

## Background

- Animals of very different sizes move in a remarkably similar fashion: transition between one locomotion mode to the other appears at the same Froude number ( $N_{fr}$ ). (Alexander, 1989)

-  $N_{fr}$  fractions lower than 1 (walking) allowed us to observe locomotor patterns similarities and to determine similar dynamic conditions between subjects. (Bisiaux et al, 2003 ; Moretto et al., 2006)

- During running, the human body can be considered as a mechanical spring-mass system. (Mc Mahon et al., 1987; McMahon and Cheng, 1990)

- The Strouhal number can theoretically be used to determine similar step frequencies between two subjects. (Alexander, 1989)

Fig. 1: the inverted pendulum model for walking

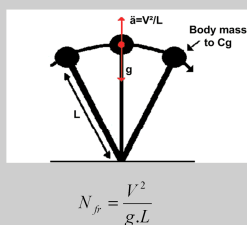
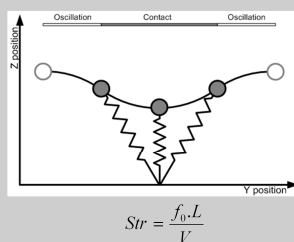


Fig. 2: the spring-mass model for running



The Strouhal number has never been used to determine similar (proportional) step frequencies between subjects.

### Aim of the study

This study compared kinetic data similarities recorded using a force platform during different running tests performed under different similar conditions determined from  $N_{fr}$  and  $Str$  fractions.

## Discussion

A condition was considered to be the best if it allowed us to obtain a greater number of similarities (quantitative aspect), and if it allowed us to obtain the greater mean correlation (qualitative aspect).

**Men:** The determination of similar dynamic conditions from the Strouhal number appeared to be the best method (quantitatively and qualitatively) to obtain inter-subjects similarities in men.

**Women:** The similar dynamic conditions determined from the Strouhal number also appeared to be the best method to obtain inter-subjects similarities in women.

These results showed an interest in using the Strouhal number for the determination of similar dynamic running conditions between subjects in men and women. Taking the leg elastic characteristics into account allowed us to observe similar running individuals' behaviour.

Different behaviour in relation to the gender: men's pattern were mainly organised in accordance with time dimension respect, while women's pattern were principally organised to manage the mass.

→ This difference is probably due to a leg stiffness difference between men and women.

Future investigations should be conducted to determine similar dynamic running conditions between subjects from dimensionless numbers taking the leg stiffness into account.

## Methods

### - Population:

20 adult men (23±8 years old, 68.5±7.05 kg, 1.78±0.06 m) and 18 adult women (27±9 years old, 57.1±5.7 kg, 1.63±0.04 m) volunteered to participate in this study.

### - Protocol:

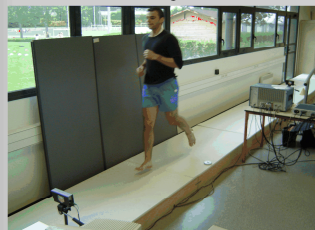
Subjects performed running test under 3 experimental conditions:

- Condition 0 (C0): the same absolute velocity  $V=3.5\text{m}\cdot\text{s}^{-1}$  was imposed on all subjects.

- Condition 1 (C1): each subject ran at his or her own velocity  $V_{N_{fr\ i}}$  determined from Froude number:  $V_{N_{fr\ i}} = \sqrt{N_{fr} \cdot g \cdot L_i}$

- Condition 2 (C2): each subject ran at his or her own step frequency  $F_{Str\ i}$  determined from Strouhal number:  $F_{Str\ i} = \frac{Str \cdot V}{L_i}$

Fig. 3: experimental device for the running test



This procedure allowed us to compare the three conditions while the subjects ran in mean at the same  $N_{fr}$  and  $Str$  numbers.

### - Data processing:

The vertical ground reaction force curve ( $F_z$ ) was analysed to check the contact time (CT); the active peak (Peak); the time to active peak (TP); the loading rate (LR) between 10 and 90% of  $F_z$  active peak; and the vertical impulse ( $I_z$ ).

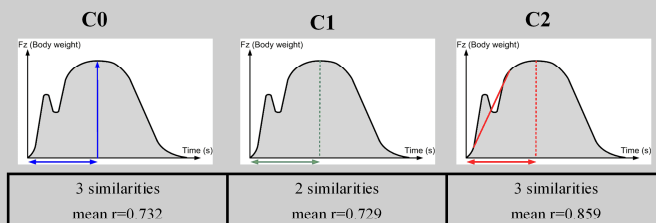
Similarity ratios were computed from each measured parameter for each subject pair combination with reversed ratios avoided → the number of similarity ratios rose to 190 in men and 153 in women.

If dynamic conditions were similar:

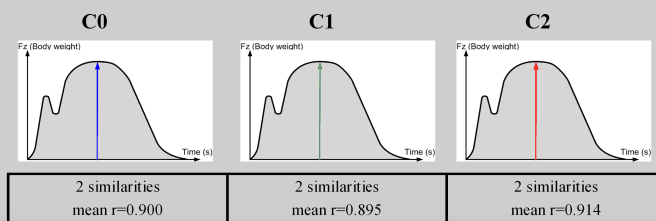
$$k_{Leg} = k_{Weight} = k_{CT} = \dots = k_{I_z}$$

## Results

### Men



### Women



## References

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