

The consideration of all mechanical energy components acting on the center of mass while running

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INTRODUCTION

- Kinetic and potential energies acting on the center of mass (COM) have been considered in running.
Cavagna 1976 J Physiol
- In running the leg behaves like a linear spring.
Blickhan 1989 J Biomech
- Thus not only kinetic and potential but also an elastic energy has to be considered.
- Moreover, it remains unknown how these energies are related during the different phases of running.

AIM

To investigate how the elastic energy, together with kinetic and potential energies, influence the total mechanical energy during the different phases of running.

METHODS

12 experienced healthy male runners

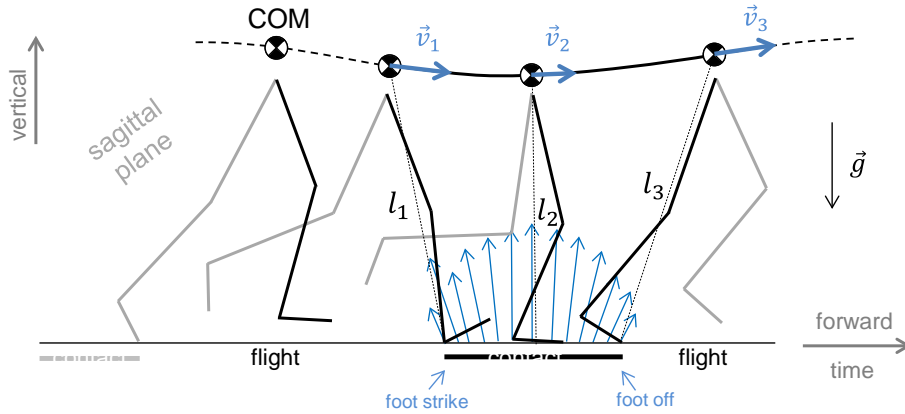
- run at self-selected gait velocity over ~4m long measurement area

Measured

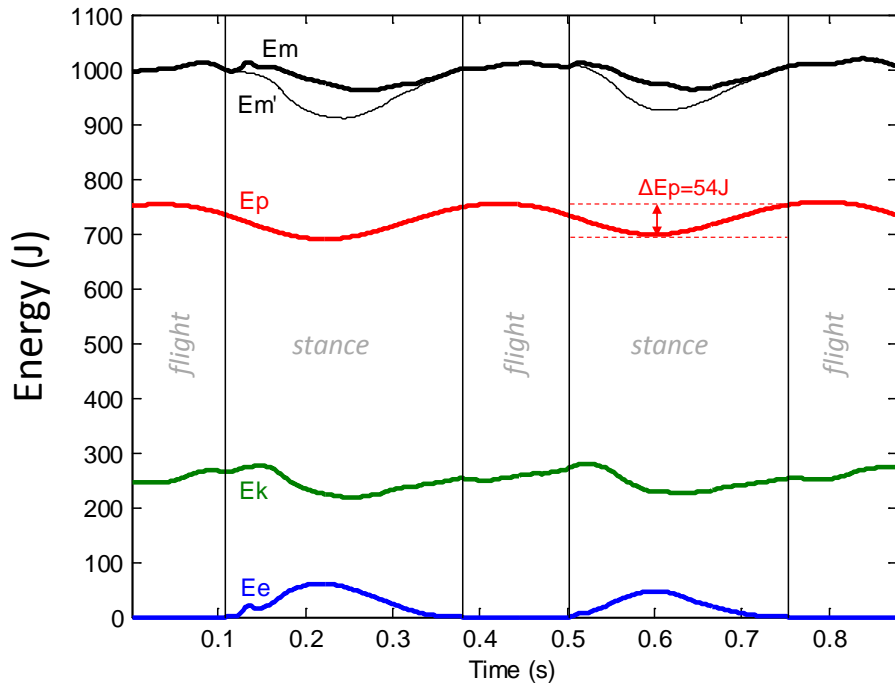
- Anthropometrics
- Vicon (Plug-in-Gait)
- Ground reaction force (GRF)



METHODS



$$\bar{v} = 3.0 \pm 0.3 \frac{m}{s}$$



$$E_{m'} = E_k + E_p$$

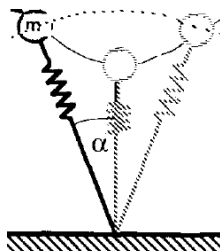
Cavagna 1976 J Physiol

$$E_p = mgh$$

$$E_k = \frac{1}{2}mv^2$$

$$E_e = \frac{1}{2} \left(\frac{F_1^2}{k_1} + \frac{F_2^2}{k_2} \right)$$

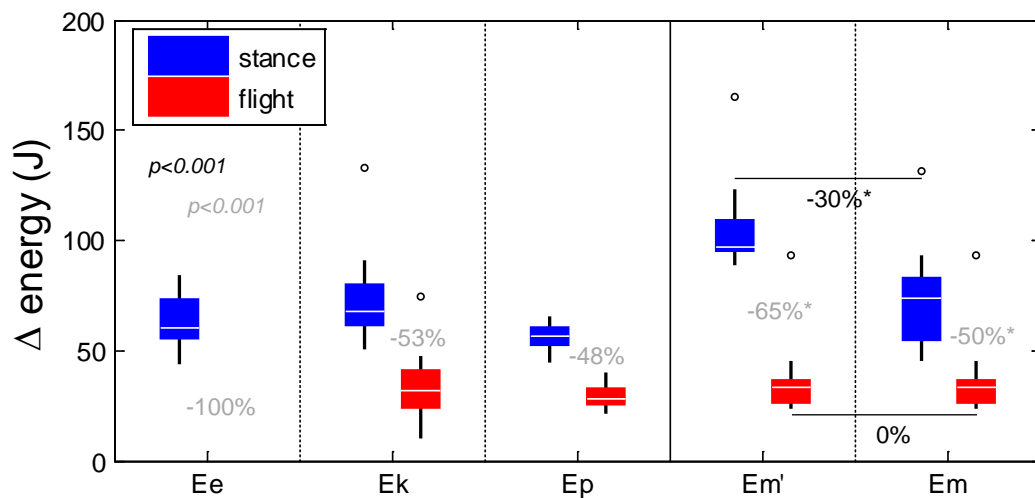
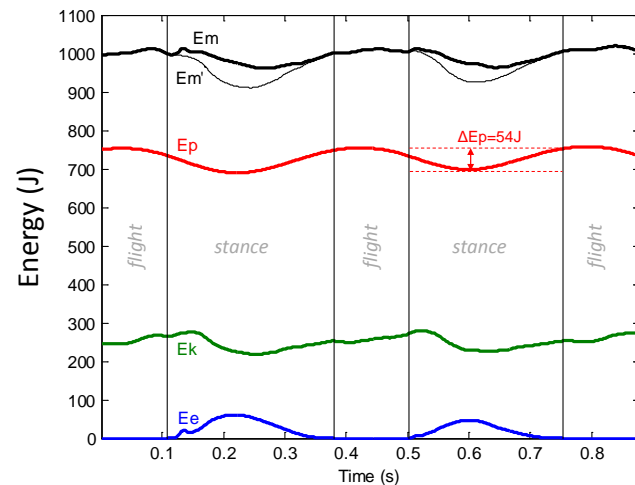
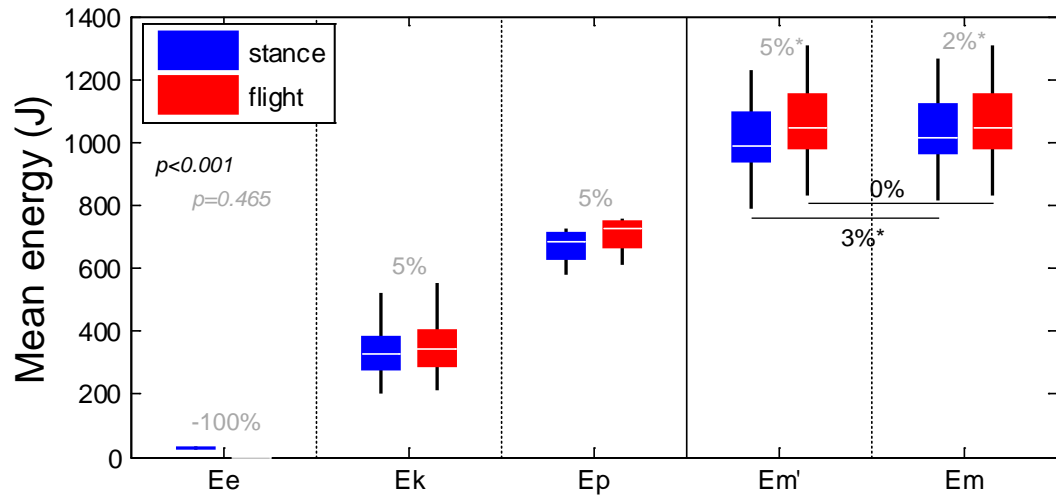
$$E_m = E_k + E_p + E_e$$



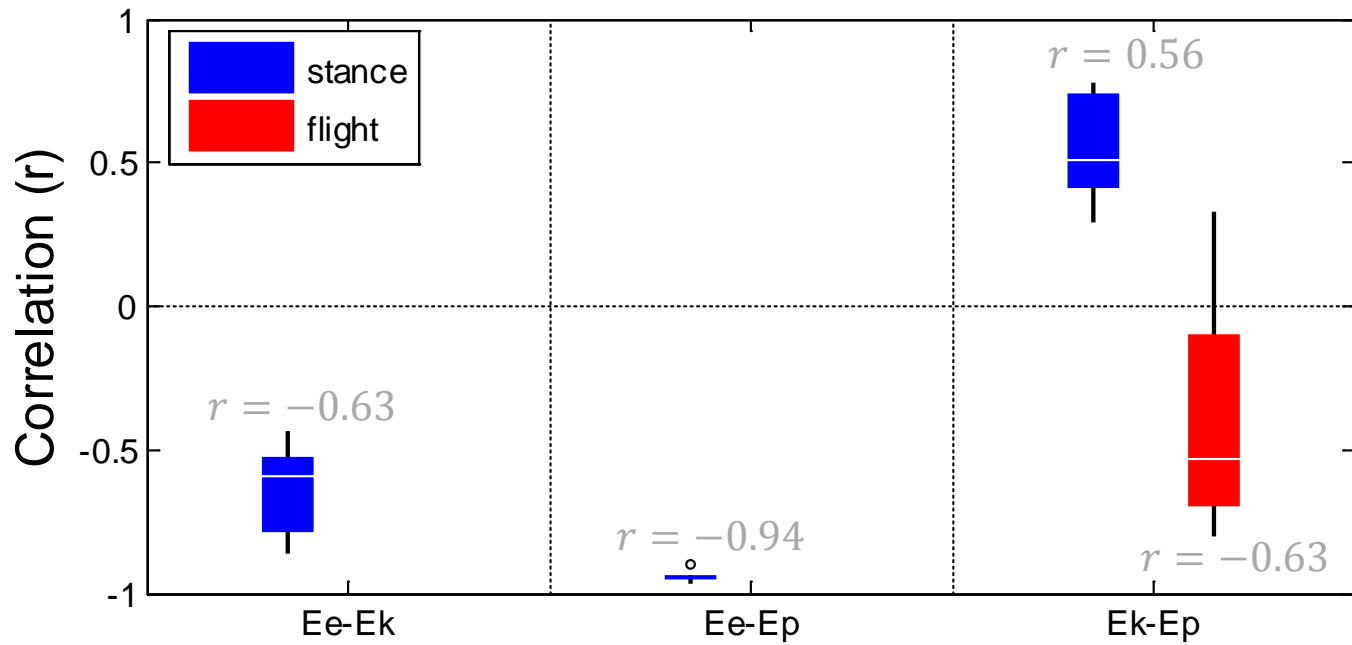
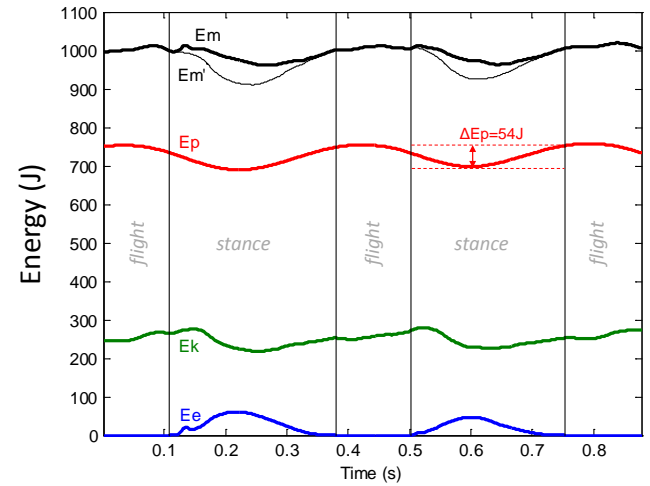
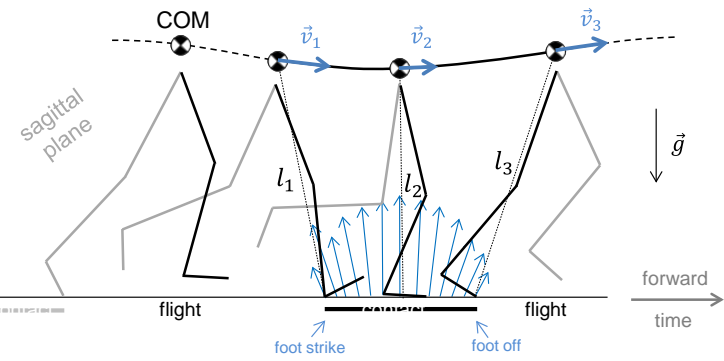
$$k = \frac{\Delta F}{\Delta l}$$

Blickhan 1989 J Biomech

RESULTS



RESULTS

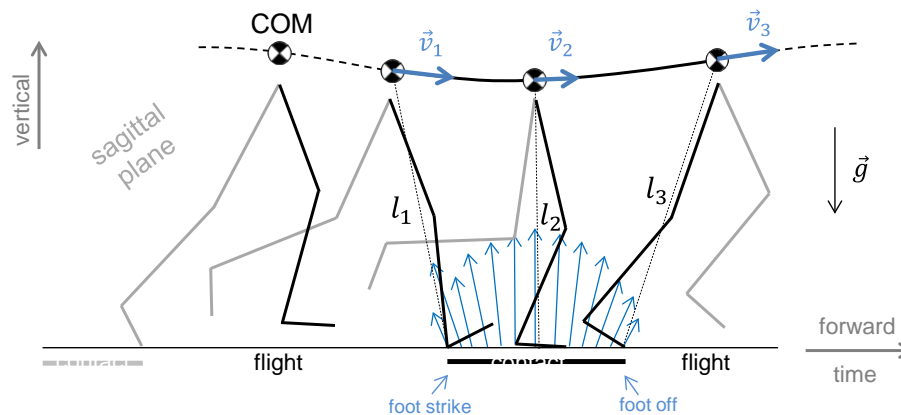


DISCUSSION

- Ee was the lowest energy followed by Ek and Ep.
- ΔE_i was lower for flight vs. stance for all energies (>48%: ΔE_e , ΔE_k , ΔE_p).
- Ee was negatively associated to Ek ($r = -0.63$), Ep ($r = -0.94$) during stance
→ which improved the energy conservation by 30%.
- The association Ek-Ep showed a positive trend ($r = 0.56$), but not as strong as previously expected.
cf. Farley 1998 Exerc Sport Sci Rev
- No association of Ee-Ek, Ee-Ep was found during flight phase.

CONCLUSION

- The consideration of the individual phases in running is important.
- Ee influences the conservation of the total mechanical energy.
- Ee showed a stronger association to Ek, Ep as between Ek-Ep.
- This approach allows a better understanding how running is energetically organized.



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