SPEED, STRENGTH & POWER CHARACTERISITCS OF HORIZONTAL JUMPERS

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INTRODUCTION: It is well established that approach speed on the long and triple jump runways is the single-most important determinant of performance across a wide range of ability levels (Hay, 1986; Hay, 1992). However, the relationship between speed and jump distance decreases when the range of performances is reduced.

At an elite level speed is regarded as a pre-requisite, the differentiating factor between performances relates more to how well athlete control their speed when they make contact with the take-off board (and subsequent take-offs in the triple jump). In the take-off athletes typically experience vertical impact forces in the range of 7.9 to 12.6 x BW (Ramey and Williams, 1985), with ground contact times ranging from 120 to 180 ms (the higher values relating to the step and jump take-offs). It is therefore imperative that horizontal jumpers are conditioned appropriately to accept such high loading forces, be powerful and reactive, in order to generate vertical speed in such a small timescale. Graham-Smith and Lees (2002) suggested that performance is made up of three main interacting factors; speed, strength and technique (with power being a derivative of speed and strength). They added that optimal performance can only be achieved when all three factors are in 'balance'.

The aim of this study was to develop a battery of tests to monitor speed, strength and power for horizontal jumpers in as functional a way as possible. The relationship between strength and power variables with speed and controlled functional performance was also investigated.

METHOD: Seventy five athletes (37 male, 38 female) from the UKA long and triple jump squads underwent a battery of tests to measure speed, strength, power and functional performance. Speed was assessed using a Laveg LDM 300C speed gun (Jenoptik) sampling at 100 Hz, recording 0-20m, 0-40m and 20-40m split times. Strength and rate of force development (RFD) was assessed via an isometric squat on a Kistler force platform (type 9286AA) sampling at 1000Hz for 5 seconds and adopting a position that reflected the body position in mid take-off (upright trunk, knee angle at 135 degrees and bar, hip and ankle being in vertical alignment). The peak force and the average RFD over 150ms were recorded. Power was assessed in terms of jump height when performing squat, countermovement (CMJ) and drop jumps (DJ) from heights of 20cm and 40cm on the force platform (sampling at 1000 Hz. Jump height was calculated on the basis of flight time using the formula, height jumped = $gT^2/8$ (where T = flight time). Reactivity Index in the drop jumps was calculated by the flight time divided by contact time. Contact was defined as the time when the vertical force exceeded 20N. Functional performance was assessed in controlled field based tests including a standing long jump and a 4 bounds + jump into the sand pit. The best of 2 attempts were recorded. All athletes included in the study had at least one familiarisation session, data presented here is for the months of November and December collected over a 5 year period from 2004 to 2009.

RESULTS: Normative data for male and female jumpers are presented in table 1. When both male and female data were combined the strength and power variables that were most strongly associated with sprint time (0-40m) were peak isometric force (R^2 = 0.65), RFD (R^2 = 0.33), CMJ height (R^2 = 0.64) and DJ40cm height (R^2 = 0.43). The same variables were also strongly associated with performance in the standing long jump; peak isometric force (R^2 = 0.64), RFD (R^2 = 0.48), CMJ height (R^2 = 0.76) and DJ40cm height (R^2 = 0.61), and the 4 bounds + jump test; peak isometric force (R^2 = 0.66), RFD (R^2 = 0.49), CMJ height (R^2 = 0.69) and DJ40cm height (R^2 = 0.56).

Table 1. Normative data for male and female horizontal jumpers

		Male		Female	
		Mean	SD	Mean	SD
Body Weight	(N)	766	77	612	57
Speed 0-40m	(s)	4.82	0.12	5.45	0.16
Strength (Isometric Squat)					
Peak Force	(N)	4476	803	2727	588
Peak Force / BW		5.85	0.81	4.47	0.93
RFD (150ms)	(N/s)	8852	3057	5264	2695
Power (Vertical Jump Tests)					
Squat Jump	(m)	0.44	0.10	0.36	0.04
CMJ	(m)	0.52	0.07	0.39	0.05
Drop Jump 20m	(m)	0.48	0.08	0.37	0.05
RI	RI	2.77	0.68	2.47	0.54
Contact time	(s)	0.24	0.07	0.23	0.06
Drop Jump 40 cm	(m)	0.50	0.09	0.38	0.05
RI	RI	2.71	0.69	2.56	0.58
Contact time	(s)	0.25	0.07	0.23	0.06
Horizontal Jumps					
Standing LJ	(m)	2.99	0.18	2.44	0.16
4 Bounds + Jump	(m)	16.05	1.00	12.88	0.62

DISCUSSION: The study has provided useful normative data on a group of elite horizontal jumpers and gives an insight into the physical requirements of athletes. No previous study has profiled speed, absolute strength, explosive power (in terms of jump height), RFD and reactivity index of horizontal jumpers, and attempted to associate these attributes to more functional (and technical) tests of performance, i.e. the standing long jump and the 4 bounds + jump. The tests quantified attributes across the force-velocity spectrum and were specific in terms of typical force-length relationships, the types of muscle loading induced and the stretch-shorten cycle. Tests that included a stretch-shorten cycle and those that mimicked the correct force-length characteristics in jumping demonstrated stronger relationships with sprint and functional performance than purely concentric tests, i.e. the squat jump. Future studies should also measure eccentric strength and examine its function in the compression phase of the take-off.

CONCLUSION: The study has successfully profiled physical attributes of male and female horizontal jumpers across the force-velocity spectrum and can be used to monitor performance throughout the training cycle.

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