HOSPITAL REPORTED FACTORS ASSOCIATED WITH MORTALITY AMONG ROAD TRAFFIC ACCIDENT VICTIMS IN SOUTHERN THAILAND

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Abstract. Road traffic accidents are a major cause of mortality in Thailand. We aimed to determine the hospital reported factors associated with mortality among road traffic accidents in southern Thailand in order to inform road traffic mortality prevention programs. We accessed data reported to the Office of Disease Prevention and Control, Thailand during 2008-2013 by hospitals in Nakhon Si Thammarat and Surat Thani Provinces, southern Thailand. We used the chi-square test to examine the associations between selected variables and mortality and multivariate logistic regression analysis to determine factors significantly associated with mortality. In the study location during the study period, there were 41,848 reported traffic injuries with 2,341 deaths. Eighty-four percent of victims were males, 78.3% involved a motorcycle and 65% did not wear their helmets. Older age, being a pedestrian, not fastening a seat belt in a blunt trauma patient and having poor clinical signs were significantly associated with mortality. These findings confirm that motor vehicle drivers and passengers need to be targeted to fasten seat belt, in order to reduce road accident mortality.

Keywords: road traffic injury, mortality, tertiary hospital, injury, severity score

INTRODUCTION

Road traffic accident mortality is an important public health problem worldwide, especially in lower and middle income countries (Chandran *et al*, 2010). Each year an estimated 1.25 million people die from road traffic injuries worldwide; this is a leading cause of mortality among those aged 15-29 years (WHO, 2015). The majority of road traffic accident fatalities occur in lower and middle income countries, even though these countries have only half of the world's vehicles, since this is where half the road traffic death occur, primarily in pedestrians, cyclists and motorcyclists (WHO, 2013).

In most parts of the world mortality rates due to road traffic accidents are increasing; it is estimated that road traffic accidents will become the seventh leading cause of death worldwide by 2030 (WHO, 2015). The numbers of deaths worldwide due to traffic accidents are estimated to

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increase from 1.3 million in 2004 to 2.4 million by 2030, primarily due to increasing motor vehicle ownership and economic growth (WHO, 2008). In Thailand, injuries and deaths due to traffic accident are a major cause of morbidity, mortality and economic loss (Tanaboriboon and Satiennam, 2005). In 2011, injuries due to road traffic accidents among men and women in Thailand were the second and eight leading causes of Disability Adjusted Life Years (DALYs) lost, respectively (IHPP, 2014). Similar to many other developing countries, injuries due to traffic accidents are a leading cause of death among young males in Thailand (Ditsuwan *et al,* 2011). Road traffic injuries and mortalities increase during holidays, such as during the Songkran festival (Thai water festival) and during the New Year, where road safety measures and law enforcement in Thailand are inadequate (Tanaboriboon and Satiennam, 2005).

Socioeconomic status is associated with road traffic injuries (Sehat *et al,* 2012). Forty-eight percent of road traffic deaths worldwide occur among those aged 15-44 years (WHO, 2015). Males are more likely to be involved in road traffic accidents than females; with three quarters of deaths due to road traffic accidents occur among males aged <25 years (WHO, 2015). Enforcement of mandatory helmet and seat belt laws have been shown to reduce road traffic accident morbidities and mortalities (Cohen and Einav, 2003; Usha *et al,* 2014). Numerous studies have described the epidemiology and injuries associated with road traffic accidents (Chalya *et al,* 2012; Chaudhry *et al,* 2012; Staff *et al,* 2014; Ay *et al,* 2015). The respiratory rate and systolic blood pressure on admission, the Glasgow Coma Scale (GCS) and the Injury Severity Score (ISS) have all been found to be associated with mortality among road traffic victims (Chalya *et al,* 2012; Staff *et al,* 2014; Ay *et al,* 2015).

Using data from 28 hospitals in Thailand during 2005-2010, the Thailand Bureau of Epidemiology reported there were 61,000 people who sustained severe injuries and 4,000 people who died per year (Bureau of Epidemiology, 2012); of these there were 6,000 injuries and 200 deaths per year among those aged less than 15 years. Those who resided in southern Thailand were more likely to die if they had a road traffic accident than any other part of Thailand (Yiengprugsawan *et al,* 2014). Therefore, we aimed to determine the factors associated with mortality among road traffic accident victims in southern Thailand in order to inform road traffic accident mortality prevention programs.

MATERIALS AND METHODS

Data source

In 1996, the Bureau of Epidemiology, Ministry of Public Health for Thailand established an injury surveillance program requiring hospitals to fill out an injury surveillance form monthly, reporting all injuries presenting to that hospital. This is sent to the Office of the Division for the Prevention and Control for Thailand (WHO, 2012). In our study, we reviewed this reported data for 2008-2013. The reported injury surveillance consists of seven parts: demographic factors, injury details, causes of injuries, methods of transferring to the hospital, first aid information, vital signs and result of treatment. A report is made for each injury case. The history was obtained by a nurse, directly from the patients if they were conscious or from the referral person who brought them in if they were unconscious. A total of 84,168 cases were reported during the study period, but mortality data was available for only 41,848 cases (49.7%), who were the focus for our study. It was the data from these cases that were reviewed to conduct this study.

The independent variables in our study were year of injury, age group, gender, road user type, mechanism of injury, use of a seat belt or a helmet, respiratory rate (RR), systolic blood pressure (SBP), Glasgow Coma Scale (GCS) score, and Injury Severity Score (ISS) on admission. Subjects were divided into 4 age groups: those aged < 20, 20-39, 40-59 and ≥ 60 years. Road user types were categorized as motorcycle driver, motorcycle passenger, pedestrian, others and unknown. Mechanism of injuries was classified as blunt only, other (penetrating only, blunt and penetrating) and unknown. Seat belts and helmets were categorized as being used, not used or unknown. An abnormal RR was considered < 10 or > 30 times/minute; a normal RR was considered to be 10-30 times/minute and an unknown RR was considered as unknown. SBP was categorized as < 90 mmHg (abnormal) and ≥ 90 mmHg (normal). A GCS score was classified as < 9 (abnormal), ≥ 9 (normal) and unknown. The ISS was classified as ≤ 15 (normal), > 15 (abnormal) and unknown. The outcome was classified as discharged with survival and death which consisted of those who died before reaching the emergency department (ED) and those who died in the ED or during hospitalization.

Statistical analysis

Bivariate analyses using chi-square tests were used to determine associations between road traffic deaths and versus demographic and injury characteristics. Multivariate logistic regression analysis was conducted to determine associations between road traffic accident deaths and various factors. The regression model used was:

$$\ln\left(\frac{p}{1-p}\right) = \alpha + \sum_{i=1}^{k} \beta_i x_i$$

when p was the expected probability of a road traffic injury, α was the intercept, χ_i through χ_k were the determinants (factors, regressors), and β_i was the regression coefficient. Sum contrasts were used to obtain confidence intervals (CI) to compare each proportion with the overall proportion. The specific contrasts for logistic regression were constructed using weighted sum contrasts rather than treatment contrasts (Tongkumchum and McNeil, 2009), where, in the latter, the first group of each categorical variable was left out of the model. Therefore, the advantage of using appropriately weighted sum contrasts was such that each proportion could be compared with the overall proportion rather than with a specified reference group. The coefficients from the logistic model were converted to proportions, which were presented as percentages. The computed 95% CI provided a way to classify each factor according to whether the confidence interval exceeds, crosses or falls below the overall mortality. A plot of the 95% CI illustrated the results of the logistic model. We used the area under the Receiver Operating Characteristic (ROC) curve as a measure of goodness-of-fit. The ROC plotted the sensitivity against the false positive rate to show how well a model predicted a binary outcome. For a range of decision choices, it plotted the sensitivity (probability of finding an outcome when it was there) against the false positive error rate (probability of finding an outcome when it was not there). All statistical analyses and graphing were

Table 1
Association between hospital reported factors and road traffic mortality.

Hospital reported factors	Road traffic mortality		*p*-value
	Died (%) (*N*=2,341)	Alive (%) (*N*=39,507)	
Year of injuries			0.054
2008	385 (16.4)	6,183 (15.7)	
2009	327 (14.0)	6,319 (16.0)	
2010	413 (17.6)	6,640 (16.8)	
2011	422 (18.0)	6,646 (16.8)	
2012	421 (18.0)	7,019 (17.8)	
2013	373 (15.9)	6,700 (17.0)	
Gender			<0.001
Male	2,068 (88.3)	33,095 (83.8)	
Female	273 (11.7)	6,412 (16.2)	
Age groups in years			<0.001
< 20	498 (21.3)	12,932 (32.7)	
20-39	794 (33.9)	14,065 (35.6)	
40-59	671 (28.7)	9,434 (23.9)	
60+	378 (16.1)	3,076 (7.8)	
Type of road users			<0.001
Driver	1,248 (53.3)	25,295 (64.0)	
Passenger	270 (11.5)	5,934 (15.0)	
Pedestrian	252 (10.8)	1,805 (4.6)	
Other	396 (16.9)	6,055 (15.3)	
Not specified	175 (7.5)	418 (1.1)	
Mechanisms of injuries			<0.001
Blunt	2,188 (93.5)	38,497 (97.4)	
Penetrating/Penetrating and blunt	106 (4.5)	966 (2.4)	
Unknown	47 (2.0)	44 (0.1)	
Used a helmet/seat belt			<0.001
Not wearing a helmet	924 (39.5)	26,278 (66.5)	
Wearing a helmet	49 (2.1)	3,809 (9.6)	
Not fastening a seat belt	206 (8.8)	4,116 (10.4)	
Fastening a seat belt	5 (0.2)	450 (1.1)	
Unknown	1,157 (49.4)	4,854 (12.3)	
Respiratory rate			<0.001
<10 or >30 times/min	433 (18.5)	845 (2.1)	
10-30 times/min	401 (17.1)	36,005 (91.1)	
Unknown	1,507 (64.4)	2,657 (6.7)	
Systolic blood pressure			<0.001
< 90 mmHg	633 (27.0)	514 (1.3)	
≥ 90 mmHg	1,411 (60.3)	38,207 (96.7)	
Unknown	297 (12.7)	786 (2.0)	

Table 1 (Continued).

Hospital reported factors	Road traffic mortality		*p*-value
	Died (%) (*N*=2,341)	Alive (%) (*N*=39,507)	
Glasgow Coma Score			<0.001
< 9	1,630 (69.6)	1,910 (4.8)	
≥ 9	456 (19.5)	37,351 (94.5)	
Unknown	255 (10.9)	246 (0.6)	
Injury Severity Score			<0.001
≤ 15	323 (13.8)	32,728 (82.8)	
> 15	1,620 (69.2)	3,392 (8.6)	
Unknown	398 (17.0)	3,387 (8.6)	

carried out using the R program, version 3.2.2 (R Development Core Team, 2015).

RESULTS

The majority (84%) of road traffic injury patients were males. The mean [± standard deviation (SD)] age of the patients was 32.7 (± 18.0) years. Seventy-eight point three percent of the accidents were motorcycle accidents. Sixty-five percent of the motorcycle accident victims were not using helmets. Ninety-seven point two percent of the injuries were blunt trauma type. The RR, SBP, GCS and ISS of the patients were normal in 87% 94.7% 90.3% and 79%, respectively. There were 2,341 road traffic injury deaths during the study period.

Table 1 shows the association between injury characteristics and road traffic accident deaths using the chi-square test. Gender, age group, road user type, mechanism of injury, use of a seat belt or a helmet, RR, SBP, GCS, and ISS were all significantly associated with road traffic accident deaths ($p<0.001$). The year of injury was not significantly associated with mortality ($p=0.054$). Among those who died, 88.3% were males, 33.9% were aged 20-39 years, 53.3% were motorcycle drivers and 93.5% were blunt trauma type. In 49.4% of deaths, it was not recorded whether the victims wore a helmet or fastened a seat belt; however, 48.3% did not wear a helmet or a seat belt. Sixty-four percent of deaths had no recorded respiratory rate. Twenty-seven percent of deaths had a recorded SBP < 90 mmHg, 69.6% had a GCS < 9, and 69.2% had a ISS > 15.

Fig 1 shows the 95% CI of the associations between road traffic accident deaths and the following: demographics, selected traffic related factors and selected clinical factors, based on multivariate analyses. In order to eliminate confounding and interaction effects on multivariate analysis, 3 combined variables were created: 1) gender was combined with age group to give a new variable called gender-age group; 2) road user types, use of a seat belt or a helmet and mechanism of injuries were combined to give a new variable called situation at accident; 3) RR, SBP, GCS and ISS were combined to give a new variable called clinical signs. The gender-age

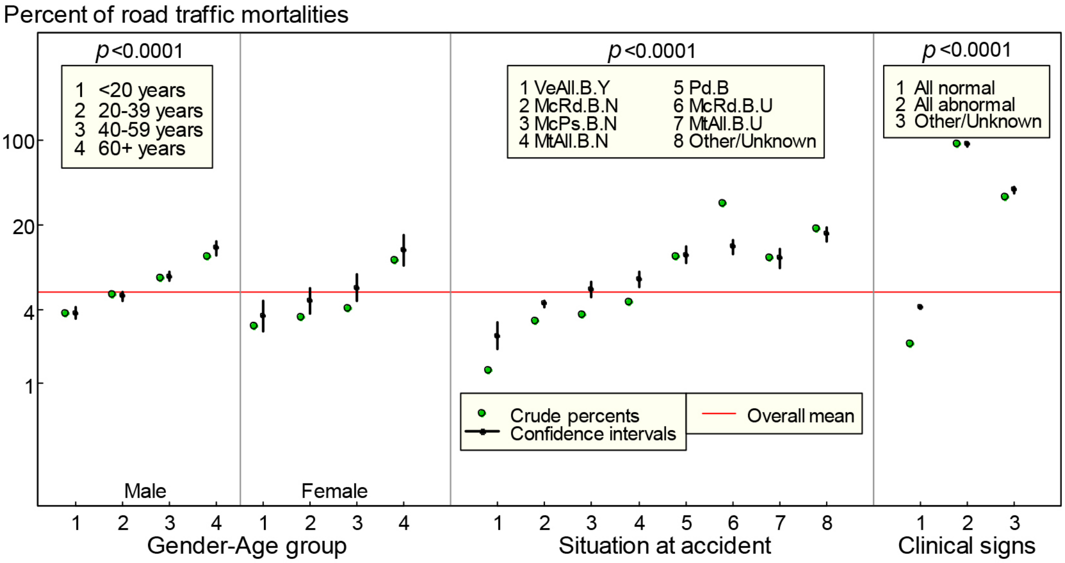

Fig 1–Association between hospital reported factors and road traffic mortality from multivariate analysis. VeAll.B.Y, All vehicle drivers and passengers with blunt trauma using a seat belt or a helmet; McRd.B.N, Motorcycle drivers with blunt trauma not using a helmet; McPs.B.N, Motorcycle passengers with blunt trauma not using a helmet; MtAll.B.N, Motor vehicle drivers and passengers with blunt trauma not using a seat belt; McRd.B.U, Motorcycle drivers with blunt trauma and an unknown status of using a helmet; MtAll.B.U, Motor vehicle drivers and passengers with blunt trauma and unknown status of using a seat belt; Pd.B, Pedestrians with blunt trauma.

group variable consisted of 8 categories (4 age groups for males and 4 age groups for females). The number of categories in variable situation at accident consisted of 8 groups: 1) all vehicle drivers and passengers with blunt trauma using a seat belt or a helmet (VeAll.B.Y); 2) motorcycle drivers with blunt trauma not using a helmet (McRd.B.N); 3) motorcycle passengers with blunt trauma not using a helmet (McPs.B.N); 4) motor vehicle drivers and passengers with blunt trauma not using a seat belt (MtAll.B.N); 5) motorcycle drivers with blunt trauma and an unknown status of using a helmet (McRd.B.U); 6) motor vehicle drivers and passengers with blunt trauma and unknown status of using a seat belt (MtAll.B.U); 7) pedestrians with blunt trauma (Pd.B); and 8) other or unknown statuses. The clinical signs variable was divided into 3 groups: 1) all normal clinical signs; 2) all abnormal clinical signs; 3) abnormal clinical signs for at least one sign or unknown status. The results show road traffic mortality was significantly associated with gender-age group, situation at accident and clinical signs. Road traffic mortality increased with age but the mortality rate was not significantly differed between males and females. All the vehicle drivers, passengers, those with blunt trauma and those who used a helmet or a seat belt (VeAll.B.Y) and motorcycle drivers with blunt trauma who did not use a helmet (McRd.B.N) had significantly lower road traffic mortality than overall mean. Motor vehicle drivers and passengers with blunt trauma and those not using seat belts (MtAll.B.N) or if it was unknown whether they used a seat belt (MtAll.B.U) had higher mortality rates than the overall mean. Motorcycle vehicle drivers with blunt trauma when it was unknown if they used a helmet (McRd.B.U), pedestrians (Pd.B.) with blunt trauma and others or unknown status had higher mortality rates than the overall mean. Patients with normal BP, RR, GCS and ISS levels had significantly lower mortality rates than the overall mean; whereas patients with at least one abnormal clinical factor or unknown status for a clinical sign had higher mortality than the overall mean. The model provided AUC equal 0.90, which indicates a good fit.

DISCUSSION

Road traffic accidents are a major public health problem in Thailand. Logistic regression analysis was used to identify associations between injury characteristics and mortality among those presenting to the emergency room or those admitted to tertiary hospitals in upper southern Thailand.

In this study most (84%) road traffic injuries occurred in males. The results of this study are consistent with a study conducted by Jelodar *et al* (2014) from Iran, who found 81% of road traffic injury patients admitted to the hospital were males. Globally, males are more likely to be involved in road traffic crashes than females since they are more likely to be involved in outdoor activities, be more frequent road users and have higher risk behavior, such as drunk driving, speeding, and drug abuse (WHO, 2015). In our study, motorcyclists accounted for 78.3% of accident victims, which is higher than in some other countries, such as Malaysia (60%) (Manan and Várhelyi, 2012), Tansania (58.8%) (Chalya *et al,* 2012) and Iran (57.1%) (Sherafati *et al,* 2017).

In our study, the predominant mechanism of injury was blunt trauma (97.2%), similar to the finding of Asuquo (2006). The mortality rates due to road traffic accidents vary by country; in our study it was 5.6%, compared to South Africa (8.9%) (Garrib *et al,* 2011), Kenya (7.7%) (Saidi *et al,* 2014), Iran (3.9%) (Sherafati *et al,* 2017), another study from Iran (11.2%) (Jelodar *et al,* 2014) and Tanzania (17.5%) (Chalya *et al,* 2012).

On multivariate analysis in our study, road traffic mortality was significantly associated with increasing age, being pedestrians or being motor vehicle drivers or passengers not fasten seat belt of blunt trauma patients and having abnormal clinical signs. Other studies also found mortality due to road traffic accidents associated with increasing age (Garrib *et al*, 2011; Hsiao *et al*, 2013, Yu *et al*, 2017). One researcher hypothesized this is due to poorer health in older age (Yu *et al,* 2017). In our study, road traffic mortality did not significantly differ by gender, similar to the findings of Oliveira and Sousa (2012), Jelodar *et al* (2014) and Sherafati *et al* (2017).

The road traffic injury victims in low-income and middle-income countries are more vulnerable road users, such as motorcyclists, bicyclists, passengers and pedestrians which accounts for most deaths (Ditsuwan *et al*, 2011; Zhang *et al*, 2013; WHO, 2015; Wang *et al,* 2015). The relatively high mortality rate of pedestrians seen in our present study is similar to the finding by Ang *at al* (2017). This may reflect low community awareness about correct road use; therefore, education about appropriate road use may be warranted. The finding in our study that motorcycle drivers and passengers, regardless of helmet use, tended to have lower mortality rates, than other victims is interesting. In Thailand, motorcycles rarely travel on the highway; mortality rates from road traffic accidents are higher on the highway in Thailand than on city and rural roads (Riyapan *et al*, 2018). This could explain the lower mortality rates seen among motorcycle drivers and passengers seen in our study.

Motor vehicle drivers and passengers who did not use a seatbelt and had blunt trauma had a higher mortality rate, similar to previous studies (Keng, 2005; Chalya *et al*, 2010; *ibid*, 2012). The large group in our study in some it was unknown if they used a helmet or not, could have influenced our finding or no greater mortality among those who did not use a helmet; underestimating the mortality rate of those who did not wear a helmet (Bhatti *et al*, 2018) We found the mortality rate was higher among those who had at least one abnormal clinical sign. These results are similar to a study by Kimura *et al* (2012) who found RR, SBP, GCS, and ISS were significantly associated with road traffic accident mortality. Similar results, except for RR, were also reported in several other studies (de Oliveira and de Sousa, 2012; Jelodar *et al*, 2014; Alghnam *et al*, 2014; Seid *et al*, 2015). These clinical factors are commonly used to assess patients in the emergency room (Majdan *et al*, 2015).

A limitation of this study was that it was retrospective and there was missing data, such as helmet use. Moreover, this study did review road traffic accident mortality and looked at victim factors including demographics, traffic-related factors, and clinical factors. Another problem with our study was that we were only able to use half the injury surveillance data because the status of the patients was not recorded in 50.3% of cases.

In conclusion, road traffic accident victims had a high mortality rate, especially among older victims, those who did not use a seat belt and those with abnormal clinical assessment on presentation to the emergency room. These factors need to be taken into consideration when developing preventive programs.

ACKNOWLEDGEMENTS

This study was partially funded by the Graduate School, Prince of Songkla University, Thailand, (Research Fund PRPM, ID 1628) and partially supported by the Centre of Excellence in Mathematics, the Commission on Higher Education, Thailand. We would like to express our gratitude to the Regional Office of Disease Prevention and Control, for permission to use their data. We are indebted to Prof Don McNeil for giving invaluable advice regarding this research. Thanks to the Research and Development Office, Prince of Songkla University for providing grammar checking and Assoc Prof Seppo Karila for grammar checking and suggestions.

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