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Fatal motorcycle crashes: a growing public health problem in Cambodia

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Abstract

This study examines the risk characteristics of fatal motorcycle crashes in Cambodia over a 5-year period (2007–2011). Secondary data analyses were conducted using the Cambodia Road Crash and Victim Information System, the only comprehensive and integrated road crash surveillance system in the country. Researchers from the Centers for Disease Control and Prevention and Handicap International found that (1) males are dying in motorcycle crashes roughly seven times more frequently than females; (2) motorcyclist fatalities increased by about 30% from 2007 to 2011; (3) the motorcyclist death rates per 100,000 population increased from 7.4 to 8.7 deaths from 2007 to 2011; and (4) speed-related crashes and not wearing motorcycle helmet were commonly reported for motorcyclist fatalities at approximately 50% and over 80% through the study years, respectively. Additionally, this study highlights that Cambodia has the highest motorcycle death rate in South-East Asia, far surpassing Thailand, Malaysia, and Myanmar. By recognising the patterns of fatal motorcycle crashes in Cambodia, local road-safety champions and stakeholders can design targeted interventions and preventative measures to improve road safety among motorcyclists.

Keywords

motorcycle; helmet; road safety; Cambodia; speeding; helmet wearing

1. Introduction

Worldwide, traffic fatalities increased by 46% from 1990 to 2010, and are expected to jump from the eighth to the fifth leading cause of death by 2030 (World Health Organization [WHO], 2008). Motorcycles are changing the face of traffic safety in low- and middle-

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income countries (LMICs). Recent estimates suggest that 92% of the annual road-traffic fatalities throughout the world occurs in LMICs, despite these countries having just 53% of the world's registered vehicles (WHO, 2013a). To combat this concerning trend in LMICs, the United Nations (UN) General Assembly approved resolution 64/255 in May 2011, making 2011–2020 the Decade of Action for Road Safety (United Nations General Assembly, 2010). The goal of this UN Resolution is to `stabilise and then reduce the forecast level of road-traffic fatalities around the world by increasing activities conducted at the national, regional, and global levels'. A region needing immediate attention is South-East Asia. In South-East Asia, road injury was the fifth leading cause of both the disability-adjusted life years and years of potential life lost in 2010 (Lozano et al., 2013; Murray et al., 2013). Within South-East Asia, the Western Pacific Region – comprising 37 countries including Cambodia – accounts for 16% of the globe's fleet of motor vehicles, but 44% of traffic-related fatalities (WHO, 2003).

The worsening road-safety issue in South-East Asia is related to the proliferation of two- and three-wheeled vehicles, which far outnumber four-wheeled vehicles (Peden et al., 2004). Among the 10 largest Asian markets, two- and three-wheelers are predicted to increase by 175% by 2035 to over 550 million (CAI-Asia, 2011). This rapid rise in motorisation is partly linked to increasing gross national product (GDP), as increasing incomes translate to more citizens purchasing vehicles. As more citizens purchase a motorised mode of transport [mainly two- and three-wheeled vehicles in South-East Asia], road-traffic injury rates tend to rise (Kopits & Cropper, 2005; Paulozzi, Ryan, Espita-Hardeman, & Xi, 2007; van Beeck, Borsboom, & Mackenbach, 2000).

While the rapid growth of vehicle use would likely contribute to increased traffic injuries, the influx in motorcycles is particularly concerning because motorcycles are more dangerous than any other type of motorised vehicle. Specifically, a US study found that per mile travelled, motorcyclists were about 30 times more likely to die in a traffic crash than occupants in a passenger car (National Highway Traffic Safety Administration [NHTSA], 2012). The lack of a protective `shell' to separate the user from traffic hazards in the case of a crash causes motorcyclists, along with pedestrians and cyclists to be classified as `vulnerable road users' (Bliss, Krug, Silcock, & Ward, 2006).

As with the majority of South-East Asia, Cambodia's road-safety culture has worsened and the number of motorcycles on the roadways has grown. As Cambodia's GDP grew from 8.6 billion USD in 2007 to over 12.8 billion USD in 2011 (Ministry of Economy and Finance, 2012), registered motorised two- and three-wheelers increased by 137% to almost 1.6 million vehicles over the same time period (Ministry of Public Works and Transport, 2012). Unfortunately, yet unsurprisingly, road-traffic fatalities increased by 23% over these same 5 years (Road Safety Cambodia, 2012).

The purpose of this study is to use data from the Cambodia Road Crash and Victim Information System (RCVIS) to describe Cambodia-specific motorcyclist fatalities and to identify patterns and risk factors for such crashes. To our knowledge, such a study has never been conducted in Cambodia, thereby making this study a unique contribution to the literature. These findings can then be used by local road safety champions and stake-holders

to identify priorities and design-targeted interventions and preventative measures to improve road safety among motorcyclists.

2. Methods

Researchers from the Centers for Disease Control and Prevention and Handicap International conducted secondary data analysis using the Cambodia RCVIS (Handicap International & National Road Safety Committee, 2011). The RCVIS is the only comprehensive and integrated road crash surveillance system in Cambodia. The Ministry of Interior (police) and Ministry of Health (health facilities) collect data for RCVIS. Cases are captured by RCVIS if someone is injured or killed in a road crash, defined as a collision involving at least one moving vehicle on a public road. The Ministry of Interior collects case information when the police are called to the site of a road crash and the Ministry of Health collects case information when a crash-related injured person receives care at health facilities. Police mainly capture fatalities, while health facilities primarily capture injuries. The Ministry of Interior then submits electronic copies of the data to the General Secretariat of National Road Safety Committee (GSNRSC), while the Ministry of Health sends hard copies of the data to GSNRSC, who then enters the data. The GSNRSC compiles all of the data and uses an algorithm to identify and remove duplicate cases based on crash details, names, and demographic information.

This study used non-identifiable data for motorcycle deaths from 2007 to 2011 from RCVIS and population data from the World Bank to calculate annual motorcycle death rates per 100,000 population (World Bank, 2013). Motorcycle death rates per 100,000 registered two- and three-wheelers were calculated using vehicle registration data obtained from the Ministry of Public Works and Transport (Ministry of Public Works and Transport, 2012). Using combined data from 2007 to 2011, researchers then calculated annualised death rates per 100,000 population overall, and by age, sex, and province. Finally, this study reports on the percentage of motorcycle crash fatalities that involved speed reported as a contributing factor, suspected alcohol use, helmet use, and head injuries.

As a census of road-traffic fatalities, confidence intervals are not needed to account for sampling error in RCVIS. However, mortality counts are subject to random variability, so 95% confidence intervals for death rates are included to account for this variability based on guidelines from the National Vital Statistics System (Murphy, Xu, & Kochanek, 2013).

The GSNRSC in Cambodia reviewed and approved this study. In addition, the protocol was determined to satisfy the US Centers for Disease Control and Prevention and the National Center for Injury Prevention and Control's Institutional Review Board's requirements.

3. Results

Overall road-traffic fatalities in Cambodia increased by 23% over the study period, from 1545 deaths in 2007 to 1905 deaths in 2011. Among the 1905 deaths in 2011, 66% were motorcyclists, 13% pedestrians, and 9% were family/passenger vehicle occupants. From 2007 to 2011, motorcyclist fatalities increased by 30%, from 971 to 1262 deaths (Table 1). The motorcyclist death rate generally increased over the entire time period (from 7.4 to 8.7

per 100,000 population), while the motorcyclist death rate per 100,000 registered motorcycles progressively decreased (from 144.7 to 79.3 per 100,000 registered motorcycles), due to a rapid increase in the number of registered vehicles (Table 1). For all years of data combined, the annualised motorcyclist death rate was 8.4 deaths per 100,000 population and the annualised motorcyclist death rate was 102.4 deaths per 100,000 registered motorcycles.

From 2007 to 2011, the highest annualised death rates when stratified by sex and age were among males between 25 and 29 years (33.8 deaths per 100,000 population) and males between 20 and 24 years (31.8 deaths per 100,000 population) (Table 2). Males 20–29 years old accounted for nearly 40% of all motorcyclist fatalities over the 5-year study period. The overall annualised motorcyclist death rate for females was much lower than for males (2.3 vs. 14.2 deaths per 100,000 population overall, respectively). Age-specific death rates for females were relatively stable after age 14 (Table 2).

When looking at province-specific motorcycle fatalities, the highest motorcyclist deaths rates were in the capital city of Phnom Penh and the province of Preah Sihanouk (15.0 and 16.0 deaths per 100,000 population, respectively), while the provinces of Kampot and Prey Veng (4.3 and 4.6 deaths per 100,000 population, respectively) had the lowest rates (Table 3). Phnom Penh, Kandal, and Kampong Cham, the three areas with the greatest populations, accounted for about 43% of all motorcyclist fatalities over this 5-year period.

Overall, from 2007 to 2011 nearly half (46%) of motorcyclist fatalities in Cambodia involved crashes where speed was reported as a contributing factor of the crash, and one-fifth of all motorcyclist fatalities involved alcohol (Table 4). When separated by year, alcohol-related motorcyclist fatalities fell from 25% of all fatalities (2007) to 18% of all fatalities (2011). When helmet status was known, just 2% of motorcyclist fatalities were wearing a helmet at the time of their crash in 2007; this rose to 17% in 2011. As helmet wearing increased among motorcyclist fatalities, the percentage who suffered a head injury as a result of their crash decreased (Table 4).

4. Discussion

This analysis of RCVIS data underscores the substantial burden of motorcyclist fatalities in Cambodia. We found (1) motorcycle crashes are killing young Cambodian men at a high rate; (2) motorcyclist fatalities increased by about 30% from 2007 to 2011; (3) the motorcyclist death rates per 100,000 population increased from 7.4 to 8.7 deaths from 2007 to 2011, while the motorcyclist death rate per 100,000 registered motorcycles fell from 144.7 to 79.3 deaths; and (4) speed-related crashes and not wearing a motorcycle helmet were commonly reported for motorcyclist fatalities, and 30% of motorcyclist fatalities were suspected to involve alcohol-impaired driving. At 79.3 deaths per 100,000 motorcycles in 2011, Cambodia has the highest motorcycle death rate in South-East Asia, with death rates more than 30% higher than the next worst performing countries of Thailand, Malaysia, and Myanmar (with 58.8, 42.9, and 25.7 deaths per 100,000 registered motorcycles, respectively) (WHO, 2013a).

Worldwide, young males 15–29 years old are almost three times more likely to die in a traffic crash than young females (WHO, 2013b). Consistent with the findings from studies in other LMICs (Carrasco, Gobinho, Barros, Rizoli, & Fraga, 2012; Manan & Varhelyi, 2012; Pang et al., 1999), we found that males in Cambodia are also much more likely to die from motorcycle crashes than females. Forty out of every 100 motorcyclist deaths in Cambodia are 20–29 year old men. Comparatively, 4 out of every 100 motorcyclist deaths in Cambodia are 20–29 year old women. This 10–fold difference may be explained by more risk taking behaviours among young men (Steinberg, 2007) and by the fact that males are more likely to drive motorcycles. Evidence suggests males are predisposed to motorcycle crashes due to exposure and inexperience (Harrison & Christie, 2005), impulsivity (Haque, Chin, & Lim, 2010), display of risky behaviours (Steg & Brussel, 2009), and a tendency to violate traffic laws (e.g., not wearing helmets and drive at excessive speeds) (Chang & Yeh, 2007; Steg & Brussel, 2009). The high death rate among working-age males is concerning because they are often the family breadwinners in LMICs, and their deaths may have broad implications for family well-being (Nantulya & Reich, 2003).

The observed increase in motorcyclist fatalities in Cambodia over the study period is consistent with neighbouring LMICs, which have also shown increases over the time period (WHO, 2013a). After 2009, the motorcyclist death rate per 100,000 population in Cambodia seems to stabilise. In 2010, multinational organisations launched two major road-safety initiatives targeting motorcyclists – the Cambodia Helmet Vaccine Initiative, which targeted passenger helmet use (Craft, 2010) and the Road Safety in 10 Countries Project, which targeted night-time helmet use and drink-driving (Peden, 2010). These two campaigns could account for some of the stabilisation in motorcyclist fatalities. While this slowing of motorcyclist fatalities is encouraging, an increasing number of motorcyclists continue to die each year. Additionally, the number of motorcycles on Cambodian roads is likely to continue to grow and be the dominant form of transportation for the foreseeable future, since motorcycles are less expensive to buy and maintain than cars.

The trend in death rates per registered motorcycle showed a different pattern than the trend in death rates per population. As newly registered motorcycles increased by 137% from 2007 to 2011 (Ministry of Public Works and Transport, 2012), the death rates per 100,000 registered motorcycles decreased dramatically. A reduction in the motorcyclist death rate per registered motorcycle over these 5 years is plausible, although the decrease is steeper than that might be expected. We learned that motorcycle registration in Cambodia is a one-time process, meaning that a motorcycle only needs to be registered once. An unknown number of motorcycles may be registered but are no longer used on the roads. Consequently, this dramatic reduction in motorcyclist death rate per 100,000 registered motorcycles could be partly artificial.

Overall, nearly half of motorcyclist fatalities involved crashes where speed was reported as a contributing factor. A review by Aarts and van Schagen (2006) supports the notion that a direct relationship exists between the speed at which a vehicle is moving and the probably of a crash involving an injury or fatality; with crashes involving faster travelling vehicles more likely to result in fatalities. Moreover, faster travelling vehicles are likely to get into a crash (Aarts & van Schagen, 2006). To combat the problem of speed-related crashes, Cambodia

may consider focusing road-safety efforts around motorcycle speed control. This might be accomplished through a combination of road smoothing/traffic calming (Grundy et al., 2009), increased enforcement (Li et al., 2011), and setting speeds that are appropriate for the roadway (Elvik, Vaa, Erke, & Sorensen, 2009) – all shown to be promising interventions.

Approximately one-fifth of all motorcyclist deaths in Cambodia from 2007–2011 involved suspected alcohol use. A blood alcohol content (BAC) above zero is associated with five times the relative risk of crashing a motorcycle compared to a zero BAC (Haworth, 2000). Over the study period, the percentage of motorcyclist fatalities in Cambodia reported as involving alcohol fell from 25% in 2007 to 18% in 2011. This reduction in alcohol-related motorcyclist deaths could be a result of increased awareness of the traffic laws and increased sobriety checkpoints by the police (Handicap International & National Road Safety Committee, 2010). Expanding and adapting the use of interventions that have shown to reduce alcohol-impaired driving – zero tolerance laws for those under the legal drinking age, sobriety checkpoints, ignition inter-locks, and mass media campaigns – might contribute to further reductions (Guide to Community Preventive Services, 2013).

Helmet wearing increased among deaths over the study period, and the percentage of motorcyclist fatalities who suffered a resulting head injury decreased. Unhel-meted motorcyclists are at the highest risk of suffering a head injury compared with any other type of road user (Javouhey, Guerin, & Chiron, 2006). Consistently and correctly wearing a helmet is the single most effective way of protecting oneself from sustaining a head injury or death on a motorcycle (Bliss et al., 2006). In fact, a comprehensive systematic review found that helmets reduce the risk of head injury by 69% and death by 42% in a crash event (Liu et al., 2009). There is evidence of increased head injuries and related fatalities as motorcycles become more frequent in South-East Asia, and this trend is expected to continue if significant actions are not taken (Bliss et al., 2006).

This study had limitations. First, although RCVIS contains both fatal and non-fatal injuries, we report only on fatalities due to inconsistent reporting among hospitals over the study period which compromised the quality of non-fatal injury data. There is more confidence in the data quality for fatalities, because fatalities are based primarily on police data, which have been shown to be more reliable than hospital data (Parker et al., in press). Nonetheless, reporting on motorcyclist fatalities underestimates the true burden of motorcycle crashes in Cambodia. Second, while we present confidence intervals for the rates to account for random variability in deaths from year to year, these confidence intervals do not account for any systematic variability that might exist in the RCVIS data collection process. For example, while RCVIS is designed to capture all deaths, the likelihood of a death being included might vary between urban and rural locations, so some caution should be used when comparing motorcyclist fatalities between provinces. Third, a systematic collection error related to the helmet status variable in 2010 and 2011 contributed to a large percentage of cases categorised as `unknown.' Consequently, we report helmet use only for cases where helmet status was known. Fourth, alcohol use is not actually measured by police officers in Cambodia. Instead, alcohol use is an assumption made by the police officers either when they are notified by witnesses of the crash (i.e., passengers or friends on other motorcycles) or from the smell of alcohol on the victim. Fifth, although Cambodian police officers

conduct thorough post-crash investigations, there is no way for the officers to know exactly how fast the motorcycle was travelling at the time of the crash, and they must subjectively determine whether speed was a contributing factor to the crash. Finally, although we report rates based on overall population and number of registered motorcycles, we are unable to provide a motorcyclist death rate per vehicle mile travelled. Finding data for estimates of exposure is a challenge in developing countries, and estimates of vehicle miles travelled were not available for Cambodia.

Our study highlights the burden of motorcycle fatalities in Cambodia and the need for the country to continue their efforts to address this growing issue. To our knowledge, this is the first time such a study has been conducted in Cambodia. These are important findings for local decision-makers in terms of designing interventions to target excessive speed, alcohol impaired driving, and helmet non-use, specifically among young men aged 20–29. Successfully addressing these issues will require continued and collaborative efforts among the Ministry of Interior, Ministry of Health, GSNRSC, non-governmental organisations, and other road-safety champions.

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Table 1

Motorcycle crash-related death rate per 100,000 population and 100,000 registered motorcycles by year, Cambodia 2007–2011.

Year	MC* deaths #	MC death rate per 100,000 population (CIs)	# of registered MC	MC death rate per 100,000 registered motorcycles (CIs)
2007	971	7.4 (6.9, 7.9)	671,252	144.7 (135.6, 153.8)
2008	1107	8.3 (7.8, 8.8)	860,167	128.7 (121.1, 136.3)
2009	1218	9.0 (8.5, 9.5)	1,135,638	107.3 (101.3, 113.3)
2010	1209	8.5 (8.0, 9.0)	1,372,252	88.1 (83.1, 93.1)
2011	1262	8.7 (8.2, 9.2)	1,590,469	79.3 (74.9, 83.7)
Total**	5767	8.4 (8.2, 8.6)	5,629,778	102.4 (99.8, 105.0)

*MC = motorcycle.

**Rates are annualised.

Table 2

Annualised motorcyclist crash-related death rate per 100,000 population by age group and sex, Cambodia 2007–2011.

	Males			Females			
	Crude number of deaths	% of total MC deaths	MC* death rate (95% CIs)	Crude number of deaths	% of total MC deaths	MC death rate (95% CIs)	Males: Females Ratio
0–4	26	0.5	0.7 (0.4, 1.0)	26	0.5	0.7 (0.4, 1.0)	1:1
5–9	31	0.5	0.8 (0.6, 1.2)	24	0.4	0.7 (0.4, 1.0)	1.3:1
10–14	43	0.7	1.0 (0.7, 1.3)	14	0.2	0.3 (0.2, 0.6)	3.1:1
15–19	550	9.5	12.5 (11.5, 13.5)	120	2.1	2.8 (2.3, 3.3)	4.6:1
20–24	1197	20.8	31.8 (30.0, 33.6)	132	2.3	3.5 (2.9, 4.1)	9.1:1
25–29	1078	18.7	33.8 (31.8, 35.8)	118	2.0	3.5 (2.9, 4.1)	9.1:1
30–34	452	7.8	22.6 (20.5, 24.7)	74	1.3	3.5 (2.7, 4.3)	6.1:1
35–39	392	6.8	19.9 (17.9, 21.9)	58	1.0	2.7 (2.1, 3.5)	6.8:1
40–44	306	5.3	16.4 (14.6, 18.2)	63	1.0	3.0 (2.3, 3.9)	4.9:1
45–49	288	5.0	18.3 (16.2, 20.4)	57	1.0	3.1 (2.3, 4.0)	5.1:1
50–54	170	3.0	15.6 (13.3, 17.9)	55	1.0	3.5 (2.7, 4.6)	3.1:1
>55	320	5.6	12.0 (10.7, 13.3)	100	1.7	2.6 (2.1, 3.1)	3.2:1
Unknown**	47	0.8	–	4	<0.1	–	

*MC = motorcycle.

**22 deaths missing sex information are excluded from table.

Table 3

Annualised motorcyclist crash-related death rate per 100,000 population by province*, Cambodia 2007–2011.

Province	Crude deaths	% of total deaths	MC** death rate (CIs)
Phnom Penh	1,092	18.9	15.0 (14.1, 15.9)
Kampong Cham	697	12.1	7.8 (7.25, 8.4)
Kandal	679	11.8	10.2 (9.4, 11.0)
Banteay Mean Chey	297	5.1	8.0 (7.1, 8.9)
Siem Reap	294	5.1	6.2 (5.5, 6.9)
Battambang	281	4.9	5.2 (4.6, 5.8)
Kampong Thom	275	4.8	8.2 (7.2, 9.2)
Takeo	251	4.4	5.7 (5.0, 6.4)
Prey Veng	231	4.0	4.6 (4.0, 5.2)
Kampong Speu	217	3.8	5.7 (4.9, 6.5)
Svay Rieng	200	3.5	7.8 (6.7, 8.9)
Preah Sihanouk	188	3.3	16.0 (13.7, 18.3)
Kampong Chhnang	174	3.0	6.8 (5.8, 7.8)
Pursat	152	2.6	7.2 (6.1, 8.3)
Kampot	131	2.3	4.3 (3.6, 5.0)
Kratie	129	2.2	7.5 (6.2, 8.8)
Rotanak Kiri	86	1.5	11.1 (8.9, 13.7)
Addar Mean Chey	82	1.4	8.9 (7.0, 11.0)
Preah Vihear	73	1.3	8.2 (6.5, 10.4)
Koh Kong	71	1.2	9.9 (7.7, 12.5)
Stung Treng	41	0.7	7.0 (5.0, 9.5)
Mondol Kiri	33	0.6	10.6 (7.3, 14.8)
Pailin	22	0.4	6.2 (3.9, 9.4)
Kep	15	0.3	7.7 (4.3, 12.7)
Unknown	56	9.7	–

* Including capital city of Phnom Penh.

** MC = motorcycle.

Table 4

Characteristics of motorcyclist fatalities, Cambodia 2007–2011.

		2007	2008	2009	2010	2011	Total
MC* fatalities where speed was reported as a contributing factor to the crash	Yes (%)	432 (44)	537 (49)	571 (47)	549 (45)	607 (48)	2636 (46)
	No (%)	539 (56)	570 (51)	647 (53)	660 (55)	655 (52)	3071 (54)
MC fatalities who were suspected to be under the influence of alcohol at the time of their crash	Yes (%)	230 (24)	210 (19)	237 (19)	236 (20)	222 (18)	1135 (20)
	No (%)	741 (76)	897 (81)	981 (81)	973 (80)	1,040 (82)	4632 (80)
MC fatalities helmeted at the time of their crash	Yes (%**)	24 (2)	42 (4)	179 (16)	67 (15)	111 (17)	423 (10)
	No (%)	905 (98)	985 (96)	956 (84)	378 (85)	535 (83)	3759 (90)
	Unknown	42	80	83	764	616	1585
MC fatalities who sustained a head injury	Yes (%)	816 (84)	952 (86)	926 (76)	846 (73)	871 (69)	4411 (76)
	No (%)	155 (16)	155 (14)	292 (24)	363 (27)	391 (31)	1356 (24)

*MC = motorcycle.

**Percentage of motorcyclist fatalities who were wearing a helmet at the time of their crash excluding unknowns.