Vulnerable road user safety: A comparison between a middle-income and a high-income country

by Jennie Oxley[1], Brian Fildes[2], Farhan Sadullah[3], Julie Lahausse[4] and Stuart Newstead[4]

[1]Monash University Accident Research Centre (MUARC) Malaysia, School of Engineering, Sunway Campus, Malaysia
[2]Monash University Accident Research Centre (MUARC) Europe, Monash University Prato Centre, Italy
[3]Malaysian Institute of Road Safety, Kajang, Malaysia
[4]Monash University Accident Research Centre (MUARC) Australia, Clayton Campus, Victoria

Abstract

The study set out to compare crash and injury patterns of Vulnerable Road Users (VRU) between a high- and a middle-income country to illustrate relative outcomes between such countries. Several analyses of crash and casualty crash patterns were undertaken using real-world crash databases from Australia and Malaysia. The factors examined included the type of vulnerable road user, the vehicle involved, the primary crash cause, age of the road user, injury outcome (fatal or casualty), crash location and single/multi-vehicle collisions. The findings from this study highlighted emerging and severe road crash problems currently not being addressed in existing safety initiatives within these countries by governments or vehicle manufacturers.

A number of potential solutions to these problems were identified including engineering countermeasures for vehicles and road infrastructure, greater use of protective equipment for riders, enhanced police enforcement efforts and technologies, and improved training and licensing practices. Public policy response to this growing epidemic in low and middle-income countries has been muted at national and international levels and policy makers need to recognise this growing problem as a public health crisis and design appropriate policy responses. With growing usage of VRU transport in developing countries, this burden is expected to become even larger in the years ahead unless action is taken.

Keywords

Road safety, Middle-income countries, Motorcyclist, Pedestrian, Cyclist, Countermeasure

Introduction

Road transportation provides real benefits to society. It is associated with economic growth and enhanced mobility for populations, including the provision of improved access to education and health services. The benefits, however, come at a severe cost: around 1.3 million people die on the world's roads each year from road crashes. Even more alarming is the injury rate associated with road trauma: each year up to 50 million people are injured or disabled worldwide in road traffic crashes [1].

Moreover, the World Health Organization [2] reported that a high proportion of these deaths (up to 90%) occur in the world's poorest countries and this number is still on the increase, even though low and middle-income countries have less than half the world's vehicles [2]. Indeed, it has been estimated that, unless immediate action is taken, road deaths will rise to become the fifth leading cause of death by 2030, resulting in an estimated 2.4 million fatalities per year [2]. Coupled with this are enormous costs to individuals, families and the community, with an estimated economic cost of USD518 billion each year from road crash fatalities.

Vulnerable road users (VRU) represent a sizeable annual trauma burden internationally. The road safety community typically define VRUs as either those who are inexperienced or fragile (i.e., children, adolescents or seniors) or those who are more exposed to injury in the event of a crash, such as pedestrians, motorcyclists or bicyclists [2]. It is generally accepted that these road user groups are more vulnerable compared to occupants of cars, small and large trucks and buses as they are less protected due to their mode of transport or personal characteristics.

The protection of vulnerable road users is a critical area of road safety, particularly in low and middle-income countries given their high presence on the road and the particular risks associated with these modes of travel. There are various ways of defining a country's development and it is most commonly measured with statistical indexes such as income per capita (GNI), life expectancy, the rate of literacy, etc. Lists of countries by development can be found at http://data.worldbank.org/about/country-classifications and http://www.imf.org, http://unstats.un.org).

It is reported that in high-income countries, the majority of deaths occur amongst car occupants, while in many poorer countries, over half of those killed are pedestrians, cyclists or motorcyclists [3]. As examples, in Australia, there were approximately 6.8 deaths per 100,000 population in 2007, with 71 per cent being vehicle drivers and passengers, and smaller proportions of pedestrian deaths (13%), cyclist deaths (2%) and motorcyclist deaths (15%). Similar trends are apparent in other high-income countries including the US, the UK and Western Europe. In contrast, in Bangladesh, there were approximately 12.6 deaths per 100,000 population overall in the same year and pedestrians deaths made up over half of road

deaths (54%). Interestingly, car occupants contributed to only 26 per cent of road deaths, and motorcyclists and cyclists to 11 per cent [2].

Even in middle-income countries, the majority of those injured or killed are vulnerable road users. For instance, Malaysia, a middle-income country that has a rapidly growing economy, has an associated high level of road trauma (24.1 deaths per 100,000 population), where 58 per cent of road deaths are motorcyclists and 23 per cent are vehicle occupants. Pedestrians and cyclists account for 10 per cent and 3 per cent of road deaths, respectively [2].

The numbers of deaths and serious injuries involving VRUs are not decreasing and appear even to be on the rise in some middle-income countries. Indeed, there are suggestions that the economic development of regions and nations is associated with an increase in the number of injuries and deaths from road traffic crashes [4, 5].

This paper therefore set out to examine trends in VRU casualties in more detail to illustrate differences in crash patterns, types of crashes and crash victims, using data from Malaysia (a middle-income country) and Australia (a high-income country). It is expected that this will identify potential road safety priorities, countermeasures and safety initiatives, of relevance in these differing countries. These countries were chosen as they represent a good contrast in traffic characteristics and mobility patterns for which representative data were available.

Data analysis

Police-based mass databases were available for analysis from the M-ROADS database in Malaysia, the police data maintained by the Malaysian Institute of Road Safety (MIROS), and police data collected from five Australian states: Victoria, New South Wales, Queensland, South Australia and Western Australia (95% of the Australian population). These two databases comprise crash records and were expected to reveal different patterns of crashes and injury outcomes for VRUs given their varying levels and types of motorisation.

Individual analyses were performed on these data by representatives of each country, using a common analysis format. The data period for the years 2005 to 2008 was selected for analysis and reported separately by each country. An overall analysis was then assembled, comparing each of the three countries to highlight similarities and differences.

Analysis procedure

The dependent variable in these analyses was the proportion of crashes by each road user type. Each analysis focused on a number of common variables, including (i) outcome severity (killed or casualty crash, i.e., requiring hospital treatment), (ii) type of vehicle involved (motorcycle, pedestrian, bicycle, passenger car, and bus or truck), (iii) area of the crash location (urban/rural), (iv) who hit who, and (v) age group of the crash victim (all ages and young drivers/riders). Different levels of risk for fatal and all casualty crashes were also computed for the various VRU groups in each country using the numbers of victims per registered vehicle for further comparison.

These databases were predominantly crash-based and inclusion criteria were applied across all of them for consistency. Where a collision occurred between a passenger car and a motorcycle for instance, each was counted twice, once for the passenger car and again for the motorcycle. If the collision was between two passenger cars, however, it was only counted once. However, for the analyses considering which vehicle hit which road user, all the vehicles have been considered. The risk analyses, though, were person-based, as is the conventional practice for computing these figures.

The number and percentage of crashes included those involving both a fatal and casualty crash outcome, as determined by the attending police officer. Fatal crashes were defined as those where at least one of the crash victims was killed within 30 days of the crash, while casualty crashes comprised those where no one was killed but where at least one victim was injured and recorded as a casualty. It was expected that fatal crashes would differ from those where someone was a casualty, as this reflects different levels of crash severity. No distinction was made between severe and moderate injuries to keep the analyses manageable.

No attempt was made to evaluate these differences statistically because of the sizeable number of cases involved in the two countries. Moreover, while we acknowledge the importance of exposure measures, comparative exposure data was not available. Hence, the findings comprised a purely descriptive analysis of differences between these two countries. The analysis, however, is useful as an overview of crash trends and helpful in setting the research agenda in these countries.

Results

Proportion of VRU crashes

Fatal and casualty crashes were analysed by road user type and outcome severity in both countries (Table 1) to illustrate proportional differences.

Table 1. Proportion of crashes by road user type, country and outcome severity

Road user type	Malaysia		Australia	
	Fatal	Casualty	Fatal	Casualty
Trucks & buses	6.9%	9.8%	11.7%	7.3%
Passenger vehicles	26.9%	41.0%	72.0%	78.5%
Pedestrians	12.0%	4.8%	7.3%	4.7%
Motorcycles	50.7%	42.6%	7.7%	6.5%
Bicycles	3.4%	1.7%	1.3%	3.0%
Total	100%	100%	100%	100%
Total proportion	7.4%	92.6%	3.4%	96.6%

Most strikingly, the proportion of VRU crashes varied between the two countries, from 16 per cent for fatal and 14 per cent for casualty cases in Australia to 66 per cent and 51 per cent, respectively, for Malaysia. Passenger vehicle crashes were the predominant vehicle type among Australian fatal and casualty crashes, while motorcycles predominated among Malaysian fatalities and casualties.

To some degree, these findings most likely reflect differences in vehicle numbers and type, VRU exposure rates and maturity of the trauma system in the two countries. Interestingly, the higher overall proportion of fatalities in Malaysia compared to Australia (7.4% vs. 3.4%) might suggest a higher risk among VRU over other forms of transport and/or differences in data recording. This is examined in more detail in later analyses.

Differences in urban and rural crash distribution

Differences in the proportion of crashes across urban and rural crash locations are illustrated in Table 2. These figures are for fatal and casualty crash outcomes combined.

Table 2. Proportion of crashes by road user type, country and urban/rural environment

Road user type	Malaysia		Australia	
	Urban	Rural	Urban	Rural
Trucks & buses	7.7%	10.1%	1.3%	7.1%
Passenger vehicles	41.3%	39.8%	71.2%	79.0%
Pedestrians	6.3%	4.6%	10.4%	1.4%
Motorcycles	42.9%	43.5%	10.0%	11.5%
Bicycles	1.9%	1.9%	7.0%	1.0%
Total	100%	100%	100%	100%
Total proportion	23%	77%	82.3%	17.7%

The proportion of urban and rural crash locations varied considerably between the two countries. Urban crashes were most frequent in Australia (82.3%) and rural crashes in Malaysia (77%). The proportion of VRU crashes also differed between the countries where the proportion of VRU urban crashes was higher in Malaysia (51%) compared with Australia (27.4%). While not shown here, the proportion of fatal crashes for VRUs in rural areas was higher for Malaysia (7.4%) compared with Australia (5.6%). This may reflect again the possible increased vulnerability and risks of VRUs in these higher speed locations and/or differences in recording criteria.

Differences between single and multiple collisions

Next, the proportions of single and multiple collisions for fatal and casualty crashes combined were examined between countries and the results shown in Table 3.

Table 3. Proportion of crashes by road user type, country and single/multiple vehicles

Road user type	Malaysia		Australia	
	Single	Multiple	Single	Multiple
Trucks & buses	10.0%	9.5%	7.3%	7.4%
Passenger vehicles	42.5%	39.3%	68.8%	79.7%
Pedestrians	0%	6.8%	0%	5.6%
Motorcycles	45.9%	42.5%	21.4%	4.3%
Bicycles	1.6%	1.9%	2.4%	3.0%
Total	100%	100%	100%	100%
Total proportion	20.7%	79.3%	13.5%	86.5%

The proportions of single and multiple collisions were relatively similar in the two countries, although Malaysia recorded a slightly higher proportion of single-vehicle crashes compared with Australia (20.7% vs 13.5%). Overall, in both countries, proportions of single- and multi-vehicle crashes involving passenger vehicles were high, and especially multi-vehicle crashes in Australia. The biggest difference was found in the proportions of motorcycle collisions where higher proportions of both single- and multi-vehicle collisions were found in Malaysia (46% and 43%, respectively), compared to Australia (21% and 4%, respectively), with the difference being most marked for multi-vehicle collisions (43% in Malaysia and 4% in Australia).

Collision configurations

The next series of analyses focuses on 'who' collided with 'whom' in multi-vehicle collisions for the fatal and casualty cases combined. Tables 4 and 5 present the proportions for Malaysia and Australia separately.

In Malaysia, passenger vehicle collisions with all other partners were the most predominant, accounting for almost half of all multi-vehicle crashes, and the most common crash partner for a passenger vehicle collision was another passenger vehicle (around 29% of all cases). A relatively high proportion of multi-vehicle passenger car crashes involved colliding with a motorcycle (17%). VRU collisions with other vehicles accounted for over 61 per cent of all multiple-vehicle crashes and more than 35 per cent of crashes among themselves. The most common collision partner for a motorcycle was another motorcycle (32%), roughly twice as frequent as with a passenger vehicle. This may be explained to some degree by the high level of exposure (47% of all vehicle registrations were motorcycles in 2007 [15]), but also may be attributed to the higher risk that VRUs have to being injured when involved in a crash.

Table 4. Proportion of multi-vehicle crashes by road user type, Malaysia

Multi-vehicle crashes	Trucks & buses	Passenger vehicles	Pedestrians	Motorcycles	Bicycles
Trucks & buses	6.8%	-	-	-	-
Passenger vehicles	3.3%	28.7%	-	-	-
Pedestrians	0.6%	2.5%	0%	-	-
Motorcycles	4.6%	17.0%	1.5%	32.1%	-
Bicycles	0.2%	0.9%	0.1%	0.6%	1.2%
Totals	15.5%	49.1%	1.6%	32.7%	1.2%

Table 5. Proportion of multi-vehicle crashes by road user type, Australia

Multi-vehicle crashes	Trucks & Buses	Passenger vehicles	Pedestrians	Motorcycles	Bicycles
Trucks & buses	1.0%	-	-	-	-
Passenger vehicles	9.2%	62.5%	-	-	-
Pedestrians	0.9%	9.5%	0%	-	-
Motorcycles	0.6%	6.9%	0.2%	0.5%	-
Bicycles	0.9%	7.4%	0.2%	0.1%	0.1%
Totals	12.6%	86.3%	0.4%	0.6%	0.1%

In contrast to Malaysia, practically all multiple-vehicle collisions in Australia involved passenger vehicles and trucks (99%). VRU collisions accounted for only 27.3 per cent of these crashes, most of which were with a passenger vehicle (23.8%). Pedestrians and cyclists seemed to be the most common VRUs involved in these figures, accounting for 10.8 and 8.7 per cent of these crashes, respectively, while motorcycles were involved in 8.2 per cent of these crashes. Given that motorcycles in Australia comprise around 3 per cent of the total motor vehicles registered in 2006 [16], this also confirms their vulnerability and potential over-involvement rates in casualty crashes.

Age group

The final analysis investigating VRUs in the two countries was to compare the proportions of fatalities for all ages with those involving only younger road users (0-25 years). The fatality proportions are shown in Figure 1. The equivalent all injured proportions are not presented, but show a similar trend to the fatality figures.

The figures for those fatally injured in Australia show a higher proportion of car and truck deaths for all ages and younger road users than for Malaysia as reported earlier, with slightly fewer young occupant deaths than those for all ages. However, there was a noticeably higher proportion of deaths among

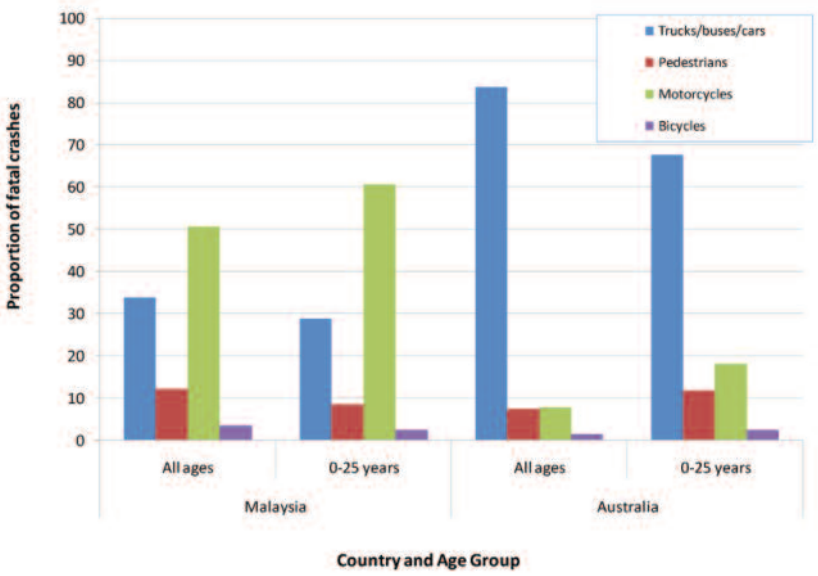

Figure 1. Proportion of fatalities by age group and road user type, Malaysia and Australia

younger motorcyclists in both countries, irrespective of differences in the level of crash involvement. While clarification using exposure measures is desirable, clearly, preventing motorcycle fatalities, particularly among young riders, must be a priority in both countries, but especially so in Malaysia.

The proportion of pedestrian deaths in Malaysia was higher among all ages, yet in Australia was higher among younger road users. It has been reported previously that the risk of a pedestrian death per population is higher among the elderly [6], which may help to explain this finding in Malaysia. However, the different finding for fatal crashes in Australia is difficult to explain by the pedestrian's age, and the availability of appropriate exposure data may shed more light on this. Of interest though, this difference is not so apparent among casualties, suggesting younger pedestrian fatal crashes may be occurring at higher speeds in this country – speed limits in urban areas in Australia being among the highest in the world [7] and young pedestrians having been reported as taking higher risks when crossing the road [8, 9].

Relative risk

An analysis of the relative risk by mode of travel per registered vehicle was also conducted as shown in Figure 2. It was not possible to do a comparative analysis for pedestrians and cyclists, as the relative risk denominator is presumably quite different and unknown. Rate per registered vehicle was chosen, as it was the only available and reliable measure in both countries. It would also have been interesting to compare the rate by distance travelled, but unfortunately, these exposure figures were not available in both countries.

Overall, these figures show a downward trend of fatalities from 1998 to 2007/08, especially in Australia, with some improvement also in motorcycle fatalities over this period. The risk of being killed in a crash is much higher for motorcyclists compared with vehicle occupants on a per registered vehicle basis (more than four times on average in both Malaysia and Australia). Interestingly, comparisons between these two countries shows that, while crash rates for car occupants are markedly higher in Malaysia, the relative crash risk for motorcyclists is similar in both countries, particularly in more recent years.

Of interest also are the proportional differences of fatal crashes involving motorcycles and cars between the two countries. In 2007 in Malaysia, 75 per cent of these vehicle-type fatalities involved motorcycles (only one-quarter were car occupants), while in Australia, the equivalent figures for motorcycles was 17 per cent. This clearly reflects differences in the frequency of use of motorcycles in these countries and the inherent risk motorcycle riders face.

It should also be noted that the real risk in the use of motorcycles in both these countries is somewhat masked by the exposure measure used (per 10,000 registered vehicles). In Europe, for example, motorcyclists are 18 times more likely to be killed than car occupants when measured on a distance travelled (per kilometre) basis [21]. It would have been preferable to have used a distance travelled measure for this analysis had these exposure measures been available, as per registered vehicle ignores the real usage rates of these vehicles.

General discussion

Death and serious casualties to vulnerable road users represents a sizeable trauma burden internationally, especially in low- and middle-income countries. This study set out to analyse trends in vulnerable road user casualty crash involvement in Malaysia and Australia to examine differences in crash patterns, types of crashes and crash configurations. The analyses highlighted both expected and unexpected findings.

The overall finding was that the proportion of VRU crashes varied considerably between the two countries. The lowest

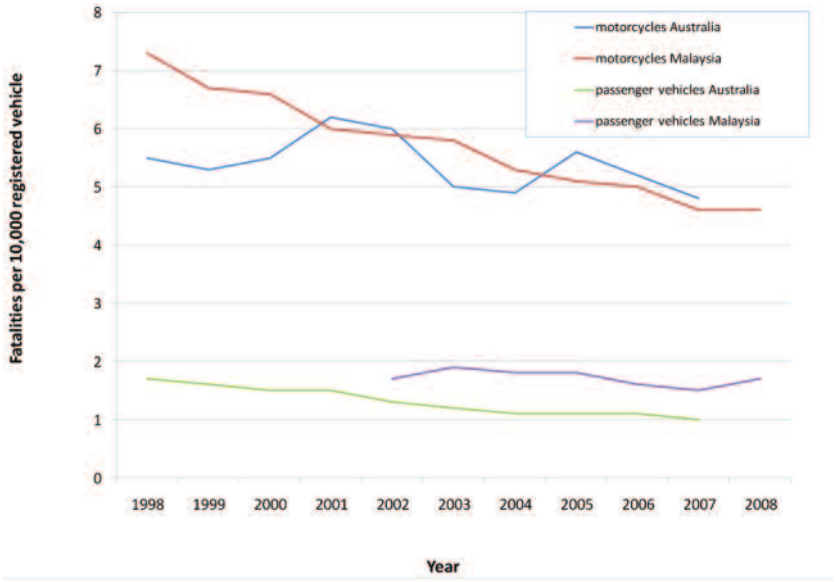

Figure 2. Fatal crash rate per 10,000 vehicles, Australia and Malaysia

involvement rate was in Australia where VRUs accounted for just 16 and 14 per cent of fatal and all casualty cases, respectively, compared with Malaysia, where the proportion was much higher (66% of fatal crashes and 51% for all injured VRUs).

These findings may reflect differences in vehicle and VRU exposure rates between the two countries, especially regarding motorcyclists, as there is a substantially greater proportion and use of motorcycles in Malaysia. The implementation of an effective trauma care management system in Australia may also contribute to the lower rate of death and serious injury in Australia [10, 11]. Regarding pedestrian and bicyclist safety, the proportions of fatalities were somewhat higher in Malaysia compared with Australia, but casualty crash proportions were similar.

With regard to location and crash configuration, there were also country differences. Overall, crashes in Australia seemed to be more an urban phenomenon (mainly amongst passenger vehicles), while Malaysia experienced more rural crashes (involving both motorcyclists as well as passenger car occupants). This was a somewhat surprising finding given the urban density in Malaysia in cities like Kuala Lumpur, but may be reflective of Malaysia's high traffic density and infrastructure in urban areas, which leads to a higher rate of gridlock and hence lower-speed crashes. Our finding that crashes in Australia seemed to be an urban phenomenon was also surprising, given the substantially higher proportion of rural crashes reported by the BITRE (estimated 57% in rural areas) [12].

While there are some possible explanations for this discrepancy, including that our data reported on fatal and serious injury crashes while the BITRE data focussed on fatal crashes only, this finding warrants further investigation. Interestingly, though, when VRU crashes were examined separately, Malaysia showed a substantially higher proportion of urban crashes involving VRUs compared with Australia (51% vs 27%). Again, the high number of urban motorcycle crashes and behavioural differences may have contributed to this finding.

Moreover, there was a high incidence of single-vehicle crashes in Malaysia compared with Australia, although there was a low number of multiple-motorcycle crashes in Australia. As the split in single- and multiple-vehicle crashes in Malaysia was closer to 50 per cent, these findings are difficult to explain without further in-depth analysis of the crashes to pinpoint possible causes. Nevertheless, these findings have ramifications for where priority setting for intervention should lie.

Pedestrian collisions in urban and rural areas are also of concern in both Malaysia and Australia, where these crashes comprised up to 12 per cent of all fatalities. Of special note, Malaysia experienced a higher proportion of rural pedestrian crashes involving a collision with a passenger vehicle, despite a general trend for less frequent pedestrian movements in rural areas than in urban areas. Many of these people have variable road crossing skills, especially young children, the elderly and those with disabilities.

Clearly, more needs to be done to reduce these numbers in both locations. From observation, it seems that failure on the part of motorists to pay greater respect to pedestrian movement may contribute to this level of trauma, but also, there is the need for pedestrians to cross and walk on roads at safe locations. That means the provision of traffic light intersections or statutory road crossing points, in addition to well maintained footpaths, and reduced vehicle speeds in areas where there is high pedestrian activity.

Of interest was the finding that there were substantial country differences in collision partner. By far the greatest trauma to VRUs in Australia was when they collided with a vehicle (truck, bus or passenger vehicle), accounting for 99 per cent of pedestrian, motorcyclist and bicyclist collisions. These findings point to the need to separate transport modes further, reduce vehicle speeds in areas where there is a mix of vehicles and VRUs, and improved vehicle technology to reduce speeds, enhance braking and provide better pedestrian protection of vehicles.

While fatal and casualty collisions between motorcycles and passenger vehicles were relatively high in Malaysia, those with another motorcycle were prevalent in this country (around one-third of all collision partners). While high exposure may contribute to this finding, the high prevalence of these crashes suggests there are other factors at play here. One potential factor may be the introduction of exclusive motorcycle lanes on some of the major highways in the Kuala Lumpur and Klang Valley areas. While the introduction of these designated motorcycle lanes is reported to have achieved substantial overall reductions in motorcyclist fatalities, particularly those involving collisions with vehicles [13], this may have resulted in an increased proportion of motorcycle-motorcycle crashes.

This suggests that, although designated motorcycle lanes provide a safer environment for motorcyclists, their safety could be further enhanced. The lanes could be widened to accommodate the number of motorcycles, the points at which they merge into the main traffic flow could be improved through appropriate design, and maintenance of lanes could be improved. Indeed, a study modelling motorcycle and non-motorcycle flows entering an intersection showed an increase in motorcycle crashes as traffic density increased [14]. It was also noted in this study that approach speed, lane width, number of lanes, shoulder width and land use were statistically associated with these crashes.

It is also possible that rider behaviour contributed to the increased proportion of motorcycle crashes in general, in addition to the high rate of motorcycle-motorcycle collisions. It was argued recently by the Director of MIROS, Professor Ahmad Farhan Sadullah [15], that transportation policies in Malaysia have a culture that generally does not put road safety first. Hence, there is a need to instil in motorists and professionals in Malaysia a greater sense of the importance of safety and safe behaviour on their roads.

While the current analysis involving mass data was unable to elaborate further on these findings, they could reflect a different driving and riding population in Malaysia to that in Australia or other traffic or behavioural differences. The motorcycle is regarded as an important mode of daily transport for commuting and running daily errands in Malaysia: it is estimated that there were 7.9 million motorcycle registrations in Malaysia or 47.3 per cent of total vehicle registrations [15].

By contrast, motorcycle ownership in Australia only represented around 3 per cent of the total motor vehicles registered in 2006 [16]. Furthermore, motorcycle ownership and use is popular in Malaysia for a number of reasons including low vehicle purchase price and insurance surcharge rates, low running costs, the ability to obtain a motorcycle licence as young as 16 years old, and ease of travel on congested roads. In contrast, in Australia, the motorcycle is often ridden for recreational purposes and therefore rider characteristics are very different.

With regard to age effects, the representation of younger VRUs was examined in this analysis across the two countries. In Australia, there were fewer young driver deaths than for all ages, but a higher proportion among younger motorcyclists and pedestrians. In Malaysia, there were higher proportions of motorcycle deaths and injuries compared with those in Australia, reflecting their higher exposure. However, young motorcycle riders in Australia were injured proportionally less than for all ages (compared to Malaysia), but more likely to be killed. This could suggest that their crashes tend to be at higher crash speeds in Australia than in Malaysia and may possibly involve a higher proportion of older riders. It may also reflect lower helmet-wearing rates in Malaysia.

Implications

The findings from this analysis raise a number of potential opportunities for countermeasures to address this growing burden of death and injury to Vulnerable Road Users in both middle- and high-income countries. It should be noted that the databases chosen for these analyses are representative samples of police-reported real-world crash data in these countries. While they are the best available databases for conducting analyses of crash and injury outcomes, they nevertheless differ in terms of their data collection procedures, the criteria applied and the level of comprehensiveness. Thus, these analyses need to be viewed with some caution in the light of these potential deficiencies. In particular, the under-reporting of serious and minor injured VRUs is claimed to be as high as 50 to 65 per cent of cases for pedestrians and 80 per cent for cyclists [17].

Nevertheless, for Malaysia, the key issues to be addressed relate to reducing motorcycle crash incidence and injury risk, not only for collisions between motorcycles and vehicles, but for motorcycle-motorcycle collisions. For Australia, the VRU group that contributes substantially to road trauma is pedestrians, and countermeasures to reduce pedestrian injury should be a priority.

Motorcyclists

There are a number of potential countermeasures to address motorcycle crashes. Training programs to better prepare riders (especially novice ones) seem to have met with some success [18] and could be considered for Malaysian riders. Motorcycle riders in Malaysia are often very young riders who would seem to be a particular target group for improved training prior to licensing. Graduated licensing for these road users would be worthy of further consideration. Moreover, rider assist technologies, particularly ABS technology, appears to be beneficial in preventing crashes from occurring as well as better positioning the motorcycle if a crash in unavoidable [19].

There are also engineering countermeasures to improve outcomes such as roadside barriers, increased use of exclusive motorcycle lanes (ensuring adequate width, maintenance and merging facilities at intersections), and Black Spot motorcycle road treatments. Riders' helmets that provide superior head and face protection, chest vests and protective riding equipment are also critical for mitigating injury. Finally, reducing travel speed, which will reduce the likelihood of a crash and/or reduce injury through better energy management, would also be very helpful, although achieving compliance may prove difficult.

Pedestrians

Countermeasures to aid pedestrian safety should focus more on crash prevention, given the low speeds generally involved in fatal pedestrian crashes [20]. Creating environments and infrastructure in areas of high pedestrian activity that enhance pedestrian safety are important, and treatments need to include those aimed at reducing vehicle speeds (reduced speed limits, in the order of 30-40km/h, traffic calming measures, barrier fencing, median strips, road narrowing and realignment, etc.). In addition, provision of more distinctive and frequent pedestrian crossings can help stream pedestrians. Traffic signals at pedestrian crossings on busy roads can also aid the elderly and disabled to cross at busy city roads and intersections. Education and training of children and the elderly to adopt safe crossing practices can also aid pedestrian safety.

All road users

The analysis of relative risk suggests that passenger vehicle occupants in Malaysia are at higher risk than their Australian counterparts. While it is difficult to highlight possible causes from the current analyses, it is probable that a number of factors are at play here, including limited occupant protection from vehicles, high and inappropriate speeds, low seatbelt-wearing rates, poor road design, differences in road user behaviour and lack of an effective trauma care management system. Indeed, the Malaysian government [15] has recently acknowledged that to achieve their mission of a road safety level in Malaysia at par with high-income countries, they see the need for greater education, awareness and advocacy programs, and improved legislation and policies to reduce injury crashes and fatalities to the minimum level.

Adopting a Vision Zero or Safe System approach is necessary to help achieve this mission. Australia and many European countries have long adopted such a model in addressing road safety targets with reasonable success. Legislation that establishes traffic law, as well as corresponding sanctions for infractions, needs to be framed so that the factors that most increase crash risk are targeted. Sanctions applicable for exceeding urban speed limits need strengthening – the practice that most endangers vulnerable road users.

Conclusions

It is argued that injury and deaths due to road traffic crashes are a major public health problem in low- and middle-income countries. More than 85 per cent of all deaths and 90 per cent of disability adjusted life years lost from road traffic injuries occur in these countries, and it appears that the highest burden of injuries and fatalities is borne disproportionately by vulnerable road users. The findings of these analyses confirm the high proportions of VRU crashes and injuries in a middle-income country compared with a high-income country and point to the requirement for a public policy response to the issues surrounding vulnerable road users, particularly motorcyclists.

References

1. World Health Organization. World report on road traffic injury prevention. Geneva: WHO, 2004.
2. World Health Organization. Global status report on road safety: Time for action. Geneva: WHO, 2009.
3. World Health Organization. World report on road traffic injury prevention. Geneva: WHO, 2004.
4. Kopits E, Cropper M. Traffic fatalities and economic growth. Accident Analysis and Prevention 2005; 37:169–78.
5. Garg NK, Hyder A. Exploring the relationship between development and road traffic injuries: A case study from India. European Journal of Public Health 2006; 16(5):487-91.
6. Oxley J, Charlton J, Fildes B. The effect of cognitive impairment on older pedestrian behaviour and crash risk, Report 244. Clayton, Vicctoria: Monash University Accident Research Centre, 2005.
7. Fildes B, Langford J, Szwed N. Balance between harm reduction and mobility in setting speed limits: Stage 2 report. Sydney: Austroads, 2009.
8. Oxley J, Congiu M, Whelan M, D'Elia A, Charlton J. The impacts of functional performance, behaviour and traffic exposure on road-crossing judgements of young children. Annual Proceedings 51st AAAM 2007; 51:81-96.
9. Oxley J, Lenné M, Corben B. The effect of alcohol impairment on road-crossing behaviour. Transportation Research Part F: Traffic Psychology 2006; 9(4):258-68.
10. Cameron PA., Gabbe BJ, et al. A statewide system of trauma care in Victoria: Effect on patient survival. Medical Journal of Australia 2008; 189(10):546-50.
11. Celso B, Tepas J, et al. A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems. Journal of Trauma - Injury, Infection and Critical Care 2006; 60(2):371-78.
12. Transport and Regional Economics, Department of Infrastructure and Transport. Canberra: BITRE, 2010. Viewed 15 February 2011. http://www.bitre.gov.au/publications/82/Files/RDA_Oct_2010.pdf
13. Pang TY, Radin Umar RS, et al. Fatal injuries in Malaysian motorcyclists. International Medical Research Journal 1999; 3(2):115-19.
14. Harnen S, Radin Umar RS, Wong SV, Wan Hashim L. Motorcycle crash prediction model for non-signalized intersections, IATSS Research 2003; 27(2):58-65.
15. Malaysian Institute of Road Safety Research (MIROS). Malaysia: MIROS, 2008. Viewed 15 February 2011. http://www.mhf.se/tylosandsseminariet/files/13.30_Ahmad_
16. Australian Bureau of Statistics. Motor Vehicle Census in Australia (9309.0). Canberra: ABS, 2006.
17. Vulnerable road users in Italy, Voice Country Sheet. Brussels: European Transport Safety Council, 2006.
18. Haworth N, Smith R, Kowadlo N. Evaluation of rider training curriculum in Victoria, Report 165. Clayton, VIctoria: Monash University Accident Research Centre, 2000.
19. Rizzi M, Strandroth J, Tingvall C. The effectiveness of antilock brake systems on motorcycles in reducing real-life crashes and injuries. Traffic Injury Prevention 2009; 10:479-87.
20. Anderson R, McLean A, Farmer M, Lee B, Brooks C. Vehicle travel speeds and the incidence of fatal pedestrian crashes. Accident Analysis and Prevention 1997; 29(5):667-74.