**Analysing the effect of body fat on musculoskeletal modelling systems: A pilot study**

Vignesh Radhakrishnan1, Samadhan Patil1, Adar Pelah1, Peter Ellision1

1: School of Physics, Engineering and Technology, University of York, York, UK

Vignesh Radhakrishnan is currently pursuing a PhD in Electronics Engineering in the School of Physics, Engineering and Technology at the University of York, UK. He has an MSc in Control Systems from Georgia Institute of Technology, USA and a BE in Electrical and Electronics from PES University, India. Prior to his PhD, Vignesh worked as a software and controls engineer at NSK Ltd in US, Japan and Germany for four years. Recent publications include a conference paper titled “Determining bone position using microwave imaging: A feasibility study” to be presented at the IPEM Science and Technology Forum 2023 in Glasgow, and a journal paper titled “Engineering functional and anthropomorphic models for surgical training in interventional radiology: A state-of-the-art review”.

**Keywords:** Soft tissue artefacts, Body Mass Index, OpenSim

**Background:**

Human movement analysis, using musculoskeletal modelling software (MMS) and marker-based systems, is used to solve real-world challenges like prosthetic design, pathology diagnosis and preoperative planning. Studies have shown that soft tissue artefacts (STA) result in significant joint angle variations in MMS, with significant increases in model marker errors, especially at the thigh. However, these findings are based on simulations or data from subjects with a healthy body mass index (BMI), with the relationship between BMI and model marker errors not being fully explored in clinically relevant patients.

**Purpose:**

This study tests the hypothesis that model marker error increases with BMI.

**Method:**

Gait data were collected from 22 healthy subjects of varying BMI using the OptiTrack system, with marker locations determined using the lower body Helen Hayes markerset. Calculation of model marker errors during walking was done in OpenSim using a scaled musculoskeletal model. Spearman’s rank coefficient was used to determine correlation between marker errors and BMI, and between marker errors and thigh body fat (determined using skin callipers). To account for weighting of markers, analyses assigning equal weight to all markers and higher weighting to markers on bony-landmarks were performed.

**Results:**

All marker errors exhibited positive correlation with BMI and thigh body fat, using both weighting strategies. Magnitude of frontal thigh marker errors were significantly correlated with thigh body fat (p<0.05) and BMI (p<0.05) with an increase in error of ca 70%. Results for other markers were non-significant.

**Conclusion:**

These results support the hypothesis that marker errors increase with BMI, especially for frontal thigh markers. With studies showing joint angle variations due to marker errors, future work will aim to quantify the relationship between marker error and joint angle error.

**Implications:**

Whilst studies compensating for STA have suggested: removal of thigh markers, new analytical methods and model constraints, they do not address kinematic accuracy nor do they account for variation in BMI. We have highlighted the importance of accounting for body fat in MMS calculated kinematics, while providing gravitas for developing clinical tools for higher BMI patients.

**Presentation preference**: Poster

**Ethics**: Ethics was required for the above study and consent was provided by all subjects prior to data collection. Ethics for the study was provided by the School of Physics, Engineering and Technology, ethics committee at the University of York, UK.