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Assessment of risky behaviours among E-bike users: A comparative study in Shanghai

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A B S T R A C T

In China, E2Ws were compared or equated to traditional bicycles for crash studies and regulation purposes. We compared the similarity in riding behaviours of e-bike riders, riders of traditional bicycles, e-scooter riders and riders of motorized two-wheelers (gasoline and Liquid Petroleum Gas-LPG). In Shanghai, different types of two-wheelers (N = 400) were compared on the basis of frequency of self-reported risky behaviours.

Overall, the results show a continuous increase in the incidence of risky behaviours as the weight and power of vehicles increases. Based on these reported behaviours, e-bikes appear to be different from traditional bikes and similar to e-scooters and other motorized two-wheelers. E-scooters are not significantly different from other types of motorized two-wheelers.

In terms of prevention and regulation, e-bikes and e-scooters could be brought closer to motorized two-wheelers in order to identify common and other targeted actions according to the type of two-wheeler.

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1. Introduction

In China, electric two-wheelers (E2Ws) represent a category of vehicles that are in constant growth in terms of traffic and that have reached nearly 200 million users (Van Schaik, 2016). This expansion is accompanied by concerns about road safety, with injuries and deaths steadily rising (Feng et al., 2010; Wang et al., 2017). The challenge is being able to define adequate regulatory measures and crash prevention initiatives for these users.

Currently, Chinese authorities classify E2Ws as non-motorized. Their riders must travel on the same dedicated lanes as traditional bicycles where they exist, and are subject to the same regulations (Wei et al., 2013; Weinert et al., 2007). In addition, local studies have been undertaken to describe unsafe behaviours by E2Ws compared to traditional bicycle users (Weinert et al., 2007; Wu et al., 2012). Some of these studies are based on direct observation and synchronized video camera recordings methodologies (Du et al., 2013; Wu et al., 2012) while other studies used risky behaviour questionnaires (Weinert et al., 2007; Yao and Wu, 2012). Other studies show that many E2W users also ride in lanes dedicated to motorized vehicles such as motorcycles and motor scooters (gasoline and Liquid Petroleum Gas -LPG) where they are then likely to adopt behaviours that are potentially dangerous for themselves and for others (Du et al., 2013).

In fact, E2Ws have different physical and dynamic properties than traditional bicycles, and there even are differences among them, whether they have a bike style (e-bike) or a scooter style (e-scooter). Gauge, weight or speed differentials all generate interaction difficulties. Ultimately, on the basis of this argument, and for the purposes of regulation and prevention, would it not be of interest to distinguish between e-bikes and e-scooters? Given the continuum related to the size and/or the power of the vehicles, one would infer that the behaviours of the former are more like those of traditional bike users, while the behaviours of the latter tend towards those of motorized engine two-wheelers (gasoline and LPG).

2. The current study

The aim of this brief report is to help characterize two-wheeled electric vehicles in road traffic compared to other types of two-wheelers. This study compares riders of different types of two-wheelers from light to heavy, from human powered to those electric or motorized powered, based on self-reporting of risky riding behaviour. One useful aspect of the questionnaire method is that enables identification of the psychological and social determinants, and individual perceptions that explain the adoption of self-reported risk behaviours. For the purposes of this study, riding behaviour qualifies as risky “if it (potentially) puts
oneself in danger or endangers others in the traffic system” (Dula and Geller, 2003).

3. Method

3.1. Procedure and participants

Data were collected using a self-administered questionnaire from a sample group of 400 local panelists recruited through a private Internet survey company based in Shanghai. Each participant received monetary compensation for completing the questionnaire. Answers were automatically and anonymously recorded as guaranteed to the participants. Prior IRB approval was obtained from both authors’ institutions.

The 400 participants were recruited with an equal distribution of 80 individuals for each of the five following conditions (n = 80): currently being solely or mainly a rider of a bike (self-propelled; 50% male riders), an E2W style bike (55% male riders), an E2W style scooter (62.5% male riders), a non-electric engine scooter (Liquefied Petroleum Gas –LPG- scooter, gasoline scooter; 50% male riders), or a motorcycle (72.5% male riders). Participants were between 18 and 65 years of age (M = 31.7 years, MD = 31 years, SD = 7.9) and were mainly from the worker population (92%).

Regarding the major areas of Shanghai in which participants rode their two-wheelers during the last 6 months, 55.50% of them indicated Puxi (including the Districts of Huangpu, Xuhui, Changning, Jing’an, Putuo, Zhabei, Hongkou, and Yangpu), 17.50% indicated Pudong New Area within the ring road, 19.25% the Suburban area (including Pudong New Area outside the ring road, and the districts of Minhang, Baoshan, and Jiading), 7.50% the Suburban area (including Districts of Jinshan, Songjiang, Qingpu, and Fengxian), and 0.25% Chongming County.

3.2. Measures

Respondents were requested to state how frequently they had adopted a series of risky riding behaviours over the last six months (from 0-never to 5-almost all the time). We used a self report instrument dedicated to all types of two-wheeler risky riding behaviours: the A-TRIBE inventory (Ragot-Court et al., 2019) (see Table 1 for an English translation of each riding behaviour; however, it does not constitute a validated version from the Mandarin-Chinese language).

The behaviours listed in the scale can be performed by riders any two-wheeled vehicles, which therefore avoids any effects that are artifacts of the type of vehicle being ridden and allowing a comparative approach. The twelve A-TRIBE items are neutral behavioural descriptions and do not refer to riding errors or regulations that may lead to under-reporting self-bias (see Table 1). These items provide information about various road situations with potential for dangerous outcomes: overtaking, forward movement, riding between two lanes, behaviours at a red traffic signal, moving into a traffic lane, riding behaviours at intersections, and riding behaviours approaching pedestrian crossings. A significant relationship was found between the A-TRIBE inventory sum scores and self-reported prior crashes informing about the risky nature of these riding behaviours.

3.3. Data analysis

First, we conducted an Analysis of Variance (ANOVA) on the total sum scores of the A-TRIBE inventory according to the different types of two-wheeler riders and using Tukey HSD’s two-by-two comparison analyses. We also ran ANOVAs on each score of the inventory items using LSD two-by-two comparison test in order to provide more detailed descriptive results. Prior to these analyses, the normality assumption was checked along with the assumption of equality of variance (homogeneity) to ensure robust F-tests while analysing Likert scale data (Carifio and Perla, 2007).

### Table 1

The 12 items of the A-TRIBE inventory.

<table>
<thead>
<tr>
<th>ITEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument introduction</td>
</tr>
<tr>
<td>‘Over the last 6 months, how often have you adopted the following riding behaviours while riding your two-wheeled vehicle?’</td>
</tr>
<tr>
<td>Responses Rating Scale</td>
</tr>
<tr>
<td>0-never, 1-almost never, 2-occasionally, 3-often, 4-very often, 5-almost all the time</td>
</tr>
<tr>
<td>ITEMS</td>
</tr>
<tr>
<td>1-I overtook cars.</td>
</tr>
<tr>
<td>2-I rode between two lanes of vehicles.</td>
</tr>
<tr>
<td>3-I kept my trajectory in front of another two-wheeler progressing straight ahead of me and facing me.</td>
</tr>
<tr>
<td>4-At an intersection with traffic signals, the red light switched on, I stopped on or beyond the continuous white stop line.</td>
</tr>
<tr>
<td>5-Seeing the traffic signal light turn red, I took the pedestrian crossing to keep on my way without stopping.</td>
</tr>
<tr>
<td>6-After a full stop at a red traffic signal, I sped up as much as possible when the signal turned green.</td>
</tr>
<tr>
<td>7-I kept riding very close to the two-wheeler in front of me.</td>
</tr>
<tr>
<td>8-I kept riding very close to the cars in front of me.</td>
</tr>
<tr>
<td>9-Leaving my parking space whilst road traffic was fluid, I entered the traffic flow in front of a two-wheeler that was already engaged on the road and was imminently approaching.</td>
</tr>
<tr>
<td>10-Leaving my parking space whilst road traffic was fluid, I entered the traffic flow in front of a car that was already engaged on the road and was imminently approaching.</td>
</tr>
<tr>
<td>11-I maintained my progress (speed and trajectory) at the approach of a pedestrian about to cross the road at any time.</td>
</tr>
<tr>
<td>12-I crossed an intersection with no set of traffic lights without letting another two-wheeler approaching at a steady pace coming from my right or my left to enter ahead of me.</td>
</tr>
</tbody>
</table>

* The original Chinese version is available upon request to the first author.

4. Results

Concerning the responses to the entire A-TRIBE inventory according to the type of two wheelers, the first ANOVA is significant (p < .005; see Fig. 1). In general, a gradual increase in the frequency of adoption of risky behaviours from the lightest to the heavier vehicles can be observed.

Tukey HSD two-by-two comparison analyses indicate that e-scooters are not different from motorized scooters (gasoline and LPG) or motorcycles. However, e-scooters also did not significantly differ from either traditional bikes or electric bikes. Interestingly, e-bike riders responses across the entire inventory are not different from those for riders of e-scooters, motorized scooters (gasoline and LPG) and motorcycles (p < NS). On the other hand, the comparison with traditional cyclists yielded a significant difference (p < .01).

The separate ANOVAs on each of the A-TRIBE inventory behaviours make clear, on the basis of the LSD comparison analyses, that e-scooters are indistinguishable from motor scooters (gasoline and LPG), motorcycles or even electric bikes, and traditional bicycles, for six out of the 12 behaviours submitted to evaluation (items 3, 4, 5, 7, 9, and 11; see Fig. 2). The same analyses show that e-bikers are in turn distinguished from bicyclists on nine behaviours at p < .05 (items 2, 4, 5, 7, 8, 9, 10, 11, and 12). In other words, e-bike riders adopt nine of the 12 driving behaviours submitted for evaluation to the same degree as riders of the most powerful motorized two-wheelers. Finally, e-bikes and e-scooters are jointly distinguished from motorcyclists on just one item, that which relates to the overtaking behaviour of cars (item 1).

5. Discussion

The results appear to support the existence of a strong positive relationship between the incidence of risky behaviour (inventory of A-TRIBE behaviours) adoption and the weight and power of the vehicles. In other words, the frequency of occurrence of risky behaviours overall increased from the traditional bike to the motorcycle. However, results from two-to-two comparisons do not make it possible to characterize the e-scooters as being more similar in these behaviours compared to other motorized two-wheelers. On the other hand, a noteworthy finding is that only e-bikes do...
not fill this continuum pattern. Indeed, e-bikers' behaviours more resemble those of riders of other type of two-wheelers than they do riders of traditional bikes. Although e-bikes are significantly lighter and slower than the other motorized vehicles, it appears that e-bike riders' behaviours are more similar to those of riders of e-scooters and other motorized two-wheelers, particularly motorcyclists. These data results are nevertheless...
contrary to their current treatment as E2W where they are most often only compared to traditional bicycles in research work, when they are not merged with them in statistics on crashes or for traffic regulations. Actually, considering their physical and dynamic properties are more close to traditional bikes. For instance, with regard to speed, there is bigger gap between e-bikes and motorized two-wheelers than between e-bikes and traditional bikes. Actually, the only behaviour in the inventory on which e-bikes as well as e-scooters are significantly different from motorcycles is the overtaking of cars ("I overtook cars"). The vehicle's speed and its ability to accelerate may be at play here. The fact remains that the risky behaviour of E2W users could be encouraged by their vehicle's performance characteristics (Hayworth and Debnath, 2013). Therefore, beyond the objective characteristics of the vehicles, the greater proximity of the behaviour of e-bike riders to those of motorized two-wheelers is to be found in factors related to the users of the e-bikes themselves. These factors can be motivational or cognitive for example encouraged by an overestimate or an error in the assessment of the capabilities of one's vehicle or by personality trait such as sensation seeking or hedonic seeking.

6. Future research

Research following up on the current study's innovative results will identify which explanatory motivational, cognitive, situational and other social psychological determinants influence risk taking behaviours (with A-TRIBE inventory) of electric two-wheelers compared to others two-wheelers. Another future study will identify which of the twelve frequently adopted behaviours, as evaluated by the participants, are the most crash-prone respectively for the riders of e-bikes, e-scooters, motorized scooters and motorcycles. Comparative observations might also be pursued by including other riders' behaviours relating to violations and misconduct in the self-reported risk assessment and on a larger sample. Concerning what they have in common in behavioural terms, allowing the coordinated implementation of regulatory measures, preventive actions and communication between these different types of vehicles could be of interest. On the other hand, based on what distinguishes them, targeted interventions could be considered that keep e-bikes and e-scooters as separate and different categories of two-wheelers in their own right.

7. Conclusion

In general, an extended comparative approach considering all two-wheelers would make it possible for common and/or targeted actions to identify common and distinctive features in terms of interactive behaviours, crash scenarios and their psychosocial determinants. The challenge remains the prevention of crash injuries and road traffic-related mortality. Beyond Shanghai, new findings could shed light on measures and precautions to be rolled out in Europe, bearing in mind the increasing usage of pedelecs in traffic — albeit in much smaller proportions (Johnson and Rose, 2015; Langford et al., 2017).

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**Declaration of competing interests**

None.

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