

ORIGINAL ARTICLE

Prevalence of helmet use among motorcycle riders in Vietnam

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Objectives: To investigate the rate of helmet use among motorcycle drivers in Hai Duong province of Vietnam during winter/spring 2005, and to compare the rates of helmet use by road types.

Method: Population-based observational surveys.

Results: 16 560 motorcyclists were observed across 37 road sites (incorporating 5 road categories). The overall weighted average of helmet use for motorcyclists was 29.94%, with male drivers more likely to wear helmets than female drivers (odds ratio (OR) 1.64, 95% confidence interval (CI) 1.53 to 1.76). Male pillion passengers were less likely to wear helmets than female pillion passengers (OR 0.78, 95% CI 0.72 to 0.85). The number of adult drivers using helmets is larger as compared with that of young drivers (OR 8.56, 95% CI 5.93 to 12.19). The rates of helmet use were significantly higher ($p < 0.001$) on compulsory roads and were 59.01%, 39.97%, 24.22%, 12.7% and 9.54% for national, provincial, district, commune and Hai Duong inner-city roads, respectively.

Conclusion: Helmet legislation has increased the rate of helmet use by motorcycle drivers on compulsory roads. Elsewhere, rate of helmet use is very low, indicating that in the absence of legislation and enforcement, motorcyclists in Vietnam will not wear a helmet.

Road traffic injuries are a global public health problem, with 1.2 million people killed and 50 million injured each year.¹ Worldwide, the economic cost of road crash injuries is estimated to be about 1% of the gross national product in low-income countries and 1.5% in middle-income countries.¹ Motorcycles are a common means of transportation in low-income and middle-income countries as they are cheap and accessible to many people. As a result, motorcycle-related injury has become a major public health concern in countries such as Vietnam. In particular, injuries to the head, after motorcycle crashes, are common causes of severe morbidity and mortality. Motorcycle helmets are designed to protect riders against head injuries and yet helmet use is not widespread in Vietnam.

In Vietnam, with a population of 81 million and increasing industrialization and urbanization, the number of motor vehicles has rapidly increased.² In 2003, there were about 11.38 million registered motorcycles compared with 1.8 million motorcycles in 1992.^{3,4} Vietnam's police data show that motorized two and three-wheelers accounted for 94.75% of all registered vehicles in 2005. Although no reliable data are available, the number of motorcycle injuries has also reportedly increased over the past years. For example, the number of reported road injuries rose from 14 174 in 1994 to 29 872 in 2002 and deaths rose from 4907 to 12 956.⁵ Recent surveys have reported that motorcycles account for 59% of road injuries and that they disproportionately affect the young.⁴ It has also been estimated that the cost of road traffic injury in Vietnam was at least 2% of the gross domestic product in 2000.⁴ To reduce deaths and injuries, the Vietnamese government promulgated the National Policy on Accidents and Injury Prevention in 2001, with the target of reducing traffic deaths from 14 to 9 per 10 000 vehicles by 2010.

Motorcycle helmets are effective in reducing head injury after a crash. According to the US National Highway Traffic Safety Administration, motorcycle helmets reduce the possibility of death in a crash by about 29%.⁶ A meta-analysis by Lui *et al*⁷ reported that motorcycle helmets reduce the risk of

head injury by 72% and are also likely to reduce the risk of death, although the effectiveness may be modified by speed.

Several studies have suggested that helmet use differs by sex, age and position of the riders. Corad *et al*⁸ found that in Indonesia, only 20% of pillion passengers wore helmets compared with 89% of drivers. Similarly, in a Chinese study,⁹ only 29% of pillion passengers wore helmets compared with 63% of drivers. With respect to sex, studies in Thailand¹⁰ as well as in the US¹¹ have found that women are more likely to report always wearing a helmet compared with men, with research indicating that the odds of a man wearing a helmet are half that of a woman (after controlling for riding position).¹²

Helmet legislation was first introduced in Vietnam in 2000, and a year later a further resolution was adopted that stipulated compulsory helmet use for all motorcycle riders on certain assigned routes and national roads.^{13–15} A financial penalty for not wearing a helmet while riding on compulsory roads was issued in February 2003, with a fine of VN\$ 10 000–20 000 (US\$ 0.7–1.5). Currently, there is no penalty for motorcyclists who use helmets that are incorrect or that are substandard. Despite such legislation, the rate of helmet use is unknown. The aim of this study was to measure and compare the prevalence of helmet use among motorcycle riders on different types of roads in Vietnam.

METHODS

A cross-sectional observational survey was undertaken in Hai Duong Province, located in the Red River Delta region, 60 km from Hanoi, with an area of 1649.55 km² and a population of 1.67 million.¹⁶ The province comprises the city of Hai Duong and 11 districts. The urban population accounts for 14% of the total population. The road system in the province comprises six national roads with a total of 126.69 km in length, 20 provincial roads (336.87 km), district roads (359 km), commune roads (1388 km), inner-city roads of Hai Duong city (112.63 km) and village roads.^{16–18}

Abbreviation: VKT, vehicle kilometers traveled

The survey was undertaken in the province between February and April 2005. The population was defined as all motorcyclists riding on public roads in the province during the observation period. To ensure that the selection of road sites for the study was representative of the road structure for the province, a stratified random sample of roads reflecting the five road groups was used.

The observation sites were selected in two stages. For national and provincial roads, the first stage involved the random selection of the road. Assuming that the characteristics of traffic and helmet use are uniform along the length of the road, the second stage involved the selection of the observation site. The site was randomly selected after dividing the selected roads into 5-km segments. All national roads and 7 of 20 provincial roads were selected with one observation site for each selected road. For each observation site, we also nominated an alternative site, identified as the next 5-km segment. Alternative sites were used whenever the observation sites did not satisfy the criteria of site selection—namely, the presence of police at the time of observation, which we know artificially increases the prevalence of helmet wearing.¹⁹

District and commune roads were also sampled using a two-stage approach. Firstly, from the 12 districts identified, two districts were excluded (Cam Giang and Binh Giang) as these districts comprised <15% (13.94%) of the province's population.²⁰ In all, 7 of the 10 eligible districts were randomly selected. Within these districts, seven district roads and nine commune roads were randomly selected using simple random sampling from a sampling frame that comprised a list of all district and intercommune roads (provided by Hai Duong's Department of Transportation).¹⁸ The second stage involved each selected road being divided into 1-km segments, of which one segment was randomly selected to be the observation site. The roads that were <1 km in length were considered to be one segment.

Hai Duong inner-city roads were sampled using the official map of the city as issued by Hai Duong's Department of National Resources and Environment, and the entire list of roads provided by the city's Division of Urban Administration.²¹ Roads that were <0.5 km in length and 5 m in width were excluded because of low traffic volumes. Six roads were randomly selected from all remaining roads and were divided into segments (one segment is defined as the road between two intersections), and one segment was randomly selected for one selected road. Observations were undertaken about 100–200 m from the randomly selected intersection.

All observation sites were established at a non-curved road segment. At each site, two trained observers, including the researchers (DVH), made the observations. The observer completed the observation form, recording all passing motorcycles and transcribing the following: number of riders, goods carried, sex of riders (male or female), age of riders (adult or child) and helmet use (correctly or incorrectly fastened). Riders who were not seated on their own (namely, babies or infants) were excluded from the observation. Observations were conducted between 09:00 and 17:00 during weekdays. Both directions of traffic at each site were observed until the required number of observations was obtained.

To minimize missing data on roads with high traffic volume, one observer observed motorcycles with only a single driver and the other observed motorcycles with ≥1 passenger. Whenever possible, the two observers cooperated to reach agreement on the required parameters to be recorded. On roads with low traffic volume, the registration number of motorcycles was noted to avoid double recording. Along with the direct observation, a video camera was used to record

traffic flow at sites with extensive traffic flows and high-speed traffic.

The proposed sample size was such that it could (1) detect a hypothesized proportion of helmet use among motorcycle riders with a relative error of 1% and a 95% confidence interval (CI) and (2) detect a difference in the proportions of helmet use between specific types of roads with an $\alpha = 0.05$ and 80% power. About 16 000 vehicle observations were collected to meet the above assumptions.

Stratum-specific helmet use rates were calculated by applying the weight defined by the formula

$$P_i = \sum_{j=1}^k W_{ij} P_{ij}$$

where W_{ij} is the weight of road j in road type i , P_{ij} is the observed proportion of helmet use and k is the number of roads selected within road type i . W_{ij} is calculated on the basis of the estimated vehicle kilometers traveled (VKT) given by equation 2:

$$W_{ij} = V_{ij} L_{ij} / \sum_{i=1}^k V_{ij} L_{ij}$$

where L_{ij} is total length for road j among road type i and V_{ij} is the estimated traffic volume of road j among road type i . We assumed that the traffic volume was constant along the whole road.

The population helmet use rate was calculated using the weighted applied road type (W_i), which is defined as the proportion of VKT of motorcycles on each road type (V_i) given that the volume is constant across the road type, as given in equation 3:

$$W_i = (V_i)(L_i) / \sum_{i=1}^5 V_i L_i$$

where L_i is the total length for road type i and V_i is the average estimated traffic volume of road type i , calculated by dividing the estimated VKT for selected roads by the total length of selected roads.

The estimated population proportion of helmet use was calculated by equation 4:

$$\hat{P} = \sum_{i=1}^5 W_i P_i$$

Standard error ($\sqrt{p(1-p)/n}$) and 95% CI of the estimates were calculated to check the precision of the estimates.

To compare the rates of helmet use between strata of roads, one-sided, two-sample z tests were used with unequal sample sizes with a significance level of 0.05 and a power of 80%. Data were stratified by road type to compare helmet use by sex and age group and Mantel–Haenszel weighted odds ratios (OR_{MH}) were calculated. 95% CI values for the difference were also calculated using unequal sample size for each stratum of road.²² χ^2 for linear trend in proportion (Mantel extension) of helmet use was calculated with five levels of roads. Logistic regression was used with stepwise selection to investigate the predictors of helmet use. All data were analyzed using SAS v.8.02.

RESULTS

A total of 16 560 drivers and 8626 passengers from 37 randomly selected sites were observed, among which 45 met the exclusion criteria; for 29 motorcyclists, the sex was not recorded. Both baby or infant and sex-missing data

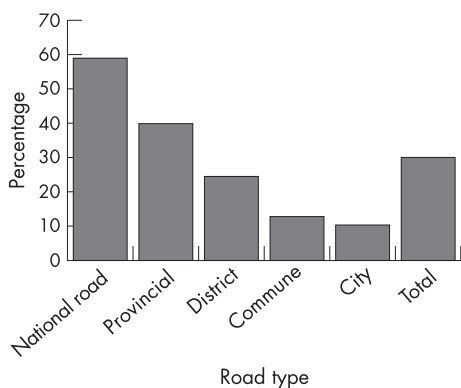


Figure 1 Helmet use by road type (using weighted proportions).

accounted for 0.32% of all motorcyclists or 1.07% of total pillion passengers. Of the observed motorcycles, 63.10% (n = 10 450) did not have a pillion passenger, with the remainder having one (32.88%, n = 5445), two (3.71%, n = 614), or three pillion passengers (0.31%, n = 51). Local roads (inner-city roads and commune roads) had the highest proportion of motorcycles without a pillion passenger (73.72%). Of the observed drivers, 83.29% (13 971) were men and 16.71% (2589) were women corresponding to a male:female ratio of 5.4:1. Almost all (99.88%, n = 16 540) of the drivers were aged ≥16 years. A total of 22 691 motorcyclists were identified as adults and 650 were recorded as children. In all, 9% (n = 1496) of motorcycle drivers carried large goods on their motorcycles. Among 6752 pillion passengers, 55% were women (n = 3713) and the remaining 3039 were men or children (n = 630).

Overall, the weighted prevalence rate of helmet use among motorcycle drivers was low—29.94% (standard error (SE) = 0.3%; table 1). The rates of helmet use were highest on national roads (fig 1) with weighted stratum-specific helmet use rates of 58.99%, followed by provincial roads (prevalence rate 39.97%), and were lowest on inner-city roads (prevalence rate 9.54%). The difference in the rate of helmet use across all road types was significant ($\chi^2 = 3936.6$, df = 4; p < 0.001). Almost 32% (n = 7236) of adults wore a helmet compared with 5.23% (34/650) of children (OR 8.45, 95% CI 5.93 to 12.19).

Of the 16 560 drivers, the weighted prevalence of helmet use was 34.69% compared with 18.97% for pillion passengers. After stratification by road type, drivers were two times as likely to wear a helmet than passengers (OR_{MH} 2.39, 95% CI 2.29 to 2.53). This trend was the same for all strata of roads (table 1). Table 2 shows the comparison of helmet use rates among male and female drivers. After stratification by road type, male drivers were more likely to wear a helmet

compared with female drivers on all road types (OR_{MH} 1.64, 95% CI 1.53 to 1.76).

Of 6781 pillion passengers, the weighted prevalence of helmet use was 18.97%, significantly lower than that for drivers (p < 0.001). Male pillion passengers were less likely to wear a helmet compared with female pillion passengers after controlling for road type (OR_{MH} 0.78, 95% CI 0.72 to 0.85). Adult pillion passengers were more likely to wear a helmet than children (OR 5.01, 95% CI 3.49 to 7.23).

Helmet use for 146 (0.63%) riders was recorded as “incorrect use”, indicating that the chin strap was either not fastened or incorrectly fastened. These observations were excluded from the number of riders wearing helmets. Additionally, 284 (1.22%) riders were coded as “helmet present but not worn”; such observations were also excluded from the analysis.

Of the 1496 motorcyclists carrying large goods, 47% (n = 716) of the drivers wore a helmet. Drivers identified to be carrying goods were more likely to wear helmets than those who were not carrying goods (OR_{MH} 1.68, 95% CI 1.56 to 1.82).

Table 3 describes the predictors for helmet use of drivers. The strongest predictor for helmet use was the type of road traveled on. An almost fivefold (OR 4.86, 95% CI 4.53 to 5.21) likelihood of wearing a helmet was observed while traveling on a road that required, by legislation, motorcyclists to wear a helmet compared with roads that had no such legislation.

DISCUSSION

In this study, we found a higher rate of helmet use on roads with legislation requiring compulsory helmet use, albeit with a low prevalence, than on roads without such requirements. The difference in the prevalence of helmet use between road types indicates that helmet legislation, in combination with its enforcement, has an effect on the rates of helmet use. Our results show that riders on national roads are more likely to wear a helmet compared with those traveling on provincial roads, despite the fact that legislation dictates helmet use while traveling on both road types. These observed large variations in helmet use on roads with compulsory helmet use suggest that law enforcement of helmet legislation is not consistent.

We found that pillion passengers were less likely to wear helmets than drivers, and these results are consistent with those of other studies in developing countries such as Indonesia and⁸ China⁹ as well as in developed countries.^{12 23 24} Similar to previous research, we also found that adults are more likely to wear helmets than children.^{11 12 19}

In contrast with other studies,^{11 12 27} we found that male drivers were more likely to wear a helmet than female drivers. This is a surprising finding and is difficult to explain without exploring the reasons further with riders or drivers, which was not the purpose of this study and clearly warrants further investigation.

Table 1 Helmet use by road type and by position of riders

Road type	Driver			Passenger			Unadjusted overall helmet use (%)	Weighted overall helmet use (%)
	n	With helmet (%)	Weighted helmet use (%)	n	With helmet (%)	Weighted helmet use (%)		
National	3918	63.63	66.72	1896	41.30	42.38	56.35	59.01
Provincial	3537	44.98	47.73	1664	19.53	23.44	36.84	39.97
District	3625	31.48	29.66	1452	12.33	11.35	26.00	24.22
Commune	2111	15.63	15.60	799	5.76	5.10	12.92	12.79
Inner city	3369	9.32	10.16	970	7.01	7.80	8.80	9.54
Total	16560	35.44	34.69	6781	20.66	18.97	31.15	29.94

Table 2 Helmet use by sex

Road type	Male			Female			Crude OR	95% CI
	n	With helmet n	(%)	n	With helmet n	%		
Overall helmet use								
National road	4330	2594	59.91	1470	681	46.33	1.73	1.53 to 1.95
Provincial	3732	1515	40.59	1464	394	26.91	1.86	1.62 to 2.12
District	3834	1066	27.80	1240	254	20.48	1.49	1.28 to 1.75
Commune	2157	312	14.46	748	64	8.56	1.81	1.35 to 2.42
City	2957	295	9.98	1380	87	6.30	1.65	1.28 to 2.13
Total	17010	5782	33.99	6302	1480	23.48	1.68	1.57 to 1.79
					OR _{MH}		1.69	1.61 to 1.78
Driver helmet use								
National	3511	2277	64.85	407	216	53.07	1.63	1.32 to 2.02
Provincial	3047	1395	45.78	490	187	38.16	1.37	1.12 to 1.67
District	3104	991	31.93	521	150	28.79	1.16	0.94 to 1.43
Commune	1788	294	16.44	323	36	11.15	1.57	1.07 to 2.31
City	2521	264	10.47	848	50	5.90	1.87	1.35 to 2.59
Total	13971	5221	37.37	2589	639	24.68	1.82	1.65 to 2.01
					OR _{MH}		1.64	1.53 to 1.76
Pillion passengers' helmet use								
National	819	317	38.71	1063	465	43.74	0.81	0.67 to 0.98
Provincial	685	120	17.52	974	207	21.25	0.79	0.61 to 1.02
District	730	75	10.27	719	104	14.46	0.68	0.49 to 0.94
Commune	369	18	4.88	425	28	6.59	0.73	0.38 to 1.39
City	436	31	7.11	532	37	6.95	1.02	0.61 to 1.73
Total	3039	561	18.46	3713	841	22.65	0.77	0.68 to 0.87
					OR _{MH}		0.78	0.72 to 0.85

OR_{MH}, Mantel-Haenszel (MH) weighted odds ratio is the summary of OR after stratification by road type.

In accordance with previous studies,^{25, 26} we observed involvement in motorcycle use is greater in males compared with females. Given the lower rate of helmet use among women, children and pillion passengers, we recommend both increased awareness of the implications of head injury after a motorcycle crash and fines for drivers carrying pillion passengers not wearing a helmet. We acknowledge that fines may be premature, given that there are few helmets currently available for young children.

As is evident from this study, making helmet use compulsory (as it is on several road types in Hai Duong) increases the likelihood of a driver using a helmet almost fivefold. This finding mirrors those reported by Ichikawa *et al.*,¹⁰ who found that helmet legislation increased helmet use fivefold in Thailand. However, the fact that the prevalence of helmet use on compulsory roads is still <60%, suggests that greater levels of enforcement are required.

This study has several limitations. Firstly, the study was conducted during the winter/spring seasonal period, a period, that may confer higher rates of helmet use than if observed during summer/autumn, when it is hot and humid. Therefore, the observed rates of helmet use may be over-estimated. Secondly, the classification of roads was based on the government's management scheme rather than the key determinants of the road such as its length or paving material. Thirdly, because of a lack of data on traffic volume, the volume estimates (used for the weightings) were

obtained by dividing the number of motorcycles traveled on the specific road during the observational period. Finally, observation of incorrect helmet use is likely to be underestimated as, in the absence of stopping the motorcyclists, it was difficult to identify the status from a distance. Similarly, assigning the age of the driver or rider may have been arbitrary, although we minimized the error by grouping age into only two categories. Importantly, attempts to minimize these errors were undertaken by video recording and reviewing the footage and, in relation to the age of the driver or rider, recent research has shown that assignment of age by independent observers is relatively high ($\geq 87\%$).²⁸

CONCLUSION AND IMPLICATIONS FOR INJURY PREVENTION

The prevalence of helmet use by motorcycle drivers is influenced by the presence of legislation and enforcement. Currently, in Vietnam, legislation for helmet use applies on only certain assigned routes and national roads, and the prevalence of helmet use on these roads has reached a prevalence of almost 60%, which is five times the prevalence on city roads. Clearly, in the absence of legislation and enforcement, Vietnam's motorcyclists do not wear helmets. Given the large number of motorcycles in Vietnam and the increasing burden due to motorcycle-related injuries, there is now an urgent need for the government to introduce a consistent policy on helmet use by motorcycle drivers—a

Table 3 Predictors of helmet use among motorcycle drivers*

Variables	Coefficient estimate	SE	Wald's χ^2	p Value	OR	95% CI
Road type†	1.6140	0.0376	1840.7430	<0.001	4.862	4.536 to 5.213
Passenger	-0.3755	0.1086	11.9682	0.001	1.138	1.059 to 1.223
Sex	0.2936	0.0620	22.4314	<0.001	1.615	1.458 to 1.788
Goods carried	0.8452	0.0839	101.5924	<0.001	1.819	1.617 to 2.046

*Model adjusted for helmet-wearing drivers.

†Road types are classified as those with legislation requiring compulsory and non-compulsory helmet use.

Key points

- Overall, the prevalence of helmet use for drivers is 34.6% and even lower for pillion passengers—18.9%.
- The prevalence of helmet use is higher on roads with legislation requiring compulsory helmet use.
- The prevalence of helmet use varies between road types that have legislation requiring compulsory helmet use, indicating that enforcement of the legislation is not consistent across road types.
- Given the large number of motorcycles in Vietnam and the increasing burden due to motorcycle-related injuries, there is an urgent need for the government to introduce a consistent policy on helmet use by motorcycle drivers—a policy that applies to all road types and for all motorcyclists.

policy that applies to all road types and for all motorcyclists. Until such time as a population-based response to motorcycle-related injury is adopted, it is unlikely that major reductions in serious head injury will be observed.

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LACUNAE

Muzzled owners and thick dogs in Geneva

A Geneva radio station reports that authorities have announced that dogs are to be muzzled in all parks in the city, not just those on a specified list, with authorities saying that compulsory muzzling of dogs must apply everywhere—or nowhere. The decision follows a ruling by the cantonal cabinet that from October, dogs must be muzzled in designated areas and those breeds considered to be dangerous must wear muzzles at all times. The new requirement did not specify a date of commencement. Unfortunately, the station’s website also reported that dogs must wear a muzzle in squares, walkways and lakeside quays and that dogs which are not a viscous breed can walk in the street without one (contributed by Ian Scott).