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DYNAMIC SIMILARITIES AND DIMENSIONLESS APPROACH TO RUNNING

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INTRODUCTION

Nowadays, a lot of tests on running gait are based on the determination of the same running speed for all subjects. This involves data variability partly due to anthropometric differences between subjects. However, studies focused on walking gait have shown that a dimensionless approach allowed authors to reduce variability of data [1]. Dimensionless analysis of running gait has never been experimented, and requires the determination of similar (proportional) dynamic conditions between subjects. As it has been shown for walking gait, the dimensionless expression of data recorded during running could reduce the variability of parameters recorded under similar conditions.

METHODS

Twenty male subjects ran barefoot on a runway equipped with a Kistler force platform sampled at 1 kHz and covered by an EVA foam.

Running tests were performed in two experimental conditions, C0: all subjects ran at the same absolute velocity $V=3.5 \text{ m}\cdot\text{s}^{-1}$; C1: the stride frequency was determined from the Strouhal number (Str). Str was determined to ensure that the mean step frequency was identical through the two experimental conditions. The vertical ground reaction force (Fz) was analysed to check CT: contact time; TP: time to peak; PF: passive peak force; LR: loading rate; Iz: vertical impulse and antero-posterior ground reaction force (Fy) was analysed to check BP: braking peak; PP: propulsive peak; BI: braking impulse; PI: propulsive impulse.

According to [1], the computation of similarity ratios (k) from anthropometric and kinetic parameters allowed us to study the dynamic similarities.

Parameters used to compute this dimensionless data were those having demonstrated the best inter-subjects similarities [2]. The variance ratio was used to compare the variability of dimensionless data collected under C0 and C1.

RESULTS AND DISCUSSION

Results in Table 1 show that C1 made it possible to highlight the best dynamic similarities. Nevertheless, the decrease of the variability of dimensionless data was observed for 3 parameters out of 9. The dimensionless normalization was founded on the best highlighted similarities, and it seemed to us that the determination of similar dynamic conditions could be improved. Our study was the first attempt to use Str for the determination of similar dynamic conditions.

According to Alexander [3], dynamic similarity between two runners required the same Froude number (dimensionless velocity) and the same Strouhal number (dimensionless step frequency). The concomitant use of Nfr and Str were tested to normalize vertical running parameters [4]. The approach should be enhanced to obtain better similarities in the different reference axis, and a more significant decrease in dimensionless data.

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Table 1: Coefficient of variation (%) of dimensionless kinetic parameters for C0 and C1.

	CT	TP	PF	LR	Iz	BP	PP	BI	PI
C0	7.5	10.7	11.3	13.7	11	-17.1	18.9	-18.1	18.8
C1	9.2	<u>12.4</u>	13.5	11.9	<u>13.2</u>	-16.3	20.7	-15.3	20.8

Values in bold: lowest coefficient of variation for each parameter. Underlined values: experimental condition (Co or C1) allowing us to obtain the best similarities. No significant difference was observed between the experimental conditions.