

Subtask 3.2.1 - Volunteer test data for active HBM developments - review and analysis existing data

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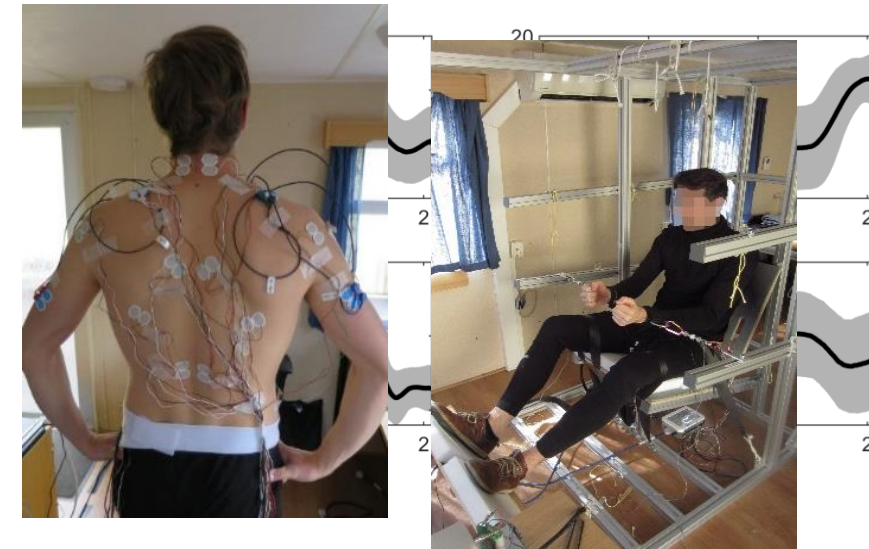
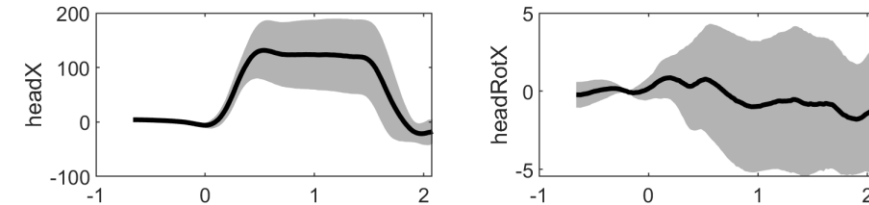
Review – Step 1

- Identifying experiments that have measured kinematics and muscle activity in simulated or actual pre-crash events
- Assess the suitability of experiments
 - Experiments on human volunteers
 - Response to appropriate pre-crash events
 - Braking
 - Lane change or cornering
 - Any combination of above
 - Restraints typical of future modern restraints
- Google scholar
- References of articles found were checked for further articles



Review – Step 2

- 25 datasets involved applying accelerations that mimic pre-crash events to human volunteers (22 published and 3 unpublished)
- Selection of datasets to be further analysed based on:
 - Number of participants
 - Proper instrumentation
 - Boundary conditions measured and presented
 - Time histories of all relevant sled or vehicle dynamics
 - Occupants kinematics for body regions of interest
 - Muscle activity data normalized by maximum voluntary contracts
 - Information on the occupant initial position
 - Model of the used seat and restraints or data for model development



Review, examples – Kinematics in different types of manoeuvres

■ Braking, with or without reversable pre-tensed e-belt



Autobrake pre-tensed e-belt



Autobrake standard belt



From: Östh J, Muscle Responses of Car Occupants, PhD-thesis

Review, examples – Kinematics in different types of manoeuvres

■ Lane change to the right, passenger



$t = 0 \text{ s}$



$t = 0.5 \text{ s}$



$t = 1 \text{ s}$



$t = 1.5 \text{ s}$

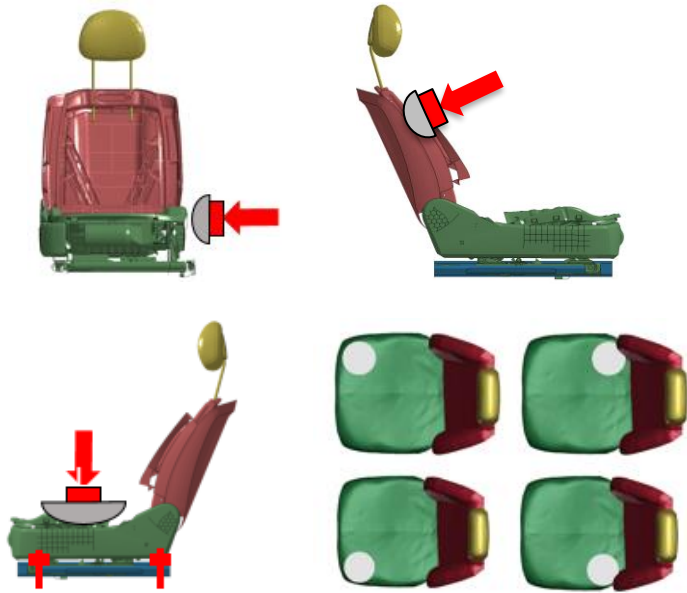
Main results

- A total of 25 datasets were identified that involved applying accelerations that mimic pre-crash events to human volunteers
- The subtask group choose five datasets to be shared with the OSCCAR partners
- A majority of these have been made available for free for everyone to be used as standardized validation data

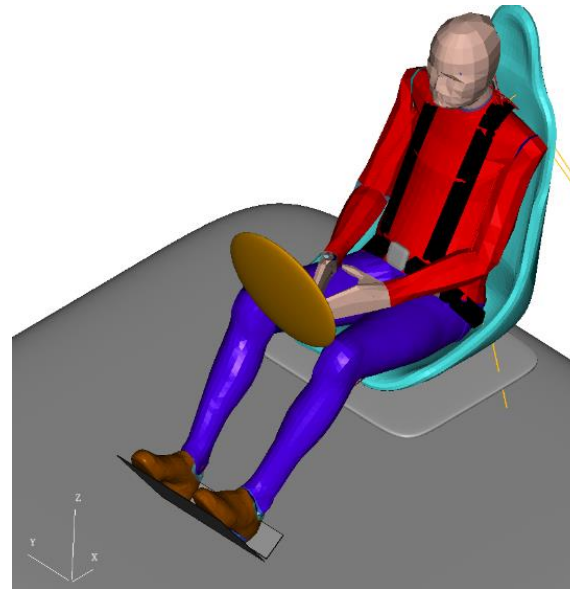


Manoeuvre	Laboratory Environment	In-vehicle Environment
Braking	Precooni	AHBM 2 and OM4IS2
Lane-change	TNO - Robot lane-change	AHBM3 and OM4IS2
Braking and lane-change		AHBM3 and OM4IS2

Development and validation of models of the original seats and restraints



Example of validation of LS-Dyna model of the test set-up used in the OM4IS2 and Precooni tests with volunteers



Simcenter Madymo model of the test set-up used in the TNO tests with volunteers



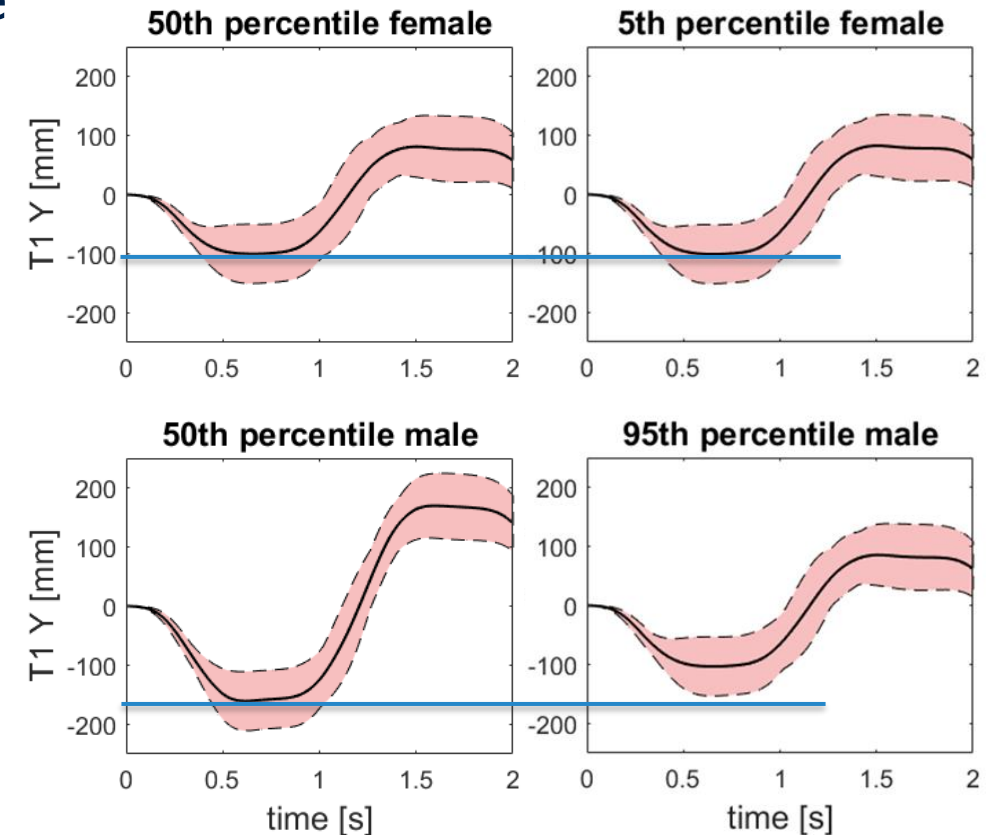
Chalmers generic LS-Dyna model of the test set-up used in the AHBM 2 and AHBM 3 tests with volunteers

Available for everyone to be used with the validation data

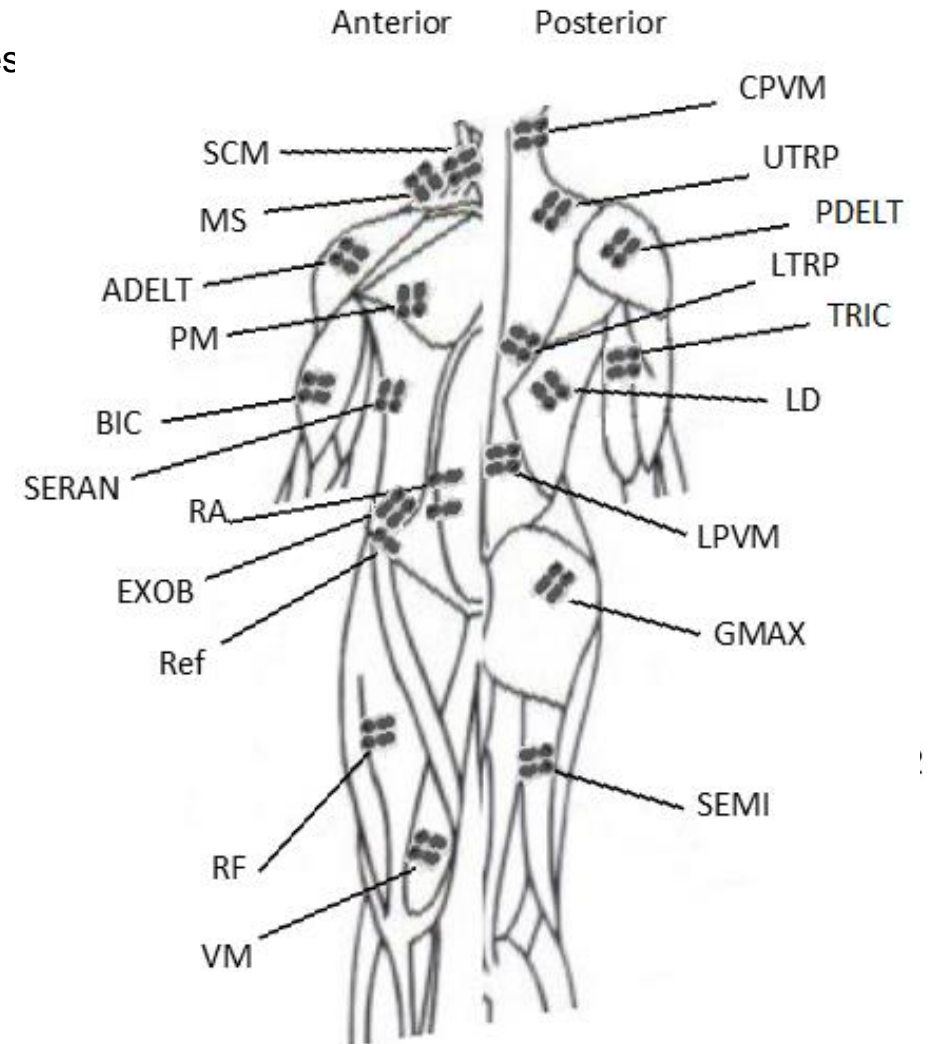
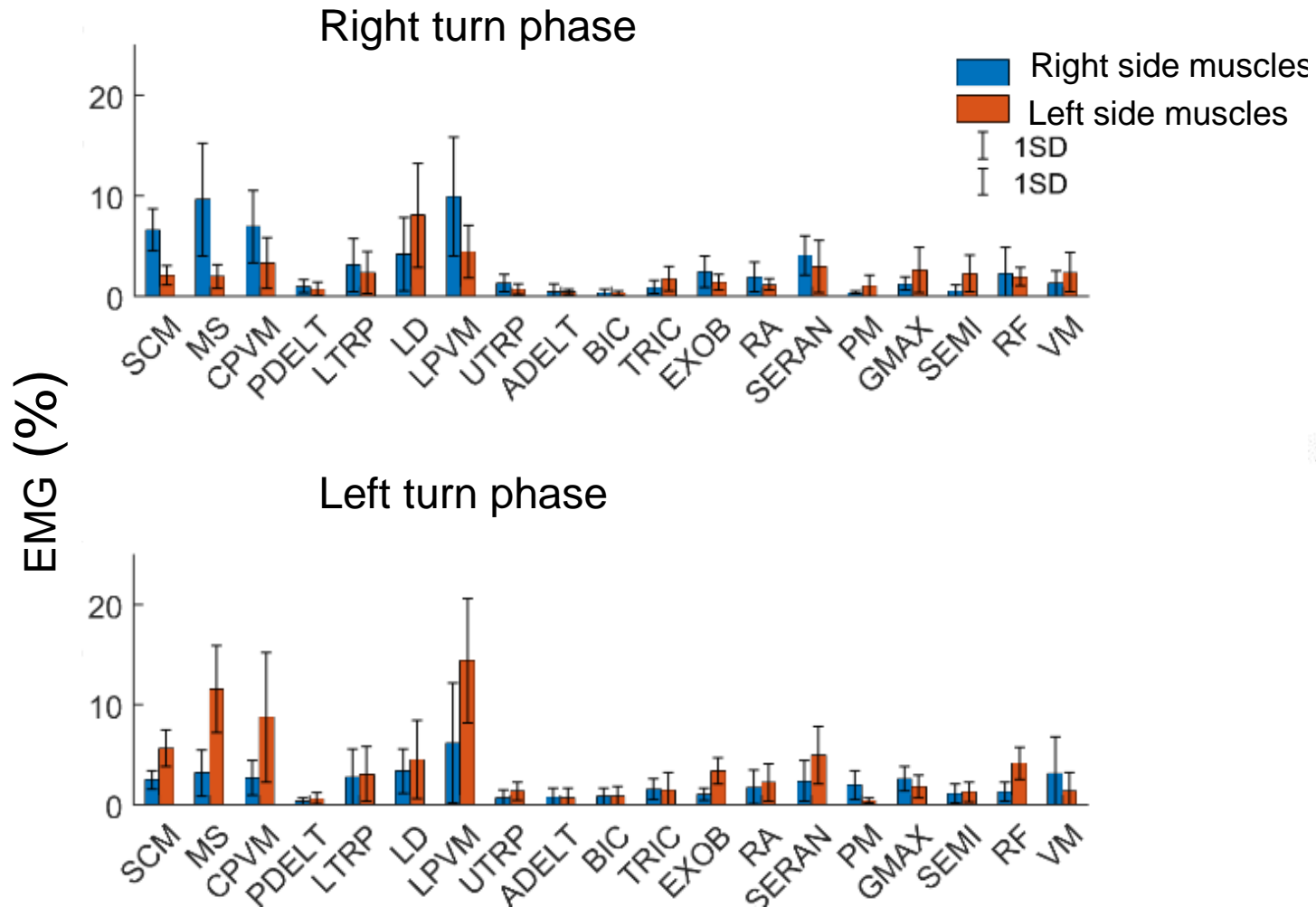


New analysis of existing data – data representative of the entire population

- Lane-changes
- Principal component analysis (PCA) was done on the selected time series of kinematics
- Linear mixed model developed
 - Can be used to predict body kinematics of volunteers with any age, stature, and sex
 - Sex, stature and their interaction effects were statistically significant for head and upper torso forward and lateral displacements
 - Age was not a significant effect
- Paper ready for submission



New analysis of existing data – Females in lane changes



- Huber P., Christova M., D'Adetta G.A., Gallasch E., Kirschbichler S., Mayer C., Prüggl A., Rieser A., Sinz W., and Wallner D.: Muscle Activation Onset Latencies and Amplitudes during Lane Change in a Full Vehicle Test; Proceedings of IRCOBI; 2013; pp: 628-640;
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- Huber P., Kirschbichler S., Prüggl A., Steidl T.: Passenger kinematics in braking, lane change and oblique driving maneuvers; In IRC-15-89.; 2015. p. 783-802;
- Kirschbichler S., Huber P., Prüggl A., Steidl T., Sinz W., Mayer C. et al.: Factors Influencing Occupant Kinematics during Braking and Lane Change Maneuvers in a Passenger Vehicle; In Proceedings of IRCOBI Conference 2014; IRC-14-70.; 2014; p. 614-625;
- OM4IS data: <https://doi.org/10.5281/zenodo.5747369>
- Van Rooij, L., Elrofai, H., Philippens, M. M. G. M., & Daanen, H. A. M. (2013). Volunteer kinematics and reaction in lateral emergency maneuver tests. *Stapp car crash journal*, 57, 313.
- Ólafsdóttir, J., Osth, J., Davidsson, J. and Brolin, K. (2013) Passenger kinematics and muscle responses in autonomous braking events with standard and reversible pre-tensioned restraints. *Proceedings of IRCOBI conference*.
- Ghaffari, G., Brolin, K., Bråse, D., Pipkorn, B., Svanberg, B., Jakobsson, L., & Davidsson, J. (2018, September). Passenger kinematics in Lane change and Lane change with Braking Manoeuvres using two belt configurations: standard and reversible pre-pretensioner. In Proceedings of the 2018 IRCOBI Conference, Athens, Greece (pp. 12-14).
- Ghaffari G., Brolin K., Pipkorn B., Jakobsson L. and Davidsson J. (2019) Passenger muscle responses in lane change and lane change with braking maneuvers using two belt configurations: Standard and reversible pre-pretensioner. *Traffic Injury Prevention*, 20(S1), S43–S51. <https://doi.org/10.1080/15389588.2019.1634265>
- Ghaffari G. and Davidsson J. (2021) Female kinematics and muscle responses in lane change and lane change with braking maneuvers. *Traffic Injury Prevention*, 236-241, <https://doi.org/10.1080/15389588.2021.1881068>
- Östh, J., Ólafsdóttir, J. M., Davidsson, J., and Brolin, K. (2013). Driver kinematic and muscle responses in braking events with standard and reversible pre-tensioned restraints: validation data for human models (No. 2013-22-0001). *Stapp - SAE Technical Paper*.

Questions?

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