

# Workshop on Field Data

## Informal Working Group on Equitable Occupant Protection

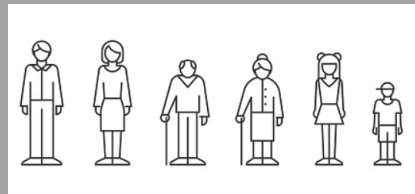
EqOP IWG

# EqOP Approach

## 0.) Field data study



Identify which loading scenarios in the field cause significant differences in injury risks for different groups of the population and review how those are currently assessed in regulations



- gender
- age
- body height
- BMI

EqOP IWG

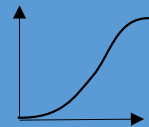
## 1.) Use available tools (already currently used in regulations) to address problems identified in 0.)

Change wordings in regulations

Change requirements in regulation with available tools:



a) Change what is required / voluntary?



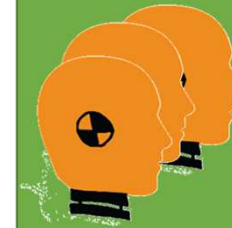
b) Change injury criteria



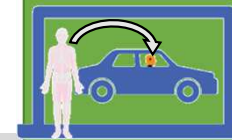
c) Change test conditions (speed, barrier, angle...)

## 2.) Use alternative test tools to address problems identified in 0.)

Which injury mechanisms can be predicted additionally compared to currently available tools, where problem in the field are observed?



Which alternative physical test tools are suitable for this?



What can be simulated what currently can't be tested?

## Goal for workshop - ToR

Present a map of diversity issues which should be addressed by regulatory upgrades directly vs gaps where more research is needed.

To be presented in Dec 2023 at GRSP.

## Aim of the review of the working table

- Prepare version of the working table which can be uploaded to UN Wiki of our IWG (supposed to be a living document)
- To Do: Fill in remaining empty cells (marked light red) and finalise review
- All eyes are needed to ensure we got everything right

# Key take away messages from field data studies

- Injury risk depends on
  - crash severity
  - vehicle crashworthiness (e.g., rating result, vehicle size, age of the vehicle (market introduction))
  - seat position (driver vs. passenger / front vs. rear)
  - age of occupant
  - BMI of occupant
  - gender / sex
  - stature of occupant (only available in a few studies)
- Relevance different for different injury and crash types (not one group at highest risk in general) and statistical models applied
- Interaction of parameters often different for females and males
  - Difference between males and females more often reported for younger groups, age distribution for fatality injured occupants
  - Interaction of BMI and gender (different body shapes, fat distributions, belt fits)
  - Crash severity (females more likely to be in smaller and struck car) → **Compatibility not part of the IWG work**
  - Females more likely to be passenger (front and rear)

# Summary of Equity Issues (1/2)

Head injuries – different conclusions in different studies; further review also with simulation studies required (many interacting factors and different injury types)

- Significant higher head injury risk for females (Abrams and Bass, 2022 for AIS2+, 3+ and fatalities; Craig et al., 2023 for AIS2+)
- Significant higher risk for brain injuries for females (Antona-Makoshi et al., 2018; Forman et al., 2019)
- Significant higher risk for males (Craig et al., 2023 for AIS3+; Nutbeam et al., 2022 for trapped; Wallbank et al., 2023 for AIS2+ in frontal; Forman et al., 2019 for skull fractures); Higher risk for males (Ostermaier, 2021)
- No significant differences between females and males (Kullgren et al, 2020; Forman et al., 2019 for AIS 4+ brain injuries – BMI and age significant)
- The probability of head injuries decreases for male drivers versus car model year (Ryan and Knodler, 2022)

Neck injuries: several studies agree on higher risk for females

- several studies agree on higher risk for females for (soft tissue) neck injuries; it seems that females have not benefitted as much from protective systems as males with higher risks for younger group (Kullgren et al., 2020 Kullgren et al., 2023, Linder et al, 2032, Kullgren et al., 2010)
- For AIS2+ and AIS3+ significant higher risks for males + significant effect of age shown in the recent NHTSA study (Craig et al., 2023); Extremity injuries (frontal crashes)
- For trapped occupants, significant higher odds of dens fractures (C2) for females (Nutbeam et al., 2022)

Spine: different conclusions in different studies; further review also with simulation studies required (different injury types)

- Higher risk for older occupants (Kullgren et al., 2020; Craig et al., 2023)
- Significant higher risk for females
  - for the spine in general and specifically spinal cord injuries and compression fractures in trapped incidents (Nutbeam et al., 2022);
  - For AIS2+ and AIS3+ thoracolumbar injuries (Craig et al., 2023)
- No significant difference for females compared to males (Kullgren et al., 2020)

# Summary of Equity Issues (2/2)

Thoracic injuries: several studies agree on higher risk for older occupants

- Significant higher risk for older occupants (Kullgren et al., 2020, Craig et al., 2023, Wallbank et al, 2023)
- Smaller odd for high BMI (<30) group – significance not evaluated (Craig et al., 2023)
- Significant higher risk for males (Craig et al., 2023, Nutbeam et al., 2023 for trapped)

Abdominal injuries in frontal crashes - different conclusions in different studies; further review also with simulation studies required:

- Higher risk/odds for females (Abrams and Bass, 2022: for young females, Ryan and Knodler, 2022: for rear-end crashes)
- No difference in risk/odds between females and males (Kullgren et al., 2020; Nutbeam et al., 2022, Wallbank et al., 2023)
- Higher risk/odds for males (Craig et al., 2023)
- Age dependent risk/odds (Craig et al., 2023; Wallbank et al., 2023: in frontal crashes; Abrams and Bass, 2022: interaction with gender)
- BMI dependent risk/odds (Craig et al., 2023: lower odds for BMI 30+, significance not evaluated)

Lower extremities – several studies agree on higher injury risk for females; interaction with BMI reported in recent study by IIHS:

- Higher risk for females (Craig et al., 2023: overall, for foot & ankle, leg (only AIS3+); Kullgren et al., 2020; Ryan and Knodler, 2022; Nutbeam et al., 2022: for pelvis; Ostermaier et al., 2021: overall, pelvis; Brumbelow, 2023: interaction with BMI, Wallbank et al, 2023)
- Higher risk for higher age (Wallbank et al, 2023: only for frontal crashes, Craig et al, 2023)

Upper extremities- studies agree on higher injury risk for females:

- Higher risk for females (Kullgren et al., 2020; Craig et al., 2023)
- Higher risk for older occupants (Craig et al., 2023)
- Higher risk for BMI 30+ occupants (Craig et al., 2023: significance not evaluated)

# Task Forces for further review of studies and regulations

Increase robustness of assessment in general

1.) *TF on Virtual Testing*

2.) TF on rear impact seat assessment with focus on soft tissue neck injuries / whiplash associated disorders

- first presentations at next GRSP (NL + CLEPA)

3.) TF on restraint system requirements

3a) geometric requirements for seatbelt

3b) dynamic testing requirements / restraint system performance

4.) TF on extension of assessments towards currently not considered injury types with high frequency and risk of PMI

4a) Lower extremity injuries in frontal and side impacts

4b) Upper extremity injuries in frontal and side impacts

4c) Brain injuries in frontal and side impacts

4d) Soft tissue neck injuries in frontal and side impacts

5.) TF drafting team on report on equity issues

Continue to work on working table and prepare written report; have a scientifically sound review of literature

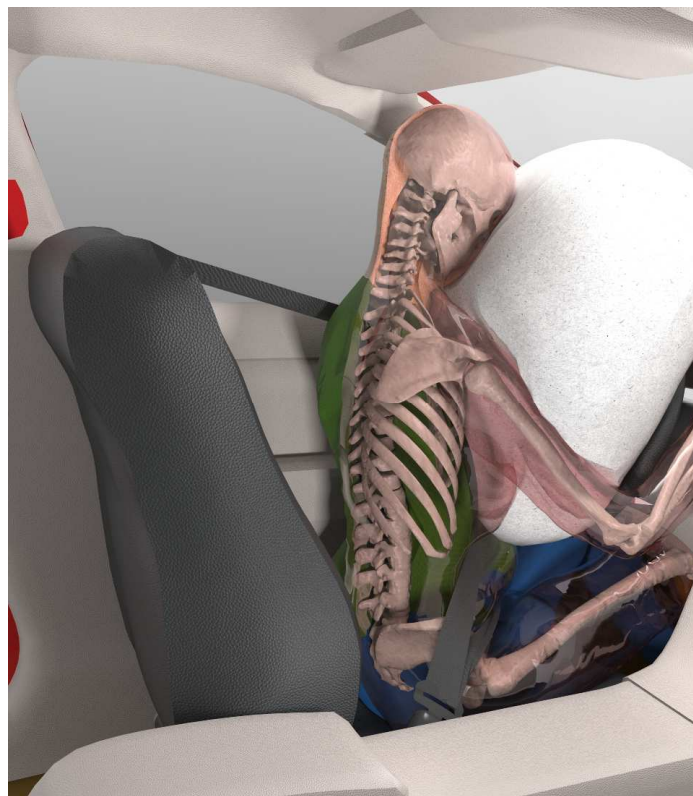


# Research gaps

- Interaction of gender with other parameters
  - Age
  - Anthropometry (height, weight, BMI, Waist-to-Hip Ratio (WHR), Shoulder Height Sitting (SHS))
- How will GTR14 & UNR 137 & UNR 94 affect thoracic injury risk (threshold adjusted to represent 65yo)?
  - US: FMVSS 214
- Equity issues for different head injury mechanism
- Understanding of injury mechanism causing equity issue for ankle
- Missing tools for injuries and sizes which have not been in focus before (e.g. not clear if ankle can be assessed with THOR)
- Missing injury criteria for ankle; No agreement on brain injury criteria
- Pregnant females (currently excluded in most of the studies)
- Analysis of equity issues based on more European Data (could EDR data help here in future?) / Asian data

## Upcoming Workshops / Meetings

- 14.11. – Virtual testing workshop
- In conjunction with IRCOBI (11-13.9.2024) in Stockholm
  - 9+10.9.2024 for Workshop of IWG
- Other ideas?
  - January 2025 in conjunction with GIM (location: Washington DC) – tbc
- Online meetings in between (e.g., in March/ April to prepare May session)



## Vehicle Safety Institute

Graz University of Technology

Inffeldgasse 13/6

8010 Graz Austria

[www.vsi.tugraz.at](http://www.vsi.tugraz.at)