

VALIDATION OF A FIELD TEST FOR THE EVALUATION OF SPECIFIC ENDURANCE IN BASKETBALL^{1,2}

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Summary.—An interval field test (TIVRE-Basket) was validated for the evaluation of specific endurance and recovery capacity in an acyclic, discontinuous sport such as basketball. It measures players' anaerobic threshold and recovery capacity. Eighteen professional basketball players carried out a treadmill stress test for measurements of VO_{2max} and assessment of the anaerobic ventilatory threshold (VT₂). Then, 48 hr. later they took part in the field test TIVRE-Basket with heart rate monitors. There were no significant differences between the treadmill test and the TIVRE-Basket test in HR_{max} nor between the anaerobic threshold. Significant correlations between VO_{2max} and maximum speeds on the treadmill and TIVRE-Basket tests were found.

Technological applications are used more and more often to evaluate functional capacities, to monitor and control effort and performance, to measure players' progression with training, to detect deficiencies in physical preparation or conditioning, and even to recognize talented athletes.

Basketball is an acyclic, discontinuous interval sport that requires both the aerobic and anaerobic systems simultaneously to carry out maximal (e.g., sprints, jumps) and submaximal (e.g., moderate running) efforts (Vaquera, Morante, García-López, Rodríguez-Marroyo, Ávila, Mendonca, & Villa, 2007). In basketball, the aerobic metabolism is important both for the game's duration and because it allows for some recovery from anaerobic activity. Nevertheless, in basketball, the values of VO_{2max} and/or of anaerobic threshold (an indicator of aerobic endurance) are not as high as in endurance specialties (Sallet, Perrier, Ferret, Vitelli, & Baverel, 2005), although their evaluation by means of a laboratory test (treadmill) or field test (Course-Navette, Cooper, Conconi, etc.) are

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based on cyclical, continuous efforts (McInnes, Carlson, Jones, & McKenna, 1995; Vaquera, *et al.*, 2007) that are applied nonspecifically to basketball and generate doubts about valid transference to the monitoring of training.

The purpose of this study was to validate a specific, progressive, and maximal interval field test, to be administered on the basketball court (TIVRE-Basket), that involves carrying out the acyclic, discontinuous, interval efforts typical of basketball, and that allows for evaluating specific endurance for these efforts, detecting anaerobic threshold, player's recovery capacity, and VO_{2max} according to the duration of effort.

METHOD

An interval test for the evaluation of specific endurance in basketball (TIVRE-Basket; Fig. 1) was developed, consisting of positioning up to 12 players on a basketball court, each one at a cone placed on the court at a distance of 8 m. Players run at the same speed (with auditory stimuli to guide them), and the test is specific (with changes of speed and direction), interval (players complete 3 laps of the 96 m circuit followed by a 30 sec. recovery), progressive (players start running at 7.8 km/hr. and increase 0.6 km/hr. at each interval) and maximal (until exhaustion).

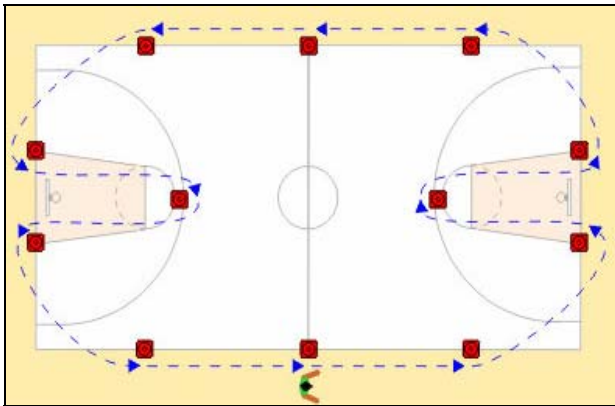


FIG 1. Placement of cones in TIVRE-basketball.

Eighteen professional basketball players (M age=27.6, SD =6.4 yr.; M weight=89.7 kg, SD =3.6; M height=194.1 cm, SD =3; M body fat %=10.3, SD =0.4) with 5 to 12 years of national and international experience in official competitions and national teams took part in a treadmill stress test (constant incline at 1% and ramp protocol: starting at 6 km/hr., speed increased 0.5 km/hr. every 30 sec. until exhaustion). The test involved electrocardiogram control and

gas exchange analysis (MedGraphics CPX-bonus) to identify the $\text{VO}_{2\text{max}}$ peak and the anaerobic ventilatory threshold (VT2, McInnes, *et al.*, 1995).

Between 48 and 72 hours later, subjects carried out the TIVRE-Basket field test while wearing a heart rate monitor (Polar Vantage NV®). The anaerobic threshold was identified (ATi) when a change in the progression of HR_{max} was detected, following the methodology proposed by Probst (Vaquera, *et al.*, 2007).

Data analyses were done utilizing the statistical package SPSS Version 14.0. The differences between variables were analyzed with the nonparametric Wilcoxon test and their correlation with the Spearman correlation coefficient.

RESULTS AND DISCUSSION

Subjects' $\text{VO}_{2\text{max}}$ on the treadmill was in the range of professional basketball players: 55–60 ml/kg/min. (Sallet, *et al.*, 2005). The players reached 98% of their theoretical HR_{max} , both in the treadmill test and in the TIVRE-Basket test. In the TIVRE-Basket test a lower maximum speed was reached because of the shorter duration of the intervals (from 2.2 min. at 7.8 km/hr. to 1.2 min. at 14.2 km/hr.), although these speeds correlated significantly with each other ($r=0.63$; $p<.01$) (Table 1). Also, those who completed more intervals in the TIVRE-Basket test should be the ones with higher $\text{VO}_{2\text{max}}$.

TABLE 1
MAXIMUM AND ANAEROBIC THRESHOLD VALUES REGISTERED IN THE TREADMILL
STRESS TEST AND TIVRE-BASKET FIELD TEST

	Treadmill		TIVRE-Basket	
	M	SE	M	SE
Maximal values				
$\text{VO}_{2\text{max}}$ (ml/kg/min.)	54.1	8.9		
HR_{max} (bpm)	189.25	1.3	189.66	1
% theoretical HR_{max}	98.38%		98.59%	
Completed periods (no.)			12.49	0.20
Speed (km/hr.)	17.58	0.12	14.2 [†]	1.21
Time test (min.)	12.03	0.12	25.80 [†]	1.21
Anaerobic threshold values				
VO_2 (ml/kg/min.)	39.8	9.5		
HR_{max} (bpm)	175.22	8	176.5	7
% HR_{max}	92.58	0.67	93.06	0.36
Speed (km/h)	12.9	0.43	10.34 [*]	0.11

(continued on next page)

TABLE 1 (CONT'D)

MAXIMUM AND ANAEROBIC THRESHOLD VALUES REGISTERED IN THE TREADMILL STRESS TEST AND TIVRE-BASKET FIELD TEST

	Treadmill		TIVRE-Basket	
	M	SE	M	SE
% Maximum speed	73.37	1.01	72.81	0.52
Correlations				
VO _{2max} treadmill _ VO _{2max} TIVRE	r=.71†			
Speed _{max} treadmill _ Speed _{max} TIVRE	r=.63†			
HR _{max} treadmill _ HR _{max} TIVRE	r=.80†			

* $p < .05$; † $p < .01$; ‡ $p < .001$.

The anaerobic threshold evaluates the endurance capacity for medium (10 to 30 min.) to long duration (more than 30 min.) efforts, and it is often used to evaluate training loads and physical condition. In only two cases the interval anaerobic threshold was not identified (Fig. 2). In Fig. 2, this threshold is identified in the interval 5.2, at a speed of 10.2 km/h, and at a heart rate of 176.5

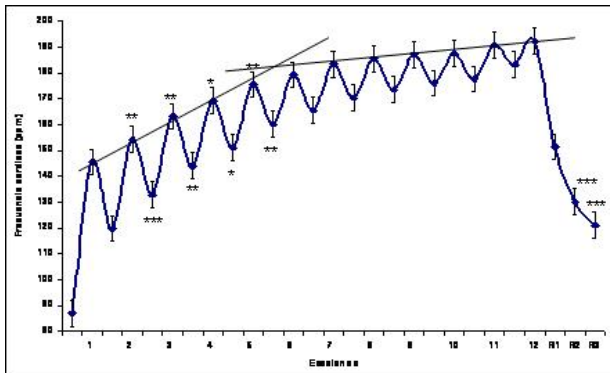


FIG. 2 Evolution of the heart rate during the test. Significant differences with the previous interval: ** $p < .01$; *** $p < .001$.

bpm. This does not differ significantly from the anaerobic threshold (VT2) on the treadmill, nor with its threshold speeds (73.3% on the treadmill vs 72.8 % in the TIVRE-Basket test). This occurs at 74.5 % of the VO_{2max} (Sallet, *et al.*, 2005).

The HR_{max} as well as that of recovery at every interval of effort of the TIVRE-Basket test was significantly different (Fig 2) from the previous interval only in the submaximal intervals, coinciding with the anaerobic threshold, which is related to training and performance, as it is an aerobic sport with frequent anaerobic actions (Graham, Douglas, Hunsakor, & Howell, 2003).

The TIVRE-Basket test is proposed as a new, indirect field test method for evaluating aerobic ability noninvasively and at little cost.

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