
DTU

Crash risk of e-bike and c-bike riders in Denmark

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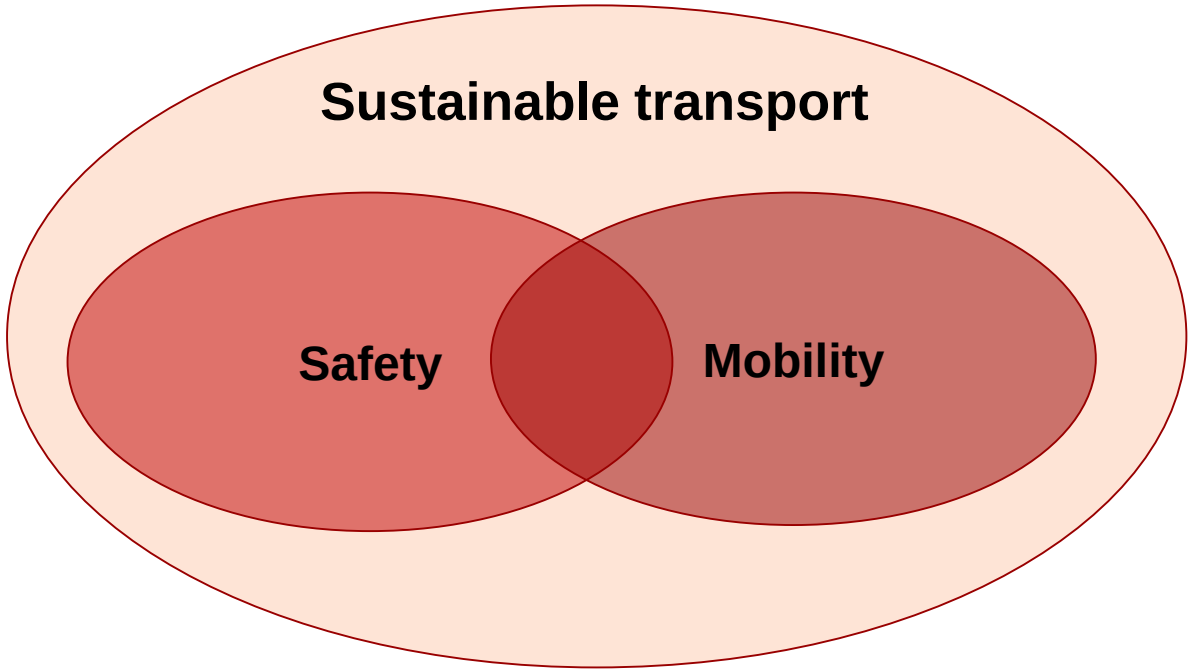


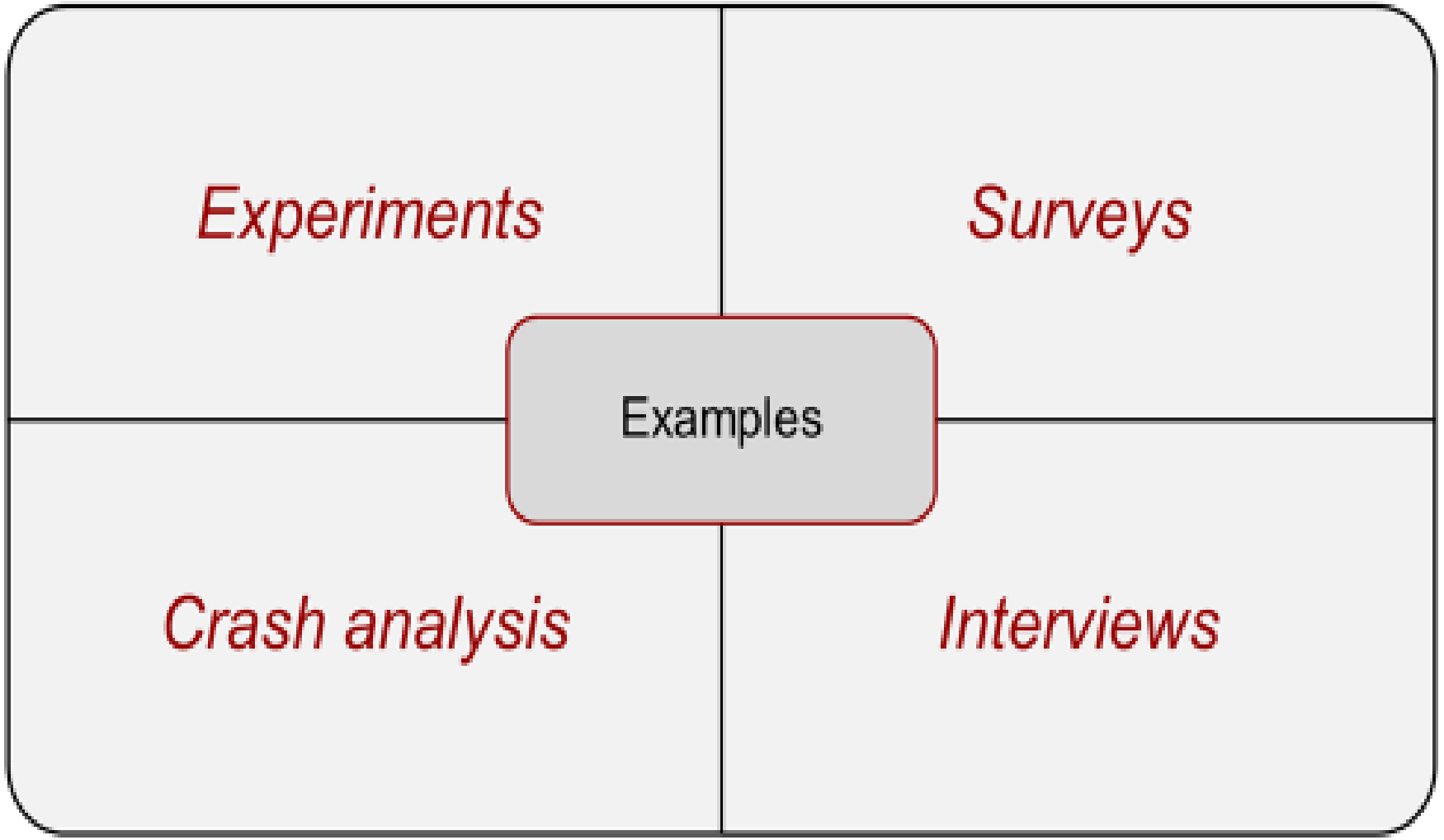
Research based knowledge regarding:

- Road user safety, health, well-being
- Individual mobility and inclusion
- Environmental friendly travel behaviour
- Behaviour change

Theoretical approach

- Social psychology
- Cognitive psychology
- Behaviour change stage models

Data and methods



Examples of ongoing projects

- RELAX –
  REduce the Level of road Anger Expression
  Development of a cognitive-behavioural
  training program

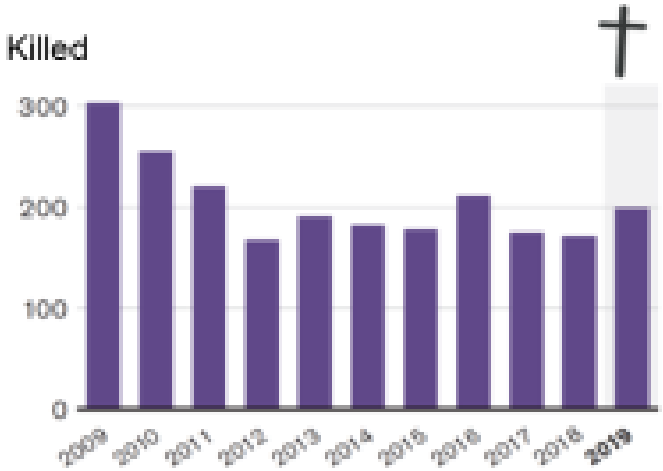
- Safety effects of
  accompanied driving for 17-year olds

- Ghost riders – crash analysis and prevention

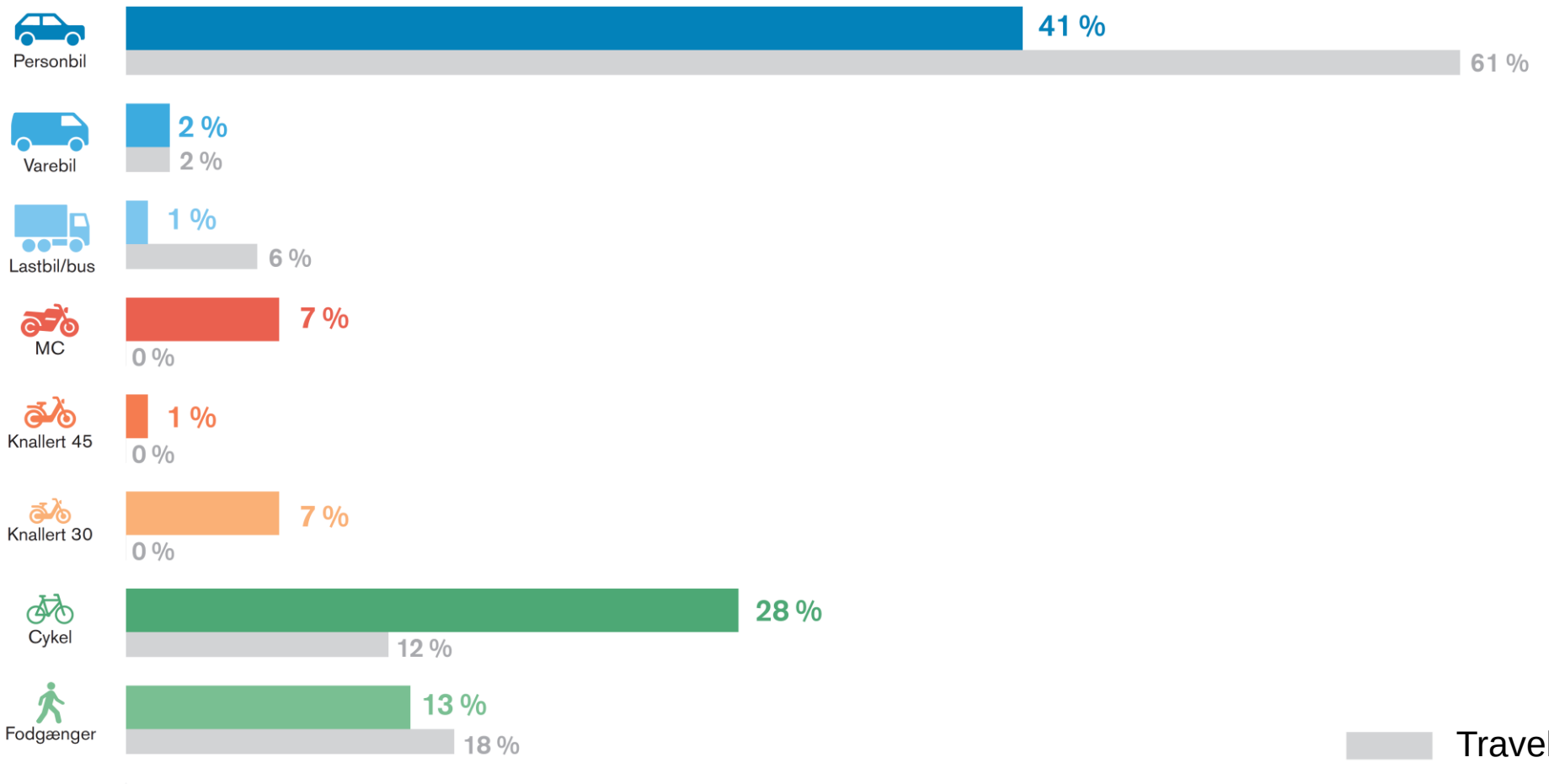
Road safety status in Denmark

Number of killed + injured in DK in 2019

- 199 killed
- 3.076 injured



Killed/injured by transport mode and travel time



Crash risk of e-bike riders and c-bike riders in Denmark

Definition of e-bike

- Electrically assisted bicycle (different from a speed-pedelec)
- Rider voluntarily chooses to engage the engine when needed
- Engine cuts off when:
  - Rider stops pedaling
  - Bicycle reaches maximum allowed speed of 25 km/h
- Some e-bikes provide support also when walking with the bike

- All (except age limit) regulations for c-bikes apply to e-bikes too:
  - Ride on bike-path when available
  - Ride on road if no bike path is available
  - Helmet not mandatory
  - License not needed
  - No speed limit
  - Handheld phone use not allowed
  - No BAC-limit, however police may give fine if judged unable to handle the bicycle
  - Age limit 6 years (only e-bikes)

Data – 2015 to 2018

Two data sources:

- **The Danish National Travel Survey:**
  - Total: 38,819 participants, e-bike = 206 (0.5%), c-bike = 6,380 (16%)
- **The national Danish Road Traffic Crash database**
  - Total number of crashes: 164,939, e-bike = 570 (5%), c-bike = 10,542 (95%)

Danish National Travel Survey (www.tudata.dk)

- Ongoing from 2006 (approx. 10,000 per year).
- Age group 6-84
- Person transport (all legal modes) - E-bikes from mid 2014
- Mainly national trips
- Sample – representative sample via CPR (personal identification number)
- Telephone interviews/Internet interviews

Danish Road Traffic Crash database

- Police notified (not mandatory) public road, injuries/material damage on motor vehicle exceeds EUR 6,700/other material damage exceeds EUR 670 (covers approx. 10% of bike crashes)

Analysis

χ^2 - differences regarding person characteristics and crash characteristics between e/c-bikes

Crash risk includes two analysis:

Risk of crash involvement

$$\frac{\textit{Number of crash involved riders}}{\textit{average km/y}}$$

Risk of fatal/serious injury crash

$$\frac{\textit{Number of dead/seriously injured riders}}{\textit{average km/y}}$$

The risk denotes the number of crash involved/injured e-bike/c-bike riders
per million kilometres travelled for each mode

Urban & rural areas

Rough categorization due to small numbers

Denmark: 5.7 million citizens

Grey Urban areas

Capital + 8 municipalities

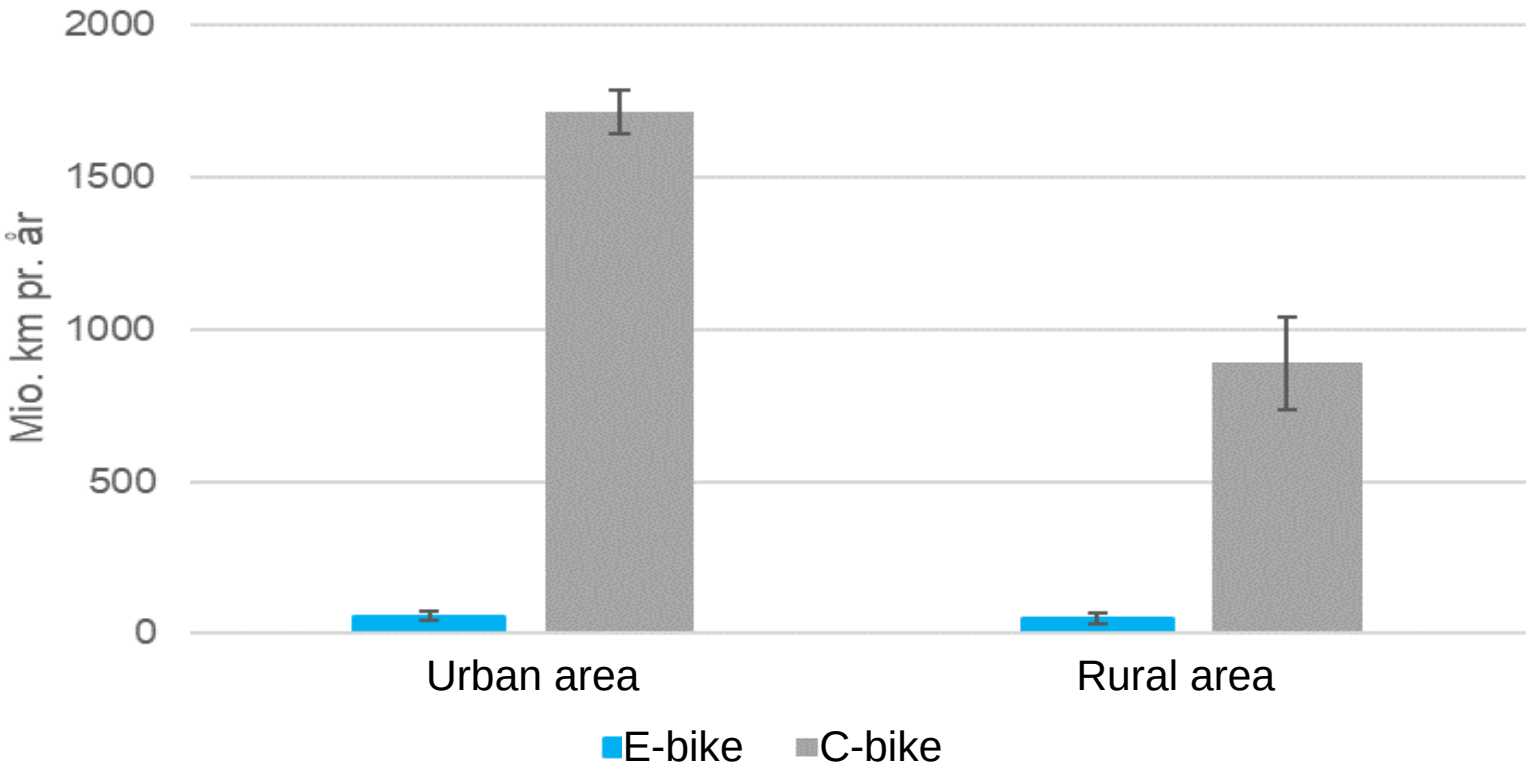
Average citizens 102,000

Green Rural areas

89 municipalities

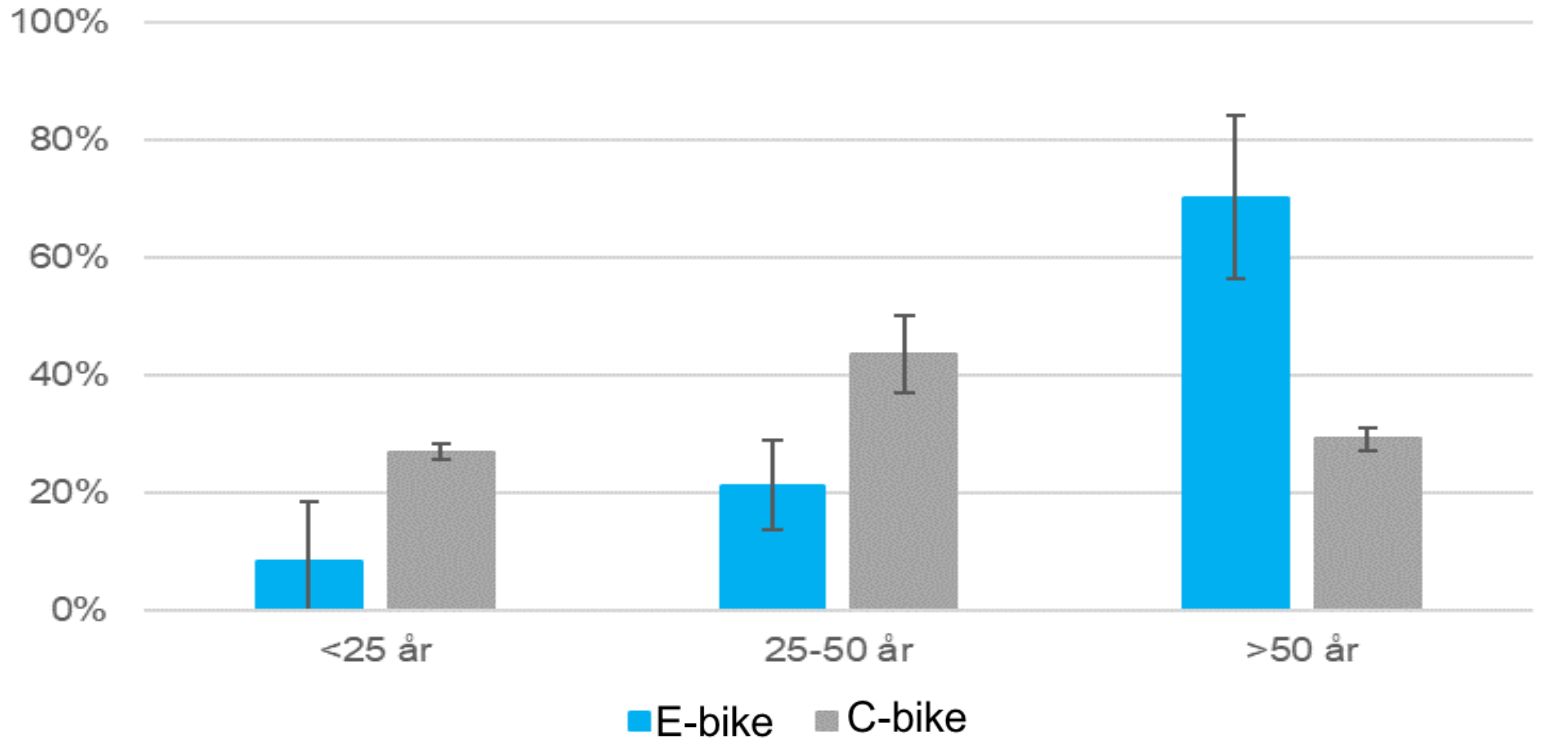
Average citizens 43,500

Travel behavior – average number of mill. km/y



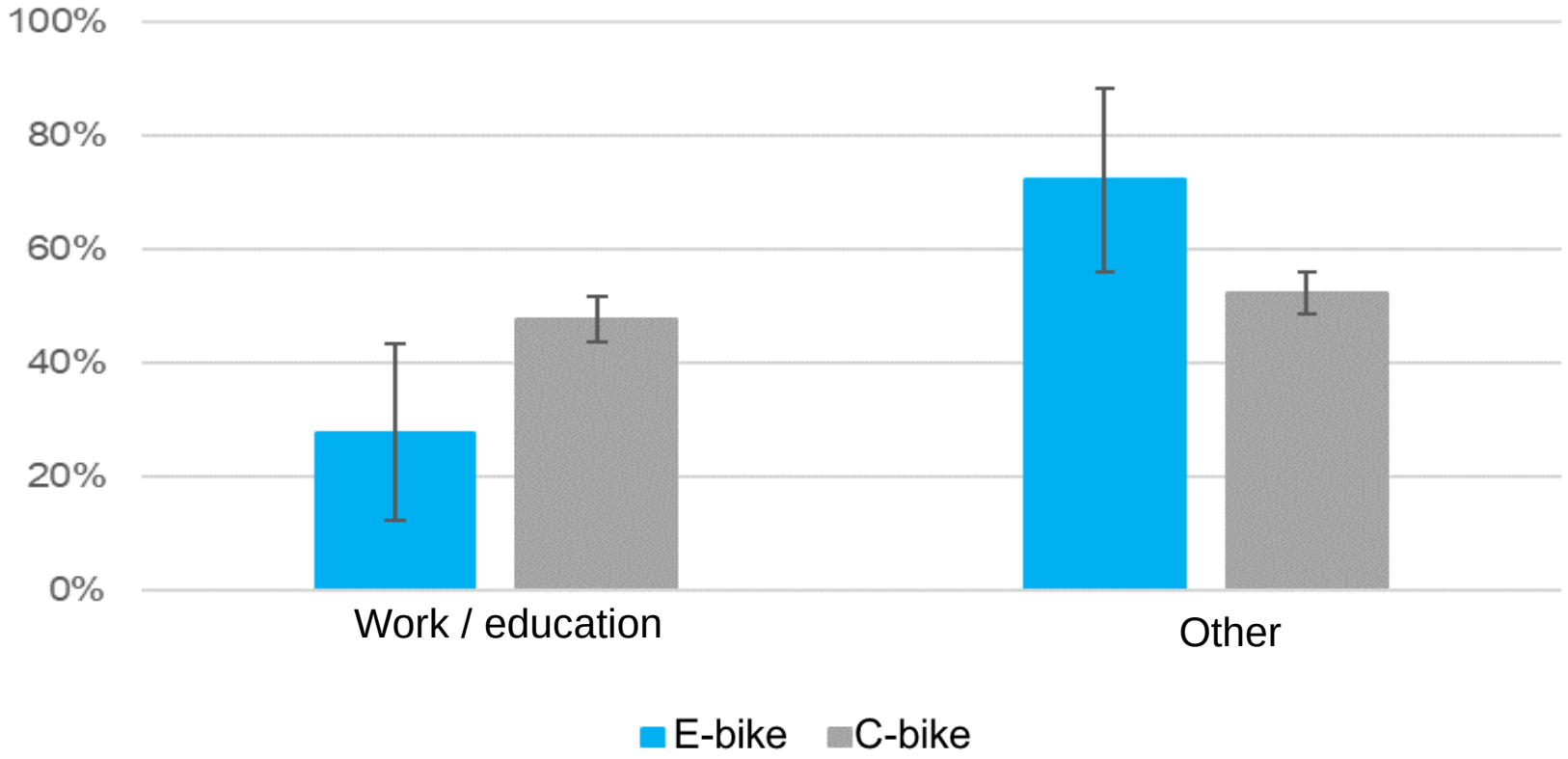
- More km on c-bikes compared to e-bikes
- Urban area: e-bike 30 x fewer km/y compared to c-bike (58 mill km/y vs 1,713 mill km/y)
- Rural area: e-bike 18 x fewer km/y compared to c-bike (49 mill km/y vs 888 mill km/y)
- On average e-bike trips are longer (2.5 km - 3.5 km) than c-bike trips 3.2 – 8 km) only sign. for youngest riders
- Majority of trips during summer (April-September) – no difference between e-bike and c-bike

Distribution of km across age groups



- Persons older than 50 ride 70% of the total number of km on e-bikes
- Few young persons ride an e-bike (8% of km)
- Male riders - 38% of e-bike km, female riders - 62% of e-bike km (different from c-bike distribution)

Trip purpose



- C-bikes: even distribution of km between work/education and other trips
- E-bikes: minority of km related to work/education (28%) – majority (72%) other purposes

Number of crash involved riders

	Number of involved persons		Number of killed/seriously injured bike riders		Total number of killed/seriously injured persons	
Year	E-bike	C-bike	E-bike	C-bike	E-bike	C-bike
2015	89	2,774	21	507	22	567
2016	139	2,666	37	488	40	571
2017	137	2,472	31	458	33	570
2018	205	2,630	59	527	61	594
Total	570	10,542	148	1,980	156	2,302

- 11,112 police registered crash involved riders (e-bikes = 5%)
- No change in the total number of persons involved in a bicycle crash
- The share of persons involved in an e-bike crash increases (3% to 7%)
- The share of injured e-bike riders increases
- The number of crash involved c-bike riders decreases during the period

Rider characteristics

		E-bike (N=570)		Conventional bike (N=10.542)	
Variable	**Category**	N	%	N	%
Severity	Fatal	14	**3**	88	1
	Severe	134	**24**	1,892	18
	Light	74	**13**	1,079	10
	No injury	334	59	6,847	65
	Unknown	14	3	636	6
Gender	Male	193	34	5,454	**52**
	Female	362	**64**	4,347	41
	Unknown	15	3	741	**7**
Age	<25	38	7	3,153	**30**
	25-50	155	27	3,821	36
	>50	362	**64**	4,347	41
	Unknown	15	3	742	**7**
Alcohol	BAC >0,5	6	**1**	30	0
	Unknown	564	99	10,512	100
Illness/medication	No	546	96	9,846	93
	Yes	7	**1**	45	0
	Unknown	17	3	651	6
Helmet	Yes	279	**49**	3,493	33
	No	173	30	3,545	34
	Unknown	118	21	3,504	**33**

p < 0, 05, **bold** highlights values significant higher than expected.

Crash characteristics

- E-bike crashes larger share (compared to c-bike crashes) occurring in the morning, daylight, painted bike-paths

- No differences regarding weather condition, weekday, time of day, time of year or crash situation

	E-bike *(N=570)*		**Conventional bike** *(N=10,542)*	
Crash situation	N	%	N	%
Single cycle crash	42	7	765	7
Collision with pedestrian/animal	17	3	333	3
Straight road	75	13	1,693	16
Intersection – same direction	142	25	2,398	23
Intersection – opposite direction	294	51	5,353	51

Risk of crash involvement

- All bike-crash involved persons (registered by the police) regardless of crash severity

Transport mode	Exposure (mill km/y)	Number of crash involved riders	Crash risk*	95% CI
E-bike	107	143	1.33	[0.94 – 1.73]
C-bike	2,601	2,636	1.04	[0.93 – 1.14]

*number of crashes per million km

- Results indicate a higher crash risk for e-bike riders (1.33) compared to riders of conventional bike riders (1.04)
- The uncertainty is much higher for e-bike riders due small numbers
- No difference in the overall risk of crash involvement between rural and urban areas was found

Crash risk - age

Transport mode	Age	Exposure (mill km/y)	Number of crash involved riders	Crash risk	95% CI
E-bike	≤50	32	48	1.51	[0.94 – 2.09]
	>50	75	91	1.21	[0.96 – 1.47]
Conventional bike	≤50	1,840	1,744	0.95	[0.86 – 1.03]
	>50	761	707	0.93	[0.87 – 0.99]

- No age differences in general crash risk for e-bike / c-bike riders

- For e-bike riders results indicate a higher crash risk riders aged 50 or younger (1.51) compared to riders above 50 years of age (1.21). Results are not significant

Risk of fatal or serious injury

Transport mode	Exposure (mill km/y)	Number of killed / seriously injured	Risk of death / serious injury	95% CI
E-bike	107	37	0.35	[0.24 – 0.48]
Conventional bike	2,601	495	0.19	[0.17 – 0.21]

- The risk of fatal/serious injury is higher for e-bike riders (0.35) than for c-bike riders (0.19)
- No differences for e-bike riders between rural (0.33) and urban areas (0.36)
- For c-bike riders the risk of fatal/serious injury is smaller in urban areas (0.17) than rural areas (0.23)

Risk of fatal/serious injury - age

Transport mode	Age	Exposure (mill. km/y)	Number of killed/ seriously injured riders	Risk	95% CI
E-bike	≤50	32	6	0.17	[0.09 – 0.24]
	>50	75	31	0.42	[0.33 – 0.51]
C-bike	≤50	1,840	283	0.15	[0.14 – 0.16]
	>50	761	211	0.28	[0.26 – 0.30]

- For e-bike and c-bike riders the risk of fatal/serious injury is higher for riders above the age of 50
- For riders aged 50 or younger the risk is similar for e-bike (0.17) and c-bike (0.15)
- For riders above the age of 50, the risk is higher for e-bike (0.42) than for c-bike (0.28)

Conclusion

- Unchanged number of bicycle crashes - increase in the share of e-bike riders involved

- Compared to c-bike crashes the share of injury crashes is higher for e-bike crashes
  – Additional analysis focusing on the crash circumstances will be done – present results indicate an effect of age related fragility

- Small numbers – but higher share of persons unfit to bicycle among crash involved e-bike riders.
  – Medication, alcohol, physical/mental capacity?

- All estimations include police registered crashes and are therefore probably underestimated.
  – Assume that the level of underreporting is similar for e-bike and c-bike crashes. Comparison between e-bikes and c-bikes (hopefully) valid.

- Based on recent published crash data for 2019 – we will update and advance the analysis hopefully be able to include more variables due to a larger number of observations.

  Suggestions are very welcome ☺

Work at DTU?

DTU Tenure Track Assistant Professor(s) or Associate Professor(s) in

Transport Economics

Transport Psychology

Transport Modelling

Deadline August 31st 2020

More information at:

https://www.dtu.dk/english/About/JOB-and-CAREER/vacant-positions/job?id=c73f4368-985b-43aa-9bd1-26f2bf2d4ff7

Thank you for your attention: mette@dtu.dk