Causes of Fatalities and Injuries from Motorcycle Accidents in Bangkok by Autopsy Investigation

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Introduction

In developing countries, motorcycle is the most favorite transportation vehicle. In Thailand, since motorcycles are in widespread use, they have become the most common type of vehicle involved in traffic accident-related crashes in most areas of the country [1]. In Bangkok, the numbers of registered motorcycles increased rapidly from 1.6 to 2.5 millions during the year 1998-2005 [2]. Unsurprising, it is well known that motorcycles have the potential to be a safety hazard. For example in years 2002-2003, the motorcycles represent to be the most of vehicle involved traffic accident, the number of injuries and fatal motorcyclists accounts for 81-92% and 81-90% of all type of traffic accidents respectively [3]. Those evidences indicated that motorcycle accidents trend to be recognized as major public health problems that make a serious cause of morbidity and mortality.

Although, many studies involve motorcycle accidents in Thailand might be reported but it occasionally be autopsy findings. Therefore, the present study purposes to investigate the causes of death (CD) in fatally motorcyclists, and determined the temporal risk factors that may have association with number of fatalities in Bangkok.

Materials and Methods

A retrospective study, data consisted of 214 fatal motorcycle accidents collected from autopsy reports of all performed at Ramathibodi Hospital during years 2003-2006 in Bangkok. Ramathibodi Hospital is responsible in Bangkok metropolitan police division1 including 9 districts of Bangkok comprising Phaya-Thai, Bang-Poh, Dusit, Samsen, Dindaeng, Mukkasan, Hui-Kuang, Nang-Learng, and Chanasongkram.

Data composed of *demographic data:* including age, gender, riding position, time of accidents, type of crash consisted of single vehicle crash (SVC) and multiple vehicle crashes (MVC) and crash objects. Alcohol consumptions categorize by blood alcohol concentration (BAC) and BAC level (expressed in legal level for BAC ≤50 mg% and illegal level for BAC >50 mg%). *Autopsy data:* causes of death (CD) and anatomical regions of injuries that forensic pathologists reported as follows head injuries, neck injuries, chest injuries, abdominal injuries and extremities injuries are given details of injuries by full autopsy investigation**.**

Statistical analysis

Descriptive statistics such as number, percentage, mean, standard deviation (SD) and range were used in describing the variables characteristics. The statistical association between the proper variables was performed by Chi-square test (χ^2), *t*-test and odd ratio (OR) with 95% confidence interval (CI). The data were analyzed by using a statistical package SPSS 14.0 for Windows. A *p*-value < .05 was considered statistical significance.

Results

Data of 214 motorcyclist fatalities collected from the full autopsy report of Ramathibodi hospital occurred during years 2003-2006 in Bangkok. An average number of cases were 53.5 cases per year. Personal data as showed in **Table 1**, there were 188 males (88%) and 26 females (12%), There were 183 riders (86%) and 31 passengers (15%). The association between gender and riding position showed that males were 18 times more likely to riding the motorcycle than female (OR = 18.5, 95%CI = 7.14, 47.72). The mean age of all fatality was 27.4 ± 10.76 (3-69) years. Obviously, age 15-24 years was the greatest group (45%), followed by age 25-34 years (30.4%).

Table 1. Personal data of the motorcyclist fatalities (n = 214)

Personal characteristics		**Number (%)**	**OR (95%CI)**
Gender	Male	188(87.9)	Male riders 18.45 (7.14, 47.72)
	Female	26 (12.1)	
Riding position	Rider	183 (85.5)	
	Passenger	31 (14.5)	
Age, years	< 15	10 (4.7)	
	15-24	96 (44.9)	
	25-34	65 (30.4)	
	35-44	24 (11.2)	
	≥ 45	19 (8.9)	
Age (years); mean ± SD (range) : 27.4 ± 10.76 (3-69)			

The greatest group of fatalities was not found alcohol in their blood account for 56% and no one of age < 15 years that found BAC. There were 36% that found differently level of alcohol. The mean blood alcohol concentration (BAC) in all fatality was 58.61 ± 93.31 (0.0-371.0) mg%. Specifically among those who tested alcohol positive, the mean BAC was 151.14 ± 92.02 mg%. There were 29% that BAC level as an illegal level (> 50 mg%), the mean BAC was 179.01 ± 74.93 mg%. There were 8.4% which was unknown group of BAC. Age 15-25 years is the largest group that found BAC account for 50% of motorcyclists that use alcohol before riding (76 cases) as showed in **Table 2** and **Table 3**.

Table 2. Alcohol consumption of the motorcyclist fatalities (n = 214)

Alcohol characteristics		15-25 yrs.	≥ 25 yrs.	Total (%)
Blood alcohol concentration (BAC), mg%	None	58	62	120 (56.1)
	< 50	10	3	13 (6.1)
	50-149	13	11	24 (11.2)
	≥ 150	15	24	39 (18.3)
	Unknown [a]	10	8	18 (8.4)
BAC level [b]	Legal level	68	65	133 (62.1)
	Illegal level	28	35	63 (29.4)
	Unknown [a]	10	8	18 (8.4)

[a] No evidence for BAC
[b] ≤ 50 mg% for legal limit

Table 3. Mean and SD of BAC in each categorizes group

BAC categorize	n (%)	Mean ± SD (mg%)
All fatal	214 (100)	58.61 ± 93.31
Group BAC +ve	76 (35.5)	151.14 ± 92.02
Group BAC > 50 mg%	63 (29.4)	179.01 ± 74.93

There were 65.9% crashed at nighttime and 34.1% at daytime. During 0:00-5:59 was the most common period of time of accidents (37.9%), followed by 18:00-23:59 (28.0%). The weekday fatalities were 145 cases (67.8%, consisted of 38.6% in daytime and 61.4% in nighttime) and weekend fatalities were 69 cases (32.2%, consisted of 24.6% in daytime and 75.4% in nighttime). However, average number of cases in weekend represented more than weekday account for 34.5 and 29 cases per day respectively. The number of weekday fatalities at daytime were nearly 2 times more likely than weekend (OR = 1.93, 95%CI = 1.01, 3.66). Wet season had nearly the same number of motorcyclist fatalities with dry season account for 51.9% and 48.1%, respectively as showed in **Table 4**.

Table 4. Time of the motorcycle accidents (n = 214)

Time Classifications		Number (%)	OR (95%CI)
Period of time	0:00-5:59	81 (37.9)	
	6:00-11:59	35 (16.4)	
	12:00-17:59	38 (17.8)	
	18:00-23:59	60 (28.0)	
Time of day	Daytime	73 (34.1)	Weekday fatalities in daytime 1.93 (1.01, 3.66)
	Nighttime [c]	141 (65.9)	
Time of week	Weekday	145 (67.8)	
	Weekend [d]	69 (32.2)	
Season [e]	Dry season	103 (48.1)	
	Wet season	111 (51.9)	

[c] 18:00-23:59 and 0:00-5:59
[d] Saturday and Sunday
[e] Dry season: November-April, wet season: May-October

Table 5. Time of the motorcycle accidents (n = 214)

Characteristic		Number (%)
Crash type	SVC [f]	51 (23.8)
	MVC	163 (76.2)
Crash object	Fall & Fixed object	48 (22.4)
	Passenger car	46 (21.5)
	Taxi	22 (10.3)
	Bus	20 (9.3)
	Pickup & Truck	46 (21.5)
	Motorcycle	15 (7.0)
	Miscellaneous [g]	9 (4.2)
	Undetermined [h]	8 (3.7)
Crash object group	Non vehicle	51 (23.8)
	MTV [i]	48 (22.4)
	Private vehicle	107 (50.0)
	Undetermined [h]	8 (3.7)

[f] Included fall, crash with fixed object or pedestrian or animal
[g] Miscellaneous included crash with van/tricycle/pedestrians or animal
[h] Cannot defined type of vehicle
[i] Mass Transportation Vehicle included taxi/bus/van or tricycle

Motorcycles crashed with other vehicle (multiple vehicle crashes: MVC) were 163 cases (76%) more than 51 cases (24%) that crashed without other vehicles related (single vehicle crash: SVC). Motorcycle falls and crash with fixed objects was the most common cause of motorcycle accidents (22.4%). Passenger car was the favorite vehicle that crashed with motorcycle in this series (21.5%). We found almost 4% that crash objects were undetermined. Private vehicle was the most common vehicle

group that crashed with motorcycle in this series (50%), followed by non-vehicle (23.8%) as presented in **Table5**.

The number of motorcyclist fatalities that were use alcohol before riding in condition with male, rider, MVC and nighttime more than female, passenger, SVC and daytime as showed in **Table 6**. However, there was no significant difference between mean BAC of male and female (p = .259). Although, ≥ 25 years had mean BAC more than younger but there was no significantly difference (p = .083). Mean BAC of rider was higher than passenger but there was no statistical difference (p = .168). The results showed no significant difference of mean BAC between MVC and SVC group (p = .900). Also mean BAC of the fatalities in nighttime higher than daytime but there was no significantly difference (p = .743).

Table 6. Mean, SD, t-value and p-value of BAC for each group of variables (n = 76).

Variables		**n (%)**	**Mean ± SD**	***t*-value**	***p*-value**
Gender	Male	71 (93.4)	150.83 ± 89.39	-0.110	.912
	Female	5 (6.6)	155.56 ± 137.44		
Age, years	< 25	38 (50)	132.82 ± 104.99	-1.760	.083
	≥ 25	38 (50)	169.46 ± 73.84		
Riding position	Rider	70 (92.1)	155.41 ± 90.96	1.391	.168
	Passenger	6 (7.9)	101.30 ± 98.01		
Crash type	SVC	21 (27.6)	153.31 ± 97.11	0.126	.900
	MVC	55 (72.4)	150.31 ± 90.91		
Time of day	Daytime	17 (22.4)	144.62 ± 130.65	-0.329	.743
	Nighttime	59 (77.6)	153.02 ± 78.89		

Table 7. Number of motorcyclist fatalities classified by BAC level with gender, age, riding position, crash type, time of day and time of week (n =196).

Variables		**Illegal / Legal group**	**OR (95%CI)**
Gender	Male	59 / 114	2.46 (0.80, 7.56)
	Female	4 / 19	
Age, years	≥ 25	35 / 65	1.31 (0.72, 2.39)
	< 25	28 / 68	
Riding position	Rider	60 / 106	5.09 (1.48, 17.50)
	Passenger	3 / 27	
Crash type	SVC	18 / 28	1.50 (0.75, 2.98)
	MVC	45 / 105	
Time of day	Nighttime	49 / 80	2.32 (1.17, 4.61)
	Daytime	14 / 53	
Time of week	Weekday	46 / 87	1.43 (0.74, 2.77)
	Weekend	17 / 46	

From **Table 7**, the numbers of male fatalities were nearly 2 times and a haft than females in illegal level (OR = 2.46). The numbers of motorcyclist fatalities age ≥ 25 years were 1.3 times more likely than younger fatalities in illegal level (OR = 1.31). Obviously, the numbers of rider fatalities were 5 times more likely than passengers (OR = 5.09). SVC had fatalities as an illegal level were 1 and a haft times more likely than MVC (OR = 1.50). The nighttime fatalities as an illegal level were nearly 2 times more likely than daytime fatalities (OR = 2.32). Also weekday fatalities as an illegal level had about 1 and a haft times more likely than weekend fatalities (OR = 1.43).

Causes of death (CD) were recognized by definite region of injuries that were majority of injury as presented in **Table 8**. The head injury was the commonest CD (51.4%), followed by multiple injuries (31.8%) and other causes (16.8%). For only one case of extremities injury was CD due to hypovolumic shock from legs laceration.

Table 8. Causes of death distribution (n = 214)

Certified cause	Number (%)
Head injury	110 (51.4)
Neck injury	5 (2.3)
Chest injury	15 (7.0)
Abdominal injury	15 (7.0)
Extremities injuries	1 (0.5)
Multiple injuries	68 (31.8)

The distribution of sustained injuries among motorcyclist fatalities decreased from the top part to the below part of their bodies is shown in **Table 9**. Head and neck (93.5%) were the most common injury area, followed by chest (84.6%) and abdomen and pelvic (49.1%). The extremities fracture is an only criterion that this study concerned involves injury of the fatalities. However, it is the commonly injury that found in motorcyclist fatalities (42.1%).

Table 9. Distribution of injuries (n = 214)

Region of Injury	Number (%)
Head and Neck	200 (93.5)
Chest	181 (84.6)
Abdomen and Pelvic	109 (49.1)
Extremities fractures	90 (42.1)

The association between CD and each factor were presented in **Table10**. There was no significant association between CD and gender (p = .057). Head injury was the most common CD for both male and female which were 49% and 69%, respectively. Although, there was no significant association between CD and age (p = .575) but young motorcyclist of age 15-24 years was the largest group for head injury obviously (55%). However, head injury was the major CD almost of age group also.

There was no significant association between CD and riding position (p = .694). Head injury was a common CD both riders and passengers account for 50% and 58% respectively. There was a significant association between CD and BAC level at p-value < .01. Sober fatalities (legal level) were larger group that head injury was CD (56%) while drunken fatalities (illegal level), head injury, multiple injuries and other were CD equally. Although there was no significant association between CD and type of crash (p = .262), but head injury in MVC had higher proportion than SVC account for 73% and 27% respectively.

Table 10. Causes of death distribution by gender, age group, riding position and crash type (n = 214) and BAC level (n = 196).

Variables		Causes of death			χ^2, p-value
		Head	Multiple	Other [j]	
Gender	Male	92	65	31	5.747, .057
	Female	18	3	5	
Age group	< 15	5	4	1	
	15-24	49	33	14	
	25-34	36	16	13	6.647, .575
	35-44	13	6	6	
	≥ 45	7	9	2	
Riding position	Rider	92	60	31	0.73, .694
	Passenger	18	8	5	
Crash type	SVC	30	16	5	2.682, .262
	MVC	80	52	31	
BAC level [b]	Legal level	74	44	15	14.46*, .001
	Illegal level	21	22	20	

[b] ≤ 50 mg% for legal limit

[j] Included neck, chest, abdominal, and extremities injuries were causes of death

Discussion

A motorcycle accident continues to be the major cause of fatal for road users. In this series, the data including 9 from 50 districts in Bangkok reported by one hospital alone. In this series, young-male rider is the commonly feature of the motorcyclist fatalities (**Table 1**) as many paper of various countries has been reported [4, 5, 6, 7, 8]. In this series, young motorcyclist age 15-24 years was the most common vulnerable group that confronts the fatal accidents (1 in 2 cases). Moreover, haft of the victims whom found BAC belong to this group. Motorcycling injuries among juvenile riders have long been identified as a global problem in nearly all developed countries in the past and traffic-related incidents have contributed to all deaths in children up to the age of 14 years [6]. This problem also occurred in developing countries, because of potential behavior risk factors and the lack of driving experience. For example in India, Dandona et al. found that risky behavior of rider motorized 2-wheeled vehicles that potentially contribute to mortality as young riders without license and unhelmeted [9].

These suggested that the new criteria to give a driving license for new one may needed to improve.

Alcohol intoxication still continues to be a problem among motorcycle riders [10, 11, 12]. The present study showed about 3 in 10 cases found alcohol in there blood and also over legal limit (**Table 2**). For this series, alcohol use is the problem of the age 15-25 years (1 in 2 of drinking motorcyclists). In Thailand, Kasantikul et al. suggested that riders simply have little reason to fear riding after drinking. They seem to be unaware that riding after drinking is not even a problem, nor do they seem to worry about encounters with the police. Clearly, public information and education programs as well as serious law enforcement efforts are needed to discourage drinking and riding motorcyclist [10].

Riding in nighttime is an interesting cause that related with the highly proportion of the fatalities. In this series, the most common time of crashing is during 0:00-5:59 (**Table 4**). The reason may explain that it is the common time after a meeting or party that may involve alcohol consumption (78% of drinking motorcyclist found in nighttime, **Table 6**). However, when we focus on weekdays; daytime had fatalities number more likely than nighttime nearly twice (**Table 4**). Possible that in daytime on weekdays are regularly day that use vehicles to go to their work place and also traffic conditions seem to be complex and vulnerable to the accident occurs, especially in the morning or evening rush hour. Stand on the reason that wet season may have badly road condition as slippery, low of visibility, but the result showed that season had no effected to distribution of motorcyclist fatalities (**Table 4**). Moreover, previous reports suggested that the days of the year with the most motorcyclist deaths were all during summer; their discussions are that when the weather is more accommodating of motorcycles, good weather can also encourage motorcyclists to increase their speed [6, 13].

High density of vehicles on the road of a metropolis as Bangkok may be the results that motorcycle collision with other vehicles more likely to occur than SVC (**Table 5**). Private vehicle was the greatest group that crash with motorcycle in this series, especially passenger car was the commonly vehicle as previous study has been reported [14]. Faster speeds travel of the passenger car than others may be affected to hardly avoidance to crashing. This is in agreement with paper has been reported that the most common type of motorcycle accident is crash with another vehicle, usually a passenger car. However, solo accidents without collision with another vehicle as running off the road is the most common occur in fatal case of their studies [14, 15]. For this series, SVC as motorcycle fall and crashed with fixed objects was the most common cause of motorcycle accidents (**Table 5**). Drunken riding was the major problem of the motorcyclist resulting in loss of motorcycle control and low responsible to road conditions that may affected to about 35% (18 in 51 cases) of SVC were illegal group compare to 28% (45 in 163 cases) were MVC. Although, in this series, it was not obvious that BAC related with SVC, however, Umesh has been reported that motorcycle riders with BAC > 10 mg% account for more than half of all rider fatalities in SVC [11]. Therefore, SVC may be a major problem with alcohol involvement recently.

Motorcycle crashes are associated with a wide spectrum of injuries, which are often in multiple anatomic regions. However, head was represented the commonest regions of injury occurred in motorcycle accidents (**Table 9**), this is in agreement with the previous findings have been reported [16, 17], followed by injuries of the chest (84.6%) and abdomen (49.1%). The results showed no association between CD with gender, age, riding position, crash type and crash objects (**Table 10**). These findings suggested that CD from motorcycle accidents was independently events from those factors. However, head injury had highest incidence in juvenile; age 15-24 years had proportion of head injury more than other age groups outstandingly (**Table 10**). Besides, the results showed that motorcyclists who had BAC > 50 mg% possible to die from cause of head injury or other injuries equally, while sober motorcyclists were distinguish to die by head injury (**Table 10**). This finding suggested that drunken riders possible to die from injury to any part of body when accident occurred due to the effect of BAC > 50 mg% may reduce an efficiency in critical performance situations of them as accident event, the ability to safe theirs body may be less than a sober rider.

Unfortunately, in this series, data of helmet uses were not available because helmet worn condition and type of helmet were benefit evidence may answer the unsolved history. Although evidence of helmet use was not available but we assumed that helmet use in the daytime has reached almost 100% because the strictly enforcement of the helmet law in Bangkok, but in nighttime was puzzling to approximate for helmet worn. This problem suggested to the data record system of motorcycle accident need to improve that may advantage for legal action and future study.

Conclusion

Motorcycle remains the vulnerable vehicle to confront an accident events and more possible to die more than the passenger car. We predicted that the number of motorcyclist fatalities trended to increase due to population growth and the increase number of registered motorcycles. Therefore, countermeasures need to improve law enforcement at nighttime and promotion of safe riding behavior especially in young men. These would be beneficial in bringing down mortality and morbidity rates from accidents.

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