CHAPTER-V
SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMMARY

Sports have emerged as a very highly competitive activity in the present decade i.e., a lot of competition is going on throughout countries of the world to establish supremacy through sports competitions. Old records are being broken and new ones are being established in almost all international competitions. This has become possible because of advancement of scientific procedures, new researches and developments.

There are numerous performance factors which contribute in the excellent performance of sports such as bio-mechanical applications, psychological approaches, sociological contributions, physiological diagnosis, anthropometric matching of athletes and so on. In the recent years anthropometry and kinanthropometry has gained popularity in the world of competitive sports. One of the main concerns of the physical anthropometry and human physiology is to discharge and convey the knowledge. Many more scientists like Sodhi and Sidhu, 1984; Mokha et al. (1998), Sehgal, 1995 etc. studied the human proportions, their body compositions, morphological make up and their relationship with sports activities. They advocated that science of anthropometry while selecting the athletes for particular sport is very important because of the fact that different sports have different somatotypes, morphological and anthropometrical requirements. In some sports like Basketball and Volleyball, tall persons are more successful where as in gymnastics and balancing like activities, short height athletes exhibit better performance. Likewise in throwing events, weight lifting and other anaerobic activities, people with heavy structure give better performance where as in activities like cycling, long distance running and aerobic activities, light weight athletes are more successful. Keeping in the view of the study the investigator has made a sincere effort to scientifically further investigate the anthropometric measurements and body composition of athletes of ball games.

5.2 STATEMENT OF THE PROBLEM

"A study of anthropometric measurements, body composition in relation to competitive performance of ball games athletes"
5.3 SIGNIFICANCE OF THE STUDY

• The present study might be helpful in understanding the relationship of anthropometric measurements with performance.

• The coaches and trainers might develop an insight for the objective selection of athletes of ball games, for their participation in different levels.

• The present study might be useful in sports where the counselling to children can be provided to which games and sports they are well suited by comparing their physique and body composition.

• Improvement in terms of physique and body composition would help in improving performance standard of male athletes of Himachal Pradesh University and India in the above mentioned ball games.

• The present study will help to evaluate and see the differences in anthropometric measurements and body composition of athletes of ball games and make recommendations in their development.

• The result of the study would add further knowledge to existing literature of kinanthropometry.

5.4 OBJECTIVES OF THE STUDY

1. To find out the difference in selected anthropometric measurements between high level and low level performers in ball games.

2. To find out the difference in body composition between high level and low level performers in ball games.

3. To find out the difference in selected anthropometric measurements among ball games athletes.

4. To find out the difference in body composition among ball games athletes.

5.5 HYPOTHESES OF THE STUDY

1. There would be significant difference in anthropometric measurements between high level and low level performers in ball games.

2. There would be significant difference in body composition between high level and low level performers in ball games.
3. There would be no significant difference in anthropometric measurements among ball games athletes.

4. There would be no significant difference in body composition among ball games athletes.

5.6 LIMITATIONS OF THE STUDY

1. Testing timings might be differing on the basis of availability of participants at specific schedules.

2. The investigator could not control other personal characteristics and habits etc.

3. The investigator tried to use the standard equipments for collecting the data on the basis of availability in the department.

5.7 DELIMITATIONS OF THE STUDY

1. The present study has been delimited to five ball games namely-
   i) Basketball
   ii) Football
   iii) Handball
   iv) Hockey
   v) Volleyball

2. The present study has been delimited to the following selected anthropometric variables:-
   a) Linear measurements:- Height, weight, sitting height, total arm length, bi-acromial breadth, bi-cristal breadth, hand length, hand width, leg length, upper leg length, lower leg length, foot length and foot width.
   b) Diameters:- humerus bicondylar diameter, wrist diameter, femur bicondylar diameter and ankle diameter.
   c) Circumferences:- chest circumference, upper arm circumference, fore arm circumference, hip circumference, thigh circumference and calf circumference.
   d) Skinfolds:- biceps skinfold, triceps skinfold, fore arm skinfold, sub scapular skinfold, supra iliac skinfold, supra spinal skinfold, thigh skinfold and calf skinfold.

3. The present study has been delimited to the male ball games athletes only.
4. The present study has been delimited to the Himachal Pradesh University ball games athletes.

5.8 DEFINITIONS OF THE IMPORTANT TERMS

(A) ANTHROPOMETRIC MEASUREMENTS: Anthropometric measurements are dimensions of the structure of human body taken at specific sites to give measures of length, girth and width.

(B) BODY COMPOSITION: Body composition is the proportion of the lean body mass and fat mass. It is one of the most important morphological features characterizing human organism.

(C) COMPETITION PERFORMANCE: The results achieved by players of ball games in Himachal Pradesh University inter college competitions will be considered as their competition performance.

(D) HIGH LEVEL PERFORMERS: First three positions in Himachal Pradesh University inter college competitions of ball games will considered as high level performers.

(E) LOW LEVEL PERFORMERS: All the teams which could not come among the best three positions in Himachal Pradesh University inter college competitions will be considered as low performers.

(F) BALL GAMES: Those sports where players play with ball either through hands or legs or with any equipment.

(G) ATHLETES: A sports person competing in an organized sport (team/individual). The word “Athlete” has been used throughout the present study in a broader sense for the individual who involves himself in any competitive sports.

5.9 SAMPLING

The investigator for the present study would adopt purposive random sampling procedure. The total sample of present study comprises of 300 subjects including high performers \( (n=150) \) and low performers \( (n=150) \) who participated in the inter-college competitions of Himachal Pradesh University in ball games. The game wise distribution of subjects is shown in the following table.
Game wise distribution of subjects

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Game</th>
<th>High level performers</th>
<th>Low level performers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basketball</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Football</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Handball</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>Hockey</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Volleyball</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Grand total</td>
<td></td>
<td>300</td>
<td></td>
</tr>
</tbody>
</table>

5.10 TOOLS TO BE USED

The following tools in the present investigation were used on the subjects to collect the data:

1. **Anthropometric Rod**

   Anthropometric rod was used to measure the standing height of players.

2. **Portable Weighing Machine**

   The Portable weighing machine was used to measure the weight of players.

3. **Flexible steel Tape**

   Flexible steel tape was used to measure the circumference of the body parts of players.

4. **Sliding Caliper**

   Sliding caliper was used to measure the diameter of the body parts of players.

5. **Skinfold caliper**

   Skinfold caliper was used to measure the skinfold thickness of players.

5.11 PROCEDURES FOR ADMINISTRATION OF THE TESTS

The following methods were used to collect the data. Anthropometric measurements were taken on each subject using standard technique of Heath and Carter (1967).
5.12 ANTHROPOMETRIC VARIABLES

Following selected anthropometric measurements were taken on each individual by using the standard technique of Heath and Carter (1967).

(A) Linear Measurements

Age (years)
- Height (cm)
- Weight (kg)
- Sitting height (cm)
- Total arm length (cm)
- Bi-acromial breadth (cm)
- Bi-cristal breadth (cm)
- Hand length (cm)
- Hand width (cm)
- Leg length (cm)
- Upper leg length (cm)
- Lower leg length (cm)
- Foot Length (cm)
- Foot width (cm)

(B) Diameters (cm)
- Humerus bi-condylar diameter
- Femur bi-condylar diameter
- Wrist diameter
- Ankle diameter

(C) Circumferences (cm)
- Chest circumference
- Upper arm circumference
- Fore arm circumference
- Hip circumference
- Thigh circumference
- Calf circumference
(D) Skinfolds (mm)

- Biceps skinfold
- Triceps skinfold
- Fore arm skinfold
- Sub scapular skinfold
- Supra iliac skinfold
- Supra spinal skinfold
- Thigh skinfold
- Calf skinfold

5.13 STATISTICAL TECHNIQUE

The data so collected were tabulated for statistical analysis according to the objectives of the investigation. ‘t’ test was used to find the statistical significance of the difference between high level performers and low level performers of different ball game athletes and analysis of variance (ANOVA) was used to find the statistical significance of difference among the athletes of ball games. Post hoc t test was used to compute significance of differences in various variables within the athletes of ball games.

5.14 CONCLUSIONS

Based on the finding of the study, the following conclusions have been drawn.

(A) CONCLUSIONS REGARDING COMPARISON OF ANTHROPOMETRIC MEASUREMENTS AND BODY COMPOSITION BETWEEN HIGH LEVEL PERFORMERS AND LOW LEVEL PERFORMERS IN BASKETBALL GAME.

1. High level performers of Basketball game were significantly heavier and possess greater sitting height, total arm length, hand width, lower leg length, foot length & foot width and lesser bi-cristal breadth as compared to low level performers of Basketball game. However they do not differ significantly in age, height, sitting height, bi-acromial breadth, hand length, leg length & upper leg length when compared with each other.
2. High level performers of Basketball game possessed significantly greater femur bicondylar diameter and lesser ankle diameter as compared to low level performers of Basketball game. However they do not differ significantly in humerus bicondylar diameter and wrist diameter when compared with each other.

3. High level performers of Basketball game possessed greater chest circumference, upper arm circumference, forearm circumference, thigh circumference and calf circumference and lesser hip circumference as compared to low level performers of Basketball game. However they do not differ significantly in all circumferences when compared with each other.

4. High level performers of Basketball game possessed significantly greater biceps skinfold, forearm skinfold, thigh skinfold & calf skinfold and lesser supra iliac skinfold as compared to low level performers of Basketball game. However they do not differ significantly in triceps skinfold, sub scapular skinfold and supra spinal skinfold when compared with each other.

5. High level performers of Basketball game possessed significantly greater bone mass, muscle mass and fat percentage as compared to low level performers of Basketball game. However they do not differ significantly in bone mass, muscle mass and fat percentage when compared with each other.

(B) CONCLUSIONS REGARDING COMPARISON OF ANTHROPOMETRIC MEASUREMENTS AND BODY COMPOSITION BETWEEN HIGH LEVEL PERFORMERS AND LOW LEVEL PERFORMERS IN FOOTBALL GAME.

1. High level performers of Football game were significantly heavier and possess greater bi-cristal breadth as compared to low level performers of Football game. However they do not differ significantly in age, height, sitting height, total arm length, bi-acromial breadth, hand length, hand width, leg length, upper leg length, lower leg length, foot length & foot width when compared with each other.
2. High level performers of Football game possessed significantly greater femur bicondylar diameter and ankle diameter as compared to low level performers of Football game. However they do not differ significantly in wrist diameter and femur bicondylar diameter when compared with each other.

3. High level performers of Football game possessed significantly greater chest circumference, upper arm circumference & forearm circumference as compared to low level performers of Football game. However they do not differ significantly in hip circumference, thigh circumference and calf circumference when compared with each other.

4. High level performers of Football game possessed significantly greater forearm skinfold, sub scapular skinfold, supra iliac skinfold & supra spinal skinfold as compared to low level performers of Football game. However they do not differ significantly in biceps skinfold, triceps skinfold, thigh skinfold & calf skinfold when compared with each other.

5. High level performers of Football game possessed significantly greater bone mass & muscle mass as compared to low level performers of Football game. However they do not differ significantly in fat percentage when compared with each other.

(C) CONCLUSIONS REGARDING COMPARISON OF ANTHROPOMETRIC MEASUREMENTS AND BODY COMPOSITION BETWEEN HIGH LEVEL PERFORMERS AND LOW LEVEL PERFORMERS IN HANDBALL GAME.

1. High level performers of Handball game possessed significantly greater total arm length, hand width, foot length & foot width and lesser bi-cristal breadth & upper leg length as compared to low level performers of Handball game. However they do not differ significantly in age, height, weight, sitting height, bi-acromial diameter, hand length, leg length and lower leg length when compared with each other.

2. High level performers of Handball game possessed greater value for humerus bicondylar diameter & femur bicondylar diameter and shown
lesser for wrist diameter & ankle diameter in comparison to low level performers of Handball game. However they do not differ significantly in all diameters when compared with each other.

3. High level performers of Handball game possessed significantly lesser hip circumference as compared to low level performers of Handball game. However they do not differ significantly in chest circumference, upper arm circumference, forearm circumference, thigh circumference and calf circumference when compared with each other.

4. High level performers of Handball game possessed significantly greater forearm skinfold as compared to low level performers of Handball game. However they do not differ significantly in biceps skinfold, triceps skinfold, sub scapular skinfold, supra iliac skinfold, supra spinal skinfold, thigh skinfold & calf skinfold when compared with each other.

5. High level performers of Handball game possessed greater bone mass, muscle mass and fat percentage in comparison to low level performers of Handball game. However they do not differ significantly in bone mass, muscle mass and fat percentage when compared with each other.

(D) CONCLUSIONS REGARDING COMPARISON OF ANTHROPOMETRIC MEASUREMENTS AND BODY COMPOSITION BETWEEN HIGH LEVEL PERFORMERS AND LOW LEVEL PERFORMERS IN HOCKEY GAME.

1. High level performers of Hockey game possessed significantly greater bi-acromial breadth & foot width and are significantly shorter as compared to low level performers of Hockey game. However they do not differ significantly in age, sitting height, total arm length, bi-cristal breadth, hand length, hand width, leg length, upper leg length, lower leg length & foot length when compared with each other.

2. High level performers of Hockey game possessed greater humerus bicondylar diameter, wrist diameter & femur bicondylar diameter and lesser ankle diameter in comparison to low level performers of Hockey game. However they do not differ significantly in diameters when compared with each other.
3. High level performers of Hockey game possessed significantly greater upper arm circumference as compared to low level performers of Hockey game. However there do not differ significantly in chest circumference, forearm circumference, hip circumference, thigh circumference and calf circumference when compared with each other.

4. High level performers of Hockey game possessed significantly lesser forearm skinfold and greater calf skinfold as compared to low level performers of Hockey game. However they do not differ significantly in biceps skinfold, triceps skinfold, sub scapular skinfold, supra iliac skinfold, supra spinal skinfold & thigh skinfold when compared with each other.

5. High level performers of Hockey game possessed lesser bone mass and greater muscle mass and fat percentage in comparison to low level performers of Hockey game. However they do not differ significantly in bone mass, muscle mass and fat percentage when compared with each other.

(E) CONCLUSIONS REGARDING COMPARISON OF ANTHROPOMETRIC MEASUREMENTS AND BODY COMPOSITION BETWEEN HIGH LEVEL PERFORMERS AND LOW LEVEL PERFORMERS IN VOLLEYBALL GAME.

1. High level performers of Volleyball game were significantly taller and possess greater hand width, lower leg length and foot length and lesser bi-acromial breadth & bi-cristal breadth as compared to low level performers of Volleyball game. However they do not differ significantly in age, weight, sitting height, arm length, hand length, leg length, upper leg length & foot width when compared with each other.

2. High level performers of Volleyball game possessed greater value for humerus bicondylar diameter, wrist diameter, femur bicondylar diameter and ankle diameter in comparison to low level performers of Volleyball game. However they do not differ significantly in diameters when compared with each other.

3. High level performers of Volleyball game possessed significantly greater upper arm circumference and calf circumference as compared
to low level performers of Volleyball game. However they do not differ significantly in chest circumference, forearm circumference, hip circumference and thigh circumference when compared with each other.

4. High level performers of Volleyball game possessed greater mean value for forearm skinfold, sub scapular skinfold, supra iliac skinfold, supra spinal skinfold, thigh skinfold & calf skinfold and shown lesser mean value for biceps skinfold & triceps skinfold in comparison to low level performers of Volleyball game. However they do not differ significantly in all skinfold when compared with each other.

5. High level performers of Volleyball game possessed significantly greater muscle mass as compared to low level performers of Volleyball game. However they do not differ significantly in bone mass and fat percentage when compared with each other.

(F) CONCLUSION REGARDING COMPARISON OF ANTHROPOMETRIC MEASUREMENTS AND BODY COMPOSITION AMONG ATHLETES OF BALL GAMES.

1. The Basketballers were oldest and Hockey players were youngest among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in age.

2. The Volleyballers were tallest and Footballers were shortest among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in height.

3. The Volleyballers were heaviest and Hockey players were lightest among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in weight.

4. The Volleyballers possess greatest and Footballers possess least value for sitting height among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in sitting height.
5. The Volleyballers possess greatest and Hockey players possess least value for arm length among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in arm length.

6. The Hockey players possess greatest and Handballers possess least value for bi-acromial breadth among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in bi-acromial breadth.

7. The Volleyballers possess greatest and Hockey players possess least value for bi-crystal breadth among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in bi-crystal breadth.

8. The Volleyballers possess greatest and Hockey players possess least value for hand length among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in hand length.

9. The Volleyballers possess greatest and Hockey players possess least value for hand width among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in hand width.

10. The Basketballers possess greatest and Hockey players possess least value for leg length among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in leg length.

11. The Basketballers possess greatest and Hockey players possess least value for upper leg length among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in upper leg length.

12. The Footballers possess greatest and Hockey players possess least value for lower leg length among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in lower leg length.
13. The Volleyballers possess greatest and Hockey players possess least value for foot length among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in foot length.

14. The Volleyballers possess greatest and Handballers possess least value for foot width among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in foot width.

15. The Basketballers possess greatest and Handballers possess least value for humerus bicondylar diameter among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in humerus bicondylar diameter.

16. The Basketballers possess greatest and Volleyballers possess least value for wrist diameter among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in wrist diameter.

17. The Volleyballers possess greatest and Handballers possess least value for femur bicondylar diameter among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in femur bicondylar diameter.

18. The Basketballers possess greatest and Volleyballers possess least value for ankle diameter among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in ankle diameter.

19. The Volleyballers possess greatest and Hockey players possess least value for chest circumference among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in chest circumference.

20. The Volleyballers possess greatest and Handballers possess least value for upper arm circumference among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in upper arm circumference.
21. The Basketballers possess greatest and Hockey players possess least value for forearm circumference among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in forearm circumference.

22. The Volleyballers possess greatest and Hockey players possess least value for hip circumference among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in hip circumference.

23. The Volleyballers possess greatest and Handballers possess least value for thigh circumference among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in thigh circumference.

24. The Volleyballers possess greatest and Handballers possess least value for calf circumference among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in calf circumference.

25. The Volleyballers possess greatest and Footballers possess least value for biceps skinfold among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in biceps skinfold.

26. The Hockey players possess greatest and Handballers possess least value for triceps skinfold among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in triceps skinfold.

27. The Volleyballers possess greatest and Basketballers possess least value for forearm skinfold among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in forearm skinfold.

28. The Footballers possess greatest and Handballers possess least value for sub scapular skinfold among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in sub scapular skinfold.
The Volleyballers possess greatest and Basketballers possess least value for supra iliac skinfold among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in supra iliac skinfold.

The Footballers possess greatest and Handballers possess least value for supra spinal skinfold among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in supra spinal skinfold.

The Footballers possess greatest and Basketballers possess least value for thigh skinfold among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in thigh skinfold.

The Footballers possess greatest and Handballers possess least value for calf skinfold among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in calf skinfold.

The Basketballers possess greatest and Handballers possess least value for bone mass among the athletes of ball games. Statistically, it has been observed that athletes of ball games do not differ significantly from each other in bone mass.

The Volleyballers possess greatest and Hockey players possess least value for muscle mass among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in muscle mass.

The Volleyballers possess greatest and Basketballers possess least value for fat percentage among the athletes of ball games. Statistically, it has been observed that athletes of ball games differ significantly from each other in fat percentage.
5.15 RECOMMENDATIONS

On the basis of the present research and result of this study, here are some recommendations and suggestions for coaches, physical educationists, sports promoters, athletes etc.

- It is recommended that the coaches and physical educationists should choose and select only those sportsmen who possess the basic physical structure and body composition required to achieve optimum performance.

- In addition to anthropometric measurements and body composition it is also suggested that physiological parameters such as VO2 max, blood pressure, pulse rate etc. may also be studied along with anthropometric measurements and body composition.

- It is recommended that the coaches and physical educationists, with the help of dieticians, should prepare dietary plan of each of the sports person, in addition to training schedule, to achieve optimum body structure for attaining high performance.

- On the basis of the finding of the present study, the coaches and physical educationists should prepare the training schedules for their athletes so that required amount of skinfolds at various sites, circumferences of different regions of the body, various diameters, linear measurements may be acquired for achieving maximum performance.

- Similar studies may also be conducted on the female athletes. Such a study will also throw light on existing trend pertaining to body structure and body composition in women section of Himachal Pradesh University.

- A similar study may be undertaken with different age levels of sports persons of both sexes.

- The study can be carried out with large group of sports persons of several socio-economic status.

- Similar studies should also be conducted on higher level performance groups such as state, national and international level of sports person.