MUSCLE FIBRE RECRUITMENT IN SPRINT START AND DIFFERENT JUMPS IN ADOLESCENT SPRINT ATHLETES

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The purpose of this study was to identify muscle fibre recruitment pattern during sprint start and jump tests in adolescent sprint athletes. A possible influence of several anthropometric parameters on this recruitment pattern was investigated. Sixty adolescent sprint athletes performed a sprint start and several jump tests with bilateral EMG recording of four lower limb muscles. EMG-signals were resolved into time and frequency using wavelet analysis. Age and muscularity did not influence fibre recruitment. In sprint start only the front leg M. Rectus Femoris generated higher frequencies compared to the rear leg. Compared to all other muscles, significant higher frequencies were found in the M. Gastrocnemius medialis during all movements. These results may lead to a better understanding of the value of using jump tests for talent detection in sprint athletes.

KEY WORDS: sprint athletes, wavelet analysis, sprint start, jump tests.

INTRODUCTION:

Muscularity and extensive recruitment of fast muscle fibres are key performance components in explosive movements such as the sprint start and jumps. As a consequence, jump tests are often used for detection of talented sprint athletes. From childhood to adulthood an increased recruitment pattern of fast twitch muscle fibres is noticed (Petrie et al. 2004). As slow and fast muscle fibres have different frequency spectra, wavelet analysis of an EMG signal allows to differentiate between fibre types during specific movements (von Tscharner, 2000, Wakeling et al., 2001). The purpose of this study was to identify the muscle fibre recruitment pattern in sprint start and common jump tests in adolescent sprint athletes. Also the influence of age and several anthropometric parameters on this recruitment pattern was investigated.

METHOD:

Data Collection: Sixty Flemish adolescent sprint athletes (mean age 14.8 ± 1.7 years) volunteered. Anthropometrical measurements were used to calculate corrected thigh girth (CTG), corrected calf girth (CCG) and total body skeletal muscle mass (SMM) (Poortmans et al., 2005). Bilateral EMG signals of the Gastrocnemius medialis (GM), Rectus femoris (RF), Biceps femoris (BF) and Gluteus maximus (Glu) were recorded with a Varioport datalogger (Becker Meditec) at 2000Hz during a counter movement jump (CMJ), a double drop jump (DDJ) and a 15 seconds Bosco jump test (BOS) (Bosco et al., 1983). Wavelet analysis of the EMG signals was performed with software from Biomechanics Research Corp (Canada).

Data Analysis: Subjects were divided into tertiles according to their age, SMM, SMM/bodyweight, CTG and CCG. After applying the Kolmogorov-Smirnov test for normal distribution, ANOVA with Scheffé post hoc test was used. All statistics were carried out using SPSS 15.0. The significance level was set at $p < .05$.

RESULTS:

Anthropometrical parameters per tertile are shown in Table 1.

Table 1 Anthropometrical parameters for the three tertiles. Values are mean ± standard deviation

	Tertile 1 (n = 20)	Tertile 2 (n = 20)	Tertile 3 (n = 20)
Age (years)	12.9 ± 0.9	14.9 ± 0.5	16.6 ± 0.6
SMM (kg)	16.9 ± 2.0	21.6 ± 1.1	26.9 ± 3.0
SMM/LG (kg)	0.353 ± 0.015	0.390 ± 0.011	0.419 ± 0.012
CTG (cm)	45.7 ± 2.3	50.1 ± 0.7	53.2 ± 1.9
CCG (cm)	30.9 ± 1.5	33.5 ± 0.7	36.1 ± 1.2

During the sprint start (Figure 1) and all jumps for all subjects significantly higher frequencies ($p < .05$) were generated in the GM muscle than all others. On the contrary, for the Glu muscle significantly lower frequencies were recorded. During the jump tests, no differences were found in frequency selection between the rear and front leg used in the sprint start. During the sprint start the RF muscle generated higher frequencies in the front leg compared to the RF muscle of the rear leg ($p < .001$). Frequencies of each muscle in the CMJ according to age are shown in Figure 1. Similar results were found for SMM, SMM/bodyweight, CTG and CCG for all jumps. No significant differences were found between the 3 subpopulations for the selected parameters. In general, wavelet analysis (Figure 3) revealed the occurrence of high and low frequency muscle fibres in all muscles for all movements.

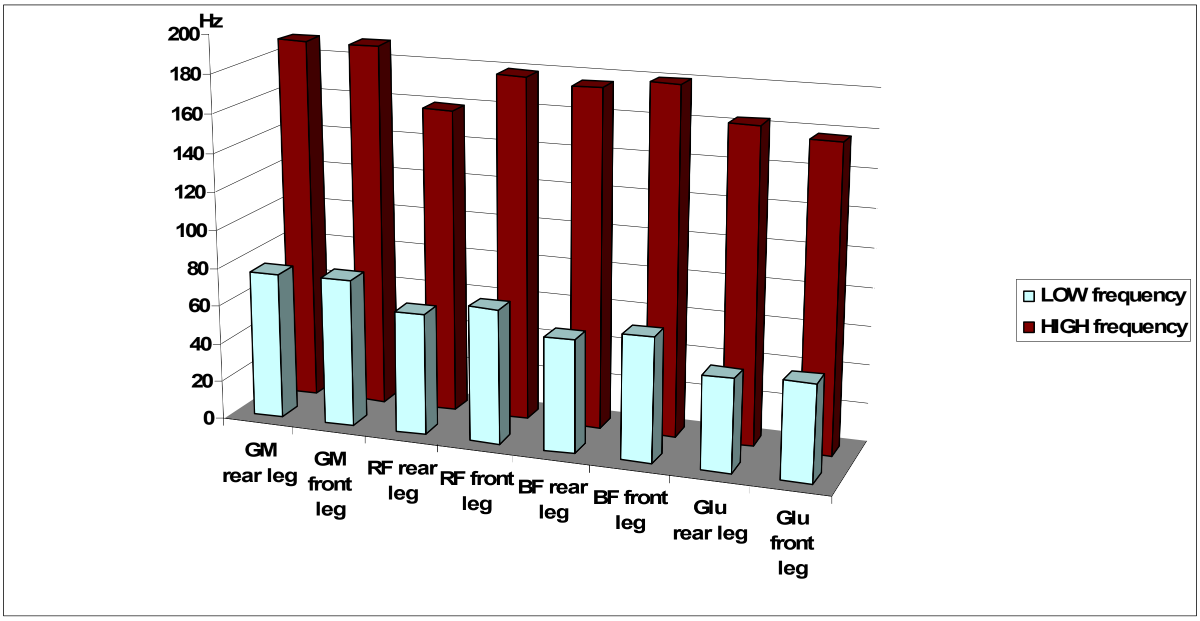

Figure 1: Frequencies in 4 muscles during the sprint start (entire subject population)

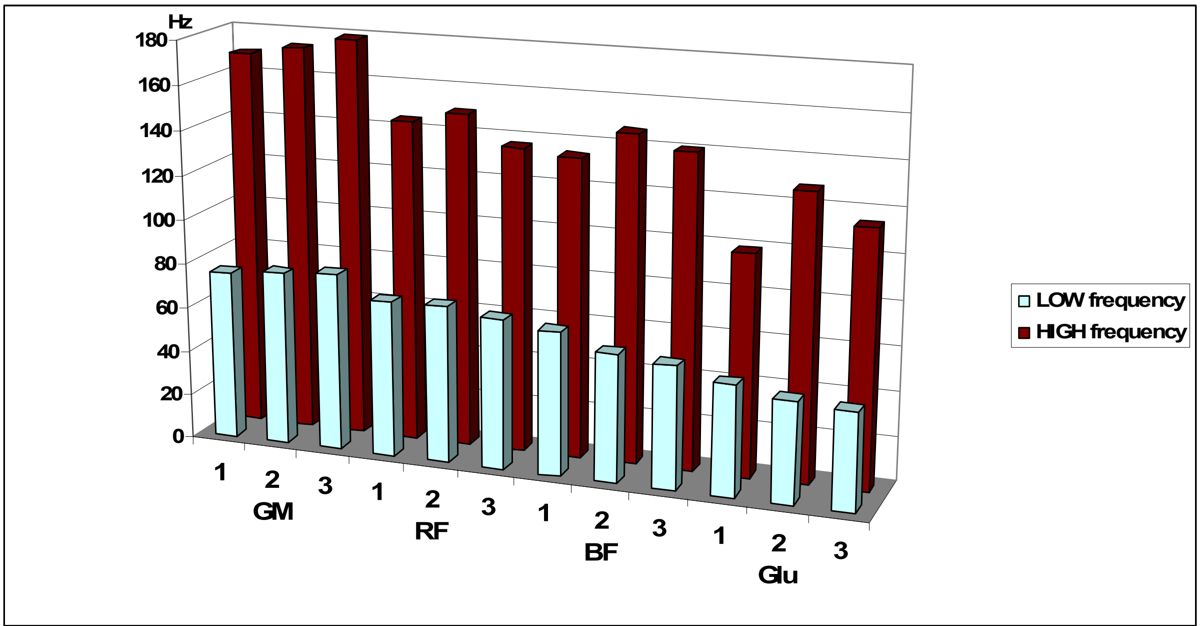

Figure 2: Frequencies in 4 muscles according to age during a CMJ

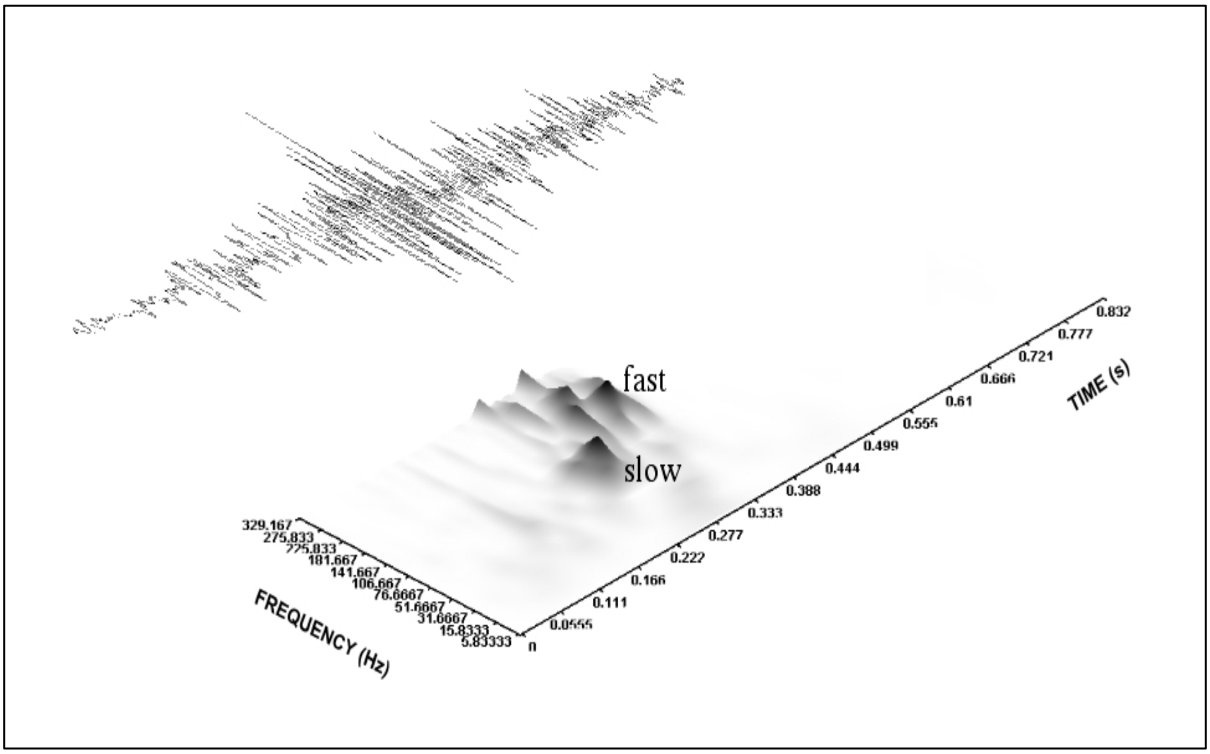

Figure 3: Raw EMG analysed into time and frequency for one subject (CMJ – GM)

DISCUSSION:

The recruitment of both high and low frequency muscle fibres during the sprint start and jumps may be explained by the explosive nature of these movements in which a rapid and maximal force exertion needs to be delivered. Significantly higher frequencies were generated in the GM muscle which delivers a short and powerful contribution to the push off-phase of these movements. The Glu muscle seems to contribute in a lesser extend to the power development in jumps and the sprint start since frequencies in this muscle were significantly lower than in other muscles. Since the sprint start is an asymmetric movement, we investigated the frequency spectra between the rear and front leg. During the sprint start no differences in frequency between the same muscles of the front and rear leg were found except for the RF muscle. The higher frequencies generated by the RF muscle of the front leg may be due to the longer contact time of the front leg in the start blocks and the asymmetric position of the two legs in set position. During jumps however, no differences between the rear and the front leg used in sprint start were found, so there is no influence on the frequencies as a result of asymmetrical training. Considering the theory that children and adolescents have lower ability in recruiting fast muscle fibres and have lower glycolytic potential than adults (Petrie et al, 2004), a change in fibre recruitment in function of age could be expected. However, neither age or muscularity parameters seemed to have an influence on the motor unit recruitment in adolescent sprint athletes. Since all athletes were talented and well trained this may clear out the age dependency on muscle fibre recruitment in these specific movements. Therefore, influence of age on the muscle fibre recruitment in jumps should be investigated in a non –sprinter control group to see whether training can influence the muscle fibre recruitment.

CONCLUSION:

This study shows a similar recruitment of muscle fibres during a sprint start and jump tests. In adolescent sprint athletes, fast and slow motor unit recruitment occurred independently of age, SMM, SMM/bodyweight, CTG or CCG during the sprint start and jumps.

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