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Turn signal use among car drivers and motorcyclists at intersections: a case study of Da Nang, Vietnam

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ABSTRACT

Turn signal neglect is a major cause of traffic crashes, particularly rear-end collisions. However, little research has investigated the use of turn signals among motorists, particularly in developing countries with high levels of motorcycle use. This research aimed to investigate the prevalence and factors associated with turn signal use at intersections among car drivers and motorcyclists in Da Nang, Vietnam. Cross-sectional roadside observations were undertaken at 24 sites across Da Nang City during weekday and weekend periods. A total of 17,142 vehicles were observed, including 2392 cars and 14,750 motorcycles. Turn signal use among car drivers (68.27%) was found to be significantly higher than motorcyclists (40.13%). Binary logistic regression modelling showed that turn signal neglect at intersections was associated with making a right turn, not carrying passengers, travelling outside of the city centre, travelling on weekdays, and the absence of separate car lanes, pedestrian crossings and traffic lights. Despite national legislation regulating turn signal use in Vietnam, the use of turn signals is relatively low compared with developed countries. The findings highlight the need for both greater and more targeted enforcement of existing legislation combined with extensive road safety education.

1. Introduction

Road traffic crashes have become a major public health concern in many countries, particularly those in the developing world. Globally, more than 1.2 million people are killed in road crashes each year while the number injured is estimated to be as high as 50 million people (WHO, 2016). Around 85% of all global road deaths are due to crashes occurring in developing countries. With a high proportion of motorcycles in South East Asia, this region is considered to be the most vulnerable in the world with more than 34% of road fatalities involving motorcyclists (WHO, 2015). In Vietnam, approximately 14,000 people lose their lives each year due to road traffic crashes, with 59% of these being motorcyclists (WHO, 2018).

Causes of vehicle crashes are multifaceted (Haddon, 1980; Robertson, 1992), with human error estimated to account for 64–95% of all traffic crashes in developing countries (TRL, 1990). Failure among motorists to use their turn signals is considered to be one of the primary causes for vehicle crashes (Ponziani, 2012). A turn signal allows motorists to more easily predict the turning movements of others, particularly at intersections (Faw, 2013). When drivers neglect to use their turn signals, rear-end collisions can occur. According to the Illinois Department of Transportation, rear-end collisions comprise the highest number of injury crashes, resulting in 30% of all injury crashes (IDOT, 2013). Rear-end auto accidents can result in whiplash, head injuries, back injuries, shoulder injuries, fractured bones, and knee injuries.

While a number of studies have examined turn signal use among car drivers in developed countries (Faw, 2013; Ponziani, 2012), no studies have explored this risky driving behaviour among motorcyclists. In south East Asia, the level of conflict caused by turn signal neglect can be more severe, given a higher proportion of vulnerable road users, namely motorcyclists, who regularly interact with car users on the road system. Unlike car drivers, motorcyclists are more exposed to the elements and face a much higher risk of becoming severely injured or dying in a crash. However, due to the smaller size and poorer visibility

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of turn signals on motorcycles, the safety benefits of turn signal use for motorcyclists might be less than those for car drivers.

The aim of the research underlying this paper was to investigate the prevalence and factors associated with turn signal use at intersections among car drivers and motorcyclists, using a case study of Da Nang, Vietnam. A better understanding of turn signal use among car drivers and motorcyclists can inform the development of policies that aim to reduce turn signal neglect rates and increase safety for road users.

2. Literature review

Although turn signal neglect is considered a major cause of traffic crashes, relatively few studies have been carried out to determine rates of turn signal use or to investigate factors affecting those rates. Clayton and Myers (2008) explored the impact of visual prompts on increasing safe driving practices by focusing on turn signal use at a four-way intersection in a university campus in the United States. A comparison of turn signal use rates between three baseline and two prompting sessions was conducted. The results showed that the average signal rate across the two prompting sessions was around 87%, much higher than the average rate across the three baseline sessions of only 63%. Another study in the United States that investigated turn signal use rates by drivers on a university campus in the presence and absence of traffic was conducted by Lebbon et al. (2007). The results showed that the rate of turn signal use was 63% when oncoming traffic was present, but this reduced to only 44% when oncoming traffic was absent.

According to a study conducted by the Society of Automotive Engineers, an estimated two million Americans are involved in collisions each year because of turn signal neglect (Ponziani, 2012). This is more than twice the number of crashes (950,000) caused by distracted driving such as the use of cell phones or texting. Neglecting turn signals has become one of the central topics of the U.S. Department of Transportation (NHTSA, 2010). Ponziani (2012) found that 48% of people did not use turn signals when changing lanes and 25% failed to use them when turning at intersections. The American Automobile Association (AAA) Foundation for Traffic Safety conducted a study in November 2014 to determine compliance with laws requiring drivers to use turn signals (SPIVEY, 2015). This found that 44% of drivers may not be using their turn signals when making a right or left turn, with 57% not using them when changing lanes.

The above studies mostly examine rates of turn signal use in different contexts. However, only two studies have explored factors influencing turn signal rates of car drivers. Faw (2013) carried out a series of observations of over 5600 vehicles making a turn at various intersections in British Columbia, Canada. On average, the rate of turn signal use was about 76%. Intersection characteristics, road configuration, direction of turn and the example of other drivers were found to influence the use of turn signals. Driver characteristics such as gender and age were not considered in this study. Another study was carried out in the United States to investigate the influence of road type, turn direction, presence of forward vehicles, whether the vehicle stopped before the turn, driver age and gender on the use of turn signals (Sullivan et al., 2015). They found that turn signal use was affected by all of these factors, except the age and gender of drivers.

In summary, limited research has been undertaken on turn signal use, with no study dedicated to the topic in a developing country where motorcyclists account for a high proportion of road traffic. To the best of the authors' knowledge, this paper represents the first study to explore the prevalence and factors associated with turn signal use at intersections among car drivers and motorcyclists in a developing country.

3. Research context

The research was undertaken in the city of Da Nang, Vietnam. The city includes a major harbour and is the largest urban centre in central Vietnam with a population of 951,700 people (GSO, 2015). Da Nang includes six urban districts (Thanh Khe, Hai Chau, Lien Chieu, Ngu Hanh Son, Son Tra, and Cam Le) in which Thanh Khe and Hai Chau are considered to be the city centre of Da Nang.

Motorcycles are the dominant mode of road transport in Da Nang, comprising 78% of road traffic in 2012. While there are more than 580,000 registered two-wheeled vehicles in Da Nang, there are only 36,000 (6%) registered four-wheeled vehicles. The number of registered vehicles in Da Nang doubled between 2005 and 2012 (Kutani et al., 2015). Like most countries, including the United States, driving in Vietnam is undertaken on the right hand side of the road.

Getting a motorcycle license in Vietnam is considered to be much easier than getting a car driver license. A car driver has to study driving theory in classes and practise driving with an instructor for at least three months before doing a final test, while a motorcyclist spends only two weeks undertaking both of these stages. Despite the presence of national legislation mandating the use of turn signals in Vietnam, police in Da Nang rarely penalise motorists for non-compliance.

4. Methodology

The data used in this research was obtained from a cross-sectional observation survey undertaken at 24 different intersections across Da Nang City (see Fig. 1) during May-June 2016. Observation sites were selected to represent a broad range of intersection types in terms of the number of approach roads, number of traffic lanes, and the presence/absence of traffic lights, separate car lanes and pedestrian crossings. The presence of police has also been found to have an impact on compliance with traffic laws (Rothengatter, 1982; Akaateba et al., 2014; Truong et al., 2016), as has the location of observation sites (within or outside of the city centre) so these characteristics were also considered in the site selection process. The sites were also chosen on the basis of surveyor safety and the ability to observe traffic inconspicuously.

A survey sheet was developed to record information relating to vehicles (vehicle type, turn direction) and their occupants (gender and estimated age of drivers/riders, presence of passengers), intersections (police presence, separate car lanes, pedestrian crossings, number of lanes, presence of traffic lights, location), observation time (time of day, weekday or weekend) and weather conditions. Each site was surveyed during three different time periods (6:30 − 7:30am, 10:30 − 11:30am and 4:30 − 5:30pm) for two weekdays and one weekend. The time periods were chosen on the basis of representing peak traffic periods in Da Nang City.

Two surveyors were positioned at an approach leg of each intersection to observe traffic entering the intersection. One surveyor was assigned to focus on cars while the other focused on motorcycles to avoid repeated observations. It was not possible to capture all vehicles turning at intersections, so the surveyors were instructed to randomly select a car/motorcycle on each lane of a road and carefully observe it approaching the intersection. If it made a right or left turn at the intersection, all information was recorded on the survey sheet. Otherwise, the surveyor would pick the next available car/motorcycle to observe. The process of random selection was stopped while they recorded what they observed. At intersections with heavy traffic, the surveyors were advised to observe traffic from a higher position (e.g. by standing on a chair) to improve their field of vision. If a selected vehicle was later hidden by others, the surveyors had to start the process again by randomly selecting another vehicle.

The recorded data was first transferred from the paper-based forms to a computer. Observations without value or with no meaningful value on any of the variables were discarded from further analysis. SPSS was used to analyse the data. Using descriptive statistics, the prevalence of turn signal use with 95% confidence intervals was calculated and classified by a number of variables such as vehicle type, turn direction, gender, age, presence of passengers and number of traffic lanes. A

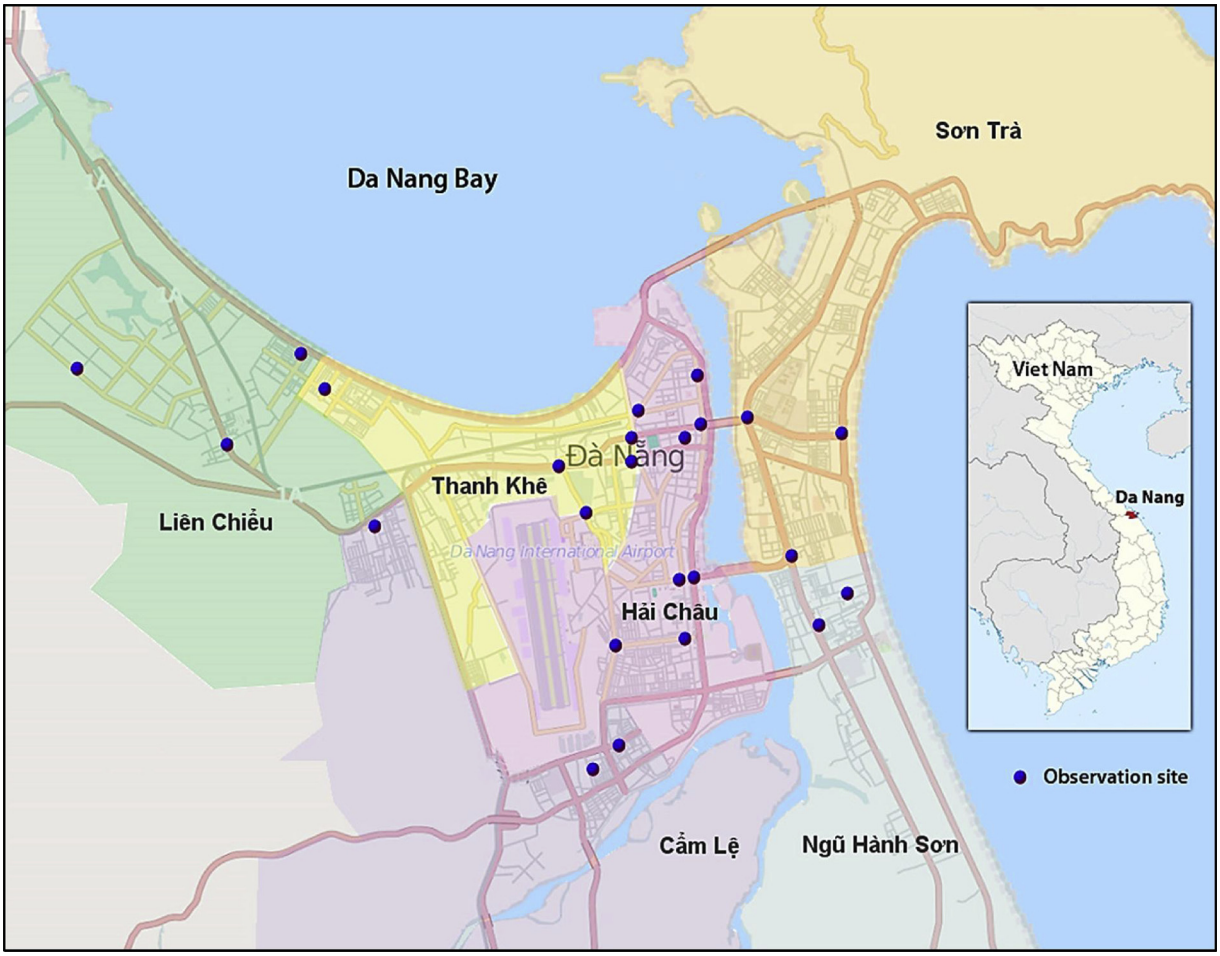

Fig. 1. Location of observation sites in Da Nang City, Vietnam.

binary logistic regression model was then developed to determine factors associated with turn signal use.

5. Results

5.1. Descriptive statistics

A total sample of 17,142 vehicles were observed across the 24 observation sites during the study period, in which 2392 (14%) were cars and 14,750 (86%) were motorcycles. Table 1 provides additional descriptive statistics regarding the sample, including rates of turn signal use at the observation sites. The rates are classified by a range of variables covering vehicle characteristics, demographics, intersection characteristics, observation time and weather conditions.

Car drivers used their turn signals 68.27% of the time (95% CI: 66.40–70.13%) compared to motorcyclists who did so only 40.13% of the time (95% CI: 39.34–40.92%). Given the greater potential for conflict associated with turning left, signal use was significantly higher for left turns than right turns: 72.85% (95% CI: 70.25–75.44%) vs. 64.19% (95% CI: 61.55–66.83%) for car drivers and 47.97% (95% CI: 46.70–49.24%) vs. 34.83% (95% CI: 33.84–35.83%) for motorcyclists.

Male car drivers had a higher prevalence of turn signal use than females, while female motorcyclists had higher prevalence than males. Prevalence was higher among both middle and older aged car drivers and motorcyclists (74.84% and 41.72% respectively) compared to younger car drivers and motorcyclists (58.55% and 38.61%). Prevalence was also found to be lower when driving alone than while carrying passengers.

The prevalence of turn signal use at intersections without police presence was higher than places with police presence (72.53% compared to 50.00% for car drivers and 40.64% compared to 37.74% for motorcyclists). Turn signal use was also higher at intersections with pedestrian crossings. The use of turn signals was generally found to reduce when there were more traffic lanes available. The presence of traffic lights was associated with a higher rate of turn signal use, particularly among motorcyclists (45.17%, 95% CI: 43.89–46.45%) compared to unsignalised intersections (36.78%, 95% CI: 35.87–37.87%).

Both car drivers and motorcycle riders were more likely to use turn signals at intersections located within the city centre and on weekends. Higher turn signal use rates among motorcyclists were observed in wet weather conditions (49.35%, 95% CI: 46.91–51.79%) compared with dry weather (38.99%, 95% CI: 38.16–39.83%).

5.2. Logistic regression modelling

Results of the logistic regression model for turn signal use are shown in Table 2. Overall, the analysis shows that males, right turns, middle and older aged motorists, presence of passengers, separate car lanes, pedestrian crossings and more than one traffic lane, and travelling within the city centre, late morning hours and weekends were all significant predictors of turn signal use.

The odds of turn signal use among both car drivers and motorcyclists when making a right turn were around a half of the odds of turn signal use when making a left turn. While male car drivers were more likely to use turn signals than female car drivers (OR = 1.30, $p < 0.05$), male motorcyclists were less likely to do so than female motorcyclists (OR = 0.83, $p < 0.001$). Carrying passengers was associated with twice the likelihood of using turn signals among both car

Table 1
Rates of Turn Signal Use (%) Among Car Drivers and Motorcyclists at Intersections.

Variable	Car				Motorcycle			
	n_c	n'_c	Rate (%)	95% CI	n_m	n'_m	Rate (%)	95% CI
Overall	2392	1633	68.27	66.40-70.13	14750	5919	40.13	39.34-40.92
Turn direction								
Left	1127	821	72.85	70.25-75.44	5945	2852	47.97	46.70-49.24
Right	1265	812	64.19	61.55-66.83	8805	3067	34.83	33.84-35.83
Gender								
Female	772	492	63.73	60.34-67.12	6779	2892	42.66	41.48-43.84
Male	1620	1141	70.43	68.21-72.65	7971	3027	37.98	36.91-39.04
Age								
Young (< 30 years old)	965	565	58.55	55.44-61.66	7530	2907	38.61	37.51-39.71
Middle and older aged (≥ 30 years old)	1427	1068	74.84	72.59-77.09	7220	3012	41.72	40.58-42.85
Carrying passengers								
No	1215	766	63.05	60.33-65.76	7288	2302	31.59	30.52-32.65
Yes	1177	867	73.66	71.15-76.18	7462	3617	48.47	47.34-49.61
Police presence								
No	1940	1407	72.53	70.54-74.51	12164	4943	40.64	39.76-41.51
Yes	452	226	50.00	45.39-54.61	2586	976	37.74	35.87-39.61
Separate car lanes								
No	750	534	71.20	67.96-74.44	5033	1765	35.07	33.75-36.39
Yes	1642	1099	66.93	64.65-69.21	9717	4154	42.75	41.77-43.73
Pedestrian crossings								
No	1262	705	55.86	53.12-58.60	8945	3082	34.46	33.47-35.44
Yes	1130	928	82.12	79.89-84.36	5805	2837	48.87	47.59-50.16
Number of lanes								
1 lane	26	20	76.92	60.73-93.12	320	218	68.13	63.02-73.23
2 lanes	916	682	74.45	71.63-77.28	5353	2418	45.17	43.84-46.50
3 lanes	419	275	65.63	61.08-70.18	3038	867	28.54	26.93-30.14
4 lanes	1031	656	63.63	60.69-66.56	6039	2416	40.01	38.77-41.24
Intersection type								
Unsignalised	1449	985	67.98	65.58-70.38	8954	3301	36.87	35.87-37.87
Signalised	943	648	68.72	65.76-71.68	5796	2618	45.17	43.89-46.45
Time of day								
Early morning	822	571	69.46	66.32-72.61	4868	1921	39.46	38.09-40.83
Late morning	738	505	68.43	65.07-71.78	4822	2032	42.14	40.75-43.53
Afternoon	832	557	66.95	63.75-70.14	5060	1966	38.85	37.51-40.20
Weekend								
No	1701	1149	67.55	65.32-69.77	11260	4144	36.80	35.91-37.69
Yes	691	484	70.04	66.63-73.46	3490	1775	50.86	49.20-52.52
City centre								
No	1355	835	61.62	59.03-64.21	9363	3525	37.65	36.67-38.63
Yes	1037	798	76.95	74.39-79.52	5387	2394	44.44	43.11-45.77
Weather								
Wet	237	162	68.35	62.43-74.28	1617	798	49.35	46.91-51.79
Dry	2155	1471	68.26	66.29-70.23	13133	5121	38.99	38.16-39.83

n_c, n_m : total number of observed cars and motorcycles respectively.
n'_c, n'_m : total number of cars and motorcycles using turn signals.
CI = confidence interval.

drivers and motorcyclists compared to travelling alone. Similarly, the presence of separate car lanes and pedestrian crossings was positively associated with the use of turn signals (OR = 1.31, $p < 0.001$ and OR = 2.34, $p < 0.001$ respectively). The presence of police was negatively associated with turn signal use among car drivers (OR = 0.51, $p < 0.001$) but was positively associated with turn signal use among motorcyclists (OR = 1.20, $p < 0.01$). An increase in the number of traffic lanes on an approach leg was generally associated with decreased turn signal use. The presence of traffic lights at intersections was associated with 1.57 times the likelihood of turn signal use among motorcyclists, yet no significant result was found for car drivers. Use of turn signals was positively associated with travel within the city centre compared to outside of the city centre (OR = 2.03 for car drivers and OR = 1.24 for motorcyclists). Travel during weekends was also positively associated with the use of turn signals, with motorcyclists being more than 1.5 times likely to do so on weekends compared to weekdays (OR = 1.51, $p < 0.001$). For both car drivers and motorcyclists, no significant associations were found between turn signal use and weather conditions.

In a further analysis, factors affecting the use of signals for each turn direction were investigated using binary logistic regression (Table 3). The presence of police was found to be significantly associated with signal use for right turns only. Similarly, significant associations with separate car lanes were only found for right turns. The findings also show that time of day and weather are significantly associated with the rate of signal use for motorcyclists making a left turn. During late mornings and afternoons, motorcyclists were more likely to activate turn signals than during early mornings (OR = 1.23, $p < 0.01$). Motorcyclists were also around two times more likely to use turn signals when making a left turn in dry weather than in wet weather (OR = 1.92, $p < 0.001$).

6. Discussion and conclusion

The aim of this research was to investigate the prevalence and factors associated with turn signal use at intersections among car drivers and motorcyclists, using a case study of Da Nang, Vietnam. Results showed that the prevalence of turn signal use among car drivers (68.27%) is higher than this figure among motorcyclists (40.13%). The proportion of car drivers using their turn signals in Da Nang is lower

Table 2
Logistic Regression Model Results for Turn Signal Use Among Car Drivers and Motorcyclists.

Variable		Car		Motorcycle	
		Adj. OR	95% CI	Adj. OR	95% CI
Turn direction	*Left*	Ref		Ref	
	Right	0.608***	0.499-0.741	0.507***	0.472-0.546
Gender	*Female*	Ref		Ref	
	Male	1.297*	1.056-1.594	0.832***	0.775-0.893
Age	*Young (< 30 years old)*	Ref		Ref	
	Middle and older aged (≥ 30 years old)	1.590***	1.303-1.940	1.100**	1.026-1.181
Carrying passengers	*No*	Ref		Ref	
	Yes	1.745***	1.412-2.155	2.046***	1.897-2.207
Police presence	*No*	Ref		Ref	
	Yes	0.511***	0.381-0.686	1.201**	1.075-1.342
Separate car lanes	*No*	Ref		Ref	
	Yes	1.382*	1.078-1.771	1.371***	1.262-1.489
Pedestrian crossings	*No*	Ref		Ref	
	Yes	3.981***	3.121-5.079	2.244***	2.066-2.437
Number of lanes	*1 lane*	Ref		Ref	
	2 lanes	0.820	0.311-2.163	0.480***	0.371-0.621
	3 lanes	0.239**	0.086-0.663	0.304***	0.232-0.398
	4 lanes	0.239**	0.087-0.657	0.382***	0.293-0.500
Number of lanes Intersection type	*Unsignalised*	Ref		Ref	
	Signalised	0.836	0.659-1.063	1.570***	1.447-1.704
City centre	*No*	Ref		Ref	
	Yes	2.032***	1.601-2.577	1.243***	1.143-1.351
Time of day	*Early morning*	Ref		Ref	
	Late morning	0.920	0.724-1.170	1.142**	1.047-1.246
	Afternoon	0.944	0.749-1.190	1.065	0.977-1.161
Weekend	*No*	Ref		Ref	
	Yes	0.793	0.586-1.074	1.508***	1.346-1.688
Weather	*Wet*	Ref		Ref	
	Dry	1.137	0.778-1.662	1.116	0967-1.289
Log likelihood		−1261.591		−9062.690	
AIC		2557.181		18,159.380 18,288.560	
BIC		2655.439			

*p < 0.05, **p < 0.01, ***p < 0.001, Adj. OR = adjusted odds ratio, CI = confidence interval.

than that in the United States with 75% for left turns and 71% for right turns (Sullivan et al., 2015), and in Canada with 87% overall (Faw, 2013). While it is not possible to ascertain from this observational study why turn signal use was lower among motorcyclists than car drivers, it is noted that it is easier to obtain a motorcycle license in Vietnam compared to a car driver license, with the process taking only two weeks. In contrast, to obtain a car driver license, road users must spend at least three months to complete all training related to traffic laws, traffic safety and driving skills before attending a theory and practical driving test.

The findings showed that both car drivers and motorcyclists were more likely to use signals when making a left turn compared to a right turn. This is expected given the greater potential for conflict with opposing traffic flow when turning left (Faw, 2013). Male motorcyclists were less likely to activate turn signals at intersections than females, consistent with previous studies on helmet use which showed compliance to be lower among males than females (Dandona et al., 2006; Akaateba et al., 2014). In contrast, male car drivers were found to be more likely to use turn signals than female drivers in Da Nang. This differs from other studies in developed countries which suggest that male drivers are more likely to ignore traffic regulations than females (Kitaori and Yoshida, 2000; Rosenbloom and Shahar, 2007). In Vietnam, males tend to do most of the driving with women often travelling as passengers, so women tend to be less experienced in driving a car. In addition, research conducted by Sivak and Schoettle (2011) showed that female car drivers had more trouble with navigating intersections than male drivers, which could potentially influence their use of turn signals. The findings also showed that middle and older aged motorists (30 years or more) were more likely than younger motorists (< 30 years old) to use turn signals. This is consistent with previous research that found greater compliance with traffic laws among older drivers (Yagil, 1998; Rosenbloom and Shahar, 2007). In this study, gender and age were two new factors which were found to affect turn signal activation. These factors were not found to influence the use of turn signals in research undertaken by Faw (2013) and Sullivan et al. (2015) in Canada and the United States respectively.

Car drivers and motorcyclists who were carrying passengers were more likely to activate turn signals at intersections, presumably due to passenger safety considerations. In other research concerning motorcyclists in Vietnam, Truong et al. (Truong et al., 2016) found that the presence of passengers was associated with reduced prevalence of distracted driving, namely mobile phone use. The presence of police was significantly associated with the use of turn signals of motorcyclists when making a right turn at intersections because police are typically positioned on right shoulders of the approach leg of intersections. However, the use of turn signals among car drivers was found not to be affected by police presence. A possible explanation is that police in Da Nang rarely penalise motorists for non-compliance with turn signal use.

While Sullivan et al. (2015) found that a greater rate of turn signal use occurred in high volume traffic areas, due to the presence of other vehicles, Faw (2013) showed that the rate of signal use was significantly higher under lighter traffic volumes as drivers were not distracted by other road users. This present study found that road users were more likely to use turn signals at intersections located in the city centre, where traffic volumes are normally high, compared to outer areas. This result seems to be consistent with Sullivan's findings and differs from what Faw found. Future research should therefore look to explore how traffic volumes and levels of congestion can affect rates of turn signal use. Motorcyclists were less likely to use turn signals during wet weather when most road users travel at lower speeds. Additionally, in wet weather, motorcyclists usually wear raincoats which can cover front turn signals. Weather conditions were found to be associated with

Table 3
Logistic Regression Model Results for Turn Signal Use by Direction.

Variable		Left turn		Right turn	
		Car	Motorcycle	Car	Motorcycle
		Adj. OR	Adj. OR	Adj. OR	Adj. OR
Gender	*Female*	Ref	Ref	Ref	Ref
	Male	1.312	0.799***	1.292	0.845***
Age	*Young (< 30 years old)*	Ref	Ref	Ref	Ref
	Middle and older aged (≥ 30 years old)	1.893***	1.136*	1.367*	1.060
Carrying passengers	*No*	Ref	Ref	Ref	Ref
	Yes	1.684**	1.844***	1.863***	2.319***
Police presence	*No*	Ref	Ref	Ref	Ref
	Yes	0.637	1.099	0.493***	1.363***
Separate car lanes	*No*	Ref	Ref	Ref	Ref
	Yes	1.299	1.150	1.444*	1.441***
Pedestrian crossings	*No*	Ref	Ref	Ref	Ref
	Yes	6.344***	5.409***	3.156***	1.488***
Number of lanes	*1 lane*	Ref	Ref	Ref	Ref
	2 lanes	0.000	0.193***	1.376	0.525***
	3 lanes	0.000	0.103***	0.420	0.370***
	4 lanes	0.000	0.070***	0.580	0.676*
Intersection type	*Unsignalised*	Ref	Ref	Ref	Ref
	Signalised	1.520	1.584***	0.588***	1.638***
City centre	*No*	Ref	Ref	Ref	Ref
	Yes	1.921***	0.981	2.155***	1.129*
Time of day	*Early morning*	Ref	Ref	Ref	Ref
	Late morning	0.775	1.226**	1.052	1.111
	Afternoon	0.865	1.230**	0.988	1.013
Weekend	*No*	Ref	Ref	Ref	Ref
	Yes	0.548*	1.684***	0.951	1.618***
Weather	*Wet*	Ref	Ref	Ref	Ref
	Dry	1.060	1.919***	1.283	1.061
Log likelihood		−521.926	−3524.967	−720.476	−5290.210
AIC		1075.852	7081.934	1473.951	10,612.420
BIC		1156.289	7188.979	1555.237	10,725.750

*p < 0.05, **p < 0.01, ***p < 0.001, Adj. OR = adjusted odds ratio.

the use of left turn signals among motorcyclists. However, similar to the findings from Faw (2013), weather was found to have no significant associated with car drivers' signal use.

With the continual domination of motorcycles in mixed traffic in Vietnam (Duc et al., 2013), the relatively high rate of turn signal neglect at intersections in Da Nang is alarming. To reduce traffic safety concerns caused by turn signal neglect, interventions need to consider a variety of measures. Increasing the amount of required education and driving experience with official driving schools, particularly for motorcyclists, is needed. In addition, enforcement of existing legislation needs to be stronger and combined with extensive education campaigns to boost the use of turn signals (Ludwig et al., 2002). Nguyen et al. (2013) also found that combined interventions were an effective solution to increase the helmet use among motorcyclists in Vietnam, while education and publicity programs alone were unlikely to create desired reductions in road accidents (O'Neill et al., 2002; Hung et al., 2008). The findings reported in this paper also suggest that enforcement of turn signal use could be better targeted by focusing on the characteristics associated with turn signal neglect, e.g. right hand turns, travel outside of the city centre, weekday travel.

This study contributes to the literature through providing an understanding of the prevalence and factors associated with turn signal use among both car drivers and motorcyclists in a developing country where motorcycles are a dominate form of transport. However, it is also subject to a number of limitations. First, this study did not consider the influence of other important variables on turn signal use such as trip purpose, driver licence ownership, education or income. A survey of motorists could be undertaken to explore the influence of these factors on turn signal activation. Second, the age of car drivers and motorcyclists was estimated by surveyors and may therefore be subject to error. This could be recorded more accurately as part of a future survey of motorists on turn signal use to better understand how age is associated with turn signal use. Third, this study focused on turn signal use at intersections only. Future research could also investigate the use of signals when making a lane change.

In closing, the prevalence of turn signal use is relatively low in Da Nang, particularly among motorcyclists. This is despite the presence of national legislation regulating the use of turn signals in Vietnam. Turn signal use is considered to be an indicator of safety performance as signal use provides an effective means of communication among road users. With a continuing increase in the number of vehicles on the road system, efforts to increase enforcement and education on turn signal use are needed, particularly in developing countries where motorcycles are the dominate form of transport.

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