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Evaluation of e-bike accidents in Switzerland

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ABSTRACT

Background: The acceptance and usage of electric bicycles has rapidly increased in Switzerland in the last years. Hence this topic has been addressed by policy makers with the aim to facilitate new transport modes and, moreover, to improve their safety.
Methods: Police-recorded accidents of the years 2011 and 2012 involving a total of 504 e-bikers and 871 bicyclists were analysed. National figures were compared with those of a rural and an urban environment.
Results: Most e-bikers who were involved in accidents were 40–65 years old. It was found that most e-bikers sustained single accidents and that helmet usage was higher in the investigated rural environment than in the investigated urban area. The evaluation of the injury severity of e-bikers, particularly compared to bicyclists, lead to diverging results.
Conclusions: The findings presented in this study are intended to serve as a benchmark since basic information on characteristics of e-bike accidents is provided. With respect to differences between the injury severity of e-bikers and bicyclists to-date no clear statement can be drawn. It is suggested to regularly evaluate e-bike accidents to show trends and/or identify changes.

1. Introduction

In recent years electric bicycle (e-bike) sales rose considerably and thus e-bikes have become an important transport mode in Switzerland (velosuisse, 2014). Since cost efficiency of electric vehicles is increasing the acceptance and usage in public is increasing as well. In Switzerland in 2012 the total number of e-bike sales which were registered since 2005 rose to about 185,000 (2011: about 135,000) (bfu, 2013). Also in context of increasing traffic and urban transport, respectively, this topic has been politically addressed. Hence in 2011 the new category *electric bicycle* was included in Swiss police reports and hence complements Swiss accident statistics.

Publications on the analysis of e-bike accidents, particularly related to injury severity, are hardly available. The Swiss Council for Accident Prevention (bfu, 2013) for example stated in a national survey that in 2012 the number of slightly, severely and fatally injured e-bikers has increased in comparison to 2011 and it was assumed that this phenomenon is related to the strong increase of e-bike sales. Besides, it was found that about one third of all e-bikers, but only about one fourth of all bicyclists who were injured in an accident sustained severe or fatal injuries. Lawinger and Bastian (2013) performed an empirical analysis on e-bike accidents in the German state of Baden-Württemberg. The study was based on an in-depth analysis of the police reports seconded by qualitative telephone interviews with the involved e-bikers. By also taking accidents with bicyclists into consideration it was found with respect to injury severity that e-bikers were not involved more often in accidents than bicyclists, but that the proportion of injured and killed e-bikers was slightly higher than that of bicyclists. From this finding it was deduced that consequences from an accident could be worse for e-bikers than for bicyclists. Also Otte et al. (2014) compared e-bike accidents to bicycle accidents in Germany. They found that e-bikers were not injured more often or more severely than bicyclists. In comparison to bicyclists they observed more single accidents, higher velocities and collision speeds, but similar helmet wearing rates in e-bikers. Furthermore, first results of naturalistic driving observations focusing on speeds, mental workload and travel behaviour of e-bikers were recently published (e.g. Twisk et al., 2013; Dozza et al., 2013; Dozza and Fernandez, 2013). Amongst other results Twisk et al. found and Dozza et al. assumed, based on their observations that e-bikers tend to drive faster than bicyclists. Further publications particularly aiming at e-bikes primarily address topics like usage and benefits, travel behaviour or transport properties. In contrast, numerous publications consider accident statistics, injury mechanisms and helmet usage in bicyclists (e.g. Kim et al., 2007; Elvik, 2011; Karkhaneh et al., 2011).

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Table 1
Injured road users by injury severity.

Road users	Injury severity	Year	
		2011	2012
All	Slightly injured	18,805	18,016
	Severely injured	4,437	4,202
	Fatally injured	320	339
	Total	23,562	22,557
E-bike	Slightly injured	127	166
	Severely injured	67	78
	Fatally injured	2	8
	Total	196	252
Bicycle	Slightly injured	2,409	2,193
	Severely injured	800	840
	Fatally injured	37	28
	Total	3,246	3,061

The aim of this study was to analyse e-bike accidents and to compare the findings with bicycle accidents in the same data set. Various parameters such as age distribution, type of accident, helmet usage and injury severity as well as analyses considering relations between some of those characteristics were investigated. An analysis and comparison of accidents in the whole country, in a rural and in an urban environment was accomplished for the first time in Switzerland.

2. Methods

2.1. Source of data

In Switzerland in 2011 a total of 23,562 road users were injured in an accident including 196 e-bikers and 3246 bicyclists. In 2012 a total of 22,557 road users who were injured in an accident including 252 e-bikers and 3061 bicyclists was reported by the police. The individual distributions with respect to injury severity are presented in Table 1.

Accidents involving 504 e-bikers and 871 bicyclists were selected from the database of the Federal Roads Office (FEDRO) in order to compare accidents in the whole country, in a rural and in an urban environment. In contrast to e-bike accidents where all cases of 2011 and 2012 were analysed, only bicycle accidents of the month September were evaluated and compared. By conducting a statistical matching the criterion “month” was identified not to enforce data polarisation and to ensure that cases of this month are representative. This limitation was chosen since it was assumed that influencing factors, such as for instance “less bicyclists being on the roads because of bad/cold weather or holidays” or “bicyclists being insecure and thus driving more careful because of not using their bicycle in the winter months”, could be eliminated to the greatest possible extent.

As rural area the Canton of Zurich and as urban area the City of Zurich were chosen since both hold the highest population among all other Swiss cantons and cities. Furthermore, in the City of Zurich in 2012 a roadmap called “Masterplan Velo” was introduced with the aim to distinctively increase the rate of bicyclists in traffic until the year 2025. For the analysis in the urban environment only accidents reported in the City of Zurich and for the analysis in the rural environment only accidents registered in the Canton of Zurich were selected, however, for the analysis in the rural environment accidents which occurred in other cities of the Canton of Zurich were excluded. The nationwide analysis included accidents of all cantons and cities, but accidents in the Canton of Zurich and in the City of Zurich. A total of 172 additional police reports containing short descriptions and sketches of accidents in the Canton and the City of Zurich allowed a detailed investigation of the local conditions of selected accidents.

The underlying database contained various information on involved persons (e.g. gender, age, protective systems, injury severity), vehicles (e.g. type of vehicle, brand, number plates), accident locations (e.g. signalisation, type of street, weather) and accident characteristics (e.g. type of accident, trip purpose, accident causation).

2.2. Evaluation

The chi-square test was applied to statistically analyse differences between the groups/categories presented below. A significance level of $\alpha = 0.05$ was chosen. In cases with small expected numbers (i.e. <5) the statistical validity of the chi-square test might be affected, which was considered in the interpretation of the results. The analysis was accomplished by using IBM SPSS Statistics and Microsoft Excel.

In this study focus was set on the analysis of age distribution, helmet usage, injury severity and the type of accident among e-bikers and bicyclists who were involved in an accident as well as on the evaluation of relations between some of those characteristics.

For an analysis of the age distribution five groups were established: below 23, 23–39, 40–65, 66+ years of age and unknown. An exclusion of school-age children, i.e. the age group below 14 years of age, was not conducted due to small case numbers (see Section 3). In the evaluation of the type of accident it was differentiated between single accidents (i.e. single-vehicle crashes only), crossing accidents, turning accidents and other accidents. According to the classifications in Swiss police reports the helmet usage was categorised into helmet, no helmet and unknown and for the injury severity it was distinguished between uninjured, slightly injured, severely injured and fatally injured. To eliminate age effects the injury severity was analysed for only one age group (40–65 y.o.). To investigate relations between the injury severity and the type of accident, only two types of accidents (i.e. single accidents and collisions) as well as two age groups of younger (0–39 y.o.) and older (40+ y.o.) e-bikers and bicyclists were chosen.

3. Results

3.1. Age distribution

Regarding the different age categories, it was checked whether school-age road users account for a particularly large amount in the youngest age group. The number of bicycle accidents with school-age children was determined using a cut-off at the age of 14 years. From this age children are allowed to ride an e-bike in Switzerland. It was found that nationwide only 13% of the bicyclists were below 14 years of age; in the urban area the rate was slightly less and in the rural area slightly higher. Due to these low case numbers, school-age children were not analysed separately and remained within the youngest age category.

In the three investigated areas (whole country, rural and urban environment) most e-bikers who sustained an accident were 40–65 years old and only few accidents with e-bikers below 23 years of age were reported. However, the distributions between e-bikers in a rural and e-bikers in an urban environment were found to be statistically significant ($p = 0.006$). The nationwide analysis revealed that most accident-involved bicyclists were 40–65 years old which is similar to e-bikers. In the analysed rural environment, however, most bicyclists were 40–65 and below 23 years old (equally distributed) and in the urban area most bicyclists were 23–39 years old. Thus differences between the distributions of e-bikers and bicyclists in the whole country, in the rural environment as well as in the urban environment were found to be statistically significant (see Table 2). For the statistical evaluation the group unknown was excluded due to small numbers.