

Prof Astrid Linder

www.projectvirtual.eu

The VIRTUAL project – Open Source Human Body Models and Tools for Virtual Crash Safety Assessment

Event: DEOP
Location: On-line
Date: 17/11/2022



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768960.



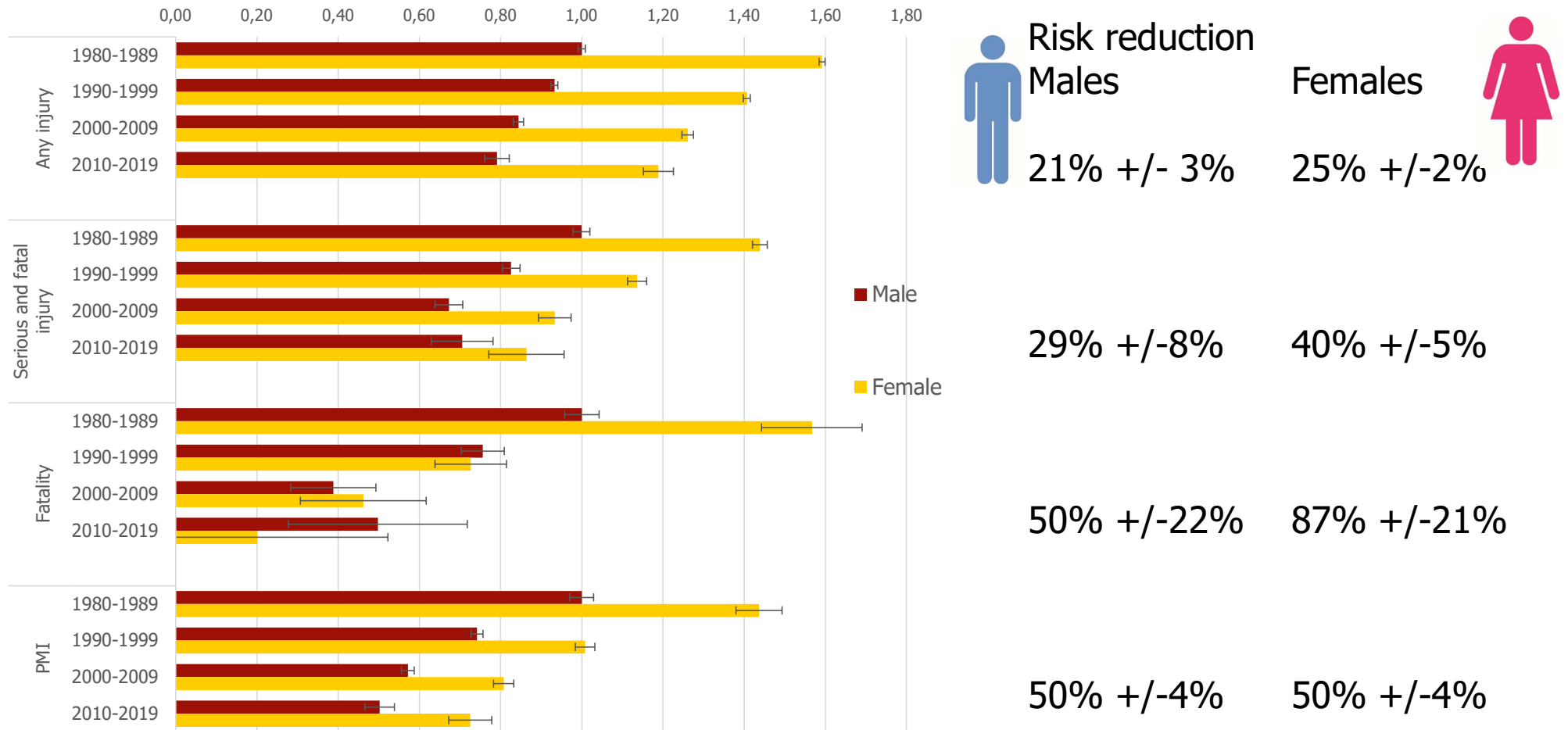
Vision: By 2030, injury protection performances of new cars will be assessed for both women and men!

Benefits:

- Inclusive crash safety assessment
- Best performing innovations identified
- Improved safety for everyone



Development, relative injury risk Folksam



Ref: Kullgren et al. (2020) Developments in car crash safety since the 1980s, IRCOBI Conference, IRC-20-14



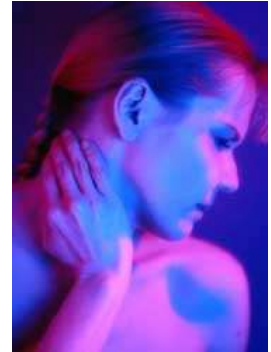
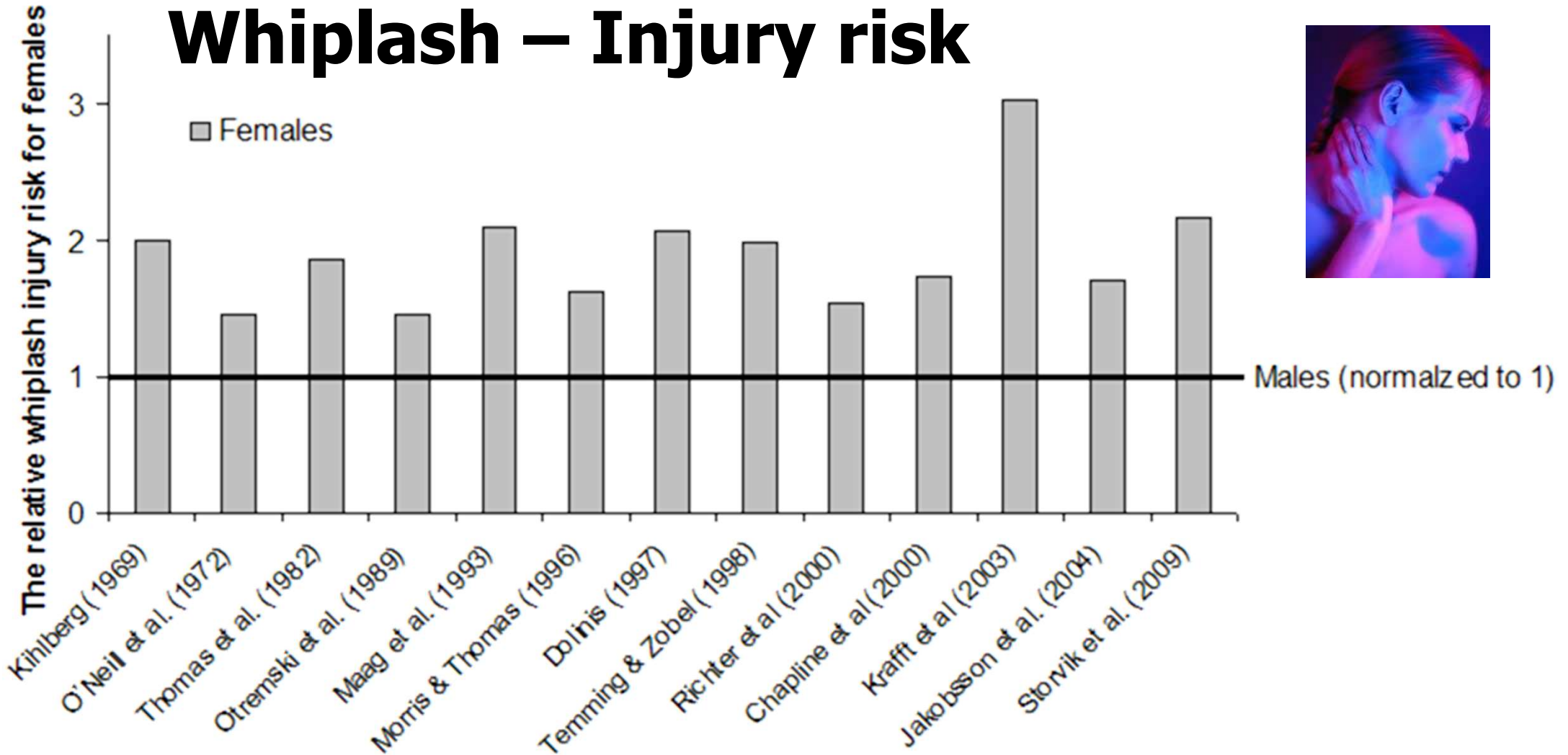
Risk and odds of fatalities and injuries

Reference	Data year/ country	Collision type	Driver/ passenger	Injury /Body part	Female/male
Evans L (2000). Age dependence of female to male fatality risk in the same crash: An independent reexamination. Journal of Crash Prevention and Injury Control 2(2): 111-121.	1984-1996 US	All	Both	Fatal/All	Females: 36.8 % higher risk of injury.
Bedard M, Guyatt GH, Stones JJ, Hirdes JP (2002). The independent contribution of driver, crash, and vehicle characteristics to driver fatalities. Journal of Accident Analysis Prevention 34(6): 717-727.	1975-1998 US	Frontal	Drivers	Fatal/All	Females: 54 % higher risk of fatal injury
Bose D, Segui-Gomez M, Crandall J R (2011). Vulnerability of female drivers involved in motor vehicle crashes: an analysis of US population at risk. The American Journal of Public Health. 101(12), 2368-73.	1998 – 2008 US	Frontal	Belted drivers	MAIS 2+ and MAIS 3+/All	Females: 47% higher odds of MAIS 2+ and 71% higher odds MAIS 3+
Parenteau CS, Zuby D, Brolin KB, Svensson MY, Palmertz C, Wang SC (2013). Restrained male and female occupants in frontal crashes: Are we different? International Research Council on Biomechanics of Injury (IRCOBI), Gothenburg, Sweden.	1997-2011 US	Frontal	Both/ Belted	MAIS 3+ /All	Females: higher risk of spine, thorax and extremity injuries.
Forman J, Poplin GS, Greg Shaw C, McMurry TL, Schmidt K, Ash J, Sunnevang C. (2019). Automobile injury trends in the contemporary fleet: Belted occupants in frontal collisions. Traffic Injury Prevention 20, 607-612.	1998–2015 US	Frontal	Belted drivers	MAIS 2+ and MAIS 3+/All	The odds ratio for females: 2.4 higher for MAIS 2+ and 1.7 for MAIS 3+

Abbreviated Injury Scale (AIS) scale from AIS 1 to 6, AIS 1 is a minor injury, AIS 6 an unsurvivable injury.

MAIS 2+: all injuries from grade AIS 2 to killed. MAIS 3+: all injuries from grade AIS 3 to killed

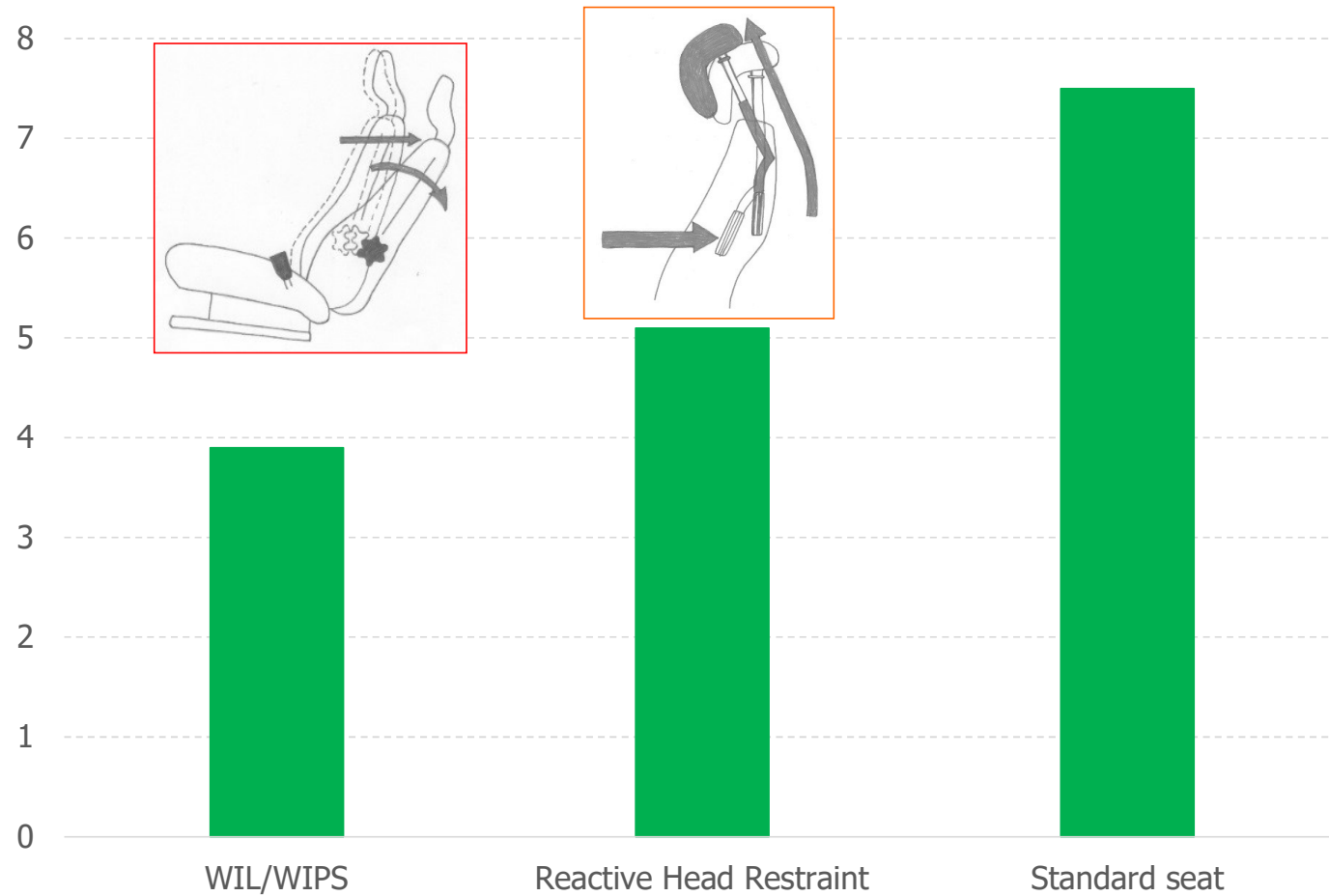
Whiplash – Injury risk



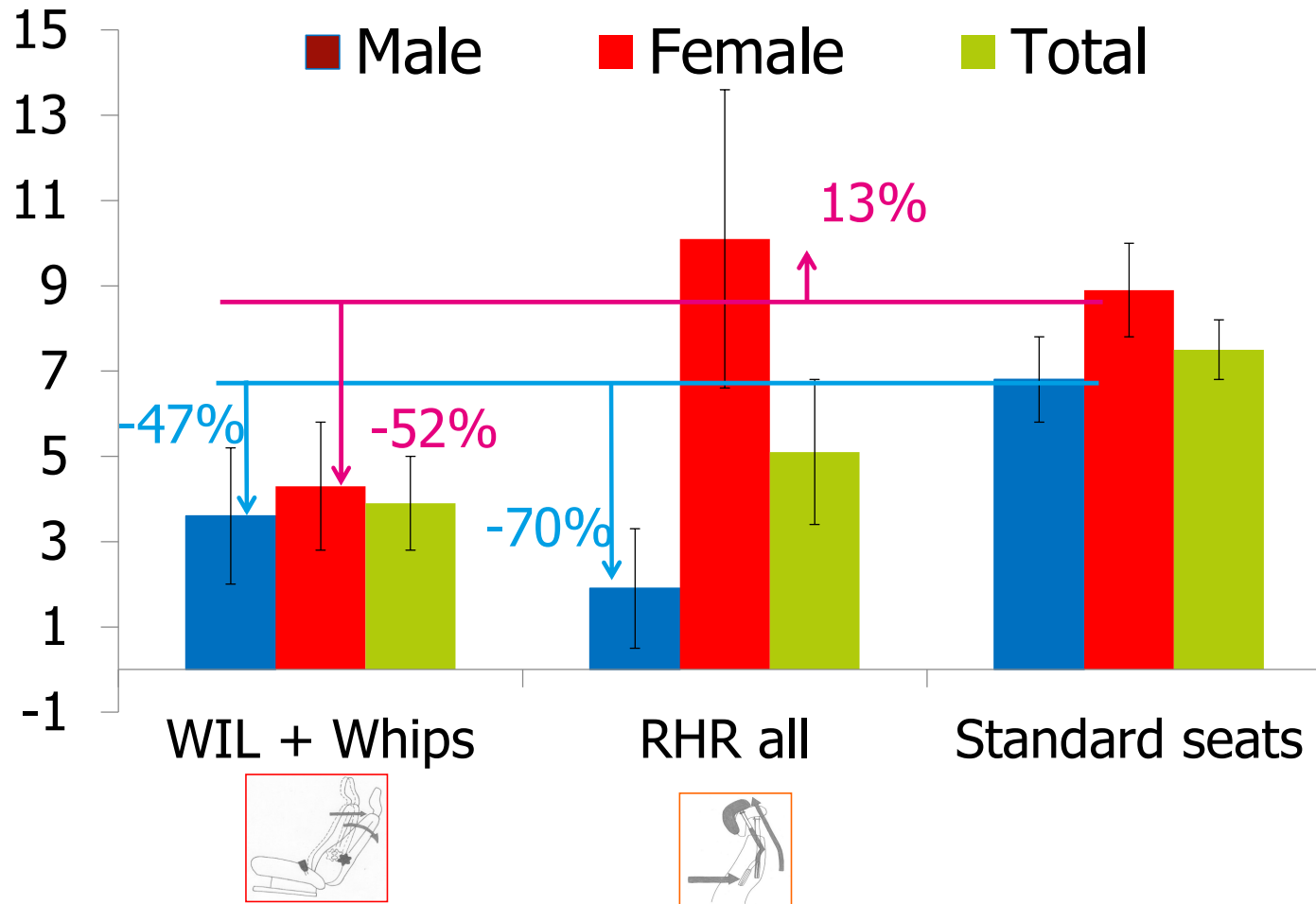
Source: Carlsson 2012

Seat performance, risk of PMI (whiplash)

Kullgren et al. (IRCOBI 2013)



Seat performance, risk of PMI (whiplash)



Ref: Kullgren et al. (2013) Development of Whiplash Associated Disorders for Male and Female Car Occupants in Cars Launched Since the 80s in Different Impact Directions, IRCOBI Conference.

Nutbeam et al. (2022) BMJ

Investigated the differences between women and men in the probability of entrapment, frequency of injury and outcomes following a motor vehicle collision. Out of 450 359 patients during the study period (**2012–2019**), **70 027** met the inclusion criteria.

Conclusions:

- There are significant differences between female and male patients in the frequency at which patients are trapped and the injuries these patients sustain.
- Female patients were more frequently trapped than male patients (female patients (**F**) **15.8%**, male patients (**M**) **9.4%**; $p < 0.0001$).
- Trapped **male** patients more frequently suffered **head, face, thoracic and limb injuries**. Trapped **female** patients had more injuries to the **pelvis and spine**.

Nutbeam T, Weekes L, Heidari S, *et al.* Sex-disaggregated analysis of the injury patterns, outcome data and trapped status of major trauma patients injured in motor vehicle collisions: a prespecified analysis of the UK trauma registry (TARN). *BMJ Open* 2022;12:e061076. doi:10.1136/bmjopen-2022-061076

VIRTUAL: Open Access Virtual Testing Protocols for Enhanced Road User Safety

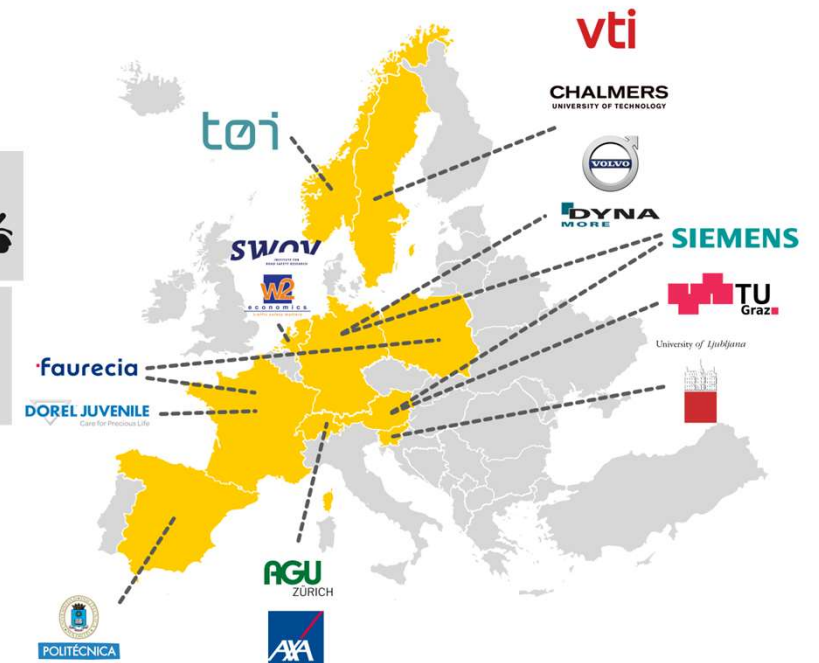
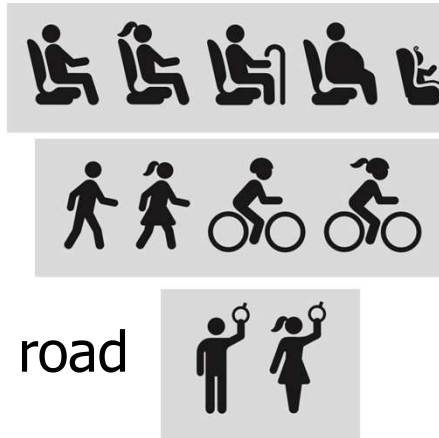
- Duration: June 2018 - Nov 2022
- Budget: Euros 7 Million
- www.projectvirtual.eu

Aim

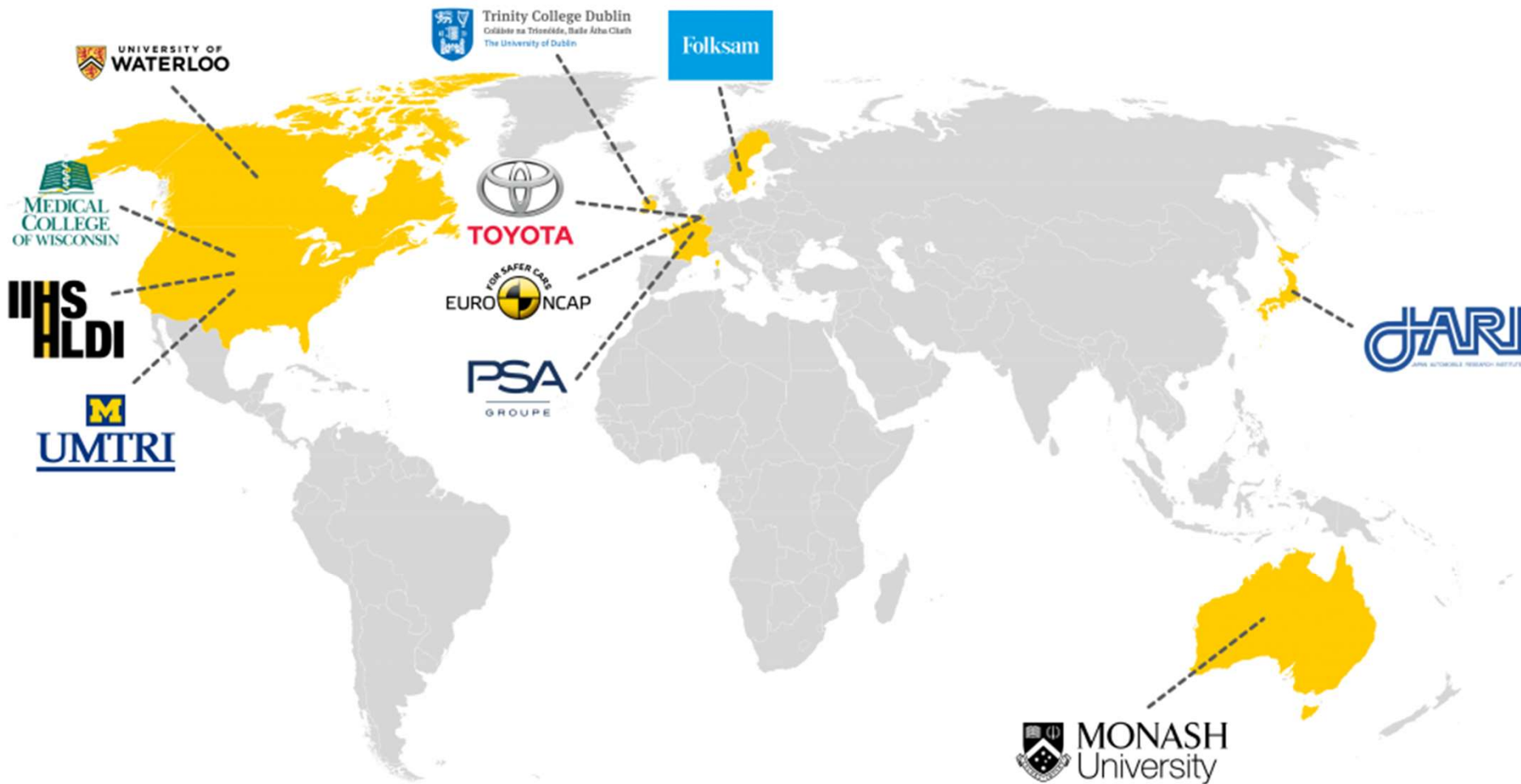
Reduce loss of life and health in road crashes

Identify protective innovations: Virtual testing and Human Body Models 50F and 50M

Share and foster knowledge: Open Source



International collaboration



Models of the occupant in European regulatory vehicle safety assessment tests

Accident Analysis and Prevention 127 (2019) 156–162



Contents lists available at [ScienceDirect](#)

Accident Analysis and Prevention

journal homepage: www.elsevier.com/locate/aap



Review of average sized male and female occupant models in European regulatory safety assessment tests and European laws: Gaps and bridging suggestions

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The Treaty
On The Functioning Of
The European Union



Models of the occupant: Legislative vehicle safety test UNECE

	ECE R16 Belt test	ECE R94 & R137 Frontal test	ECE R95 & R 135 Side Impact
Average female model	X	X	X
Average male model	R16 manikin 	Hybrid III 	ES-2 Side Impact & WorldSID 

ECE R16, Seat belt test

- A R16 Manikin is used to represent an occupant that is **the weight of an average sized male (75.5 kg, pp 68) and has the torso shape of a male.** Which gender this manikin represents is not disclosed in the R16.
- The dummy manufacturer website (www.humaneticsatd.com) describes that the **R16 manikin represents a 50th percentile male adult in general size and weight distribution.**
- The manikin is specified as a test device for ECE-regulation No. 16; "Uniform provisions concerning the **approval of safety belts and restraint systems for adult occupants** of power driven vehicles".



(Picture: www.humaneticsatd.com)

Source: UNECE 2017, WP29: <http://www.unece.org/trans/main/wp29/wp29regs.html>

ECE R94 and 137, Frontal test

- ECE R94 states that a dummy corresponding to the specifications of the **Hybrid III** should be used. The footnote to the Hybrid III (H III 50M) describes that “**the Hybrid III corresponds to the principal dimensions of a 50th percentile male**”.
- In ECE R137, a dummy corresponding to the specifications of the **Hybrid III 50th percentile male dummy** shall be installed in the driver seat.
- A dummy corresponding to the specifications for the Hybrid III 5th percentile female dummy shall be installed in the passenger seat. The Hybrid III 5th percentile female dummy is described as follows “The dummy represents the smallest segment of the adult population and has been derived from scaled data from the Hybrid III 50th Dummy” (H III 5F).

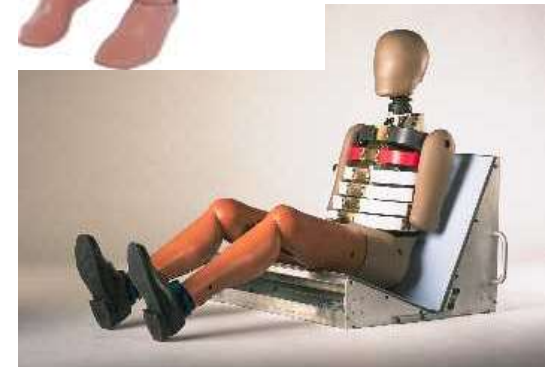


(Picture:
www.humaneticsatd.com)

Source: UNECE 2017, WP29: <http://www.unece.org/trans/main/wp29/wp29regs.html>

ECE R95 and 135, Side impact

- The side impact dummy in ECE R95 should have “the dimensions and masses of the side impact dummy representing a **50th percentile male**, without lower arms.” The footnote on page 48 states: The dummy is corresponding to the specifications of the ES-2 dummy (ES-2).
- In ECE R135 it says that “a **WorldSID 50th percentile adult male dummy**” should be used (WorldSID).



(Pictures:
www.humaneticsatd.com)

Source: UNECE 2017, WP29: <http://www.unece.org/trans/main/wp29/wp29regs.html>

Anthropometry of an adult dummy family

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle DEVELOPMENT OF ANTHROPOMETRICALLY BASED DESIGN SPECIFICATIONS FOR AN ADVANCED ADULT ANTHROPOMORPHIC DUMMY FAMILY, Volume 1		5. Report Date December 1983
7. Author(s) L.W. Schneider, D.H. Robbins, M.A. Pflüg, R.G. Snyder		6. Performing Organization Code
9. Performing Organization Name and Address The University of Michigan Transportation Research Institute 2901 Baxter Road Ann Arbor, Michigan 48109		8. Performing Organization Report No. UMTRI-83-53-1
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		10. Work Unit No. (TRAIS)
15. Supplementary Notes Volume 2: Anthropometric Specifications for Mid-Sized Male Dummy Volume 3: Anthropometric Specifications for Small Female and Large Male Dummies		11. Contract or Grant No. DTNH22-80-C-07502
		13. Type of Report and Period Covered FINAL REPORT Oct. 1980 - Dec. 1983
		14. Sponsoring Agency Code

1. A *small female* whose height and weight are approximately the 5th percentile values for all U.S. adult females;
2. A *mid-sized female* whose height and weight are approximately the 50th percentile values for all U.S. adult females;
3. A *mid-sized male* whose height and weight are approximately the 50th percentile values for all U.S. adult males;
4. A *large male* whose height and weight are approximately the 95th percentile values for all U.S. adult males.

Current safety testing, occupant diversity

Small occupant
5th percentile
female



Average occupant
50th percentile
female

X

Average occupant
50th percentile
male



Large occupant
95th percentile
male



Weight: 49 kg
Height: 1.51 m

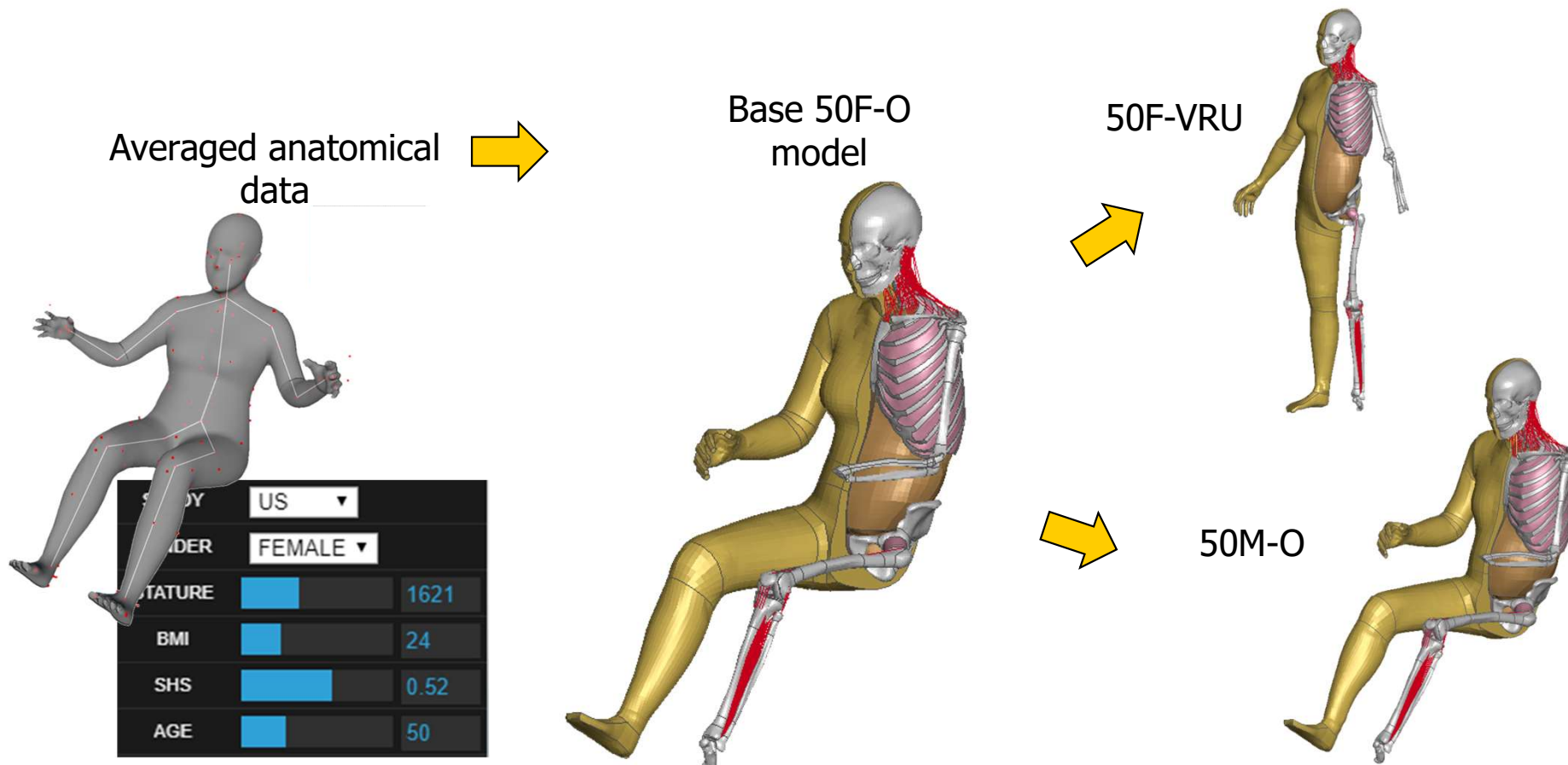
Weight: 62 kg
Height: 1.62 m

Weight: 77.7 kg
Height: 1.77 m

Weight: 101.3 kg
Height: 1.87 m

Source of pictures: www.humaneticsatd.com, crash-test-dummies/frontal impact/HIII

Development of the VIVA+ HBMs

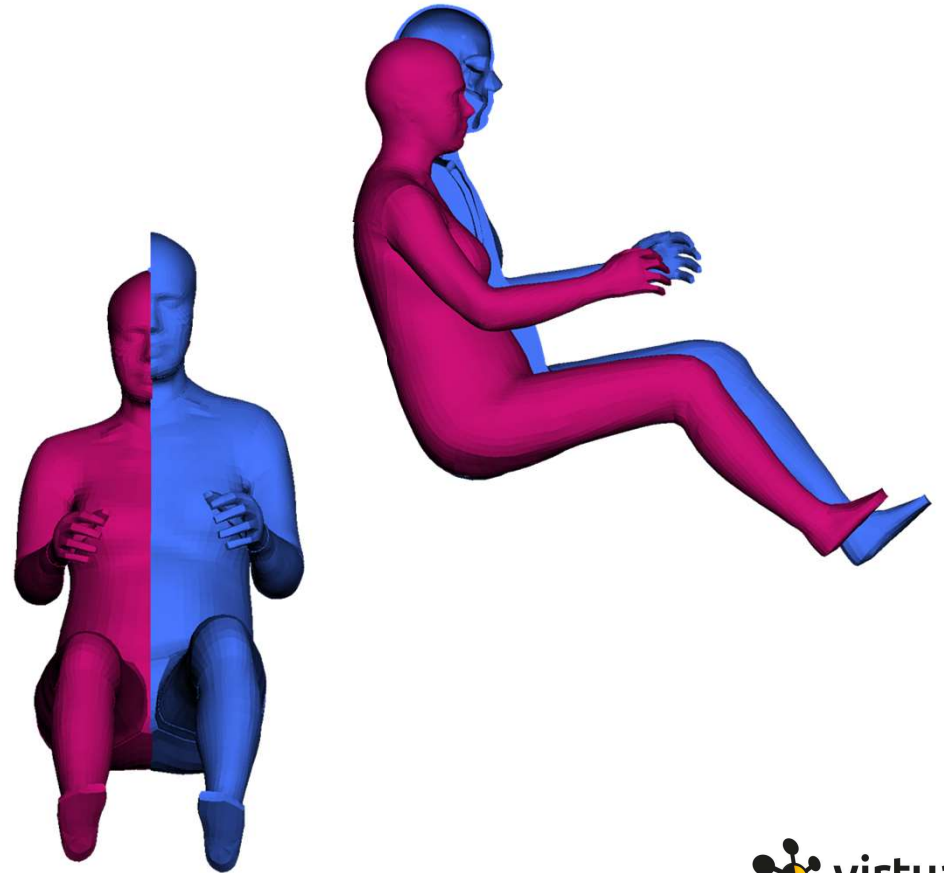


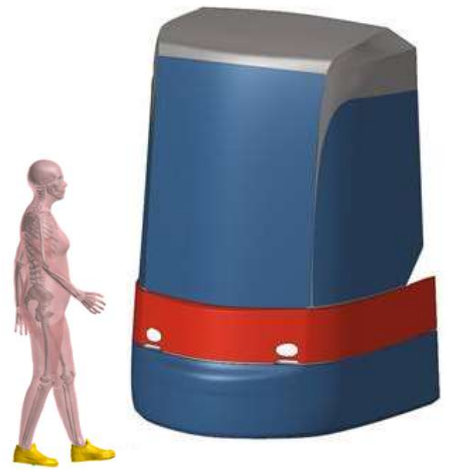
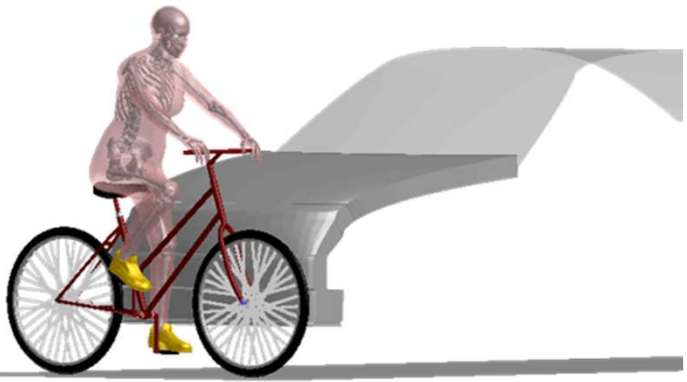
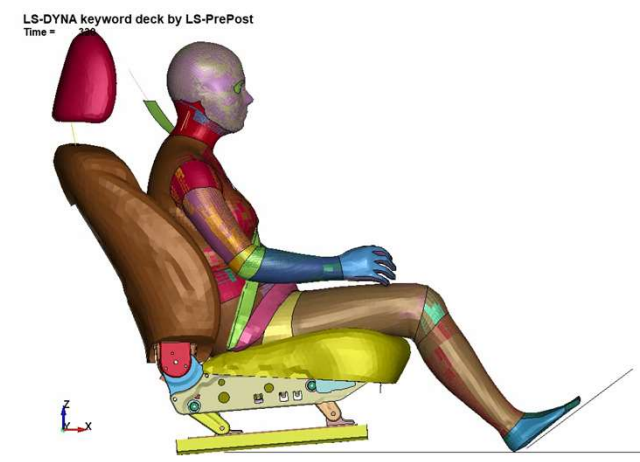
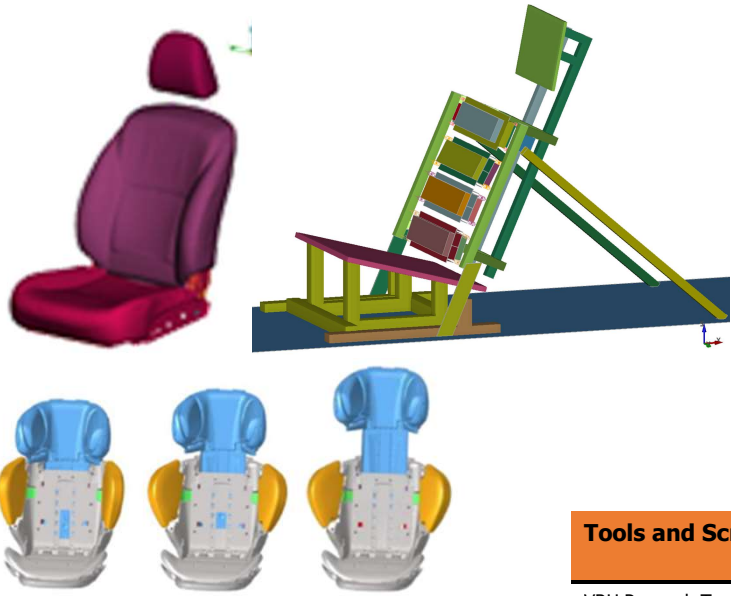
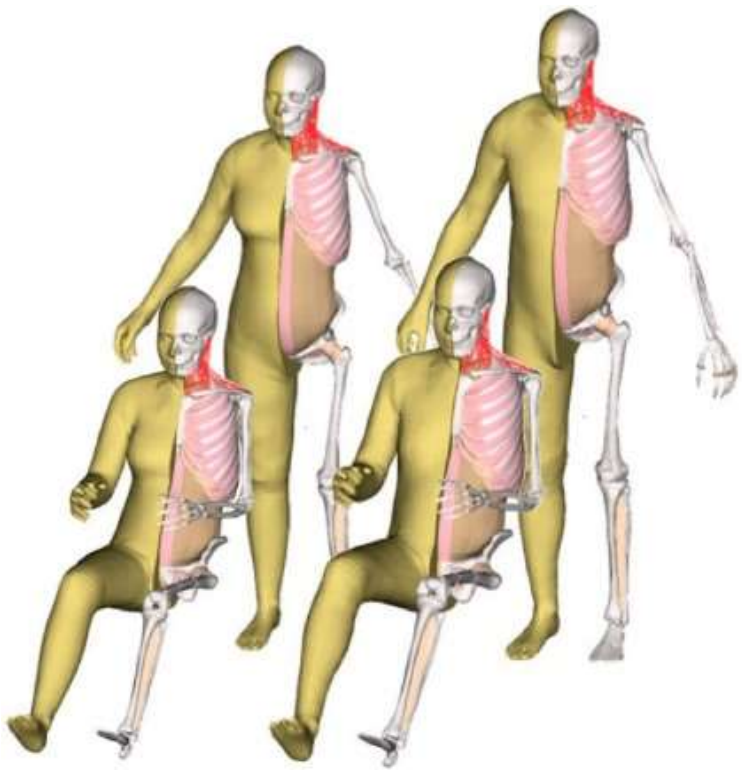
COUNTRY	US
GENDER	FEMALE
HEIGHT	1621
BMI	24
SHS	0.52
AGE	50

www.humanshape.org

VIVA+ models, 50F and 50M

- Scalable model architecture, providing a framework for further development
- Released under the LGPL Open Source license, LS-Dyna
- Basis for addressing diversity such as age, height and weight

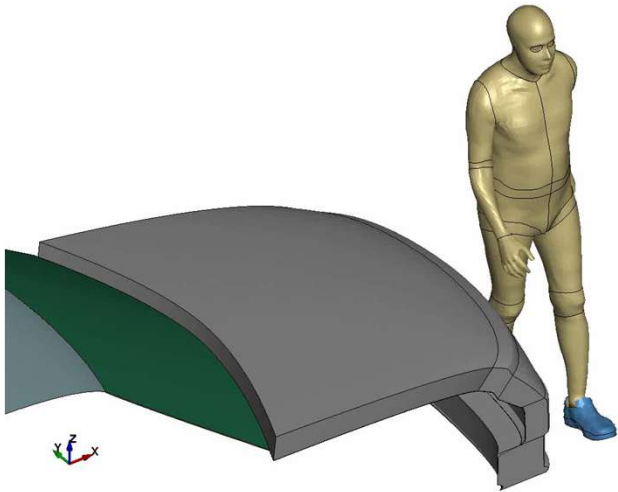




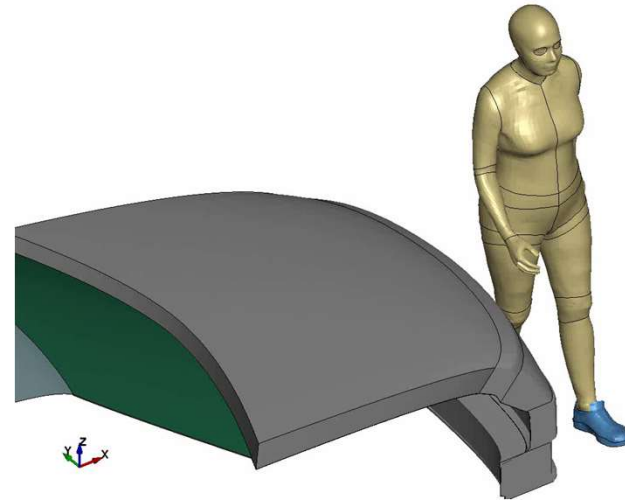
Tools and Scripts	Link to repository on OpenVT	Software
VRU Precrash Tool	https://virtual.openvt.eu/virtual_precrash/vru-precash-tool	LS-DYNA
VISAFE VRU notebooks and scripts	https://virtual.openvt.eu/wp-4/VISAFE-VRU	Jupyter/Python
VIRTUAL Cost Benefit Analysis Tool	https://virtual.openvt.eu/cost-benefit-analysis/cost-benefit-tool	MS Excel
Postprocessing routines for PIPER child models	https://virtual.openvt.eu/fem/piper-child-model	DYNASAUR
Postprocessing routines for VIVA+ Models	https://virtual.openvt.eu/fem/viva/vivaplus/-/tree/master/model/postprocess/Dynasaur	DYNASAUR
PIPER metadatafiles for positioning the VIVA+ models	https://virtual.openvt.eu/fem/viva/vivaplus/-/tree/master/model/preprocess/PIPER_Metadata	PIPER

VRU pedestrian simulations with VIVA+ models

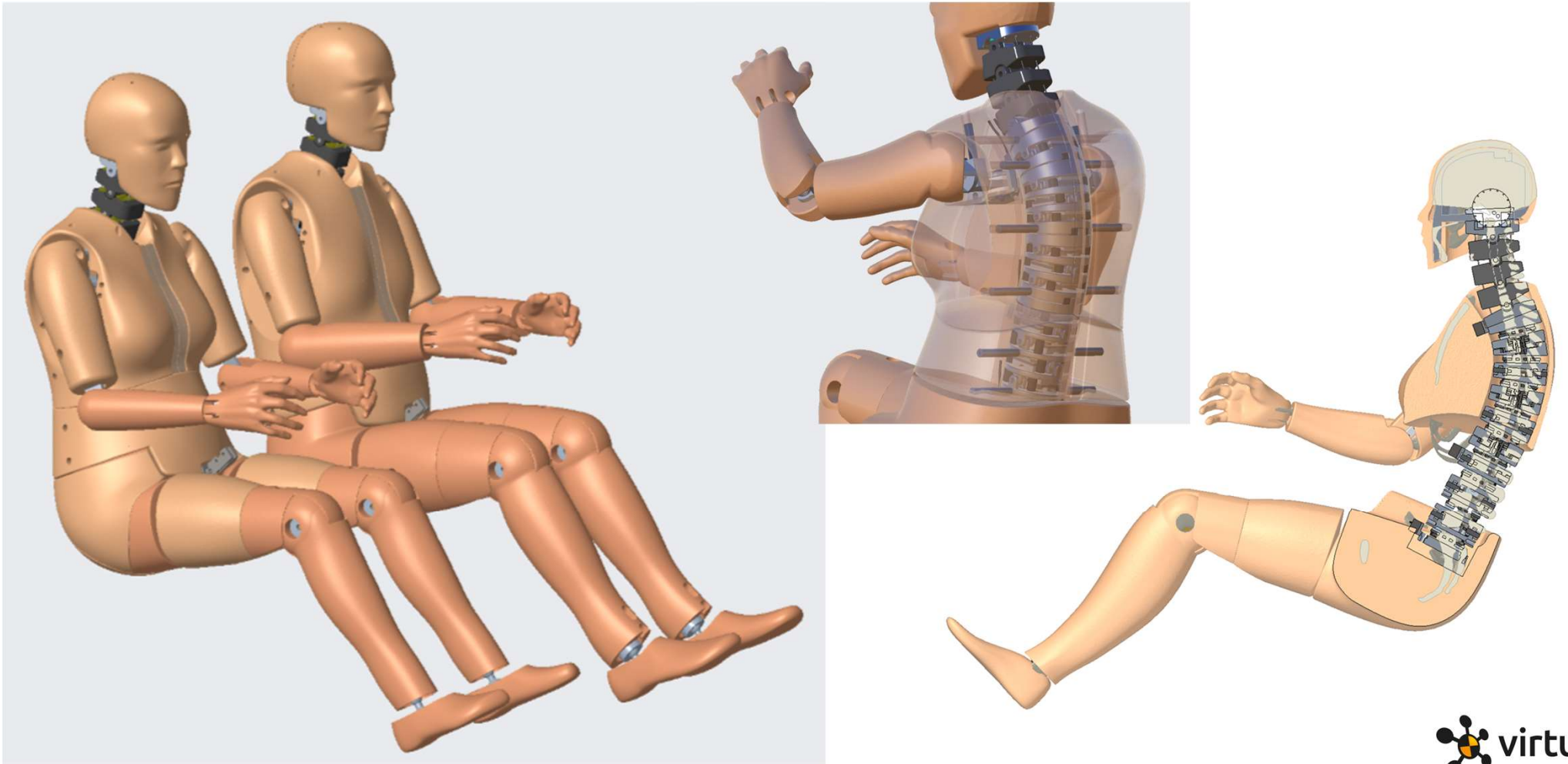
VIVA+ v0.3.0rc4
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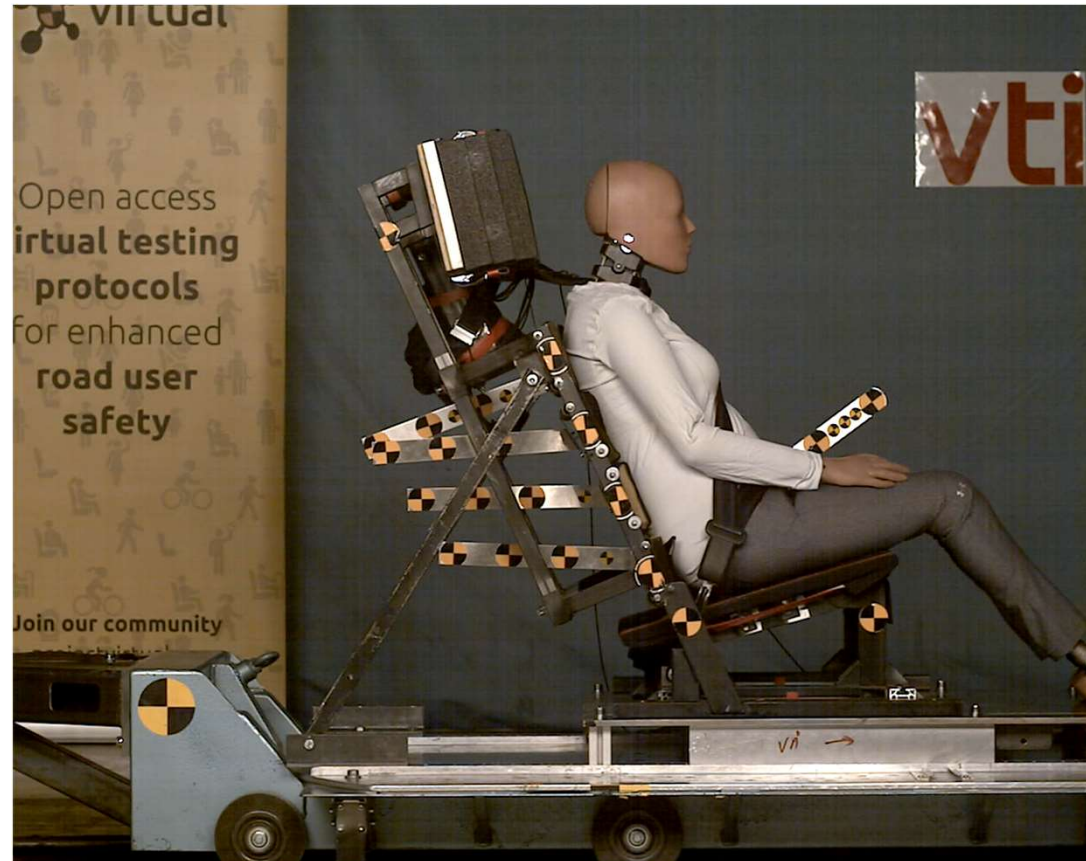
VIVA+ v0.3.0rc4
Time = 0



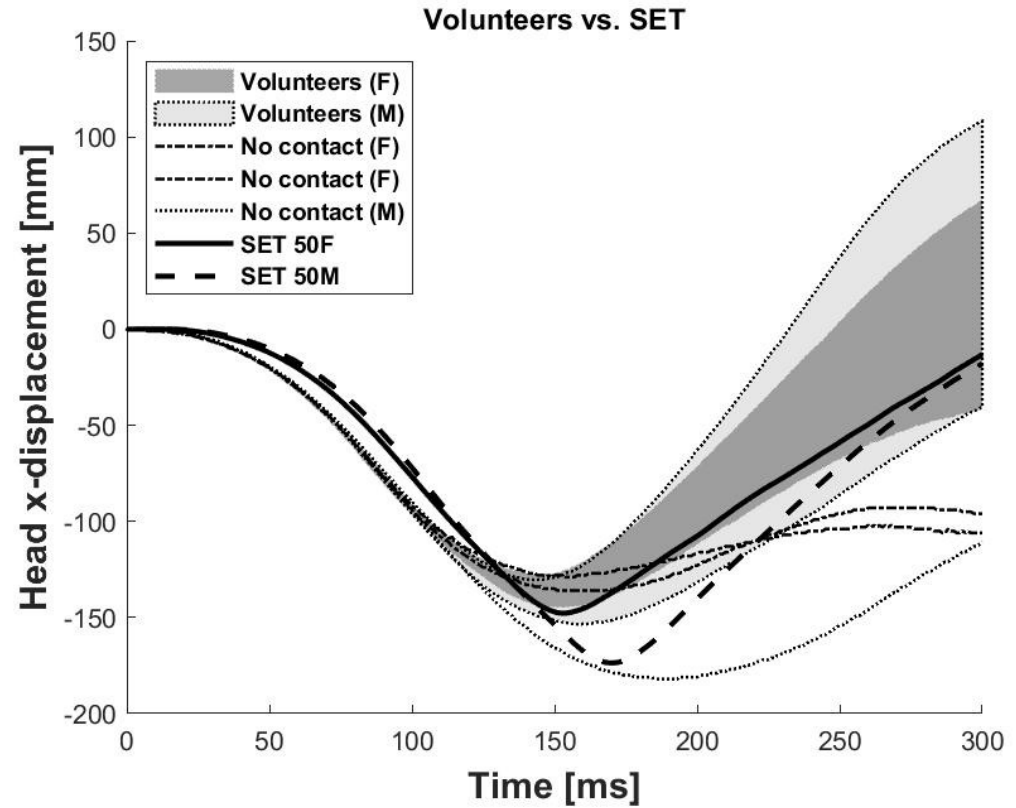
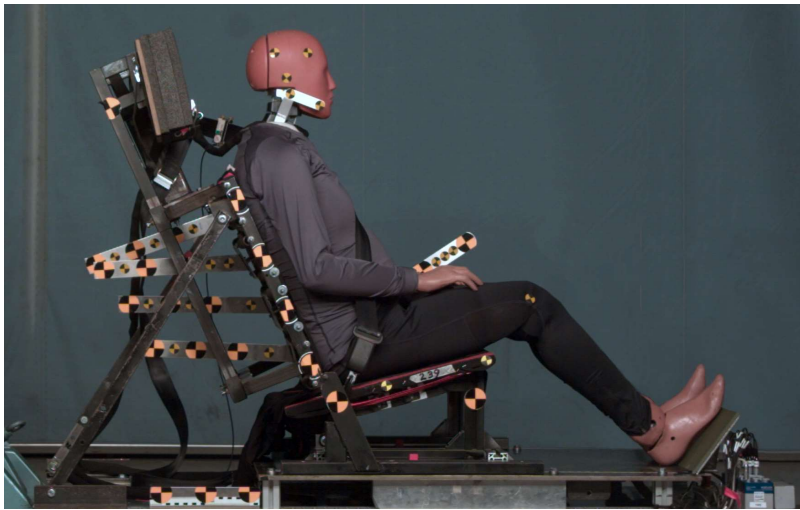
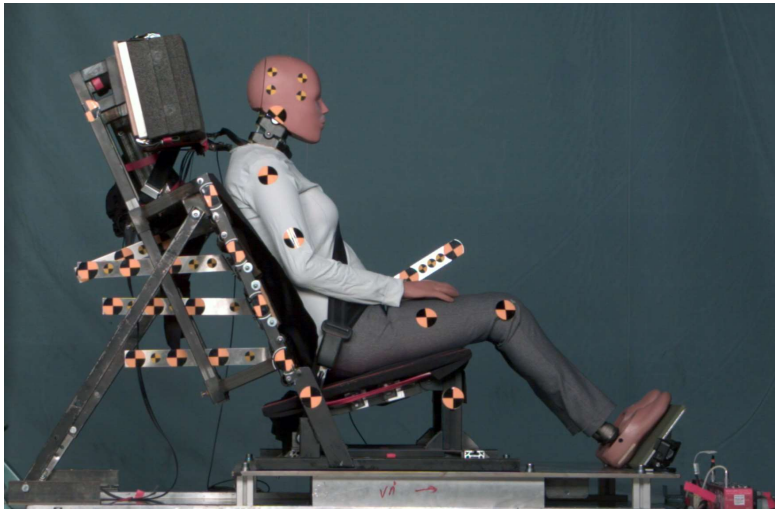
Seat Evaluation Tool, SET 50F and 50M



SET 50F



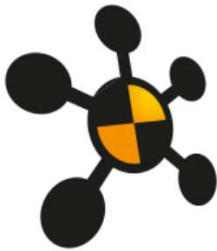
Seat Evaluation Tool, SET 50F and 50M



The OpenVT platform <https://openvt.eu>



OpenVT Gitlab platform



This is the OpenVT platform, the platform for open access virtual testing for enhanced road users safety.

Username or email

Password

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For more information:
www.projectvirtual.eu

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