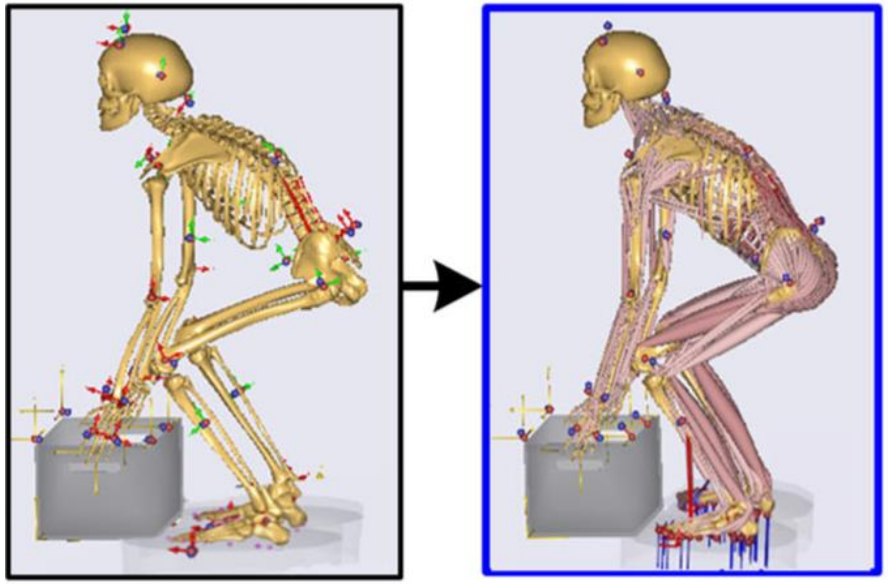
The webcast will begin shortly…

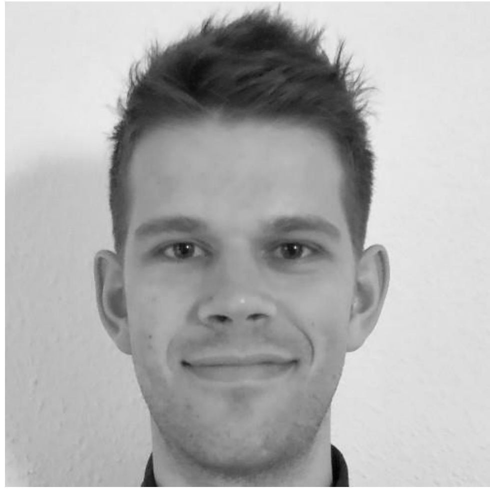
Estimation of Spinal Loading During Lifting Using Inertial Motion Capture

March 19th, 2020

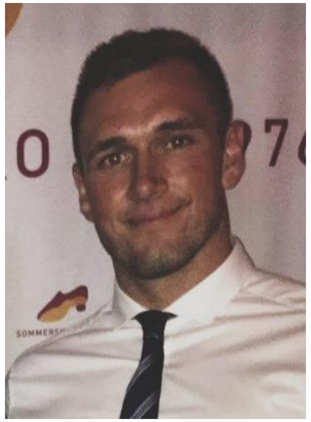


Outline

- General introduction to the AnyBody Modeling System
- Presentation by Frederik Greve Larsen
  - *Estimation of Spinal Loading During Lifting Using Inertial Motion Capture*
- Question and answer session



Presenter:
Frederik Greve Larsen
M.Sc. Sports Technology
Department of Health Science and Technology,
Aalborg University, Denmark



Host:
Kristoffer Iversen
R&D Engineer
AnyBody Technology

Control Panel

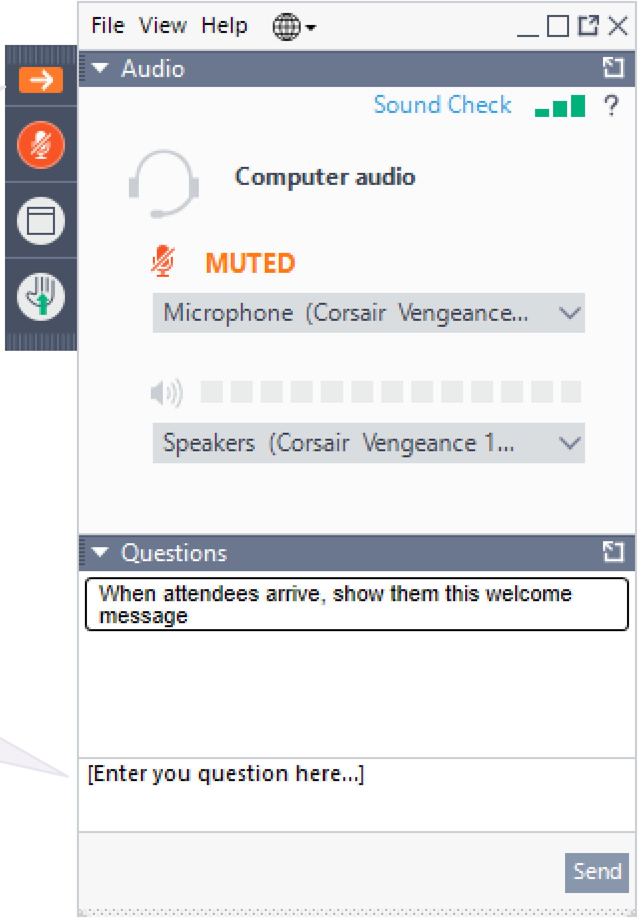
The Control Panel appears on the right side of your screen.

Submit questions and comments via the Questions panel.

Questions will be addressed at the end of the presentation. If your question is not addressed, we will do so by email.

Expand/Collapse the Control Panel

Ask a question during the presentation



Musculoskeletal Simulation

Motion Data

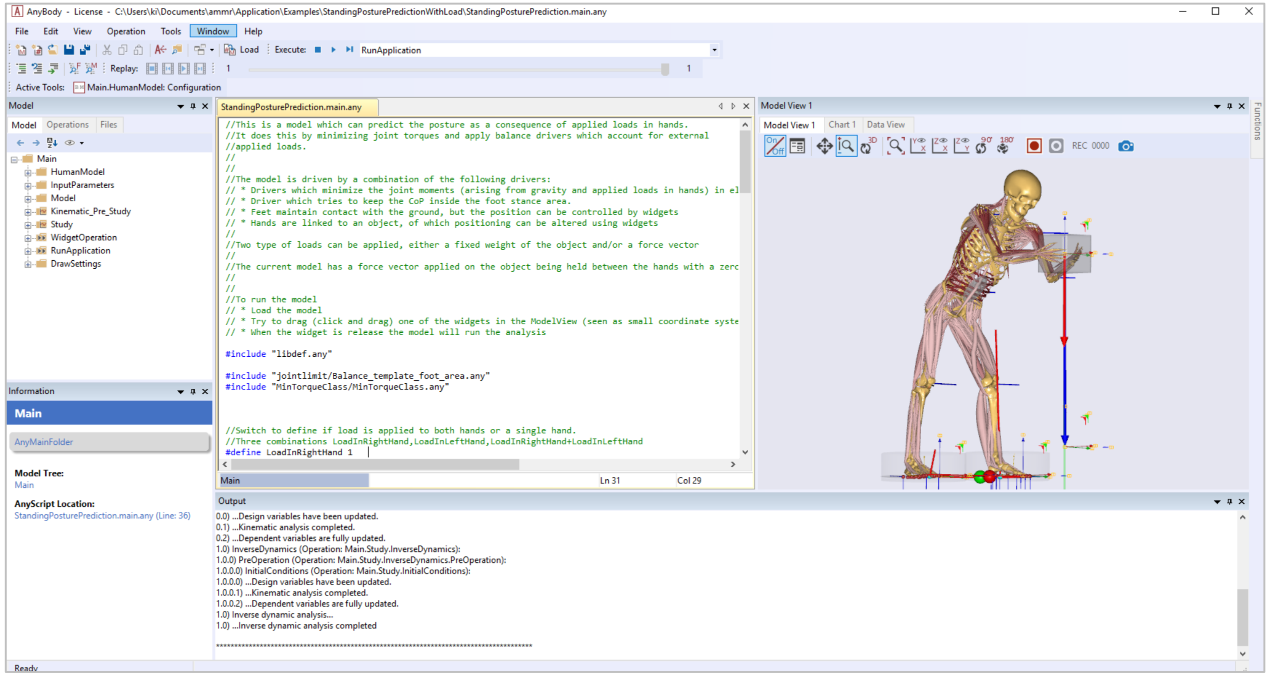
Kinematics and Forces

AnyBody

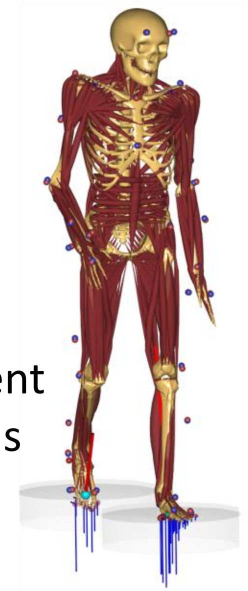
Modeling System

Body Loads

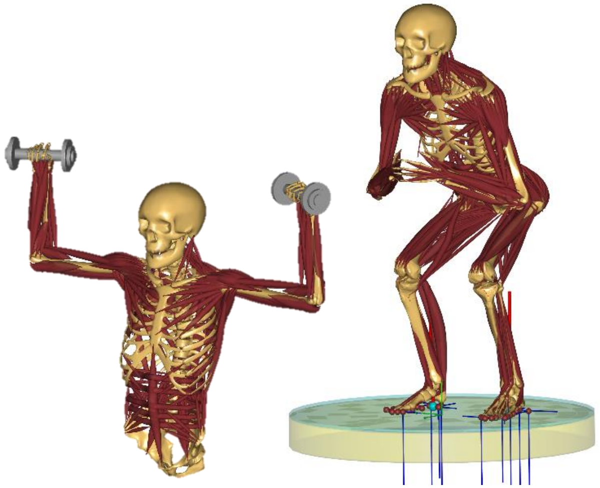
- Joint moments
- Muscle forces
- Joint reaction forces



Product optimization design

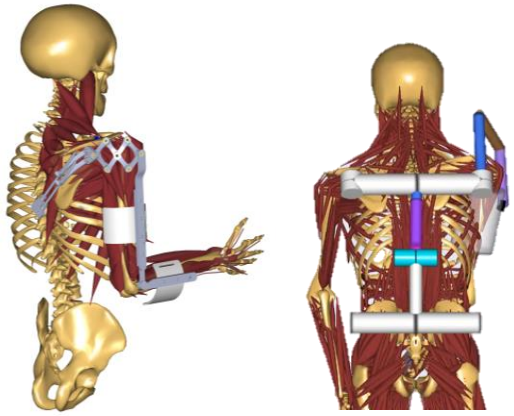


Movement Analysis

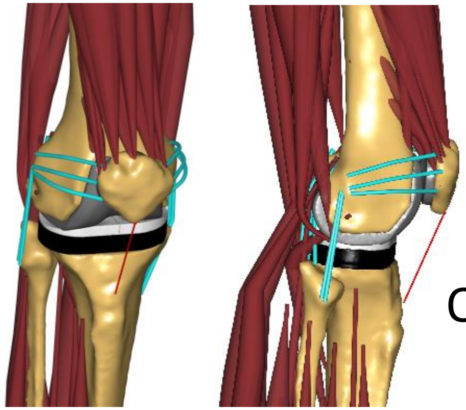


Sports

AnyBody Modeling System



Assistive Devices



Orthopedics and rehab

AnyBody Modelling System

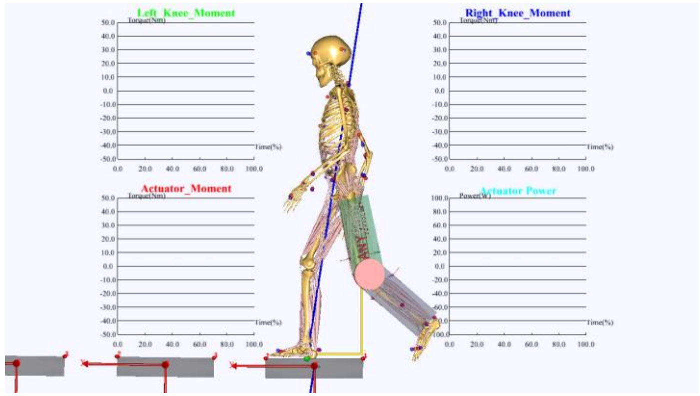
Motion and Forces

Body model

Environment model

Inverse dynamics
Muscle recruitment

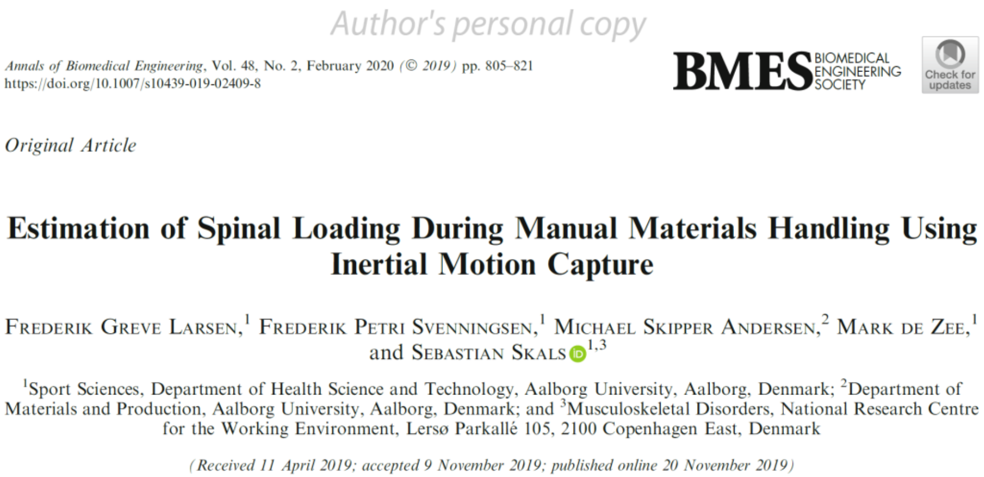
Simulation



Internal body loads
- Muscle forces
- Joint moments

Design Optimization

Post Processing (e.g. Finite element tools)



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https://doi.org/10.1007/s10439-019-02409-8

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Check for updates

Original Article

Estimation of Spinal Loading During Manual Materials Handling Using Inertial Motion Capture

Frederik Greve Larsen,[1] Frederik Petri Svenningsen,[1] Michael Skipper Andersen,[2] Mark de Zee,[1] and Sebastian Skals[1,3]

[1]Sport Sciences, Department of Health Science and Technology, Aalborg University, Aalborg, Denmark; [2]Department of Materials and Production, Aalborg University, Aalborg, Denmark; and [3]Musculoskeletal Disorders, National Research Centre for the Working Environment, Lersø Parkallé 105, 2100 Copenhagen East, Denmark

(*Received 11 April 2019; accepted 9 November 2019; published online 20 November 2019*)

Estimation of Spinal Loading During Manual Materials Handling Using Inertial Motion Capture

Frederik G. Larsen*, Frederik P. Svenningsen, Michael S. Andersen, Mark de Zee, Sebastian L. Skals

Background

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- Low back pain is the most frequent musculoskeletal disc
  1999)

- Assessment of spinal loading during material handling
  - 2-D biomechanical models (Potvin 1997, Merryweather 2009)
  - 3-D computer simulations in the lab (Bassani et al. 2017)
- Inertial motion capture
  - Combining the kinematics with predicted GRF to estimate spinal loading (Karatsidis et al. 2019)

Aim

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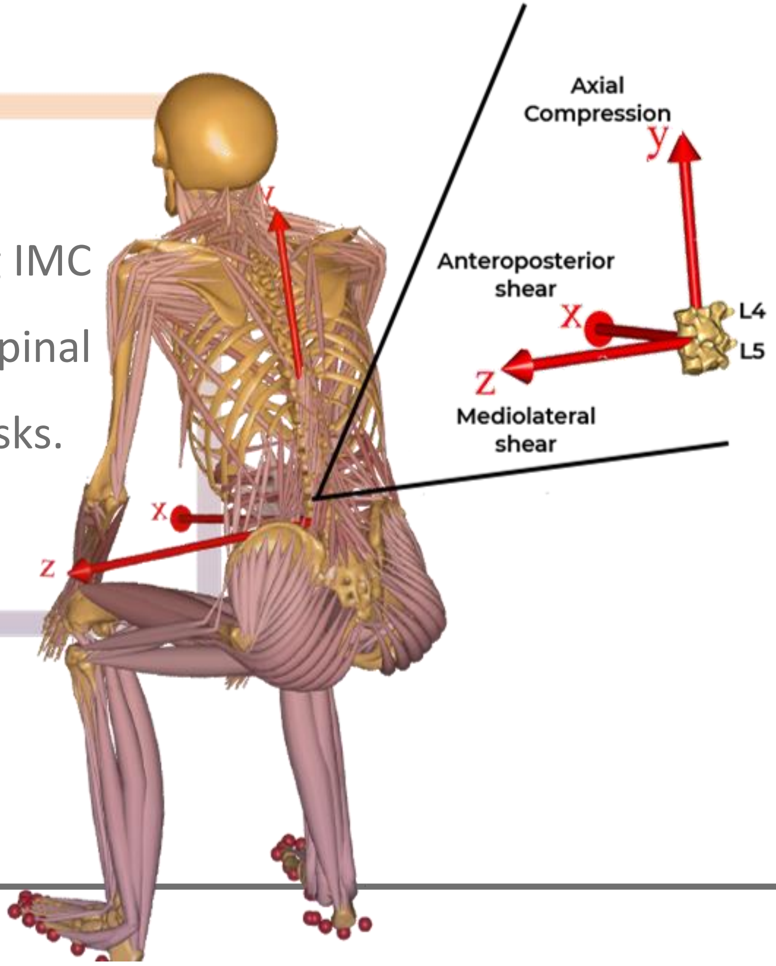
to evaluate the concurrent validity of a musculoskeletal model driven exclusively using IMC data and GRF prediction for estimating L4–L5 spinal forces during various lifting and transferring tasks.



Experimental Data

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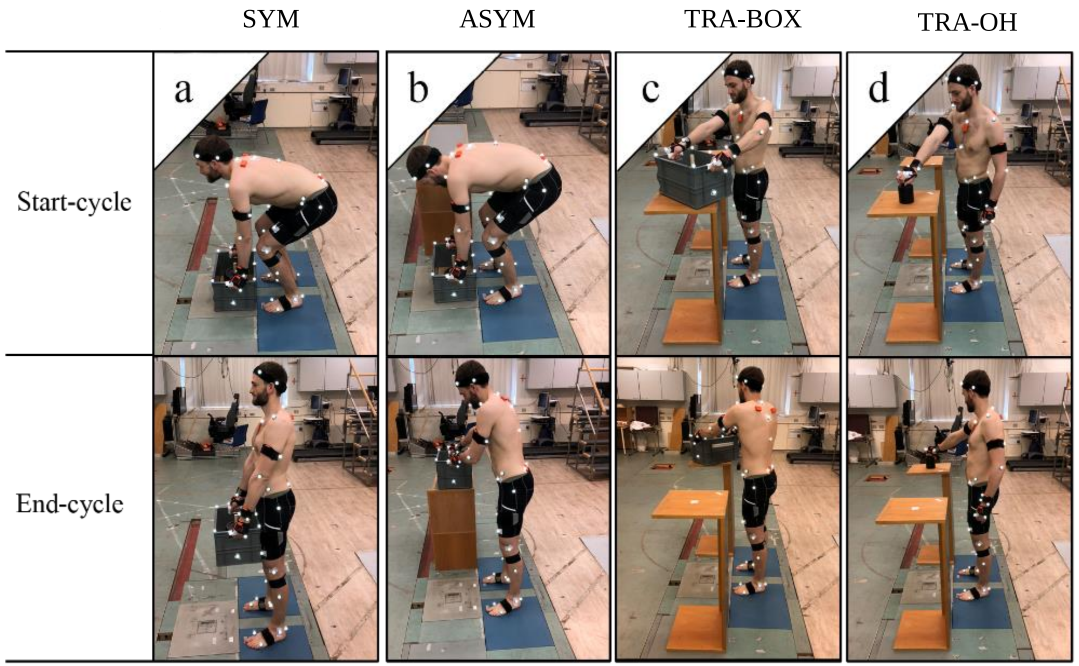
- 9 men, 4 women
- Standardized lifting tasks with increments of the burden (5-20 kg)
- Kinematics
  - Qualisys (42 markers, 120 Hz)
  - Xsens MVN Awinda (17 IMU, 60 Hz)
- Kinetics
  - AMTI force plates (1200 Hz)



Computer simulations

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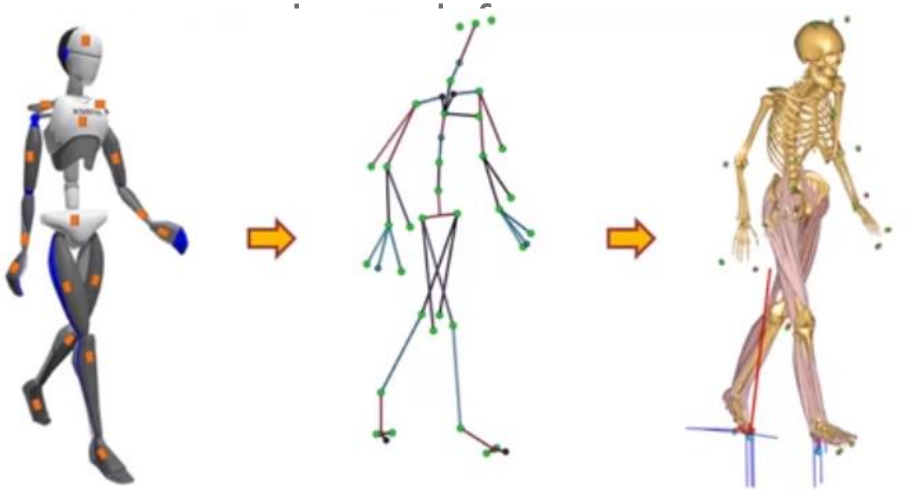
- IMU input into the AnyBody Modeling System
  - Apply sensors, measurement of body dimensions and calibration
  - Stick figure from .bvh file
  - Virtuel markers (Skals et al., 2017)
- Prediction of ground reaction forces (Fluit et al., 2014; Skals et al., 2017)
  - Contact elements with



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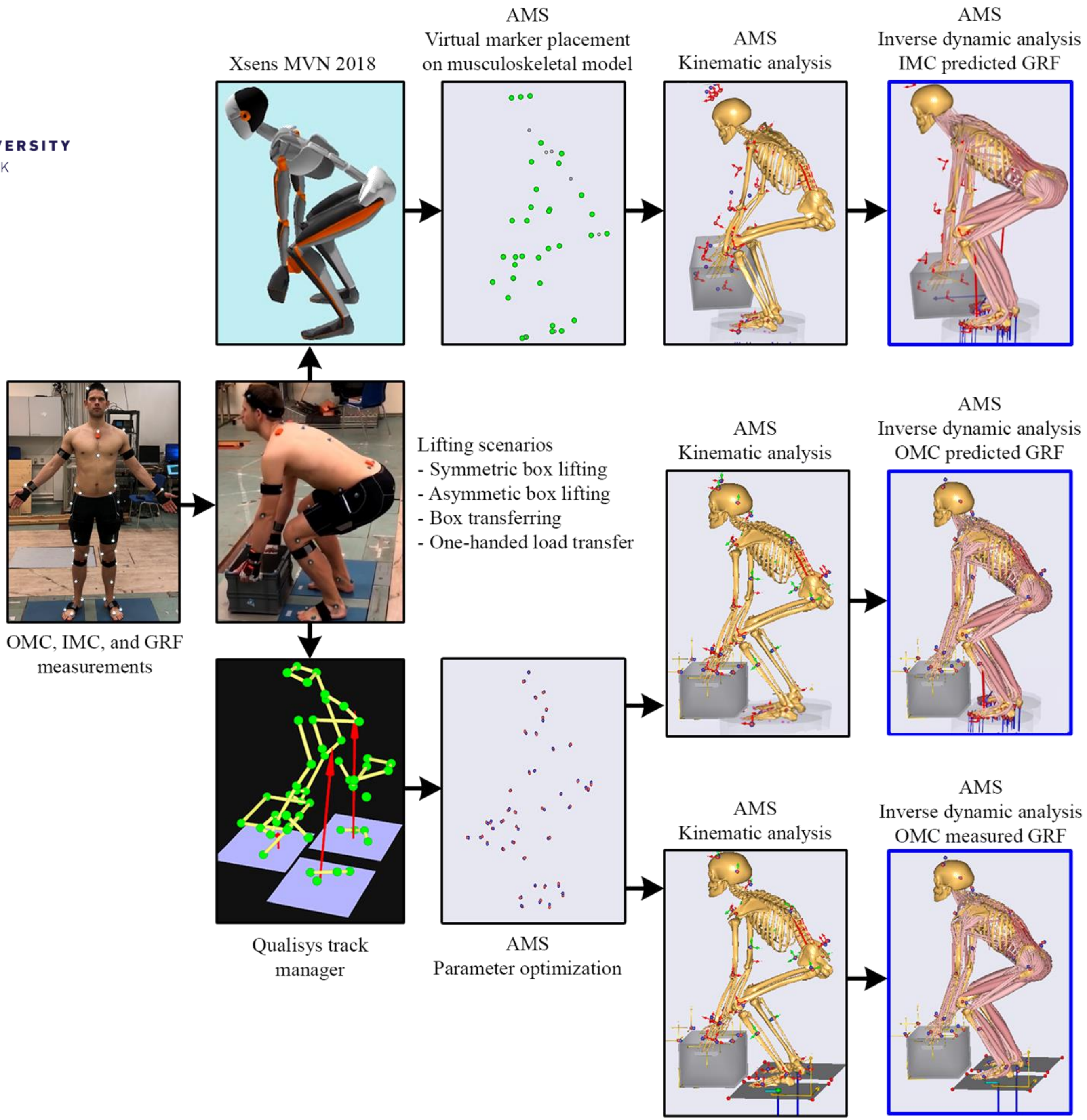
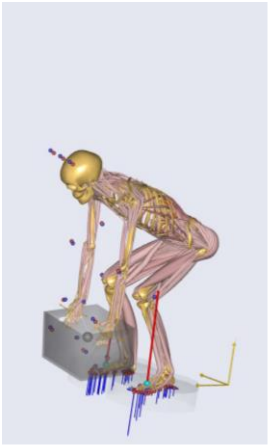
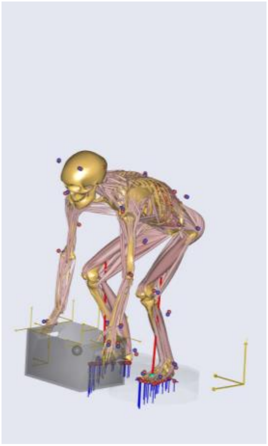


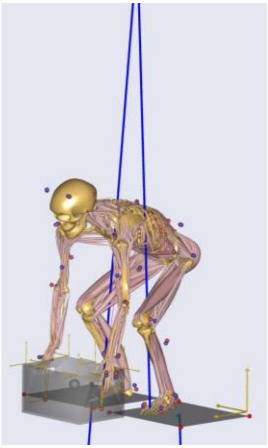
● 1) IMC-PGRF



● 2) OMC-PGRF



● 3) OMC-MGRF



Data analysis and statistics

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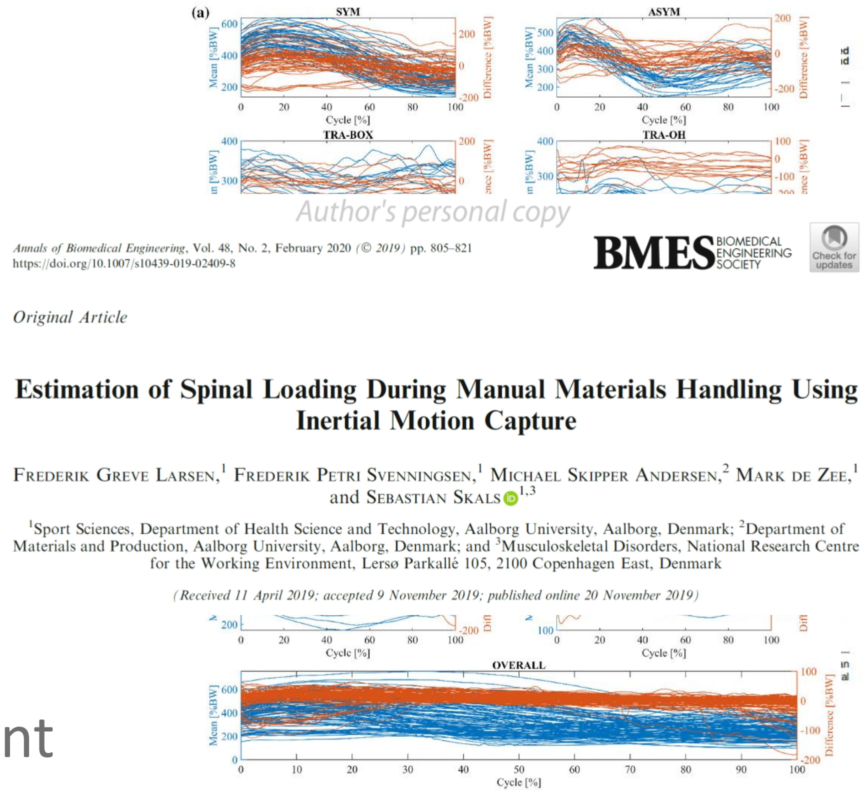
- Parameters of interest
  - Trunk flexion
  - Vertical GRF for the right and left foot
  - JRFs at the L4–L5 discs
  - Forces erector spinae muscle force
- Statistical comparison
  - Intraclass correlation coefficients
  - Root mean square error
  - Relative root mean square error
  - Bland – Altman bias and limits of agreement



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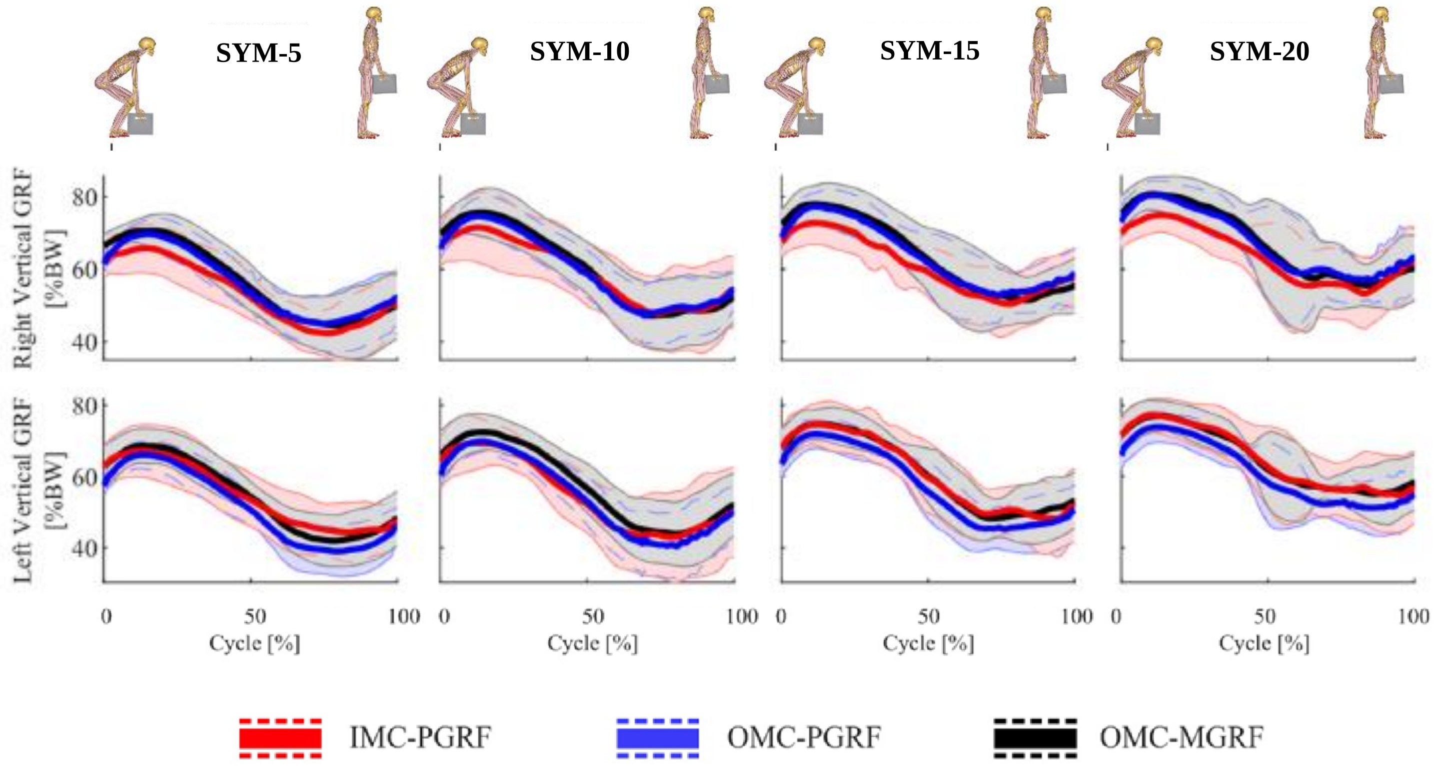
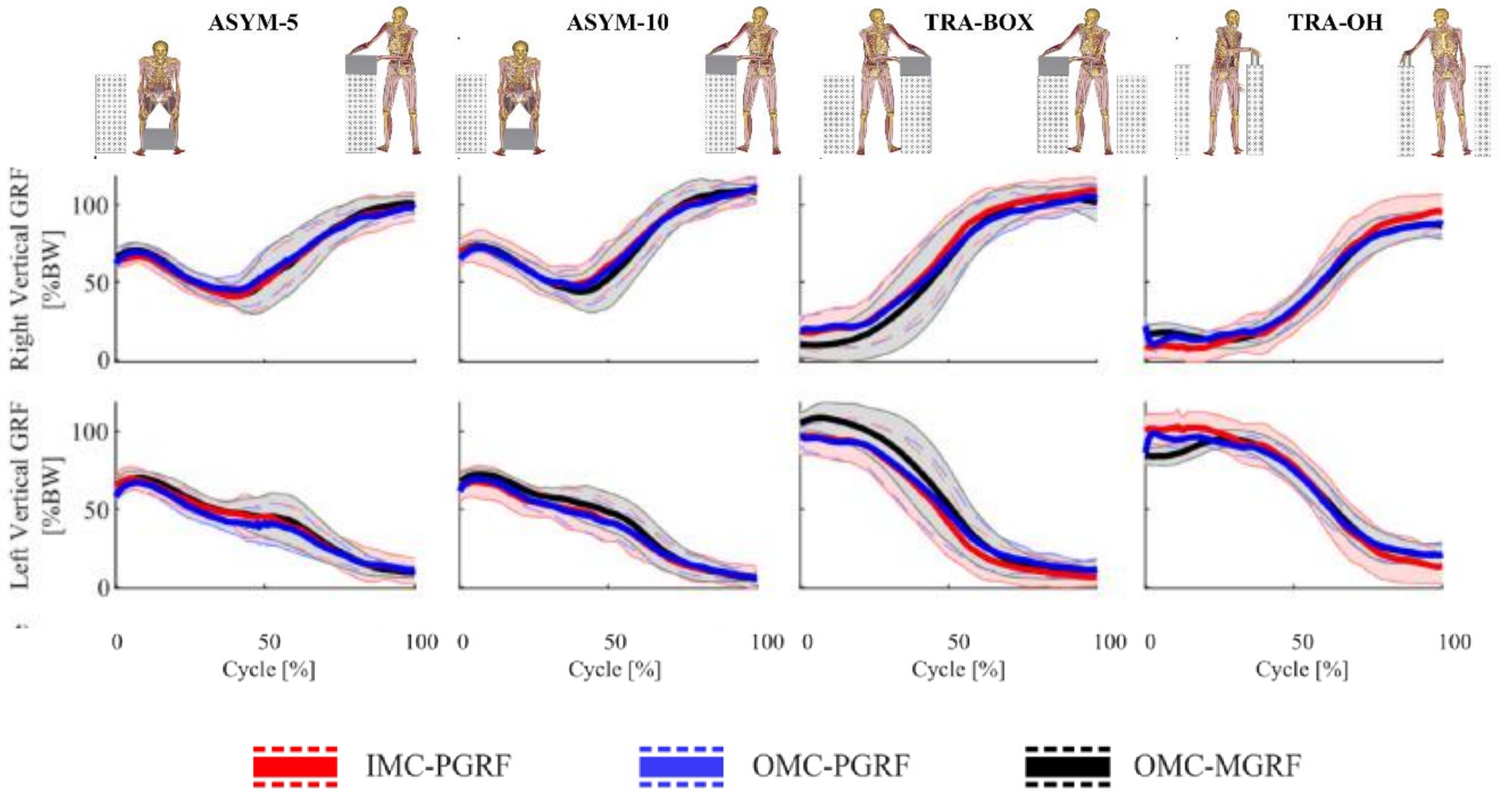
(Received 11 April 2019; accepted 9 November 2019; published online 20 November 2019)

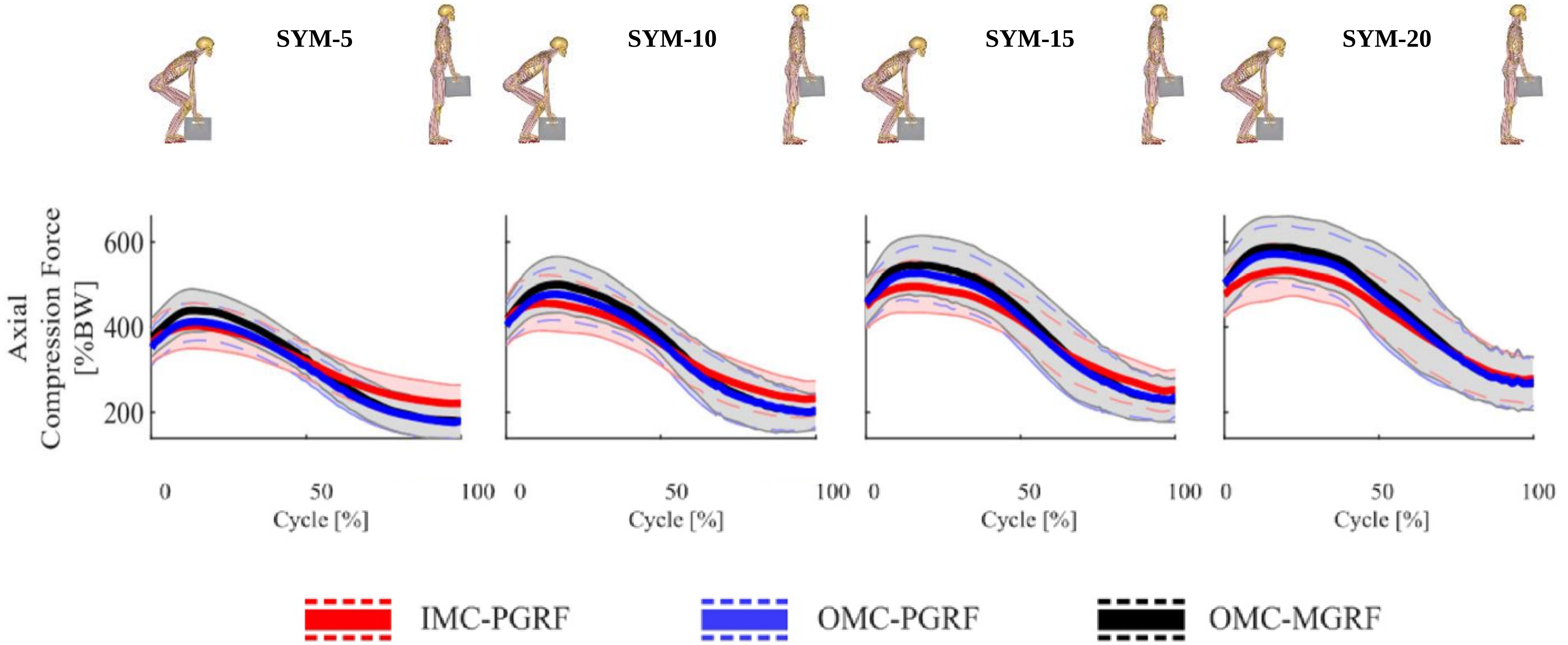
Results: SYM Vertical GRF



Results: ASYM Vertical GRF



Results: SYM axial compression force



Results: ASYM axial compression force

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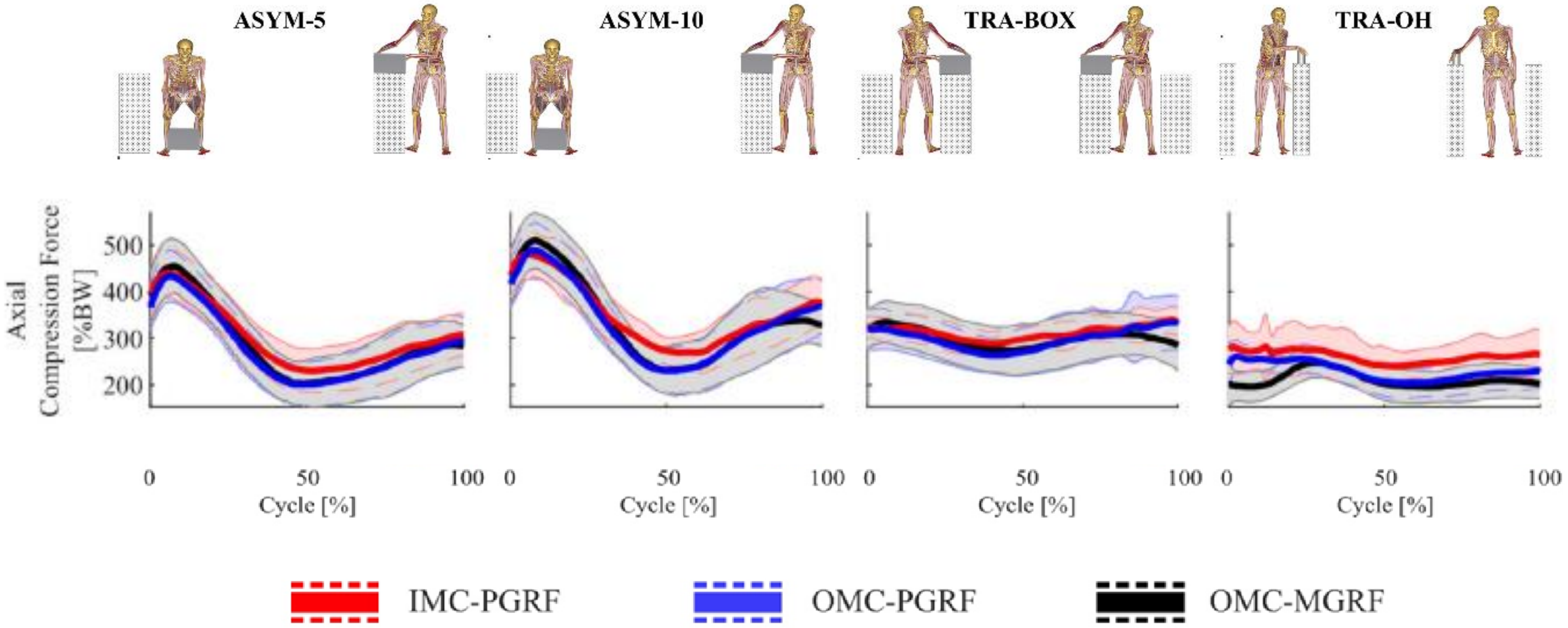

Results: Axial compression force LOA

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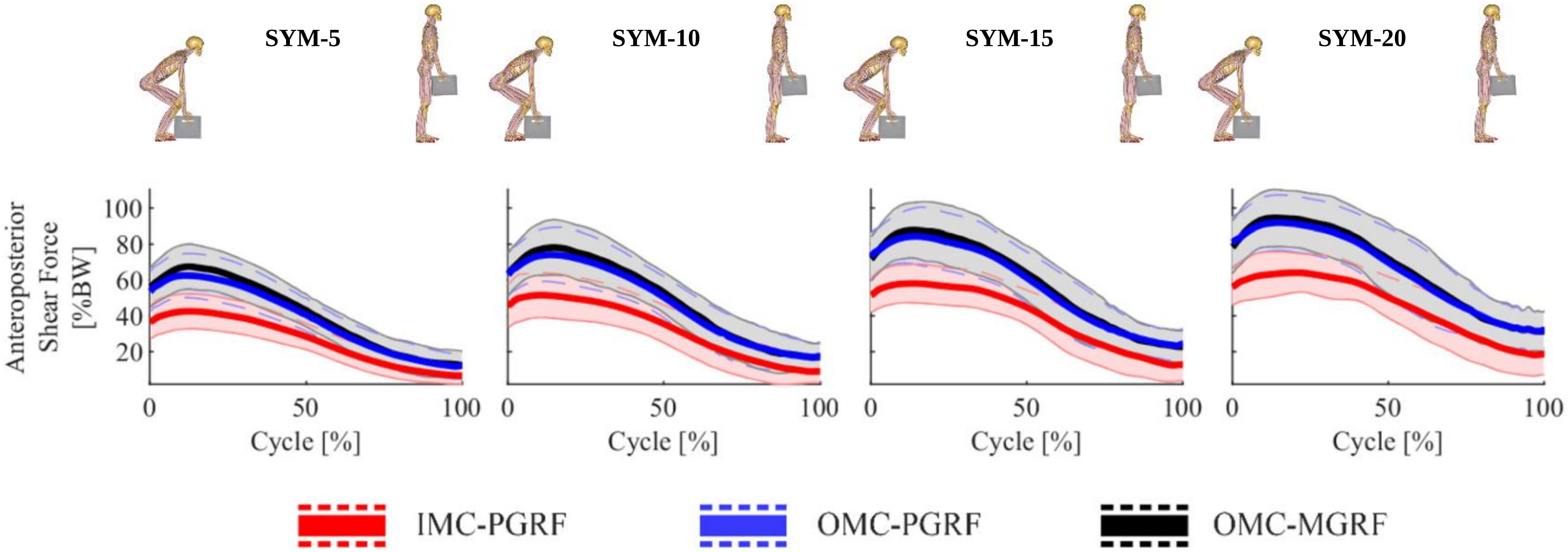
TABLE 3. Median, 5th percentile and 95th percentile comparing inertial motion capture with predicted ground reaction forces (IMC-PGRF) vs. optical motion capture with measured ground reaction forces (OMC-MGRF) and optical motion capture with predicted ground reaction forces (OMC-PGRF) vs. OMC-MGRF for symmetrical lifting (SYM) with 5, 10, 15 and 20 kg, asymmetrical lifting (ASYM) with 5 and 10 kg as well as one- (TRA-OH) and two-handed transferring (TRA-BOX).

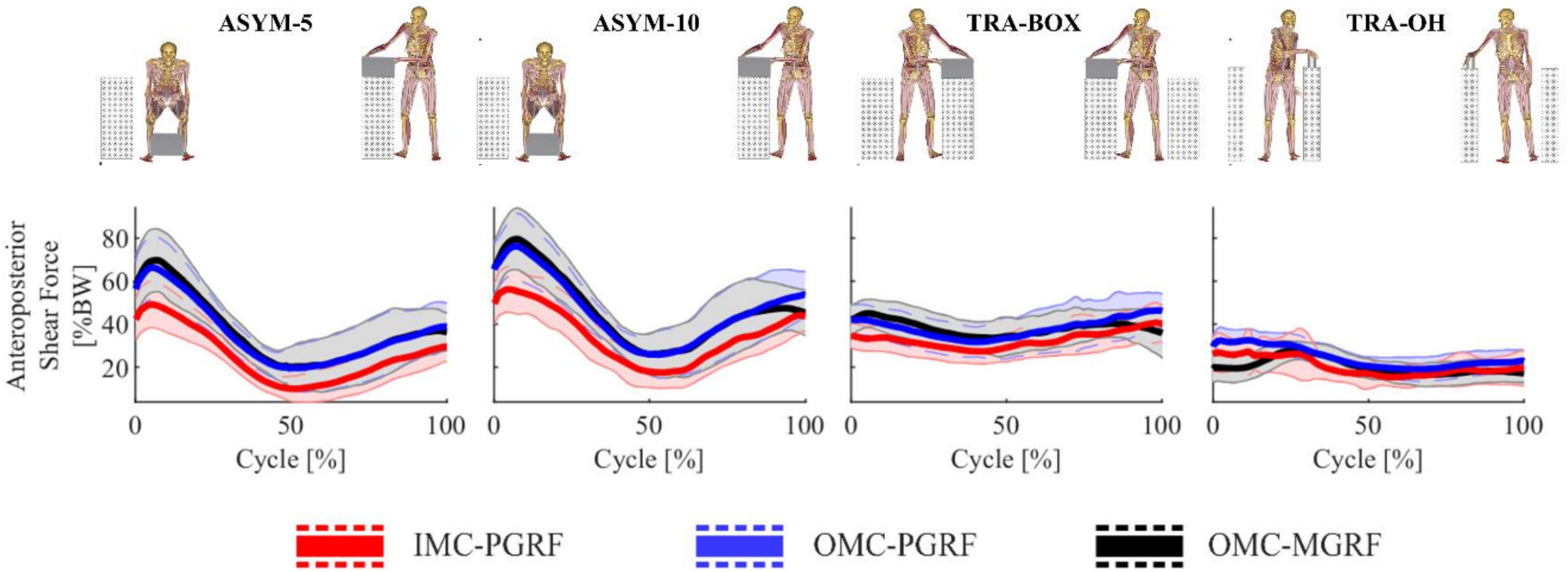
	SYM	ASYM	TRA-BOX	TRA-OH	Overall
OMC-MGRF vs. IMC-PGRF					
Median	12.00	− 16.43	− 13.00	− 47.50	− 10.00
5th percentile	− 118.83	− 105.16	− 91.31	− 145.84	− 111.28
95th percentile	160.90	91.80	82.30	37.85	123.01
OMC-MGRF vs. OMC-PGRF					
Median	12.00	5.65	4.18	− 10.73	6.45
5th percentile	− 7.59	− 12.14	− 69.00	− 72.27	− 23.10
95th percentile	37.60	29.14	31.57	6.03	34.02

Results are for L4–L5 axial compression force (%BW).

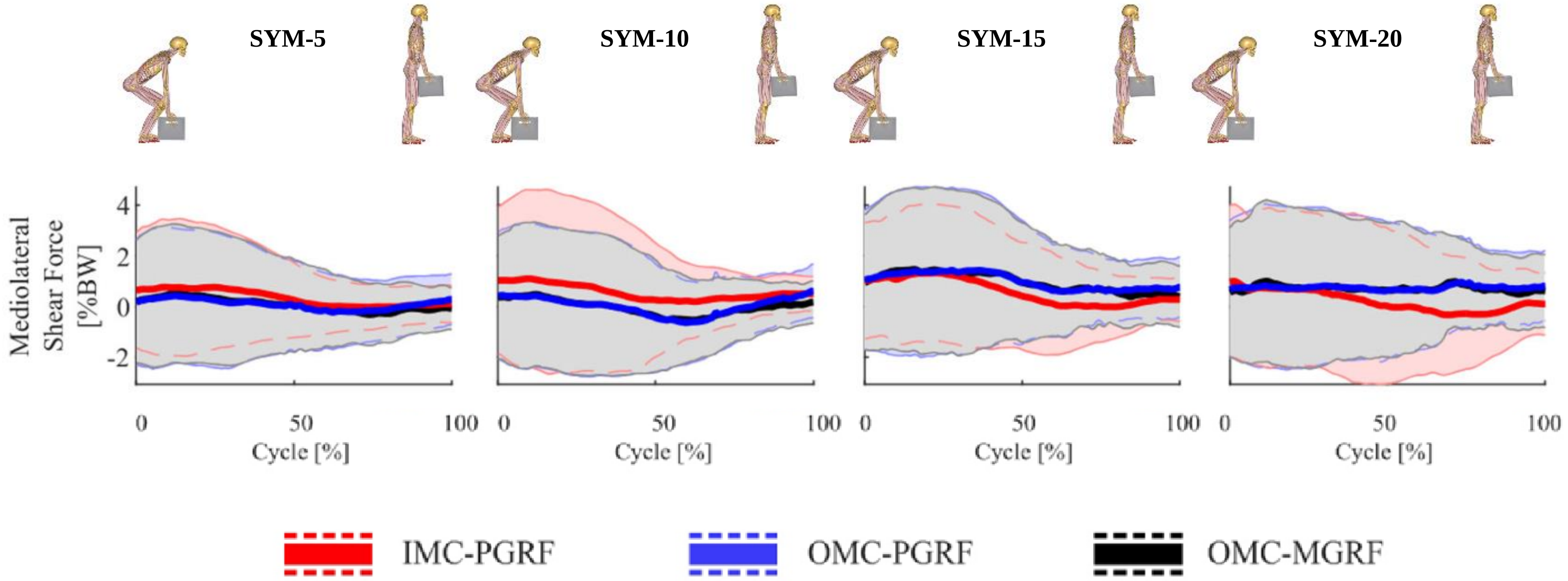
Results: SYM anteroposterior shear force



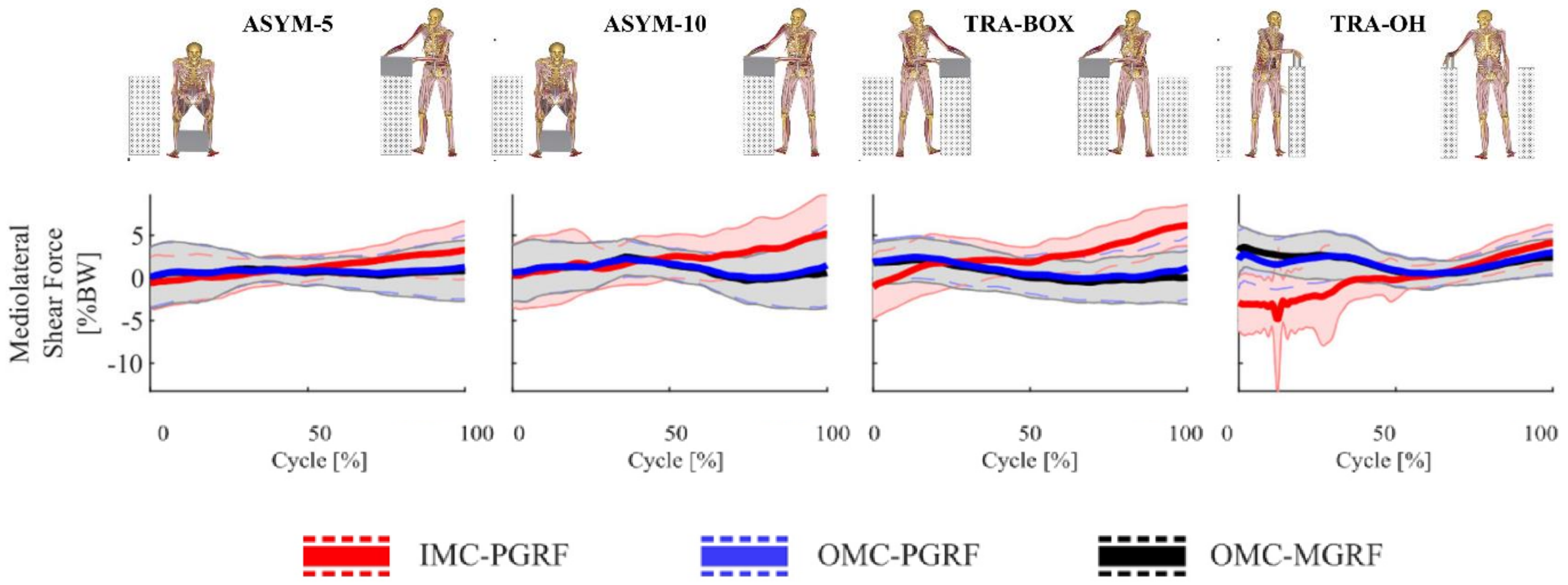
Results: ASYM anteroposterior shear force



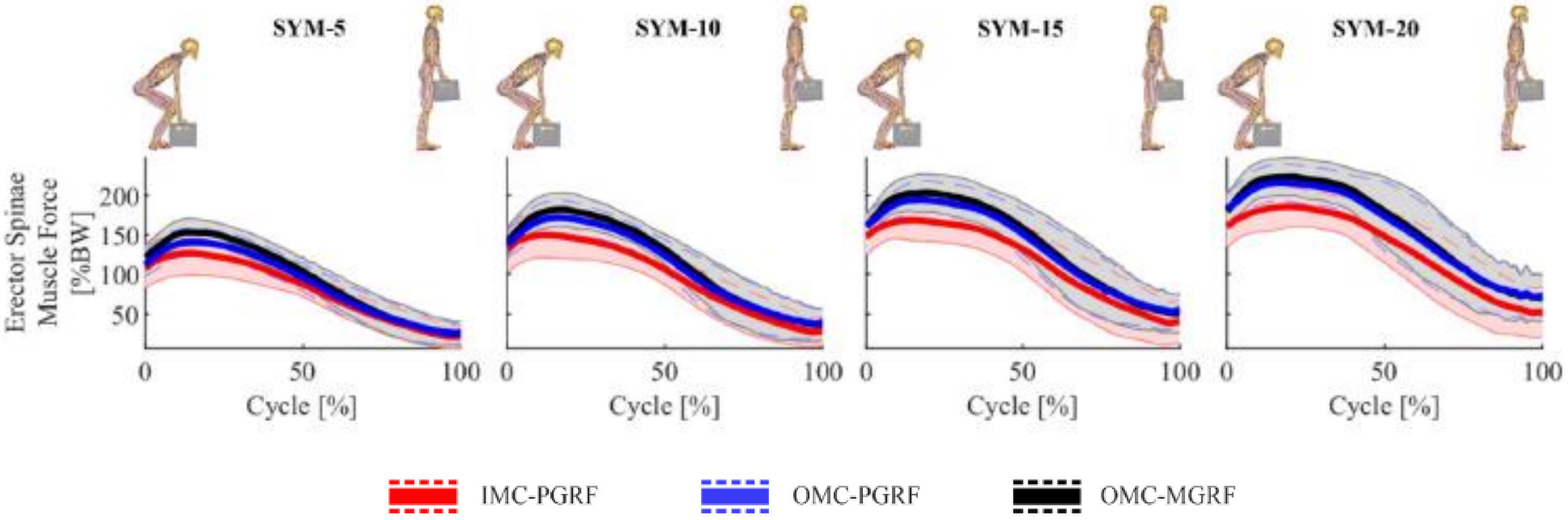
Results: SYM mediolateral shear force



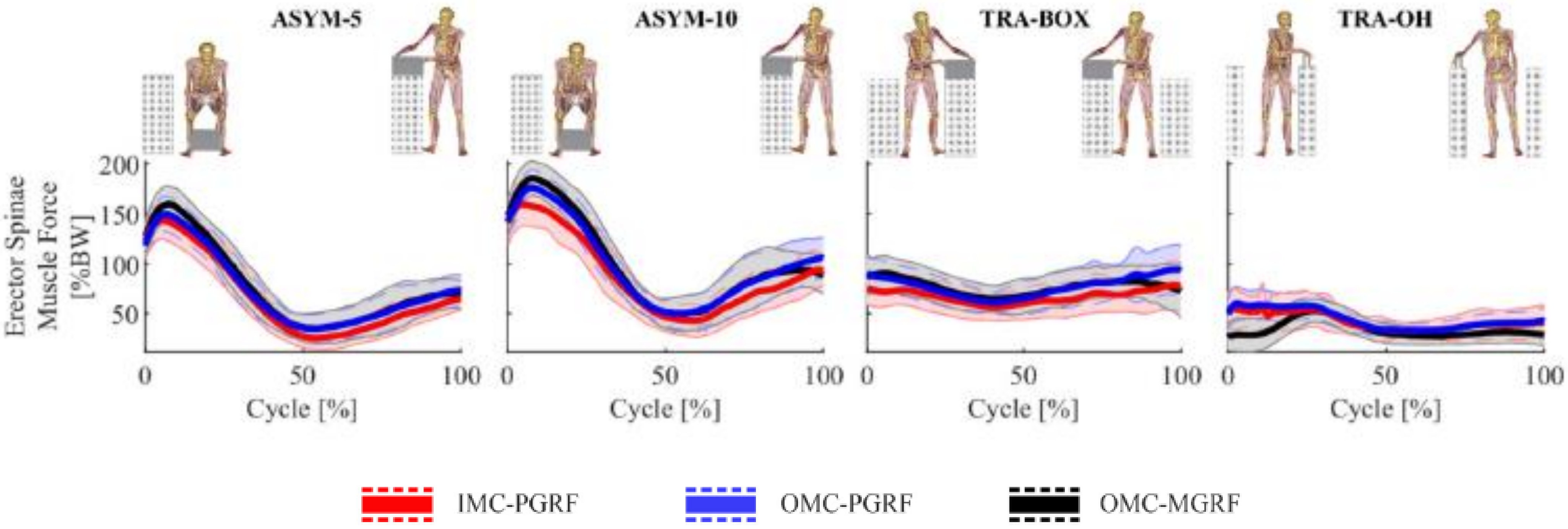
Results: ASYM mediolateral shear force



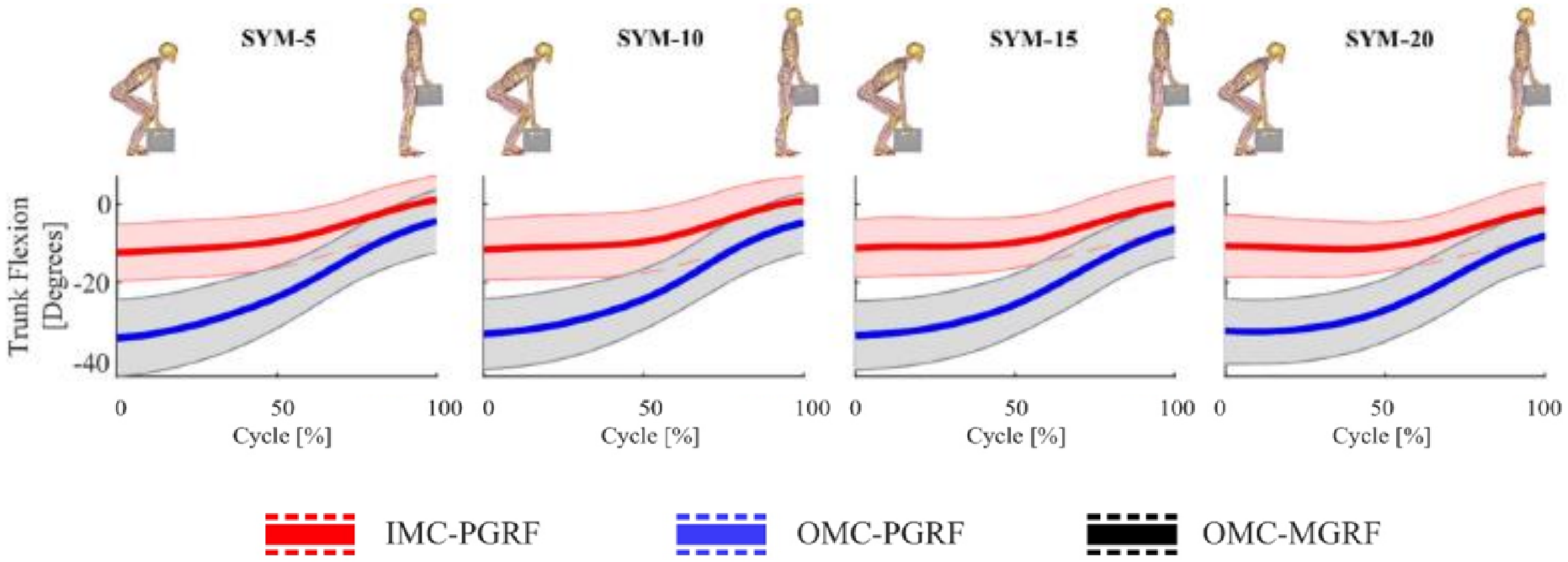
Results: SYM Erector spinae



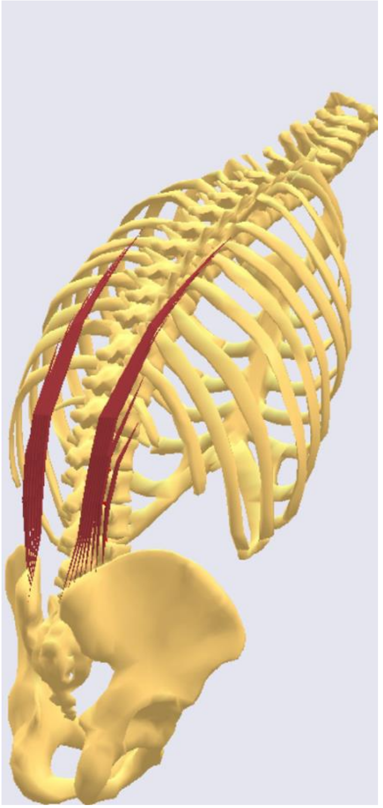
Results: ASYM and TRA Erector spinae



Thorax-Pelvis orientation



Sensitivity of pelvis tracker?



(De Zee et al. 2007)

Conclusion

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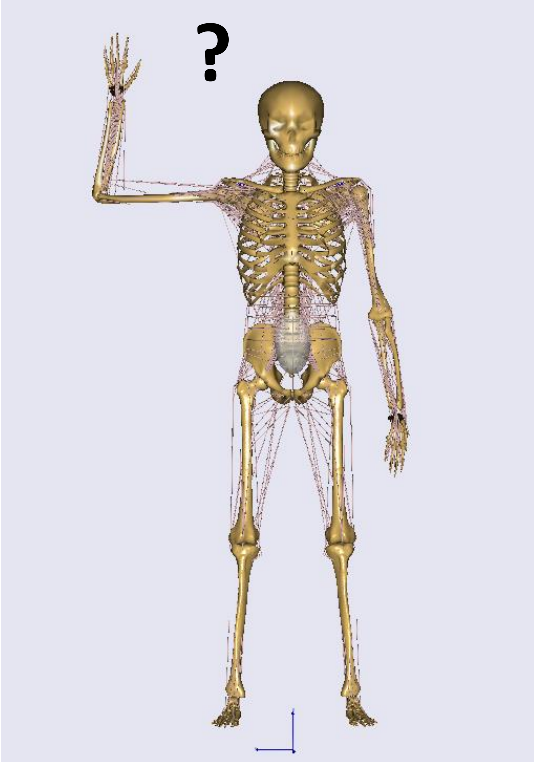
- IMC-PGRF model can be used to estimate musculoskeletal loading during standard manual materials handling tasks under dynamic conditions
- The introduction of a burden to the analysis results in less accurate JRF compared to a previous study on gait (Karatsidis et al. 2019)
- IMC-PGRF models might be used in the field to track relative changes in axial compression forces

Acknowledgements

- Xsens for lending us the Awinda system
- Sebastian Skals is funded by the Danish Council for Independent Research



New BVH improvements in version 7.2.3

! Ensure you use the newest version:
- Anybody Model Repository (AMMR v.2.2.3)
- AnyBody Modeling System (AMS v.7.2.3)

- 1.Virtual markers are attached to the BVH rig
- 2.When models loads the position of the markers are calculated using a "forward" approach
- ✓ 3.Removes jump in angles problems entirely
- ✓ 4.The PreProcess analysis step is no longer needed

Note:
- Many inertial MoCap system suffer from bad acceleration data.
- Wrong accelerations == wrong forces

ANYBODY TECHNOLOGY

Updating older models

Goto AMMR documentation:

ANY MODEL REPOSITORY

Quick search

Go

Table of Contents

Welcome to the AMMR documentation!
Getting Started with AMMR
Configuring the Body Model
The Body Models
Application Examples
- Daily activities and ergonomics
- Motion Capture and gait analysis
- Orthopedics and rehab
- Other examples
- Sports
- Validation

Creating a Human model from scratch
Introduction to Scaling
The AnyMoCap Framework
About the AMMR

Updating old (ammr < 2.2.3) BVH based models

The safest approch is to reimplement your model based on the newest BVH example and AMMR v.2.2.3.

However, it is also posible to change a few files in existing models to utilize the new BVH improvments in AnyBody v.7.2.3.

1. **Important**: Make sure your use the new AMMR (>=2.2.3) and new AnyBody Modeling System (>=7.2.3). You can copy your existing model folder into the new AMMR, or edit the local `libdef.any` file to point to the new AMMR.
2. Add following to the local `libdef.any` file to enable new features:

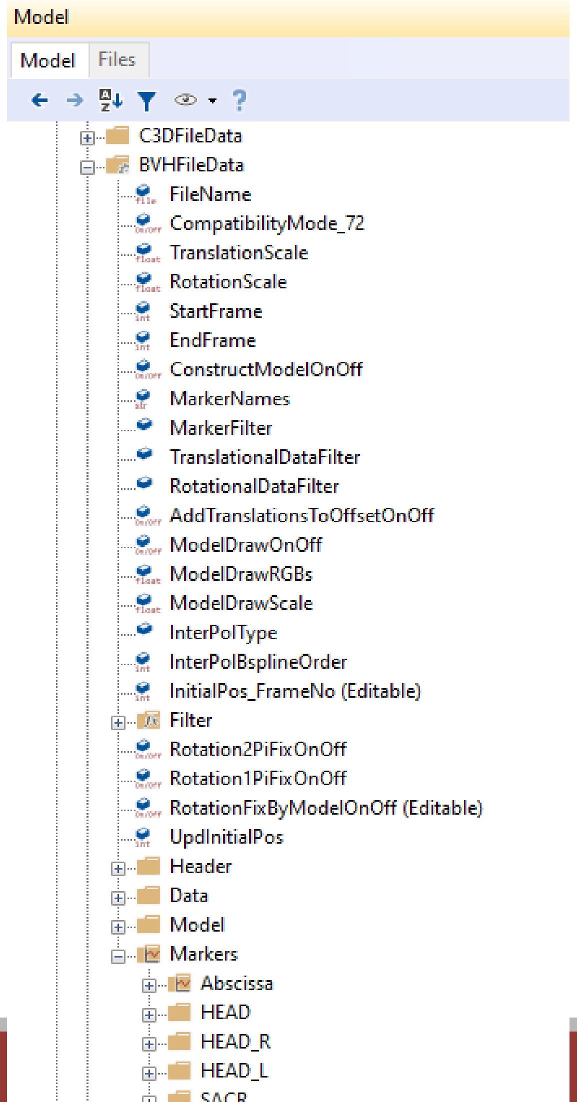
```
#define MOCAP_FUTURE_BVH_READER_73
```

From future version 7.3 this will not be necessary

2. Add the following the follwing to `MarkerProtocol.any` file:

```
Main.ModelSetup.BVHFileData.CompatibilityMode_72 = Off;
Main.ModelSetup.BVHFileData.MarkerNames = {
    "HEAD", "HEAD_R", "HEAD_L", "SACR", "RHJC", "LHJC", "T1C7Jnt", "SPINE",
    "L3", "CHEST", "RSJC", "REJC", "RALE", "RWRB", "RWJC", "RHT1", "RHT2",
    "LSJC", "LEJC", "LALE", "LWRB", "LWJC", "LHT1", "LHT2", "RKJC", "RKNE",
    "RAJC", "RTOE", "RTOE2", "LKJC", "LKNE", "LAJC", "LTOE", "LTOE2"
};
```

Note: If you have adapted your protocol to anything else that the Xsens standard you need to use your own marker names. Also, the model may complain about deprecated members, which can just be deleted.



www.anybodytech.com

- Events, dates, publication list, ...

www.anyscript.org

- Wiki, Repositories, Forum

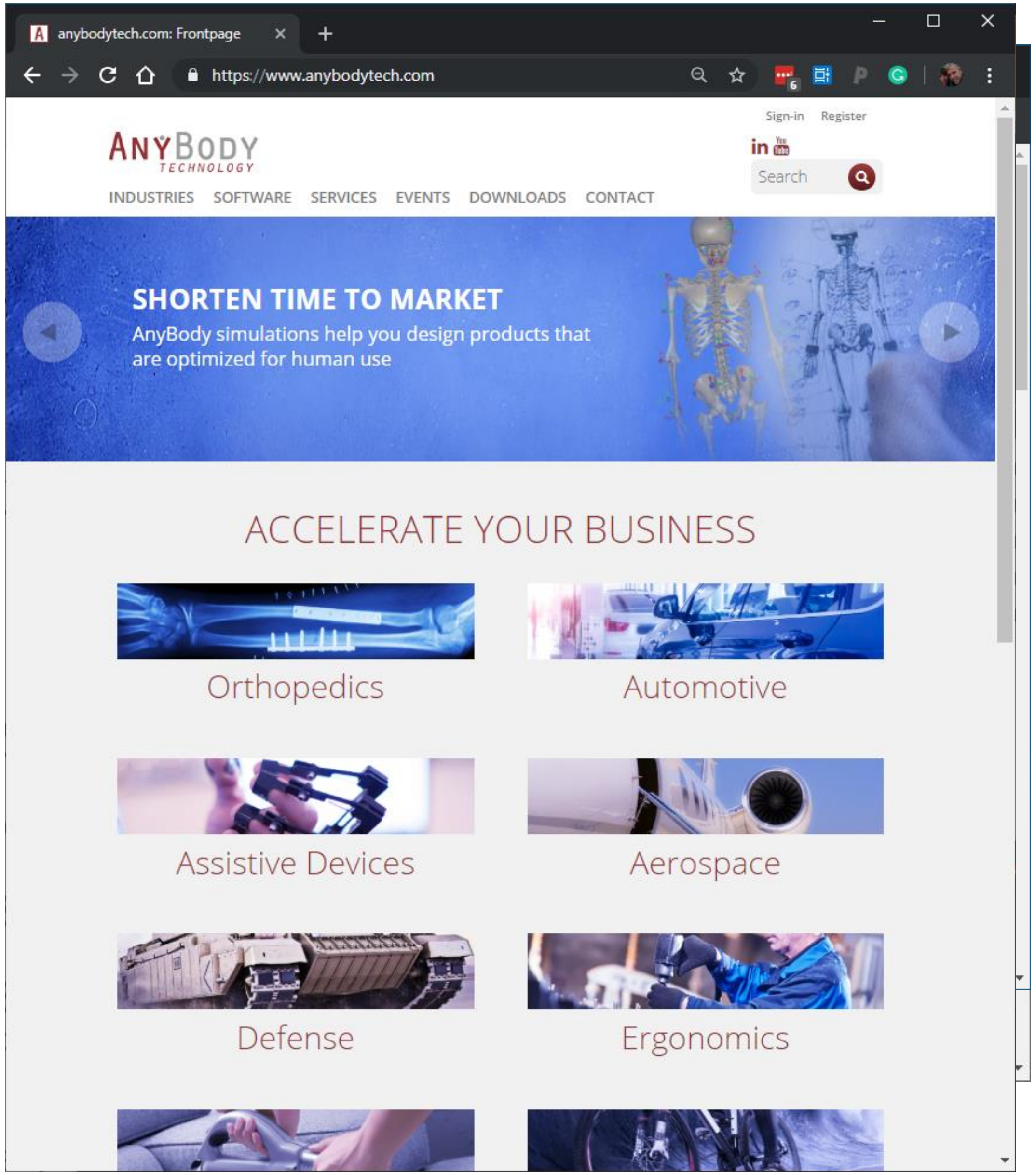
Events:

- May 6th Webcast (English):

Subject-specific lower limb modeling and evaluation with a force-dependent kinematics natural knee model

- May 7th Webcast (Spanish):

Modelado y evaluación del miembro inferior nativo usando cinemática fuerza-dependiente y geometrías específicas del sujeto



Meet us? Send email to sales@anybodytech.com

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Time for questions: