Chapter I

INTRODUCTION

Handball has become one of the most popular team sports at both the national and international level (Clanton & Dwight, 1997; Marczinka, 1993). The game of handball is played between two teams, each with six court players and a goalie. The objective of the game is to score as many goals as possible by dribbling, passing, and throwing the ball at the goal. While one team attempts to score a goal, the opposing team attempts to block and intercept throws. The six court players are positioned as follows: two wing players, two back-court players, one center back-court player, and one pivot player. The game is played over two periods of 30 minutes, with a 10-minute break between the periods.

Modern team handball consists of intense, intermittent activities such as running, sprinting, jumping as well as regular in fights between players (i.e. holding, pushing etc.). Research indicates that heavy, strong players, who are not compromised in regard to running capacity or speed seems to be superior. The need for bigger, stronger and faster team handball players is supported by the development in anthropometrics and physical performance parameters over the years. Besides the advantage of physical superiority, tactical and technical skills are better expressed if a player is not inhibited by poor conditioning. In addition, tougher tournaments, more games per season and more aggressive playing supports the need for optimal conditioning.
Demands of modern handball

Competitive team handball is an intermittent high intensity body-contact team sport that requires a combination of aerobic and anaerobic fitness to perform a sequence of well-coordinated activities (Chelly et al. 2011). Performance in a variety of intermittent team sports has been linked to the participant’s speed, power, strength, agility, and a sustained ability to repeat short high intensity bursts of activity throughout a match, rather than the capacity to sustain a steady submaximal work rate (Chelly et al. 2011). Team handball places a heavy emphasis on sprinting, running, jumping, and throwing (Chelly et al. 2011). The capability to perform skills is a prominent feature of human exercise (Schmidt & Wrisberg 2000).

Contemporary handball requires a high level of general and specific fitness. The effective length of a match is about 60 minutes, with consecutive attacks and defences played with high intensity. Defensive and offensive plays (about 50% in a match) last on the average 21 - 35 s (about 60% of such plays), 22% last over 35 s, and 17% of them are short attacks or defences, not longer than 20 seconds. During a game, direct action with opponents takes place, and players perform a lot of accelerations, turns and jumps. The diversity of efforts requires a comprehensive preparation in terms of endurance, speed and strength. The energy necessary for handball competition is derived both from aerobic and anaerobic processes. The heart rate during competition ranges from 168 to 198 beats per minute, and the oxygen debt may exceed 6 l/min. A good level of general fitness, as well as a
high aerobic and anaerobic capacity, forms the foundation for success in handball (Delamarche et al. 1987, Loftin et al. 1996). A systematic assessment of fitness, somatic and functional changes creates the basis of rational planning and executing training loads in team sports. The basic role in the assessment of adaptive changes caused by training is played by metabolic indices (Willmore & Costill 1999). Regular physical training in handball brings about functional changes as an increase in aerobic and anaerobic fitness (Zając et al. 1999, Norkowski & Huciński 2007).

**Training**

Traditionally, coaches and trainers have planned conditioning programs for their teams by following regimens used by teams that have successful win-loss records. This type of reasoning is not sound because win-loss records alone do not scientifically validate the conditioning programs used by the successful teams. In fact, the successful team might be victorious by virtue of its superior athletes and not its outstanding conditioning program. Without question, the planning of an effective athletic conditioning program can best be achieved by the application of proven physiological training principles. Optimizing training programs for athletes is important because failure to properly condition an athletic team results in a poor performance and often defeat. To improve sports performance of handball players different types of training are administered, among which weight training and high intensity intermittent training were administered in this study.
It is well known that aerobic capacity and muscle strength are important elements of fitness in the sports environment, as well as in human day to day activities. Adequate aerobic and muscle fitness, regular physical activity and proper health related behaviours are essential for mental well-being and sufficient functional capacity. All of these elements are also associated with a better quality of life (Blair & Church 2004).

This game requires players to have well developed physical and physiological capacities. Motor abilities like sprinting, jumping, flexibility and throwing velocity represent physical activities that are considered as important aspects of the game and contribute to the high performance of the team (Mitchell et al. 2005; Zapartidis et al. 2009). Investigations had showed that these motor fitness parameters contributes to handball players getting selected into the team. In addition, results from motor performance tests will allow trainers to identify players’ weaknesses and design training models for improving specific athletes’ deficiencies, and also follow up the athlete’s improvement during a competitive season (Zapartidis et al. 2009).

Physical and physiological profiles may contribute to understanding the suitability of players for the sport of handball, particularly at a high standard of play. Therefore, handball requires a combination of strength and endurance training. In this game, movement patterns are characterized as intermittent and change continuously in response to different offensive and defensive situations (Deng et al. 1990).
Fitness training

In many sports, the athletes need a high level of fitness to cope with the physical demands of the competition and to allow for their tactical and technical skills to be utilized throughout the competition. Fitness training in any sport has to be focused on the demands in the sport, and in many sports it has to be multifactorial to cover the different aspects of physical performance in the sport. Therefore, the exercise performed should, whenever it is possible, resemble the activities during competition as closely as possible.

Aerobic training

Aerobic training causes changes in central factors such as the heart and blood volume, which result in a higher maximum oxygen uptake (Ekblom 1969). A significant number of peripheral adaptations also occur with this type of training (Henriksson & Hickner 1996). The training leads to proliferation of capillaries and an elevation of the content of mitochondrial enzymes, as well as the activity of lactate dehydrogenase 1–2 (LDH1–2) isozymes. Further, the mitochondrial volume and the capacity of one of the shuttle systems for NADH are elevated (Schantz & Sjoberg 1985). These changes cause marked alterations in muscle metabolism. The overall effects are an enhanced oxidation of lipids and sparing of glycogen, as well as a lowered lactate production, both at a given and at the same relative work rate (Henriksson & Hickner 1996).
Components of aerobic training

Aerobic training can be divided into three overlapping components: aerobic low-intensity training, aerobic moderate-intensity training, and aerobic high-intensity training. The principles behind the various categories of aerobic training, which take into account that in some sports the training may be performed as a game, and thus, the heart rate of the athlete may frequently alternate during the training. The main aim of high intensity aerobic training is to improve central factors such as the pump capacity of the heart, which is closely related to VO$_2$max. These improvements increase an athlete’s capability to exercise repeatedly at high intensities for prolonged periods of time.

Specific muscle training

Specific muscle training involved training of muscles in isolated movements. The aim of this type of training is to increase the performance of a muscle to a higher level than can be attained just by participating in the sport.

Strength training

In handball there are activities that are forceful and explosive, e.g., jump shot, throwing the ball at greater velocity for distance, and efforts applied to stop the offensive players. The power output during such activities is related to the strength of the muscles involved in the movements. Thus, it is beneficial for an athlete in such sports to have a high level of muscular
strength, which can be obtained by strength training. Strength training can result in hypertrophy of the muscle, partly through an enlargement of muscle fibers. In addition, training with high resistance can change the fiber-type distribution in the direction of fast twitch fibers (Aagaard & Bangsbo 2005; Andersen et al. 1994). There is also a neuromotor effect of strength training and a part of the increase in muscle strength can be attributed to changes in the nervous system. Improvements in muscular strength during isolated movements seem closely related to training speeds. However, significant increase in force development at very high speeds (10–18 rad s\(^{-1}\)) has also been observed with slow speed high-resistance training (Aagaard et al. 1994).

Similarly, one essential function of the muscles is to protect and stabilise joints of the skeletal system. Hence, strength training is of importance also in preventing injuries as well as re-occurrence of injuries.

It is well known that aerobic capacity and muscle strength are important elements of fitness during handball competition, as well as in human daily activities. Fine aerobic capacity and muscle strength are required for handball players, who attempting to optimize their peak performance. In order to improve the aerobic capacity and muscular strength of handball players, coaches prescribe different types of workout which are specific to the game demand.

The coaches presently implement high intensity intermittent training which improves both aerobic and anaerobic capacity whereas continuous training improves only aerobic capacity. The high-intensity work bouts are
thought to train both the slow and fast twitch motor units, allowing for improvements in both anaerobic and aerobic systems. This dual system enhancement may also lead to better utilization of both fat and carbohydrates. Interval training has also been associated with improvements in the muscle’s ability to buffer lactic acid thus delaying the onset of fatigue brought about by the buildup of lactic acid and consequently raising the anaerobic threshold. Similar to strength training, interval training allows for a longer and more effective overload on the heart. This in turn translates to a stronger heart muscle, greater contractility and increased stroke volume. If more total work can be accomplished, then more calories will be utilized; this makes interval training an effective in improving aerobic and anaerobic capacity (Singh 1993).

Muscular strength contributes to functional capacity (Hunter et al. 2004). The research findings of Hunter et al. (2004) emphasis the importance of strength training aside from endurance as a method to improve functional capacity and overall health. The beneficial effects of both endurance and strength training are, thus, evident. Concurrent endurance and strength training are generally used to seek health benefits beyond endurance or strength training alone. Hickson (1980) however, reported in his renowned study an interference in the development of maximal strength after eight weeks of training when endurance and strength were trained simultaneously several times per week. Since then, in several studies the combination of
endurance and strength training regimes has been investigated by modifying both the training protocols and the subjects groups.

The complex interplay of several control mechanisms at the muscular and cellular levels that enables the human body to adapt to different external stimuli seem to be on a collision course in combined endurance and strength training, producing smaller training adaptations compared to the adaptations to endurance or strength training alone.

**Statement of the Problem**

The purpose of the study was to examine the alterations on selected motor fitness and physiological variables of male handball players due to combined high intensity intermittent training and weight training for eight weeks.

**Delimitations**

1. In this study twenty four (24) male handball players volunteered to participate in the study. These selected players have right hand and left leg as dominant.

2. These players were randomly selected from Sports Authority of India, Sports Training Centre (STC), Sarurnagar, Hyderabad, Andhra Pradesh. The mean age of the subjects is 22.55 ± 3.24 years.

3. These subjects were classified into two groups, namely combined training group (High intensity intermittent training and weight training) and control group. Each group consisting of twelve players.
4. The experimental groups confined to this study were subjected to four days a week for eight weeks. They performed high intensity intermittent training for two sessions and weight training for two sessions per week for eight weeks.

5. The criterion variables selected for the study were motor fitness variables (balance, speed, power and agility) and physiological variables (percent body fat, lean body mass, aerobic capacity anaerobic capacity, fatigue index and resting heart rate).

6. During the period of training, all the subjects confined to this study have undergone handball practice in the evening sessions, and in the morning sessions the experimental groups performed combined training while control group remained passive.

**Limitations**

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

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

**Hypotheses**

On the basis of the literature reviewed, expert’s opinion and scholar’s own understanding of the problem, the following hypotheses were formulated.
1. It was hypothesized that combined training will not have significant alterations on selected motor fitness variables of male handball players.

2. It was also hypothesized that combined training will not have significant changes on selected physiological variables of male handball players.

Definitions of the Terms

Handball

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

Strength

The ability to exert a force against a resistance is known as strength.

Physical strength

Physical strength is the ability of a person or animal to exert force on physical objects using muscles. Increasing physical strength is the goal of strength training.

Weight training

Strength training (or weight training) is a program of repetitive, progressive exercise that uses a range of devices such as free weights to increase strength and ultimately improve athletic performance.

Interval training

Interval training involves alternating periods of work and rest during a training session. It is a program that varies the intensity within the training
session by interspersing a work bout of a higher intensity with a rest period of lower intensity; then another work bout is completed, once again followed by a rest period, and so on through the workout.

High intensity intermittent training

High intensity intermittent training generally refers to repeated sessions of relatively brief, intermittent exercise, often performed with an “all out” effort or at an intensity close to that which elicits VO$_2$peak (e.g., ≥90% of VO$_2$peak).

Combined endurance and strength training

Combined endurance and strength training refers to the performance of endurance and strength training programs simultaneously within the same training session, during the same day on different occasions or on alternating days.

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).
**Motor fitness**

Motor Fitness refers to the ability of an athlete to perform successfully at their sport. (Davis *et al.* 2000).

**Speed**

The ability to perform a movement within a short period of time (Birch, MacLaren, & George 2005).

Speed is the maximum rate at which a person is able to move his body (Davis *et al.* 2000).

**Agility**

Agility is the physical ability that enables a person rapidly to change body position and direction in a precise manner (Davis *et al.* 2000).

**Power**

Power is a skill-related component of physical fitness that relates to the rate at which one can perform work (Nieman 2011).

**Balance**

Balance is defined as the process of maintaining the body’s center of gravity within the weight support base. It requires constant adjustment, which is provided by muscle activity and joint positioning.

**Physiology**

Physiology is defined as the science of the normal functions and phenomena of living things.
Body composition

The relative proportion within a sportsperson’s body of bone, muscle and fatty tissue (Davis et al. 2000)

Body composition analysis provides an evaluation of percentage body fat and fat-free mass (Birch, MacLaren, & George 2005).

Skinfold measure

The subcutaneous fat is the largest depot of body fat, measurement of these fat depots may be useful in estimating the total body fat. The skinfold method measures a double fold of skin and subcutaneous fat by means of calipers which should apply a constant pressure over the measurement site (Birch, MacLaren, & George 2005).

Percent body fat

Percent body fat is the percentage of total weight represented by fat weight, and it is the preferred index used to evaluate a person’s body composition.

Lean body mass

Body composition refers to the body’s relative amounts of fat and lean body tissue or fat-free mass (e.g., muscle, bone, water). Body weight can be subdivided simply into two components: fat weight (the weight of fat tissue) and fat free weight (the weight of the remaining lean tissue).
**Aerobic capacity**

It is the maximal capacity for oxygen consumption by the body during maximal oxygen consumption, and cardio respiratory endurance capacity (Wilmore & Costill 1999).

The $\text{VO}_{2\text{max}}$ provides a quantitative statement of an individual’s capacity for the aerobic energy transfer (McArdle, Katch & Katch 1996).

Cardiorespiratory endurance is the ability of the lungs and heart to take in transport adequate amount of oxygen to working muscles which allow activities involving large muscle groups to sustain for long period of time (Davis *et al.*, 2000).

**Anaerobic capacity**

Anaerobic capacity may be defined as the maximal amount of ATP formed by the anaerobic processes during a single bout of maximal exercise.

**Fatigue index**

It indicates the rate at which power output declines for an athlete.

**Heart rate (HR)**

The number of heart beats per unit time, usually per minute.

**Resting HR**

Resting heart rate (RHR) refers to the number of times your heart beats in one minute while at rest.
Significance of the Study

1. Strength is the basis of high-level performance in most sports. Speed, endurance, power, agility and quickness are some of the most significant, and visible, components that required for handball players to excel in competition. This study would reveal the importance of carefully designed weight training and high intensity intermittent training programs in improving overall performance of male handball players.

2. The present study would represent the importance of combined training which can be administered to active and inactive individuals those wishes to reduce their body weight.

3. This study would show the level of alterations elicited on repeated sprint ability of handball players due to combined training programmes.

4. Aerobic capacity plays a vital role in modern handball game. This study would show the effectiveness of combined training in enhancing aerobic capacity.

5. Resting heart rate decline generally indicates a strong heart that works less hard to pump blood throughout the body and also it indicates aerobic fitness. In the present study would assess the impact of combined training in improving stronger heart.

6. In the game of handball, linear speed of players is determined by leg strength, power and agility. In the present study the influence of combined training on speed, power and agility would be revealed.
7. Handball players make body feints and change direction frequently during a game. Present study would be useful in determining the efficiency of combined training on agility of handball players.

8. The findings of this study may also in general assist the physical education teachers, coaches, and experts in the assessment of performance status of their players.

9. 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 movement of performance abilities.