CHAPTER-V
SUMMARY AND CONCLUSIONS

5.1 INTRODUCTION

The sportspersons are more competitive now-a-days and always aim at the consistency of performance and thus the gap between winning and losing has eventually narrowed. The sports scientists and coaches study each and every aspect of the players to make them yield maximum performance. On the basis of physical, emotional, physiological and psychological aspects of the sportspersons, the researchers have collected such a data so as to help in increasing the potential of the player in every sport.

The sports performance depends on the complex combination of various factors such as physical, physiological, technical, tactical, psychological and environmental. They supersede each other depending upon the nature of sports. It is often seen that though the athletes are imparted with same training keeping in view all the above stated factors, the performance level of each athlete differs. It depends basically on the difference in body structure and body composition of each athlete. To excel in a physically competitive sport, the player must possess some specific dimensions of body characteristics which suit the most in his or her sport. Detailed information regarding kinanthropometric characteristics of athletes is certainly important in modern sports. It is a well known fact that most of the kinanthropometric characteristics are almost exclusively genetically determined and length and breadth measurements can not be changed with training (Norton and Olds, 2001). Besides the relationship with physical performance, kinanthropometric status is also important for sports trainers in order to direct young athletes into the sports they are best suited to at the beginning of their careers.

Studies on the physical characteristics of the human body till date indicate that the morphological characteristics of athletes successful in a specific sport differ in somatic characteristics from the general population. Each individual is unique. The extent of human variability is so enormous that no two individuals are the same. With this enumerable variety of human physique, it is well known fact that some sports events are more suitable to individuals with specific physique than others. Specific physique characteristics such as body composition, size, type and structure are considered to be some of the key factors for the enhancement of high level
performance in various sports events. It is an established fact that the ideal somatotype for athletes varies according to the requirements of sport or event (Carter & Heath, 1990; Duquet & Carter, 1996). Somatotype analysis can provide a synthetic descriptive picture of the kinanthropometric characteristics of high level athlete. In this sense, the somatotyping method is believed to yield better results than simple linear anthropometric measurements (Rienzi et al., 1999), since it combines adiposity, musculo-skeletal robustness and linearity.

Body composition is also an important determining factor for performance ability of an athlete. Excess body fat is detrimental to performance in most sports. Whereas, fat free body mass, especially muscle mass, is generally associated with performance.

Although various researchers have already investigated the relationship between morphological characteristics and performance of elite jumpers and throwers (Morrow et al., 1982; Singh et al., 1987; Guennadi, 1990) there is insufficient new information with regard to kinanthropometric characteristics, somatotyping and body composition in high and low performer jumpers and throwers. The purpose of this study is therefore to find out the differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer jumpers and throwers of inter university.

5.2 STATEMENT OF THE PROBLEM

The purpose of the study is to find out the differences in kinanthropometric characteristics, somatotyping and body composition of low and high performer jumpers and throwers of inter university level.

5.3 OBJECTIVES

1. To know the differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer throwers of inter university level.

2. To know the differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer jumpers of inter university level.

3. To find out the differences in kinanthropometric characteristics, somatotyping and body composition among the various groups of throwers.

4. To find out the differences in kinanthropometric characteristics, somatotyping and body composition among different groups of jumpers.
5. To find out the differences in kinanthropometric characteristics, somatotyping and body composition between jumpers and throwers.

5.4 HYPOTHESES

1. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer throwers.
2. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition of high and low performer jumpers.
3. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition among different groups of throwers.
4. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition among different groups of jumpers.
5. There would be significant differences in kinanthropometric characteristics, somatotyping and body composition between jumpers and throwers.

5.5 DELIMITATION OF THE STUDY

1. The study was delimited only to male athletes who have participated in All India Inter University Athletic Meet for the year 2005-2006 held at Manonmaniam Sundaranar University, Trinelvelli, Tamil Nadu.
2. The study was delimited to the jumpers (long jump, high jump, triple jump, pole vault) and throwers (shot put, discus, javelin, hammer throw) from 18 to 25 years of age group.
3. The study was delimited to 26 kinanthropometric characteristics of 160 male athletes.
4. The study was delimited to the selected structural aspects i.e. kinanthropometric characteristics, body composition and somatotyping.

5.6 LIMITATIONS

1. The inter university athletic meet was held only for five days and study was conducted only on inter university level jumpers and throwers. So, the number of subjects taken as low and high performer was a limiting factor.
2. The athletes studied in this work were from the different parts of the country so that the present sample can be heterogeneous in nature.

5.7 SIGNIFICANCE OF THE STUDY

The study may contribute towards the promotion of athletic performance in following ways:
1. The findings of the study may provide criteria for selecting best talent that exist for jumping and throwing events.
2. A comparative analysis of the physique of jumpers and throwers would be helpful in the evaluation and prediction of their performance in their respective events.
3. This study will also help to compare inter university jumpers and throwers with the international athletes.
4. The study may help physical education teachers and coaches by way of informing them about the kinanthropometric characteristics, somatotyping and body composition which the athletes require.
5. The study will add more knowledge in the existing literature and provide guidelines to the future researchers in kinanthropometry of jumpers and throwers.

5.8 SAMPLING PROCEDURE
The study has been conducted only on male jumpers and throwers. The jumpers included high jumpers, long jumpers, triple jumpers, and pole vaulters and the throwers included discus throwers, javelin throwers, hammer throwers and shot putters. The athletes were divided into two groups on the basis of their performance in competition. The first ten position holders were considered as 'High Performer Athletes' where as those who could not qualify for final were considered as 'Low Performer Athletes'. The data of athletes was collected during the All India Inter University Athletic Meet held at Manonmaniam Sundaranar University, Tirunelveli, Tamilnadu, from 30.01.66 to 03.02.06. The athletes from various universities from all over India were analyzed. The subjects were aged between 18 to 25 years. Total one hundred sixty male field athletes were studied. The athletes were divided into various groups given in the table below.

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Event</th>
<th>No. of High Performer</th>
<th>No. of Low Performer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High Jump</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Long Jump</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Pole Vault</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Triple Jump</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Discus Throw</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>Hammer Throw</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Javelin Throw</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>Shot Put</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>
5.9 DATA COLLECTION

All the kinanthropometric measurements of all subjects were taken in the morning hours with empty bowl. All the bilaterally represented kinanthropometric measurements were taken on the left side. Body weight of the subjects was measured with portable weighing machine to the nearest 0.5 kg. Height measurements were taken by using the standard anthropometric rod to the nearest 0.5 cm. 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. Kinanthropometric measurements taken from each subject were as follows

Gross Body Measurements
   1. Weight (Kg)
   2. Height (cm)

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

Diameters of Body Parts (cm)
   1. Biacromial Diameter
   2. Bi-iliocristal Diameter
   3. Bicondylar Femur Diameter
   4. Ankle Diameter
   5. Bicondylar Humerus Diameter
   6. Wrist Diameter

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

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

### 5.10 DERIVED MEASUREMENT

**Body Mass Index**

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

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

**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).

### 5.11 STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS version 16.0 for windows (SPSS Inc, Chicago, IL, USA). All descriptive data was reported as means and standard deviation. Independent samples t-test was used to test if population means estimated by two independent samples differed significantly. One-way analysis of variance (ANOVA) was employed to test the differences among three or more groups. Following the detection of a significant main effect, Tukey post-hoc analyses were performed to locate where specific mean differences lay. Significance levels were set at \( p<0.05 \).
5.12 RESULTS

The independent sample t-test was used to make comparisons between high performer and low performer athletes. The analysis of the data indicated that the high performer shot putters were significantly taller and had significantly greater mean values in all the segment lengths. The upper arm, forearm, chest and thigh circumferences were found significantly greater in high performer shot putters. Further, the bicondylar humerus, wrist, biacromial and bi-iliocristal diameters were significantly wider in high performer shot putters. The low performer shot putter showed significantly greater mean value in triceps skinfold measurement. Whereas, in weight, BMI, abdominal and calf circumferences, bicondylar femur and ankle diameters, biceps, subscapular, suprailiac and calf skinfolds no statistically significant differences were found between high and low performer shot putters.

The data of body composition showed that the lean body mass of the high performer shot putters was significantly higher than those of the low performer shot putters. It was also found that there were variations in other body composition variables but the differences were not statistically significant. Regarding somatotyping of the low and high performer shot putters, it was noticed that the low performer shot putters possessed significantly higher endomorphic component as compared to high performer shot putters. Whereas, no significant differences were observed in mesomorphic and ectomorphic components in high and low performer shot putters.

The data of hammer throwers revealed that the high performer hammer throwers were significantly heavier than low performer hammer throwers. The sitting height, BMI, lower leg length, all the six circumferences, bicondylar humerus and wrist diameters were significantly greater in high performer hammer throwers. The biceps, triceps and subscapular skinfold measurements were found significantly greater in low performer hammer throwers as compared to high performer hammer throwers. Whereas in height, leg length, upper leg length, arm, upper arm and forearm length, biacromial, bi-iliocristal, bicondylar femur and ankle diameters, suprailiac and calf skinfolds no significant differences were observed between high and low performer hammer throwers.

The body density and lean body mass were observed significantly greater in high performer hammer throwers, but low performer hammer throwers had significantly higher percentage body fat. There was no significant difference in total
body fat between high and low performer hammer throwers. In somatotyping, the high performer hammer throwers had significantly greater mesomorphic component, whereas, low performer hammer throwers significantly dominated in endomorphic and ectomorphic components.

In the comparison of Javelin throwers, the high performer Javelin throwers had significantly greater mean values in height and all segment lengths than those of the low performer Javelin throwers. BMI was significantly higher in low performer Javelin throwers. Further, the forearm and thigh circumferences were found significantly greater in high performer javelin throwers. Only bi-iliocristal diameter was observed significantly wider in low performer Javelin throwers. All the skinfold measurements were significantly greater in low performer Javelin throwers. No significant differences were found in weight, sitting height, upper arm, chest, abdominal and calf circumferences, bicondylar humerus, wrist, biacromial, bicondylar femur and ankle diameters between the two groups.

In case of body composition the body density of high performer Javelin throwers was significantly higher than low performer Javelin throwers. Whereas, percentage body fat and total body fat were significantly greater in low performer javelin throwers. No significant differences were observed between high and low performer javelin throwers in relation to lean body mass. In the study of somatotyping the endomorphic components were significantly dominated by low performer Javelin throwers and ectomorphic component was significantly dominated by high performer Javelin throwers. Whereas, in mesomorphy no significant difference was found between high and low performer javelin throw.

The data regarding discus throwers showed that high performer discus throwers were significantly taller and heavier than the low performer discus throwers. In addition, significantly greater values were observed in all segment lengths, circumferences and diameters when compared to the low performer discus throwers. However, the low performer discus throwers had significantly greater biceps, triceps, subscapular and calf skinfolds mean values as compared to high performer discus throwers. There were no significant differences found in BMI and suprailiac skinfold between the two groups.

Body density, total body fat and lean body mass were significantly higher in high performer discus throwers whereas, percentage body fat was significantly lesser in high performer discus throwers. Regarding somatotyping the endomorphic
component was found significantly greater in low performer discus throwers and mesomorphic component was significantly dominated by high performer discus throwers. Whereas, no significant difference was observed in ectomorphy between the two groups.

Comparing the high and low performer long jumpers, it was observed that the high performer long jumpers were significantly heavier and had significantly greater BMI values than the low performer long jumpers. Similarly, calf circumference was found significantly higher in high performer long jumpers. The low performer long jumpers showed significantly higher mean values of biceps, triceps, subscapular and suprailiac skinfold measurements when compared to high performer long jumpers. Whereas in height, all segment lengths, all diameters, upper arm, forearm, chest, abdominal and thigh circumferences and calf skinfold no significant differences were found between low and high performer long jumpers.

Body composition of the high and low performer long jumpers showed that the body density and lean body mass values were significantly higher in high performer long jumpers whereas low performer long jumpers had significantly greater values of percentage body fat and total body fat. It was noticed in somatotyping that the endomorphic component was significantly higher in low performer long jumpers, whereas mesomorphic component was significantly greater in high performer long jumpers. There was no significant difference in ectomorphy between the two groups.

The data of high jumpers showed that high performer high jumpers had significantly greater values in body weight, height, sitting height, BMI, all diameters and all circumferences when compared to low performer high jumpers. In addition, leg length, upper leg length, arm length and upper arm length were found significantly greater in high performer high jumpers as compared to low performer high jumpers. However, the low performer high jumpers had significantly greater triceps, subscapular and calf skinfolds. No significant differences were reported in lower leg length, forearm length, biceps and suprailiac skinfolds between the two groups.

Body composition analysis showed that the body density and lean body mass were significantly greater in high performer high jumpers. Percentage body fat was found significantly greater in low performer high jumpers whereas, no significant differences were observed between high and low performer high jumpers in relation to total body fat. The results of somatotyping showed that endomorphic component was significantly greater in low performer high jumpers whereas mesomorphic
component was found significantly greater in high performer high jumpers and the ectomorphic component was almost similar in low and high performer high jumpers.

High performer triple jumpers had significantly greater height, sitting height, leg length, upper leg length, lower leg length, arm length and upper arm length as compared to low performer triple jumpers. Similarly, biacromial, bi-iliocristal, bicondylar humerus, bicondylar femur and ankle diameters, chest, abdominal and calf circumferences were also found greater in high performer triple jumpers. However, no significant differences were reported in weight, BMI, forearm length, upper arm, forearm and thigh circumferences, wrist diameter and all skinfold measurements between the two groups.

In body composition, lean body mass was significantly greater in high performer triple jumpers. No significant differences were observed between high and low performer triple jumpers in relation to body density, percentage body fat and total body fat. In case of somatotyping, endomorphy was significantly higher in low performer triple jumpers and no significant differences were observed between high and low performer triple jumpers in relation to mesomorphy and ectomorphy.

The high performer pole vaulters were found to have significantly higher weight, sitting height, arm length and upper arm length as compared to the low performer pole vaulters. Further, the high performer pole vaulters also showed significantly greater forearm, chest, abdominal, thigh and calf circumferences and biacromial, bi-iliocristal, bicondylar femur and ankle diameters when compared to the low performer pole vaulters. No significant differences were found in height, BMI, leg length, upper leg length, forearm length lower leg length, upper arm circumference, bicondylar humerus and wrist diameters and all skinfolds values between the two groups.

Lean body mass was observed significantly higher in high performer pole vaulters. However, no significant differences were observed between high performer and low performer pole vaulters in relation to body density, percentage body fat and total body fat. No significant differences were reported in somatotyping components between the two groups.

One-way analysis of variance (ANOVA) was applied to find the differences in various anthropometric measurements, components of body composition and somatotyping among the different groups of jumpers and throwers. In jumpers, there were significant differences in all the kinanthropometric measurements among the
different groups of jumpers except abdominal circumference and bi-acromial diameter. Similarly, skinfold measurements and different components of body composition were also significantly different among the different groups of jumpers. Further, the different groups of jumpers were also significantly varying in various components of somatotyping. In throwers, significant differences were observed in all the kinanthropometric measurements between various groups of throwers. In addition, skinfold measurements and different components of body composition were also significantly varying in various groups of throwers. It was also observed that the various components of somatotyping were significantly different in the various groups of throwers.

Independent samples t-test was used to find out the differences between throwers and jumpers. It was observed that the throwers had significantly higher mean values for all the kinanthropometric measurements as compared to jumpers except leg length, upper leg length and lower leg length. All the skinfold values were observed significantly higher in throwers than those of jumpers. In addition, throwers were also found to have significantly higher percent body fat, total body fat and lean body mass when compared to jumpers. However, body density was significantly greater in jumpers as compared to throwers. Further, throwers were found to have significantly greater endomorphic and mesomorphic components than the jumpers. Whereas, significantly higher endomorphic component was observed in jumpers as compared to throwers.

**5.13 CONCLUSION**

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

1. The high performer throwers were significantly taller and heavier and had significantly greater segment lengths, circumferences and diameters than the low performer throwers. Whereas, low performer throwers had significantly greater skinfold measurements.

2. The lean body mass and body density were found significantly higher in high performer throwers whereas low performer throwers showed significantly greater values in percentage body fat.
3. In somatotyping, the endomorphic component was found significantly greater in low performer throwers whereas mesomorphic component was significantly dominated by high performer throwers.

4. The high performer jumpers were found significantly taller, heavier and they had significantly greater values in all segment lengths, circumferences and diameters than the low performer jumpers. However, the high performer jumpers had lesser skinfold measurements than the low performer jumpers.

5. The high performer jumpers had significantly higher values in body density and lean body mass. Whereas, percentage body fat was reported significantly higher in low performer jumpers.

6. The physique of high performer jumpers was characterized by significantly higher mesomorphy and lower endomorphy as compared to low performer jumpers.

7. The significant differences were observed in height, weight, all segment lengths, circumferences, diameters and skinfold measurements among various groups of throwers.

8. The different components of body composition were significantly varying among the various groups of throwers.

9. All the groups of throwers showed significant differences in endomorphy, mesomorphy and ectomorphy.

10. All the groups of jumpers were significantly varying in kinanthropometric measurements except waist circumference and bi-acromial diameter. Further, skinfold measurements showed significant differences among various groups of jumpers.

11. The different components of body composition were significantly varying among the various groups of jumpers.

12. The significant differences were found in endomorphy, mesomorphy and ectomorphy among the different groups of jumpers.

13. When comparisons were made between throwers and jumpers, the throwers showed significantly higher values of kinanthropometric measurements. Similarly, the throwers also possessed significantly higher values of skinfold measurements.

14. Body density was significantly greater in jumpers whereas percentage body fat, total body fat and lean body fat were significantly greater in throwers.
15. Endomorphic and mesomorphic components were significantly higher in throwers. Whereas, jumpers had significantly higher value of ectomorphic component.

5.14 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 field athletes of university and International level athletes.

2. Physical education teachers and coaches can use the results of this study as an aid in screening, identification and selecting jumpers and throwers.

3. High performance in sports depends upon many factors such as psychological, sociological, physiological, physical fitness etc. These variables should be incorporated in similar studies to know the relationship of these variables with kinanthropometric variables and performance.

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

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

6. 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 jumpers and throwers.

7. In the training program for jumpers and throwers, emphasis must be laid on improvement of those kinanthropometric characteristics, somatotyping and body composition which have been found to be significantly related to high performer athletes.