Tutorial 1A: **Benno Nigg** University of Calgary

Paradigms of running biomechanics

Paradigms describing running biomechanics have been proposed rather early in the recent research publications related to running. It has been proposed that 1) running should be modified to minimize impact loading and 2) running should be modified to minimize foot pronation, both to minimize running related injuries.

We have proposed that these original running paradigms in their current form are not valid and should be rejected. Furthermore, we have proposed some new paradigms: 1) the muscle tuning paradigm and 2) the preferred movement path paradigm, both to improve the understanding of running biomechanics.

This tutorial will (a) discuss the epidemiological and functional reasons why the impact and pronation paradigms should be rejected, (b) discuss and explain the muscle tuning paradigm and (c) discuss the preferred movement path paradigm. The tutorial will use lectures and discussions.

Recommended literature:

Nigg, B. M., Mohr, M. & Nigg, S. R. (2017). Muscle tuning and preferred movement path – a paradigm shift. Current Issues in Sport Science, 2:007. doi:10.15203/CISS_2017.007.

Tutorial 1B: **Todd Pataky** from Kyoto University Graduate School of Medicine

Statistics and Biomechanics

This tutorial will review the history of applied statistics and its uses in biomechanics. The roles of classical, modern and computational statistics and machine learning will be highlighted along with some key examples from the biomechanics literature. Increasingly popular analysis techniques will be reviewed including: functional data analysis, principal components analysis and statistical parametric mapping. Frequentist vs. Bayesian perspectives will be considered, and key statistical controversies will be discussed.

Tutorial 2A: **Saija Kontulainen**, University of Saskatchewan

Bone strength and physical activity

This interactive tutorial will discuss bone adaptation to physical activity with a specific focus on evidence from advanced imaging studies. The tutorial will review pertinent evidence from experimental and observational studies, as well as randomized controlled exercise trials assessing bone adaptation in clinical studies of growing and aging skeleton. Findings will be discussed in relation to theoretical bases of bone adaptation to loading stimulus with interactive examples. Theoretical bases will include the Mechanostat model, which explains how bone strain from loading stimulus leads to bone adaptation. The tutorial will also discuss physical activity interventions in individuals at risk of fracture as well as future research directions. By the end of this tutorial, participants will be able to describe, with examples: 1) bone structure and strength adaptation to physical activity/loading; 2) the Mechanostat model explaining bone adaptation to loading; 3) evidence of physical activity and bone strength in individuals at risk of fractures; and 4) areas of future research.

Tutorial 2B: **Tim Derrick,** Iowa State University and **Stacey Meardon,** East Carolina University

Standardization of reporting kinetic data in biomechanics

The calculation and presentation of 3-dimensional joint moments gives the researcher a variety of choices that must be made and documented. From smoothing noisy kinematic and kinetic data, to choosing an anthropometric model and utilizing a specific method of calculation, there are a number of options that affect the joint moment values. Once the moments have been calculated there are additional choices that must be made so that the data convey the maximal amount of information. These include the choice of presenting the internal or external moments, the choice of a coordinate system, and the method of normalization. If these decisions are made carefully the joint moments can provide a wealth of information concerning human movement. Haphazard or undocumented decisions can lead consumers of the research to a frustrating experience.

The purpose of this tutorial is to take a slow and methodical look at the calculation of joint moments. We will cover data smoothing, anthropometric modelling, and briefly describe methods of calculation. We will then look at the presentation of these data with special regard for the type of moments, the coordinate system and methods of normalization. Participants will have access to an online database that will allow an interactive how these varying methods affect the resulting curves.