Accidents with Pedestrians and Cyclists in Germany
Findings and Measures

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Unfallforschung der Versicherer (UDV)

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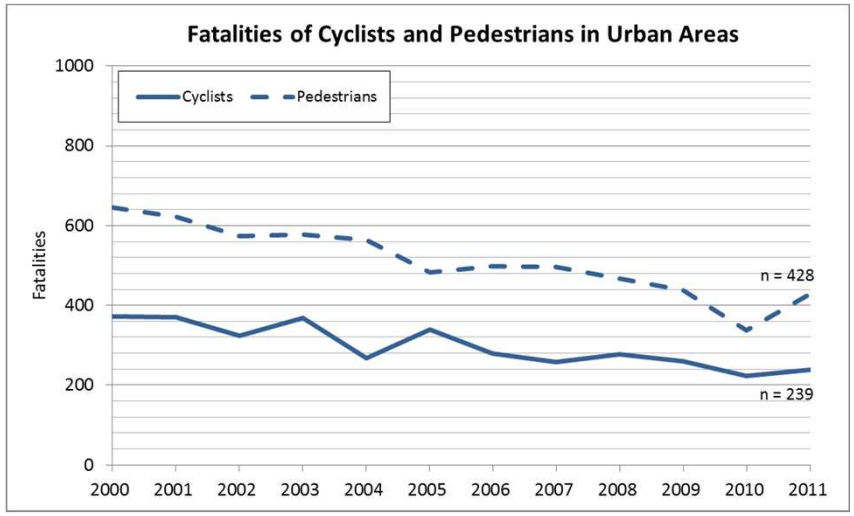
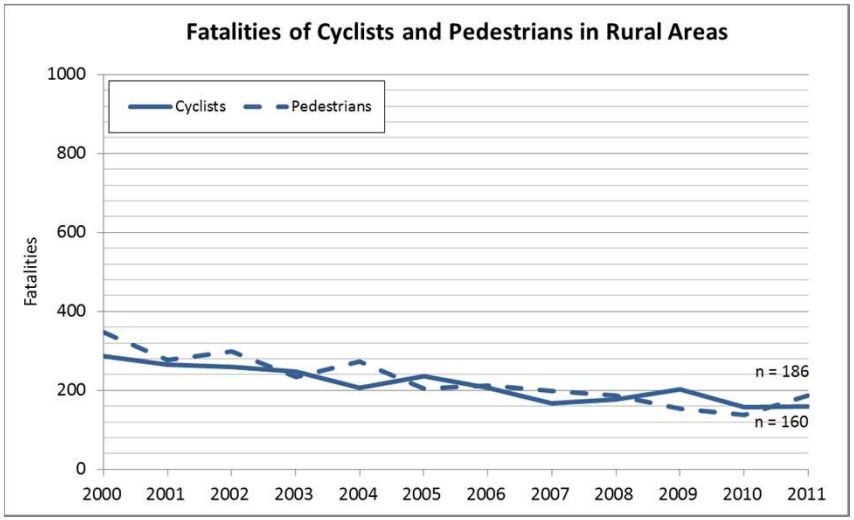
Unfallforschung der Versicherer GDV

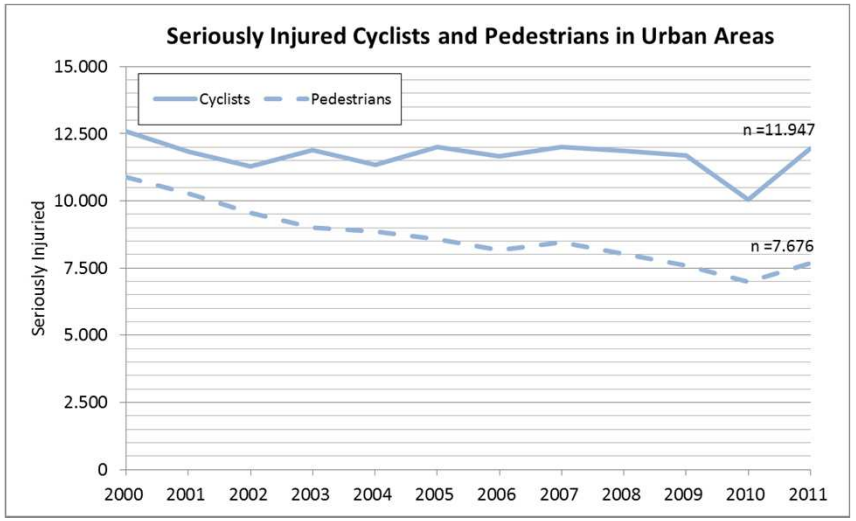
Content

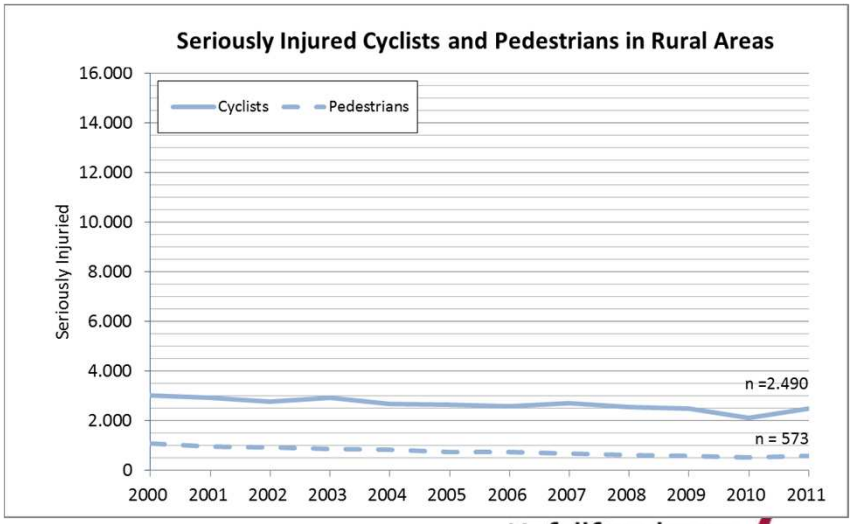
- **Accident situation in Germany**
  based on National statistics
  based on Accident Database of German Insurers (UDB)
- **Infrastructural findings**
  based on research work of UDV
- **A new danger?**
  Electric bicycles also known as pedelecs
- **Safety benefits of Advanced Driver Assistant Systems (ADAS)**
  based on UDB analysis
- **Benefit estimation of pedestrian safety measures for car fronts**
  based on an advanced assessment procedure

Accident situation in Germany / national statistics









source: German national statistics

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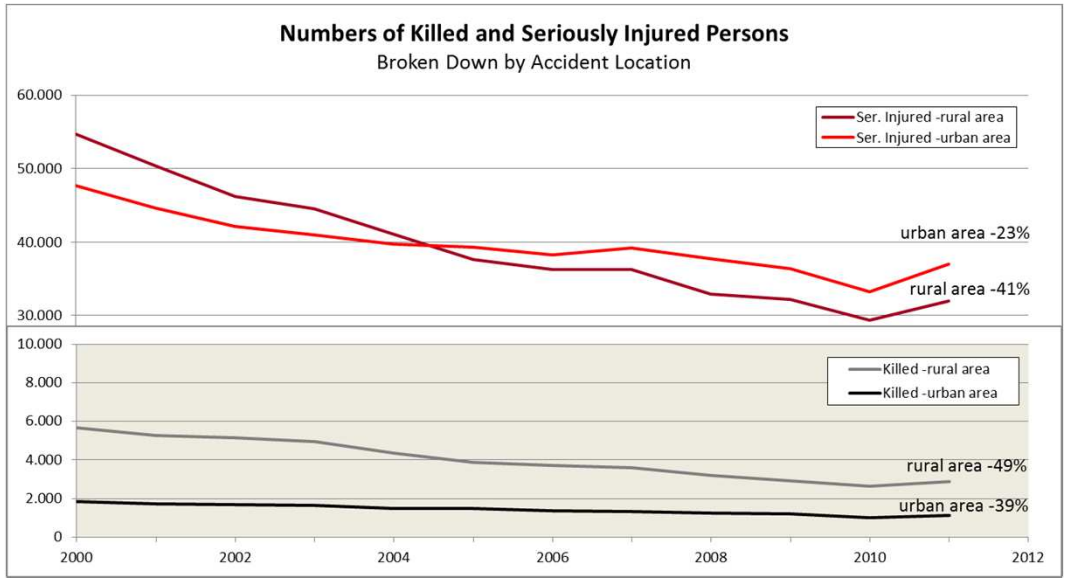
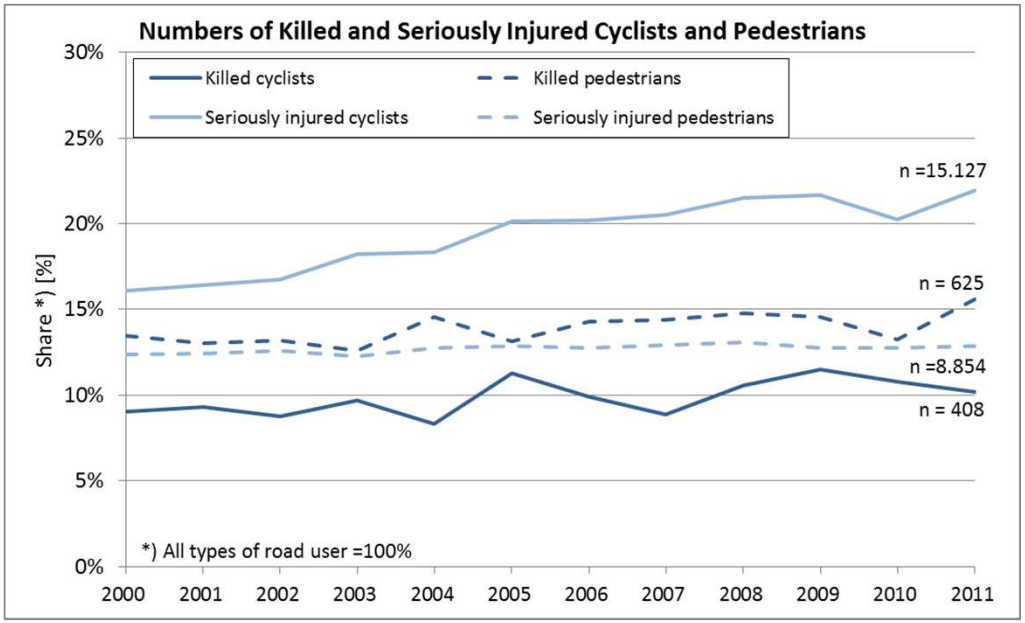
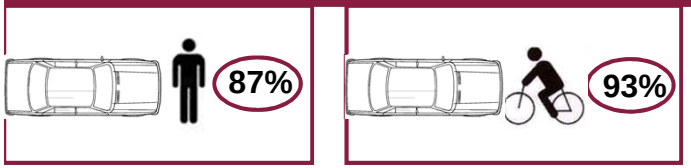
Accident situation in Germany / national statistics





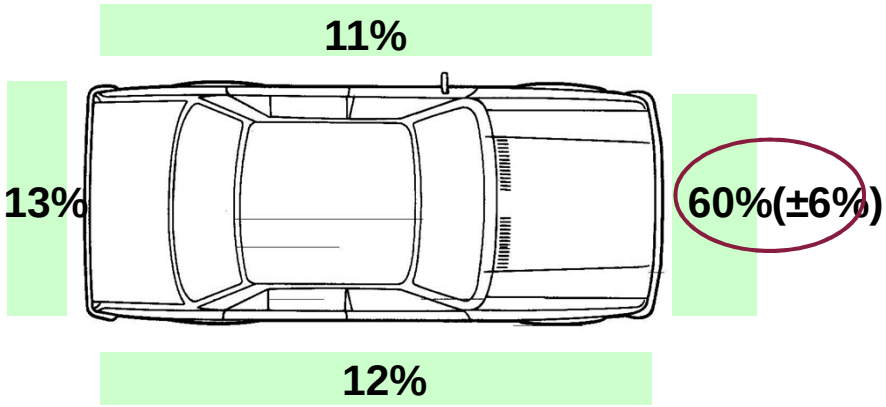
source: German national statistics



Accident situation in Germany / UDB

Type of Impact with the Car

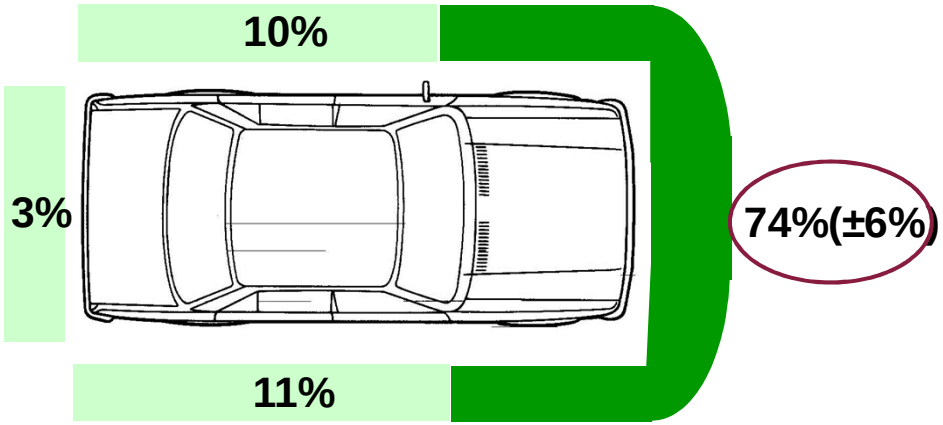
Pedestrian



Only cases with known first impact of the car

n=236; N=18,224

Bicyclist



Only cases with known first impact of the car

n=217; N=21,955

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Similarities Between Pedestrian and Bicyclist Accidents

- The most frequent accident opponent is the passenger car.
- Collisions with cars result predominantly in frontal impacts.
- In frontal car impacts:
  - Most of the accidents occur at daylight.
  - In the majority of the cases, the road was dry at the time of accident.
  - Accidents with a crossing pedestrian/bicyclist are most frequent.
  - Accidents due to a turning off from the road by the car are of high relevance and make up the second main accident group.

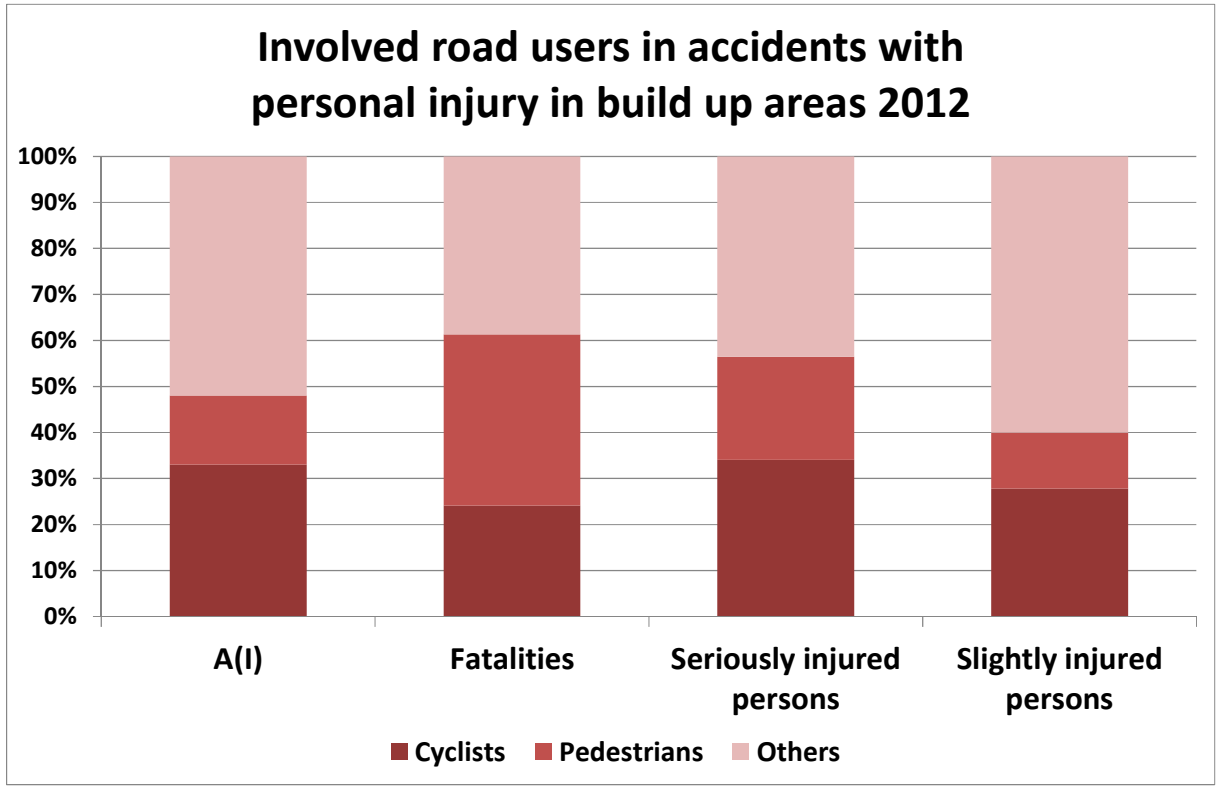
Differences Between Pedestrian and Bicyclist Accidents

- In collisions with cars, pedestrians are more than twice as likely to suffer fatal injuries as bicyclists .
- The likeliness to be involved in a collision with a reversing car is for pedestrians four times higher than for bicyclists.
- In frontal car impacts:
  - Compared to bicyclist accidents, pedestrian accidents are characterized by a higher average driving speed of the car.
  - Pedestrian accidents occur most frequently on straight roads, whereas the majority of the bicyclist accidents occur at crossings/junctions.
  - Compared to pedestrians (8%), cyclists are more than twice as likely to be involved in collisions when they are moving in the same or the opposite direction of the car along the road (21%).
  - Darkness has more relevance for pedestrian accidents, especially when the car is travelling at high speeds (> 50 kph).
  - In pedestrian accidents, the car driver predominantly performs a braking manoeuvre, whereas in the majority of the bicyclist accidents he doesn`t.
  - View obstruction due to parked vehicles is an important issue in pedestrian accidents, for bicyclist accidents, however, it has a low relevance.

Infrastructural findings

High accident risks for non motorised road users

- One in three killed persons in build up areas
- Thereof more than 50 % cyclists and pedestrians
- Constant percentage since several years



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Accidents with pedestrians occur when crossing the street

Example: Berlin 2006-2010

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Infrastructural findings

Safe road crossings

- Safe design of road crossings
- Improving visibility
- Minimising conflicts

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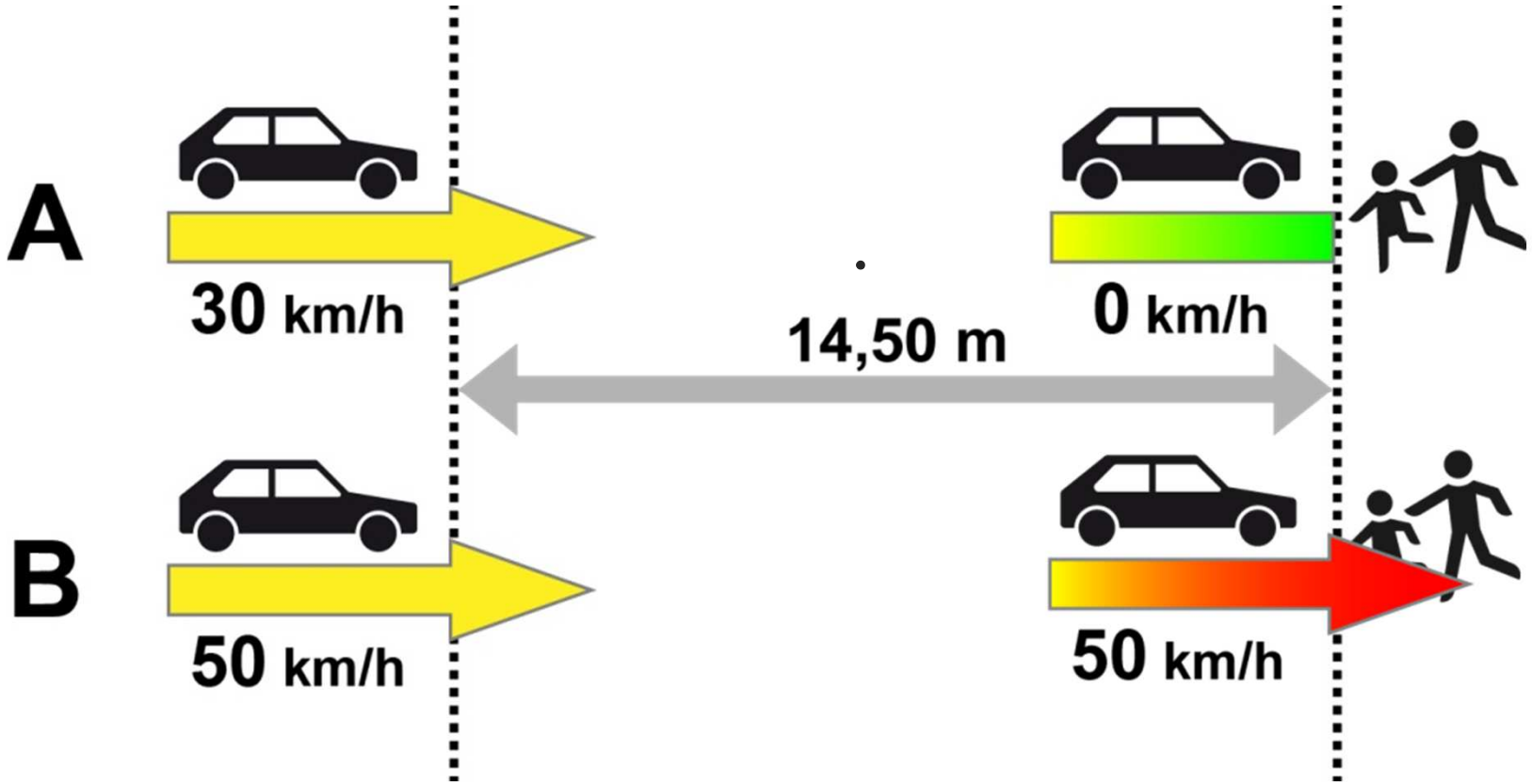
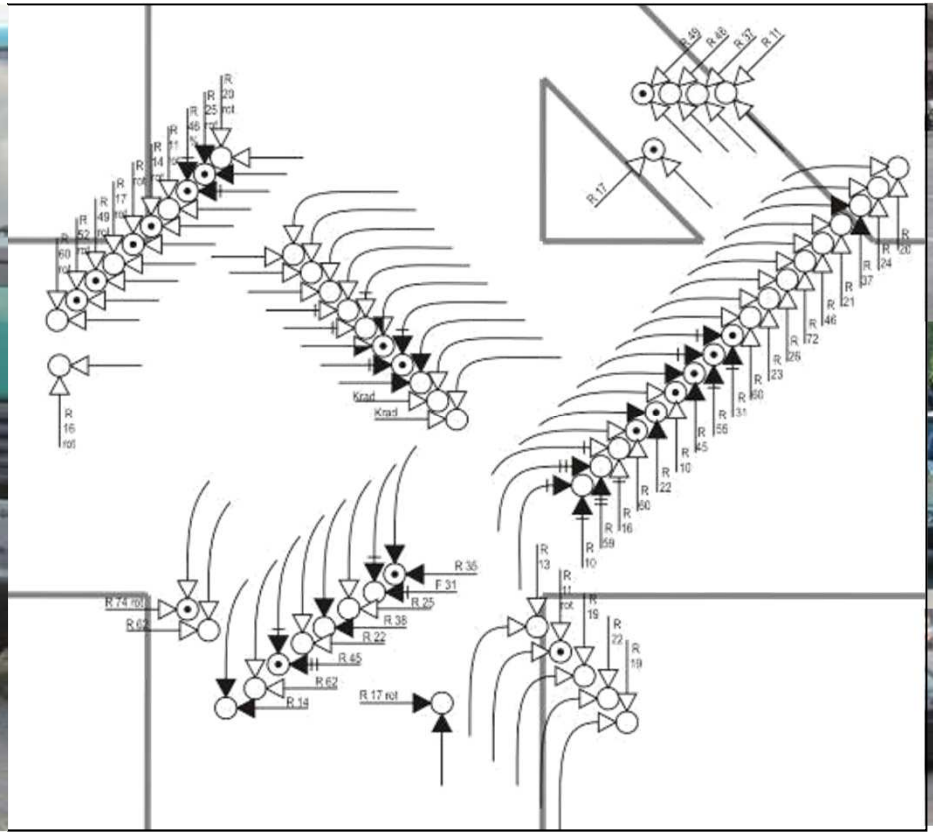
Reduction in vehicle speed

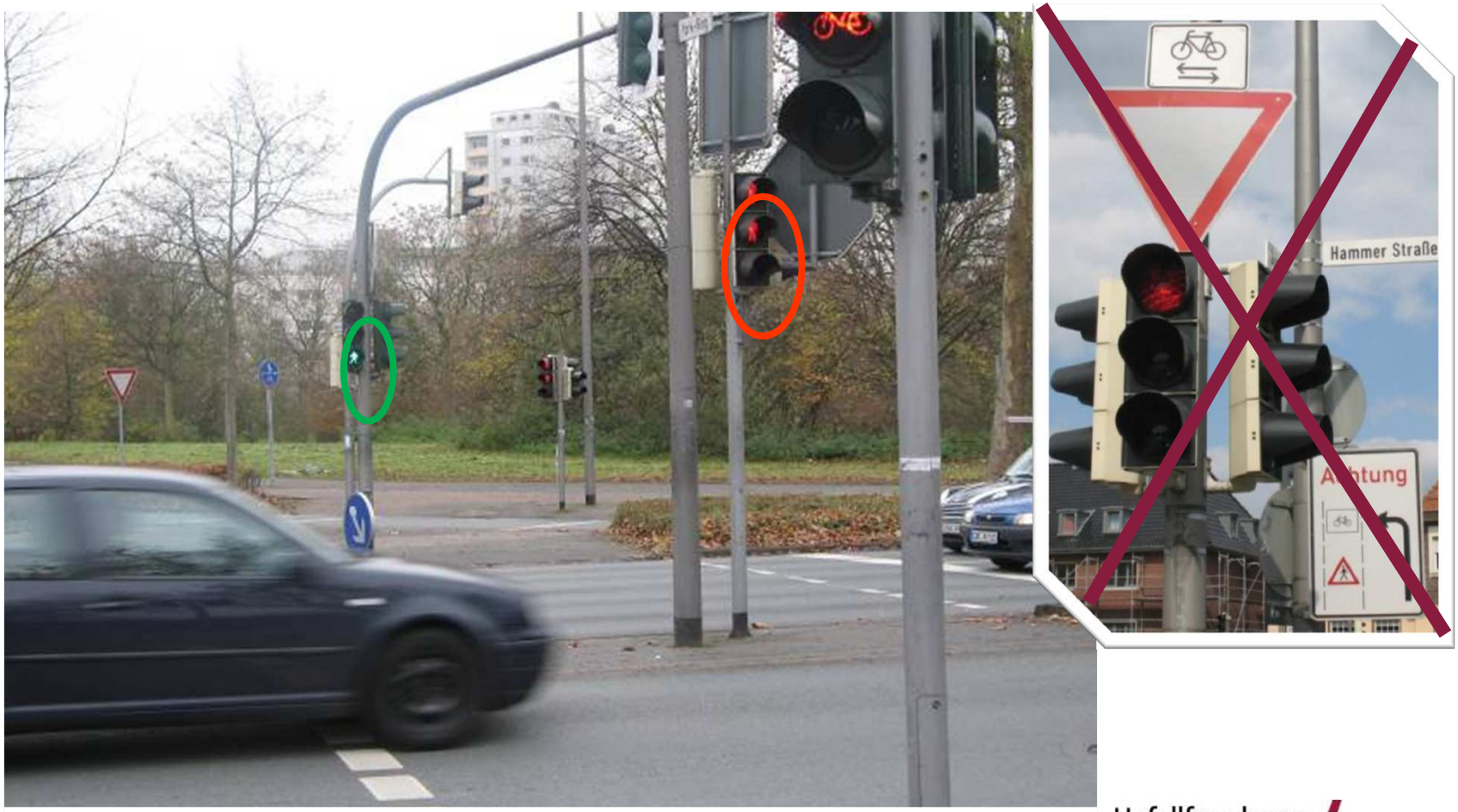
Reduction in vehicle speed



Accidents with cyclists occur at intersections



Improving infrastructure



Visible and comprehensible signalisation

Separate phases in signalisation for turning vehicles

Results of the accident analyses

Turning-off accidents involving cyclists*

- 36% of all accidents with personal injury in build-up areas
- 80% of turning-off accidents involving cyclists result in personal injury
- 2/3 right-turning accidents, 1/3 left-turning accidents
- Main causer is the driver (>90%)
- Most frequent accident cause is cycling on the pavement or in wrong direction (in total 12%)

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* Accidents between cars turning-off to the right (near side) or to the left (off side) and cyclists cycling straight ahead

Observation of traffic behaviour

Phase of signalisation

- Driver and cyclist start at green → conflict rate* = 3.2%
- Running green for driver and cyclist → conflict rate = 10.4%
- Driver starts at green, cyclist approaching from behind → conflict rate = 29.8%

Lines of vehicles turning off

- Vehicle in a line of vehicles turning off → conflict rate = 38.4% (single vehicles: 6.1%)
- Cyclist in a line of cyclists → conflict rate = 6.1% (single cyclists: 13.2%)

Visual contact

- Cyclist in the field of view of the driver → conflict rate = 2%
- Cyclist behind the driver resp. head to head → conflict rate = 16%

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* Conflictrate: conflicts as share of all 736 interactions [%]

Traffic behaviour and violation of traffic rules

Behaviour observed as a percentage of interactions			In case of conflict
	Missing look over the shoulder (missed more often by the elderly)	19.2 %	More often in case of conflict (33.3 %)
	Not to set the indicator	1.9 %	Similar
	Distraction (especially mobile phone)	4.7 %	Similar
	Jumping red lights*	0.3 %	Not appraisable
	Approaching intersection on pavement	3.8 %	Similar
	Cycling in wrong direction**	17.4 %	Similar
	Crossing on pedestrian crossing or right hand of the cycle crossing**	13.3 %	More often in case of conflict (24 %)
	(without cyclists cycling in wrong direction)	(5.6 %)	(16.3 %)

* *Cause of accidents with cyclists in German accident statistics (destatis): 4.0 %*

** *Cause of accidents with cyclists in German accident statistics (destatis) „cycling on wrong infrastructure or in wrong direction“: 11.5 %*

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Results and Recommendations

Infrastructure with conspicuous accident ratios

- **Right-turning accidents**
  Cycle paths at intersections with or without traffic lights
  with a distance of > 2m from the road
  in combination with obstructions to visibility (70-80%)
- **Left turning accidents**
  Intersections without traffic lights, where the road is shared in mixed traffic
  in combination with low traffic volumes of cyclists and vehicles turning left as well as cyclists
  cycling in wrong direction or cycling on the pavement

Recommendations

- No obstructions to visibility, also for the look over the shoulder
- Preference of cycling lanes or cycle paths close to the road
- Separate phases in traffic signalisation
- Pilot projects about the stationary roadside detection of cyclists
  and visual warning of drivers

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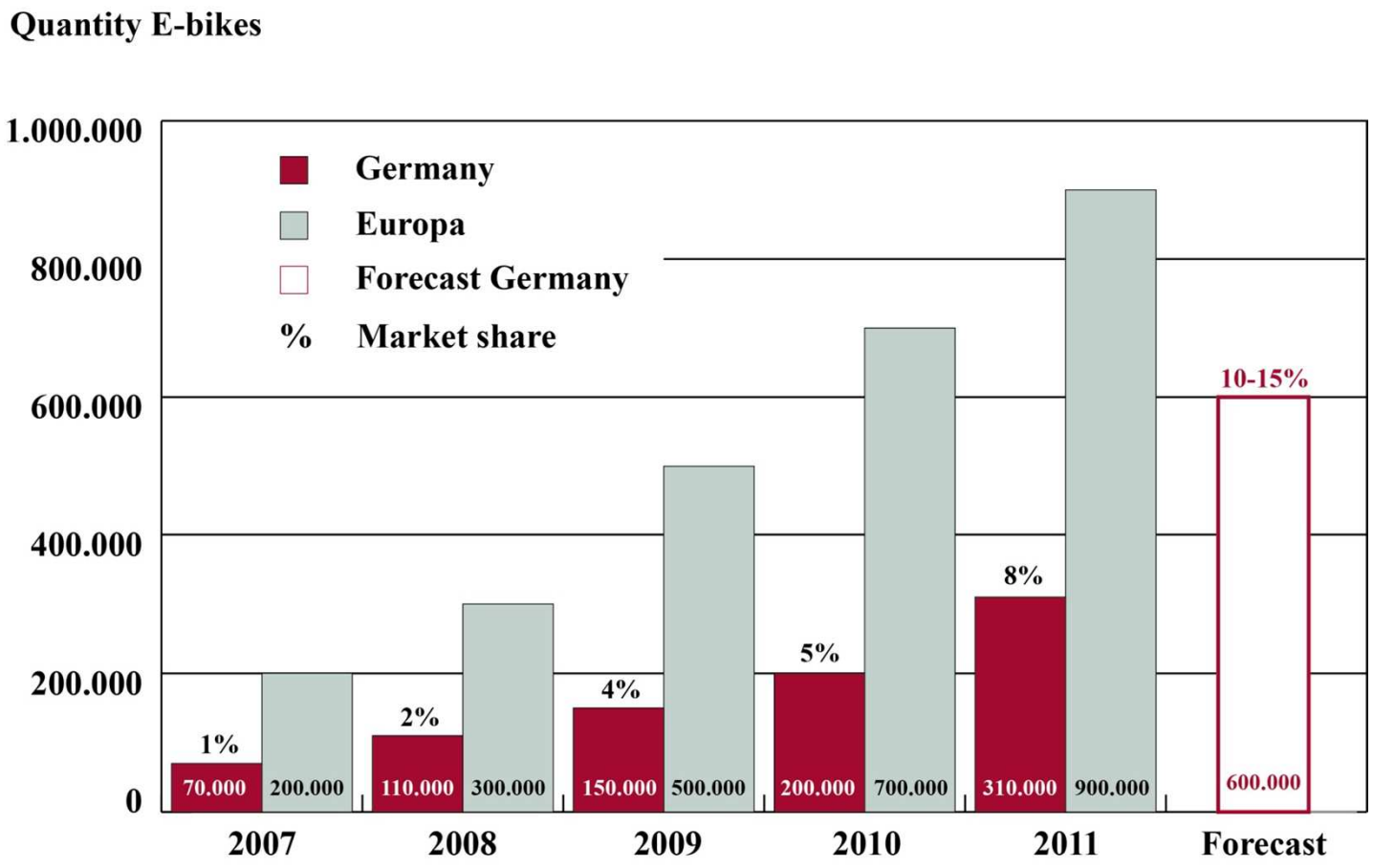
Pedelec market development



Data: Two Wheeler Association (ZIV), 2012

General Danger

car drivers do not anticipate „bicyclists“ with such high speeds

General Danger

car drivers do not anticipate „bicyclists“ with such high speeds

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General Danger

different speeds on cycle paths

A new danger?

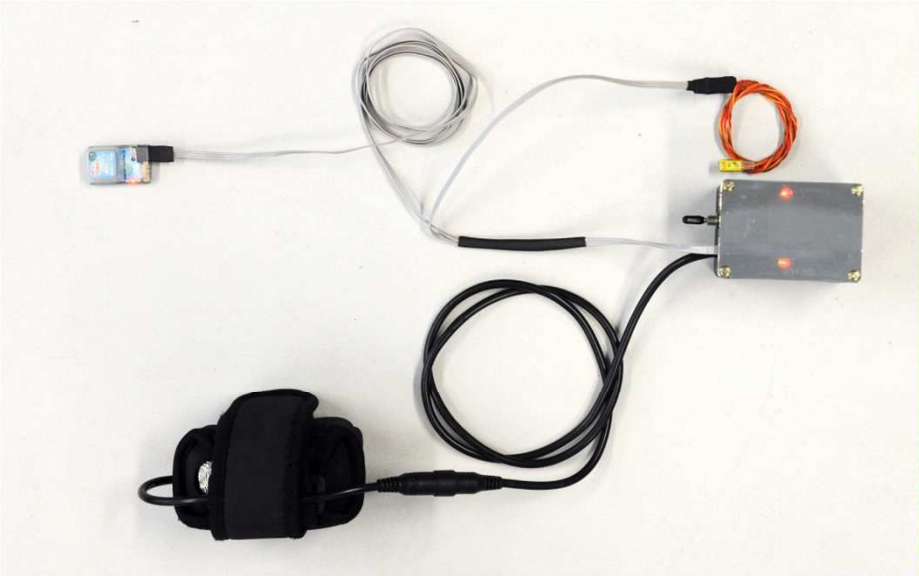
Research questions

- New tools are needed to answer open research questions
- **Naturalistic Cycling Study** is able to address:

1) Who uses Pedelec / E-bikes and why?
2) For wich trips are they used?
3) Where do Pedelec / E-Bike cyclist ride?
4) How fast do Pedelec / E-bike cyclist ride?
5) How many and what type of critical incidents and / or accident occur?
6) …

Naturalistic Cycling Study

Measures – Data aquisition system (DAS)



- Battery
- Wheel sensor
- GPS sensor
- Box incl. 2 cameras (front~, face~), data storage, 2 Status LED‘s

A new danger?

Naturalistic Cycling Study

First impressions

[redacted]

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Safety benefits of Advanced Driver Assistant Systems (ADAS) for Cars

- Autonomous Emergency Brake (AEB) 2: 17.8 %
- Autonomous Emergency Brake (AEB) 2*: 19.6 %
- Lane Departure Warning (LDW): 4.4 %
- Blind Spot Detection: 1.7 %

basis:
all car accidents

- AEB 2* with pedestrian detection: 35.1 %
- AEB 2* with bicyclist detection: 45.4 %
- Rear view camera with ped. detection: 12.9 %

basis:
all car/pedesrian accidents
respectively
all car/bicyclist accidents

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Safety benefits of Advanced Driver Assistant Systems (ADAS) for Cars

AEB with bicyclist detection (Volvo since 2013)

source: Volvo, press release, 5.3.2013

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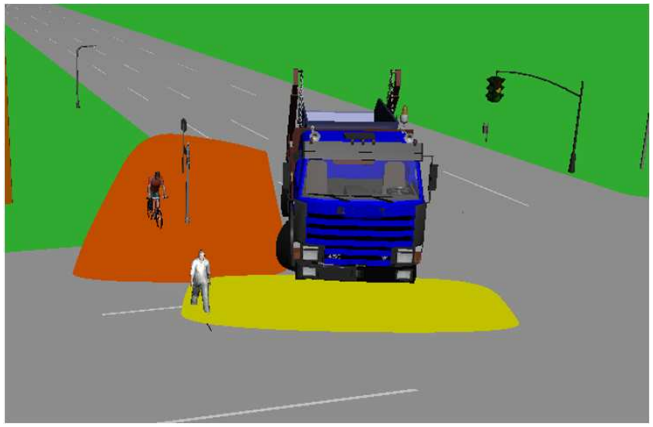
Safety benefits of Advanced Driver Assistant Systems (ADAS) for Trucks

Turn-off Assist (with pedestrian and cyclist detection)



Safety benefit potential

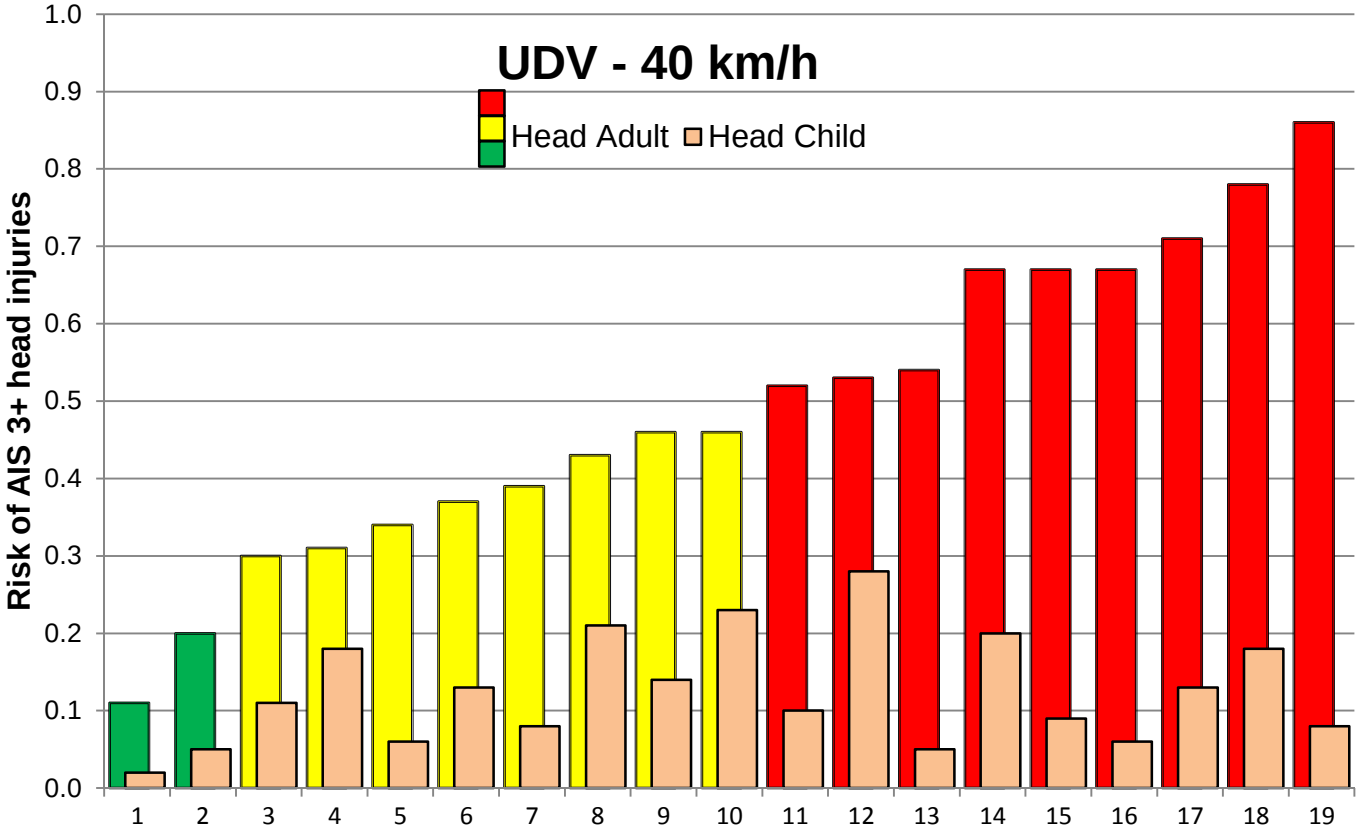
- Basis are all accidents between a truck and a pedestrian or cyclist:

Avoidable accidents	Avoidable fatalities	Avoidable seriously injured persons	Avoidable slightly injured persons
42.8%	31.4%	43.5%	42.1%

Benefit estimation of safety measures

Crash test with an uplifting hood and an airbag (40kph)

Benefit estimation



	Vehicle class (acc. Euro NCAP)	Adult	Child		Vehicle class (acc. Euro NCAP)	Adult	Child
1	Execut. Saloon (upl. b.) (A)	0,11	0,02	11	Small MPV (E)	0,52	0,10
2	Execut. Saloon (upl. b.) (B)	0,20	0,05	12	Execut. Saloon (upl. b.) (C)	0,53	0,28
3	Small MPV (A)	0,30	0,11	13	Small Off-Road (A)	0,54	0,05
4	Small MPV (B)	0,31	0,18	14	Small Off-Road (B)	0,67	0,20
5	Supermini (A)	0,34	0,06	15	Supermini (C)	0,67	0,09
6	Small Family Car (A)	0,37	0,13	16	Large MPV (A)	0,67	0,06
7	Small MPV (C)	0,39	0,08	17	Large Family Saloon (A)	0,71	0,13
8	Small MPV (D)	0,43	0,21	18	Small MPV (F)	0,78	0,18
9	Supermini (B)	0,46	0,14	19	Small Family Car (C)	0,86	0,08
10	Small Family Car (B)	0,46	0,23		***Average***	***0,49***	***0,13***

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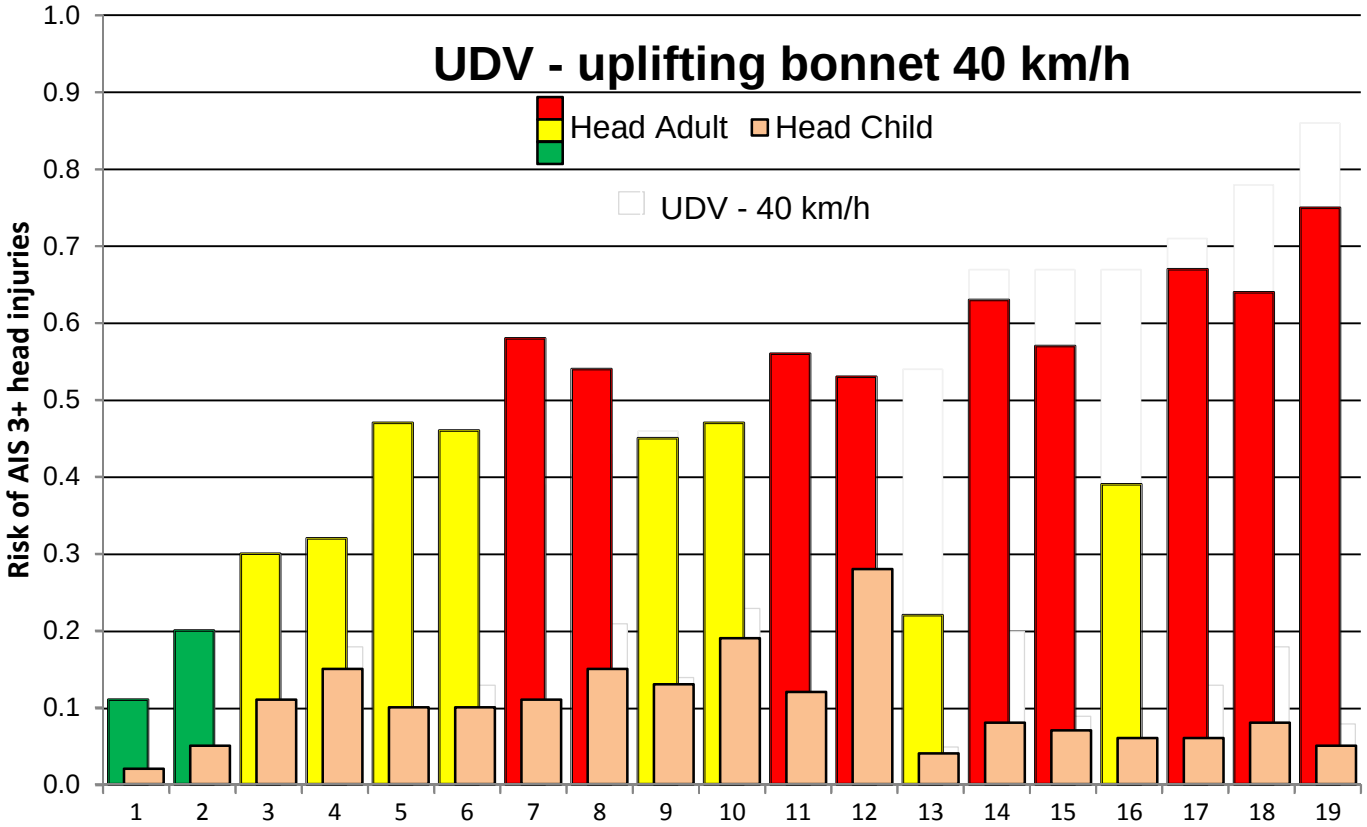
Benefit estimation



	Vehicle class (acc. Euro NCAP)	Adult	Child		Vehicle class (acc. Euro NCAP)	Adult	Child
1	Execut. Saloon (upl. b.) (A)	0,11	0,02	11	Small MPV (E)	0,56	0,12
2	Execut. Saloon (upl. b.) (B)	0,20	0,05	12	Execut. Saloon (upl. b.) (C)	0,53	0,28
3	Small MPV (A)	0,30	0,11	13	Small Off-Road (A)	0,22	0,04
4	Small MPV (B)	0,32	0,15	14	Small Off-Road (B)	0,63	0,08
5	Supermini (A)	0,47	0,10	15	Supermini (C)	0,57	0,07
6	Small Family Car (A)	0,46	0,10	16	Large MPV (A)	0,39	0,06
7	Small MPV (C)	0,58	0,11	17	Large Family Saloon (A)	0,67	0,06
8	Small MPV (D)	0,54	0,15	18	Small MPV (F)	0,64	0,08
9	Supermini (B)	0,45	0,13	19	Small Family Car (C)	0,75	0,05
10	Small Family Car (B)	0,47	0,19		***Average***	***0,47***	***0,10***

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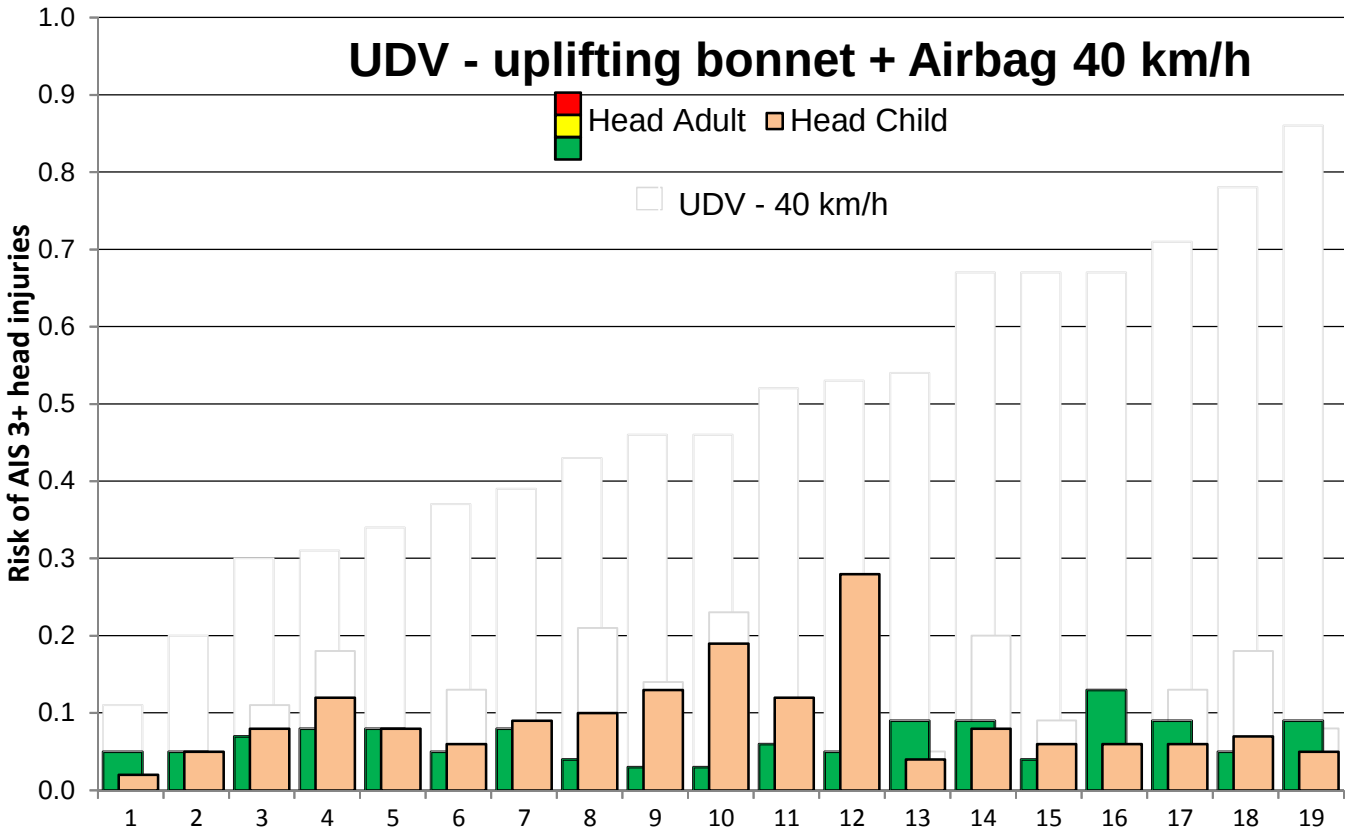
Benefit estimation



	Vehicle class (acc. Euro NCAP)	Adult	Child		Vehicle class (acc. Euro NCAP)	Adult	Child
1	Execut. Saloon (upl. b.) (A)	0,05	0,02	11	Small MPV (E)	0,06	0,12
2	Execut. Saloon (upl. b.) (B)	0,05	0,05	12	Execut. Saloon (upl. b.) (C)	0,05	0,28
3	Small MPV (A)	0,07	0,08	13	Small Off-Road (A)	0,09	0,04
4	Small MPV (B)	0,08	0,12	14	Small Off-Road (B)	0,09	0,08
5	Supermini (A)	0,08	0,08	15	Supermini (C)	0,04	0,06
6	Small Family Car (A)	0,05	0,06	16	Large MPV (A)	0,13	0,06
7	Small MPV (C)	0,08	0,09	17	Large Family Saloon (A)	0,09	0,06
8	Small MPV (D)	0,04	0,10	18	Small MPV (F)	0,05	0,07
9	Supermini (B)	0,03	0,13	19	Small Family Car (C)	0,09	0,05
10	Small Family Car (B)	0,03	0,19		***Average***	***0,07***	***0,09***

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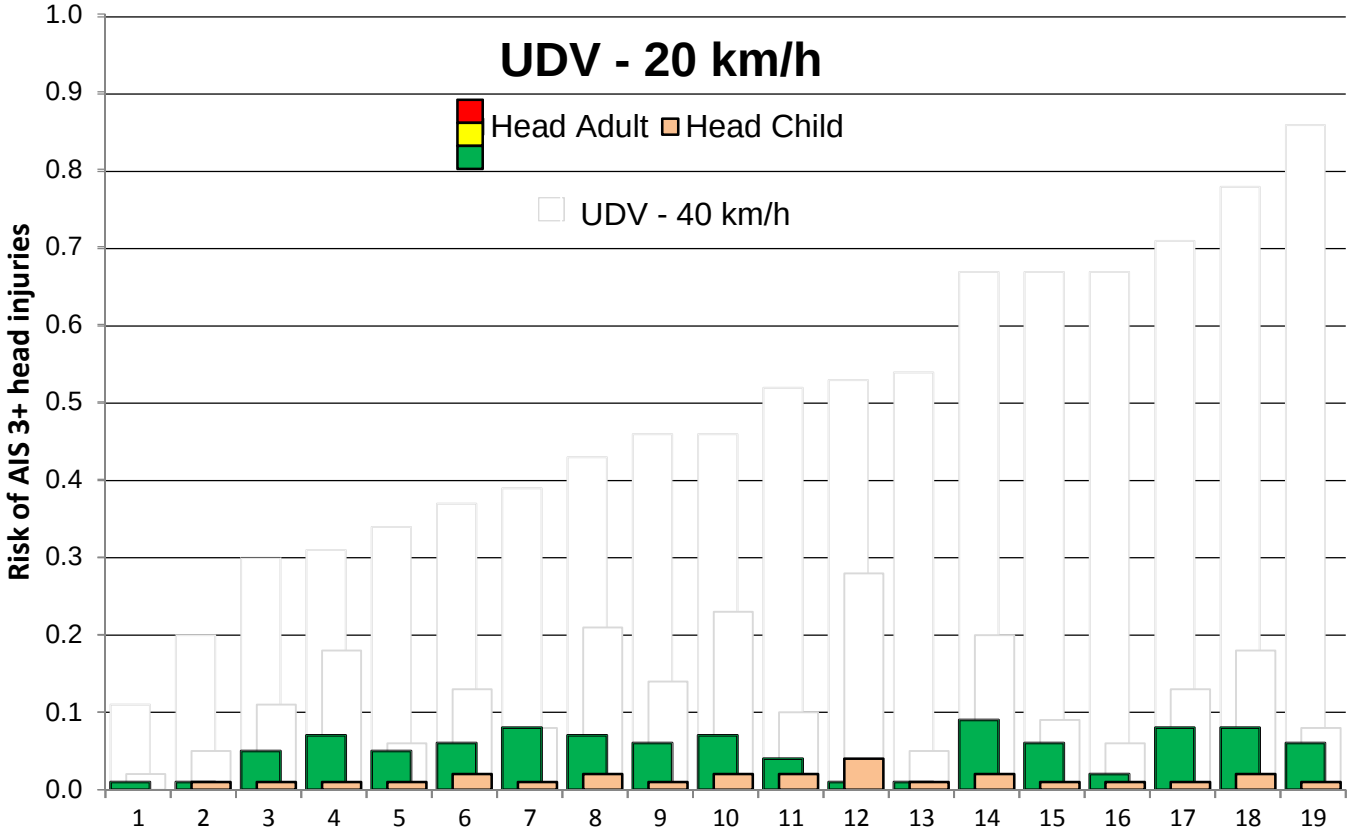
Benefit estimation



	Vehicle class (acc. Euro NCAP)	Adult	Child		Vehicle class (acc. Euro NCAP)	Adult	Child
1	Execut. Saloon (upl. b.) (A)	0,01	0,00	11	Small MPV (E)	0,04	0,02
2	Execut. Saloon (upl. b.) (B)	0,01	0,01	12	Execut. Saloon (upl. b.) (C)	0,01	0,04
3	Small MPV (A)	0,05	0,01	13	Small Off-Road (A)	0,01	0,01
4	Small MPV (B)	0,07	0,01	14	Small Off-Road (B)	0,09	0,02
5	Supermini (A)	0,05	0,01	15	Supermini (C)	0,06	0,01
6	Small Family Car (A)	0,06	0,02	16	Large MPV (A)	0,02	0,01
7	Small MPV (C)	0,08	0,01	17	Large Family Saloon (A)	0,08	0,01
8	Small MPV (D)	0,07	0,02	18	Small MPV (F)	0,08	0,02
9	Supermini (B)	0,06	0,01	19	Small Family Car (C)	0,06	0,01
10	Small Family Car (B)	0,07	0,02		***Average***	***0,05***	***0,01***

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Benefit estimation of safety measures
Summary

- It becomes obvious that a reduced collision speed (as achieved by AEB) is the first choice for long-term pedestrian safety measures at cars. This is because the effect of this measure is independent from:
  - the front shape of the car
  - the height of the pedestrian.
- In contrary to this, the uplifting bonnet with airbag shows rather little effect for children.