



INFLUENCES OF DIFFERENT PHASES OF TRAINING ON AEROBIC CAPACITY OF MALE HANDBALL PLAYERS

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Abstract: The purpose of this study was to determine the influence of different phases of training on aerobic capacity of male handball players. Twelve (12) male handball players were selected. These twelve players represented Annamalai University in South Zone Inter University handball tournament for the year 2011. The criterion variables selected in this study was aerobic capacity, which was measured in treadmill through Bruce treadmill test. Testing took place at four points during the periodized training year; at the beginnings of general preparation (T1), specific preparation (T2), and competition phase beginning (T3) end of competition phases of training and peaking (T4). A full testing battery was conducted at T1 and T4, while two minor testing sessions were conducted at T2 and T3. The ANOVA revealed a significant change in aerobic capacity of handball players during different phases of training ($F = 4.953, p < 0.05$). Bonferroni post hoc test revealed no significant difference between all comparisons (all $ps > 0.05$) on aerobic capacity of handball players. It is concluded that aerobic capacity undergoes significant changes during the different phases of training.

Keywords: handball, aerobic capacity, male, preparation, competition, periodization

Introduction

Periodization can be defined as the purposeful variation of a training programme over time, so that the competitor will approach their optimal adaptive potential just prior to an important event. Handball is fast body contact sports which require aerobic fitness, in order to improve aerobic fitness specific training has to be incorporated, but the players under go complex training throughout the year to improve their overall physical fitness. Although the structural, physiological and metabolic characteristics of athletes have been thoroughly studied over the years, the physiological mechanisms which support the efficiency of periodized training programmes remain unclear.

According to Fleck (1999) relatively short training regimes, periodized programmes are able to elicit significantly greater adaptations in selected performance indices than non-periodized [1]. Another explanation for the supremacy of the periodized training approach may be that, compared to controls, higher training loads have been reported by groups practising these programmes, which eventually bring about significantly greater adaptations and performance improvements [2].

Maximum oxygen uptake ($VO_2\max$) refers to the highest rate at which oxygen can be taken up and consumed by the body during intense exercise [3].



Traditionally, the magnitude of an individual's $VO_2\text{max}$ has been viewed as one of the most important predictors of endurance performance. Prolonged exercise requires sustained energy provision to maintain muscle contraction and is accomplished through the continual production of ATP (adenosine triphosphate), the universal energy molecule. The production of ATP is accomplished through three metabolic pathways (breakdown of a fuel to release energy), which include the phosphagen system (the production of ATP from creatine phosphate), glycolysis (glucose breakdown), and mitochondrial respiration (aerobic metabolism within the mitochondrion of the cell). The first two pathways are only capable of energy production for short durations; consequently, ATP regeneration for extended exercise is accomplished predominantly through mitochondrial respiration. The biochemical reactions involved in mitochondrial respiration depend on continuous oxygen availability for proper functioning.

Enhanced oxygen delivery and utilization during exercise will improve mitochondrial respiration and subsequently the capacity for endurance exercise. The central (heart, lungs, blood vessels) physiological functions can limit $VO_2\text{max}$.

Chittibabu (2014) stated that endurance display greater relationship with handball playing performance [4]. So evaluating and understanding of physiological capabilities throughout the course of a training season may be of great value in perspective of physical performance. The training imposes cardiovascular and pulmonary adaptation and their effect on performance are noticed. Lack of studies on empirically investigating the adaptation of physiological capabilities during a training season has motivated to taken up a study in enriching quantum of theory in the field of training methods. The purpose of this study was to determine the influence of different phases of training on aerobic capacity of male handball players.

Methods

Subjects

Twelve (12) male handball players were selected. These twelve players represented Annamalai University in South Zone Inter University handball tournament for the year 2011. These players were selected at random as subjects, who volunteered to participate in this study. All the players had been part of the team for a minimum of 2 years. The selected subjects provided written, informed consent to participate in this study. All subjects were familiar with all the testing that took place, which included both field and laboratory assessments.

Physical characteristics of the subjects

The age of the subjects ranged between 20 and 24 yr. The mean \pm SD of age, height and body mass were 22.0 ± 2.4 years, 158.7 ± 7.9 cm, 55.9 ± 6.1 kg respectively. On average, the players had 7.9 ± 2.1 years of playing experience.

Environmental factors

Chidambaram is 5.75 metres above mean sea level (*MSL*) and Latitude with $11^{\circ}24'$ North and $76^{\circ}44'$ East. During the course of the study the environmental temperature and humidity recorded are presented in Table 1.



Table 1: Metrological data recorded during testing of handball players within the periodized training year

Parameters	T1	T2	T3	T4
Mean temperature	29.4°C	32°C	29°C	27°C
Maximum temperature	38.5°C	39°C	34°C	31°C
Minimum temperature	25°C	26°C	24°C	23°C
Average humidity	74	64	67	86

Variables and test

The criterion variables selected in this study was aerobic capacity, which was measured in treadmill through Bruce treadmill test. The players were provided with 10 minutes of warming up followed by the test. The subjects were asked to start the exercise with 1.7 mph at 10% grade and gradually the load increases. The recorder starts the stop watch and stops the stop watch when the player is unable to continue and records the time (T). The time taken by the players in treadmill test was used in estimation of VO₂max. Foster *et al.* (1984) proposed an equation to estimate VO₂ max based on time in treadmill test as follows: $VO_{2max} = 14.8 - (1.379 \times T) + (0.451 \times T^2) - (0.012 \times T^3)$ [5].

Experimentation

Testing took place at four points during the periodized training year; at the beginnings of general preparation (T1), specific preparation (T2), and competition phase beginning (T3) end of competition phases of training and peaking (T4). A full testing battery was conducted at T1 and T4, while two minor testing sessions were conducted at T2 and T3. A schematic figure of the periodized year can be found in Figure 1.

Figure 1: A schematic representation of the periodized training year of the Annamalai University handball team

July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
General preparation			Specific preparation			Competition		Peak
T1			T2			T3		T4

The study commenced after the end of the previous competitive season and at the beginning of the general preparation phase of training. The training year was divided into three mesocycles (general preparation, July to September; specific preparation, October to December; competition, January to March). The players trained daily and thus it is not possible to quantify exact training loads. The battery of tests utilized was based on selected anthropometrical and cardiopulmonary parameters, comprising both laboratory and sport-specific protocols. All subjects were familiarized with the procedures prior to testing. Sport-specific testing had been used frequently as part of the training programme, while for the laboratory-based tests the subjects undertook specific familiarization trials prior to the testing sessions. The subjects had



been instructed to refrain from strenuous exercise for forty-eight hours prior to testing and to avoid food and caffeine intake for two hours preceding the assessments. All subjects completed testing at the same time of day to avoid any circadian rhythm effects [6].

Training Schedule followed during periodized training year

The selected subjects were trained on both sessions (i.e., morning and evening). These subjects underwent different types of training during morning and game specific skill and played match during evening. The quantification of training is done during evening hours were these subjects undergone different types of training.

Statistical analyses

Descriptive statistics were calculated for all variables. One-Way Repeated Measures ANOVA was utilized to determine significant differences for each variable between the different phases of training. Bonferroni *post-hoc* test was used to locate differences between the different phases of training. Significance level was set at $P < 0.05$. All statistical analyses were conducted using SPSSv11.5.

Results

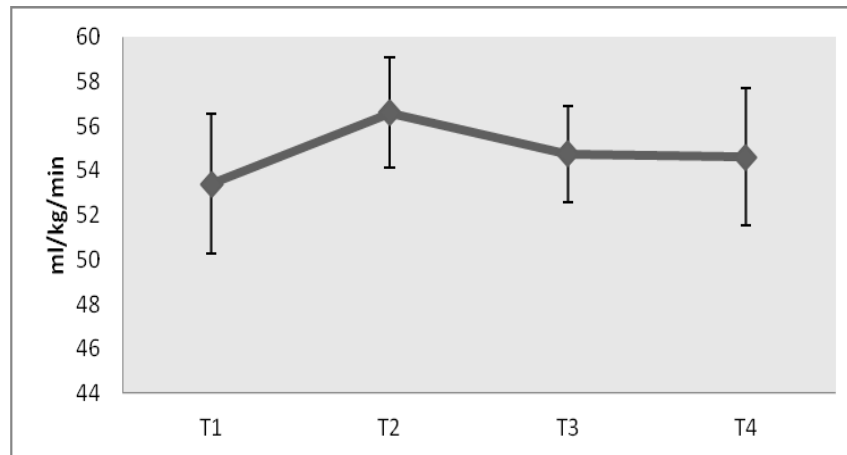
Table 1
Changes in aerobic capacity at designated point within the periodized

Testing Conditions	Mean (ml/kg/min)	Standard deviation	F
T1	53.41	3.15	4.953*
T2	56.59	2.48	
T3	54.74	2.14	
T4	54.61	3.09	

*significant at 0.05 level of confidence
($p < 0.006$)

There is a significant change in aerobic capacity of handball players during different phases of training (Table 1). The obtained F ratio of 4.953 is greater than the required table value of 2.965 at $\alpha = 0.05$ for the df of 3 and 33. Since F is significant Bonferroni *post-hoc* test was applied (Figure 2). Bonferroni post hoc test revealed no significant difference between all comparisons (all $ps > 0.05$) on aerobic capacity of handball players.

Figure 2
Changes in aerobic capacity of handball players



Discussion

In this study male handball players displayed an average aerobic capacity of 54.83 (ml/kg/min). General preparatory phase (T1) is an important period of conditioning the handball players (Natal Rebelo & Soares, 1995) and the high values of VO_2 max attained and maintained till end of competitive phase [7]. Endurance training during this period, usually results in little or no muscle hypertrophy but does increase capillary and mitochondrial density, enzyme activity (creatine phosphokinase and myokinase), metabolic stores (ATP, Creatine phosphate and glycogen), connective tissue strength (ligament and tendon) [8-9]. Astrand (2003) stated that aerobic training could improve or decrease an athlete's aerobic power by 5% to 30%, though this greatly depended on the athlete's starting fitness levels, with low starting levels gaining the greatest increases [10]. As anticipated, aerobic parameters fluctuated across the season. However, similar results were obtained in this study. The magnitude of change in response to any training programme depends on the athlete's pre- training level and the characteristics of the programme or playing season. The reasons for this decrement most likely reflect the training stimulus. Brady *et al.* (1995) attributed the seasonal decrement to the fact that coaches may be reducing the training stimulus towards the end of the season [11].

Conclusions

The aerobic capacity showed significant difference at different phases of training. However, bonferroni post hoc test revealed no significant difference between all comparisons (all $ps > 0.05$).



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