The weekly recap of what is going on in the world of biomechanics.

In todays update on recently published papers we share a glance at a journal pre-proof on the regulation of foot and ankle stiffness. Enjoy the read!

Regulation of foot and ankle quasi-stiffness during human hopping across a range of frequencies:

The group of researchers from Australia and Canada had a close look at the behavior of the foot stiffness during hopping. Basically, human legs during walking and running (locomotion) behave like springs with adjustable stiffness. In modeling, this is often represented by a rigid-foot segment. That means all calculations are carried out as if the shank was directly connected to one rigid foot. We know that the foot is not entirely rigid, but using a model means we work with simplifications of reality.

However, the group wanted to find out whether the stiffness of the foot can be actively regulated, for example by the intrinsic foot muscles (that are the ones located only in your feet, unlike the extrinsic foot muscles which can be reaching up to your knee). To be more precise, the group examined the quasi-stiffness of the foot, which is used as a measure of joint deformation under an applied load. The group invited 22 individuals and recorded a single-leg hopping task at three distinct frequencies. Methods that were used included the lower limb kinematics, kinetics, and EMG. If you are unsure about the differences between kinetics and kinematics have a look at our Fundamentals of Physics section.

Back to the paper, the group calculated kinetics and kinematics once using the mentioned rigid-foot model and then again, this time using a multi-segment-foot model. The latter model uses an anatomical ankle, meaning the shank is connected to the calcaneus.
During hopping, the midfoot quasi-stiffness increased with hopping frequency and muscle activation of the intrinsic foot muscles during contact phase decreased. Why this happens is not clear yet. But interestingly the rigid-foot model, which is so commonly used, overestimated ankle Range of Motion (ROM) by around 10% and underestimated ankle quasi-stiffness by 45-60%! That is an impressive demonstration of the need to rethink the use of the rigid-foot model.

Since we´ve been quite obsessed with new methods the past month, we really like to show you how also established methods get adjusted and evolve. As always, we recommend reading the original abstract or article if you are interested in more details!

Sarah E. Kessler, Glen A. Lichtwark, Lauren K.M. Welte, Michael J. Rainbow, Luke A. Kelly, Regulation of foot and ankle quasi-stiffness during human hopping across a range of frequencies, Journal of Biomechanics, 2020, 109853, ISSN 0021-9290, https://doi.org/10.1016/j.jbiomech.2020.109853