HONG KONG SPORTS INSTITUTE
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RESEARCH HIGHLIGHTS

Correlation between Strength Qualities and Maximum Sprinting Speed among Rugby Sevens Players

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MARCH 2020

Introduction

Sevens rugby is a sport with a high demand for sprinting. The maximum sprinting speed in this sport has been reported to correlate with different strength and power characteristics. Smirniotou et al. [1] found that squat jump performance can predict the sprinting speed at 10–30-m and 30–60-m split times. The isometric mid-thigh pull (IMTP) relative peak force (PF) and the relative countermovement jump (CMJ) peak power output predict 20-m linear sprint performance of elite soccer players [2]. Among a group of track and field athletes, Young et al. [3] found that the maximum absolute strength and stretch-shortening cycle (SSC) were related to the maximum sprinting speed. With good SSC performance, there is a more effective transfer of muscle strength to power. Researchers purported that the Dynamic Strength Index (DSI = CMJ/IMTP) can determine whether the athlete is able to apply force dynamically in relation to his maximal force capability, and the index is considered to be optimal when it falls between 0.6 and 0.8 [4]. In rugby movements, such as scrums, acceleration and maximum speed sprinting, the movement speed and strength requirement are different, which may require different DSI. As sprinting is one of the critical movements in rugby sevens, the purpose of this study was to interpret how lower limb DSI, strength and power are related to 20–30-m split time.

Methodology

In this cross-sectional study, 14 male rugby sevens players (mean ± Standard Deviation: age: 27.4 ± 4.7 years; mass: 85.1 ± 9.9 kg; height: 1.78 ± 0.08 m) were recruited. They were trained athletes who train 4 days per week and 14–16 h per week. The data were collected over 3 test days with 24–48-h rest before each test day. The tests were conducted in the morning after 30-min mobility and muscle activation as warm up. Day 1 – Body height and body weight (BW), CMJ and 40-m sprint. Day 2 – 1-repetition maximum (RM) squat (three trials). Day 3 – IMTP. Infrared speed gate (Brower Timing Systems, USA) was used for 30-m sprint with 20-m split. The 20–30-m split time represented the maximum sprinting speed. Subjects were instructed to use a two-point starting position and sprint with maximal effort. Two trials were completed with 3–5-min rest in between. The CMJ was performed on a force plate interfaced with computer software (600 Hz, Ballistic Measurement System, Fitness Technology, Adelaide, Australia). The subjects performed the jump with their hands on the their hips and were instructed to complete a rapid dip to a self-selected depth in order for them to achieve the greatest jump height. Three trials were conducted with 1-min rest in between. Concentric PF during the propulsion phase was used for further analysis. The IMTP was performed on the same force plate as the CMJ. The subjects performed the IMTP from a knee angle 125° and a hip angle 140°–150°, which allowed the subject to stay in an upright position. They needed to complete the pull with maximal effort for 5 s. Two trials were completed with 2-min rest in between. Trials were repeated if the PF values varied by >250 N. The DSI was calculated by dividing the IMTP-PF with the CMJ-PF. For 1RM back squat, a standardised warm-up protocol was performed, followed by three to five trials with 4–5-min rest in between. The subjects were required to squat to a depth at which the thighs were parallel to the ground. Strength performance was reported as absolute and relative strength. SPSS software (21.0) was used for statistical analyses, and significance was set at an alpha level of 0.05. Data are presented as the mean and Standard Deviation. Shapiro–Wilk test was used to test the data normality. Regression analysis was performed using the backward method to evaluate the correlation between sprinting time and strength quality. The quadratic relationship was estimated between the DSI and 20–30-m split time. DSI, DSI2, 1RM squat, relative 1RM squat, CMJ-PF, IMTP-PF, CMJ-PF relative to BW (CMJ-PF/BW), IMTP-PF relative to BW (IMTP-PF/BW), age, BW and height were input into the linear regression model.

Results

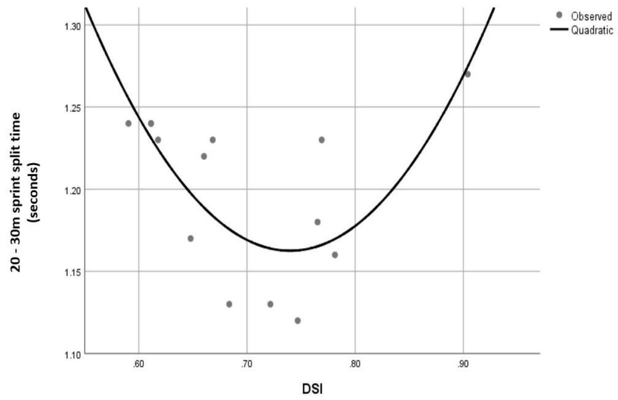
Significant correlations were found between several parameters: 20–30-m split time and relative 1RM squat ($r = -0.575$, $p = 0.031$), IMTP-PF/BW and relative 1RM squat ($r = 0.678$, $p = 0.008$), and CMJ-PF/BW and relative 1RM squat ($r = 0.852$, $p = 0.000$). Regression analyses highlighted that 96% of the variance in 20–30-m split time was explained by age, DSI^2, DSI, BW, CMJ-PF/BW, IMTP-PF/BW and IMTP-PF ($p < 0.01$). The R-square of quadratic relationship between 20–30-m split time and the DSI was 0.568 ($p < 0.01$, Figure 1).

Table 1. Unstandardised and standardised beta values for the regression models

Assessment	Variable	B	Std. Error	Beta	Sig.
20–30-m split time	(Constant)	11.63	1.379		0.000
	DSI	−21.657	2.695	−38.355	0.000
	Body Weight	−0.009	0.006	−1.806	0.205
	DSI^2	10.877	1.286	28.268	0.000
	CMJ-PF/BW	0.164	0.025	9.391	0.001
	IMTP-PF/BW	−0.138	0.023	−13.056	0.001
	IMTP-PF	0	0	2.436	0.144
	Age	0.003	0.001	0.258	0.037

DSI = Dynamic Strength Index;
CMJ-PF/BW = countermovement jump peak force relative to body weight;
IMTP-PF/BW = isometric mid-thigh pull peak force relative to body weight

Figure 1. The regression analysis for 20–30-m split with DSI



Discussion

The results showed that the DSI, DSI^2, CMJ-PF/BW, IMTP-PF/BW and IMTP-PF can accurately predict the maximum speed performance (20–30-m split). This prediction model is more accurate than that reported in a previous study. Northeast et al. [2] found that IMTP-PF/BW and CMJ peak power output relative to BW explained 55% of variance when predicting 20-m sprint performance. In our study, the DSI further increased the accuracy of the prediction model. This indicated that the optimal ratio (DSI) of dynamic (CMJ) and static (IMTP) strength is critical to maximum speed performance.

Chelly et al. (2001) [5] showed that optimal leg stiffness is critical to maximum speed performance. The leg absorbs the negative work and subsequently releases during push-off, which increases the power output during the stance phase of maximum speed sprinting, thus utilising the SSC effectively. Furthermore, the CMJ performance is contributed by good SSC performance. This explains that an optimal DSI (0.7 – 0.8) is critical to good maximum speed performance and sufficient CMJ performance is needed.

Limitation

The small sample size limits the generalisability of this study's results, which cannot be extended to subjects with different physiques. However, the results do explain a wide data range. As these factors were input into the regression analysis, they did not contribute to the regression model. Sprinting skill may also be a limiting factor that affects the sprint performance. However, it is difficult to assess and is assumed to be similar between rugby sevens players.

Conclusion

Optimal DSI, CMJ-PF/BW and IMTP-PF/BW are the key parameters related to the maximum speed performance.

Practical Application

The DSI (CMJ/IMTP) could be used regularly to monitor the sprinting competence of rugby sevens players, and individualised strength training (strength-dominant or power-dominant) programmes could be designed.

Reference

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