Musculoskeletal Modeling of the Pelvis and Lumbar Spine During Running

Musculoskeletal modeling provides an alternative to in-vivo characteristics that are difficult to directly measure for movements such as running, especially for trunk muscles and joints.

The full-body-lumbar-spine (FBLS) model by Raabe and Chaudhari, 2016 is an OpenSim model created for simulations of jogging.

The lifting full-body (LFB) model by Beaucage-Gauvreau et al., 2018 is an adaptation of the FBLS created for estimating spinal loads during lifting.

We show that when executing Inverse Kinematics (IK) for running motion in OpenSim, the adaptations of the LFB model result in large changes in pelvis and lumbar rotation.

Inverse Kinematics were executed using experimental data for the FBLS and LFB models.

5 runners ran on a treadmill at self-selected jogging pace (2.6±0.2 m/s).
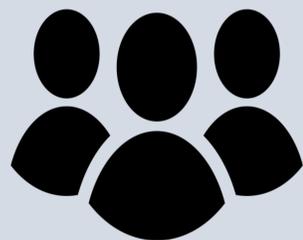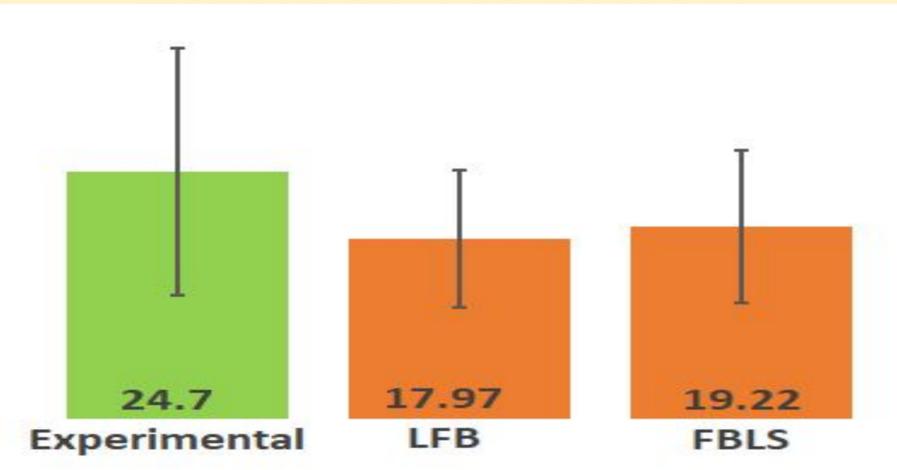
Axial rotations at the pelvis segment and for the sum of lumbar motion (L1-L5 intervertebral disc joints) were calculated from marker data.

The range of motion (ROM) was averaged for the experimental data and each computational model.

Pelvis Rotation

Experimental	LFB	FBLS
33.6	29.53	18.39

Lumbar Rotation

Experimental	LFB	FBLS
24.7	17.97	19.22

Conclusions

The addition of linear kinematic coupling constraints in the LFB model to distribute the net trunk motion across the six intervertebral joints (T12-L5) resulted in a significant increase in total lumbar ROM.

Both models showed less ROM at the lumbar and pelvis than experimental data.

The differences could be because the experimental data used a multi-segmented torso and a rigid lumbar spine marker model, whereas the OpenSim models utilized a rigid torso (lumped thoracic and cervical vertebrae, ribcage, scapulae, and head) with a coupled lumbar spine.

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