CHAPTER - 5
SUMMARY AND CONCLUSIONS

5.1 INTRODUCTION

Human sports performance is determined by a combination of several physical, anthropometrical, physiological, and psychological factors. The relative importance of each of these depends on the nature of the sports. Volleyball game is an intermittent exercise that requires the players to perform frequently short bouts of high-intensity activities such as jump and spike, followed by periods of low-intensity activities (Kuenstlinger et al., 1987, Viitasalo et al., 1987). In volleyball, technical and tactical skills, anthropometric characteristics and individual physical performance capacities are most important factors that contribute to the success of a team in competitions (Hakkinen, 1993).

Volleyball players require well-developed muscular strength, power, endurance, speed, agility, flexibility, fast reaction time, swift movements and have a high level of jumping ability (She, 1999). Considerable demand is also placed on the neuromuscular system during sprints, jumps (blocking and spiking), and high intensity court movements that occur repeatedly during competition (Hakkinen, 1993). Among all the physical performance indicators, speed and power (e.g. in jumping and spiking) are of the most important ones. Particularly, jumping height is decisive for the execution of techniques and tactics (Jin et al., 2007). In volleyball the vertical jump is an integral part of game itself. The players with superior vertical jumping ability are very successful in spiking and blocking. The Reaction time, agility, balance, coordination and physiological variables play a significant role in volleyball performance.

Optimal physique is apparently an advantage to volleyball performance. An athlete’s anthropometric characteristics represent important prerequisites for successful participation in any given sport (Gualdi-Russo and Zaccagni, 2001). Indeed, it can be assumed that an athlete’s anthropometric characteristics can in some way influence his/her level of performance (Carter and Heath, 1990, Rienzi et al., 1999). A volleyball team collectively equipped with all the ideal anthropometric characteristics can have the dominance in a game (Chen, 2005). Height has been reported to be a discriminating factor between successful and non-successful teams.
(Morrow et al., 1979), correlating significantly with performance of the volleyball players. The height over the net is a decisive factor for volleyball game determined by the athlete’s stature and jumping height, and shown in blocking height and spiking height. Body mass correlates well to muscle size and power in elite athletes. 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. You and Huang (2000) suggested that arm length had a significant correlation with the performance over the volleyball net, especially in attacking (You and Huang, 2000). Longer arm is important too in defense.

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.

Among all the factors, the physiological variables play an important role for the attainment of high level sports performance. Among the various physiological parameters, cardio-vascular efficiency forms the basis to under-take sports efforts successfully. 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 et 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.

5.2 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.

5.3 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.

5.4 SELECTION OF SUBJECTS
The present study was conducted on 240 male (120 inter-university and 120 inter-college) volleyball players. The subjects of the study were purposively selected from the various universities and colleges of North India. The age of players was between 18 to 25 years. The data of inter-university volleyball players were collected during the North-Zone Inter-University Volleyball Championship held at Kurukshetra University, Kurukshetra and during the training camps of different universities in the academic session 2010-2011. The data of inter-college level volleyball players were collected from the players of different colleges affiliated to Himachal Pradesh University, Simla, Panjab University, Chandigarh, Punjabi University, Patiala and Guru Nanak Dev University, Amritsar.

Table-5.1  Division of volleyball players as sample

<table>
<thead>
<tr>
<th>GROUP</th>
<th>SAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter-university</td>
<td>120</td>
</tr>
<tr>
<td>Inter-college</td>
<td>120</td>
</tr>
</tbody>
</table>

5.5 SELECTION OF VARIABLES
Selected components of physical fitness, anthropometric measurements and physiological variables were taken from each subject were as follows:

Selected Components of Physical Fitness:
Following physical fitness components were taken on each subject:

1. Agility
2. Speed
3. Power
4. Reaction Time
5. Balance
6. Coordination

Anthropometric Measurements:
Anthropometric Measurements taken from each subject were as follows:
Gross Body Measurements
1. Height (cm)
2. Weight (kg)

Length of Body Parts (cm)
1. Leg Length
2. Upper Leg Length
3. Lower Leg Length
4. Arm Length
5. Upper Arm Length
6. Forearm Length

Diameters of Body Parts (cm)
1. Bicondylar Humerus Diameter
2. Biacromial Diameter
3. Hip Diameter
4. Bicondylar Femur Diameter

Circumferences of Body Parts (cm)
1. Upper Arm Circumference
2. Forearm Circumference
3. Chest Circumference
4. Thigh Circumference
5. Calf Circumference

Skinfold Thickness (mm)
1. Biceps
2. Triceps
3. Subscapular
4. Suprailiac
5. Calf

Physiological Variables:
Following physiological variables were taken:
1. Vital Capacity (L)
2. Expiratory Reserve Volume (L)
3. Inspiratory Reserve Volume (L)
4. Inspiratory Capacity (L)
5.6 DATA COLLECTION
Illious agility test was used to measure agility. 50m dash test was used to determine speed. Vertical jump test was used to measure power. Reaction time was assessed using the nelson hand reaction time test. Stork balance stand test was used to assess the ability to balance and ball transfer test was used to determine the eye-hand coordination. Height measurements were taken by using the standard anthropometric rod to the nearest 0.5 cm. Body weight of the subjects were measured with portable weighing machine to the nearest 0.5 kg. Widths and diameters of body parts were measured by using sliding caliper. Girths and lengths were taken with the steel tape to the nearest 0.5 cm. Skinfold thickness measurements were taken with Harpenden Skinfold Caliper (British Indicators, UK) to the nearest 0.1 mm. Respiratory variables were measured by computerized spirometer.

5.7 DERIVED MEASUREMENTS

Body Mass Index
Body mass index (BMI) was calculated by the following formulae

\[ BMI (Kg/m^2) = \frac{\text{Body mass in Kg}}{\text{Stature in Meters}}^2 \]

(Meltzer et al., 1988)

Percent Body Fat
Percentage body fat as estimated from the sum of skinfolds was calculated using equations of Siri (1956) and Durnin and Womersley (1974).

Somatotyping
Somatotype components (endomorphy, mesomorphy, ectomorphy) were estimated according to the protocol of Carter and Heath (1990).

5.8 STATISTICAL ANALYSIS
Statistical analysis was performed using SPSS version 16.0 for windows (SPSS Inc, Chicago, IL, USA). All descriptive data pertaining to selected components of physical fitness, anthropometric measurements and physiological variables was reported as mean and standard deviation. An independent sample t-test was used to compare the means values of selected components of physical fitness, anthropometric measurements and physiological variables between inter-university and inter-college volleyball players. One-way analysis of variance (ANOVA) was employed to
compare the volleyball players among different playing positions. Following the detection of a significant main effect, Bonferroni’s post-hoc analyses were performed to locate where specific mean differences were laid. Significance levels were set at p<0.05.

5.9 RESULTS
While comparing the selected components of physical fitness between inter-university and inter-college volleyball players, it was observed that the inter-university volleyball players had significantly better agility, speed, power, balance and coordination as compared to inter-college volleyball players. Whereas there was no significant difference in reaction time between the two groups.

The analysis of the data indicated that the inter-university volleyball players were significantly taller and heavier than inter-college volleyball players. There was no significant difference in body mass index between inter-university and inter-college volleyball players. The inter-university volleyball players had significantly greater mean values of leg length and lower leg length than inter-college volleyball players. There was no significant difference in upper leg length, arm length and upper arm length between the two groups. However, the forearm length was significantly greater in inter-college volleyball players when compared to inter-university volleyball players.

The inter-university volleyball players were found to have significantly greater upper arm, forearm, thigh and calf circumferences as compared to inter-college volleyball players. In case of chest circumference, no significant difference was found between the two groups. In case of bicondylar femur diameter, no significant difference was found between inter-university and inter-college volleyball players. Whereas the hip diameter was significantly wider in inter-university volleyball players as compared to inter-college volleyball players.

The inter-college volleyball players showed significantly greater mean value in biceps and subscapular skinfold thickness as compared to inter-university volleyball players. In relation to triceps, suprailiac and calf skinfold thicknesses, there were no statistically significant difference between the two groups.

The data analysis of body composition showed that the body density and lean body mass of the inter-university volleyball players were significantly higher than those of the inter-college volleyball players. On the other hand, the inter-college
volleyball players had significantly greater percentage body fat than the inter-university volleyball players. No significant difference was observed in total body fat between the two groups.

Regarding somatotyping of the volleyball players, it was observed that the inter-college volleyball players possessed significantly higher endomorphic component as compared to inter-university volleyball players. Whereas, inter-university volleyball players had significantly higher mesomorphic component as compared to inter-college volleyball players. There was no significant difference in ectomorphic component between inter-university and inter-college volleyball players.

In case of physiological variables, the inter-university volleyball players had significantly higher vital capacity, inspiratory reserve volume, expiratory reserve volume and inspiratory capacity as compared to inter-college volleyball players.

One-way analysis of variance (ANOVA) was applied to find the differences in selected components of physical fitness, anthropometric measurements, body composition, somatotyping and physiological variables among the different playing positions of the volleyball players. There were significant differences in height and body weight among the different playing positions of volleyball players. Further, the significant differences were reported among different playing positions of volleyball players with regard to all the length measurements, upper arm, forearm, chest and thigh circumferences. There were also significant differences in bicondylar humerus, biacromial and bicondylar femur diameters among different playing positions of the volleyball players. There were no significant differences among playing positions of volleyball players for all the skinfold thicknesses, body density and percentage body fat. On the other hand, total body fat and lean body mass were different among playing positions of volleyball players. There were no significant differences among playing positions of volleyball players for reaction time, agility, balance and coordination while speed and power were significantly different among different playing positions of volleyball players. There were significant differences among playing positions of volleyball players for inspiratory reserve volume and expiratory reserve volume. No significant differences were observed for vital capacity and inspiratory capacity among different playing positions.
5.10 CONCLUSIONS

On the basis of findings of the present study, the following conclusions have been drawn:

1. The inter-university volleyball players had significantly greater agility, speed, power, balance and coordination as compared to inter-college volleyball players.

2. The inter-university volleyball players were significantly taller and heavier than inter-college volleyball players.

3. The inter-university volleyball players had significantly greater leg length and lower leg length than inter-college volleyball players. On the other hand, the inter-college volleyball players had significantly greater forearm length.

4. The inter-university volleyball players were found to have significantly greater forearm, upper arm and thigh circumferences and bicondylar humerus and biacromial diameters as compared to inter-college volleyball players. Whereas, hip diameter was significantly greater in inter-college volleyball players.

5. The inter-university volleyball players had significantly lower biceps and subscapular skinfold thicknesses and percentage body fat than the inter-college volleyball players.

6. Body density and lean body mass was significantly higher in the inter-university volleyball players.

7. Endomorphy was significantly higher in the inter-college volleyball players whereas mesomorphy was significantly higher in inter-university volleyball players.

8. The inter-university volleyball players had significantly greater mean values of all the physiological variables than the inter-college volleyball players.

9. There were significant differences among playing positions of volleyball players for all the anthropometric measurements except BMI, forearm circumference and hip diameter.

10. There were no significant differences among playing positions of volleyball players for all the skinfold thicknesses, body density and percentage body fat. On the other hand, total body fat and lean body mass were different among playing positions of volleyball players.

11. Speed and power were significantly different among different playing positions of volleyball players.
There were significant differences among playing positions of volleyball players for inspiratory reserve volume and expiratory reserve volume.

5.11 RECOMMENDATIONS
In the light of the findings of the present study the following recommendations seem to be acceptable for further studies:

1. This study can be further extended for the comparative study of volleyball players of national and International level.

2. Physical education teachers, trainers and coaches can use the results of this study as an aid in spotting young talented players in volleyball.

3. The study can be extended for comparative study of various sports disciplines so that their differences with each other can be examined.

4. The similar study may be conducted by selecting large number of subjects belonging to different level of performance and the sex other than those employed in the present study.

5. It is suggested that a longitudinal study with the subjects employed in this research work may be carried out in order to find the changes in contributing variables and their effect on the performance of volleyball players.