Accident Analysis and Prevention 52 (2013) 210–218

Contents lists available at SciVerse ScienceDirect

Accident Analysis and Prevention

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

The effects of sunshields on red light running behavior of cyclists and electric bike riders

Yiqi Zhang, Changxu Wu*

State University of New York at Buffalo, United States

ARTICLE INFO

Article history:
Received 16 February 2012
Received in revised form
12 December 2012
Accepted 22 December 2012

Keywords:
Sunshield
Bicycle safety
Red light running
Bicycle
Cyclist

ABSTRACT

Bicycles held an important position in transportation of China and other developing countries. As accidents rate involving electronic and regular bicycles is increasing, the severity of the bicycle safety problem should be paid more attention to. The current research explored the effect of sunshields (a kind of affordable traffic facility built on stop line of non-motor vehicle lanes (According to National Standard in China, e-bikes share the non-motor vehicle lane with regular bikes.) which was undertaken to avoid riders suffering from sunlight and high temperature) on diminishing red light running behavior of cyclists and e-bike riders. An observational study of 2477 riders was conducted to record and analyze their crossing behaviors at two sites across the city of Hangzhou, China. Results from logistic regression and analysis of variance indicated a significant effect of sunshield on reducing red light infringement rate both on sunny and cloudy days, while this effect of sunshield was larger on sunny days than on cloudy days based on further analysis. The effect of intersection type in logistic regression showed that riders were 1.376 times more likely to run through a red light upon approaching the intersection without sunshields compared to with sunshields in general. The results of MANCOVA further confirmed that rates of running behaviors against red lights were significantly lower at the intersections with a sunshield than at intersections without sunshields when other factors including traffic flow were statistically controlled. To sum up, it is concluded that sunshields installed at intersections can reduce the likelihood of red light infringement of cyclists and e-bike riders on both sunny and cloudy days. For those areas or countries with a torrid climate, sunshield might be a recommended facility which offers an affordable way to improve the safety of cyclists and e-bike riders at intersections. Limitations of the current sunshield design and current study are also discussed.

1. Introduction

Bicycling, including electronic bike riding, is beginning to receive renewed attention. This common means of transportation gets support from urban planners because it is non-polluting, energy-efficient, and space-efficient, regarded as a way to reduce roadway congestion (Vandenbulcke et al., 2009). There are programs and policies recommended bicycling as a mean of transportation proposed by department of city planning in United States. For instance, the Congestion Mitigation and Air Quality Improvement program (CMAQ, 2010) suggested by Department of Transportation in Wisconsin encourages efforts to enhance public transit, bicycle facilities, ridesharing programs and facilities, and technologies that improve traffic flow and vehicle emissions. Also the program about bicycles implement by the Department of City Planning in New York City aims to reduce congestion by promoting cycling (BGP, 2012).

1.1. The situation of bike mode share in developed countries

It is known that bicycling is a general mode of transportation in most developing countries, while developed countries have also been experiencing a bicycling boom over the past three decades. Take the development of bicycling in the area of North America and Europe as example.

From 1980 to 1999, the number of bicycle trips in the United States has doubled. Moreover, the number of people choosing to commute to work or school by bicycle in the United States continues to rise in recent years. The 2008 national bicycle commuter mode share of 0.5%, though small, represents 720,000 commuters, an increase of almost 200,000 people in three years (Pucher et al., 1999). US Census Bureau's American Community Survey (ACS) reports twice as many daily bike commuters in 2009 as in 2000 and an increase in bike mode share to 0.6%. At the same time, the data from the Canadian Census reveals a 42% increase in the

* Corresponding author at: Cognitive System Lab at SUNY-Buffalo, 319 Bell Hall, State University of New York at Buffalo, 14260, USA.
E-mail addresses: seanwu@buffalo.edu, changxu.beijing@gmail.com (C. Wu).

0001-4575/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.aap.2012.12.032

number of daily bike commuters between 1996 and 2006 (Pucher et al., 2011).

In the same period, bicycling has increased significantly in Europe (Pucher et al., 1999), for instance, in Denmark, Germany, Switzerland, and the Netherlands (Dutch Ministry of Transport, 1995; Zegeer, 1994; Tolley, 1997; Pucher, 1997). The number of bicycle trips has grown substantially in these countries and, in many cities, cycling's share of travel has risen as well. In Germany, for example, bicycling modal share for urban trips rose by half between 1972 and 1995, from 8% to 12% (Pucher, 1997). The annual survey reported a tripling rise in bike mode share of work commuters from 3% in 2000 to 8% in 2008 (City of Portland, 2008). Bicycling is also thriving in Scandinavian countries such as Sweden, where older persons commonly use bicycles. The nine million Swedes have more than six million bicycles (Scheiman et al., 2010).

1.2. The situation of bike mode share in developing countries

Compared to these developed countries, developing countries usually regarded bicycling as one of major types of transportation. The participation of bicycling in Bogota, Columbia grew from 5000 in 1974 to over 400,000 in 2005 (Pucher et al., 2010). Bogota has the world's fifth largest intensive bicycle transportation network with 268 km of bicycle paths, and are still building a more intensive and safe bicycle network (Li, 2008). China, taken as another example, has a much higher rate of commuter bicycling. In general, average bicycling modal share for urban trips in China accounts for 38% (Zhang and Lu, 2010). In 2000, ten million people from the age of 15 to 64 in the city of Beijing had 15–20 million bicycles (Zhao and Rong, 2010). Currently, cycling still makes up a large percentage of all modes of travel, such as in Tianjin with a portion of its transportation as large as over 60 percent. Moreover, electric bicycles (e-bike) appeared in south China since 1997 and had become popular in China within a few years (Yao and Wu, 2012), since e-bikes are suitable for urban transportation in south China where there are a lot of cities with around million people. For example, Suzhou city[1] keeps 180,000 pieces of e-bike currently, where 1.5 million e-bikes were sold in 2002 and 3.6 million or more were sold in 2003 (Zhen et al., 2006). Sales of e-bikes reached 15 million in 2005, which made electric bicycles now become a real industry and business (Zhang, 2006). According to the statistics published by the government of Hangzhou city,[2] its ownership of e-bikes has exceeded 50 million units till the end of 2006, where four of every ten families use e-bikes (Wang, 2007). This illustrates how electric bicycles have become one of the vital means of transportation of Hangzhou.

1.3. Cycling accident and the major reason: red light running behavior

Although bicycle commuting is believed to be beneficial to the health of both the individual and the community, the potential for fatalities and injuries also exists (Hoffman et al., 2010). In 2004, the number of regular bicycle riders killed in accidents was 13,655 which account for 12.8% of all traffic fatalities (CRTASR, 2004). Accordingly, the number of e-bikers being killed rose from 589 to 2469 in three years since 2004 (CRTASR, 2004, 2007). According to statistics published by the Hong Kong government in 2006, bicycle related events accounted for 7.4% of all traffic incidents and 6.3% of all traffic-related fatalities (Yeung et al., 2009).

Currently, increasing rates of misconduct of cyclists and e-bike riders, especially electric bicycles (E-bike), have led to an increase in transportation accidents aroused public concern nationwide.[3] Data of traffic accidents collected in Zhejiang Province, for example, further illustrates the safety condition of electric bikes: 430 e-bike riders were killed and 3957 accidents referred e-bikes, representing 5% of all traffic fatalities and 10.8% of all accidents that occurred in 2006. The corresponding figures increased to 798 (14.0%) and 5434 (23.2%) after three years in 2009. As the capital city of Zhejiang Province, Hangzhou's overall accident rate has declined year by year since 2008, but the rate of accidents caused by electric bicycles has increased (Chen, 2010). Looking more closely at the data collected in the year of 2008 (Ding, 2009), the number of traffic fatalities involving e-bikes in Hangzhou rose from 108 to 152, up by 40.74% compared to the previous year, which accounts for 17.63% of total traffic fatalities and 48.41% of traffic fatalities involving bicycles (including e-bikes). In the year of 2010, Hangzhou had 178 fatalities due to e-bikes, representing 23.4% of the total traffic fatalities and 1012 traffic accidents caused directly by electronic bicycles, which grew by 16.19% over the same period of last year. Therefore, the studies about regular bicycle and e-bikes safety are necessary in China to improve the overall traffic safety condition.

Among the reasons, cyclists' and e-bike riders' violation of road traffic law (red light running behaviors or called red light infringement) is the major factor contributing to such vehicle related accidents (Spence et al., 1993). Based on the statistics published by the traffic police department in Hangzhou,[4] red light running behaviors of e-bike riders contributes to 15% of accidents (Hua, 2010). Red light infringement was ranked as the top four reasons resulting in traffic accident referring cyclists and e-bike riders (Everyday Economic News, 2011). Another report shows that red light running is responsible for around 80% of accidents involving e-bike riders in Shaoxing (Another city in Zhejiang province) (Pei, 2011). Cyclists' non-compliance is also viewed as the typical and most annoyed by vehicle drivers (Basford et al., 2002; O'Brien et al., 2002). However, there are only a few studies focused on the red light running behavior of cyclists and e-bike riders. Johnson et al. (2011) observed non-compliance behavior of 4225 cyclists and concluded that travel directions, the presence of other road users, and the volume of cross traffic are three main predictive indexes for the infringement behavior. Wu et al. (2012) observed 451 two-wheeled riders and explored the rate, related factors, and characteristics of two-wheel riders' infringement behavior in China. Accordingly, studies about reducing rate of running behavior on red light of cyclists and e-bike riders might help to improve safety at urban road intersections.

1.4. Improve cycling safety: the facility of sunshield

Recently researchers start to focus on how to improve cycling safety. A few studies about interventions improving safety cyclists come from North-Western Europe, mainly from countries such as the Netherlands, Denmark, and Germany (Wegman et al., 2012). Two subjects related to cyclist safety that have been discussed thoroughly in peer-reviewed literature are bicycle helmets and roundabouts. Aultman-Hall and Kaltenecker (1999) compared differences between collision, fall and injury rates for bicycle commuting on-road, off-road and on sidewalks in Toronto and indicated that moving cyclists away from automobile traffic onto pathways is not, on its own, the solution to the bicycle safety problem. They

[1] Located between Shanghai and Nanjing, with population of half million in the down town area.

[2] Hangzhou is the first city install sun-shield facility for riders in bicycle track.

[3] E-bike belongs to non-motor vehicle according to National Standard in China.

[4] There is no national official data published by China Statistical Yearbook Database. Therefore, we use data from traffic police department of Hangzhou to describe the effect of red light running behavior on traffic accidents.