Chapter I

INTRODUCTION

Handball has achieved an impressive level of growth and popularity in the world today. Since 1960s, handball has proved and established itself as one of the most popular team sports (Clanton & Dwight 1997; Marczinka 1993). This attracts enormous television audiences and players worldwide. Today it has attained unique status as that of other games, as professional and amateur handball is played in countries of every continent. World championships, Continental championships, Asian championships, World University championships and International tournaments in handball take place regularly. From the inception of handball in the 1972 Munich Olympic games, it has undergone serious changes in rules and playing styles which increased the glamour of the game.

Today, handball is played in 167 countries and almost 19 million players play handball. Similarly, in India right from junior to senior level in both sections it is played and the sport is focused on the entire country. However, it has not become as popular as like that of cricket, football etcetera. Indian handball federation (IHF) is aiming to increase the number of participants, venues to practice and coaches to
train. These initiations would bring about changes in Indian handball in the world arena.

**Handball in general**

Handball is a fast body contact team sport, played by two teams. There are six field players and a goalkeeper on each side. Normally a team on their offence has two wing players, three back court players and a pivot. In defence, the positions depend on the chosen defensive system. Handball game lasts for 60 minutes with interval of 10 minutes. Goals are scored quite often, usually 20-30 goals during a match.

**Physical requirements of handball players**

Contemporary handball requires a high level of general and specific fitness. The actual length of a match is about 60 minutes, with consecutive attacks and defences, performed with high intensity. During a game, direct contact with opponents takes place, and players perform a lot of accelerations, turns and jumps. The diversity of efforts requires comprehensive preparation in terms of endurance, speed and strength. The energy required for handball competition derives from both aerobic and anaerobic processes. Good levels of general fitness, as well as a high aerobic and anaerobic capacity, form the foundation for
success in handball (Boraczyński & Urniaz 2008; Delamarche et al. 1987; Luig et al. 2008).

The high performance of this modern complex handball game depends on several athletic aspects. Fitness profile is one of the important factors for handball players, which requires players to have well-developed basic and specific motor abilities, cardio-respiratory capacities and speed endurance (Delamarche et al. 1987; Gorostiaga et al. 2006; Zapartidis et al. 2009). A good level of sprinting and maximum jumping in defence and offence, flexibility, as well as agility and coordinative abilities, which are indispensable for the efficient solving of game situations. Further, a high level of aerobic capacity ensures the slower onset of fatigue and a fast recovery, whereas anaerobic capacity is responsible for endurance in high-intensity repetitive activities (Galal El-Din & Ibrahim 2009; Marques & Gonzalez-Badillo 2006).

**Training of handball players**

In order to attain and sustain a high level of proficiency of handball players, their training programmes should use knowledge from various sport-related domains of sports sciences. Information on training-related issues, such as anthropometric measurements of handball players (Noustus
et al. 2008), physiological attributes (Ramadan, Hasan, & Barac-Nieto, 1999), throwing velocity and accuracy (van den Tillaar & Ettema, 2003, 2004, 2006), and on-court performance (Delamarche et al. 1987; Luig et al. 2008) can be utilized effectively in handball programmes, especially strength and conditioning programmes developed for handball players. Professionals involved in training programmes for handball players, such as handball coaches, strength and conditioning coaches, athletic trainers, and sport physicians, should have access to the physical and physiological aspects of handball players so that they can use this information when planning short and long-term programmes for their players. In addition, this knowledge can be beneficial when these professionals assess the contribution of their programmes for the development of their handball players.

Handball is a very physically demanding sport which requires greater conditioning which has become an integral part of handball training, as tactics and systems of play have changed over the years. Indeed, counter attacks and high pressure defending are key parts of the high-tempo, modern-day game, and attaining high levels of fitness is critical to succeeding. Players today are quicker, stronger and have
greater endurance than ever before. In fact, one of the major differences between top class and mediocre players is the amount of high-intensity actions they perform during a game.

The greater contribution of fitness towards handball performance has placed an added emphasis on designing and implementing effective training programs. Several factors have to be considered while designing these programs; most importantly, the various physical requirements of the sport must be understood. Handball is a multi-dimensional and dynamic sport that incorporates speed, agility, balance, endurance, power, as well as repeated sprint ability; and it is essential that handball coaches choose exercises that closely resemble game situations. The different positions will also have specific fitness requirements, especially with older and more advanced players, and this also needs to be considered when planning the conditioning program.

In the game of handball multiple actions and movement patterns are involved, and it is clear that the development of specific elements of conditioning is necessary for successful performance in handball (Figure 1). These elements include: balance, flexibility, speed, agility, strength, explosive power, anaerobic endurance, and aerobic capacity.
Designing an effective fitness program for handball is not an easy task and the coach needs to consider all the different elements of fitness when choosing the various exercises. In addition, it is imperative that the coach selects handball-specific conditioning drills that reflect the demands of the sport and not just general fitness drills, especially with older and more experienced players.
**Importance of Aerobic capacity on handball performance**

For about 20 years, highly developed aerobic performance, determined as maximal oxygen uptake (VO$_2$max), has been considered to be a fundamental basis for team handball on the international level (Platen 1989). This statement has been summarized for team sports in general in a recent review (Stone & Kilding 2009). In the training of handball players there are exercises of highly differentiated energetic character. The reason of such structure of exercises is the characteristic of activities undertaken during the game. The high specificity of activities in the game locates the start effort to a group of interval effort of variable time of brakes during which aerobic metabolism dominates (Fox et al. 1975; Green & Dawson 1993; Green et al. 1994). The essence of the training oriented on such features of effort is the use of training loads with different metabolic character.

The intensity of the performance of each exercise is a factor determining the choice of metabolic area, which provides energy for work. Aerobic efficiency is important from the point of view of training component of handball player's preparation. Aerobic efficiency expresses the integral interaction of all physiological systems responsible for oxygen
intake, transport and introduction into the metabolic transformations during muscle's work and defines the ability to realize the work by the cost of energy emitted from resynthesized ATP during aerobic metabolism (Maugham et al. 1997; Carmeli et al. 2002). This type of energy provision of the muscle's work has the highest importance during the long low-intensity exercises, as well as during breaks between short efforts of small-intensity, facilitating the rapid reconstruction of disturbed balance of the functional systems of the organism (Hargreves 1995; Hill et al. 1997). Today, handball is played in fast pace for 60 minutes without getting fatigued. Within the course of play players have to perform repeated sprint. This clearly shows the requirements of the aerobic and anaerobic endurance for handball players.

**Importance of high intensity training**

High intensity training involves periods of intense exercise interspersed with periods of recovery. Exercise intensity is typically above an athlete VO$_2$max, and due to the intense nature of this training modality, the duration of the repetitions is relatively short (30 seconds to 5 minutes), with rest intervals typically lasting 15-120 seconds. Coaches attempt to optimize the training stimulus via manipulation of
the duration and intensity of both the repetition and the recovery phase. Such optimization depends upon the specific event in which the athlete performs. High intensity training improves the repeated sprint ability, endurance and economy. This enables the athlete to perform at a higher intensity for longer duration prior to the onset of the debilitating effects associated with the accumulation of blood lactate.

**Sports specific aerobic training**

Sport specific aerobic training are very popular in as that of soccer and rugby, where players use smaller play area and less number of participants during games, each player comes into contact with the ball and deals with common game situations more often (Capranica *et al.* 2001). These situations require good technical skills such as passing, dribbling, feinting and shooting as well as tactical skills such as running without the ball, unmarking and cooperation with other players. Drastic improvement of on-court fitness and skill is the advantage of sports specific aerobic training that might ensure the players to perform optimally during a game. Examining the effectiveness of handball specific aerobic training among university level handball players is a pioneer attempt made by the investigator.
Statement of the Problem

Coaches and athletes have endeavoured, largely through a process of trial and error, to identify appropriate training techniques of short duration to elicit the greatest improvements in performance. Coaches face great problems while preparing their team for interuniversity competition. They were provided with short duration to prepare their team. Therefore, the aim of the study was to assess the effect of handball specific aerobic training on selected physical fitness (speed, agility, explosive power, arm explosive strength) and physiological variables (percent body fat, lean body mass, resting heart rate, aerobic capacity, maximum heart rate, anaerobic endurance) of male handball players.

Objectives of the Study

The specific objectives of the present study were:

- To study the effectiveness of eight weeks handball specific aerobic training on selected physical fitness and physiological variables of male handball players.
- To elicit the level of changes adhered in handball specific aerobic training group after four weeks of training on selected physical fitness and physiological variables of male handball players.
Delimitations

The study was delimited in the following aspects:

1. To achieve the purpose of the study, twenty four (24) male handball players were selected as subjects from the Department of Physical Education and Sports Science, Annamalai University, Chidambaram, Tamilnadu.

2. These subjects were classified into two groups namely handball specific aerobic training group (HSATG) and Control group (CG), each group constituted of twelve (12) subjects.

3. The selected player’s age was 22.12 ± 3.22 years; height was 174.50 ± 7.83 cm and weight was 65.62 ± 7.79 kg.

4. The study was further delimited to eight weeks of handball specific aerobic training performed three (3) days per week (Monday, Wednesday and Friday).

5. The physical fitness and physiological variables data were collected from HSATG and CG before, after four weeks of training and after eight weeks of training.

6. The physical fitness variables confined to this study were speed, agility, explosive power and arm explosive strength.

7. The physiological variables chosen for this study were percent body fat, lean body mass, resting heart rate,
aerobic capacity, maximum heart rate and anaerobic endurance.

8. The subjects’ physical fitness variables were tested by means of 30 metres dash, T-test, vertical jump test and handball throw for distance.

9. The subjects’ aerobic capacity was measured by using Yo-Yo intermittent recovery test II and anaerobic endurance was measured by 300 yard run.

10. The subjects’ percent body fat and lean body mass was measured through skinfold caliper and polar heart rate monitor was used to measure resting heart rate and maximum heart rate during exercise.

11. All testing took place at the same time of the day to control the circadian variation on selected physical fitness and physiological variables.

**Limitations**

1. In the present study, handball team goalkeepers were not selected, though they remained in the goal post area to defend goals during the eight weeks of handball specific aerobic training. Hence this was considered as exclusion factor.
2. The influence of mid test performed before and after four weeks of training might have influenced the result and which could not be controlled.

3. The heterogeneous character of the subjects in hereditary and environmental factors was considered as limitation.

4. The disparity prevailed in internal and external factors during testing periods could not be controlled.

5. During their handball specific aerobic training heart rate monitor produced beep sound when their intensity was high and low which could not controlled.

**Hypotheses**

On the basis of the literature reviewed, and available research findings, experts’ opinion and the scholar’s own understanding of the problem, the following hypotheses were formulated.

- Ho¹: There may not be a significant improvement on selected physical fitness and physiological variables by means of handball specific aerobic training for four weeks.
Ho²: There may not be a significant improvement on selected physical fitness and physiological variables by means of handball specific aerobic training for eight weeks.

**Operational Definitions and Explanations of the Terms**

**Handball**

Handball is a team game characterized by two alternating sides: the attack and the defence with the purpose to score or obstruct the goal.

**Training**

A consistent or chronic progression of exercise sessions designed to improve physiological function for better health or sport performance.

**Exercise**

Exercise is a single acute bout of bodily exertion or muscular activity that requires an expenditure of energy above resting level and that in most, but not in all cases results in voluntary movement.
**Endurance training**

Endurance training is the act of exercising to increase the endurance. The term 'endurance training' generally refers to training the aerobic system.

**Aerobic training**

It is well recognized that adults are able to increase cardio respiratory (or aerobic) fitness, or maximal oxygen uptake (VO₂ max), after performing an appropriate exercise stimulus over a period of time.

**Handball specific aerobic training**

Handball game related skills are involved during handball specific aerobic training which are directed towards optimizing athletic performance.

**Physical fitness**

A physiological state of well-being that provides the foundation for the tasks of daily living and a basis for participation in sport.

**Speed**

Speed is the ability to complete a given task in the shortest possible time.
**Agility**

Agility is the ability to change the direction rapidly while on the ground or in the air.

**Power**

*Power* is the rate at which work is performed or the rate of the transformation of metabolic potential energy to work.

**Strength**

Strength will be employed to identify the maximal force or torque that can be developed by the muscles performing a particular joint movement.

**Arm strength**

Arm strength is the ability of a muscle or muscle group to exert maximal force against a resistance in a single repetition. Throwing handball for distance is used to measure arm strength.

**Exercise physiology**

A basic and an applied science that describes, explains, and uses the body’s response to exercise and adaptation to exercise training to maximize human physical potential.

**Body composition**

The partitioning of the body mass into fat free mass (weight or percentage) and fat mass (weight or percentage).
**Body height**

The maximum distance from the floor to the vertex of the head, when the head is held in the Frankfort Plane and a gentle traction force is applied (Duquet & Carter, 2009).

**Body mass**

The force of gravity acting on the mass of the body (Duquet & Carter, 2009).

**Skin fold fat thickness**

The most widely applied field technique used to estimate body density, relative body fat, and fat-free mass. It involves measurements with caliper of the skinfold fat at one or more sites.

**Percent body fat**

The ratio of fat mass to total body mass expressed as a percentage.

**Lean body mass**

The sum of the body’s fat-free mass and essential fat is lean body mass.

**Fat mass**

The absolute amount of body fat is termed as fat mass.
**Aerobic fitness**

Aerobic fitness may be defined as the ability to deliver oxygen to the exercising muscles and to utilize it to generate energy during exercise. Aerobic fitness, therefore, depends upon the pulmonary, cardiovascular and haematological components of oxygen delivery and the oxidative mechanisms of the exercising muscles.

**Aerobic capacity**

Aerobic capacity is the maximum rate at which an athlete can produce energy through oxidation of energy resources (carbohydrate, fats and proteins) and is usually expressed as a volume of oxygen consumed per kg of body weight per minute (i.e., ml/kg/min).

**Maximal oxygen consumption**

The highest amount of oxygen an individual can take in and utilize to produce ATP aerobically while breathing air during heavy exercise.

**Anaerobic capacity**

Anaerobic capacity is the maximal rate of energy production by the combined phosphate and lactic acid energy system for moderate duration activity.
Heart Rate

Heart rate is the speed of the heartbeat, specifically the number of heartbeats per unit of time. The heart rate is typically expressed as beats per minute (bpm).

Maximum heart rate

The highest heart rate value attainable during an all-out effort to the point of exhaustion is maximum heart rate.

Significance of the Study

1. This kind of research in the field of physical education is to help the physical educationist and coaches to gain additional knowledge in the area of training methods. The present investigation will have the following significant contributions.

2. The findings of the study will clearly show the effectiveness of short duration handball specific aerobic training on selected physical fitness and physiological variables of male handball players.

3. This study would clearly show whether handball specific aerobic training would improve or maintain speed, power, agility and arm strength.

4. The study will reveal the level of alterations on percent body fat and lean body mass that is associated with
fitness development by means of handball specific aerobic training.

5. Aerobic capacity plays a vital role in the performance of handball players. This study would show the effectiveness of handball specific aerobic training in enhancing aerobic capacity of male handball players.

6. The handball players make repeated sprint frequently during a game. Earlier studies showed that aerobic capacity and repeated sprint ability has significant relationship. So, this study exemplifies greater capacity to high intensity repeated sprints.

7. Earlier studies showed that maximal heart rate (HR max) is closely related to maximal oxygen uptake. Maximal heart rate is usually higher in untrained than in trained subjects. However, some authors claim that HRmax does not change significantly with training. HRmax reduction with training is probably due to adaptive responses in the heart and autonomic nervous system to achieve an optimal cardiac output. The findings of the present study would reveal the extent to which changes resulted in resting and maximum heart rate due to handball specific aerobic training.
8. The finding of the study may add to the quantum of knowledge in the area of training methods and results of the study may be of great value for designing suitable training program for the improvement of performance abilities.

9. The finding of the study may clearly show the significance of incorporating skills during handball specific aerobic training, which may develop greater game sense through increased team work, communication skills and player awareness. Furthermore, the athletes may perform better under pressure situations during matches and develop into tactically smarter players whilst increasing their fitness. Finally, and probably most importantly, most players tend to enjoy skill based conditioning more than traditional fitness conditioning methods.