SPECIFIC ADAPTATIONS OF STRENGTH, POWER AND SPEED VARIABLES ALONG A SEASON IN ENDURANCE RUNNERS

Jonathan Esteve-Lanao, Fernando Naclerio, Javier España

European University of Madrid, Madrid, SPAIN

INTRODUCTION

Endurance running performance has been traditionally associated with a complex interplay of several physiological factors, like VO_2 max, anaerobic threshold, running economic and anaerobic power (1). Strong evidence exists on the positive effects of strength training on several running performance determinants, mainly running economy (2). A key determinant of running economy is the ability to maintain power in fatiguing situations (3). Moreover, it has been generally stated that power measurements are among the best indicators of sports performance (4,5). However, these longitudinal measurements have not been published in endurance sports. The main purpose of this study with trained endurance runners was to assess the relationship between strength, power and speed indices that may be related to endurance running performance along a 23-weeks macrocycle.

METHODS

Five trained endurance runners (age: 27±3 years (mean±SD), height: 174±3 cm; weight: 68.1± 4.5 kg; VO2 max: 68.0±5.6 mL•kg-1•min-1) were evaluated three times over a cross country macrocycle including a simulated cross country race and a full battery of physiological tests in each of the three evaluations (weeks 7, 15 and 23). The third set of evaluations was performed within a week after the main target on the season (week 22, regional cross-country championships). Testing battery included sprints, jumps and lifting tests.
Vertical jump tests. Squat (SJ) counter-movement jumps (CMJ), and 60s straight-knee rebound jumps were performed using a contact mat (Globus Ergo Tester, Codognè, Italy).
100-meter running stride test. Subjects were required to run 100 m on a flat track as fast as possible and with the lowest possible number of jumping steps.
Squat test (1RM). Squat tests for maximal strength (1RM) at 90º angle of knee flexion.
Power squat test. Mechanical power was evaluated during a progressive load test at the same squat exercise using a modified approach to the method developed by Baker (2001) with a rotational encoder system (Globus Real Power, Codognè, Italy) (5).
Maximal running frequency was recorded during maximal sprint velocity over 10 steps over a 17 m flat distance which 11 cardboard devices (height: 17 cm) separated from each other by 1.7 meters. *Maximal Speed*. Subjects performed two trials at maximal sprint velocity over 10 m dash run with a 30-40 meters previous acceleration. Both tests were conducted with two photocell barriers (Telemechanique, France).
Simulated Competition. Subjects ran all together a 11.5-km cross-country race on a loop frequently used in their training session under similar environmental conditions. this loop which is frequently used in their training sessions.
Statistical analyses were performed with SPSS 13.0 software (SPSS Inc., Chicago, IL). Friedman and Tukey post-hoc test were applied to compare 3 evaluations.

RESULTS

Vertical Squat Jump performance decreased along the season, as well as the velocity and power at maximal power squat test. Endurance performance and maximal strength improved continuously along the season, while the other variables remained constant.

Table 1. Results (mean±SD) of the three testing batteries performed over the macrocycle.

Test	Variable	1st Test (Preparatory Period)	2nd Test (Specific Period)	3rd Test (Competition Period)
Vertical jump tests	Height in SJ (cm)	32.6±2.0	30.9±2.3	28.9±2.7 **, †
	Height in CMJ (cm)	31.9±4.5	32.1±3.1	29.8±3.6
	60 s RJ: Height decrease (%) initial *vs.* last 10 jumps	-4.6±9.4	-0.7±5.4	-5.2±12.5
100 m running stride test	Step number x time (s)	723±101	735±65	714±79
Power Squat test	Maximal power (W)	1224±166	1119±128	1055±120 **, †
	Maximal load (kg+BW) related to maximal power	118.1±9.6	115.3±6.2	142.3±10.6 **†
	Velocity at maximal power ($m\cdot s^{-1}$)	0.90±0.09	0.83±0.07	0.66±0.03 **,†
Maximal Strength test (Squat)	1RM squat (kg)	138.9±16.0	154.5±19.7*	167.8±31.0 †
	1RM· kg body weight ¯	2.0±0.2	2.3±0.2*	2.5±0.3 †
Maximal frequency	$steps\cdot s^{-1}$	4.5±0.1	4.6±0.2	4.5±0.2
Maximal Speed	$m\cdot s^{-1}$	4.04±0.09	3.98±0.08	4.04±0.07
Simulated cross country Competition	Performance time	44min22s±2min32s	41min54s±2min0s*	41min43s±2min48s†

* *P*<0.05 for 1st *vs.* 2nd test; ** *P*<0.05 for 2nd *vs.* 3rd test; † *P*<0.05 for 1st *vs.* 3rd test. Abbreviations: SJ (squat jumps), CMJ (counter-movement jumps), 60 s RJ (sixty-second repeated-jumps), BW (body weight)

DISCUSSION

All subjects displayed a very good performance during that season (top 15 in the Madrid Regional Cross Country Championships and actual performance increases along the season around 5 to 6%. In a similar way, all maximal strength variables continuously improved. But all speed variables remained stable, and it seems a key factor that all concentric power variables showed a constant decrease along the season. Many endurance variables improved, especially lower lactate levels near competition speeds (data not shown). It has been previously shown that specific strength training is related to the ability of maintaining step length in fatigue (3). Taken all together, it seems that, in contrast to power-sports, in endurance sports a power decrease is related positive adaptations of training specificity. In contrast, maximal strength increases, maybe because it is a basic capacity that may determine the development of more specific capacities (like running economy or anaerobic power).

CONCLUSIONS

With exception of 1RM, single action or brief efforts don't provide additional information to aerobic, endurance-strength or performance profile.

REFERENCES

(1) Brandon JL. Sports Med. 19:268-277, 1995.
(2) Jung AP. Sports Med. 33:539-552, 2003.
(3) Esteve-Lanao et al. J. Strength Cond. Res. 22: (in press), 2008.
(4) Naclerio et al. Med. Sci. Sports Exerc. 39 (Suppl.): S293, 2007.
(5) Baker D. J. Strength Cond. Res. 15: 198-209, 2001.