CHAPTER - 1
INTRODUCTION

Millions of people play volleyball across the world. In many countries, it has been ranked as one of the top-level competitive sport. William G. Morgan, an instructor at the Young Men's Christian Association (YMCA) in Holyoke, Massachusetts, invented volleyball in 1895. The game was designed to include aspects of baseball, basketball, and tennis. As a highly competitive sport, Volleyball arrived on the international level relatively late in the late 1950’s. The International Olympic Committee (IOC) designated volleyball as an Olympic sport in 1957, to be included in the 1964 Olympic Games in Tokyo. FIVB (Federation of International de Volleyball) is the largest sports organization in the world with 220 affiliated member countries (Reeser, 2003). Volleyball involves frequent bouts of intense activities such as jumping, diving, and lateral movement, and these activities are coupled with short rest periods throughout a match duration that is typically 60-120 minutes (Sheppard et al., 2007).

Volleyball is a complex game of simple skills. It is a sport played by two teams consisting of 12 players each on a playing court, divided by a net. The object of the game is to send the ball over the net in order to ground it on the opponent’s court and to prevent the same effort by the opponent. The volleyball court is a rectangular field with the size of $9 \times 9$ m on each half separated by a net of 2.43 m in height in the middle. Two teams in the match, as opponents, will exercise various skills and tactics to attack and to defend. In each team there are six players standing in two rows with three players in each. The front row players’ task is to attack and “spike” the ball, or “block” a ball, to prevent the ball crossing the net. The back row players, also known as “setters”, have to “set” the ball for an attacking team-mate in the front row, or pass or “dig up” balls that have penetrated the block. In a match, every player should change their position in turn except the libero, which means every player on the court should be able to serve, set, pass, spike and block. The ball is served into play. To attack, the players try to make the ball fall down onto the ground of the opposite side. To defend, they try to prevent the ball from falling down onto the ground of their own side. In the game the players use their hands to bat a ball back and forth over a high net, trying to make the ball touch the court within the opponents’ playing area before it can be returned. To prevent this a player on the opposing team bats the ball up and toward a teammate before it touches the court surface that teammate may then volley
it back across the net or bat it to a third teammate who volleys it across the net. A team is allowed only three touches of the ball before it must be returned over the net. As a purely rebound ball game (you can't hold the ball), volleyball is a sport of constant motion. The basic pattern of movement in making an attack includes a dig (an underarm pass made with the forearms), a set (an overhead pass made with the hands), and a spike (the overhead attacking shot). Teams can also try to block the opponent's spike as the ball crosses the net (Reeser, 2003). So it is essential for the players to possess physical fitness, physique and physiological parameters that allow them to play their roles most effectively ((Sndhu, 1982; Chen, 1989).

1.1 PHYSICAL FITNESS OF VOLLEYBALL PLAYERS

Physical fitness has been of great significance in the lives of human beings form times immemorial. In the pre historic times, physical fineness was the key element for the survival of a human being. People during those times were confronted with hostile environment and only fit individuals could survive. Hence survival of the fittest was the dictum. Even the civilization of Sparta, Athens and Rome in the history of the world has stressed physical fitness or physical training as an important objective of the educational programme (Nixon et al., 1969).

Physical fitness is, in a very broad sense, determined by the individual’s capacity for optional work and motor and sport performance (Astrand & Rodahl, 1986). The United States President’s Council on physical fitness and sports defined the terms physical fitness as “the ability to carry out daily tasks with vigor and alertness without undue fatigue, with ample energy to enjoy leisure time pursuits, and to meet unforeseen emergencies” (Clarke, 1971). General fitness implies the ability of a person to live most effectively with his/her potential, which depend upon the physical, mental, emotional, social and spiritual component of fitness which are highly interrelated. The primary components of physical fitness identified by the President’s Council on physical fitness and sports were muscular strength, muscular endurance and cardio respiratory endurance. However later on, the President Council also included some other motor performance components namely agility, speed, flexibility and balance in physical fitness. However, Kansal (1981) defines physical fitness by the group of five components, namely muscular strength, muscular endurance, cardiovascular endurance, freedom from obesity and flexibility. It is important to mention here that some of the experts, Clarke and Clarke (1987) and
AAHPERD (1980) call such fitness test which includes the measurement of percentage body fat, as health related physical fitness test.

According to Carl E. Willgoose, “Physical fitness is often referred to as organic vigor or vitality the physical elements of behavior that permits the person to be active”. The greater the physical fitness, the greater will be physical endurance and the precision of movements. The greater the physical fitness, the longer a person will be able to keep going; he will be able to perform more efficiently and at greater speed and to recover faster from fatigue. Poor health and lowered physical capacity reduce one’s ability to perform mental task.

Physical fitness is an inseparable part of sports performance and achievements. The quality of its utilization value is directly proportional to the level of performance. That means the greater the level of fitness, the greater will be the ability of a person to attain higher level of performance. Players are required to have good physical fitness that will enable successful performance at the competitive level. The sport specific technical skills in sports are predominant factors. The physical fitness of a player however can be a decisive determinant of success during competition (Smekal et al., 2001). A player would need to develop higher levels of the basic physical qualities to be able to compete effectively. Chin et al (1995) recommend that if a player wants to achieve reasonable success in competitions at higher level, improvements in physical fitness needs to be emphasized in addition to skill training. In sport theory and practice, the level of motor abilities is the key factor in majority of sports achievements (Kasa, 2003). The scientists collected the data of athlete physical characteristics and fitness, and based on the data, they provided the profiles of the top-ranked athletes in specific sports events (Yang & Lee, 1988; Fleck, 1983; Puhl et al., 1982; Williams et al., 1981).

Volleyball players require well-developed muscular strength, power and endurance, speed, agility, and flexibility, and have a high level of jumping ability, fast reaction time and swift movements (She, 1999). Lower body power, speed, and agility are important indicators of volleyball performance (Vescovi & Meguigan, 2008). Volleyball requires athletes to be explosive in the lower limbs; this is especially emphasized in the front row hitting positions when attacking on offense or blocking on defense. Vertical jump emphasizes lower body power, and it is known that Power = (Force x Distance)/Time. Vertical jump is an anaerobic explosive movement that requires recruitment of the highest threshold motor units (Amasay, 2008). The body
needs to apply large amounts of muscular force over the largest amount of distance in the smallest amount of time in order to produce the highest vertical jump. Jumping height is decisive for the execution of techniques and tactics in volleyball (Jin et al., 2007). Volleyball requires the athlete to jump as high as possible while attacking the ball with upper body movements. Vertical jump is important in volleyball because of the need to hit the ball around the opponent on the opposite side of the net. The higher a players’ vertical jump height, the less likely it is that the ball will be blocked by the opponent on defense.

Vertical jump is a major determinant of volleyball performance and many researchers have studied different aspects of vertical jumping. According to Gutierrez & Marcos (2009), the factors that affect vertical jump are height reached by the center of gravity, time required for execution, and the spatial orientation of the corporal segments. The research by Japan Volleyball Association demonstrated the significant correlation between the vertical jumping index and the competitive ability of the volleyball players. It was found that the jumping ability had a positive correlation with the number of spiking, and the total success rates of spiking, blocking and serving in a game (Tian, 2006).

Among all the physical performance indicators, speed is also of the most important one. Speed is the trend of development in modern volleyball sport. Speed requires the athletes to be able to move quickly to the optimal place on the court. Speed and agility in tactics, as the key factors, work together to make suddenness the feature of modern volleyball sport (Huang, 1992).

One of the most important factors influencing movement is agility, involved in coordinating quickly and accurately the big muscles of the body in a particular activity. One’s level of agility is probably a result of both innate capacity and training and experience. Agility plays a vital role in all games and sports specially in the field of volleyball because when a player participate in game then he has to bring about a purpose of quick change in direction and movement of various parts of the body.

Reaction time is extremely important in all requiring quick response, sharp reflexes play a vital role in volleyball, The game is so fast that the players has to react to it as quick as possible, part of second do matter in successful execution in defensive and offensive movements.
1.2 ANTHROPOMETRIC CHARACTERISTIC OF VOLLEYBALL PLAYERS

Anthropometry is the measurement of body size and proportions. The measurements include body weight, height, circumference, skin fold thickness and bony widths and lengths (Heyward, 2006). Anthropometry is a branch of science concerned with comparative measurements of the human body, its parts, and its proportions and composition. It is the study of measurement of the human body in terms of the dimensions of bone, muscle and adipose tissue. Anthropometry has been used to assess gross structure and function. There are numerous factors which are responsible for the performance of a sportsman. The physique and body composition, including the size, shape and form are known to play a significant role in this regard. At present, sportsman for superior performance in any sports is selected on the basis of physical structure and body size.

Anthropometric measurements are widely used to assess and predict performance in various sports. Anthropometric measurements and morphological characteristics play an important role in determining the success of a sportsperson (Wilmore & Costill, 1999; Keogh, 1999). An athlete’s anthropometric and physical characteristics may represent important prerequisites for successful participation in any given sport (Gualdi-Russo & Zaccagni, 2001). Indeed, it can be assumed that an athlete’s anthropometric characteristics can in some way influence his/her level of performance, at the same time helping to determine a suitable physique for a certain sport (Carter & Heath, 1990). It has been well established that specific physical characteristics or anthropometric profiles indicate whether the player would be suitable for the competition at the highest level in a specific sport (Claessens et al., 1999; Reilly et al., 2000; Gabbett, 2000; Slater et al., 2005).

Therefore, it is of practical relevance and importance to identify those skeletal characteristics that will favor a specific sport. The changeable (body composition) and unchangeable (skeletal size, shape and proportion) anthropometric characteristics predisposing to success will differ from sport to sport. Bale (1986) suggested that size, shape and body composition play an important part in providing distinct advantage for specific playing positions, especially at elite level of competition where there is a high degree of player specialization. This suggests that the anthropometric characteristics for success may not only differ from sport to sport, but also within different playing positions in team sports. The knowledge of anthropometric
characteristics also allows the athlete and the coach to make adaptations to his/her training regime to attain the optimal physical attributes for best performance.

In fact, the information regarding the anthropometric status of an athlete is essential for two main reasons, firstly, to design an effective training program and secondly to select the event-specific talents in the players. Some anthropometric characteristics, e.g. length and breadth measurements, are genetically determined and can hardly be changed with the effects of a training program. Various anthropometric measurements were found to be closely associated with excellent performance in volleyball.

Composition of athlete’s body is also most important factor in the success of a team in all athletic endeavors (Wilmore, 1982). Body composition plays an important role in achieving excellence in sports performance (Mathur & Salokun, 1985). Body composition refers to the characterization of body weight in terms of absolute and relative amounts of fat mass and fat-free mass. It is the relative percentage of muscles, fat, bone, and other tissues of the body (Kirk et al., 2008). Body composition is an important determining factor for performance ability of an athlete. Fat free body weight also known as the lean body mass, and the fat mass is the total amount of essential and storage fat in the body (Thygerson & Thygerson, 2009). Body composition of players is an important tool to evaluate the health of the players, to monitor the effects of a training program and to determine optimal competitive body weight and other components of body composition (Prior et al, 2001). Body composition, specifically body fat percentage is of great interest to athletes and is often negatively associated with athletic performance (Gomez, 2004; Malina, 2007; Sigurbjorn et al., 2000). Excess body fat is detrimental to performance in most sports whereas, fat free mass, especially muscle mass, is generally associated with performance. Body composition also makes an important contribution to an individual’s level of physical fitness for performance, particularly in such sports that require one to carry one’s body weight over a distance, which is facilitated by a large proportion of active tissue (muscle) in relation to a small proportion of fat tissue (Jain, 2004). The appraisal of body composition can provide valuable information for both the athlete and coach in monitoring sequentially the influences of training and nutrition. Therefore, the determination of body composition is important in terms of a training plan as well as success in the game (Kurt et al, 2010).
Optimal physique is apparently an advantage to volleyball performance. Only when a volleyball team is collectively equipped with all the ideal anthropometric characteristics can the team succeed in a game (Chen, 2005). Height has been reported to be a discriminating factor between successful and non-successful teams in a collegiate tournament (Morrow et al., 1979), correlating significantly with the final standings of an open national tournament (Gladden and Colacino, 1978). The height over the net is a decisive factor for volleyball games, determined by the athletes’ stature and jumping height, and shown in blocking height and spiking height. Grgantov et al. (2006) indicated that a greater body height would allow the ball contact occurring at a greater height above the net. All these bring forward the demand for specific physique of volleyball athletes.

In modern volleyball game, focus is to win the dominance over the net, and the best way to win this dominance is to recruit athletes who are taller with greater jumping ability. Previous investigations indicated that elite volleyball players did demonstrate advantageous physique characteristics (Li, 1995). The major characteristics of volleyball players include high stature and standing reach height, low Katoly index = (mass/height×1000), long arm span and long lower-limbs.

Body mass correlates well to muscle size and power in elite athletes. It has been reported that Katoly index correlates well to the quantity and strength of muscles (Gai & Li, 2002; Li, 2002). Arm span and standing reach height have also been suggested as essential factors for higher spiking and blocking (Zeng, 1992). Arm span is closely related to most of the volleyball techniques, especially in attacking. To make full use of the spiking speed of a waving arm, a long arm is an advantage. Jin and colleagues suggested that standing reach height should be used as an essential criterion in recruitment of volleyball players (Jin et al., 2007). You and Huang (2000) suggested that arm length had a significant correlation with the performance over the volleyball net, especially in attacking. Longer arm is important too in defense. The length of the arm span of elite volleyball players has been found to be approximately 5 cm longer than his/her height. The arm span and the standing reach height are found to be closely related (Zeng, 1992). Greater ankle diameter would ensure a greater stability and facilitate landing and taking off in spike and block; an increased wrist diameter would contribute to the ball shooting strength on spike and serve; and increased trunk and thigh muscle strength would contribute to the efficacy in all techniques, especially those involving jump (Grgantov et al., 2006).
In summary, the anthropometric characteristics of volleyball players have been reported as high stature, and relatively longer limbs, shorter sitting height, higher lean mass, larger girth difference between the relaxed and flexed-and-tensed arm, wider hand, narrower pelvis and longer calf (Tian, 2006).

1.3 PHYSIOLOGICAL VARIABLES OF VOLLEYBALL PLAYERS

Among all the factors, the physiological variables play an important role for the attainment of high level sports performance. Physiological variables may be defined as those variables which are directly linked with various physiological systems such as heart rate, blood pressure, vital capacity, respiratory rate and hemoglobin. Physiological variables such as cardiovascular efficiency, percentage of fat, reaction time, vital capacity and other should be taken into consideration while selecting volleyball players. Cardio-respiratory endurance denoted capacity of individual to work effectively with the help of oxygen which is collected, transported and utilized by lungs, blood and muscles respectively. Any work as daily task or form of physical activity is directly related to energy supplying system which in turn is the cardio-respiratory endurance. Cardio-respiratory endurance varies from individual to individual and one of the important variables for establishing top class performance in volleyball as the game involves work of long duration/endurance type.

Physiologically, volleyball is an intermittent sport that requires players to participate in frequent short bouts of high-intensity exercise, followed by periods of low-intensity activity (Kunstlinger et al., 1987; Viitasalo et al., 1987). The high-intensity bouts of exercise, coupled with the total duration of the match, requires players to have well-developed aerobic and anaerobic alactic (ATP-CP) energy systems (Polglaze & Dawson, 1992; Viitasalo et al., 1987). Considerable demands are also placed on the neuromuscular system during the various sprints, jumps (blocking and spiking), and high-intensity court movement that occurs repeatedly during competition (Hosler et al., 1978). As a result, volleyball players require well-developed speed, agility, upper body and lower body muscular power, and maximal aerobic power (VO$_{2\text{max}}$). Several studies have documented the physiological and anthropometric characteristics of volleyball players (Fleck et al., 1985; Hakkinen, 1993; Hosler et al., 1978; Spence et al., 1980), with the fitness of players typically increasing as the playing standard is raised (Gabbett & Georgieff, 2007; Smith et al., 1992; Thissen-Milder & Mayhew, 1991). Smith et al. (1992) compared physical,
physiological, and performance characteristics of national and college standard volleyball players and found significantly higher block and spike jumps, 20-m speed, and \( \text{VO}_{2\text{max}} \) in the national standard players, suggesting that physiological capacities play an important role in the preparation and selection of elite volleyball players. In addition, Thissen-Milder and Mayhew (1991) demonstrated that selected physiological and anthropometric characteristics could successfully discriminate among freshman, junior and varsity volleyball teams and starting and non-starting players.

The physiological variables involved in sports performance have long been of interest to players, coaches, sport physiologists and sports scientists. From a physiological point of view, the lung function tests, like other physiological tests must be of the utmost importance for measuring the fitness of an athlete. There is also a need to develop respiratory capacities, which pertains to the ability of the body to supply the oxygen. Respiratory parameters vary from individual to individual and one of the important variables for establishing top class performance in volleyball as the game involves work of long duration.

Several studies have documented the physiological and anthropometric characteristics of volleyball players (Fleck et al., 1985; Hakkinen, 1993; Hosler at al., 1978; Spence et al., 1980), with the fitness of players typically increasing as the playing standard is raised. Despite concern about the fact that the selected components of physical fitness, anthropometric measurements and physiological variables are an essential key for successful participation in sport competition but very little has been explored in relation to different level of competition.

The purpose of this study is, therefore, to find out the difference in selected components of physical fitness, anthropometric measurements and physiological variables between inter-university and inter-college volleyball players and to find out the differences by playing position in terms of selected components of physical fitness, anthropometric measurements and physiological variables among the volleyball players.

1.4 STATEMENT OF THE PROBLEM

A study of selected components of physical fitness, anthropometric measurements and physiological variables of volleyball players.
1.5 OBJECTIVES OF THE STUDY
1. To find out the differences in selected components of physical fitness between inter-university and inter-college volleyball players.
2. To find out the differences in anthropometric measurements between inter-university and inter-college volleyball players.
3. To find out the differences in physiological variables between inter-university and inter-college volleyball players.
4. To find out the positional differences in selected components of physical fitness among the volleyball players.
5. To find out the positional differences in anthropometric measurements among the volleyball players.
6. To find out the positional differences in physiological variables among the volleyball players.

1.6 HYPOTHESES
1. There would be significant difference in selected components of physical fitness between inter-university and inter-college volleyball players.
2. There would be significant difference in anthropometric measurements between inter-university and inter-college volleyball players.
3. There would be significant differences in physiological variables between inter-university and inter-college volleyball players.
4. There would be significant positional differences in selected components of physical fitness among the volleyball players.
5. There would be significant positional differences in anthropometric measurements among the volleyball players.
6. There would be significant positional differences in physiological variables among the volleyball players.

1.7 DELIMITATION OF THE STUDY
1. The study was delimited to male volleyball players of 18-28 years of age group.
2. The study was delimited to volleyball players of the northern states of India.
3. The study was delimited to 120 inter-college level and 120 inter-university level volleyball players.
4. The study was delimited to selected components of physical fitness, anthropometric measurements and physiological variables.

1.8 LIMITATIONS OF THE STUDY

1. Certain factors like diet, rest, sleep etc. was beyond the control of the investigator and were considered as limitation of the study.

2. As the subject came from different socio-economic groups, their dietary habits, life style, routine of study and play was different which were considered as limitations of the study.

3. No special technique was used to motivate the subjects during the administration of the tests.

1.9 DEFINITION AND EXPLANATION OF TERMS

- **Anthropometric Measurement**: An anthropometric measurement is defined as dimension of the structure of the human body taken at specific sites to give measures of length, girth and width and subcutaneous fatty tissue.

- **Anthropometry**: Branch of science concerned with comparative measurements of the human body, its parts, and its proportions and composition.

- **Body Composition**: is used to describe the percentages of fat, bone and muscle in human bodies.

- **Lean Body Mass**: The total body weight minus the fat mass. Lean body mass consists of water, bones, collagen, and muscle.

- **Percentage Body fat**: This describes the percentage of total weight that is composed of fat. Body fat percentage is that percentage of body mass that is not made up of bone, muscle, connective tissue and fluids; that is, everything else. This is referred to as 'fat-free mass'.

- **Body fat**: It is body mass not made up of bones, muscles, organs or water.

- **Body Mass Index (BMI)**: A measurement of the amount of body fat and lean body mass. It is calculated by dividing a person’s weight in kilograms by their height in meters.

- **Endomorphy**: It is the first component of somatotyping. It refers to the relative fatness of the physique.

- **Mesomorphy**: It is the second component of somatotyping. It refers to the relative musculoskeletal robustness in relation to stature.
Ectomorphy: It is the third component of somatotyping. It refers to the relative linearity of and fragility of the body.

Physical Fitness: Physical fitness refers to the capacity of an athlete to meet the varied physical demands of their sport without reducing the athlete to a fatigued state.

Agility: It is defined as one’s controlled ability to change body position and direction rapidly and accurately.

Power: Power is one’s ability to release muscular force per second.

Balance: It is defined as the state of equilibrium.

Speed: Speed is the rapidity with which a movement or successive movements of same kind may be performed by an individual.

Reaction Time: It is the interval of time between the presentation of stimulus and the initiation of the response.

Coordination: The state of being coordinate; harmonious adjustment or interaction.

Vital Capacity: It is defined as the largest volume of air that can be exhaled followed by deepest possible inhalation.

Inspiratory reserve volume: It is defined as the maximal amount of gas that can be inhaled from the end-inspiratory position.

Exspiratory reserve volume: It is defined as the amount of gas that can be exhaled from the resting end-expiratory level.

Inspiratory capacity: It is defined as the volume of gas that can be taken into the lungs in a full inhalation.

Libero: A defensive specialist player wears a different shirt than his/her teammates and plays only in the back row. Libero means “free” in Italian.

Setter: A player who is responsible for getting the second ball to the hitter by setting it with the hands or bump setting with the forearms.

Spiker: A player who spikes or hits the ball over the net.

Blocker: A player who attempts block (intercept) an opponent player’s attack.

1.10 SIGNIFICANCE OF THE STUDY
The research in physical education and sports is providing new insights and innovation to the physical educationist and coaches. The ultimate goal of research in
physical education and sports is to help physical educators and coaches train their players based on new concepts to improve their sports performance.

The findings of this study will be of significance in the following ways:

1. The findings of this study may add to the existing fund of knowledge with regard to the selected components of physical fitness related to volleyball performance.
2. The findings of this study may add to the existing fund of knowledge with regard to the anthropometric measurements related to volleyball performance.
3. The findings of this study may add to the existing fund of knowledge with regard to the physiological variables related to volleyball performance.
4. The results of the study may provide guidelines, which will help the physical educators and Coaches in preparing the training schedules for volleyball players.
5. The findings of the study may provide criteria for selecting best talent that exist for volleyball.
6. This study will also help to compare inter university volleyball players with the international volleyball players.
7. The study may help physical education teachers and coaches by way of informing them about the anthropometric measurements, somatotyping, body composition, physical fitness components and physiological variables which the athletes require.