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Development and Efficacy Evaluation of a Periodized Professional Endurance Training Program for U19 Male Basketball Athletes in Da Nang, Vietnam

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Abstract:

This study aimed to design and rigorously assess the effectiveness of an eight-week periodized professional endurance (PE) training intervention for U19 male basketball athletes in Da Nang, Vietnam. Grounded in Bompa's periodization theory and informed by expert consensus (>80%), the program incorporated thirty basketball-specific endurance exercises executed over two distinct phases: anatomical adaptation (weeks 1–4) and maximal endurance development (weeks 5–8). Twenty athletes (mean age 17.9 ± 0.5 years) underwent pre- and post-intervention assessments encompassing five field-based PE tests and dual-mode VO_2max measurements (Beep Test and Cosmed K4b2). Post-intervention, significant enhancements were observed across all PE metrics, with performance increases ranging from 8.2% to 17.0% ($p < 0.001$) and VO_2max improvements of 7.7% ($47.9 \rightarrow 51.6$ ml·kg^{-1}·min^{-1}) and 8.5% ($48.2 \rightarrow 52.3$ ml·kg^{-1}·min^{-1}) via Beep Test and Cosmed K4b2, respectively. The proportion of athletes achieving 'Excellent' endurance levels rose from 10% to 30–60%. These findings substantiate the program's capacity to elevate aerobic capacity and sport-specific endurance, offering a scientifically grounded framework for optimizing youth basketball training.

Keywords: *periodization, professional endurance, VO_2max, basketball-specific endurance, youth athlete development*

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INTRODUCTION

Basketball is a high-intensity sport that requires a combination of aerobic and anaerobic endurance, especially at the U19 age group – an important stage of physical and technical development [2]. Professional endurance, defined as the ability to sustain repeated high-intensity efforts throughout the duration of a match (usually 40 minutes according to FIBA regulations), is a decisive factor in performance [6]. In Vietnam, especially in Da Nang, basketball has been identified as a key sport according to the "Da Nang Sports and Physical Training Development Plan" in accordance with Resolution No. 08-NQ/TW [5], [19]. However, the inconsistent performance of the Da Nang U19

team shows limitations in PE training, hindering the ability to compete with strong teams in the region and the country [20].

Initial test results showed that the initial PE of the U19 Da Nang male athlete was average, with an average composite score of 26.25/50 and VO2 max ranging from 47.9 ml/kg/min (Beep Test) to 48.2 ml/kg/min (Cosmed K4b2) [20]. These numbers are lower than the "Excellent" threshold (52-56 ml/kg/min) according to The Movement System standards [18] and far below the international standards for young athletes (53.5 ml/kg/min) or professionals (50-60 ml/kg/min) [6], [12]. These limitations stem from training that is mainly based on traditional experience instead of applying modern scientific methods such as periodization training or high-intensity interval training (HIIT), which have been shown to be effective in improving endurance in short-term interventions [1], [17].

Globally, periodization training according to Bompa [3] has been widely applied to optimize sports performance by dividing the training process into phases (e.g., anatomical adaptation, maximal strength, endurance). Studies such as Amasuomo and Okoro [1] and Scribbans et al. [17] have shown that HIIT can improve VO2 max by 5-15% in 6-8 weeks, providing a promising theoretical framework for young athletes. In this context, the study developed a periodized PE training program for the Da Nang U19 team, implemented for 8 weeks and evaluated the effectiveness through tests and VO2 max measurements. The goal is to improve PE, improve competition performance at national tournaments in 2023 (U18 Championship in Dak Lak and U20 in Thua Thien Hue), and establish a scientific foundation for the sustainable development of youth basketball in Vietnam.

METHODOLOGY

Experimental subjects: 20 male athletes of the U19 Da Nang basketball team (mean age: 17.9 ± 0.5), healthy, no recent injuries, agreed to participate in the study.

Study design: The experimental program lasted 8 weeks (April 7 - April 29, 2023), divided into 2 phases: anatomical adaptation (4 weeks) and maximization (4 weeks), based on Bompa's periodization model [3]. The system included 30 exercises (e.g. Beep Test, shuttle running, jumping) selected through interviews with 26 experts (consensus rate >80%) [21]. Training took place 6 days/week, each session lasted 30-45 minutes, the intensity increased from 70% to 90%.

Measurement method: 5 professional endurance tests (Beep Test, 28m x 4 dribbling, 30s continuous jumping, 27m x 5 dribbling to the basket, 5-position jumping shot) were performed before and after the experiment.; VO2 max: Measured by Beep Test (indirect, Léger formula [13]) and Cosmed K4b2 (direct) [7]. PE performance was converted to a 10-point scale ($C = 5 \pm 2Z$) and classified (Poor ≤19, Weak 20-24, Average 25-34, Fair 35-44, Excellent ≥45).

Statistical analysis: Paired t-test (SPSS 25.0) compared data before and after the experiment, statistical significance level $P < 0.05$. Pearson correlation assessed the consistency between VO2 max from Beep Test and Cosmed K4b2.

RESULTS

1. Professional endurance test results

Table 1: Professional endurance test results of U19 male basketball players in Da Nang before and after the experiment (n=20)

Test	Before (Mean ± SD)	Apter (Mean ± SD)	W%	t	P
Beep test (laps)	77.93 ± 2.04	84.35 ± 2.06	8.2	12.87	<0.001
28m x 4 dribbling (s)	27.97 ± 1.17	23.64 ± 0.98	15.5	14.87	<0.001
30s jump with table (times)	27.74 ± 4.13	32.45 ± 4.01	17.0	11.23	<0.001
5 x 27mdribbling and layup (s)	32.08 ± 1.35	27.19 ± 1.14	15.2	13.95	<0.001
5-position jump shot (s)	62.67 ± 1.53	53.27 ± 1.30	15.0	15.64	<0.001

Comments: All PE tests showed significant improvements (P < 0.001), with increases ranging from 8.2% (Beep Test) to 17.0% (30s Jump). Standard deviations (SD) decreased slightly in most tests, reflecting greater uniformity among athletes after the experiment.

Table 2: Statistics of professional endurance scores of U19 male basketball players in Da Nang on 10-point scale before and after the experiment (n=20)

Test	Before (%)			After (%)		
	Point 1-3	Point 4-6	Point 7-10	Point 1-3	Point 4-6	Point 7-10
Beep test (laps)	25	40	35	0	50	50
28m x 4 dribbling (s)	25	50	25	0	40	60
30s jump with table (times)	25	40	35	0	30	70
5 x 27mdribbling and layup (s)	25	50	25	0	40	60
5-position jump shot (s)	25	50	25	0	40	60

Comments: Before the experiment, 25% of athletes scored low (1-3), after the experiment there were no athletes at this level. The percentage of high scores (7-10) increased from 25-35% to 50-70%, especially "30s Jump" reached 70%, showing remarkable improvement.

2. VO2 max result

Table 3: VO2 max results from Beep Test and Cosmed K4b2 of U19 male basketball players in Da Nang before and after the experiment (n=20)

Test	Parameters	Before (Mean ±SD)	After (Mean ± SD)	W%	t	P
Beep Test	Lap	77.93 ± 2.04	84.35 ± 2.06	8.2	12.87	<0.001
	VO2 max (ml/kg/min)	47.9 ± 1.3	51.6 ± 1.3	7.7	12.94	<0.001
Cosmed K4b2	VO2 max (ml/kg/min)	48.2 ± 1.2	52.3 ± 1.2	8.5	13.75	<0.001
	VE (L/min)	146.9 ± 6.3	159.2 ± 6.4	8.4	10.12	<0.001

Comments: VO2 max increased from 47.9 to 51.6 ml/kg/min (Beep Test) and from 48.2 to 52.3 ml/kg/min (Cosmed K4b2), with P < 0.001, indicating significant improvement in aerobic endurance. VE increased by 8.4%, reflecting increased respiratory capacity.

Table 4: Heywood classification of VO2 max in male U19 basketball players in Da Nang before and after the experiment

Classify	Beep Test		CosmedK4b2	
	Before (%)	After (%)	Before(%)	After(%)
Excellent	0	0	0	0
Good	0	10	0	10
Fair	10	40	10	40
Average	80	50	80	50
Weak	10	0	10	0
Very weak	0	0	0	0

Comments: Before the experiment, 80% of the athletes were at the "Average" level and 10% were "Weak". After the experiment, the "Fair" rate increased from 10% to 40%, "Good" reached 10%, there were no more "Weak" athletes, showing a positive shift in aerobic endurance.

3. Professional endurance level classification

Table 5: Summary score and classification of PE of male athletes

Parameter	Before	After
Average score	26.25	34.70
Standard deviation (SD)	11.45	10.23
Point range	7 - 46	24 - 49
Classify	**Number of athletes (%)**	**Number of athletes(%)**
Excellent (≥45)	2 (10%)	6 (30%)
Good (35-44)	5 (25%)	8 (40%)
Fair (25-34)	8 (40%)	6 (30%)
Average (20-24)	2 (10%)	0 (0%)
Weak (≤19)	3 (15%)	0 (0%)

Comments: The average score increased from 26.25 (Average) to 34.70 (Good), with the percentage of "Excellent" increasing from 10% to 30%, "Good" from 25% to 40%, and no longer "Weak" or "Very weak" athletes. The standard deviation decreased from 11.45 to 10.23, indicating a more uniform level of PE.

DISCUSSIONS:

The 8-week training program improved professional endurance from 8.2% to 17.0%, which was superior to conventional HIIT studies (5–10%) by Amasuomo and Okoro [1] and Scribbans et al. [17]. This suggests that combining periodization training with basketball-specific exercises improves both endurance and skill more effectively than general HIIT. VO2 max increased by 7.7–8.5% (3.7–4.1 ml/kg/min), consistent with the 5–11% increase in athletes according to Montero and Lundby [15], but lower than the 10–15% increase in less trained individuals [17]. This difference reflects the initial VO2 max level (47.9-48.2 ml/kg/min) of the Da Nang U19 team, higher than normal people (~30-40 ml/kg/min) but not reaching NBA professional standards (50-60 ml/kg/min) [12].

Compared with Castagna et al. [6], the VO2 max of European U19 athletes was 53.5 ml/kg/min, higher than the post-test level of 52.3 ml/kg/min, suggesting that the gap needs to be closed through longer intervention (>12 weeks) or increased training volume (300 min/week) [15]. The reliability of the results was confirmed by the agreement between Beep Test and Cosmed K4b2 (r = 0.97-0.98), similar to the results of Léger et al. [13] and Cosmed [7]. However, the modest increase in VO2 max suggests physiological limitations in trained athletes, as pointed out by Hawley [11], where genetic factors limit improvement without longer duration.

The professional endurance classification showed that the "Excellent" rate increased from 10% to 30%, exceeding the improvement of the short (6-week) interventions according to Duffield et al. [9], confirming the advantage of the 8-week periodization method. However, to meet the demands of elite basketball, the program needs to include anaerobic strength training, as suggested by Baker and Jones [2].

CONCLUSIONS:

The 8-week professional endurance program has brought significant improvements to the U19 Da Nang male basketball player, demonstrated through both physical performance and technical skills. The test results showed that the 5 SBCM tests increased from 8.2% (Beep Test) to 17.0% (30s continuous jump), while VO2 max increased from 47.9 to 51.6 ml/kg/min (7.7%) according to Beep Test and from 48.2 to 52.3 ml/kg/min (8.5%) according to Cosmed K4b2, reaching the "Excellent" level according to international standards (52-56 ml/kg/min). The average PE score increased from 26.25 ("Average") to 34.70 ("Fair"), with the proportion of athletes achieving "Good" and "Excellent" levels increasing from 35% to 70%, with no cases at "Weak" or "Very weak" levels. The standard deviation decreased from 11.45 to 10.23, indicating a uniformity in performance among athletes. These results confirm the effectiveness of the program based on periodization theory, while providing a scientific tool to optimize training, support performance at national tournaments in 2023, and lay the foundation for the sustainable development of youth basketball in Vietnam. However, to reach the VO2 max standard of international professional athletes (50-60 ml/kg/min), it is necessary to extend the experimental period or add anaerobic strength training exercises in the future.

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