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Speeding in urban South East Asia: Results from a multi-site observational study

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Key findings

- There is a high prevalence of speeding in three large cities in Southeast Asia
- Motorcycles were speeding at >50 km/hr over posted speed limits in Bandung
- Speed prevalence was highest during the weekends in all three cities.

Abstract

Speed is an important risk factor for road traffic crashes. We studied the prevalence of speeding in three major cities in Southeast Asia (Bandung, Bangkok and Ho Chi Minh City-HCMC), and factors associated with it. The study was conducted between July 2015-September 2016 using a standardized protocol and data collection tool. Observation locations were selected through systematic sampling. Speed was measured using a microwave radar gun on weekdays and weekends, and 5 times during each day. Descriptive and logistic regression analysis was done separately for each city**.** 623,744 vehicles were observed (Bangkok:61.8%; Bandung:36.0% and HCMC:2.2%). 21.8% vehicles were found to be speeding across the three cities. The prevalence of speeding was 7.8% in Bandung, 30.7% in Bangkok, and 1.9% in HCMC. When adjusted for other variables, compared to motorcycles, SUVs were more likely to be speeding in Bandung (aOR:1.97); large trucks (aOR:7.69) in Bangkok; and light trucks in HCMC (aOR:2.39). In Bandung, speeding was mostly observed in the peri-urban parts of the city (94.5%). Speed was likely to be highest during non-peak hours of the day in HCMC (aOR:3.08). High prevalence of speeding was observed in the three cities, making this an important risk factor for road safety in urban Southeast Asia. Findings, especially with regards to variations by vehicle type, times of day, days of week, and types of roads would be useful for city governments and traffic police to better plan strategies to improve road safety in these cities.

Key words

Speeding, Asia, developing countries, multi-site analysis

Introduction

In 2015, more than 1.3 million people were estimated to have died around the world as a result of road traffic crashes (“Global Burden of Diease 2015,” 2017; “Global status report on road safety 2015,” 2015) . Many more are injured and suffer from short-term and long-term disability. Estimates show that road traffic injuries contribute to 67,270,399 disability-adjusted life years (DALYs) lost annually, making them the number one cause of the burden of injuries globally (“Global Burden of Diease 2015,” 2017). Low- and middle-income countries (LMICs) are disproportionally affected, with 90 % of this burden (“Global status report on road safety 2015,” 2015). Poor infrastructure, rapid urbanization and motorization, poor enforcement, and post-crash care systems have all shown to contribute to this burden in LMICs (“Global status report on road safety 2015,” 2015).

Speeding is an important risk factor for road traffic injuries (“Global status report on road safety 2015,” 2015). Several studies have demonstrated the increased risk of serious injury and fatality with speed (Elvik et al., 2009; “Global status report on road safety 2015,” 2015; Rosen et al., 2011). The Global Status Report on Road Safety identifies speed as one of the leading risk factors for road traffic crashes, serious injuries, and fatalities (“Global status report on road safety 2015,” 2015). A comparative analysis conducted by Center for Disease Control USA found that in 2013 speeding was responsible for 15% – 42% deaths in 19 countries of Organization for Economic Co-operation and Development (Sauber-Schatz et al., 2016). In the United States, for example, slightly over a quarter of crash fatalities in 2015 were related to speeding according to the National Highway Traffic Safety Administration (“Quick facts,” 2015). Recent studies from LMICs also show that the proportion of road crash fatalities due to speeding tends to vary in LMICs, it is reported to be 14.0% in China, 19.3% in Iran, 32.0% in DR Congo (Nangana et al., 2016; Rad et al., 2016; Zhang et al., 2013).

The prevalence of speeding also varies within a country or city depending on the types of roads, traffic volume, and presence or absence of speed calming measures and police enforcement (“Global status report on road safety 2015,” 2015). An observational study done in two Kenyan districts found that in one of the districts, 69.5% of vehicles were found to be speeding compared to less than half of that (34.3%) in another district. The same study shows that the most common type of vehicles speeding in both districts were light trucks, large trucks and minibuses. Despite the differences in proportion of speeding vehicles, the enforcement in both the districts was low (Bachani, Hung, et al., 2013; Bachani et al., 2012). While there is consensus that speed is a significant risk factor for road traffic crashes, especially in LMICs, where the infrastructural development has not been able to keep up with rapid motorization, empirical data from these settings are scant.

The Bloomberg Initiative for Global Road Safety (BIGRS) aims to promote the implementation of evidence-based interventions for road safety in ten large cities around the world (“Road Safety,” 2017). Three major cities in Asia - Bandung in Indonesia, Bangkok in Thailand, and Ho Chi Minh City (HCMC) in Vietnam, are part of this program and focus on addressing speed as one of the risk factors for road safety (Table 1). As part of this project evaluation, observational studies are being conducted in each of the cities to track the prevalence of road safety risk factors over time. This represents a unique opportunity to understand the distribution and changes of risk factors over time in urban areas of LMICs.

In this paper, we aim to assess speed in three Asian cities – Bandung, Bangkok, and HCMC, in a rapidly developing part of the world. We present data on the average prevalence of speeding in each of the cities, and explore factors associated with speeding in these cities. This information would be valuable for cross-city learning to understand what may or may not work in terms of addressing this major risk factor for road safety.

Table 1. City description and basic road safety data

City	Population (million)	Registered vehicles (number)	Vehicle per 100,000 population	Road traffic (rate per 100,000 population)			Reference year
				Crashes	Injuries	Fatalities	
Bandung (Indonesia)	2.4	1,617,022	65840	38.1	42.9	4.9	2012
Bangkok (Thailand)	5.7	9,018,594	158321	468.8	98.3	3.5	2015
HCMC (Vietnam)	7.4	6,849,285	92608	-	-	-	2013

Source: Indonesian Police ("Indonesian National Police," 2017), Ministry of Interior and Department of Land Transport, Thailand ("Bangkok Statistics," 2015), Statistical Office of Ho Chi Minh City ("HCMC statistics", 2013)

Methods

Speed observations were conducted in three Asian cities: Bandung, Bangkok and HCMC. Three rounds of speed observational studies were implemented between July 2015 and September 2016: Round 1 was conducted in July-August 2015, Round 2 in March-April 2016 and Round 3 in August-September 2016. Observation sites were randomly selected from a list of all eligible sites within the city, and included the different road types present in the city based on a standardized protocol to systematically survey a representative proportion of the local traffic; detailed methodology has been previously published (Bachani, Branching, et al., 2013; Bachani et al., 2012; Slyunkina et al., 2013; Vecino-Ortiz et al., 2014). In summary, the objective of this study was to understand average, city-wide prevalence of speed in the three cities by conducting observations on different days of the week and at different times of each day. Therefore, speed was recorded for all vehicles systematically observed during each observation time period at each selected location in each city. To avoid the risk of bias, observation locations excluded areas where vehicles may generally slow down, such as junctions or intersections, construction sites or parts of the road with speed bumps, entrance of parking lots, gas stations, malls, or shopping centres. Locations where tourists rather than location populations were likely to be observed were also excluded, and so were locations that were considered unsafe for observations to be conducted. Observations were conducted at 10 out of 39 eligible locations in Bandung, 6 out of 46 in Bangkok and 5 out of 20 in HCMC. Each round of observations consisted of 3 randomly selected full days, including both weekdays and weekends. Observations were conducted in 90-minute intervals with a 15 minute traffic volume assessment before the beginning of each observation interval. A full-day observation schedule included five 90-minute periods throughout the day, from early morning to evening. Peak time was between 07:00 – 09: 00 and 17:30 – 19:00.

All the different road types represented within the official city limits were included. Road were categorized into arterial and collector/distributor roads.("Highway Functional Classification Concepts, Criteria and Procedures," 2013). Roads were grouped into urban, peri-urban and rural locations. Vehicle types constituted cars, light trucks, SUVs, taxis, minibus/vans, large trucks, motorcycles and buses. Weather on day of observation was also recorded.

In all three cities standardized data collection methodology was followed for systematic observations to obtain reliable estimates for speed measurements with the exception of HCMC where weather and vehicle ownership data was collected in round 3 only. Observations were done inconspicuously; vehicles were observed traveling in one-direction only to minimize counting the same vehicles twice during the observation period; observations at each location were conducted by two trained observers, with one observer taking the speed measurement using a microwave radar gun, while the other observer recorded the observed speed and vehicle type. If more than one vehicle crossed the observer, then the observer measured the speed of the one nearest to them.

This paper presents pooled analysis for each city. To estimate the prevalence of vehicles traveling above the speed limit in each city, we calculated the proportion of vehicles traveling above the speed limit for each observation round. Speeding above the posted speed limit was categorized into 5 groups: ≤10 km/hr, 11-20 km/hr, 21-30 km/hr, 31-50 km/hr and >50 km/hr. Speed limits in the cities varied based on road type and vehicle type based on local laws; this was accounted for during the analysis. For the sites selected for this study, the speed limit in Bandung was 50 km/hr for all vehicle types within the city, in Bangkok speed limit was 60km/hr for trucks and buses, and 80km/hr for all other types of vehicles while the speed limit for all vehicles in HCMC varied between 40 – 60 km/hr based on observation site.

We conducted bivariate logistic regression analyses to explore the association between speeding and independent variables which included data collection round, road type, road location (urban,peri-urban and rural), vehicle type, day of week, weather and observation time. Subsequently, we performed multivariate logistic regression to estimate independent association with these variables. Data management and analysis was done using MS Excel and STATA 12 (StataCorp 2011), respectively.

The speed observation study protocols were reviewed and approved by the Institutional Review Boards at Johns Hopkins University Bloomberg School of Public Health (JHSPH) and at the ethical review board at each of the implementing local institutions: Universitas Padjadjaran in Bandung, Indonesia, ThaiRoad Foundation in Bangkok, and Hanoi School of Public Health in HCMC. The study is led by the Johns Hopkins International Injury Research Unit (JH-IIRU) hosted by the Department of International Health at JHSPH.

Results

A total of 623,734 vehicles were observed for speeding across the three cities, Bandung: 224,588 (36.0%); Bangkok: 385,546 (61.8%); and HCMC: 13,600 (2.2%) during three rounds of data collection (Table 2). The number of observations conducted varied from 2,455 to 134,276 vehicles across the three rounds. Overall, 21.8% (n=135,869, 95% CI 21.7-21.9) vehicles were found to be above the speed limit across the three cities: 7.8% (n=17,464, 95% CI 7.7-7.9) in Bandung, 30.7% (n=118,180, 95% CI 30.5-30.8) in Bangkok, and 1.7% (n=225, 95% CI 1.5-1.9) in HCMC. The prevalence of speeding in each city varied over the 18 months covered by the three rounds of observations with the highest prevalence seen in the first round and the lowest in the latest round (Bangkok: 37.9% in round 1 to 21.7% in round 3; Bandung: 12.6% in round 1 to 6.0% in round 3and HCMC: 3.7% in round 1 to 0.7% in round 3).

Exploratory data analysis showed that speeding prevalence varied by type of vehicle and this differed across the three cities. In Bandung, it was mostly suburban utility vehicles (SUVs) (32.1%, n=5,610), cars in Bangkok (42.8%, n=50,531) and motorcycles in HCMC (76.9%, n=173). This could reflect the vehicle mix in these cities (Table 2). Speeding also varied by time of day and day of week, with highest prevalence in Bandung observed between 12:30 – 14:00 hours (21.4%, n=3,730), in Bangkok between 7:30 – 9:00 (21.8%, n=25,703) and in HCMC 17:30 – 19:00 (32.9%, n=74) and during weekdays (Bandung: 63.1%, Bangkok: 64.2%, and HCMC: 57.8%). In Bandung, weather was recorded to be dry on most (88.9%) observation days with only 8.2% observations conducted during rain. However, weather was dry for all the observations conducted in Bangkok and HCMC. (Table 2). In Bandung, speeding was more of an issue in the peri-urban parts of the city (94.5%, n=16,497). However, in Bangkok and HCMC, speeding was mostly observed to be highest in urban parts of the city (Bangkok: 100.0%, n=118,180; HCMC: 76.9%, n=173).

An analysis looking at the extent over the speed limit revealed that on average, speeding vehicles were traveling at between 5-12km/hr over the posted speed limits in the three cities (Bandung: 8.9 ± 8.0 km/hr; Bangkok: 11.6 ± 9.1 km/hr; HCMC:5.0 ± 4.2 km/hr). Majority of speeding vehicles (>50%) were traveling at ≤10 km/hr over the posted speed limits (Bandung: 54.5%, Bangkok: 55.0%, and HCMC: 90.7%). The proportion of vehicles traveling between 11-20 km/hr was 24.7% Bandung, 30.1% in Bangkok and 8.0% in HCMC (Table 2). Among the vehicles found to be speeding at >50 km/hr above the local speed limit, motorcycles were the commonest in Bandung (31.5%) and cars in Bangkok (38.8%) (Figure 1).

Results from logistic regression analyses showed that after controlling for data collection round, road type, road location, day of week, weather and observation time, the adjusted odds ratio of speeding were highest for SUVs compared to motorcycles in Bandung (aOR: 1.97, 95% CI: 1.86-2.08) followed by cars (aOR: 1.94, 95% CI: 1.86-2.06) and large trucks (aOR: 1.35, 95% CI: 1.26-1.46). In Bangkok, large trucks were 7.69 times (95% CI: 7.08-8.35) more likely to speed compared to motorcycles, followed by buses (aOR: 3.17, 95% CI: 2.81-3.56) and light trucks/pick-ups (aOR: 3.14, 95% CI: 2.95-3.34) (Table 3). In HCMC, light trucks/pick-ups were two times more likely to speed (aOR: 2.39, 95% CI: 0.68 – 8.43) compared to motorcycles, but this was not statistically significant.

The odds of speeding on collector/distributor roads were quite low as compared to arterial roads in both Bandung (aOR: 0.13, 95% CI: 0.12-0.14) and Bangkok (aOR: 0.23, 95% CI: 0.22-0.23). While all speeding in Bangkok was in urban areas of the city, this was not the case in Bandung, where the adjusted odds of speeding were almost 24 times higher in peri-urban areas of the city as compared to urban areas (aOR: 23.6; 95% CI 22.05-25.23) after controlling for data collection round, road type, road location, vehicle type, day of week, weather and observation time. In HCMC, speeding was more likely on roads in areas of the city classified as rural (aOR: 2.68; 95% CI: 1.90-3.79) as compared to urban roads when controlled for other factors. The adjusted odds of speeding were also lower during the weekdays compared to weekends (Bandung: aOR 0. 70, 95% CI 0.68-0.73; Bangkok: aOR 0.68, 0.67-0.70 and HCMC: aOR 0.96, 95% CI 0.72-1.29). Interestingly, however, the adjusted odds of speeding were lower for all observation times compared to the morning peak time (7:30-9:00) in Bandung and Bangkok, but the opposite was the case for HCMC, where the adjusted odds for speeding were 3.08 times higher between 12:30 – 14:00 compared to morning peak hour (95% CI 1.18- 8.05) in HCMC (Table 3).

Discussion

This study shows that there is significant prevalence of speeding in Bandung, Bangkok and HCMC. To our knowledge this is one of the first attempts to empirically document the prevalence of speeding using standardized approaches in these cities, and presents an opportunity to understand factors associated with speeding in these three large metropolitan cities in Southeast Asia. The BIGRS initiative is city-led and involves collaboration with city mayors and city governments ("Road Safety," 2017). This has thus created an opportunity for cross-city learning to improve road safety, and our study is the first step in the process to understand the prevalence of speed and factors underlying it.

Table 2. Prevalence of speeding and distribution in three Asian cities (n=135,905)

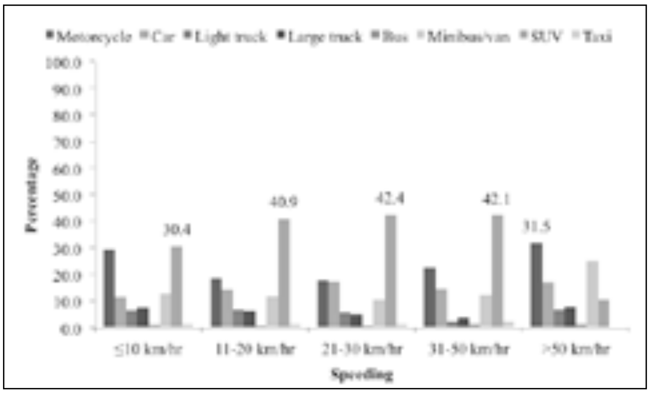
	Bandung	Bangkok	HCMC[c]
Total observations[a]	224,588	385,546	13,600
Vehicles speeding, n(%)[a]	17,464 (7.8)	118,180 (30.7)	225 (1.7)
Vehicle related factors			
Vehicle type			
Car	2,300 (13.2)	50,531 (42.8)	29 (12.9)
Light truck	1,115 (6.4)	38,321 (32.4)	3 (1.3)
SUV	5,610 (32.1)	11,655 (9.9)	-
Taxi	206 (1.2)	8,410 (7.1)	-
Minibus/van	2,382 (13.6)	4,471 (3.8)	12 (5.3)
Large truck	1,202 (6.9)	2,836 (2.4)	3 (1.3)
Motorcycle	4,515 (25.9)	1,303 (1.1)	173 (76.9)
Bus	132 (0.8)	637 (0.5)	5 (2.2)
Vehicle ownership			
Private	10,217 (85.1)	89,527 (75.8)	18 (7.0)
Commercial	898 (7.5)	16,060 (13.6)	-
Government	195 (1.6)	288 (0.2)	-
Taxi	688 (5.7)	12,158 (10.3)	-
Tourist	6 (0.1)	121 (0.1)	-
Environment related factors			
Day of week			
Weekday	11,015 (63.1)	75,893 (64.2)	130 (57.8)
Weekend	6,449 (36.9)	42,287 (35.8)	95 (42.2)
Weather[b]			
Dry	15,533 (88.9)	118, 180 (100.0)	18 (7.0)
Drizzle	485 (2.8)	-	-
Rain	1,428 (8.2)	-	-
Observation timing			
7:30-9:00	3,542 (20.3)	25,703 (21.8)	56 (24.9)
10:00-11:30	3,421 (19.6)	23,565 (19.9)	45 (20.0)
12:30-14:00	3,730 (21.4)	21,884 (18.5)	9 (4.0)
15:00-16:30	3,631 (20.8)	24,392 (20.6)	41 (18.2)
17:30-19:00	3,140 (18.0)	22,636 (19.2)	74 (32.9)
Road related factors			
Road type			
Arterial	16,490 (94.4)	99,077 (83.84)	225 (100.0)
Collector/ Distributor	974 (5.6)	19,103 (16.16)	-
Road location			
Urban	967 (5.5)	118,180 (100.0)	173 (76.9)
Peri-urban	16,497 (94.5)	-	-
Rural	-	-	52 (23.1)
Extent of speeding			
≤10 km/hr	9,521 (54.5)	64,991 (55.0)	204 (90.7)
11-20 km/hr	4,321 (24.7)	35,544 (30.1)	18 (8.0)
21-30 km/hr	1,517 (8.7)	12,287 (10.4)	3 (1.3)
31-50 km/hr	259 (1.5)	5,061 (4.3)	-
>50 km/hr	1,846 (10.6)	294 (0.3)	

[a] All subsequent percentages are calculated based on speeding vehicles

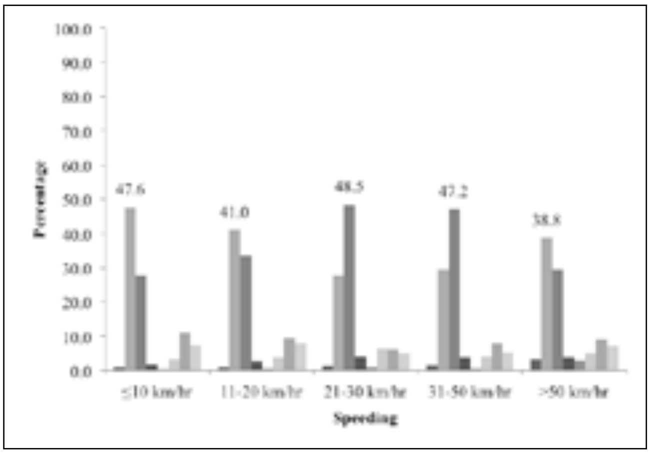
[b] Weather was recorded to be dry in Bangkok and HCMC (round 3) for all days on which observations were conducted
[c]Vehicle ownership and weather data for HCMC was available for round 3 only

SUV - suburban utility vehicle

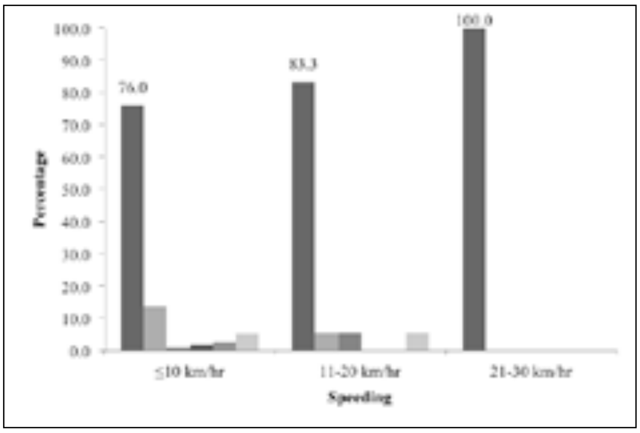
Speeding puts lives of every road user at risk. Therefore, even a seemingly small prevalence is problematic as it has far reaching implications which not only include death and disability, but also economic consequences due to property loss and lost productivity ("Global status report on road safety 2015," 2015). Studies have demonstrated that the risk of death increases with increase in speed: 10% if vehicle is driving at 30 km/hr, 20% at <50 km/hr and 60% at 80 km/hr ("Global status report on road safety 2015," 2015; Rosen et al., 2011; "Speed management : A road safety manual for decision-makers and practitioners," 2008). Another study, by Finch et al, found that for every 1 km/hr increase in speed, the risk of injury due to a crash goes up by 3% (Finch et al., 1994). Our data showed that a significant proportion of speeding vehicles were traveling at speeds of >20 km/h over the posted limits. This is especially important in light of the infrastructural challenges that many LMICs face in keeping up with rapid motorization, the wide variation in traffic mix, and little or no separation between motorized traffic and pedestrians or even larger vehicles from smaller ones such as two-wheelers. Speeding exacerbates the vulnerabilities of these vulnerable road users ("Global status report on road safety 2015," 2015; Hazen et al., 2006).



a. Bandung



b. Bangkok



c. HCMC

Figure 1. Extent of speeding for vehicles over the posted speed limit (n=135,905)

Our study also found higher prevalence of speeding on arterial roads. Our data showed that it was mainly large vehicles that were found to be speeding on these roads. This is a significant issue for metropolitan cities like Bandung, Bangkok and HCMC; these roads are often also shared by pedestrians, motorcyclists and cyclists, increasing their vulnerability. Furthermore, the posted speed limits across the three cities vary—ranging from 40 km/hr for large vehicles to 80 km/hr for cars and motorcycles. These limits are above the recommended limit of 30 km/hr for roads that have diverse vehicle mix as well as a combination of motorized and non-motorized road users ("Global status report on road safety 2015," 2015; "Speed management : A road safety manual for decision-makers and practitioners," 2008).

Additionally, speeding was more of a problem during morning peak hours, especially in Bandung and Bangkok. This was also observed in a study from Kenya where speed observations were made in two districts. The authors found that speeding was common during morning peak hours in one of the districts in Kenya (Bachani, Hung, et al., 2013). This has implications for road traffic crashes as shown in a modelling study from China. According to the study, speeding during peak hours increases risk of road traffic crashes compared to off-peak hours (Wang et al., 2015). This could be because many people are trying to reach their workplace at that time, but this is also a time when drivers of large vehicles who tend to drive long distances overnight are reaching urban centres, often fatigued. This mix could potentially exacerbate the risk posed by speeding (Ellison et al., 2015; "Speed management : A road safety manual for decision-makers and practitioners," 2008). However, further work is needed to understand such driver related factors associated with speeding. In HCMC, majority of the speeding occurred during non-peak hours, and this may be a result of congestion during peak hours in the morning and the evening.

Appropriate laws and regular and visible enforcement of the laws has been shown to be key in addressing behavioural risk factors for road safety such as speeding (Bachani et al., 2017; "Global status report on road safety 2015," 2015; "Speed management : A road safety manual for decision-makers and practitioners," 2008). Previous studies have found that among other factors associated with speeding, lack of police enforcement changes drivers' behaviour and

Table 3. Logistic regression of factors associated with over-speeding [a,b]

	Bandung	Bangkok	HCMC
Data collection round			
Round 1	Reference	Reference	Reference
Round 2	**0.75 (0.71-0.78)**	**0.82 (0.81-0.84)**	**0.11 (0.07-0.17)**
Round 3	**0.92 (0.87-0.97)**	**0.42 (0.41-0.43)**	**0.08 (0.04-0.16)**
Road type [c]			
Arterial Road	Reference	Reference	-
Collector/ Distributor Road	**0.13 (0.12-0.14)**	**0.23 (0.22-0.23)**	-
Road location [d]			
Urban	Reference	-	Reference
Peri urban	**23.6 (22.05-25.23)**	-	-
Rural	-	-	**2.68 (1.90-3.79)**
Vehicle type			
Motorcycle	Reference	Reference	Reference
Car	**1.94 (1.83-2.06)**	**1.59 (1.49-1.69)**	0.81 (0.54-1.21)
Light truck	1.06 (0.98-1.14)	**3.14 (2.95-3.34)**	2.39 (0.68-8.43)
Large truck	**1.35 (1.26-1.46)**	**7.69 (7.08-8.35)**	0.42 (0.13-1.34)
Bus	1.10 (0.90-1.34)	**3.17 (2.81-3.56)**	0.68 (0.27-1.67)
Minibus/van	**1.18 (1.11-1.24)**	**2.58 (2.40-2.78)**	0.78 (0.43-1.43)
SUV	**1.97 (1.86-2.08)**	**1.69 (1.58-1.80)**	-
Taxi	**0.66 (0.57-0.77)**	**1.26 (1.18-1.34)**	-
Day of week			
Weekend	Reference	Reference	Reference
Weekday	**0.70 (0.68-0.73)**	**0.68 (0.67-0.70)**	0.96 (0.72-1.29)
Weather [e]			
Dry	Ref	**-**	**-**
Drizzle	1.04 (0.93-1.16)	**-**	**-**
Rain	**3.09 (2.87-3.33)**	**-**	**-**
Observation time			
7:30-9:00	Reference	Reference	Reference
10:00-11:30	**0.91 (0.86-0.96)**	**0.86 (0.84-0.88)**	1.22 (0.82-1.83)
12:30-14:00	0.99 (0.94-1.04)	**0.71 (0.70-0.73)**	**3.08 (1.18-8.05)**
15:00-16:30	**0.84 (0.79-0.89)**	**0.81 (0.80-0.83)**	0.89 (0.59-1.34)
17:30-19:00	**0.67 (0.63-0.70)**	**0.71 (0.69-0.73)**	1.19 (0.8531.69)

[a] Independent variables for speeding included data collection round, road type, road location, vehicle type, day of week and observation time

[b] Odd ratios are statistically significant

[c] Road type was not included in logistic regression analysis of HCMC because all roads were arterial roads

[d] Road location was not included in logistic regression analysis of Bangkok because all the roads were urban

[e] Weather was included in logistic regression for Bandung only. Weather was recorded to be dry in all rounds in Bangkok and HCMC (round 3) for all days on which observations were conducted. Weather data in HCMC was available for round 3 only

they tend to speed (Hassan et al., 2017; Stanojevic et al., 2013). There is lack of data on speed law enforcement in the three cities, however, there are national speed control laws in the three countries but the degree of enforcement (self-enforcement) is low as reported in Global Road Safety report 2015 (Table 4) ("Global status report on road safety 2015," 2015). These countries need to revise speed laws to bring them in line with acceptable standards such as lower speed limits within the cities (Bachani et al., 2017; "Global status report on road safety 2015," 2015). Additionally, in resource limited settings such as these three cities, data collected through this study presents an opportunity to improve efficiency through more targeted enforcement. Given the observed variations in speeding prevalence at different times of the day, different days of the week, and by vehicle type, police could plan additional targeted enforcement activities to reduce speeding rates (Hyder et al., 2013). These cities are among the most populous cities in their countries, and data from the three cities can facilitate discussions with local and national level government for improving legislation and enforcement ("Global status report on road safety 2015," 2015).

Table 4. National speed control laws

Speed indicators	Indonesia	Thailand	Vietnam
National speed limit law	Yes	Yes	Yes
Max urban speed limit (km/hr)	70	80	50
Max rural speed limit (km/hr)	100	90	80
Max motorway speed limit	No	120	No
Local authorities can modify limits	Yes	No	No
Country reported enforcement [a]	5	3	6

Source: ("Global status report on road safety 2015," 2015)

[a] On scale of 0 to 10 with 0 being no enforcement and 10 being maximum enforcement; 'good' enforcement was defined by the GSRRS 2015 as 8 or above ("Global status report on road safety 2015," 2015)

One limitation of this study is that this was an observational study which, while yielding important empirical evidence on the prevalence and distribution of speeding in the three cities, was not designed to understand underlying factors that could be responsible for the observed rates. The study also focused on assessing city wide prevalence of speed on different road types on different days of the week and times of the day. As such, it did not focus on factors associated with individual drivers' selection of speed. The three cities differ considerably in terms of their population, number of registered vehicles, vehicle per 100,000 population and rate of road traffic crashes, injuries and fatalities. Bandung's population and number of vehicles is lower compared to Bangkok and HCMC but has the highest road traffic fatalities as reported by their police data ("Bangkok Statistics," 2015; Hazen et al., 2006; "HCMC statistics ", 2013; "Indonesian National Police," 2017). On the other hand, HCMC has the largest population among the three cities with over 90,000 vehicles per 100,000 population on the road with a very small proportion of vehicles speeding on the road. Effective speed control law enforcement could be one among other reasons, but this needs further exploration in future work ("HCMC statistics ", 2013). Additionally, further studies looking into knowledge, attitudes, and practices around speed, such as knowledge of existing legislation, knowledge of speed limits, and perceptions about the risks of speeding, and reasons why people choose whether or not to speed, would be invaluable when combined with our data to support the development of comprehensive programs to address speeding.

In conclusion, speeding is a major road safety issue in Bandung, Bangkok and HCMC. Evidence from this empirical work can help to drive future work on speed control and speed control enforcement in these cities. Information from this study, especially with regards to distribution of the prevalence of speeding by vehicle type, times of day, days of week, and types of roads would be useful for city governments and traffic police to better plan strategies to improve road safety in these cities. Further studies that examine factors underlying the differences observed in these cities are warranted to facilitate cross-city learning of what works and doesn't work to address this important risk factor. We recommend further studies of this nature at city level to be a new agenda for road safety in LMICs.

Conflict of interest

None declared

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Author contribution

Abdulgafoor M. Bachani and Adnan A. Hyder conceptualized the idea for the paper, coordinated the planning and implementation of BIGRS project in the three cities and provided extensive feedback during development of manuscript. Nukhba Zia was involved in analysis and draft development. Yuen W. Hung and Rantimi Adetunji were involved in draft development and helped with analysis. Pham Viet Cuong, Ahmad Faried and Piyapong Jiwattanakulpaisarn coordinated field work and were involved in local implementation of the observation protocols, facilitated training of data collectors, managed data collection and entry and reviewed the draft manuscript. All authors approved the final version of the manuscript.

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