STUDY OF PERFORMANCE RELATED STRENGTH TESTS FOR COMPETITION LEVEL SPRINTERS

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INTRODUCTION

Most sprint coaches agree that muscle strength is one of the key components in sprinting speed. Therefore from a coaches' point of view it is important to select specific strength tests to allow for an evaluation of the performance related strength requirements of sprinters. However muscle strength can be measured in many different conditions: in several joints, at different speeds, through various ranges of motion and with different types of contraction. In literature there seems to be little unanimity when comparing the results of previous studies concerning the relation between strength tests and sprint performance. The comparison of these studies is already difficult because of the lack of consistency in methodology. Therefore in this study we decided to confine strength measurements to isokinetic tests and to investigate the significance of a variety of these tests to control strength requirements for sprinters. But even within these limitations it is still impossible to make a selection of sprint related strength tests based on literature (Alexander 1989; Anderson 1991; Farrar 1987).

In the study of Farrar (1987) was concluded that for college-age males little of the interindividual variability in 40 and 100 yard sprint performance can be accounted for by leg strength as measured by means of isokinetic tests at the hip and knee joint at 30°/s or 300 °/s. Alexander (1989) selected two isokinetic tests with the highest correlation with 100 meter time for his group of 14 male competition level sprinters: knee extension at 230°/s ($r=-.71$) and ankle dorsiflexion at 30°/s ($r=-.53$). He also concludes that neither the hip muscles nor the hamstrings were found to have a significant correlation with sprinting speed. On the contrary the investigation of Anderson (1991) on college-age male athletes indicates that specific hamstring forces are more predictive of 40 yard dash time than variously measured quadriceps forces. Of the various hamstring forces the peak concentric hamstring force at 60°/s was most predictive ($r^2=.33$).

We suppose that the variability in the results of these three studies is due to differences in performance level of the subjects and to the quantification of the sprint performance. by means of the final sprint time. This latter remark is based on recent findings (Delecluse 1993) that indicate that the performance determining factors in running speed change in relation to running distance. Three phases can be distinguished within a 100 meter sprint performance: an initial acceleration phase (0-10 m), a continued acceleration phase (10-36 m) and a phase of maximum running speed and speed endurance (36-100 m). This implies that also the relation between strength and running speed will be determined by the distance where running speed is recorded. On the contrary in most studies the sprint performance was quantified by means of the final sprint time over 40 or 100 meter.

So it is the purpose of this study to determine to what extent strength abilities around knee and ankle joint as measured by different isokinetic tests account for interindividual variability in sprint performance within a homogeneous group of high level male sprinters, when taking into account the multidimensional structure of sprint performance.

METHODOLOGY

Eighteen competition level sprinters (M 100 **m-time=10.94** s, SD = 0.22 s) ran a **40** meter sprint and performed 30 isokinetic strength tests on an active dynamometer **(PROMETT-system)**. These tests consisted of static, concentric, eccentric and plyometric muscle work at velocities between **0** and 300 "is for knee extensors, knee flexors and ankle extensors. For each movement the torque was recorded at three different joint angles. For the knee joint: **120°**, 135" and 150". For the ankle joint each subject was tested over his total range of motion. Hereby three angles were **determined:** one third of the total range **(dorsiflexion,DF)**, half the range (=HR) and two thirds of the range **(=plantarflexion**, PF).

During the sprint test running speed and running time were recorded by means of a velocimeter **(Witters** 1985). The system allowed us to record running speed every 0.1 m. The running speed data was further reduced to an average speed value per two meter running distance.

As we expect the performance determining factors to change in relation to running distance, the relation between the recorded torques and the running speed is graphically presented in relation to running distance by means of the determinationcoefficient (r^2*100). For each type of contraction the **torque-value** that showed the highest correlation with running speed was selected for further analysis.

RESULTS

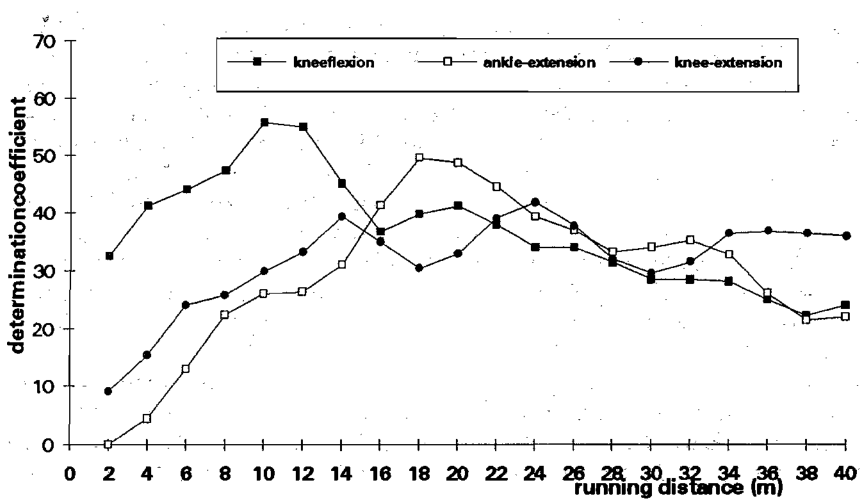

Figure 1: The detenninationcoefficient between three selected torque values and running speed in relation to running distance.

For knee flexion only one dynamic test with concentric muscle work was performed at 65 "is. At that test the torque value recorded in an angle of **150** ° showed the highest correlation with running speed (shown in figure 1). For knee extension and ankle extension the torque with the highest correlation with running speed was selected for further analysis: for knee extension: a concentric test at **65°/s** (joint angle= 150") and for ankle etension also a concentric test at **200°/s (plantarflexion)** (both shown in fig.1).

The shape of the three curves in figure 1 seems to be specific for each muscle group, The tests for knee flexors show a high correlation with running speed during the initial acceleration phase. For ankle extension the highest determinationcoefficient is situated between 16 and 24 meter and the coefficient for knee extension fluctuates around 35 % from 12 to 40 meter.

But it is clear that compared to the other tests this knee extension-test has the highest correlation with running speed in the phase of maximum running speed (from 36-40 m).

CONCLUSIONS

For each phase of the 40 meter sprint the strength tests that showedthe highest correlation with running speed are summarized in table 1. In general the results confirm that isokinetic evaluation systems can be used to determine sprint related strength requirements at a competition level. Thirty-five to fifty percent of variance in running speed within each of the three phases can be explained by the variance in one single isokinetic strength test. It may be concluded that the strength of the knee flexors determines 50 % of the variance within the phase of initial acceleration. Ankle extension torques explain 45 % of the variance in running speed within the phase of continued acceleration, and the strength of the knee extensors determines 35 % of the variance in maximum running speed.

Table 1: Selection of the most specific strength tests per running phase on the basis of the determinationcoefficient with running speed.

RUNNING PHASE	SELECTED TESTS	DETERMINATION COEFFICIENT
INITIAL ACCELERATION	knee flexion conc. 65°/s	40-55 %
	knee extension ecc. 65°/s	35 %
CONTINUED ACCELERATION	ankle extension conc. 200°/s	45-50 %
	knee extension conc. 130°/s	40 %
	knee flexion conc. 65°/s	35 %
MAXIMUM RUNNING SPEED	knee extension conc. 130°/s	35 %
	knee flexion conc. 65°/s	22 %
	ankle extension conc. 200°/s	20 %

We also notice that mainly tests with concentric muscle work were selected. For ankle extension the high-velocity tests were selected (200°/s), while for knee extension low-velocity tests were selected (65 and 130°/s).

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