



The effects of safety knowledge and psychological factors on self-reported risky driving behaviors including group violations for e-bike riders in China

Chen Wang^{a,b}, Chengcheng Xu^{a,*}, Jingxin Xia^b, Zhendong Qian^b

^a Jiangsu Key Laboratory of Urban ITS, Southeast University, Nanjing, China

^b Intelligent Transportation Research Center, Southeast University, Nanjing, China

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ABSTRACT

Objectives: It is unknown that how safety knowledge and psychological factors affect e-bike rider safety. Also, group violation behaviors, which are commonly observed in the field, have been rarely examined for e-bike riders in China. In this paper, the effects of safety knowledge and psychological factors on self-reported risky driving behaviors including group violations were examined.

Methods: A questionnaire was developed to acquire information of e-bike riders in Guilin, Guangxi Province. Explanatory factor analysis was used to examine the reliability of the questionnaire and exclude redundant measurement items. Then, a Structure Equation Model was developed to examine the relationships among safety knowledge, safety attitude, risk perception and risky driving behaviors. After that, multiple regression models were fitted to examine the effect of safety knowledge on each type of risky driving behavior, as well as factors associated with group violations. At last, ANOVA tests were conducted to identify significant differences among e-bike rider groups in safety knowledge, safety attitude, and risk perception.

Results: Safety knowledge was found significantly associated with risky driving behaviors for e-bike riders in China, including aggressive driving, erroneous driving, and group violations. E-bike riders severely lack safety knowledge, especially that of traffic rules, including unmarried riders, under-educated riders, riders without driver's license, younger riders, and riders with little riding experience. Group violations were largely found among e-bike riders, and to be associated with safety knowledge of traffic rules, risk-taking attitude, and riding experience of e-bike riders.

Conclusions: The findings could add some new safety implication and be beneficial for developing safety policies and interventions for e-bikes.

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1. Introduction

Electric bikes (i.e. e-bikes) are fully or primarily propelled by electric power from rechargeable batteries when it entered China's market in 1997. E-bikes are regulated with the maximum design speed of 20 km/h, the maximum weight of 45 kg, and the maximum power of 240 W in China (Yao & Wu, 2012). Two major e-bike types were found in China: bicycle-type

* Corresponding author.

E-mail address: xuchengcheng@seu.edu.cn (C. Xu).

and scooter-type, both of which could actually travel much faster than the design speed (Yao & Wu, 2012). According to previous literature, the operating speed of e-bikes were found 50% higher than bicycles in China (Lin & He, 2008). Thus, e-bikes provide higher mobility than bicycles. Additionally, unlike motorcycles, no driving license or training courses are mandatorily required and no restricted area are regulated for e-bikes in China. In light of these, e-bikes have become more and more popular. In 2011, the total e-bike ownership in China has reached more than 120 million, with an annual increase of 30% (Gu et al., 2011). In 2012, 93% of global e-bike sales came from China market. In 2015, the annual sale of e-bikes in China had reached over 36 million. However, despite of a rapid increase in e-bike ownership, safety issue also raises with an upward trend in crash rates (Traffic Administration Bureau of China State Security Ministry, 2016).

Previous literature has been focusing on several safety topics related to e-bikes, including specific risky driving behaviors such as red-light running and speeding (Bai, Liu, Chen, Zhang, & Wang, 2013; Du et al., 2013; Weinert, Ma, Yang, & Cherry, 2007; Wu, Yao, & Zhang, 2012), crash trend and propensity (Otte, Facius, & Müller, 2014; Schepers, Fishman, Hertog, Klein, & Schwab, 2014; Weber, Scaramuzza, & Schmitt 2014), and contributing crash factors (Hu, Lv, Zhu, & Fang, 2014; Wang, Xu, Xia, & Qian 2017). However, safety effects of e-bike riders' psychological factors and safety knowledge were rarely examined. Such effects have been examined for many other road users, including automobile drivers (Iversen, 2004; Rundmo & Iversen, 2004), bicyclists (Broughton et al., 2009), moped-riders (Steg & Brussel, 2009), and motorcyclists (Wong, Chung, & Huang, 2010). It is still unknown that how psychological factors and safety knowledge could affect e-bike rider safety. Moreover, e-bike riders were observed to commit group violations (e.g. running a red-light in a group) in the field in China (Guilin Police Department, 2015). However, few research has been found to examine such behavior in details for e-bike riders.

To fill the current gaps, we examined the relationships among safety knowledge, psychological factors (i.e. safety attitude, risk perception), and self-reported risky driving behaviors (including group violations) for e-bike riders in China. In this study, we focused on the scooter-type e-bike because it dominates China market and most previous research in China focused on this larger powered two-wheel type (Fishman & Cherry, 2016). This study was expected to provide useful information for developing effective policies/interventions to improve e-bike safety in China.

2. Literature review

Psychological factors, such as safety attitude and risk perception, have been identified as significant factors related to the safety of two-wheeled riders, such as moped riders and motorcyclists. Broughton et al. (2009) compared the driving behaviors between car drivers and two-wheeled riders and found that riders' pleasure on riding fast could result in their speeding offence on rural roads and at nights. Steg and Brussel (2009) found that young moped riders had strong intention to speeding to meet others' expectation. Chen (2009) focused on the relationship between risky driving behaviors of young motorcyclists and their safety attitudes. 257 students were investigated by questionnaires and the results also suggested a significant effect of safety attitude. Wong et al. (2010) found that motorcyclists with different personality traits perceived risk differently, resulting in different risky behaviors. Brandau, Daghofer, Hofmann, and Spitzer (2011) determined four sub-types of young moped riders and found a strong relationship between their personality and injury risk. Ozkan et al. (2012) concluded that traffic violations were found to be associated with attitudes and subjective norms of motorcyclists. Moller and Hausteiner (2016) claimed that attention error was a significant psychological factor for young moped rider safety. Eyssartier, Meineri, and Gueguen (2017) found that there were significant differences in psychosocial factors among sport rider, tour rider and other rider categories. Sukor, Tarigan, and Fujii (2017) found that attitude, desire, perceived behavioral control, and the perception of others' behaviors were significantly related to motorcyclist safety. To note, only few research has examined such psychological effects for e-bike riders (Yao & Wu, 2012).

Safety knowledge has also been found to be significantly associated with driving safety. Nyberg and Gregersen (2007) examined gender difference in basic driving knowledge among novice drivers and how such difference affected their crash involvement. Young novice drivers among 18–24 were studied and the research showed that female young novice drivers generally had more driving knowledge than males, which helped them to prevent traffic violation and crash involvement to a certain extent. Vanlaar et al. (2008) examined the relationship among the knowledge, attitude and aggressive driving behavior for Canadian drivers. Totally 1201 questionnaires were collected and the results indicated that aggressive driving behaviors could be ameliorated by improving drivers' knowledge. To our knowledge, few research has been identified to examine whether and how safety knowledge possibly affects e-bike rider safety.

Self-reported risky driving behaviors were often examined to understand safety implication for road users. They were oftentimes classified into different types in previous literature. Westerman and Haigney (2000) classified risky driving behaviors into three types based on questionnaires: error, violations, and lapses. Zhuang, Bai, and Xie (2008) claimed four major types of risky driving behaviors (ordinary violation, aggressive violation, harmless fault, harmful fault), by applying factorial analysis. Li, Wang, and Yin (2008) studied the risky driving behaviors of motorcyclists in Chongqing. Four types of risky driving behaviors were defined: reckless driving, speeding and violation, erroneous driving, and careless driving. Notably, e-bike riders were often found to commit different types of violations in the field, such as running a red-light (Pai & Jou, 2014; Porter & England, 2000), speeding (Yang et al., 2014), and use other facilities for travel purpose (UDV, 2017). However, most previous studies focused only on individual behaviors. Group violations were early found for pedestrians (Rosenbloom, 2009; Zhuang & Wu, 2011) that road users tend to violate a red-light when they are waiting in groups at intersections. Such

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