

Gesamtverband der Deutschen Versicherungswirtschaft e. V.

Effects of Seating Position of Short Stature Drivers in Frontal Impacts

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IRCOBI

Gothenburg

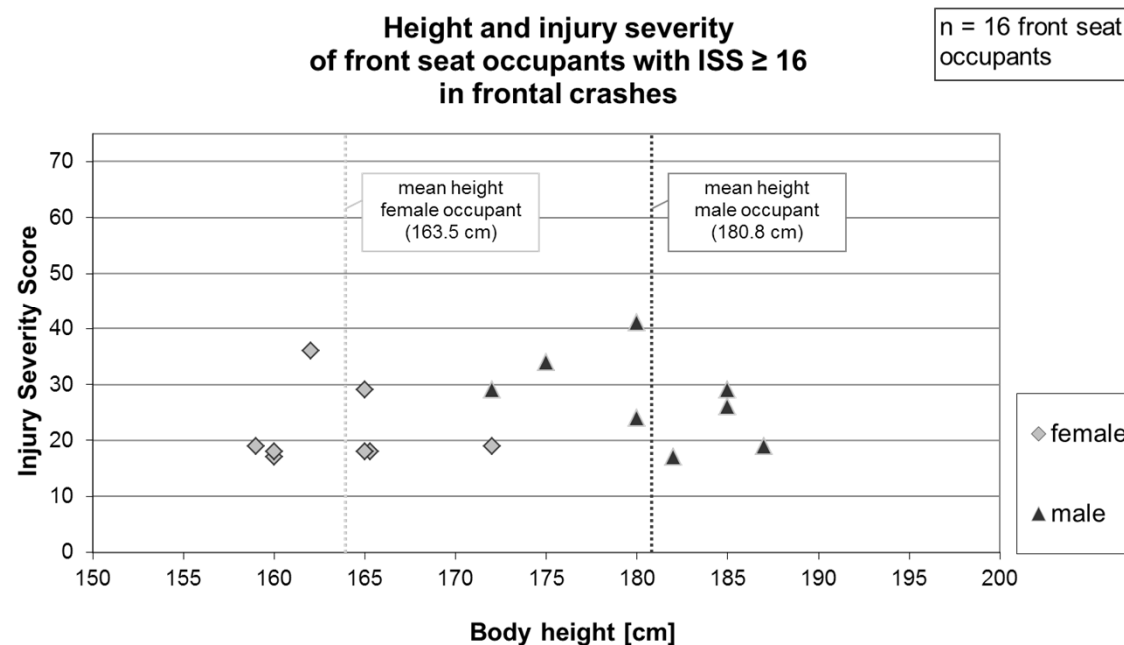
Axel Malczyk

German Insurers Accident Research

Ingo Müller, Stefanie Eßers, Michael Hänsel
Takata, Berlin

Motivation for Study

- Survey of accidents with multiple severe injuries ($ISS \geq 16$) in south German region in 2008
 - Frontal collisions most frequent cause for fatal or critical injuries of car occupants
 - Females with $ISS \geq 16$ appeared to be particularly short



Literature

- USA: Higher risk of lower extremity fractures for women (20% vs. 13%), or small drivers, resp., particularly foot fractures (Dischinger et al., 1995)
- USA: Among belted drivers in NASS data, 3.3% with lower leg injuries AIS 2+; 1.1% with upper leg injuries AIS 2+. Several times higher injury odds for female drivers than male drivers (Austin, 2012)
- U.K.: Injury outcome in relation to driver height showed higher injury risk for head and lower extremities in small drivers (up to 155 cm), but also some taller drivers. Survey of seating positions of 100 small drivers in their own and in reference car revealed closer distance to steering wheel and instrument panel (Welsh et al., 2003)
- U.K.: In post-EuroNCAP cars, female drivers had higher risk of serious injury of lower and upper leg than males, but slightly lower risk of serious thorax injury (Frampton, 2004)

Objective of Study

- **Accident analysis**

Objective: Compare injury risks of short-statured and average height drivers in frontal crashes of modern cars

- GIDAS data (small vs. taller drivers)
- data from study on multiple severe injuries (small vs. taller drivers)
- UDB (German Insurers) accident database (female vs. male drivers)



Source: Fire department

- **Field study**

Objective: Determine seating position and posture of short-statured and average height drivers in modern cars

- size of current German adult population
- measurements of drivers in their own vehicle
- driver interviews



Accident Analysis – Methodology

- **GIDAS**

Focus on serious and severe injuries in frontal impacts;

small vs. taller drivers:

- frontal crash
- belted driver
- MAIS 3+, known height

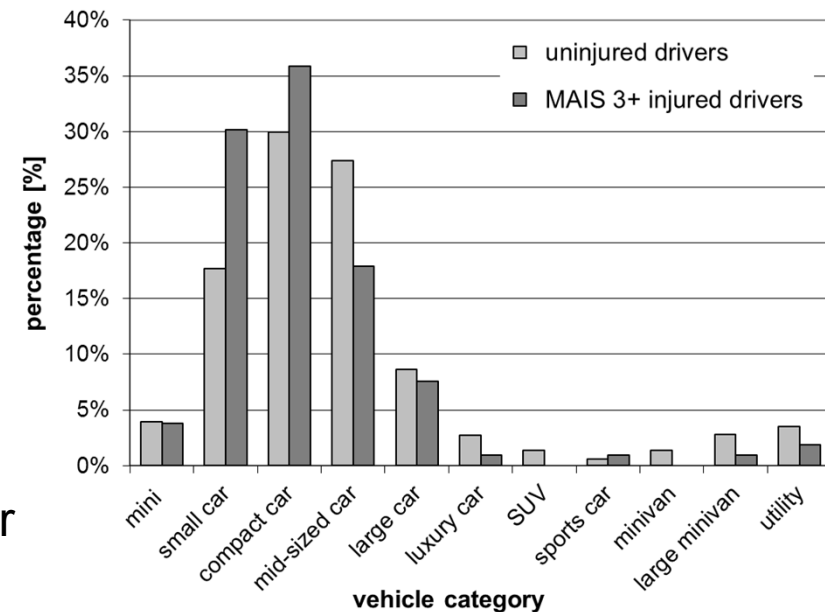
⇒ 113 cases

with further constraints:

- Δv 20 – 70 kph
- subcompact or compact pass. car
- driver airbag deployed

⇒ 19 cases:

- 7 drivers \leq 170 cm („small driver“)
- 12 drivers $>$ 170 cm („taller driver“)



Accident Analysis – Methodology, cont'd

- **Survey of crashes with multiple severe injuries**

Focus on serious and severe injuries in frontal impacts;
small vs. taller drivers:

- frontal crash
- belted driver
- MAIS 3+; known height
- passenger car of any category
- driver airbag deployed

⇒ 14 cases:

- 8 drivers \leq 170 cm („small driver“)
- 6 drivers $>$ 170 cm („taller driver“)

Accident Analysis – Methodology, cont'd

- **UDB (database of Insurers Accident Research)**

Focus on all injury severity levels in frontal impacts; female vs. male drivers:

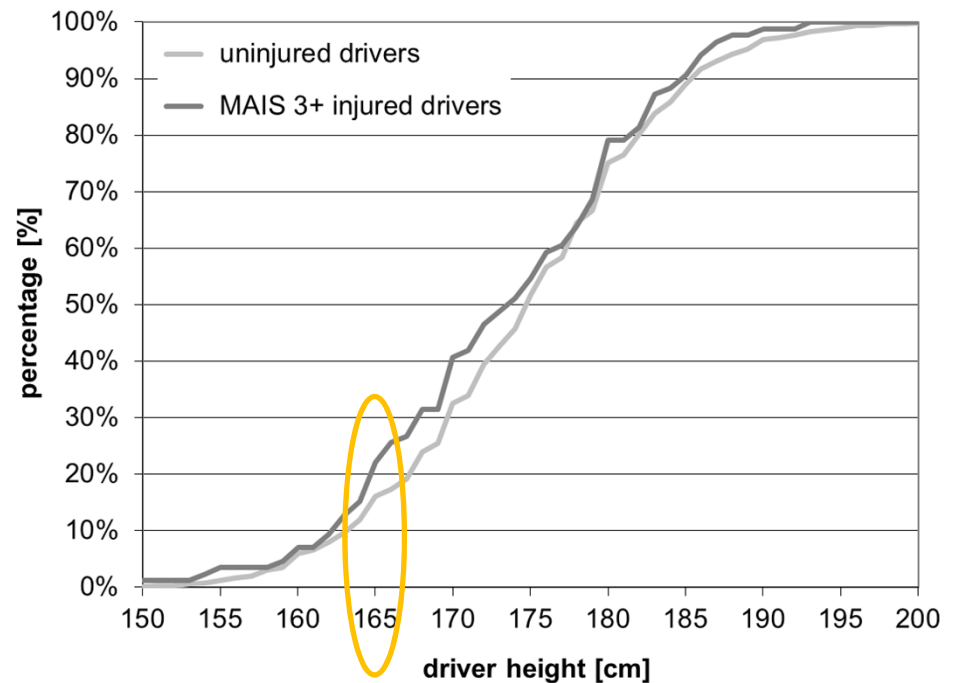
- frontal crash
- belted driver
- any driver injury severity
- passenger car of any category
- driver airbag deployed

⇒ 609 cases:

- 192 female drivers
- 417 male drivers

Accident Analysis – Results

- **GIDAS data** [material: MAIS 3+ vs. uninjured]
 - 113 belted drivers w. MAIS 3+, regardless of airbag protect. and pass. car category
 - minor difference to height distribution of uninjured drivers in GIDAS

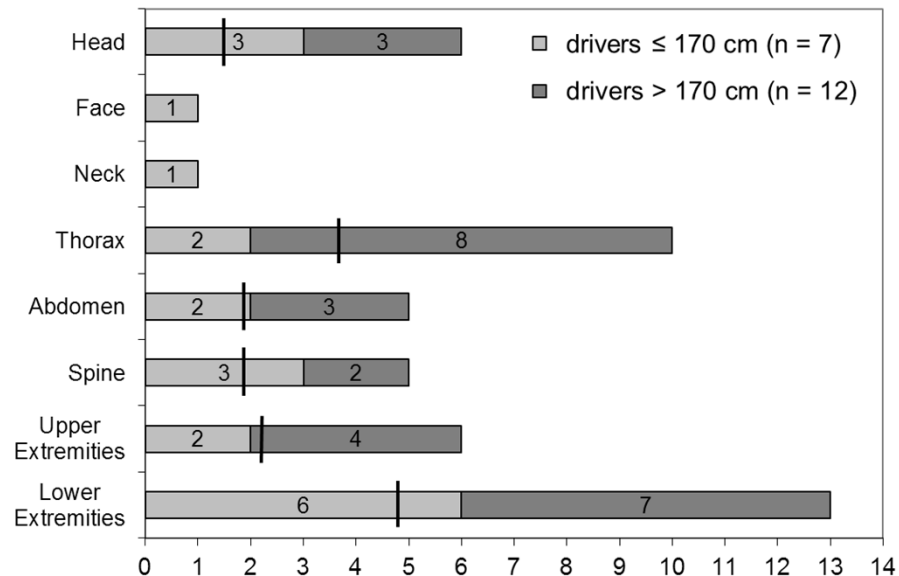


Accident Analysis – Results, cont'd

- **AIS 2+ injury levels by body region [material: MAIS 3+ injured]**

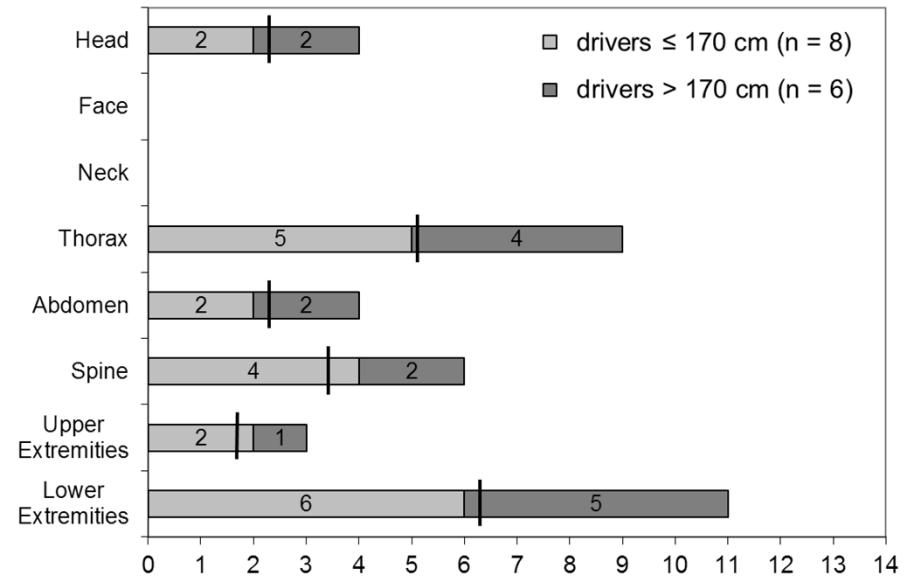
GIDAS

Number of drivers with injuries AIS 2+ per body region, small and compact cars



Crashes with multiple severe injuries

Number of drivers with injuries AIS 2+ per body region, cars of all categories



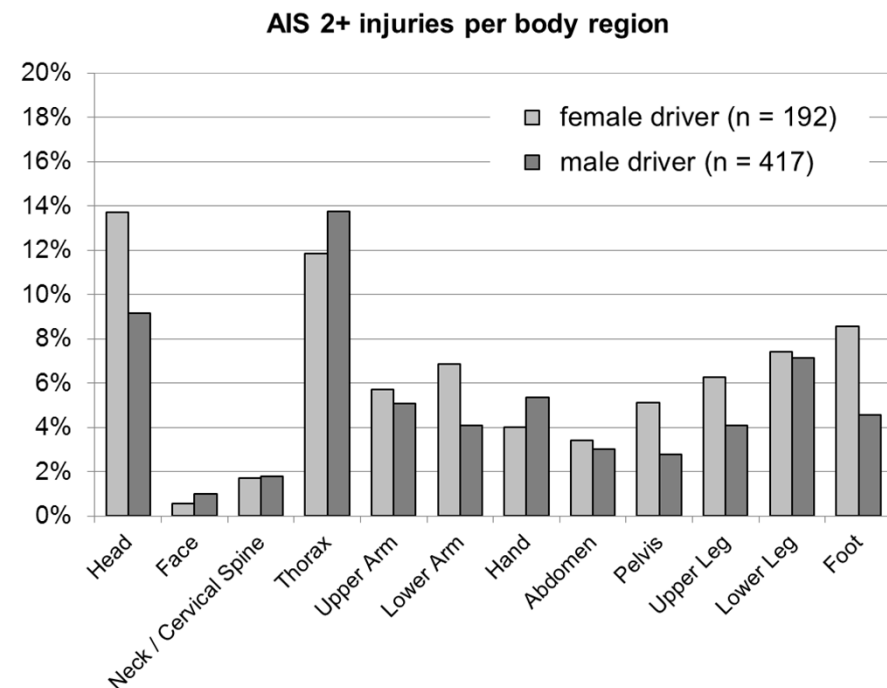
- similar distribution: focal points on lower extremities, thorax
- minor differences in injury risk; small drivers slightly over-represented in spine, taller drivers in thorax (small case numbers !)

Accident Analysis – Results

- **UDB (Insurers Accident Database)** [material: all injury severity levels]

Characteristics of female and male drivers:

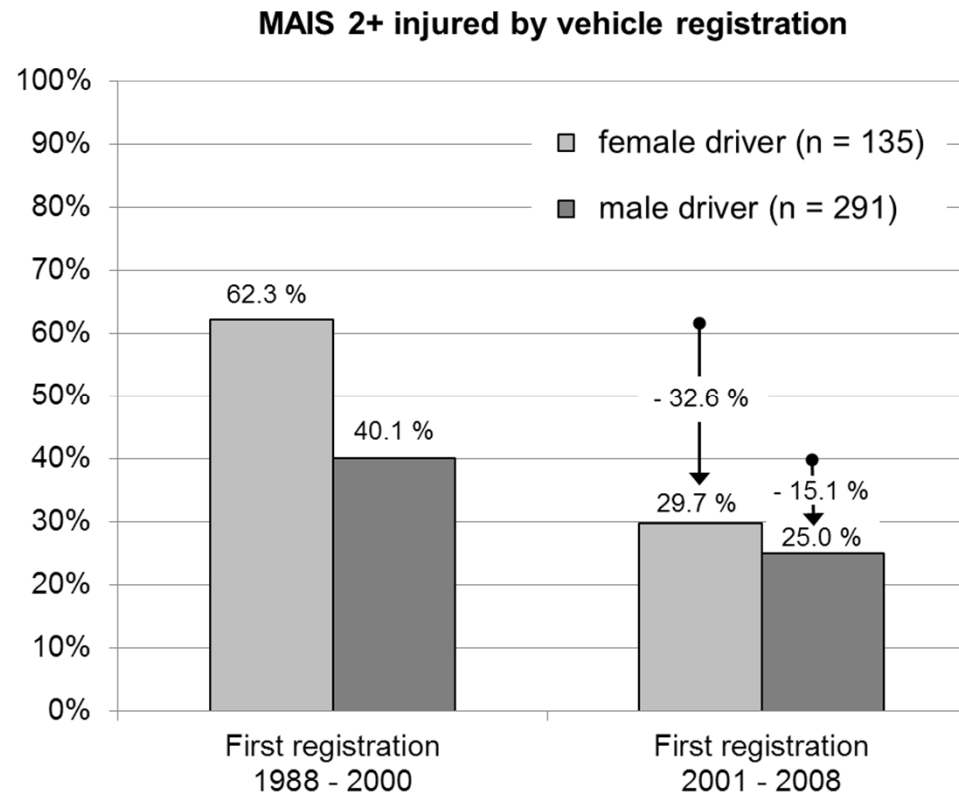
		female	male
driver	Ø age	39.6 yrs.	44.8 yrs.
vehicle	Ø curb weight	1,209 kg	1,335 kg
	Ø year of registration	2000.8	2000.2



- females drive lighter (\Rightarrow smaller) cars, but not older cars
- female drivers with higher proportion of AIS 2+ injuries to head, lower extremities, esp. to feet, but smaller share of thorax injuries

Accident Analysis – Results, cont'd

- **UDB (Insurers Accident Database)** [material: all injury severity levels]



- MAIS 2+ injury risk decreased in younger vehicles
- female drivers with larger benefit from this development

Field Study – Methodology

- **Height of general adult population in Germany**

Anthropometric data from

- German Institute for Standardisation (DIN)
- research project for textile and automotive industry (SizeGermany)

		DIN 33402-2 (2005)	Size-Germany (2009)	Hybrid III theoretical erect height
female	5th percentile			150 cm
	50th percentile	163 cm	165 cm	
	95th percentile	172 cm		
male	5th percentile	165 cm		
	50th percentile	175 cm	179 cm	175 cm

Field Study – Methodology, cont'd

- **Measurement of driver posture in passenger car**

Focus on similarity and comparability of vehicle environments:

- only drivers of compact or small cars recruited
- three, resp. two, compact and small car models of single OEM, to ensure similar interior architecture
- models represented > 20% of German market share in 2011
- drivers arrived and were measured in own car

	Small drivers (experimental group)	Taller drivers (control group)
definition	height \leq 165 cm	175 \leq height \leq 183 cm
no. of particip.	30	35
Ø height	162 cm	179 cm
Ø age	45.9 yrs.	42.7 yrs.

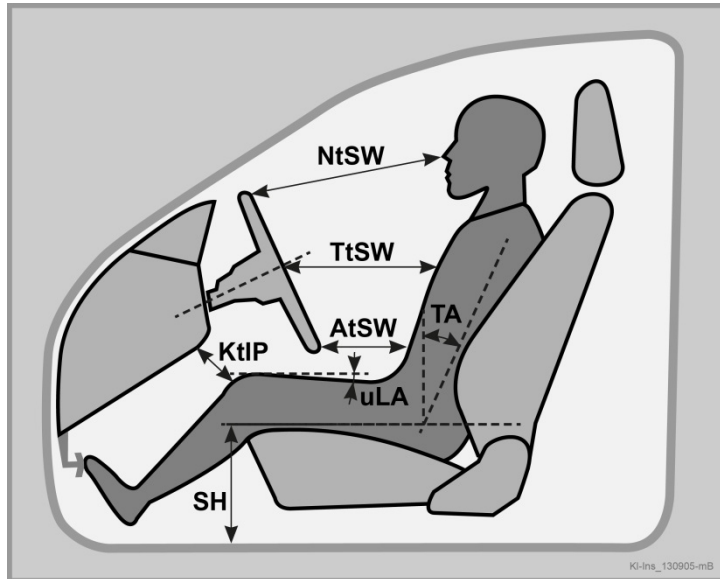
Field Study – Methodology, cont'd

- **Measurement of driver posture in passenger car**
 - measurement in own car, adjustments (seat height and track, recliner, steering column, belt height) unchanged
 - driver photographed on stool outside of car
 - interview and questionnaire



TAKATA	
<p>Liebe Teilnehmerin, lieber Teilnehmer,</p> <p>Im folgenden Fragebogen möchten wir Ihnen über die Gestaltung Ihres Arbeitsortes und über Ihre Zufriedenheit mit den Möglichkeiten der Einstellung erfahren. Wir bitten Sie den folgenden Fragebogen anschließend für die Bewertung Ihrer eigenen Einstellung oder Ihrer Arbeitsstelle auszufüllen.</p>	
<p>Einstellung des Fahrer/Steuerleiters</p>	
<p>Bitte kreuzen Sie Zufriedenheit an (bestimmte Antworten möglich)</p>	
<p>Welche Einstellungspunkte für Ihren Arbeitgeber (Steuerleiters/Beschäftigten)?</p>	
<p><input type="checkbox"/> Zufriedenheit</p> <p><input type="checkbox"/> Unzufriedenheit</p> <p><input type="checkbox"/> Keine Angabe</p>	<p><input type="checkbox"/> Keine Angabe</p> <p><input type="checkbox"/> Unzufriedenheit</p> <p><input type="checkbox"/> Zufriedenheit</p>
<p>Welche Einstellungspunkte für Ihre Tätigkeit (als Fahrer/Steuerleiter)?</p>	
<p><input type="checkbox"/> Zufriedenheit</p> <p><input type="checkbox"/> Unzufriedenheit</p> <p><input type="checkbox"/> Keine Angabe</p>	<p><input type="checkbox"/> Keine Angabe</p> <p><input type="checkbox"/> Unzufriedenheit</p> <p><input type="checkbox"/> Zufriedenheit</p>
<p>Bitte kreuzen Sie Ihre Einstellung an (bestimmte Antworten möglich)</p>	
<p>Wie zufrieden sind Sie mit der Gestaltung Ihres Arbeitsortes?</p>	
<p><input type="checkbox"/> Sehr unzufrieden</p> <p><input type="checkbox"/> Unzufrieden</p> <p><input type="checkbox"/> Zufrieden</p> <p><input type="checkbox"/> Sehr zufrieden</p>	<p><input type="checkbox"/> Sehr unzufrieden</p> <p><input type="checkbox"/> Unzufrieden</p> <p><input type="checkbox"/> Zufrieden</p> <p><input type="checkbox"/> Sehr zufrieden</p>
<p>Wie zufrieden sind Sie mit der Gestaltung Ihrer Tätigkeit?</p>	
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<p>Bitte beschreiben Sie Ihre Arbeitsstelle (als Fahrer/Steuerleiter) in 3-5 Zeilen.</p>	
<p>_____</p> <p>_____</p> <p>_____</p>	

Field Study – Results



dimensions with significant differences shown

difference between
Ø value experiment. and
Ø value control group

Nose to Steer. Wheel	- 6.2 cm
Thorax to Steer. Wheel	- 6.7 cm
Abdomen to Steer. Wheel	- 7.8 cm
Knee to Instrument Panel	- 2.5 cm
upper Leg Angle	- 6.7°
Torso Angle	+ 4.9°
Seat Height	+ 2.0 cm

small driver, 153 cm
forward posture



small driver, 164 cm
rearward posture



- small drivers closer to steer. wheel, airbag and instr. panel ($p < 0.001$)
- nevertheless, large variance in seating posture among small drivers
- except for seat height, adjustment features not used

Field Study – Results, cont'd

Small driver (152 cm)
in ca. mean position
of experiment. group



„Small female“
Hybrid III (150 cm)
in ca. mean position
of experiment. group



„Small female“
Hybrid III (150 cm)
in position accord. to
FMVSS 208

- small drivers tend to „slouch“ in their seat to reach control pedals
- FMVSS 208 position appears more upright than real small drivers

Summary / Conclusions: Accident Analysis

- Analysis of MAIS 3+ injured drivers, belted and protected by airbag, confirms that AIS 2+ injuries most frequently in lower extremity region
- No particularly higher injury risk for small drivers (small drivers defined as ≤ 170 cm; limited number of cases!)
- In Germany, women tend to drive smaller cars than men
- Recent frontal protection improvements appear to benefit especially female drivers

⇒ Open issues:

- Not clear whether being female or being small or driving small car has more effect on injury outcome
- Do EuroNCAP requirements increase protection of small drivers, though not part of current test suite?

Summary / Conclusions: Field Study

- Confirms earlier studies' findings that small drivers sit closer to steering wheel and instrument panel
- Studies on seating position recommended in similar vehicle environments
- Large variance of postures among small drivers
- Pedal position determines seating posture to large degree
- Many adjustment features not known or used by drivers

⇒ Open issues:

- Are (power) adjustable pedals better solution for small drivers?
- Does FMVSS 208 placement procedure of „small female“ dummy reflect reality ?



Source: askcars.com

Thank you for your attention!

Contact:

Axel Malczyk

Unfallforschung der Versicherer (UDV)

German Insurers Accident Research

a.malczyk@gdv.de