injured motorcyclist is typically a young male. The consequent loss of life expectancy and of productivity due to disabling injury is therefore unusually high for the number of cases.

The aim of this research project was therefore to identify ways in which the casualty rate among motorcyclists might be reduced, with particular reference to licensing requirements.

The emphasis on licensing requirements arose because there are differences in these requirements between countries in the Western Pacific Region and because one country, Singapore, introduced a major change in this regard in 1985.

In Japan, motorcycle rider training is conducted at off-road facilities and a licence to ride a motorcycle on the road is not issued until a satisfactory standard has been attained. This requirement does not apply to the riders of mopeds.

Before 1985, Singapore issued a learner's permit to operate a motorcycle on public roads, subject to the applicant having passed a test on the highway code. In October 1985 new licensing requirements were introduced, modelled on the Japanese system. Both theoretical and practical training were, and still are, required to be undertaken at an off-road rider training facility.¹

In Malaysia, a learner's permit to operate a small motorcycle (less than 90 cc engine capacity) can be obtained without first passing a test on the highway code. That test is taken when applying for a full licence, at which time a road test of riding proficiency is also conducted.

In Australia, motorcycle licensing requirements vary between the States. In South Australia at the time when this study was planned, a learner's permit was issued after first passing a test of knowledge of the highway code, and a full licence after a road test. This procedure was modified in 1987, with new riders in the major urban area of the state now being required to undertake two 4 hour periods of off-road rider training before being issued with a learner's permit.

Hypothesis

The differences in motorcyclist licensing procedures between the above jurisdictions indicated that a comparative study could be used to test the following hypothesis:

"off-road rider training during the learner period, with no on-road exposure until the full licence is awarded, will result in a lower risk of injury to a motorcyclist during the first six months* of on-road operation."

Consequently, the specific objectives of the study were:

- (1) To calculate the ratio of the motorcyclist casualty rate in the first six months of riding to the casualty rate during subsequent periods.
- (2) To describe the characteristics of licensing schemes for motorcyclists which are associated with a low ratio of casualty rates for inexperienced/experienced riders.

It was recognised that a study confined to Singapore could provide a direct test of the hypothesis, and indeed that has since been done.¹ However the potential benefit of a comparative study between countries is that it may provide some information on the extent to which the experience of one country might be applicable to the solution of a similar problem in another country.

The four study areas chosen were Singapore, Kuala Lumpur, Suita (near Osaka), and Adelaide. The first two areas are similar in many respects, other than licensing requirements. Suita, being in Japan, has licensing requirements which were adopted by Singapore, but in many other respects the two areas differ. Finally, Adelaide had licensing requirements similar to those superseded in Singapore but a traffic environment in which motorcycles form a small minority of the motorized vehicles; motorcycles

* Based on data collected in Adelaide in 1976-77²; subsequently changed to the first twelve months of on-road operation.

(including scooters and mopeds) constituted 3.5 per cent of registered vehicles in Adelaide in 1986 compared with 60 per cent in Kuala Lumpur and almost 30 per cent in Singapore and Suita.

APPROACHES

The study was based primarily on interviews with injured motorcycle riders who were treated at hospital for their injuries. In three of the centres information was also collected on riders who were not known to have been involved in an accident. The data collection procedures for each centre were as follows:

ADELAIDE

Cases: A total of 218 riders who were admitted for at least 24 hours to any one of the four major trauma hospitals in the city, were interviewed by an investigator from the NHMRC Road Accident Research Unit over a 12 month period from June, 1986.

Controls: A mail questionnaire was sent to 852 registered owners of motorcycles in July, 1989. These persons were selected rather than holders of a licence to ride a motorcycle because most persons in the latter category are no longer active motorcyclists. The control sample was matched to the cases by area of residence. Four controls were identified for each case rider. Four hundred and twenty eight, or 50.2 per cent of the 852 questionnaires were returned. Sixty six questionnaires could not be delivered, so the response rate on those that were delivered was 54.6 per cent.

KUALA LUMPUR

Cases: The cases consisted of 1,281 riders presenting at the General Hospital and the Universiti Hospital in Kuala Lumpur in September and October, 1986. Thirty five were recorded as having no injury and 940 were treated but not admitted. One hundred and thirty-six surviving cases were admitted to hospital for more than 24 hours.

Controls: A count was made of the numbers of persons applying for a learner's permit or a full licence to ride a motorcycle, or renewal of either permit or licence, during a two week period in 1987.

SINGAPORE

- Cases:** One hundred and ninety eight riders admitted to the Singapore General Hospital from April 1986 to June 1987 were interviewed.
- Controls:** Control riders were selected primarily from armed forces volunteers matched by age and sex with the case riders. Interviews with the controls were conducted in 1987.

SUITA

- Cases:** The cases comprised 648 riders who presented at the Senri Critical Care Medical Centre in Suita following involvement in an accident. Of these, 135 were found to be uninjured and 112 survivors were admitted to hospital for more than 24 hours. Most of the remainder were treated but not admitted (Table C1).
- Controls:** The Suita study did not include collection of a control sample.

Information Collected

The items of information obtained in all or most of the four centres are listed in Appendices A, B and C. Appendix A contains items relating to the characteristics of the accident including effects of alcohol; Appendix B contains rider characteristics; and Appendix C contains some information relating to the injuries sustained by the motorcyclists.

Because of the differences between centres with respect to case selection, the results for Kuala Lumpur and Suita are presented in two sets, one being for total cases and the other for cases admitted to hospital for more than 24 hours. This is done to facilitate between-centre comparisons of factors likely to affect, or be affected by, injury severity.

The data collected on the control sample in Kuala Lumpur are not listed in Appendix B, but are referred to in comparisons with information on the accident-involved riders later in the report.

FINDINGS

There were marked differences between the four centres in several respects, as can be seen in some of the tables in Appendices A and B, particularly with regard to the type of motorcycle and the category of licence held by the rider.

TYPE OF MOTORCYCLE

The type of motorcycle which was being ridden at the time of the accident is listed in Appendix A (Table A12). Virtually all of the riders in Adelaide and Kuala Lumpur were on machines which are categorized as motorcycles, although those in Adelaide were mainly much larger than those in Malaysia. Three-quarters of the riders in Singapore were on motorcycles, with the remainder on motor scooters. In Suita, two thirds of the accident-involved riders were on mopeds, with most of the others being on motorcycles.

LICENCE CATEGORY

The various categories of licence according to size of motorcycle are listed in Table B7. In Singapore and Kuala Lumpur the most common licence categories among the accident-involved riders were "less than 200cc" and "90 to 250cc" respectively. In Adelaide most of the injured riders were licensed to ride motorcycles of more than 250cc whereas in Suita two thirds of the riders involved in accidents were only licensed to ride mopeds (engine capacity less than 50cc).

There were instances in which the rider's licence category did not entitle them to operate the motorcycle being ridden at the time of the accident. This was particularly so in Adelaide where 11.7 per cent of the accident-involved riders who held a motorcycle operator's licence or learner's permit were riding a larger machine than was stipulated by their licence or permit. The corresponding percentage in Kuala Lumpur was 3.1 and in Singapore 1.6 per cent.

Even with the use of larger machines than permitted by their licence category, riders holding a licence in the "250cc or less" category in Adelaide were only slightly over-represented in the accident group when compared with the control sample (Table 1, based on data in Table B7 in Appendix B). However, in Singapore riders licenced to operate motorcycles under 200cc were clearly over-represented in the accident group (Table 1).

TABLE 1: PERCENTAGE OF RIDERS LICENSED TO RIDE ONLY SMALL MOTORCYCLES: ACCIDENT AND CONTROL GROUPS IN ADELAIDE AND SINGAPORE

	Adelaide (% ≤ 250cc)	Singapore (% < 200cc)
Cases	20.0	75.1
Controls	17.8	58.3
Relative Odds ^a	1.15	2.16

Note: ^a Relative odds of accident-involved rider being licensed to ride a smaller motorcycle than the control (non-accident-involved) rider.

UNLICENSED RIDERS

There were no unlicensed riders in the accident-involved sample in Singapore and only 2.2 per cent in Suita (Table B7). The corresponding percentages in the other two centres were 5.2 for Kuala Lumpur and 6.5 for Adelaide. However, when only those cases admitted to hospital for more than 24 hours were considered, these percentages rose to 5.6 per cent in Suita and 7.4 per cent in Kuala Lumpur.

Although Adelaide had the highest percentage of riders who did not have a licence to ride a motorcycle, just over half of those riders did have a car licence. In Suita, one third of the riders without a motorcycle licence had a licence to operate some other type of motor vehicle but in Kuala Lumpur only 1.3 per cent of the unlicensed riders were in that category.

AGE OF RIDER

The age distributions of the four groups of accident involved riders are listed in Table B2, together with control data for Adelaide and Singapore. The proportion of riders who were 25 years of age or less was in the 60 to 68 per cent range for all centres except Singapore, where slightly fewer than half were in this younger age group (Table 2).

TABLE 2: PERCENTAGE OF RIDERS AGED LESS THAN 26 YEARS

Centre	Per cent aged less than 26 years	Total No.
Adelaide:		
Cases	67.1	216
Controls	30.0	420
Kuala Lumpur:		
Cases	60.5 (64.2) ^a	1,265 (136) ^a
Singapore:		
Cases	48.5	198
Controls	40.7 ^b	182
Suita:		
Cases	65.2 ^c (64.3) ^a	673 (112) ^a

Note: ^a Numbers in parentheses represent cases admitted to hospital for more than 24 hours.

^b Controls matched to cases by age and sex.

^c 79.9 per cent for riders of motorcycles (excluding mopeds).

There was a marked difference between the age distributions of the cases and the controls in Adelaide, where the accident-involved riders were more than twice as likely to be in the younger (under 26 years) age group than were those in the control group. The age distributions for cases and controls in Singapore were similar because in that centre the controls were matched to cases by age and sex.

SEX OF RIDER

Motorcycling is predominantly a male activity in Adelaide, Kuala Lumpur and Singapore, but in Suita more than a quarter of the accident-involved riders were females. The female riders were, on average, older than the males, with 54.7 per cent being over 25 years of age compared to 27.5 per cent for the male riders. However, when moped riders were excluded, 92.5 per cent of the remaining motorcycle riders in Suita were males (for the "admitted to hospital" subset, this percentage was 97.0).

ALCOHOL

No riders in Suita had been drinking alcohol before their accident although there were four cases in which alcohol was a factor, presumably due to a road user other than the motorcyclist (Tables A13-A14). In Adelaide, where a blood alcohol reading was available for more than 92 per cent of the riders, just over a third of the riders had been drinking and 24.5 per cent of the total were above the legal blood alcohol limit of 0.08 g/100 mL. The requirement for riders on learner's permits to have no alcohol in their blood had little effect; 32.6 per cent had been drinking and 23.3 per cent were above 0.08. About two per cent of the riders involved in accidents in Kuala Lumpur (4 per cent of the "admitted to hospital" subset) were subjectively assessed as being affected by alcohol (Table A15). This would be an underestimate of the percentage who had been drinking.

In Singapore, alcohol was listed as having been a factor in the causation of one in ten of the accidents involving motorcyclists (Table A14). However this includes other road users who were involved in the accidents as well as the motorcyclist.

TYPE OF ACCIDENT

One-third of the accidents in Adelaide and Singapore and 39.1 per cent of those in Kuala Lumpur involved the motorcycle alone compared with 2.1 per cent in Suita (Table A10). However there are two factors which should be considered when comparing the types of accident between the four centres. The first is the difference in case selection between Adelaide and Singapore on the one hand, and Kuala Lumpur and Suita on the other. As noted earlier, the samples of injured riders in the former two centres were drawn from riders who were admitted to hospital, whereas in Kuala Lumpur and Suita the samples comprised riders who presented at hospital after an accident but who were

not necessarily admitted. As the severity of injury varies with the type of crash, for example only one of the riders whose motorcycle or moped collided with a pedestrian in Suita was severely injured, it is to be expected that comparisons based only on riders admitted to hospital in Kuala Lumpur and Suita will yield different results, as shown in Table A10.

The major change in type of accident when only riders admitted to hospital are considered was in Kuala Lumpur where the percentage of accidents that involved the motorcycle alone decreased from 39.1 per cent to 17.4 per cent (Table A10). The substantial reduction in Kuala Lumpur in the percentage involved in this type of accident was reflected in an increase in the percentage of riders whose accident involved a collision with another motor vehicle. A collision with another motorcycle or moped was the third most common type of accident in both Kuala Lumpur and Suita, regardless of the outcome of the accident in terms of hospital outpatient treatment or admission.

The second factor to be considered in this comparison of types of accident is the effect of the high proportion of mopeds in Suita. Again, as noted earlier, moped riders in that city were not required to complete a course of off-road rider training nor were they required to wear a protective helmet. However, the high percentage of mopeds in the sample did not contribute to this result as the relative proportions of the different types of accident were very similar for persons licensed to ride mopeds and those licensed to ride larger motorcycles.

There was a strong association between a rider's blood alcohol concentration (BAC) and the type of accident in the Adelaide sample (Table 3). Crashes which did not involve another party ("motorcycle alone") were much more likely to be alcohol related than were other types of accident.

**TABLE 3: TYPE OF ACCIDENT AND BLOOD ALCOHOL
CONCENTRATION OF RIDER: ADELAIDE**

Type of Accident	Blood Alcohol Concentration (g/100mL)			No. of Cases
	Zero	0.001-0.079	0.080+	
Motorcycle alone	46.3%	4.5%	50.2%	67 (100%)
Other than the above	67.1%	11.6%	21.2%	146 (100%)

PILLION PASSENGER

In about one quarter of the accidents in Kuala Lumpur and Singapore a pillion passenger was being carried on the motorcycle (Table A11). This proportion was much higher than in Adelaide, while in Suita hardly any of the machines carried a pillion passenger. These differences may indicate that motorcycles in Kuala Lumpur and Singapore are typically used more for transportation than in Adelaide. In Suita the very large proportion of mopeds, which usually cannot carry a pillion passenger, would have influenced the comparative lack of pillion passengers in the accident sample.

NOVICE RIDERS

There was a clear indication that novice riders were at greater risk of being injured than were more experienced riders. In Adelaide the risk was almost two times greater for motorcyclists in the first year of riding (Table 4). In Singapore the novice rider was 50 per cent more likely to be injured (this effect may have been diminished by the matching of controls with cases by age). In Kuala Lumpur the percentage of seriously injured motorcyclists (those admitted to hospital) who were in the first year of riding was similar to that for Singapore (14.1 per cent and 15.7 per cent respectively), whereas in Suita one-fifth of the seriously injured riders were in that category (Table B4, Appendix B). The relatively high percentage in Suita was not a consequence of the large proportion of moped riders in that sample; when only motorcycle riders were considered 32.3 per cent of all cases and 22.2 per cent of those seriously injured, were in the first year of riding.

In Singapore and Suita novice riders (those in the first twelve months of riding) were involved in similar types of accident to more experienced riders. However in Adelaide novice riders were more likely to be involved in "motorcycle alone" crashes; this applied also for the total sample in Kuala Lumpur, but seriously injured novice riders in that city were less likely to have had "motorcycle alone" crashes (Table 5). Although the percentage of "motorcycle alone" crashes was very low in Suita, the pattern of types of accident according to the categories in Table A10 was very similar for both novice and experienced riders, regardless of whether they were on a moped or a motorcycle.

TABLE 4: ACCIDENT INVOLVEMENT AND PERIOD SINCE FIRST LICENSED TO RIDE A MOTORCYCLE

	Percentage in First Year of Riding ^a			
	Adelaide	Kuala Lumpur	Singapore	Suita
Cases ^b	11.2	14.1	15.7	20.0 ^d
Controls ^c	5.7	-	10.4	-

Notes: ^a The 12 month period from receipt of first permit or licence to ride a motorcycle on the public road.

^b Accident-involved riders who were admitted to hospital for more than 24 hours.

^c Non-accident-involved riders.

^d See text.

TABLE 5: TYPE OF ACCIDENT AND PERIOD SINCE FIRST LICENSED

Period Since First Licensed ^a	Percentage of Crashes Involving Motorcycle Alone (Cases admitted to hospital for more than 24 hours)			
	Adelaide	Kuala Lumpur	Singapore	Suita
< 12 months	41.7	15.8	35.5	4.5
≥ 12 months	32.3	17.9	31.7	2.3

Note: ^a Refer to Note a in Table 4.

RIDERS ON LEARNER'S PERMITS

The accident experience of riders on a learner's permit could be investigated only in Adelaide and Kuala Lumpur. As noted earlier, in 1985 Singapore chose to adopt the Japanese procedure of off-road rider training up to the stage at which a motorcyclist is able to qualify for a full licence.

The percentage of riders holding a learners permit was more than four times greater among the accident-involved group in Adelaide than among the control, or non-accident-involved, group (Table 6).

TABLE 6: ACCIDENT INVOLVEMENT AND LEARNER'S PERMITS

	Percentage holding a Learner's Permit	
	Adelaide	Kuala Lumpur
Cases	22.8	20.5
Controls	5.3	5.8 ^a

Note: ^a Learner's permit for the smallest size of motorcycle.

In Kuala Lumpur the great majority of persons who wish to obtain a motorcycle licence first apply for a category B3 learner's permit. A category B3 licence authorizes the holder to operate a motorcycle having an engine capacity of less than 90cc. Having in due course obtained a B3 licence, the rider can then obtain a learner's permit for category B2, which applies to motorcycles of 90 to 249cc, and so on through to a category B licence for machines of 500cc or more (Table B7). Considering here only the holders of a B3 learner's permit, it was found that they were 3.5 times more likely to be involved in an accident, and 4.5 times more likely to be admitted to hospital, than were fully licensed riders.

INJURY CHARACTERISTICS

The information on injury severity in terms of the Injury Severity Score (ISS), which is presented in Table C3 of Appendix C, is influenced by the criteria used to select the accident-involved riders. As noted earlier, in Adelaide and Singapore the study was based on injured riders admitted to hospital. In Kuala Lumpur and Suita, all riders who presented at hospital, but many of whom were not injured severely enough to warrant admission, were selected. Only 10.7 per cent of the total cases in Kuala Lumpur and 17.3 per cent in Suita were admitted to hospital for more than 24 hours; the results for these admitted cases were used in comparing the injury data between centres. Injury details were available for only 34 of the 136 Kuala Lumpur cases, so comments regarding this group must be regarded as tentative. However, 30 per cent of the Adelaide riders had an

ISS of more than 10 compared with 23.5 per cent in Kuala Lumpur, 17.1 per cent in Singapore and 22.5 per cent in Suita.

Further comparative analysis of the injury data is difficult due to the small number in this sample of the Kuala Lumpur cases and to the fact that a maximum of three injuries were recorded in Singapore compared with six in the other three centres. Nevertheless, it may be noted that in all four centres the most frequently injured body region, with the exception of "superficial injuries", was "extremities and girdles" (Table C4). These injuries (mainly fractures) to the limbs, pelvis and shoulder constituted nearly 40 per cent of the total injuries for the Adelaide sample and less than 30 per cent for each of the other three centres. On the other hand, in Adelaide where the wearing of an approved helmet is compulsory, and virtually universally complied with, for motorcyclists exceeding a speed of 25 km/h, injuries (other than superficial) to the head, face and neck accounted for 13.9 per cent of all injuries. Full-face helmets account for the great majority of all helmets used in Adelaide. In Singapore and Kuala Lumpur where helmet wearing is also compulsory, the full-face helmet is rarely used, being prohibited for security reasons in Singapore. Injuries to the head, face and neck were 20.5 per cent of the three most severe injuries in Singapore, 30.8 per cent of all injuries in Kuala Lumpur and 16.1 per cent in Suita.

OBSERVATIONS

As noted at the start of the previous section, there were major differences between the four centres in several respects. It is clear that motorcycling is not a similar activity in Kuala Lumpur (or Singapore) and Suita, nor is motorcycling in Adelaide similar to any of the other three centres. Hence in this study, which has been focussed on the relevance of licensing requirements in motorcycle accident prevention, it has been necessary to consider also the influence of several other factors. These include the type and size of the motorcycle; characteristics of the rider, including age, sex, and alcohol level; and the type of accident.

In Adelaide, until recently, a rider could obtain a learner's permit and then ride a motorcycle of up to 250cc on the road, without any prior formal training. Most (58%) of the accident-involved riders in Adelaide taught themselves to ride a motorcycle. A further 38 per cent had some informal tuition from a friend or relative. That situation has now changed, but the extent of off-road training is trivial by comparison with Japanese practice for motorcycle (not moped) riders, which has been followed in Singapore since 1985. The choice of 250cc as the limit on the size of motorcycle for a learner rider in Adelaide means that some high performance motorcycles, which may not be easy to control, can legally be operated by learners. However, as mentioned earlier, riders involved in accidents in Adelaide did not necessarily observe the legal restrictions on motorcycle size; 11 per cent of them were riding a larger motorcycle than was allowed by their licence or permit category when they were involved in an accident. Nor did learner riders appear to be influenced by the legal prohibition on riding with a positive blood alcohol level in Adelaide; almost one third of them had been drinking, the same proportion as for fully licensed motorcyclists. Adelaide riders involved in accidents were the youngest of the four centres, with two thirds under 26 years of age. Finally, the accident sample in Adelaide differed from those of the other three centres in that nearly 15 per cent of the accidents were on roads having a speed limit of 100 km/h or greater. There were no such cases in Singapore, and in Suita the highest speed limit at any of the accident sites was 60 km/h. In Kuala Lumpur 1.4 per cent of the accident cases occurred on roads having a speed limit above 80 km/h.

The sample of accidents in Suita differed from the other three centres in that there were very few crashes involving the motorcycle alone, compared to at least one third of all crashes being in this category in the other centres. As this characteristic of the Suita crashes implies, other types of crash, such as collisions with pedestrians, pedal cyclists

and light commercial vehicles were much more common in Japan. The lack of crashes involving the motorcycle alone was not a consequence of the very high proportion of mopeds, or of the high proportion of female riders (26.6 per cent compared to a maximum of 2.8 per cent in the other three centres). The fact that none of the roads had a speed limit greater than 60 km/h, and the reported total absence of alcohol use by the riders in Suita would have tended to limit the frequency of crashes involving the motorcycle alone. However the possibility of some artifact in the reporting procedure should not be discounted.

Singapore riders who were involved in accidents were somewhat older than those in the other centres. More than half of them were over 25 years of age, compared to about one third in Adelaide and Suita (20 per cent for riders of motorcycles other than mopeds in Suita; the moped riders were older) and 40 per cent in Kuala Lumpur. This may reflect differences in the use that is made of motorcycles, at least between Adelaide, where recreational riding is popular, and Singapore and Kuala Lumpur where the motorcycle plays an important role in basic personal transportation. This would be consistent with the finding, noted earlier, that about a quarter of the motorcycles involved in accidents in both these centres were carrying a pillion passenger.

Kuala Lumpur had the highest proportion of crashes involving the motorcycle alone, even though alcohol appeared to play a very small role in that centre. However, only 4.4 per cent of these crashes resulted in serious injury. The proportion of accidents which involved collisions between two motorcycles was also high, doubtless a reflection of the predominance of motorcycles among the motor vehicle population (about 60 per cent of the registered motor vehicles are motorcycles).

With differences between the centres of the type and magnitude described above it is clear that considerable care is needed when attempting to evaluate the effects of differences in licensing requirements on the rate of crashes involving motorcyclists. However there are some observations which can be made on the basis of the information which has been collected in this study.

First, comparison of the data from Adelaide and Singapore, the two centres where detailed information was obtained on non-accident-involved riders, shows that novice riders (those in the first year of riding) were at greater risk of being injured than were more experienced riders. This indicates the desirability of replacing the learner's permit stage, where it exists, with an effective period of off-road rider training prior to licensing.

As the Singapore off-road rider training scheme is based on the Japanese practice, as noted earlier, it is surprising to find that the centre with, by far, the highest involvement of novice riders in crashes was Suita. At 32.3 per cent, the proportion of novice motorcycle riders (excluding moped riders, who do not have to take part in off-road training) among those involved in accidents in Suita was double that in Singapore and Kuala Lumpur and three times that in Adelaide. However it should be noted that novice riders in Adelaide and Singapore were much more likely to be involved in "motorcycle alone" crashes (Table 5) and that type of accident was very rare in Suita. Furthermore, the distribution of types of accident involving motorcyclists in Suita was very similar for both novice and experienced riders. One possible explanation is that involvement in an accident in Suita was more a function of the actions of another road user rather than those of the motorcyclist, which in turn may be a consequence of differences in factors such as traffic density between the four centres. Finally, the percentage of motorcycle (not moped) riders in Suita who were young (less than 26 years) males was 82 per cent, which was much higher than in the other centres. That may have contributed to the relatively high proportion of novice riders among those injured in Suita.

The role played by licensing requirements can also be assessed by comparing the data from Adelaide and Kuala Lumpur, the two centres out of the four studied which still have the learner's permit stage. In both of these centres riders operating on a learner's permit were at least four times more likely to be admitted to hospital as a result of being involved in an accident than were fully licensed riders.

The injury data for riders admitted to hospital for more than 24 hours in each centre indicates that, on average, the accident-involved riders in the Adelaide sample were injured more severely than those in the other centres. This illustrates, yet again, that it is not reasonable to assume that motorcycling, or its consequences, has similar characteristics in different countries.

CONCLUSIONS

In highly developed motorized countries motorcycling is regarded, with considerable justification, as being a relatively dangerous activity. The Australian data support such a view. However it is clear that many basic characteristics of motorcycling in Australia are not found in Japan, with Singapore and Malaysia being different again.

Despite these differences it has been possible to show that riders operating on a learner's permit have four times the risk of fully licensed riders of being injured seriously enough to warrant admission to hospital in Adelaide and Kuala Lumpur. This result indicates a need for improvements in the learner's permit system. Novice riders, i.e. those in the first year of riding, had a lower risk of injury than those on a learner's permit but still double that of more experienced riders in Adelaide and fifty per cent greater than that in Singapore. Furthermore, in Suita there was by far the highest percentage of novice riders among those injured, followed by Singapore: the two centres which had off-road rider training.

Risks to pillion passengers were not focussed upon in this study but, in view of the higher than average risk of accident for novice riders and riders with learner permit status, it seems reasonable to suggest that these riders should be prohibited from carrying a pillion passenger.

It is not possible, on the basis of this study, to conclude that off-road rider training to the stage of full licensure, as operating in Japan and Singapore, results in a meaningful reduction in the relatively high risk of injury experienced by the novice motorcyclist. Such training may have some benefits in safety terms, possibly including a reduction in the rate of applications for a motorcycle licence (a factor that was not included in this study), but there appears to be considerable potential for further development. It is clear that factors other than licensing procedures are also important and they too need further investigation. Similar conclusions have been reached by other investigators who have been unable to show that pre-license training decreases the risk of subsequent accident involvement.³

RECOMMENDATIONS

1. There is a need for more effective training procedures for motor- cyclists because there is a high risk of serious injury to novice riders compared with those who are more experienced. Furthermore, it has not been possible to show in this study that, in centres with a compulsory pre-licence off-road rider training scheme, novice riders have a lower risk of serious injury relative to more experienced riders than is the case in centres which do not have such a scheme. It is therefore recommended that:
 - a more detailed investigation be conducted of a pre-licence off-road rider training scheme, such as that operating in Singapore, and its potential for further development. The investigation should relate the training curriculum to the characteristics of subsequent accident involvement.

2. It is possible that the introduction of a compulsory pre-licence off-road rider training scheme could influence a person's decision to apply for a motorcycle rider's licence. As such a scheme was introduced in Singapore in 1985 and, although a far less comprehensive scheme, in Adelaide in 1987, it is recommended that:
 - the effect of the introduction of a compulsory pre-licence off- road rider training scheme on the rate of applications for a motorcycle rider's licence be investigated in Singapore and Adelaide.

3. Because novice motorcyclists have a relatively high risk of accident involvement, it is recommended that:
 - motorcyclists operating on a learner's permit or in the first year of riding, should not be permitted to be accompanied by a pillion passenger.

4. Motorcycle riders admitted to hospital in Adelaide were, on average, injured more severely than those admitted to hospital in the other centres included in the study. It is therefore recommended that:
 - the reasons for the observed differences in injury severity between Adelaide and the other centres be investigated further with a view to the identification of factors susceptible to change in the Adelaide setting.

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APPENDIX A: ACCIDENT CHARACTERISTICS

	ADELAIDE (Adm)* %	KUALA LUMPUR (Adm)* %	(Total) %	SINGAPORE (Adm)* %	SUITA (Adm)* %	(Total) %
(Percentages calculated on known cases for each category, throughout)						
Table A1: <u>DAY OF WEEK</u>						
Sunday	18.5	12.5	12.8	19.3	8.0	14.1
Monday	13.9	16.2	15.9	12.2	17.0	16.8
Tuesday	13.4	9.6	14.8	14.7	20.5	15.6
Wednesday	8.8	12.5	13.4	12.2	16.1	14.3
Thursday	9.7	17.6	14.9	14.2	12.5	14.7
Friday	21.3	17.6	15.3	14.2	17.9	13.2
Saturday	14.4	14.5	12.9	13.2	8.0	11.3
Total No. Known Cases	216	136	1281	197	112	673
Table A2: <u>TIME OF DAY</u>						
0001-0600	10.6	2.2	4.9	14.2	5.4	4.0
0601-1200	14.8	36.0	31.1	21.6	36.6	39.4
1201-1800	38.9	27.2	34.1	32.6	28.6	36.2
1801-2400	35.7	34.6	29.9	31.6	29.5	20.4
Total No. Known Cases	216	136	1275	190	112	673
Table A3: <u>LIGHTING</u>						
Day	59.0	65.4	66.8	48.2	68.5	75.0
Dawn-dusk	6.9	0.0	0.0	12.5	0.0	0.1
Night, street illuminated	21.7	34.6	33.2	37.2	31.5	24.9
Night, street not illuminated	12.0	0.0	0.0	2.1	0.0	0.0
Other	0.4	0.0	0.0	0.0	0.0	0.0
Total No. Known Cases	217	136	1281	191	111	672
Table A4: <u>WEATHER</u>						
Fine	94.5	90.4	84.6	89.4	74.1	77.1
Rain or fog	5.5	9.6	15.4	10.6	9.8	8.5
Snow or sleet	0.0	0.0	0.0	0.0	0.0	0.4
Other	0.0	0.0	0.0	0.0	16.1	14.0
Total No. Known Cases	217	136	1281	189	112	673

* Results under this heading are for cases admitted to hospital for more than 24 hours, throughout.

	ADELAIDE	KUALA LUMPUR		SINGAPORE	SUITA	
	(Adm) %	(Adm) %	(Total) %	(Adm) %	(Adm) %	(Total) %
Table A5: ROAD CONDITIONS						
Dry	88.8	86.0	75.6	85.7	90.9	91.7
Wet	10.0	11.8	19.0	13.2	9.1	7.7
Snow	0.0	0.0	0.0	0.0	0.0	0.5
Other	1.2	2.2	5.4	1.1	0.0	0.1
Total No. Known Cases	169	136	1281	189	110	671

Table A6: ROAD LAYOUT

Intersection	47.6	26.5	29.6	34.4	62.1	60.7
Midblock	46.6	64.0	56.8	47.8		
Other	5.8	9.5	13.6	17.8	37.9	39.3
Total No. Known Cases	189	136	1281	186	111	671

Table A7: ROAD TYPE

Expressway	1.5	5.9	7.2	14.1	0.0	0.1
Other major road	59.3	87.5	87.7	43.3	48.2	48.9
Minor route	20.4	2.2	2.7	27.0	51.8	50.4
Minor street	12.2	3.7	2.3	12.4	0.0	0.6
Other	6.6	0.7	0.1	3.2	0.0	0.0
Total No. Known Cases	196	136	1281	185	112	671

Table A8: SITE SPEED LIMIT

15-30 km/h	0.0	2.2	4.3	1.6	36.0	33.2
31-60 km/h	82.0	89.0	86.5	82.9	64.0	66.8
61-80 km/h	3.3	8.1	7.8	15.5	0.0	0.0
81-100 km/h	1.6	0.7	1.4	0.0	0.0	0.0
110 km/h	13.1	0.0	0.0	0.0	0.0	0.0
Total No. Known Cases	183	136	1281	181	112	664

Table A9: ESTIMATED SPEED OF MOTORCYCLE

0-14 km/h	3.9	7.0	4.3	10.6	3.6	6.4
15-30 km/h	13.0	24.3	27.3	12.6	63.4	60.8
31-60 km/h	62.3	58.3	53.9	70.7	32.2	31.1
61-80 km/h	10.4	7.8	12.3	6.1	1.8	1.5
81-100 km/h	5.2	2.6	1.8	0.0	0.0	0.2
110 km/h	1.3	0.0	0.2	0.0	0.0	0.0
> 110 kph	3.9	0.0	0.2	0.0	0.0	0.0
Total No. Known Cases	77	115	1174	198	112	673

	ADELAIDE (Adm) %	KUALA LUMPUR (Adm) %	(Total) %	SINGAPORE (Adm) %	SUITA (Adm) (Total) % %	
Table A10: TYPE OF ACCIDENT						
(i) All riders:						
M/cycle alone	33.3	17.4	39.1	33.5	3.6	2.1
M/cycle - animal	1.9	0.0	0.9	3.1	0.0	0.2
M/cycle - pedestrian	0.0	1.6	4.0	1.0	0.9	8.3
M/cycle - pedal cycle, trishaw	0.0	0.8	1.2	0.0	0.9	9.7
M/cycle - m/cycle	1.4	16.7	12.3	3.7	11.6	11.2
M/cycle - car	54.6	48.4	35.4	44.0	59.8	49.2
M/cycle - LCV (light commercial vehicle)	0.9	3.2	1.9	7.9	22.3	18.1
M/cycle - bus, lorry	4.2	11.9	5.0	5.2	0.0	0.3
M/cycle - other	3.7	0.0	0.2	1.6	0.9	0.9
Total No. Known Cases	216	126	1267	191	112	670
(ii) Novice riders*:						
M/cycle alone	41.7	15.8	55.0	35.5	4.5	1.7
M/cycle - animal	0.0	0.0	0.0	3.2	0.0	0.0
M/cycle - pedestrian	0.0	0.0	3.8	0.0	0.0	9.7
M/cycle - pedal cycle, trishaw	0.0	5.3	1.5	0.0	4.5	12.5
M/cycle - m/cycle	4.2	15.8	5.3	6.5	18.2	11.4
M/cycle - car	50.0	42.1	23.7	41.9	50.0	48.9
M/cycle - LCV	0.0	0.0	3.1	6.5	22.7	15.3
M/cycle - bus, lorry	4.2	21.1	6.9	3.2	0.0	0.0
M/cycle - other	0.0	0.0	0.8	0.0	0.0	0.6
Total No. Known Cases	24	19	131	31	22	176
(iii) Riders with learner's permits:						
M/cycle alone	47.8	17.8	42.1			
M/cycle - animal	0.0	0.0	0.9			
M/cycle - pedestrian	0.0	2.2	3.9			
M/cycle - pedal cycle, trishaw	0.0	2.2	1.3			
M/cycle - m/cycle	4.3	8.9	9.7			
M/cycle - car	43.5	46.7	33.5			
M/cycle - LCV	0.0	4.4	2.1			
M/cycle - bus, lorry	2.2	17.8	6.5			
M/cycle - other	2.2	0.0	0.0			
Total No. Known Cases	46	45	463	Not Applicable	Not Applicable	

* Novice riders = riders in their first year of riding.

	ADELAIDE (Adm) %	KUALA LUMPUR (Adm) %	(Total) %	SINGAPORE (Adm) %	SUITA (Adm) %	(Total) %
Table A11: <u>PILLION PASSENGER</u>						
Yes	10.9	22.4	24.2	26.9	1.8	2.7
No	89.1	77.6	75.8	73.1	98.2	97.3
Total No. Known Cases	147	134	1272	197	112	670

Table A12: TYPE OF MOTORCYCLE

Moped	0.5	0.0	0.0	0.0	67.6	65.1
Scooter	2.3	3.7	2.6	25.3	1.8	4.1
Motorcycle	97.2	96.3	97.4	74.7	30.6	30.8
Total No. Known Cases	218	136	1281	198	111	660

Table A13: RIDER BAC (gm/100 mL)

Zero	66.2	Not Available	Not Available	100.0
0.001-0.050	8.0			
0.051-0.080	2.0			0.0
0.081-0.150	13.4			0.0
0.151+	10.4			0.0
Total No. Known Cases	201			673

Table A14: ALCOHOL A FACTOR

No	Not Available	Not Available	89.9	98.2	99.4
Yes			10.1	1.8	0.6
Total No. of Known Cases			198	112	673

Table A15: SUBJECTIVE EVIDENCE OF ALCOHOL CONSUMPTION BY RIDER

No	Not Available	96.3	97.9	Not Available	100.0
Yes		3.7	2.1		0.0
Total No. Known Cases		136	1258		673

APPENDIX B: RIDER CHARACTERISTICS

	ADELAIDE		KUALA LUMPUR		SINGAPORE		SUITA		
	Accident Cases (Adm)* %	Controls %	Accident Cases (Adm)* %	(Total) %	Accident Cases (Adm)* %	Controls %	Accident Cases (Adm)* %	(Total) %	
Table B1: SEX					(Singapore cases and controls matched by sex)				
Male	97.2	92.9	99.3	99.4	99.0	99.5	70.5	73.4	
Female	2.8	7.1	0.7	0.6	1.0	0.5	29.5	26.6	
Total No. Known Cases	218	423	136	1281	198	182	112	673	
Table B2: AGE					(Singapore cases and controls matched by age)				
16 yrs or less	3.7	0.0	0.0	0.5	0.0	0.0	7.1	6.5	
17-20	32.4	8.3	23.9	23.6	19.7	13.2	38.4	39.8	
21-25	31.0	21.7	40.3	36.4	28.8	27.5	18.8	18.9	
26-40	26.9	46.4	29.1	31.7	37.9	41.7	17.9	19.5	
Over 40 yrs	6.0	23.6	6.7	7.8	13.6	17.6	17.9	15.3	
Total No. Known Cases	216	420	134	1265	198	182	112	673	
Table B3: RIDING FREQUENCY									
Daily, commercial	2.8	26.4	41.0	33.5	15.7	92.9)	0.0	0.6	
Daily, private	81.5	37.6	47.8	58.7	77.8	7	82.9	78.9	
Weekly	8.8	13.5	6.0	5.2	4.0	7.1	14.4	19.2	
Monthly	3.7	6.4	0.7	0.7	1.0	0.0	0.9	0.5	
Annually	1.8	11.6	3.0	1.7	1.0	0.0	1.8	0.5	
Other	1.4	4.5	1.5	0.2	0.5	0.0	0.0	0.3	
Total No. Known Cases	216	421	134	1241	198	182	111	673	

* See note on Appendix A /1

	ADELAIDE		KUALA LUMPUR		SINGAPORE		SUITA	
	Accident Cases (Adm) %	Controls %	Accident Cases (Adm) %	Accident Cases (Total) %	Accident Cases (Adm) %	Controls %	Accident Cases (Adm) %	Accident Cases (Total) %

Table B4: RIDING EXPERIENCE

(i) Riders of mopeds and motorcycles:

< 1 year	11.2	5.7	14.1	10.9	15.7	10.4	20.0	26.5
≥ 1 year	88.8	94.3	85.9	89.1	84.3	89.6	80.0	73.5
Total No. Known Cases	215	423	135	1261	198	182	110	667

(ii) Riders of motorcycles only (Suita):

< 1 year							22.2	32.3
≥ 1 year							77.8	67.7
Total No. Known Cases							36	198

Table B5: MOTORCYCLE/MOPED OWNERSHIP

Yes (a) ¹	88.9	Not	64.4	73.8	79.8	Not	92.5	91.9
Yes (b) ²	5.1	Applicable	6.1	8.7	6.6	Applicable	0.0	0.0
No (a) ³	5.1		29.5	17.3	13.6		0.0	0.1
No (b) ⁴	0.9		0.0	0.2	0.0		7.5	8.0
Total No. Known Cases	216		132	1241	198		108	666

¹ Yes (a) = Owned accident motorcycle/moped

² Yes (b) = Owned a motorcycle/moped but not that involved in accident

³ No (a) = Owned no motorcycle/moped

⁴ No (b) = Not owner of accident motorcycle/moped, not known if owned one at all

	ADELAIDE		KUALA LUMPUR		SINGAPORE		SUITA	
	Accident Cases (Adm)	Controls	Accident Cases (Adm)	(Total)	Accident Cases (Adm)	Controls	Accident Cases (Adm)	(Total)
	%	%	%	%	%	%	%	%
Table B6: HELMET WORN AT TIME OF ACCIDENT								
Yes	Not recorded	Not	96.2	97.4	99.0	Not	77.7	68.2
No	(see text "Injury	Applicable	3.8	1.9	1.0	Applicable	22.3	31.8
Turban	Characteristics")		0.0	0.7	0.0		0.0	0.0
Total No. Known Cases			133	1255	198		112	672

Table B7: LICENCE CATEGORY

None	6.5	3.8	7.4	5.3	0.0	0.0	5.4	2.2
<u>Adel.</u> Learner's Permit	21.3	5.0						
≤ 250cc	14.3	15.8						
> 250cc	57.4	72.9						
Other	0.5	2.5						
<u>K.L.</u> Learner's B3			19.9	20.8				
Learner's B2			11.0	12.1				
Learner's B			5.9	4.2				
Full licence B3 (< 90cc)			4.4	4.0				
Full licence B2 (90-249cc)			44.9	49.1				
Full licence B1 (250-499cc)			0.7	0.5				
Full licence B (500+cc)			5.9	4.0				
<u>Sing.</u> Learner's Permit					0.0	0.5		
< 200cc					73.3	57.7		
≥ 200cc					24.2	41.2		
<u>Malaysian</u>					2.5	0.5		
<u>Suita</u> < 50cc							62.2	67.4
50-< 125cc							0.0	0.5
125-< 250cc							4.5	4.4
> 249cc							27.9	25.5
Total No. Known Cases	216	424	136	1262	198	182	111	666

	ADELAIDE		KUALA LUMPUR		SINGAPORE		SUITA	
	Accident Cases (Adm) %	Controls %	Accident Cases (Adm) %	Accident Cases (Total) %	Accident Cases (Adm) %	Controls %	Accident Cases (Adm) %	Accident Cases (Total) %
Table B8: LICENCE STATUS								
Current	97.4	96.6	88.4	92.2	99.5		100.0	99.8
Expired	1.6	1.3	10.8	7.7	0.0	Not	0.0	0.0
Suspended	0.5	2.1	0.0	0.0	0.5	Available	0.0	0.1
Cancelled	0.5	0.0	0.8	0.1	0.0		0.0	0.1
Total No. Known Cases	189	381	121	1167	197		107	651

Table B9: ANY OTHER LICENCE?

Yes	79.3	93.4	38.2	38.5	45.4	48.6	44.1	41.9
No	20.7	6.6	61.8	61.5	54.6	51.4	55.9	58.1
Total No. Known Cases	217	424	136	1261	196	181	111	670

APPENDIX C: INJURY CHARACTERISTICS

	ADELAIDE (Adm)* %	KUALA LUMPUR (Adm)* %	(Total) %	SINGAPORE (Adm)* %	SUITA (Adm)* %	(Total) %
Table C1: CLASS OF CASUALTY						
Fatality within 24hrs	0.0		2.8	Not Available		0.8
Fatality after 24hrs	0.0		0.5			0.5
Hospitalised > 24hrs	100.0	100.0	10.7		100.0	17.3
Hospitalised up to 24hrs	0.0		9.7			2.0
Other treatment	0.0		73.6			58.6
No injury	0.0		2.7			20.8
Total No. Known Cases	218	136	1277		112	648
Table C2: OTHERS INJURED						
Yes	18.8	27.2	26.2	27.0	4.5	22.9
No	81.2	72.8	73.8	73.0	95.5	77.1
Total No. Known Cases	170	136	1281	196	112	669
Table C3: RIDER ISS VALUES						
0	0.0	0.0	69.4	0.0	0.0	8.4
1-5	25.8	58.8	26.1	48.0	41.4	74.0
6-10	44.3	17.6	3.0	34.8	36.0	11.4
11-19	23.7	20.6	1.2	13.6	16.2	4.5
20 or more	6.2	2.9	0.3	3.5	6.3	1.7
Total No. Known Cases	194	34	1281	198	111	666
Table C4: RECORDED INJURIES						
Head or neck	11.7	17.5	6.6	18.3	14.2	14.4
Face	2.2	1.3	3.6	2.2	1.9	1.2
Chest	4.0	2.5	1.1	4.3	2.5	2.5
Abdomen & pelvic contents	2.9	0.0	0.3	1.5	1.9	0.7
Extremities and girdles	39.1	21.7	17.2	24.8	27.9	23.4
External	40.1	45.0	71.2	48.9	51.6	57.8
Maximum number recorded/case	(6)		(6)	(3)		(6)
Total No. Injuries	631	120	868	552	359	1513
Total No. Known Cases	194	34	1281	198	111	666

* See note on Appendix A /1.