THE RELATIONSHIPS BETWEEN SPRINT RUN AND STRENGTH PARAMETERS IN YOUNG ATHLETES AND NON-ATHLETES

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The aim of this study was to examine the relationships between the sprint run and strength tests, which measure the capability to produce force in isometric, pure concentric and stretch shortening cycle muscular actions. The seventy two subjects were assessed for six tests 60m sprint run, to evaluate the speed, and isometric leg-press, squat jump, countermovement jump, drop jump, and 5 horizontal jumps, to evaluate strength parameters. The 5 jumps, was the most important predictor of the 60m sprint time, maybe because of is cyclic and horizontal characteristics (more similar to the specific movement of sprint run). We suppose that the reason for results do not explain different relationship between tests and sprint performance, in young athletes can be find in multifactorial characteristics of sprinting performance and the characteristics of the subjects, youngest have reduced training adaptation.

KEY WORDS: sprint running, evaluation, SSC strength, isometric strength, rate of force development

INTRODUTION

Sprint performances depend on many parameters. Improving one of these parameters may improve the whole performance. The sprinters will require more than just the finish time, to evaluate and prepare properly their racing proficiency. For that, the coach applies a battery of tests to monitor the effects of training. Many have been the attempts to obtain predictions to the sprint performance, and some authors have tried to find relationships between sprint (or sprint phases) and different kind of tests (to measure muscle strength). We can find studies examining the relationships between: sprint and stretch-shortening cycle (SSC) tests (Mero et al., 1981; Nesser et al.1996; Kukolj et al. 1999; Hennessy and Kilty, 2001; Berthoin et al. 2001; Bret et al. 2002); sprint and isokinetic tests (Alexander, 1989; Guskiewicz et al.1993; Blazevich and Jenkins, 1998; Dowson et a. 1998); and sprint and isometric tests (Mero et al., 1981; Young et al.1995). Our option to choose the tests was related to the goal, validity and reliability of the tests. The squat jump (SJ) and LegPress has been described as a measure of leg explosiveness in concentric and isometric conditions The Isometric dynamometry is one of the most popular methods for assessing neuromuscular function in sport science as it permits the evaluation of both peak force and rate of force development. The countermovement jump (CMJ) assessed leg power in long SSC, the drop jump (DJ) and the 5 horizontal steps (5hj) a measure of short SSC performance.Their external validity in athletic assessment is still a topic of debate (Wilson and Murphy, 1996). While some authors have found a significant correlation between isometric peak force or rate of force development and performance of sprinting (Mero et al., 1981; Young et al., 1995), others have failed to find a significant relationship between static measures of neuromuscular function and dynamic performance (Wilson et al.,1995; Kukolj et al., 1999). The aim of this study was to examine the relationships between the sprint run and the results obtained in common strength and power tests, which measure the capability to produce force in isometric, pure concentric and SSC contraction modes, to discriminate sprint capacity.

METHODS

Seventy two subjects were divided in groups in agreement with their different training status: athletes (14,05 ± 1,58 years; 1,62 ± 0,28m; 51,60 ± 13,20 kg) and non-athletes (13,72 ± 3,14 years; 1,64 ± 0,10m; 52,11± 10,57 kg). The subjects were assessed for 6 tests performed in random order: 1 attempt of 60m sprint run (60m), to evaluate the speed, and 3 trials from isometric leg-press (LP), squat jump (SJ), countermovement jump (CMJ), drop jump, from 24 cm height (DJ), and 5 horizontal jumps (5hj) to evaluate strength parameters. For the SJ and CMJ, the subjects were required to bend the knees to about 90°. For the SJ they have to maintain the posture at least one second before jumping. The best measurement of each jump test was retained for statistical analyses. From 60m run video footage was collected images from one video camera (50 Hz - JVC GR-DVL 9800 digital video camera) that follow with panning method (Cunha, 2004) the subject's that run over the entire 60m start from a standing position, with out spike shoes. The video was placed on a tripod (at the middle of track, 20m from the sagittal plane of the running lane, and 4,20m height) to obtain the curves of velocity, stride length (SL) and stride rate (SR). From the Leg-press, in a lying down position at a knee angle of 110° we recorded the force, using a strain-gauge force platform, to obtain the forces-time curves and the respective rate force development (RFD). From the SJ, CMJ, and DJ, we measure the flying time from one electronic contact mat system to obtain the height of each jump ($h=gt^2/8$). From the 5hj, with no previous balance, was measure the total horizontal distance. We performed correlations (Person *r* was used to establish the relationships) among all variables (60m time the respective kinematic variables and the tests performed), and stepwise multiple regression analysis to determine predictors of 60 m sprint time 60m from the different tests performed.

RESULTS AND DISCUSSION

The results indicate: 1) the ones who have superior capability to produce force, in the all types of force production used (isometric, pure concentric and SSC contraction), can run the 60 m sprint faster (Max Force: -.716; RFD: -.569; SJ: -.844; CMJ: -.823; DJ: -.831; DJindex: -.684; 5HJ: -.894; $p \leq .001$).

	60m Time	SL Max	SL Avg.	SR Avg.	SR Max	Max Force	RFD	SJ	CMJ	DJ	DJindex
Stride Length Max	-.685**										
Stride Length Avg.	**-.745****	.932**									
Stride Rate Avg.	-.651**	-.009	-.005								
Stride Rate Max	**-.739****	.163	.155	.935**							
Max Force	**-.716****	.446**	.518**	.507**	.574**						
RFD	-.569**	.362**	.410**	.423**	.481**	.790**					
SJ	**-.844****	.590**	.637**	.541**	.665**	.696**	.606**				
CMJ	**-.823****	.615**	.673**	.477**	.601**	.674**	.587**	.975**			
DJ	**-.831****	.614**	.670**	.478**	.595**	.652**	.564**	.897**	.907**		
Djindex	**-.684****	.601**	.617**	.294*	.431**	.499**	.404**	.637**	.606**	.759**	
5HJ	**-.894****	.585**	.613**	.660*	.773**	.793**	.608**	.880**	.843**	.801**	.736**

Table 1. Correlation matrix between the 60m time, the respective kinematic variables and the tests performed, from all the subjects (n=72). 60m Time; SL Max (average of maximal value of stride length); SL Avg. (Average of average values of stride length); SR Avg. (Average of average values of stride rate); SR Max (average of maximal value of stride rate); Max Force (Maximal Force); RFD (Rate Force Development); (squat jump) SJ; (countermovement jump) CMJ; (drop jump) DJ; index between contact time and height of the DJ (DJ index); 5 horizontal jumps (5hj).** Correlation is significant at the 0.01 level (2-tailed),
* Correlation is significant at the 0.05 level (2-tailed).

2) Boys run faster than girls in all ages. 3) Athletes run faster than non-athletes in all ages. 4) Older subjects run faster than youngest, in all ages. They all achieved superior maximal velocity. The times at 5 and 10 m of the 60m dash are poor predictors of the 60m run time (r^2 between .20 and .32). The best time predictors of the 60m run time are among 30m (in the group of 12 – 13 years r^2=.92) and 40m (r^2 between .92 and .94), corresponding to the distance were the subjects achieved there maximal velocities. The results correspond with Cunha, 2003, with elite sprinters in 100m sprint run (maximal velocity between 50-60m r^2 =.96).

Regression equations to predict sprint the 60m sprint time

Criterion	Groups)	**72**	time=13.68+(Max Force x -0.00039)+(RFD x 0.00034) (5hj x -0.348)+(SJ x 0.009)+(CMJ x -0.03)+(DJ x -0.023)+(DJindex x -0.000036); **r^2=.822 (5hj p≤..001)**
training status	athletes	39	time =11.55+(Max Force x -0.000057)+(RFD x 0.0001) (5hj x -0.395)+(SJ x -0.001)+(CMJ x -0.013)+(DJ x -0.023)+(DJindex x -0.0001); **r^2=.851 (5hj p≤.001)**
	non-athletes	33	time =16.91+(Max Force x 0.0001)+(RFD x 0.0001) (5hj x -0.554)+(SJ x -0.043)+(CMJ x 0.069)+(DJ x -0.117)+(DJindex x -0.0001); **r^2=.861 (5hj p≤.001;**
sex	male	32	time =12.44+(Max Force x 0.000027)+(RFD x 0.0001) (5hj x -0.376)+(SJ x 0.004)+(CMJ x -0.012)+(DJ x -0.005)+(DJindex x -0.0001); **r^2=.795 (5hj p≤.01)**
	female	40	time =14.86+(Max Force x -0.000052)+(RFD x 0.00039) (5hj x -0.347)+(SJ x -0.044)+(CMJ x -0.013)+(DJ x -0.027)+(DJindex x 0.001); **r^2=.849 (5hj p≤.05)**
ages	12-13	25	time =15.14+(Max Force x 0.0001)+(RFD x -0.000087) (5hj x -0.561)+(SJ x 0.020)+(CMJ x 0.014)+(DJ x -0.043)+(DJindex x 0.001); **r^2=.902 (5hj p≤.001)**
	14-15	28	time =14.19+(Max Force x 0.0001)+(RFD x 0.0001) (5hj x -0.666)+(SJ x 0.042)+(CMJ x -0.016)+(DJ x -0.005)+(DJindex x -0.002); **r^2=.844 (5hj p≤.01)**
	16-17	19	time =13.36+(Max Force x -0.00001)+(RFD x -0.001) (5hj x -0.064)+(SJ x 0.070)+(CMJ x -0.103)+(DJ x -0.053)+(DJindex x -0.002); **r^2=.873**
training status sex	athletes male	17	time =10.61+(Max Force x -0.000044)+(RFD x 0.0001) (5hj x -0.355)+(SJ x -0.006)+(CMJ x -0.001)+(DJ x -0.017)+(DJindex x -0.001); **r^2=.766 (5hj p≤.01)**
	athletes female	15	time =16.97+(Max Force x 0.0001)+(RFD x 0.001) (5hj x -0.589)+(SJ x -0.047)+(CMJ x 0.046)+(DJ x -0.076)+(DJindex x -0.011); **r^2=.878 (5hj p≤.01)**
	non-athletes male	18	time =13.66+(Max Force x -0.0009)+(RFD x -0.0004) (5hj x -0.384)+(SJ x -0.009)+(CMJ x -0.03)+(DJ x -0.023)+(DJindex x -0.0006); **r^2=.820**
	non-athletes fem	22	time =10.61+(Max Force x -0.000044)+(RFD x 0.0001) (5hj x -0.355)+(SJ x -0.003)+(CMJ x -0.001)+(DJ x 0.017)+(DJindex x 0.001); **r^2=.766 (5hj p≤.01)**

Table 2. The prediction of the 60m sprint time by multiple linear regressions equations, using the results from the five tests performed. Maximal Force (Max Force) and Rate Force Development (RFD) from the isometric leg-press; distance from the 5 horizontal jumps [5(hj)], squat jump (SJ), countermovement jump (CMJ), drop jump, from 24 cm height (DJ), and the index between contact time and height of the DJ (DJ index). Different groups and respective criterions: training status (athletes, non-athletes); sex (Male, Female); ages (12-13, 14-15, 16-17 years); training status / sex (Athletes Male, Athletes Female, non-athletes Male, non-athletes Female).

No kinematic parameters (SL or SR) are good predictors of the 60m run time (r^2 between .57 in entire group and .17 in the athletes group to SR and r^2 between .66 in the athlete group and .37 in the non-athletes group to SL). These values are achieved almost at the same place were the subjects achieved there maximal velocities and correspond also to the average of the maximal values in the SR and SL. No morphological parameters (height and body mass) are good predictor of the 60m run time (r^2 between .05 in non-athletes group and .30 in the entire group to height and r^2 between .01 in the no athlete group and .23 in the 14 – 15 years to body mass), except for the athletes group (r^2 of .59 to body mass and .61 to height). The results of this study do not explain the expected different relationship between SSC (long and short) and isometric actions, and sprint performance for different phases of sprint run, in young athletes and non-athletes. The reason for that can be find in multifactorial characteristics of sprinting performance and the characteristics of the subjects (youngest: reduce training adaptation). Perhaps because the tests used do not have a high degree of specificity to sprint running: acyclic vertical action (SJ, CMJ, and DJ), we do not find different correlation or predictions to different phases of sprint running. The various stepwise multiple linear regressions was performed (table 2) to predict the 60m sprint time show that the total variation in the time are explained by more than 80% with the tests performed. The variable of distance from the 5 horizontal jumps (5hj) is the most important variable of the models, and explained alone about 80% (r^2 = .80, $p \le 0.001$) of the variance in sprint time. It is the only variable in all the equations (of different groups) statistically significant (with at least $p \le .01$)

CONCLUSION

Coaches of young athletes may well, find it useful to use the CMJ, DJ, and 5hj tests as part of a battery of tests to help monitor sprinting performance. Particularly the 5hj, the most important predictor of the 60m sprint time. One future direction to this type of research is to determine the influence of other parameters, from the same tests and other tests. In the case of vertical jumps (SJ, CMJ, and DJ), instead of measure only the height of the centre of gravity, measure (from a force platform) also the power output, peak power, average force, peak force, vertical ground reaction force (GRF), vertical impulse, in overall tests and excentric and concentric phases, Continuous horizontal jumps (jumps distance, jumps average contact time, power, etc.), continuous vertical jump (reactivity coefficient: height / contact time), power, etc.). Additionally to this different strength measures, the combination with others measures (e.g., kinematic, kinetic, physiologic, etc.) can provide a best prognostic of sprint run. We believe in developing a better prognostic based on a multifactorial analysis of a sprint run.

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