International Transport Forum

Rijkswaterstaat
Ministerie van Verkeer en Waterstaat

veiligheid nl

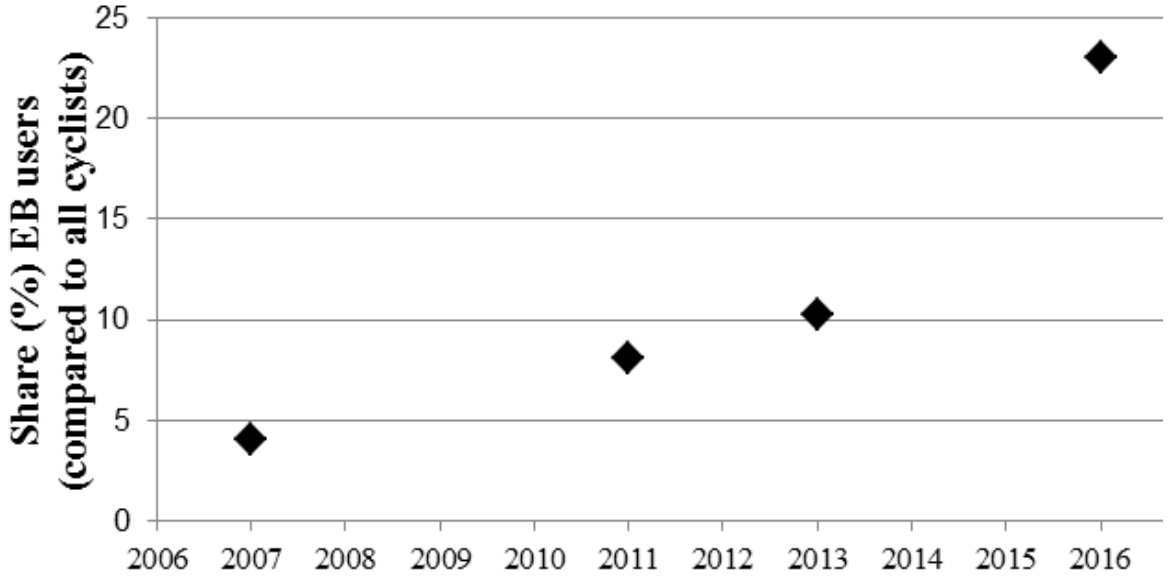
The safety of electrically assisted bicycles (EBs) compared to classic bicycles (CBs) in the Netherlands

Paul Schepers, Karin Klein Wolt, Elliot Fishman

Introduction

- Increasing use of Electric Bicycles (EBs) up to 25 km/h
- Especially among (vulnerable) elderly particularly
- Need for knowledge on road safety effects of EBs

Share of EB users > 16 years



What do people usually believe?

EB is more dangerous

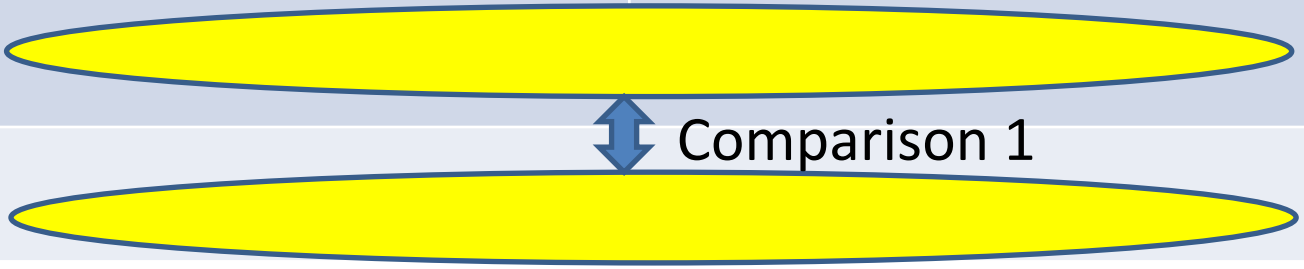
EB leads to more serious injuries

veiligheid nl

Research questions

1. Does crash likelihood differ between those riding EBs and CBs?
2. Does crash severity differ between EB and CB crash victims?

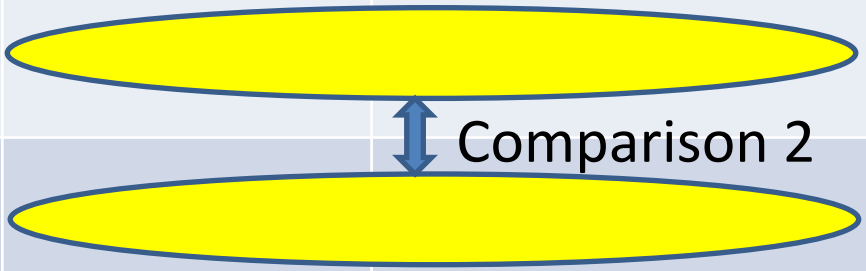
Bicycle type	Victims treated at EDs	Cyclists/ Controls without accident
EB		
CB		



Research questions

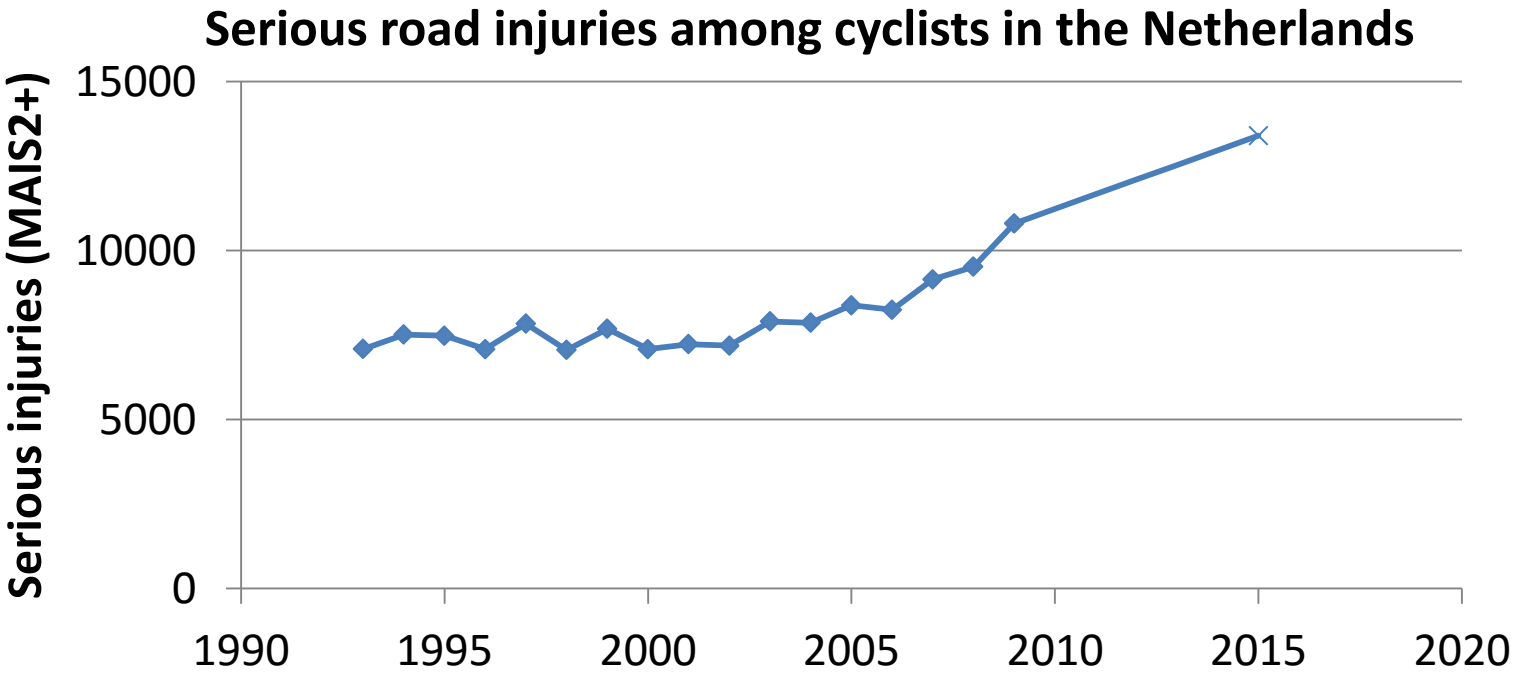
1. Does crash likelihood differ between those riding EBs and CBs?
2. Does crash severity differ between EB and CB crash victims?

Bicycle type	Victims treated at EDs		Cyclists/ Controls without accident
	Hospitalised	ED only	
EB			
CB			



Context: The Netherlands

- High cycling participation (26% modal share)
- Stable number of cyclist deaths, rise of serious injuries
- Need for knowledge within the Transport Ministry



Literature: crash research

Conclusions of a similar study conducted in 2013:

1. EB users are more likely to be treated at an ED after a crash
2. Crash severity did not differ between EB and CB crash victims

- We are not aware of other studies on crash likelihood; conclusion 2 is confirmed in several crash studies

veiligheid nl

Literature

- Cruising speed differs between 1 to 3 km/h between EBs and CBs: unfavourable for safety except under adverse conditions such as riding uphill
- EBs weigh some 5 kg more than CBs and have a different weight distribution, which interferes with (dis)mounting (experimental research):
  - less stable in the initial mounting phase (transition from ‘earth bound’ to ‘balance’)
  - help to accelerate faster
- Hypothesis: front wheel traction problematic
- EB users more vulnerable: older, more morbid conditions and more likely to be obese

Method: case-control study

KANTAR TNS

Bicycle type	Victims treated at EDs	Cyclists/ Controls without accident
EB	795	357
CB	1,788	1,451
Total	2,383	1,808

DISS case-referent study 2016 on cycling accidents

- Dutch Injury Surveillance System: 14 hospitals
- All cycling accidents between January 1, 2016 and January 1, 2017, treated at a DISS Emergency Department
- Structured paper questionnaires and link to online questionnaire sent by hospitals to more than 8.000 victims
- 60 questions on causes, circumstances and effects
- Response rate: 38%

veiligheid nl

Questionnaire study control group

- Conducted by Kantar, one of the largest panel survey companies in the Netherlands
- 3,364 disseminated with one batch per week, yielding a response of 1,808 cyclist without known crash involvement (54%)
- Similar questions application to ‘non-victims’
- Cyclists were classified EB users if they rode over half of the distance cycled per year on an EB

veiligheid nl

Corrections for selective non-response

- We used weighting factors, based on comparing the response among victims /controls to DISS / the Dutch population
- Weighting factors used in SPSS to represent age, gender and other demographical characteristics in the Dutch population

veiligheid nl

Analysis

Comparison on 2 items using binary logistic regression in SPSS:

- Crash likelihood (victim vs control)
- Injury severity (hospital admittance vs ED only)

veiligheid nl

Crash likelihood… EB seems more likely to be treated at an ED….

Table 3. **Association between bicycle type and involvement in crashes for which treatment at an ED is needed**

	Treated at an ED		
	no	yes	OR (95%CI)
*N**	1,806	2,082	
Categorical variables	*share*		
type of bicycle			
CB	82%	77%	1
EB	18%	23%	**1.24 (1.03 - 1.48)**
none	57%	58%	1
one or more	43%	42%	1.10 (0.94 - 1.29)
morbid conditions			
one or more	39%	30%	**0.65 (0.55 - 0.75)**
none	61%	70%	1
Continue var.	*gem (SD)*		
Body Mass Index	25.8 (4.8)	24.5 (4.1)	**0.94 (0.93 - 0.96)**
Nagelkerke R^2	16.8		

* Number of included cases, cases with missing values for one of the variables are excluded; numbers are therefore lower than in table 1

veiligheid nl

But, after controlling for distance…

	Treated at an ED		
	no	**yes**	**OR (95%CI)**
*N**	1,806	1,882	
Categorical variables	*share*		
type of bicycle			
CB	82%	77%	1
EB	18%	23%	1.18 (0.97 - 1.43)
Continue var.	*gem (SD)*		
annual km by bicycle	1098 (1611)	2725 (2931)	**0.94 (0.93 - 0.96)**
ln(annual km by bicycle)			
Nagelkerke R^2	24.5		

veiligheid nl

Injury severity

Table 5. **Association between bicycle type and injury severity (hospitalization required after an ED treatment)**

	Admitted to hospital		
	no	**yes**	**OR (95%CI)**
*N**	1,622	460	
Categorical variables	*share*		
type of bicycle			
CB	78%	73%	1
EB	22%	27%	1.17 (0.89 - 1.55)
3 – 4 days	26%	29%	1.21 (0.70 - 2.09)
4 – 7 days	54%	54%	1.28 (0.75 - 2.17)
medication use			
none	59%	52%	1
one or more	41%	48%	1.12 (0.87 - 1.43)
morbid conditions			
one or more	28%	35%	1.22 (0.96 - 1.56)
none	72%	65%	1
speed			
up to 5 km/h	6%	9%	1
15 - 25 km/h	22%	22%	0.77 (0.50 - 1.21)
up to 5 km/h	37%	33%	0.75 (0.49 - 1.16)
5 - 15 km/h	23%	27%	0.95 (0.60 - 1.51)
> 25 km/h	12%	11%	0.73 (0.43 - 1.25)
Continue var.	*gem (SD)*		
Body Mass Index	24.6 (4.4)	24.2 (3.4)	**0.94 (0.91 - 0.97)**
Nagelkerke R^2	5.6		

* Number of included cases, cases with missing values for one of the variables are excluded; numbers are therefore lower than in table 1

Crash type: (dis)mounting

Table 6. **Association between bicycle type and involvement in crashes regarding (dis)mounting the bicycle**

	Crash type mounting/dismounting		
	no	yes	OR (95%CI)
*N**	1,890	172	
Categorical variables	*share*		
type of bicycle			
CB	79%	61%	1
EB	21%	39%	0.92 (0.59 - 1.43)
gender			
male	53%	29%	1
female	47%	71%	1.40 (0.91 - 2.17)
age			
16 - 24 years	18%	6%	1
24 - 49 years	31%	10%	1.03 (0.39 - 2.69)
50 - 69 years	35%	34%	1.94 (0.81 - 4.64)
>70 years	16%	50%	**3.09 (1.26 - 7.55)**

veiligheid nl

Conclusions

- After controlling for distance travelled and other potential confounders we find :

  - no difference in crash likelihood and injury severity between EB and CB users

  - crashes on EBs and CBs to be equally severe

- A higher share of EB crashes are while (dis)mounting but there is no difference with CB crashes after controlling for factors such as gender and age

veiligheid nl

Recommendations for practitioners

- General road safety / cycling safety measures are likely to improve safety of EB users as well

- Designing a bicycle such that cyclists can sit on their saddle with their feet on the ground ((dis)mounting accidents!)

Research limitations and recommendations

- Self reporting bias

+ The possibility to control for a wide range of factors

- We recommend future research using more standard crash databases and travel surveys although the range of possible control factors in such research is more restricted
- We recommend experimental research to expand our understanding of how to design safer EBs and training programs

veiligheid nl

Paul Schepers - paul.schepers@rws.nl

Karin Klein Wolt - k.kleinwolt@veiligheid.nl

Elliot Fishman - info@sensibletransport.org.au