Development of German pedelec (and bicycle) accidents between 2012 and 2020

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1 INTRODUCTION

In the recent years, pedelecs (pedal electric cycles) have seen a massive growth in ridership. In 2013, around 1.3 million e-bikes were on German roads, while in 2020, this number was already at 8.5 million (with about 99% of the e-bikes being pedelecs) [1], [2]. The rapid spread of pedelecs has given rise to concerns for road safety, especially due to the fact that riders of electric bicycles reach higher speeds [3]. Indeed, some studies have reported that pedelec riders suffer from more severe crashes than users of conventional bikes [4], [5]. However, the highly dynamic development in pedelec ownership and use [6] might cast some doubts on the long term validity of investigations of pedelec accidents and their characteristics that have to rely on data collected over shorter periods of time. Therefore, the aim of this study was to investigate pedelec accidents and their characteristics over several years in a longitudinal fashion, and compare them to accidents involving cyclists, to be able to identify trends, and to clarify whether such trends are specific to pedelecs.

2 METHOD

We analysed police reported pedelec and bicycle accidents with personal injury from 2012 till 2020. The dataset consisted of accidents from three federal states of Germany: Brandenburg, Hesse and Saxony. Accidents were included in the analysis if at least one pedelec rider or one cyclist were involved and one of the accident partners was injured.

3 RESULTS

In total, 94.823 injury accidents with the involvement of at least one cyclist or one pedelec rider were found in the dataset. 4,175 of the individuals involved rode a pedelec, 97,647 rode a conventional bicycle. The number of crashed cyclists was quite stable over the years. The number of pedelec riders, however, increased each year, with the 2020 crash number being more than 40 times than the one in 2012.

Table 1: Number of accidents and with the involvement of cyclists and pedelec riders.

	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Number of accidents	9,916	9,219	10,527	10,135	10,550	10,188	11,401	11,117	11,770	94,823
Bicycle rider	10,592	9,770	11,137	10,531	10,989	10,499	11,652	11,059	11,418	97,647
Pedelec rider	33	119	176	286	290	398	648	887	1,338	4,175

3.1 Sex and age

For both bicycle types, men were more frequently involved in accidents than women throughout the years (total bicycle: 64.3 % men, pedelec: 64.9 % men). Pedelec riders who crashed were about 15 to 20 years older than the conventional cyclists ($F(1, 99692) = 1099.80$, $p < .001$, $\eta^2_p = 0.011$). At the same time, however, the mean age of these pedelec riders has decreased noticeably over time, from 61 years in 2016 to 54 years in 2020

(see Figure 3; $F(8, 99692) = 9.86$, $p < .001$, $\eta^2_p = 0.001$ for the interaction). The ANOVA revealed also a main effect of the time ($F(8, 99692) = 6.45$, $p < .001$, $\eta^2_p = 0.001$), which was driven by the decrease in age of the pedelec riders.

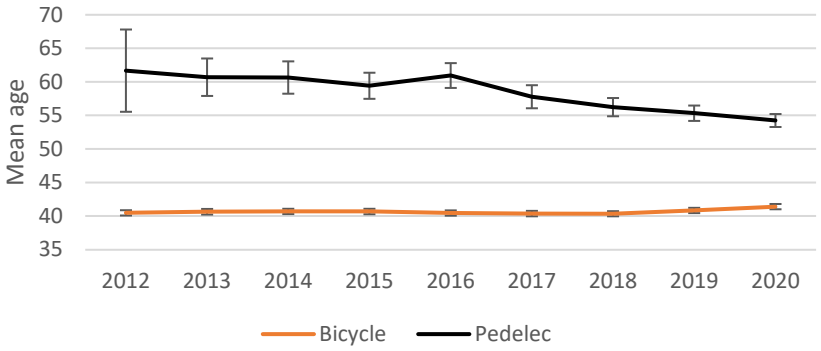

Figure 1: Mean age of the pedelec riders and conventional cyclist from 2012 - 2020.

3.2 Accident location

Most of the accidents occurred in town/village for both bicycle types, however the share was lower for pedelec riders (85.9 %) compared the conventional cyclists (92.2%). In contrast, the proportion of accidents out of town/village were nearly twice as high for the pedelec riders (14.1 %) than for cyclists (7.8 %). The overwhelming number of the accidents occurred on the roadway for both bicycle types (both 84.0 %), followed by bicycle infrastructure (bicycle: 11.8 %; pedelec: 11.0 %). Accidents on the pavement and unpaved paths were rare occurrences for both groups. The relative frequency for pedelec riders crashing while riding downhill (12.2 %) was slightly higher than for conventional cyclists (8.3 %). Cyclists, on the other hand, had a higher proportion of accidents that occurred at intersection and junctions (69 %) than pedelec riders (60.3 %). A longitudinal analysis of this data will be part of the full paper.

3.3 Accident severity

In each year from 2012 till 2020, injury accidents for pedelec riders were more severe than those of conventional cyclists (see Figure 1). The share of fatalities among pedelec riders was more than twice as high as for cyclists in most years. The proportion of seriously injured cyclists remained stable over the years. From 2014 to 2019 the difference between the bicycle types stabilised at around 6 to 7 percentage points. In 2020, however, the gap increased again, with nearly 10 percentage points between the two bicycle types.

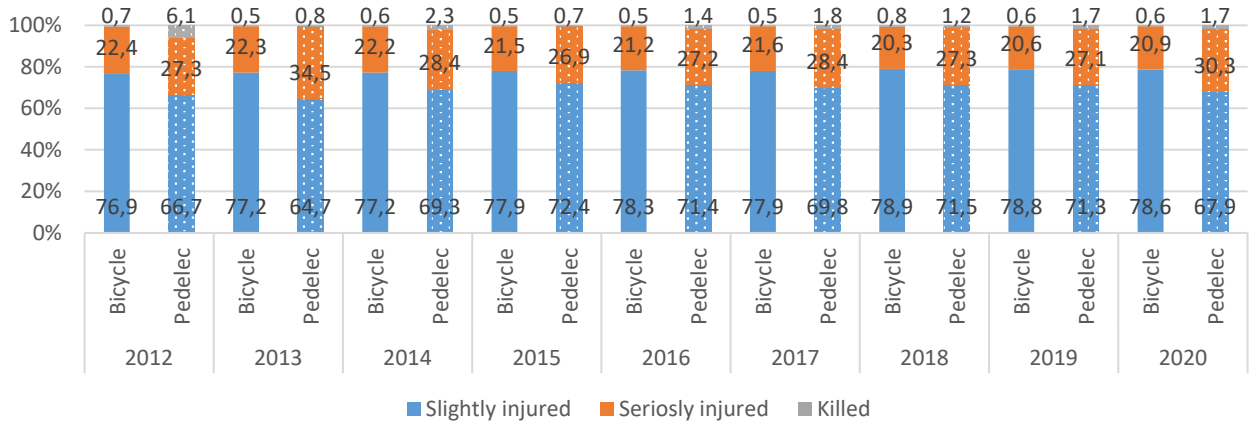

Figure 2: Proportion of accidents per accident severity and bicycle type from 2012 - 2020.

3.4 Accident type and number of accident parties

For both bicycle types, most frequent were accidents by turning into a road or by crossing it, which stayed the number one accident type over the whole period of time (bicycle: 33.3 % - 40.1 %; pedelec: 34.7 % - 41.4 %). Pedelec riders had a noticeably higher proportion of riding accidents (loss of control without other road users having contributed) than conventional cyclists throughout the years (bicycle: 8.9 %-17.2 %; pedelec: 12.1 % - 23.6 %). Accordingly, the number of single accidents was consistently higher for pedelec riders than for conventional cyclists. At the same time, the number of single accidents has risen considerably since 2017 for both bicycle types (2017: bicycle: 12.8 %, pedelec: 16.3 %; 2020: bicycle: 20.9 %; pedelec: 26.8 %).

3.5 Further variables

Among other variables of interest were the time of day the accident occurred, as well as the accident partner. Not surprisingly, cars were the most frequent conflict partners overall, for both bicycle types. Pedelec riders were found to crash at a higher relative frequency before noon (9.00 till 11.59) and at lunchtime (12.00 till 14.59) compared to cyclists, while cyclists' accidents occurred more frequently in the morning hours between 5.00 and 8.59.

4 DISCUSSION

The aim of this study was to shed some light on the characteristics of pedelec accidents over a longer period of time. Overall, many of the analysed variables showed a certain degree of temporal stability, with differences as well as similarities between accident characteristics of the two bicycle types staying quite consistent over the years. Just like the rider population in general, pedelec riders that crashed tended to be older than cyclists, although their mean age declined slightly in recent years, which reflects changes in the user group. As expected, we also found a higher accident severity for pedelec riders compared to cyclists, which is comparable to other studies [5], [7]. Especially in 2020, the difference was quite pronounced, which might be explained by different usage patterns during the COVID-19 pandemic compared to previous years. Overall however, the difference was rather consistent over time. In line with the findings of other studies a higher number of single respectively riding accidents for the pedelec riders compared to the conventional cyclists was detected [4].

While of considerable size, the dataset is not without limitations. Many bicycle and pedelec accidents go unreported, especially single-vehicle accidents and those of low severity [6], resulting in a potential bias. In addition, a measure of exposure, e.g., distance travelled, is missing, since no such information is available on a year-by-year basis in Germany. Still, a combination with travel data from one of the regular household surveys might be considered to at least get a general understanding how the trends in crashes might relate to developments in bicycle and pedelec use.

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