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# Influences of Different Phases of Training on Percent Body Fat and Aerobic Capacity of Male Handball Players

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

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**ABSTRACT** *The purpose of this study was to determine the influence of different phases of training on percent body fat and 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 percent body fat (F = 4.45, p < 0.05) and 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 percent body fat and aerobic capacity of handball players. It is concluded that percent body fat and aerobic capacity undergoes significant changes during the different phases of training.*

## 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. 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 (Stone *et al*. 1999).

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 (Bassett & Howley 2000). Traditionally, the magnitude of an individual's $VO_2$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 $VO_2$max.

Chittibabu (2014) stated that endurance display greater relationship with handball playing performance. So evaluating and understanding of physiological capabilities throughout the course of a training season may be of great value in prespective 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 ± SD of age, height and body mass were 22.0 ± 2.4

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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°24′ North and 76°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**
In the present study percent body fat was selected as criterion variables. Measuring body fat percentage is an easy method of discovering correct body weight and composition. Beneath the skin is a layer of subcutaneous fat, and the percentage of total body fat can be measured by taking the 'skinfold' at selected points on the body with a pair of calipers.

Estimation of body fat was carried out by skinfold thickness measurement. Measurement can use from 3 to 9 different standard anatomical sites around the body. The right side is usually only measured (for consistency). The tester pinches the skin at the appropriate site to raise a double layer of skin and the underlying adipose tissue, but not the muscle. The calipers are then applied 1 cm below and at right angles to the pinch, and a reading in millimeters (mm) taken two seconds later. The mean of two measurements should be taken. If the two measurements differ greatly, a third should then be done, then the median value taken.

**The sites**
There are many common sites at which the skinfold pinch can be taken. The four sites (triceps, biceps, subscapular and suprailliac) proposed by Durnin and Womersley (1974) is applied in this research.

**Formula to Calculate**
Body density and percentage body fat is calculated using the equations of Durnin and Womersley (1974), for each side of the body, using the following equations:

Density ($g/cm^3$) = c – m (log ΣS)

Once density is calculated, the Siri (1961) equation is used to estimate percentage body fat:

Fat (%) = [(4.95 / D) – 4.5] x 100

Where: D = Density 4.95 and 4.5 are the constants calculated by Siri (1961) using the assumptions on the density of FM and FFM.

The aerobic capacity 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 $VO_2max$. Foster *et al.* (1984) proposed an equation to estimate $VO_2$ max based on time in treadmill test as follows: $VO_2max = 14.8 - (1.379 \times T) + (0.451 \times T^2) - (0.012 \times T^3)$

**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 (Atkinson and Reilly, 1996).

**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.

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**Results**

**Table 1**

**Changes in percent body fat and aerobic capacity at designated point within the periodized**

| Variable | Testing Conditions | Mean (ml/kg/min) | Standard deviation | F |
|---|---|---|---|---|
| Percent body fat | T1 | 20.41 | 3.62 | 4.45* |
| | T2 | 19.25 | 2.41 | |
| | T3 | 17.00 | 3.13 | |
| | T4 | 16.75 | 2.98 | |
| Aerobic capacity | 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 percent body fat and aerobic capacity of handball players during different phases of training (Table 1). The obtained *F* ratio of 4.45 and 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. Bonferroni post hoc test revealed no significant difference between all comparisons (all *p*s > 0.05) on percent body fat and aerobic capacity of handball players.

**Discussion**

Success at the highest levels of many sports requires a specific physique. Body composition is one variable related to physique. A very basic assessment of body composition allows for the division of the body components into fat tissue and lean tissue. Percent Body fat is the proportion of one's body made that consists of fats. There are currently several methods for assessing percent body fat. Most methods for assessing percent body fat are based on the relationship between body density and percent body fat (Zuluaga, 1995). Sadhan and his colleagues (2007) in their study the linear regression analysis showed that, percent fat and fat mass have strong correlations with $VO_2$ max in boys. The lesser the fat percent and fat mass in boys, greater is the $VO_2$ max. The study of Guerra et al. (2002) also showed that boys had greater $VO_2$ max in comparison to girls. This may also be attributed, impart, to boys higher level of hemoglobin concentration and lower level of subcutaneous fat (Armstrong *et al.*, 1997). The correlation for skin fold measurements (biceps skin fold, triceps skin fold and sub scapular skin fold) with $VO_2$ max also had been seen in the boys in the present study. This may be attributed to the lower level of fat% in boys, thus producing high $VO_2$ max values. This may be due to the fact that there exists certain cardiovascular adaptations with fitness training which cause lower blood pressure. The stroke volume increases with lower heart rate, there by increased capillarization of muscles and greater extraction of oxygen from the arteries. (Wilmore *et al.*, 1999). These results also coincide with our findings.

Hoff and Helgerud (2004) stated that normal $VO_2$max value for football players lie between 55 to 67 (ml/kg/min), however, in this study male handball players displayed an average aerobic capacity of 56.59 (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. 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) (Baechle and Earle, 2000; Amigo *et al*. 1998). Astrand and Rodahl (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. 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.

**Conclusions**

The percent body fat and aerobic capacity showed significant difference at different phases of training. However, bonferroni post hoc test revealed no significant difference between all comparisons (all *p*s > 0.05).

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