INTRODUCTION

Human movement variability is the variation of a motor performance across multiple repetitions of a task. In recent years movement variability has been analysed with respect to injury and performance. For example, a low variability in joint segment coupling of the knee joint has been associated with patellar femoral pain syndrome [1]. Studies analysing the variability in running usually focus on time dependent one dimensional variables such as the step frequency or the step length [2]. The step length is the result of the coordinated movement of the limbs and therefore an analysis of the whole movement would provide further insight for the origin of the variability. A comprehensive approach, combining the whole body movement can provide further insight to movement control. The purpose of this paper is to use a comprehensive approach to analyse the whole body movement of running with respect to variability.

METHODS

Ten healthy male recreational runners (age 25.4 ± 5.4 years, mass 75.8 ± 11.3 kg, heights 180.8 ± 5.1 cm, 10k running time = 54.1 ± 7.4 minutes, mean and standard deviation (SD)) performed treadmill runs at five different speeds (1.3 m/s, 2.2 m/s, 3.1 m/s, 4.0 m/s and 4.9 m/s). All speeds were performed for 40 seconds for which the last 30 seconds were recorded. Kinematic data were collected at 240 Hz using 47 reflective markers with an eight camera motion capture system (EVaRT, Motion Analysis Corp, Santa Rosa, CA).

The marker data were analysed with a principal component approach (PCA) [3] in order to identify the principal movements (PMs) of running. The first three PMs explaining 95% of the running movement as well as the general movement defined by the first 12 PMs (explaining 99% of the movement) were analysed.

The coefficient of variation (CV) for each subject and each PM was calculated. The mean and standard error of the CVs for different speeds were tested for significant (α = 0.05).

RESULTS

The average 10k speed for the runners was 3.0 ± 0.4 m/s. The CV within the preferred movement was smallest for 3.1m/s. The preferred movement was split into the horizontal movement in the frontal plane (1st PM) of the limbs, heel lift (2nd PM) and centre of mass movement (3rd PM). CV for the 1st PM did not show any difference with speed. In the 2nd PM the CV was lowest for 3.1m/s. CV for the 3rd PM decreased for higher speed.

DISCUSSION AND CONCLUSIONS

A minimum of the CV in the preferred movement was found close to the 10k running speed. The minimum of the preferred movement could be explained by the U-shape of the CV for the heel lift, while the reduced CV of the centre of mass movement shifts the minimum slightly to the right.

REFERENCES


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