Accident Analysis and Prevention xxx (2015) xxx–xxx

Contents lists available at ScienceDirect

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap

Red-light running rates at five intersections by road user in Changsha, China: An observational study

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ARTICLE INFO

Article history:
Received 19 December 2014
Received in revised form 9 April 2015
Accepted 14 June 2015
Available online xxx

Keywords:
Red-light running violation rate
Motor vehicle drivers
Motorcyclists
Bicyclists
Pedestrians
China

ABSTRACT

The red-light running rate by type of road users has not been reported in China so far. We conducted an observation study to report the violation rate in Changsha, China. Portable digital devices were used to record red-light running violations at five selected intersections. The observation was performed for three days (weekday, weekend and holiday), four time periods per day and an hour per time period (peak and off-peak hours in the morning and in the afternoon). Violation rate was calculated as number of violations divided by total number of vehicles/pedestrians × 100%. We used adjusted violation rate ratio (VRR) to quantify the effects of type of day and time period based on Poisson model. Totally, 162,124 vehicles (including motor vehicles, motorcycles and bicycles) and 31,649 pedestrians were recorded. The red-light running rate was 0.14% for motor vehicle drivers, far lowering than those for motorcyclists (18.64%), bicyclists (18.74%) and pedestrians (18.54%). The rate on holiday was 1.89 times that on weekday for drivers. The rate for motorcyclists was high in off-peak hours (adjusted VRR: 1.11), but low on weekend and on holiday (adjusted VRRs: 0.80 and 0.65). The rate for bicyclists was 32% lower on weekend than on weekday. For pedestrians, the rates were high on weekend and holiday and in off-peak hours (adjusted VRR: 1.09, 1.67 and 1.30). The red-light running rate of motor vehicle drivers is far lower than those for motorcyclists, bicyclists and pedestrians. The effects of type of day and time period on violation rate vary with road users, indicating the type of day and time period should be considered when developing and implementing interventions to reduce red-light running of different road users.

1. Introduction

Road traffic injuries are the eighth leading cause of deaths globally (Lozano et al., 2012). About 1.30 million people were killed on roads worldwide in 2010 (Lozano et al., 2012). According to *the Global status report on road safety 2013: supporting a decade of action* (World Health Organization, 2013), 275,983 persons in China were estimated to die of road traffic crashes in 2010, accounting for 22% of global road traffic deaths. Traffic violations are important risk factors of road traffic deaths. Based on the statistics released by the Traffic Management Bureau of the Ministry of Public Security of China, 96% of road traffic deaths were caused by traffic violations from motor vehicles (91%), non-motor vehicles (3%), and pedestrians and passengers (2%) in 2013 (*Note*: the traffic violations are defined according to the Traffic Safety Law of China) (The Traffic Management Bureau of the Ministry of Public Security of China, 2014).

Red-light running is a common traffic violation. Many published studies related to red light running focused on drivers. About 260,000 red light running crashes are estimated to occur annually in the United States, of which approximately 750 lead to deaths (Retting et al., 1999). A national telephone survey revealed that approximately 20% of drivers reported having one or more red light running when entering the last ten signalized intersections in the United States (Porter and Berry, 2001). A study in Greater Manchester, United Kingdom showed that 11.3% of drivers run through red lights at urban shuttle-lane road works (Yousif et al., 2014). 153 of 1190 drivers (12.9%) were observed running red lights at 15 rural and suburban signalized intersections in Jordan (Al-Omari and Al-Masaeid, 2003).

In addition, researchers reported various rates of running red lights for other road users: 4.8% for electric bicyclists in Suzhou, China (Du et al., 2013), 6.9% for urban commuter cyclists in Melbourne (Johnson et al., 2011), 37.3% for cyclists in Australia (Johnson et al., 2013), and 56% for two-wheelers riders at urban intersections in Beijing, China (Wu et al., 2012).

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http://dx.doi.org/10.1016/j.aap.2015.06.006
0001-4575/

To comprehensively describe the red-light running rate of different road users is critical for developing appropriate interventions to reduce red light running. However, only a study by Kim et al. (2008) compared the odds of running red lights between drivers and pedestrians in Hawaii and concludes that drivers tend to commit proportionately more red-light running violations than pedestrians in Hawaii, United States. Due to distinctions in culture and road traffic management, the violations of running red lights may differ between China and the United States. We conducted an observational study to estimate the red-light running rates of different road users and to examine differences in rates from type of day and time period by road user in Changsha, China.

2. Material and methods

2.1. Design

An observational study was designed to record the red-light running violations of different road users at intersections. Changsha is located in the middle of China and is the capital city of Hunan Province. In 2012, Changsha has a residential population of 7.04 million. The amount of motor vehicles has reached 8.73 million in 2013. According to the statistics of Changsha Traffic Management Bureau (Ren et al., 2012), we selected five intersections that have the highest traffic crash rates, including Yao Ling, Shi Zi Ling, Wen Yi Lu Kou, Yu Hua Ting, and Song Gui Yuan. Of five intersections, three have an underpass in one direction, the other two have no underpass. For the three intersections with an underpass, we chose the crosswalks in the other direction as observation sites. For the other two intersections, we randomly chose one from four crosswalks in two directions as observational sites.

2.2. Data collection

Considering that the road traffic crash rates were reported to vary with time (peak hours vs. off-peak hours) and the type of day (weekdays, weekends, and holidays) (Zhao et al., 2009), we conducted the observations at each intersection for all three types of days. The selections of weekday, weekend and holiday were determined at random. For each selected day, we conducted the observations in four time periods, including two peak hours (7:30–8:30 am and 5:30–6:30 pm) and two off-peak hours (9:30–10:30 am and 3:30–4:30 pm). In total, the traffic flows of 60 h were recorded at the five intersections.

Portable digital cameras and smart phones with high-definition camera were used to record the traffic flow at given dates and time periods. The basic information of five intersections were also collected, including length of red light and green light for pedestrian to cross the road, width of roads and crosswalks, whether the intersection has a safety strip, and type of warning light (flashing, beeping or both). The traffic signal phases at intersections kept constant when being observed because Changsha, as well as many other cities in China, does not adopt automatic traffic signal system that can adjust signal phase based on traffic volume and time of day.

The field observations were performed by researchers (Yang F., Li B., Zhang W.) and 15 volunteers. The volunteers were recruited from undergraduates of the School of Public Health, Central South University. All volunteers received the training on the requirements of field observations and the collection of road characteristics, in addition to issues to prevent being injured in the collection of data and privacy protection of individuals being recorded. The data were collected between September, 2012 and April, 2013.

2.3. Outcome measures

According to the Traffic Safety Law of the People's Republic of China (Road traffic safety law of China, 2011), the motor vehicles and non-motor vehicles and pedestrians should stop driving or walking in front of red traffic lights. Thus, we defined red light violation as crossing the intersection against the red light. The cameras were placed at the site where the information of crosswalk traffic lights, vehicle traffic lights and pedestrians, bicyclists, motorcyclists, and motor vehicles for the crosswalk being observed can be recorded simultaneously (Fig. 1).

The violation rate of red-light running was calculated as the numbers of vehicles or pedestrians being observed running red light divided by total number of vehicles or pedestrians $\times$ 100%.

2.4. Statistical analysis

Based on preliminary analysis (not shown here), we divided road user into four categories (motor vehicle driver, motorcyclist, bicyclist, and pedestrian) and report violation rates for all four categories. We reported violation rates by type of day and time period. Poisson regression was used to examine the significance of type of day and time period. Adjusted violation rate ratio (VRR) and 95% confidence interval (CI) were used to quantify the effects of type of day and time period. '$p < 0.05$' was considered statistically significant. We used Stata/IC 12.1 to analyze data.

2.5. Ethnic considerations

The research plan was approved by the Ethnic Committee of School of Public Health, Central South University. The videos that were recorded at five intersections were strictly managed and were used for only counting the number of violations and vehicles/pedestrians.

3. Results

3.1. Characteristics of five selected intersections

The width of five roads being observed ranged from 29 to 40 m, and the width of five crosswalks ranged from 4.9 to 5.4 m (Table 1). Three crosswalks had safety strips. The time lengths of red lights for crosswalks were 1.6–4.8 times those of green lights (102–140 s

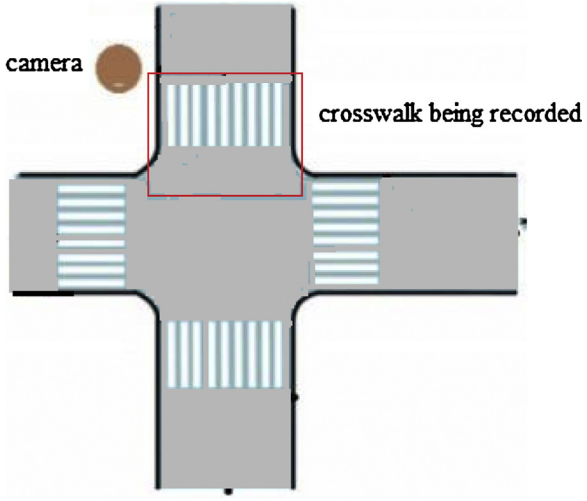

Fig. 1. The selection of observation site at intersections.
Note: The red-light running of different road users within the red line can be clearly recorded.

Please cite this article in press as: F. Yan, et al., Red-light running rates at five intersections by road user in Changsha, China: An observational study, Accid. Anal. Prev. (2015), http://dx.doi.org/10.1016/j.aap.2015.06.006