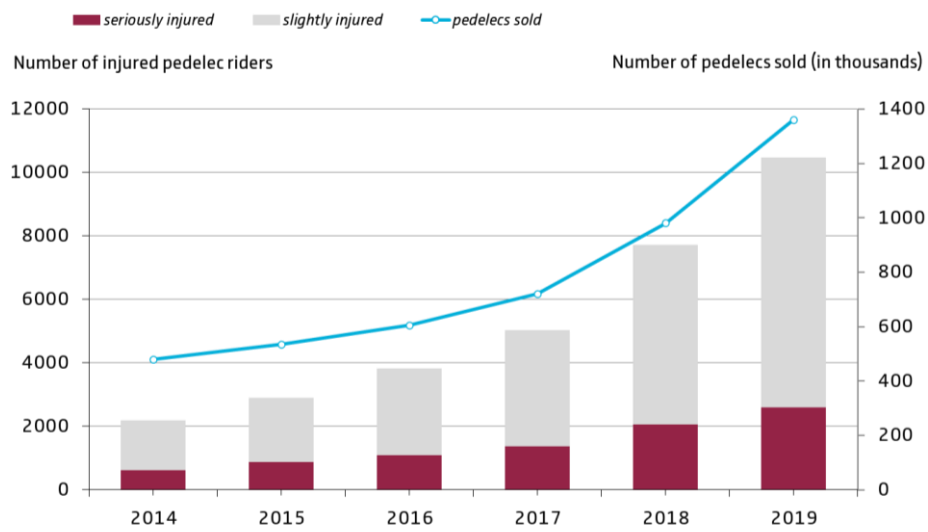
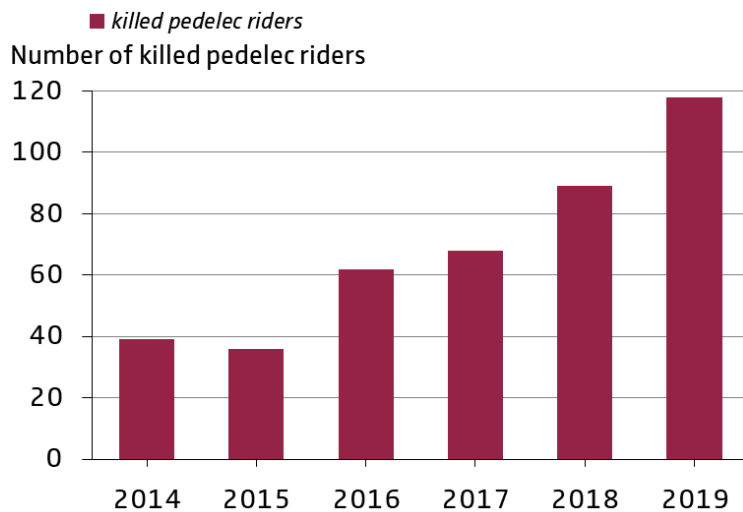


20 At the same time also the number of casualties has increased as can be seen in the accident
 21 statistics (Figure 1, Figure 2). While in the year 2014, a total of 2,220 pedelec riders were injured
 22 or killed in a traffic accident inside and outside of built-up areas, in 2019 a total of 10,585 persons
 23 was counted (Federal Statistical Office of Germany, 2015, 2020). Of these persons, 7,878 pedelec
 24 riders were slightly injured, 2,589 were seriously injured, and 118 were killed (Federal Statistical
 25 Office of Germany, 2020).



26

27 **Figure 1.** Trends in the number of injured pedelec riders and in the number of pedelecs sold between
 28 2014 and 2019 (data from Federal Statistical Office of Germany, 2015 – 2020 and ZIV, 2015 - 2020)



29

30 **Figure 2.** Number of pedelec riders killed in a traffic accident between 2014 and 2019 (data from
31 Federal Statistical Office of Germany, 2015 – 2020)

32 Unfortunately, the development of the distance travelled by pedelec cannot be demonstrated,
33 since such data has not been collected regularly in Germany so far. Due to the increasing sales
34 figures though it can be assumed that the distance travelled by pedelec has also increased over
35 the last years. The associated increase in the number of casualties suggests that new challenges
36 for road safety might emerge. To examine this, accidents of pedelec riders will be analysed and
37 compared to accidents of riders of conventional bicycles.

38 **1 METHOD**

39 Included in the analyses were pedelec and bicycle accidents with personal injury inside and
40 outside of built-up areas reported to the German police in the year 2019¹. These included
41 collisions with other road users as well as single bicycle crashes. Only data of pedelec and bicycle
42 riders 18 years and older were used. Data were compared with respect to age distribution,
43 gender distribution, casualties, location of accident, type of accident, cause of accident (as noted
44 by the police), and other party involved.

45 **2 RESULTS**

46 In 2019 in Germany, a total of 10,348 pedelec riders (older than 18 years) who were involved in
47 accidents with personal injury were registered. In the same year, 62,378 bicycle riders were
48 registered. The analyses showed the following results.

¹ Data were provided by Statistical Office of the state Saxony-Anhalt, Halle (Saale), 2021.

49 **2.1 Age distribution**

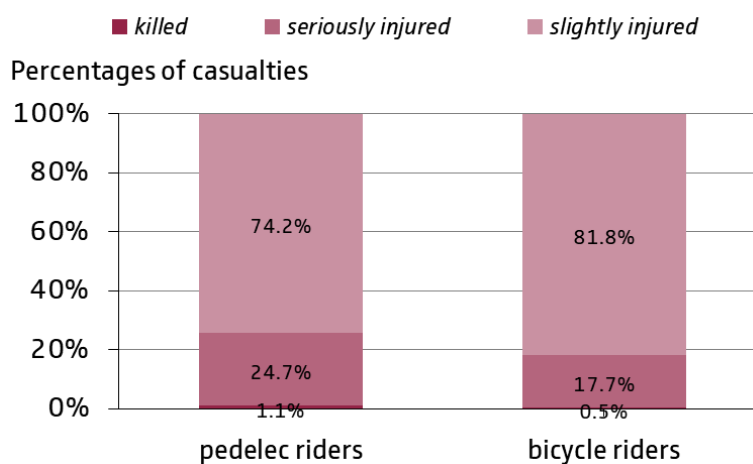
50 About 62 % of pedelec riders involved in an accident with personal injury were at least 55 years
51 old. This was true for only 36 % of cyclists. Closely examined, 37 % of pedelec riders involved in
52 an accident were 65 years and older (cyclists: 19 %), 18 % were 75 years and older (cyclists: 10
53 %). Therefore, the proportion of elderly riders among those involved in accidents was higher for
54 pedelec riders than riders of conventional bicycles.

55 **2.2 Gender distribution**

56 With respect to gender distribution no difference was found between accident involved pedelec
57 and bicycle riders. Among all pedelec riders involved in an accident with personal injury 59 %
58 were male. This was true for 62 % of riders of conventional bicycles.

59 **2.3 Casualties**

60 Figure 3 shows the percentages of injured and killed pedelec and bicycle riders. Of pedelec riders
61 who were injured or killed in an accident 24.7 % were seriously injured and 1.1 % was killed. Of
62 cyclists 17.7 % were seriously injured and 0.5 % was killed. Therefore, the consequences of an
63 accident were more serious for pedelec riders than for cyclists.



64

65 **Figure 3.** Percentages of injured and killed pedelec riders and cyclists

66 **2.4 Location of accident**

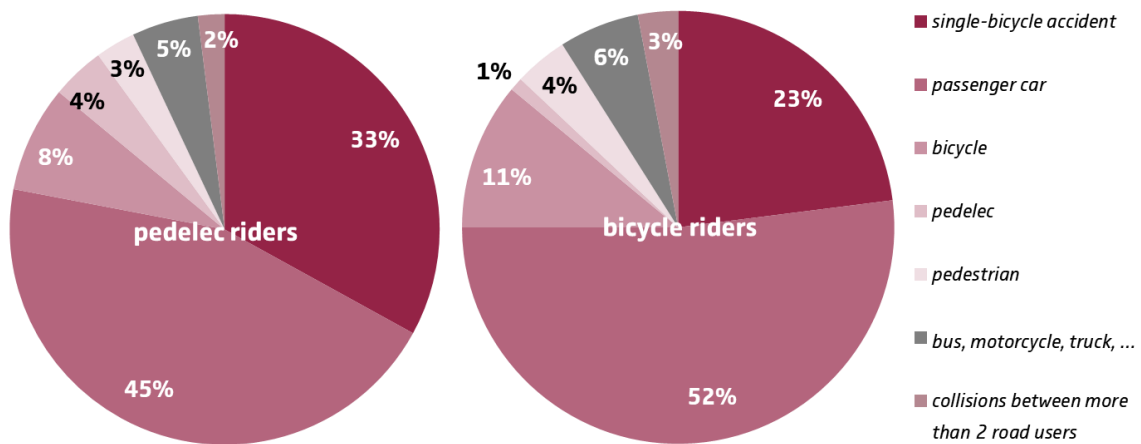
67 Pedelec and bicycle accidents mainly occurred inside of built-up areas. However, the proportion
68 of pedelec riders involved in an accident outside of built-up areas (18 %) was almost twice as
69 high as the proportion of cyclists (10 %).

70 **2.5 Type of accident**

71 In Germany, the type of accident describes the conflict situation that led to an accident. It does
72 not describe the actual collision but indicates how the conflict was triggered prior to the
73 potential collision. The analyses here showed that the share of riders involved in a “riding
74 accident” is higher for pedelec riders (22 %) than cyclists (15 %). A riding accident is characterized
75 by the rider losing control of his or her bicycle (e.g., due to inappropriate speed or misjudgement
76 of the road conditions), without other road users having contributed to this. As a result of
77 uncontrolled bicycle movements, however, a collision with another road user may occur.

78 **2.6 Other party involved**

79 Figure 4 shows the other party involved in pedelec and bicycle accidents. The share of riders
80 who had a single-bicycle accident was higher among pedelec riders (33 %) than among cyclists
81 (23 %). If a collision between two road users occurred, car drivers were somewhat less often
82 recorded as other party involved for pedelec riders (45 %) than they were for cyclists (52 %).



83

84 **Figure 4.** Other party involved in pedelec and bicycle accidents.

85 **2.7 Cause of accident**

86 Accident causes listed in the official accident statistics in Germany are taken from the standard
87 traffic accident notices by the police officers who attend the accident. For pedelec and bicycle
88 riders involved in an accident no striking differences were found regarding the share of the
89 different accident causes. Only the cause “inappropriate speed” was registered slightly more
90 often as accident cause for pedelec riders (11 %) than for cyclists (8 %). On the other hand,
91 “unlawful use of the carriageway or of other parts of the road” was noted as accident cause
92 slightly less often for pedelec riders (8 %) than for cyclists (11 %).

93 **3 DISCUSSION**

94 The results described above suggest that pedelec accidents differ in certain aspects from bicycle
95 accidents. The share of elderly riders is significantly higher among pedelec riders involved in an
96 accident than among bicycle riders involved in an accident. This is not surprising since it is
97 meanwhile known that pedelecs in Germany are predominantly ridden by elderly persons (Nobis
98 and Kuhnimhof, 2018; UDV, 2016). Also, the consequences of an accident with respect to injuries
99 are more serious for pedelec riders. They have a higher share of killed or seriously injured riders
100 compared to cyclists. Pedelec riders are more often involved in accidents outside of built-up
101 areas than bicycle riders are. Presumably, pedelec riders more often ride outside of built-up
102 areas. They seem to use their pedelec more often for recreational and leisure riding than cyclists
103 do and tend to travel longer distances (Nobis and Kuhnimhof, 2018). With respect to the type of
104 accident, pedelec riders more often than cyclists seem to lose control of their bike (without
105 other road users having contributed to this). It was also shown that the share of single-bicycle
106 accidents is higher among pedelec riders.

107 A few years ago, the German Insurers Accident Research found similar results with respect to
108 the characteristics of pedelec accidents in Germany (UDV, 2017). Back then accidents of pedelec
109 riders and cyclists that were reported to the German police in the years 2012 to 2015 were
110 analysed. Data came from 8 of the 16 federal states and one city in another federal state. Similar
111 results were also found by Panwinkler and Holz-Rau (2019) using the official accident statistics
112 of the whole Federal Republic of Germany for the years 2014 until 2017. They also showed that
113 pedelec accidents were more severe than bicycle accidents. The mean age of injured and of
114 killed pedelec riders was higher than that of cyclists. They also found that pedelec riders were
115 more likely to have accidents in rural areas than cyclists were. Pedelec riders also showed a
116 higher share of riding accidents and were more likely to have single-bicycle accidents. The fact
117 that the results of 2019 described above are similar to earlier findings suggests that qualitatively
118 no major changes have occurred over the last couple of years with respect to the characteristics
119 of pedelec accidents. Nevertheless, accidents should be further monitored to reveal potential
120 changes in the future. There are indications that there is an increasing demand for pedelecs also
121 among younger persons (18 to 44 years old; Platho et al., 2019).

122 When looking at the results, one must keep in mind that data were taken from official accident
123 statistics and therefore only include accidents that were reported to the police. There seem to
124 be systematic differences in what kind of accidents get reported to the police. When it comes
125 to bicycle accidents there is a high number of unreported cases. Often the police are only called
126 if someone has suffered serious injuries or if it cannot be clarified who caused the accident. Von
127 Below (2016) estimates the number of unreported cases of bicycle accidents in Germany to be
128 between 58 and 88 %. This figure also differs depending on the other party involved in the
129 accident. For single-bicycle accidents it is 88 to 96 %, for collisions with passenger cars 26 to 47
130 %. According to a current study by Platho et. al (2019) who analyzed pedelec accidents by means
131 of surveys and official accident statistics, the proportion of pedelec accidents that is not

132 recorded by the police but in which the rider had to be treated in a hospital was about two
133 thirds. Since pedelecs are more expensive than bicycles, the willingness to report accidents for
134 insurance claims might be higher, but this assumption has not yet been proven. Von Below
135 (2016) also found that in bicycle accidents the distribution of the reported other party involved
136 varies greatly depending on the data source used. She found that the proportion of reported
137 single-bicycle accidents in all accident situations is much higher if injured cyclists in hospitals are
138 asked about the accident situation than if official accident statistics are consulted. On the other
139 hand, if accident statistics are consulted a higher share of collisions with passenger cars is found
140 than in surveys among cyclists or surveys among injured cyclists in hospitals. The share of
141 reported collisions with pedestrians or other cyclists, then again, is higher when surveying
142 cyclists than when consulting official accident statistics or surveying injured cyclists in hospitals.

143 Another problem with pedelec data in official accident statistics concerns the correct
144 classification of this vehicle type in the standard traffic accident notices by the police officers
145 who attend the accident. Platho et al. (2019) found that less than 30 % of pedelec accidents
146 were classified correctly as such. The others were mainly misclassified by the police either as an
147 accident with a conventional bicycle or with a speed-pedelec.

148 Last but not least, considering only the absolute accident figures might be problematic because
149 it disregards exposure. Elderly persons seem to travel longer distances by pedelec than younger
150 persons do. To account for the increase in riding for elderly riders, it is necessary to calculate
151 accident rates per kilometres travelled by age group.

152 **4 CONCLUSIONS AND PROSPECTS**

153 Based on the analyses it can be concluded that new challenges for road safety work are
154 emerging. Accident involved pedelec riders are predominantly elderly riders. For this risk group
155 (75 years and older) appropriate prevention measures (e.g., education, (guided) practical

156 training aside public roads, advice from bicycle dealers when choosing bike) need to be
157 implemented.

158 Furthermore, it is important to continuously monitor the characteristics of pedelec riders and
159 their accidents. This is essential to identify changes and to evaluate the effectiveness of road
160 safety measures. Also, a constant assessment of the distance travelled by pedelec would be
161 beneficial, so that mileage-related accident analyses can be performed.

162 Knowledge about pedelec accidents derived from official accident statistics should be
163 supplemented by information from surveys among pedelec riders who have experienced an
164 accident.

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