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Changes in motorcycle-related injuries and deaths after mandatory motorcycle helmet law in a district of Vietnam

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Abstract

Objective—Our study measured the change in head injuries and deaths among motorcycle users in Cu Chi district, a suburban district of Ho Chi Minh City.

Methods—Hospital records for road traffic injuries (RTIs) were collected from the Cu Chi Trauma Centre and motorcycle-related death records were obtained from mortality registries in commune health offices. Head injury severity was categorized using the Abbreviated Injury Score (AIS). Rate ratios (RRs) were used to compare rates pre- and post-law (2005/2006–2009/2010). Cu Chi's population, stratified by year, age, and sex, was used as the denominator.

Results—Of records identifying the transportation mode at the time of injury, motorcyclists accounted for most injuries (3,035, 87%) and deaths (238, 90%). Head injuries accounted for 70% of motorcycle-related hospitalizations. Helmet use was not recorded in any death records and not in 97% of medical records. Males accounted for most injuries (73%) and deaths (88%). The median age was 28 years and 32 years for injuries and deaths, respectively. Compared to the pre-law period, rates of motorcycle injuries (RR = 0.53; 95% confidence interval [CI], 0.49–0.58), head injuries (RR = 0.35; 95% CI, 0.31–0.39), severe head injuries (RR = 0.47; 95% CI, 0.34–0.63), and deaths (RR = 0.69; 95% CI, 0.53–0.89) significantly decreased in the post-law period.

Conclusions—Rates of head injuries and deaths among motorcycle riders decreased significantly after implementation of the mandatory helmet law in Vietnam. To further examine the impact of the motorcycle helmet law, including compliance and helmet quality, further emphasis should be placed on gathering helmet use data from injured motorcyclists.

Keywords

Helmets; road traffic injuries; mortality; motorcycle; Vietnam

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Introduction

Unintentional injuries cause more than 5 million deaths each year and are a major public health problem in developing countries (Ghaffar et al. 2004; Gosselin et al. 2009). For every injury-related death, it is estimated that about 10 to 50 people are living with a permanent disability (Gosselin et al. 2009). Among all types of injuries, road traffic injuries (RTIs) contribute the greatest proportion, costing more than US$500 billion per year (Gosselin et al. 2009). Motorcycle users are the most vulnerable road users, with a high risk of morbidity and mortality (Solagberu et al. 2006). High-quality, certified motorcycle helmets have been well documented in preventing head injuries in many countries (Chiu et al. 2000; Ichikawa et al. 2003).

In Vietnam, motorcycles account for 95% of vehicles and are the primary mode of transport for the majority of residents (Le and Blum 2013). The number of registered motorcycles in 2013 was about 37 million (Ivers et al. 2014; Ministry of Transport 2013). RTIs kill approximately 14,000 people each year, 70% of which are related to motorcyclists (Ivers et al. 2014). Head injuries are attributed to 78% of deaths related to motorcycles (Ivers et al. 2014). RTIs cost 2.5% of the gross domestic product in 2010 and caused a significant economic hardship to the victims and their families (Ivers et al. 2014). On average, a hospitalization related to an RTI costs US$363, equal to 6 months of an average salary (Ivers et al. 2014; H. Nguyen et al. 2013).

In response to the burden of RTIs and deaths among motorcycle users, helmet legislation was introduced in 2000 in Vietnam and then amended in 2001 and 2003 (Ministry of Transport 2000, 2001, 2003). Under these laws, helmet use was mandatory for motorcycle users on provincial roads and national freeways but not mandatory in urban areas. Incomplete implementation and enforcement and the fact that the penalty for violating the helmet legislations was less than US$2 (20,000 VND; Ministry of Transport 2003) limited the impact of these laws. Helmet use was around 30% among motorcycle users in surveys conducted in 2004 and 2005 (Hung et al. 2006; Le and Blum 2013).

In 2007, a helmet law was passed with more comprehensive legislation and enforcement (Government of Socialist Republic of Viet Nam 2007a, 2007b; Ministry of Public Security 2008). Compared with requirements in the pre-2007 legislation, this new regulation made helmet use compulsory for all motorcycle drivers and passengers on all roads starting in December 2007. The new law increased penalties up to 6 times higher, to US$12, equal to 30% of the average monthly income per capita (Pass-more, Nguyen, et al. 2010). Although several loopholes were identified after introduction of the law, such as no punishment for unfastened or uncertified helmets, most loopholes were amended in 2008 (Passmore, Nguyen, et al. 2010).

The strong enforcement of the 2007 law has led to a substantial increase in helmet use among motorcycle users. Although no national surveys have been done to monitor helmet use before and after the mandatory helmet law, many cross-sectional studies have shown that helmet use among motorcycle users increased from 30% pre-law (Hung et al. 2006; Le and

Blum 2013) up to 90–99% post-law (Le and Blum 2013; H. Nguyen et al. 2013). Though these studies show increased use of helmets, limited information exists about the contribution of the law to a reduction in injuries and deaths among motorcycle users. One preliminary evaluation showed that the helmet law contributed to a 16% reduction in road traffic head injuries over the first 3 months of the launching of the law (Passmore, Tu, et al. 2010). However, the evaluation did not evaluate changes in head injuries and deaths related to motorcycle users and did not account for the impact of seasonal weather variations in RTIs (Passmore, Tu, et al. 2010). This study aimed to compare rates of head injuries and deaths related to motorcycle accidents in Cu Chi district, Ho Chi Minh City, 2 years before and 2 years after the introduction of the 2007 helmet law in Vietnam.

Methods

Study design and setting

A pre and post study was conducted in Cu Chi district, Ho Chi Minh City. Cu Chi is a suburban district, located 50 km from Ho Chi Minh City, with an area of 435 km^2 and a population of 356,000 (Statistical Office in Ho Chi Minh City 2010). The district, composed of 21 communes, accounts for 5% of the Ho Chi Minh City population. The road system in the district includes a national freeway, 3 provincial roads, and many inner-district roads.

Sources of data

Information was collected regarding people with any injuries admitted to Cu Chi hospital and deaths related to road traffic crashes in Cu Chi district in the 2 years (2005–2006) before and 2 years (2009–2010) after the mandatory helmet law. The data collection over a 2-year period controls for any variation due to the impact of seasonal weather. Records involving RTIs were extracted from Cu Chi regional hospital medical charts. Information regarding road traffic deaths was collected from mortality registries in the 21 commune health stations because limited information is available at the hospital for those who died at the scene, during transport, or after admission. A total of 7,189 medical charts (3,779 pre-law and 3,410 post-law) and 331 death records (179 pre-law and 152 post-law) were reviewed and collected for data analysis. Ethical approval for the study protocol was obtained from the Scientific Board of the Institute of Public Health in Ho Chi Minh City.

Main measures

A standard case reporting form was used to collect information on injuries from medical charts in Cu Chi hospital. The RTI cases were stratified according to the type of road user (motorcycles, cars, bicycles, pedestrians, others, and unknown). Those RTIs related to motorcycles were further classified by gender, age (0–14 years, 15–29 years, 30–44 years, 45–59 years, and 60+ years), place of residence (Cu Chi, others), time of admission (11:00 p.m.–5:59 a.m., 6:00 a.m.–12:59 p.m., 1:00 p.m.– 5:59 p.m., 6:00 p.m.–10:59 p.m.), length of stay in hospital in days, and anatomical location of injuries (head injuries and non-head injuries). The severity of the head injury was measured using the standardized Abbreviated Injury Scale (AIS; Greenspan et al. 1985) and then classified into 3 groups: mild if AIS was 1 or 2; severe if AIS was 3; and very severe if AIS 4 or 5. Motorcycle helmet use was not recorded for 97% of medical charts; thus, no measure was taken.

Deaths related to RTIs were collected in a reporting form for information on gender; age of deceased (0–14 years, 15–29 years, 30–44 years, 45–59 years, and 60+ years); type of road user (motorcycle and others [car, pedestrian, bicycle, and unknown]); and type of injuries (head injuries, multiple injuries, and others/unknown).

Statistical analysis

Only those living in Cu Chi were included in data analysis. Means and 95% confident intervals (95% CIs) were determined for a continuous variable (length of stay) and proportions for categorical variables. Cu Chi's population, stratified by year, age, and sex, was used as the denominator to calculate the rate of injuries and deaths (To and Nguyen 2012). Percentages and rate ratios were calculated for each type of injury in the post-law vs. pre-law period. For injuries related to motorcycle users, the total number of injuries, head injuries, and severe head injuries were used as the numerator to calculate rates in each studied period. For deaths related to motorcycle users, the number of deaths was used to calculate the rate. All rates were calculated per 100,000 Cu Chi population for each year and for the 2-year periods pre-and post-law. Rate ratios (RRs) with 95% CIs were used to compare pre- and post-law rates of injuries and deaths related to motorcycle users by age and gender.

The electronic medical records, available since 2006 for administrative purposes in Cu Chi hospital, were used to estimate the total number of injuries admitted to the hospital each year. Compared with the electronic records, there was a 10–15% undercount in the total number of injuries, although no significant difference in gender and age distribution were observed between electronic records and our data. To minimize underestimation of the rate of injuries per population, poststratification weights were used to adjust for the number of injuries by a proportional increase in age and gender. All analyses were performed using STATA 13.0 (StataCorp LP, Texas, USA).

Results

Characteristics of the studied population

Road traffic injuries accounted for 70 and 60% of all admissions related to injuries in the pre-law and post-law periods, respectively. The rate of RTIs significantly decreased after the law (RR = 0.97; 95% CI, 0.96–0.98), whereas the rates of other injuries such as those that occur at home (RR = 1.2; 95% CI, 1.18–1.24) or work (RR = 1.2; 95% CI, 1.14–1.26) or those due to violence (RR = 1.04; 95% CI, 1.01–1.07) significantly increased over the same period (Table1).

About 58% of pre-law and 35% of post-law medical charts indicated the mode of transport related to RTIs. Considering only those charts where the mode of transport is identified, motorcycles users accounted for 86% in the pre-law period and 89% in the post-law period of admissions related to RTIs. The rate of injuries and death was calculated for each year. The rate of injuries related to motorcycles significantly decreased from 230/100,000 population in 2005 to 102/100,000 population in 2010 ($P < .001$), with similar trends observed among other modes of transport. Motorcycle-related accidents accounted for 74%

of road traffic deaths in the pre-law period and 70% in the post-law period. A downward trend was observed among deaths related to motorcycles (23.7/100,000 population in 2005 vs. 11/100,000 population in 2010) but not among other modes of transport (Table 1).

Motorcycle injuries and deaths

Motorcycle injuries were highest among males (72.4% pre-law and 74.6% post-law), young adults aged 15–29 years old (48.6% pre-law and 44.8% post-law), and those admitted during late evening/night (6:00 p.m.–10:59 p.m.; 41.8% pre-law and 42.6% post-law). The distribution of motorcycle injuries by age and gender was not significantly different between the 2 studied periods ($P > .05$). Head injuries accounted for 70% of admissions in the pre-law period and were significantly lower (52%) in the post-law period ($P < .001$). The majority of head injuries (74% pre-law and 62% post-law) were mild. The proportion of severe and very severe head injuries, however, was higher in the post-law period compared to the pre-law period (22.5% post-law vs. 14.4% pre-law and 15.4% post-law vs. 11.3% pre-law, respectively; Table 2).

Of the fatal cases, young adults aged 15–29 years old (41.7% pre-law and 36.8% post- law) and males (90.9% pre-law and 89.6% post-law) accounted for the highest proportions. The majority of deaths (59.8% pre-law 56.6% post-law) involved head injuries. No significant differences in death distribution by age, gender, or type of injury was observed between the 2 studied periods (Table 3). No deaths were observed in children under 15 years of age during the study period.

Changes in motorcycle injuries and deaths

Rates for motorcycle-related injuries, head injuries, severe head injuries, and deaths all decreased in the post-law vs. pre-law period. The rates for motorcycle injuries dropped from 235.2 to 125.6/100,000 population (RR = 0.53; 95% CI, 0.49–0.58), for head injuries from 183.4 to 64.7/100,000 population (RR = 0.35; 95% CI, 0.31–0.39), for severe head injuries from 20.8 to 9.7/100,000 population (RR = 0.47; 95% CI, 0.34–0.63), and for deaths from 22.3 to 15.4/ 100,000 population (RR = 0.69; 95% CI, 0.53–0.89). For death rates, a significant decrease was found in both males (RR = 0.67; 95% CI, 0.51–0.88) and females (RR =0.79; 95%CI, 0.34–1.7) and young adults aged 15–29 years old (RR = 0.61; 95% CI, 0.4–0.92). No significant change in death rates was seen among other age groups (Table 4).

Discussion

This study measured the impact of the 2007 mandatory helmet law on injuries and death related to motorcycles 2 years pre-and post-law period using both hospital records and mortality registries. Over the studied period, RTIs consistently accounted for the highest number of hospital admissions and deaths among all types of injuries. The majority of RTIs and deaths were related to motorcycles. RTIs and deaths related motorcycle users were highest in males (73 and 90%, respectively) and young people aged 15–29 years old (46 and 38%, respectively). The characteristics of our study population are highly reflective of RTIs in Vietnam. This proposition is strengthened by the finding that our results are similar to those of other studies conducted in different regions in Vietnam (Ngo et al. 2012; Tam et al.

2012; Van et al. 2006) and the World Health Organization (2010a) fact sheet on road safety in Vietnam. In addition, road traffic deaths in our study reduced to 22.1 per 100,000 population in the 2-year post-law period. The result was consistent with the results of a study measuring road traffic mortality over the same period across 16 provinces in Vietnam that observed a rate of 21 per 100,000 population (Ngo et al. 2012) and slightly higher than the national estimation on RTI death rates of the World Health Organization 19 per 100,000 population (World Health Organization 2010b). Given that males and young people are the most economically productive group, the results highlight the need to improve safe driving targeted to males and young age groups to reduce economic loss to families and society.

Our study showed evidence of significant decreases in mortality and morbidity from motorcycle-related RTIs following implementation of the 2007 mandatory helmet law in Vietnam. Compared to the rate of injuries and deaths related to motorcycles 2 years before the law, a significant reduction in the rates of overall and head-specific injuries was observed in males and females and across all age groups in the 2 years following the law. Statistical differences in the death rates were observed in both males and females in the young age group (15–29 years) but not in other age groups.

The decreasing trend in injury and death rates observed in our study is similar to that of previous studies in Vietnam (Pass-more, Tu, et al. 2010), Thailand (Ichikawa et al. 2003), and Taiwan (Chiu et al. 2000), although the rates vary between studies. The reasons for variability are differences in methodology, sampling techniques, and available information from each data source. A previous study in Vietnam reported a reduction of 16% in the head injury rate and 18% in the death rate 3 months after introduction of the helmet law (Passmore, Tu, et al. 2010). However, the study was limited to overall RTIs and there was no specific information about motorcycle users and the change in the group by age and gender. In Thailand, a study was conducted among motorcyclists to measure the impact of helmet law (Ichikawa et al. 2003). It found reductions of 41.4% in head injuries and 20.8% in deaths but the change in death rate was not statistically significant 2 years after introduction of the law (Ichikawa et al. 2003). A study in Taiwan also showed the effect of a helmet law on head injuries and deaths among motorcycle users after one year of implementation (Chiu et al. 2000). Compared to the pre-law period, the rate of injuries decreased by 34%, and deaths decreased by 33% (Chiu et al. 2000).

Although a significant reduction was observed in the injury and death rates related to motorcycles, our study also found a slight increase in the proportion of admissions for motorcycle users in the post-law period. The slight increase in the proportion of admissions for motorcycle users might be explained by a rapid increase in ownership of motorcycles compared to other vehicles in Vietnam. Motorcycles accounted for 95% of newly registered vehicles, and almost 9,000 new motorcycles are on the road every day (Pervin et al. 2009). Although we did not find any specific measurement in a motorcycle-to-car ownership ratio, the literature shows that in less advanced economic countries, including Vietnam, with emerging economies, the motorcycle-to-car ownership ratio shows an initial increase when there is an increase in income of the population (Law et al. 2015). Thus, for RTIs, hospital admission related to motorcycles would be consistently dominant and slightly increase compared to the pre-law period. Our results may reflect the situation of RTIs in Vietnam in

which though a significant reduction in RTIs related to motorcycles was observed over the studied period, the burden of RTIs attributable to motorcycle use is still critical.

The proportions of severe head injuries and very severe head injuries were higher in the post-law period compared to the pre-law period. This finding is explained by an increase in helmet use that may increase the chance of survival after severe crashes and thus increases the proportion of severe injuries admitted to the hospital. In addition, poor helmet quality and incorrect helmet wearing are common in Vietnam (Ackaah et al. 2013; Passmore, Nguyen, et al. 2010), which may reduce protection in high-energy crashes. In one study, 80% of helmets on the market did not meet national standards (Passmore, Nguyen, et al. 2010). In addition, helmet use was only 28 and 52% among children under 7 years and children 8–14 years in Ho Chi Minh City according to a study conducted in 2008 (Pervin et al. 2009). Since 2010, a large number of interventions and campaigns have been implemented to increase the rate of helmet use among children, but there has been limited impact on awareness and helmet use in children (Trinh and Le 2016). Although a significant decrease in motorcycle-related injury and death rates per thousand populations was observed, continued severe injuries and deaths necessitate further action.

This study has some limitations that need to be considered when interpreting the results. Although we observed a significant reduction in motorcycle-related head injuries and deaths after introduction of the mandatory helmet law, we were unable to capture the direct impact of helmet use due to insufficient information about helmet use in medical charts and death records. This study used a pre–post study design to compare a change in the rate of injuries and deaths related to motorcycle users pre and post introduction of the helmet law in Vietnam. Although the study design has been common used many studies (Chiu et al. 2000; Ferrando et al. 2000; Passmore, Tu, et al. 2010), this study design does not control for other elements that were also changing and affected by the study outcomes during the studied period (Thiese 2014). Thus, the reduction in injuries and deaths could be attributable to ongoing strong enforcement through higher penalties, greater presence of traffic police, and communication. All of these factors together with improvement in traffic infrastructure have created an incentive for riders to comply with traffic rules and improve safety. To further examine the impact of the motorcycle helmet law, including compliance and helmet quality, further emphasis should be placed on gathering helmet use data from injured motorcyclists. However, many studies measuring helmet use in the same period showed that the proportion of helmet use increased significantly from 30 to 95% of motorcycle users after enforcement of the mandatory helmet law (Hung et al. 2006; Le and Blum 2013; H. Nguyen et al. 2013), and 97.8% of motorcycle users owned a helmet (Ackaah et al. 2013). Thus, it is appropriate to at least partially attribute the reduction in head injuries and deaths to increased helmet use after the law. In addition, although we did not find any publications on helmet use in this particular district, a random observational study in 4 major cities including Ho Chi Minh City showed that more than 90% of motorcycle users wore helmets, with little variation between cities: 90.2% in Ha Noi, 94.1% in Ho Chi Minh City, 98% in Da Nang, and 97.9% in Can Tho; Pervin et al. 2009).

The rates presented here may be an underestimation because the population in the district was used as the denominator instead of number of registered motorcycles by age. The

overall underestimation is thought to be minimal because 98% of households in Ho Chi Minh City own at least one motorcycle (V. T. Nguyen 2009), though it may over- or undercount among age categories (i.e., fewer older motorcyclist riders or passengers). This population-based study was conducted in only one large referral hospital in a suburban district of Ho Chi Minh City, preventing citywide or national generalizability, although a prior study revealed similar helmet use rates throughout Vietnam (Pervin et al. 2009). Finally, based on observational studies showing very low helmet use among children before and after the helmet law, failure to identify deaths under 15 years of age calls into question the accuracy of pediatric vital statistics data in Cu Chi District.

The introduction and strong enforcement of the 2007 mandatory helmet law in Vietnam coincided with a statistically significant reduction in motorcycle-related head injuries and deaths in Cu Chi district. Although the study was conducted in only one district, the finding serves as primary evidence in support of the mandatory helmet law in Vietnam. To further examine the impact of the motorcycle helmet law, including compliance and helmet quality, further emphasis should be placed on gathering helmet use data from injured motorcyclists.

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Table 1

Classification of injuries and deaths by years for only individuals living in Cu Chi district.

	Pre-law				Post-law					
	2005		2006		2009		2010		RR(post-/pre-law)	
Type of injuries	***N*(%)**	**Rate/100,000 population**	***N*(%)**	**Rate/100,000 population**	***N*(%)**	**Rate/100,000 population**	***N*(%)**	**Rate/100,000 population**	**(95% CI)**	***P* value**
All injuries	1,883	639.3	1,927	744.8	1,617	810.0	1,800	735.2	1.03 (1.01–1.04)	<.001
Road traffic injuries	1,287 (68.4)	4382	1,332 (69.1)	513.3	949 (58.7)	476.9	962 (53.4)	389.9	0.97 (0.96–0.98)	<.001
Household injuries	225 (11.9)	75.9	274 (142)	109.0	362 (22.4)	179.2	523 (29.1)	217.6	12 (1.18–124)	<.001
Work injuries	47 (2.5)	15.8	59 (3.1)	22.4	85 (5.3)	43.0	100 (5.6)	40.2	12 (1.14–126)	<.001
Violent injuries	167 (8.8)	56.7	208 (10.8)	79.2	164 (10.1)	82.6	184 (102)	74.4	1.04 (1.01–1.07)	.01
Others	157 (8.3)	522	54 (2.8)	20.8	57 (35)	28.2	31 (1.7)	12.8	0.8 (0.78–0.87)	<.001
Mode of transport related to RTIs										
Motorcycles	676 (52.9)	230.3	625 (46.9)	240.0	298 (31.4)	150.1	254 (26.4)	102.3	0.85 (0.83–0.87)	<.001
Others (car, bicycle, pedestrian, etc.)	118 (9.2)	395	85 (6.4)	34.1	43 (4.5)	20.8	28 (2.9)	11.5	0.8 (0.76–0.85)	<.001
Unknown	483 (37.8)	164.9	622 (46.7)	239.0	607 (64.0)	305.4	680 (70.7)	276.1	1.1 (1.07–1.11)	<.001
Type of road traffic deaths										
Motorcycles	69 (74.1)	23.7	63 (73.3)	21.0	67 (76.4)	19.9	39 (60.9)	11.0	0.89 (0.84–0.95)	.001
Others (cars, pedestrian, etc.)	3 (3.2)	1.03	8 (9.2)	2.6	9 (11.2)	2.7	6 (9.3)	1.7	1.04 (0.8–1.2)	.6
Unknown	21 (22.6)	72	15 (17.4)	5.0	12 (13.6)	3.5	19 (29.7)	5.4	0.9 (0.83–1.04)	2

Table 2

Characteristics of motorcycle injuries in Cu Chi hospital, Vietnam.

Characteristics	Two years pre-law *N* (%)	Two years post-law *N* (%)	*P* value
Age group (years)			
0–14	94 (7.3)	35 (6.3)	.4
15–29	628 (48.6)	247 (44.8)	
30–44	314 (24.3)	152 (27.6)	
45–59	179 (13.9)	83 (15.1)	
60+	76 (5.9)	34 (6.2)	
Gender			
Male	942 (72.4)	412 (74.6)	.43
Female	359 (27.6)	140 (25.4)	
Time of admission (24 h)			
11:00 p.m.–559 a.m.	126 (9.7)	79 (14.3)	.002
6:00 a.m.–12:59 p.m.	276 (21.4)	84 (15.2)	
1:00 p.m.–5:59 p.m.	349 (27.0)	154 (27.9)	
6:00p.m.–1059p.m.	539 (41.8)	235 (42.6)	
Length of stay in hospital (days)			
Mean (95% CI)	62 (5.7–6.7)	7.8 (7.1–8.4)	<.001
Median (interquartile range)	4 (2–8)	5 (3–10)	
Anatomical location of injuries			
Head	1,014 (782)	285 (51.7)	<.001
Non-head	282 (21.8)	266 (48.3)	
Severity of head injuries			
Mild (AIS 0–1)	749 (74.3)	174 (62.1)	<.001
Severe (AIS 3)	145 (14.4)	63 (225)	
Very severe (AIS 4–5)	114 (11.3)	43 (15.4)	

Table 3

Characteristics of deaths related to motorcycle crashes, pre- and post-law periods, Cu Chi district, Vietnam.

Characteristics	Two years pre-law Motorcycle deaths *N* (%)	Two years post-law Motorcycle deaths *N* (%)	*P* value
Age group (years)			
0–14	0	0	.82
15–29	55 (41.7)	39 (36.8)	
30–44	36 (27.3)	30 (28.3)	
45–59	31 (23.5)	26 (24.5)	
60+	10 (7.6)	11 (10.4)	
Gender			
Male	120 (90.9)	95 (89.6)	.74
Female	12 (9.1)	11 (10.4)	
Type of injuries			
Head	79 (59.8)	60 (56.6)	.87
Multiple	28 (212)	24 (22.6)	
Others/unknown	25 (18.9)	22 (20.8)	

Table 4

Number of motorcycle-related injuries, head injuries, severe head injuries, and deaths per 100,000 population in Cu Chi district, by study period: pre-law (2005–2006) and post-law (2009–2010).

	Study period			
Characteristics	**Pre-law**	**Post-law**	**RR (95% CI)**	***P* value**
Injuries	235.2	125.6	0.53 (0.49–058)	<.001
Gender				
Male	351.9	192.5	055 (0.49–0.60)	<.001
Female	126.3	62.8	0.49 (0.42–058)	<.001
Age (years)				
0–14	79.4	34.1	0.43 (0.31–0.60)	<.001
15–29	357.0	177.5	0.49 (0.43–056)	<.001
30–44	218.7	131.1	0.60 (051–0.71)	<.001
45–59	258.8	150.2	058 (0.47–0.72)	<.001
60+	206.8	117.8	057 (0.41–0.81)	<.001
Head injury	183.4	64.7	0.35 (0.31–0.39)	<.001
Gender				
Male	277.3	102.8	0.37 (0.32–0.42)	<.001
Female	95.9	29.0	0.30 (0.24–0.37)	<.001
Age (years)				
0–14	63.7	20.6	0.32 (0.21–0.49)	<.001
15–29	285.5	100.3	0.35 (0.29–0.41)	<.001
30–44	167.5	68.1	0.40 (0.32–050)	<.001
45–59	191.5	58.9	0.30 (0.22–0.42)	<.001
60+	151.9	44.9	0.29 (0.17–0.48)	<.001
Severe head injury	20.8	9.7	0.47 (0.34–0.63)	<.001
Gender				
Male	34.7	17.7	0.51 (0.37–0.71)	<.001
Female	7.8	2.2	0.29 (0.13–0.64)	.002
Age (years)				
0–14	9.7	1.3	0.1 (0.02–056)	.009
15–29	29.6	15.3	0.51 (0.33–0.78)	.002
30–44	21.4	10.0	0.48 (0.27–0.85)	.01
45–59	20.1	13.3	0.64 (0.30–1.38)	.2
60+	19.9	6.4	0.34 (0.1–1.31)	.12
Death	22.3	15.4	0.69 (053–0.89)	.005
Gender				
Male	42.1	28.6	0.67 (051–0.88)	.005
Female	3.9	3.1	0.79 (0.34–1.7)	57
Age (years)				
0–14	0	0	NA	
15–29	29.6	18.0	0.61 (0.4–0.92)	.01

	Study period			
Characteristics	**Pre-law**	**Post-law**	**RR (95% CI)**	***P* value**
30–44	23.4	16.7	0.71 (0.44–1.16)	.17
45–59	40.1	28.9	0.72 (0.42–1.2)	.22
60+	24.9	23.5	0.94 (0.40–2.2)	.88