ADAC

Restraint systems – for all occupants?

Accident analysis and crash tests

Isabella Ostermaier, ADAC e.V. | January 26, 2022

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Initial situation and research questions of the study

- Do women have a higher risk of injury because the vehicle safety is often examined using male dummies?
- Are there any other risk groups with regard to occupant safety in our society?
- How do common dummies represent other groups of people, e.g. regarding body stature and age?

Approach and content of the study

Background information → Database analysis → Crash tests

Can risk groups be identified?
Which measures are suitable
to increase the safety of this people?

Definition of a dummy

A dummy is an anthropomorphic test instrument that is modeled on humans as closely as possible.

- Instead of volunteer test persons, dummies have been used more and more frequently since the 1950s to examine the **safety of ejection seats**, **helmets** or **restraint systems** in the aerospace industry as well as in vehicle technology.
- However, it can take **up to 20 years** for a dummy to be developed and used.
- Depending on the load case, a dummy is equipped with various **sensors** that measure the **forces, accelerations and compression** that act during a crash in different parts of the body.
- However, **injury risk curves** are required in order to be able to **convert the measured values** into an injury severity and probability.

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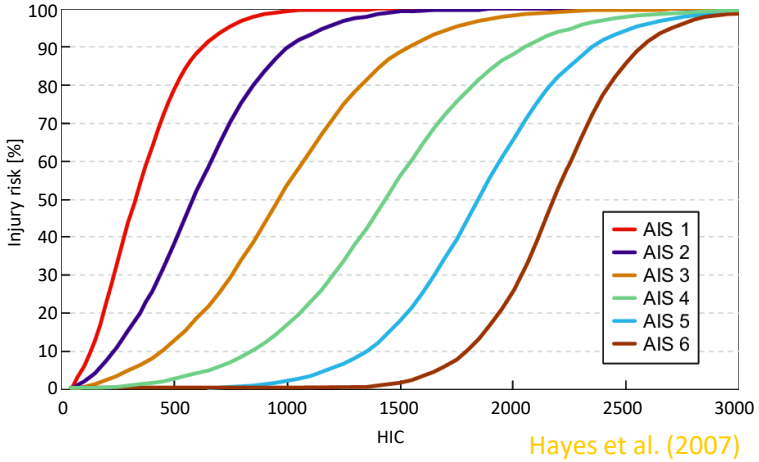


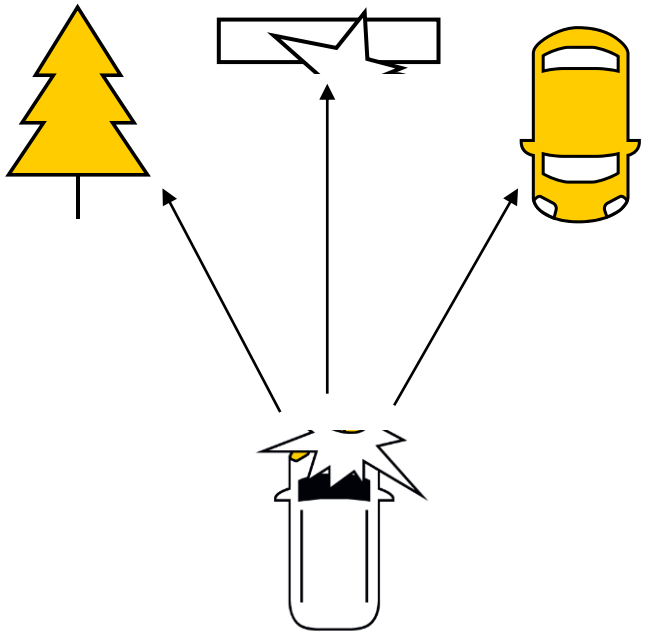
Hayes et al. (2007)

Accident data analysis

The **ADAC accident database** consists of serious traffic accidents in Germany, which mainly took place at **interurban spots** where **ADAC Air Rescue Service** is needed the most.

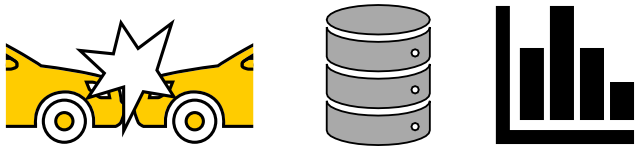
Filter Criteria

- Frontal impacts, 11 to 1 impact angle
- Car/Minibus to vehicle, car to obstacle
- Belted driver and passenger
- Front airbag activated
- Vehicle year of registration 2005 and younger

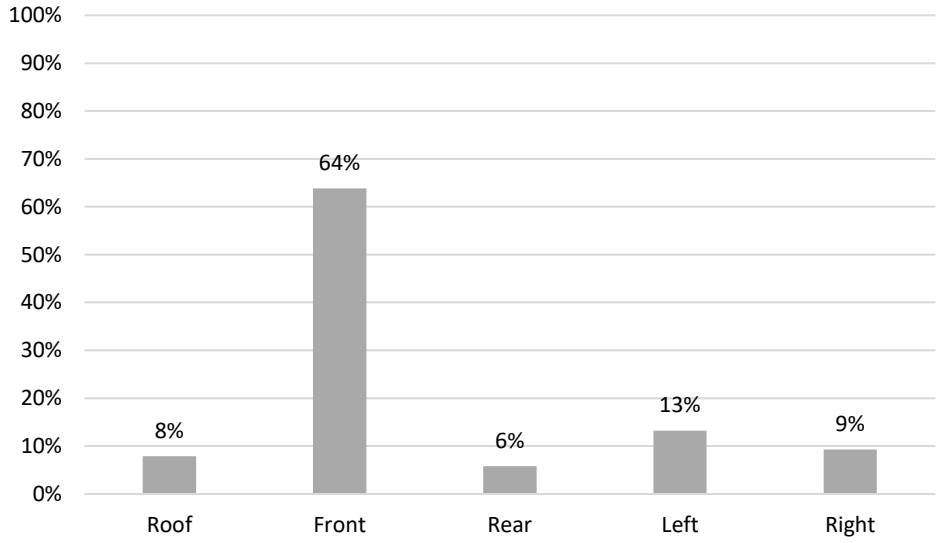


769 frontal accidents with 804 occupants were available for the analysis

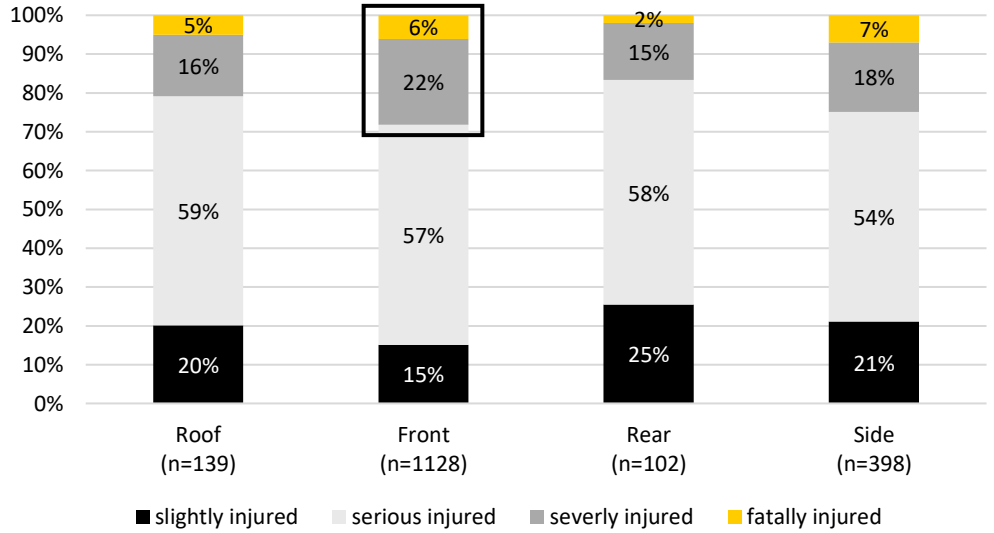
Frontal Impact Scenario



Distribution of injured occupants in the ADAC database (n=1.767)



Distribution of the injury severity of the injured occupants over the deformation area

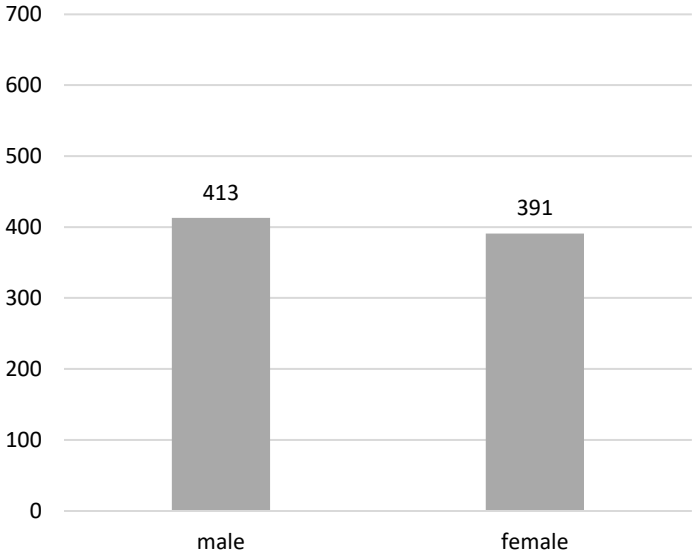


- 2/3 of all injured passengers have a frontal impact
- Highest injury risk in frontal impact scenarios

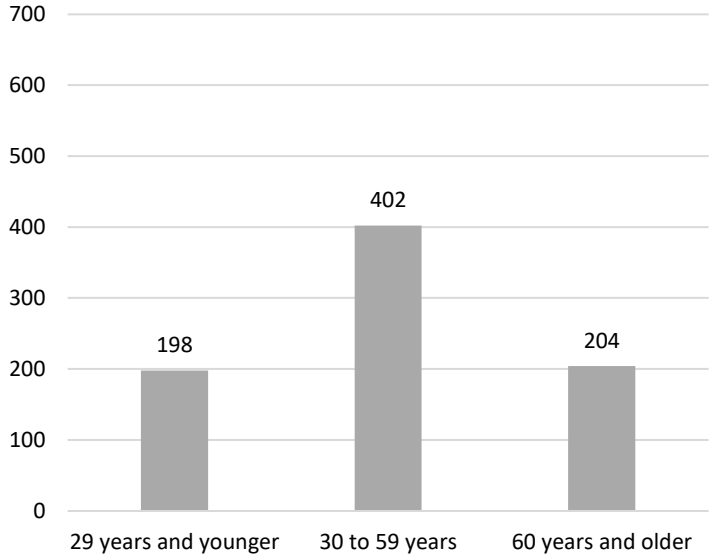
Accident data analysis

804 injured passengers in **769** accidents

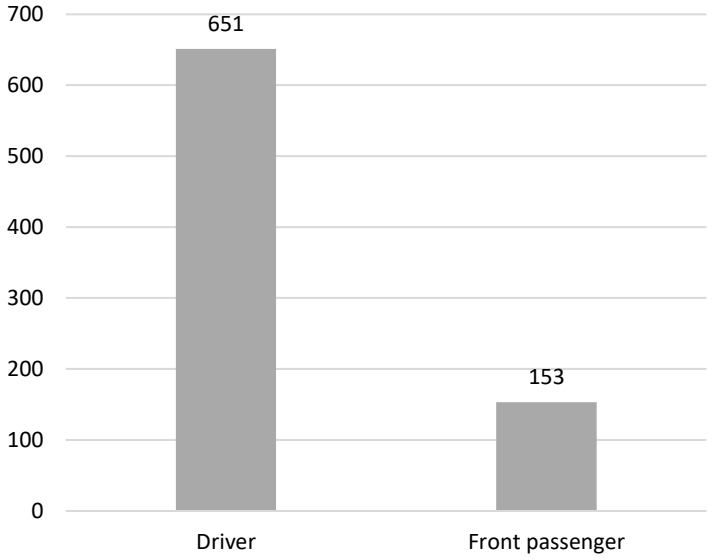
Number of patients according **sex** (n=804)



Number of patients according **age** (n=804)

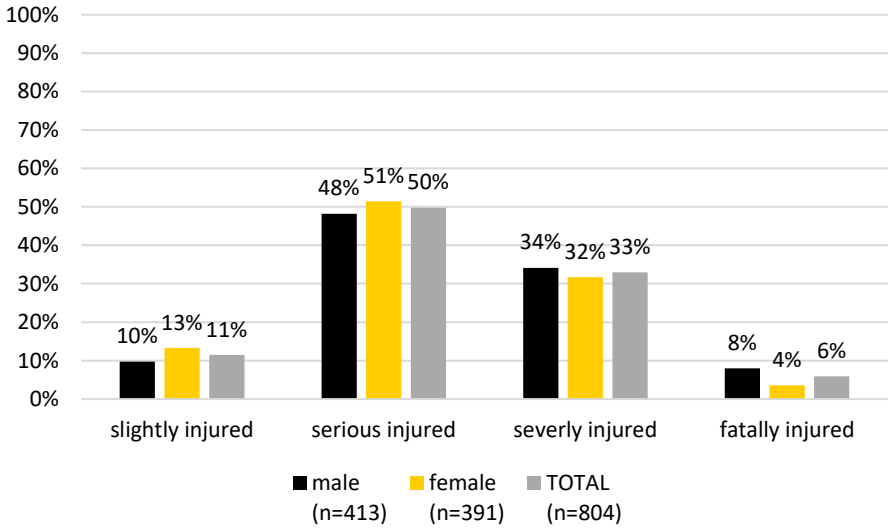


Number of patients according **seat position** (n=804)

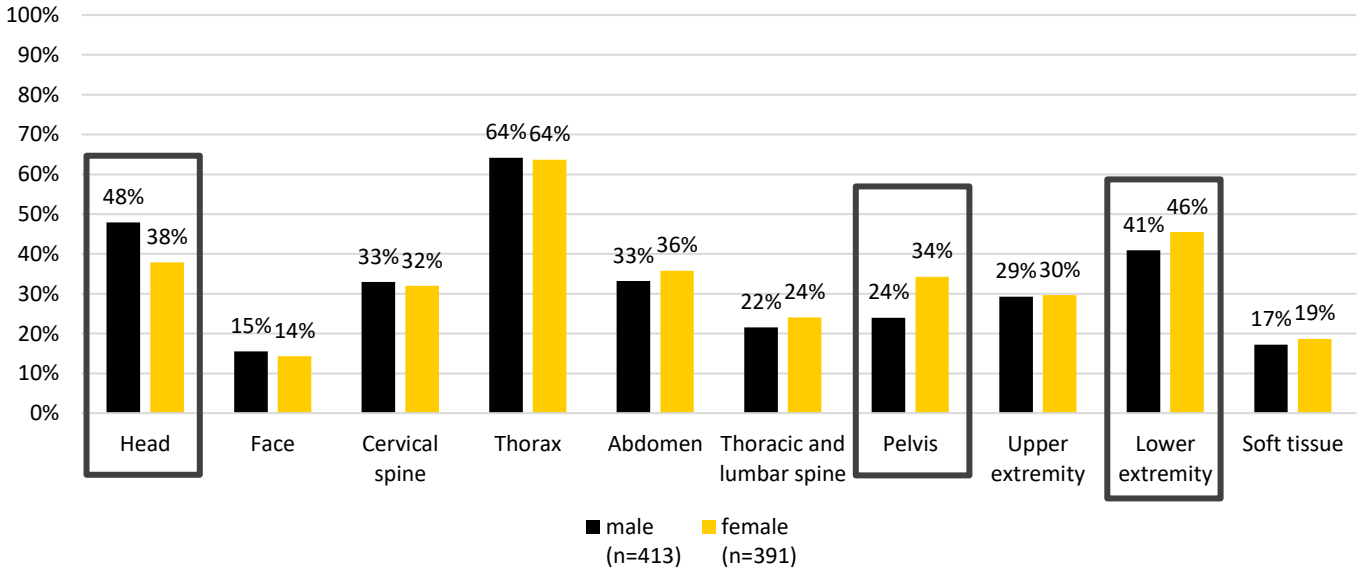


Accident data analysis
female vs. male

Injury severity of patients in serious traffic accidents by sex

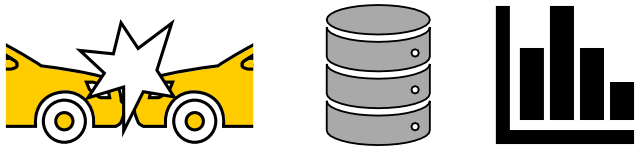


Frequency of trauma depending on the patient's sex

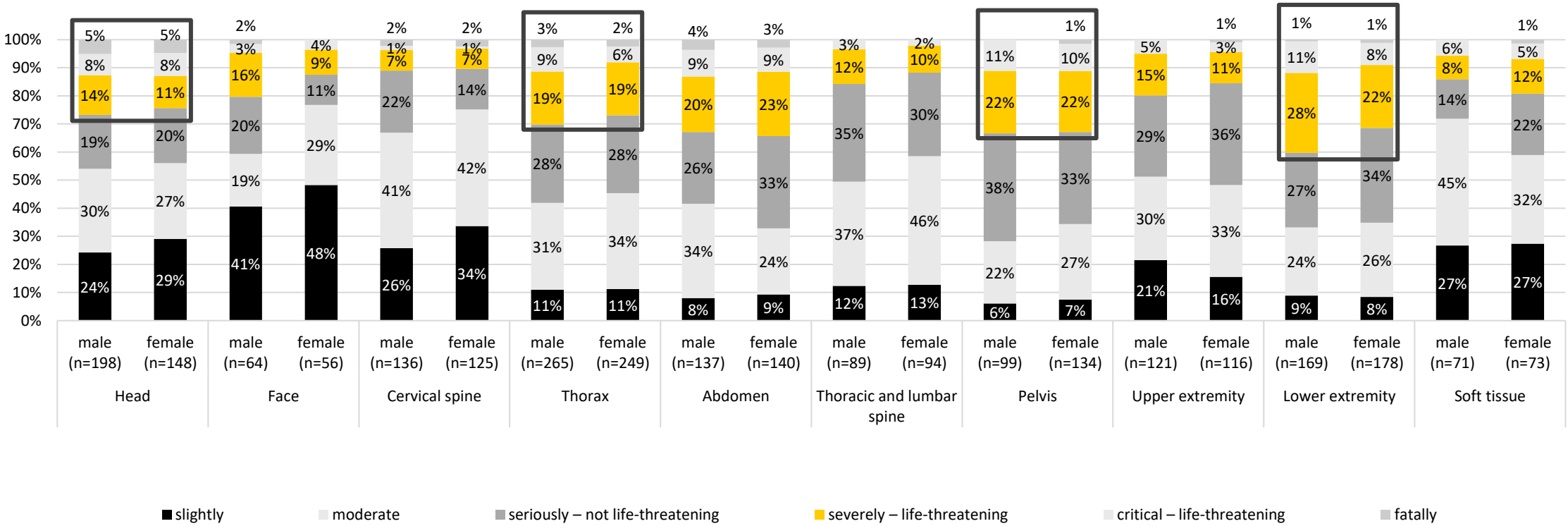


Accident data analysis

female vs. male

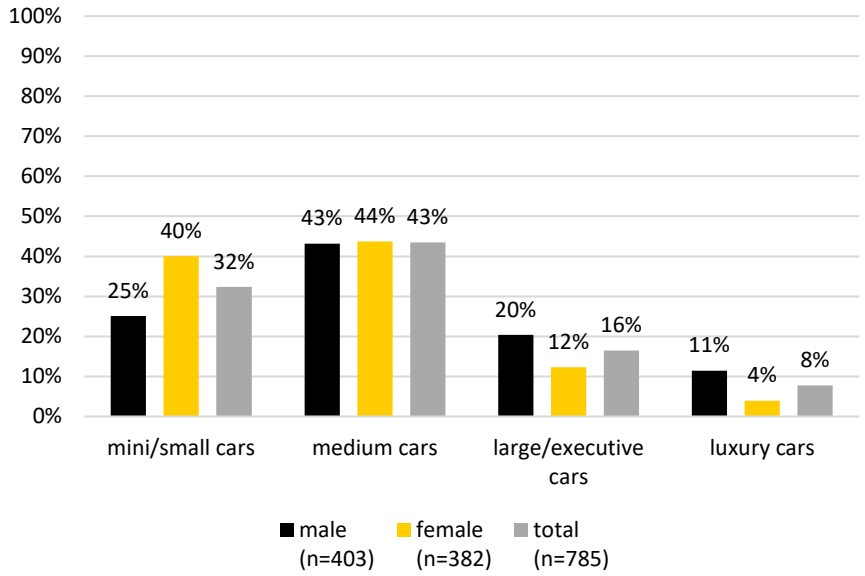


Percentage frequency of trauma severity per body region per gender

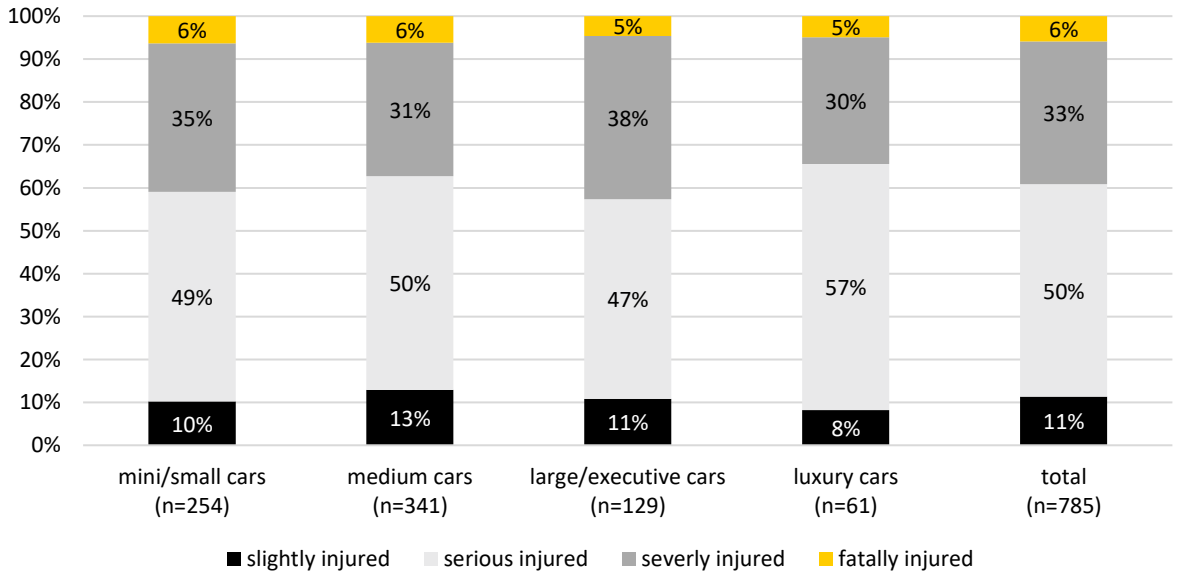


Accident data analysis
female vs. male

Vehicle class of the injured occupants by sex

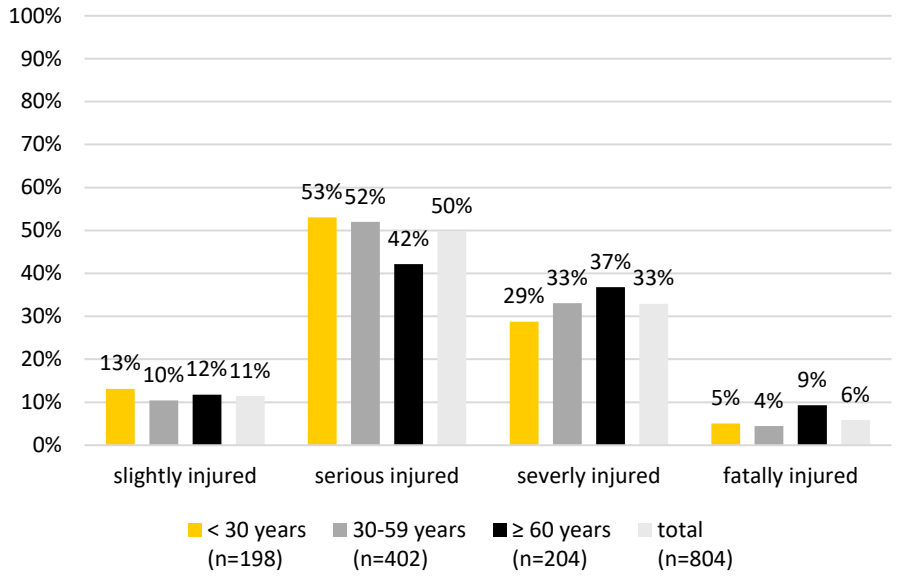


Injury severity of the occupants depending on the vehicle class

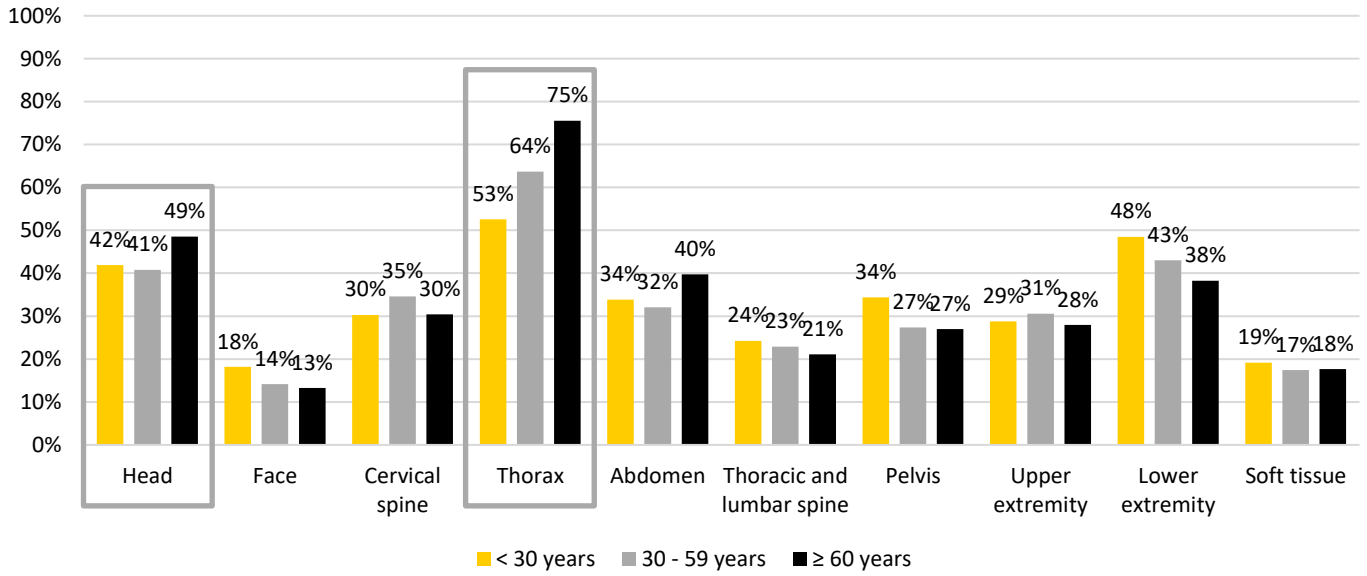


Accident data analysis
young vs. elderly

Injury severity of occupants by age

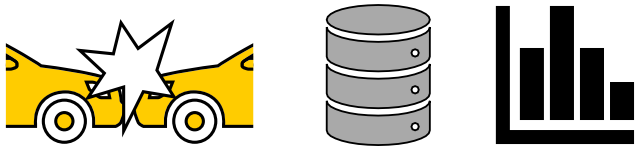


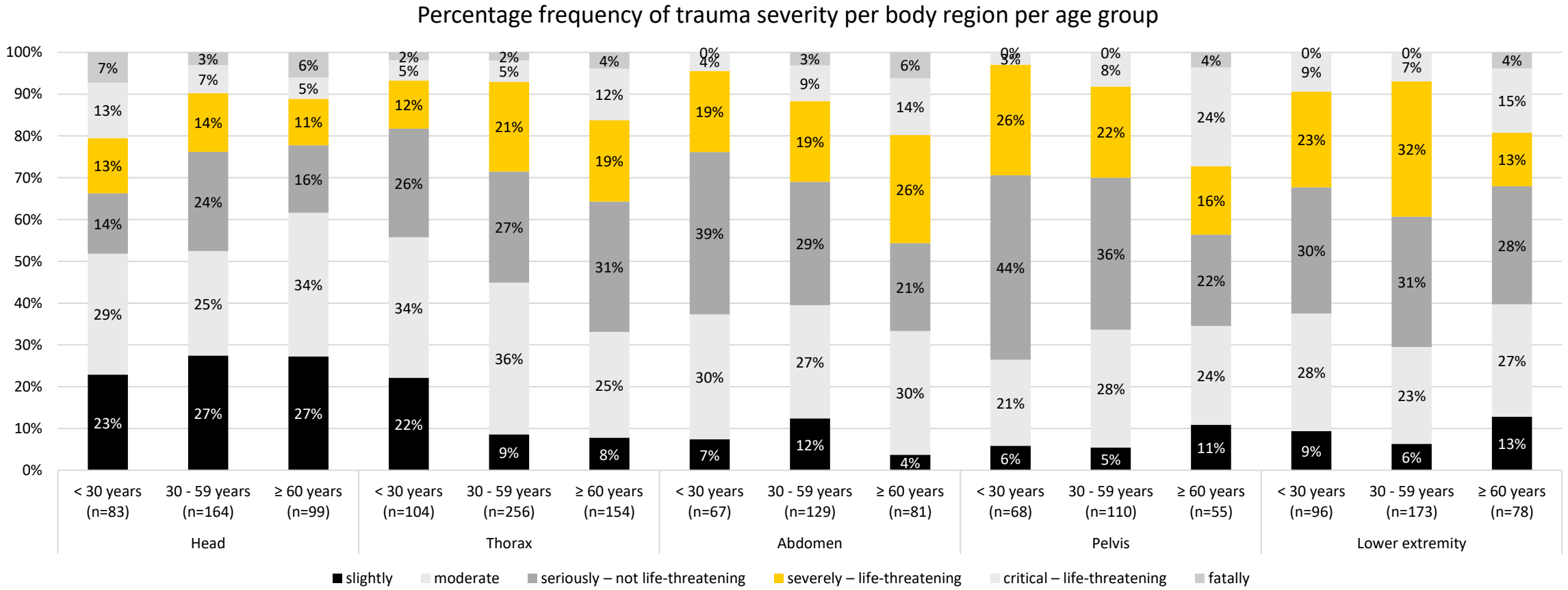
Frequency of trauma depending on the patients's age



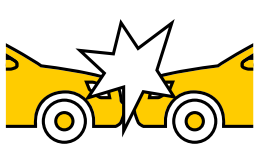
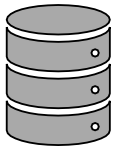
Accident data analysis

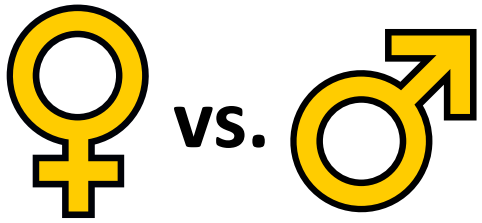
young vs. elderly





Summary accident data analysis

The accident data do **not** indicate an **increased risk of injury for women or men**.

Different injury patterns can be identified, which can be attributed to the **physiological differences**.

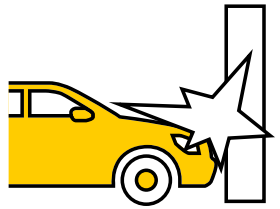
Young vs. Elderly

Older car occupants have a higher risk of injury than younger ones.

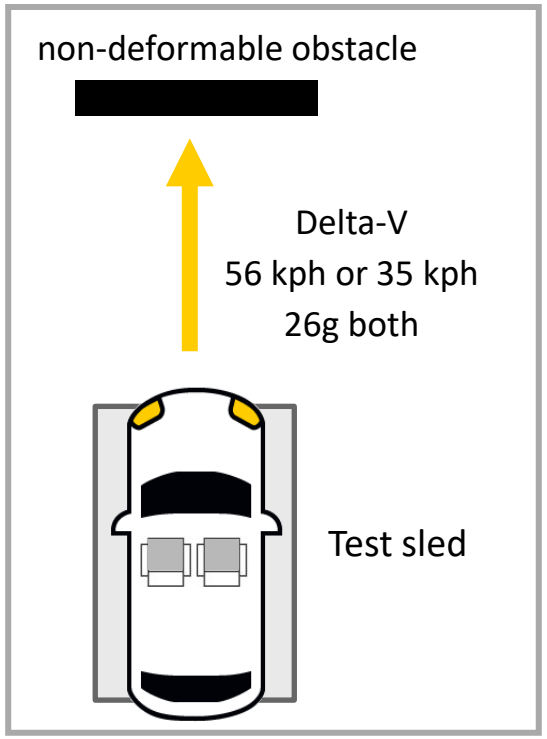
Injuries to the **head, abdomen and pelvis** are more common.

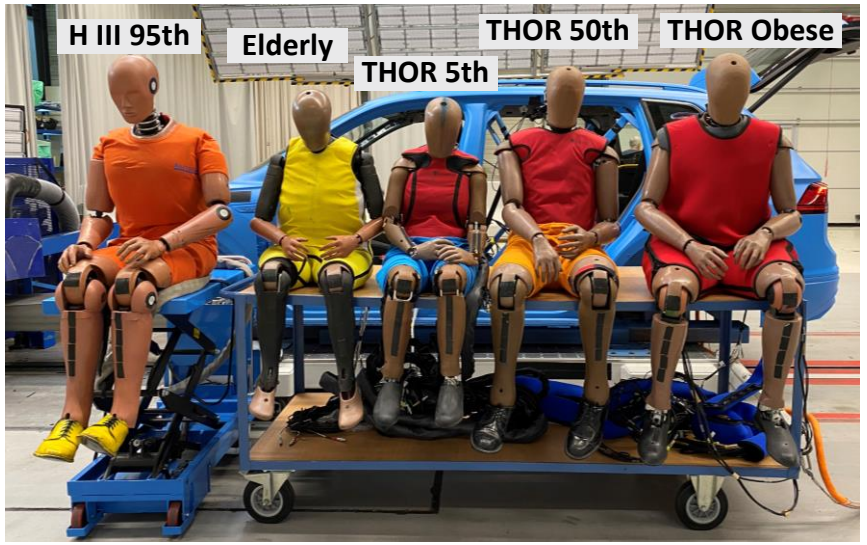
This can be attributed to the **higher vulnerability** by increasing age.

Crash tests with different dummies and restraint systems

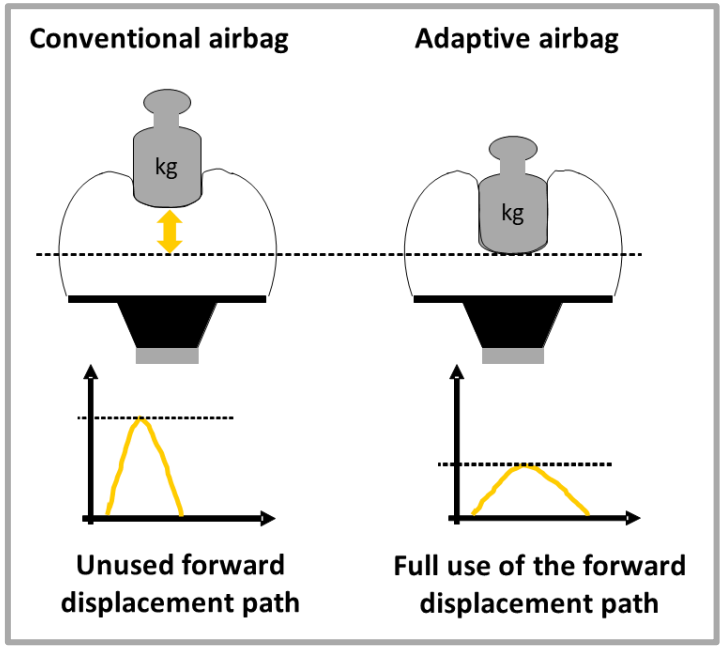


Type of crash test → Dummies → Restraint systems





Dummy	THOR 5th	Elderly ATD	THOR 50th	H III 95th	THOR Obese
Weight	48 kg	73 kg	77 kg	101 kg	125 kg
Height	1,51 m	1,61 m	1,75 m	1,91 m	1,88 m

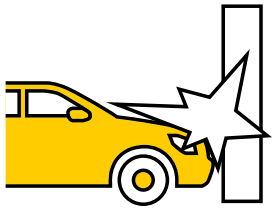


Test schedule

No.	Dummy Driver	Dummy Co-Driver	Restraint system	Crash pulse	Delta-V
1	THOR 50th	THOR 5th	conventional	Full Width	56 kph
2	THOR 5th	Elderly ATD	conventional	Full Width	56 kph
3	Elderly ATD	H III 95th	conventional	Full Width	56 kph
4	H III 95th	THOR Obese	conventional	Full Width	56 kph
5	THOR Obese	THOR 50th	conventional	Full Width	56 kph
6	THOR 50th	THOR 5th	adaptive	Full Width	56 kph
7	THOR 5th	Elderly ATD	adaptive	Full Width	56 kph
8	Elderly ATD	H III 95th*	adaptive	Full Width	56 kph
9	H III 95th*	THOR Obese*	adaptive	Full Width	56 kph
10	THOR Obese*	THOR 50th	adaptive	Full Width	56 kph
11	Elderly ATD	THOR 5th	conventional	Full Width	35 kph
12	Elderly ATD	THOR 5th	adaptive	Full Width	35 kph

** The sled test was not carried out with adaptive restraint systems, as conventional RHS have a higher protection potential for this dummy due to the design especially for the tests carried out.*

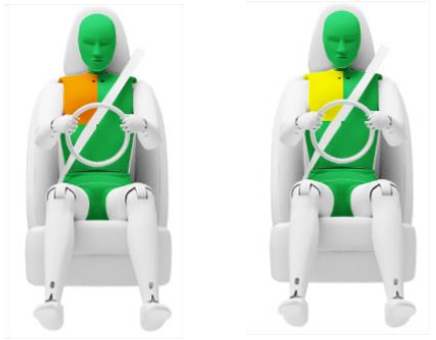
Results of the crash tests and the study



- Carrying out **12 sled tests**, with each dummy being a driver and a co-driver. In addition to conventional restraint systems, adaptive restraint systems were also used.
- The comparison between conventional and **adaptive restraint systems** demonstrates that adaptive seat belts and airbags can **reduce the load** on occupants who correspond to the **THOR 50th, THOR 5th and Elderly ATD** dummies during a frontal crash.

THOR 50th - average male

Driver	Driver
conventional	adaptive

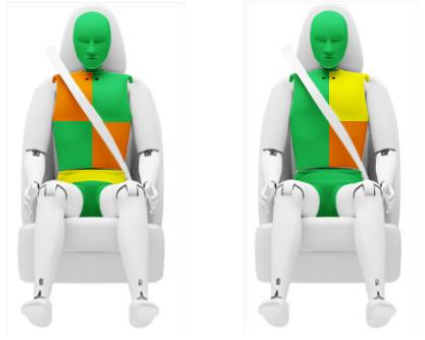


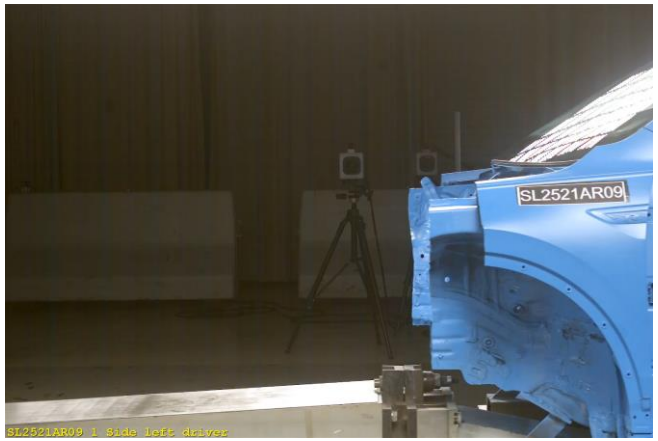
Elderly ATD – elderly lady

Driver	Driver
conventional	adaptive

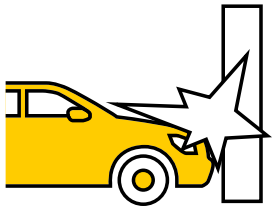
THOR 5th – petite, slim female

Co-Driver	Co-Driver
conventional	adaptive





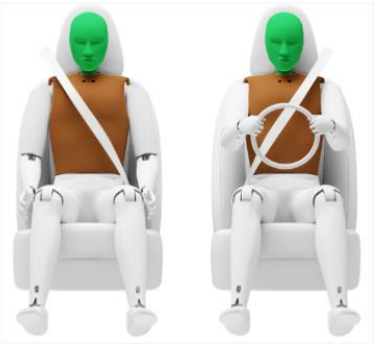
Results of the crash tests and the study



- **Adaptive restraint systems were not used for the THOR Obese and H III 95th** dummies since the adaptive safety systems used in the sled tests cannot adequately restrain the taller and heavier dummies.
- Alternative restraint methods such as **knee airbags** and **multiple seatbelt tensioning** would positively impact the severity of the potential injuries sustained by taller and obese car occupants.

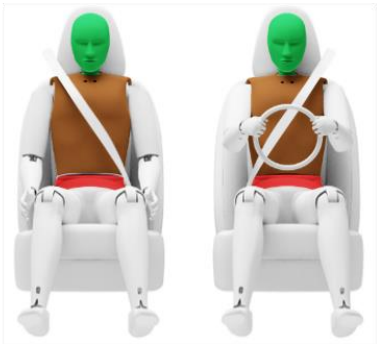
H III 95th - tall male

Co-Driver	Driver
conventional	conventional

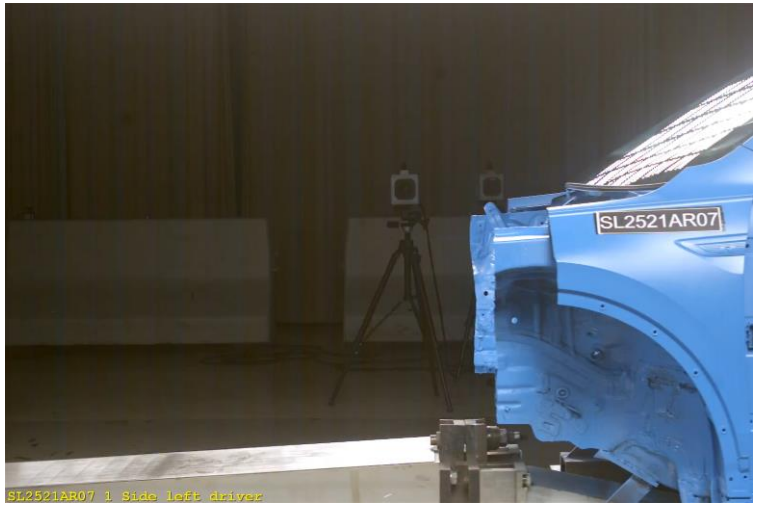


THOR Obese – obese male

Co-Driver	Driver
conventional	conventional



good | adequate | marginal | weak | poor



Remarks

Many thanks to Humanetics for their kind and professional support regarding the sled tests and for providing the dummies!

Thank you!

Ostermaier, Isabella

Project Manager Accident Research, Vehicle Safety

+49 8191 938 656

isabella.ostermaier@adac.de

Otto-Lilienthal-Str. 2 | 86899 Landsberg am Lech, Germany