THE RELATIONSHIP BETWEEN HIP MUSCLES PERFORMANCE AND LOWER LIMB KINEMATICS DURING RUNNING.

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Running is a popular physical activity for involving a large number of participants and because easiness of practice. However, the number of injuries related to running is high. Poor hip muscle performance, especially in the frontal and transverse planes, has been associated with lower limb dysfunctions. Besides that, altered kinematic during running, such as excessive hip adduction and knee abduction, is a common characteristic of symptomatic individuals. Therefore, this study aimed to investigate the relationship between the performance of hip abductors and external rotators and the kinematics of pelvis, hip and knee during running. Seventeen recreational runners (10 men and 7 women, 29.24 ± 4.73 years old, 63.35 ± 7.34 kg e 1.69 ± 0.07 m) were enrolled in this study. After answering to an initial interview and going through an anthropometric setup, markers were placed on five anatomical landmarks for a 2D kinematic assessment of running in the frontal plane. Running protocol was performed on a treadmill (Super ATL, Inbramed, Brazil) and lasted approximately 12 minutes. The participant started running at7 km/h and then the speed was raised in 0.5 km/h at every 20 seconds. The participant was asked at every minute about the running intensity, based on Borg Scale of Perceived Extension (SPE). The self-selected speed was determined when the participant reported being able to maintain the current speed for at least 10 minutes between the 12th and 14th levels of the SPE. One digital video camera (CASIO EX-FH20, Japan) recording at 210 Hz was used for kinematic data collection during a 2-min interval of running at a self-selected speed. The pelvis, hip and knee angles were measured through the software Kinovea v. 0.8.15 (Kinovea Project, France). Four steps of the dominant limb in the mid-third of the 2-min interval were used for analysis. The joint angles were measured in the first contact (t_0) and at the peak knee flexion (t_1). The range of motion (ROM) (t1-t0) was calculated, and positive values mean pelvis contralateral drop, hip adduction and knee abduction. For performance measurement of hip muscles, an isokinetic dynamometer Biodex System 4 Pro (Biodex Medical Systems Inc., EUA) was used. The isokinetic assessment protocol consisted of a warm-up, familiarization and test. The movements tested were hip abduction/adduction in standing position and internal/external rotation in seated position, both using the concentric-concentric mode, with the angular velocity set at 30°/s. These measures were randomized according to the position (seated or standing) and the limb (dominant and non-dominant). After

the warm-up and familiarization period, the participant was asked to perform five maximum repetitions. The participant was verbally encouraged while performing maximum strength. The peak torque of the five repetitions performed with the dominant limb, within the isokinetic zone was extracted and normalized for participant's body mass for analysis. The pelvis, hip and knee ROM were individually correlated with the abductors and external rotators peak torque using the Pearson Correlation. All procedures were carried out in IBM SPSS Statistics 20.0 for Windows (IBM Inc, USA), and the significance level was set at $p<0.05$. The results are shown in table 1. Correlations between pelvis and hip ROM with abductors peak torque, as well as pelvis, hip and knee ROM with external rotators peak torque, ranged from poor to no correlation. The knee ROM and the abductors peak torque showed a moderate positive correlation (figure 1), with p=0,091. Even not being statistically significant, this result seems to be a tendency for this specific group. For most of the tested relationships, other factors rather than the peak torque of abductors and external rotators may better explain the kinematics of the lower limb in frontal plane during running. A possible cause for this result is the specificity of the muscle performance measurement, which may not represent the real action of the muscles during running. More researches are needed to investigate this topic.

Table 1. Correlations between abductors and external rotators' muscle peak torque and knee, hip and pelvis range of motion during running.

Muscle Torque	Joint	r	p-value
Abductors	Knee	,422	,091
	Hip	,006	,911
	Pelvis	-,256	,321
External Rotators	Knee	,274	,287
	Hip	,187	,873
	Pelvis	,049	,851

Figure 1. Dispersion graph of the correlation between the abductors muscle peak torque and knee range of motion.