

## The estimation of body center of mass kinematics in sport: proposal of a new protocol

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The assessment of body Center of Mass (CoM) kinematics is an important measure in the analysis of sport movements since it is strictly related to balance and stability control [1]. Among the methods proposed to estimate CoM displacement, Segmental method appears to be suitable to investigate CoM kinematics in sport: human body is assumed as a system of rigid segments, and the whole-body CoM is calculated as the weighted average of the CoM of each segment. Each segment is defined by a set of landmarks, and their overall number represents a crucial choice in the protocol design process, being a compromise between accuracy and invasivity [2]. In the present study, using a motion capture system, we validated a protocol based upon the Segmental method, adopting a 14-landmarks anatomical model.

Two sets of experiments were made. At first, our protocol was compared to the Ground Reaction Force method (GRF), accounted as a golden standard in CoM estimation. Subsequently, we investigated the aerial phase typical of many sports, comparing our protocol with: (1) an absolute reference, the parabolic regression of the vertical CoM trajectory during the time of flight; (2) two common approaches to estimate CoM kinematics in gait, known as Sacrum and Reconstructed Pelvis methods. Recognized accuracy indexes proved that the results obtained were comparable to the GRF; what is more, during the aerial phase our protocol showed to be significantly more accurate than the other two methods.

The protocol assessed can therefore be adopted as a reliable tool for CoM kinematics estimation in further sport researches.

### References

- [1] McKinnon et al. (2004) *Physiological Measurement* 25: 1339–1354.
- [2] Forsell and Halvorsen (2009) *J Biomechanics* 42: 361–365.

### Key words

Motion analysis, sport, center of mass, segmental centroid.