

Chapter IV

ANALYSIS OF DATA AND RESULTS OF THE STUDY

The data collected on selected criterion variables for hockey players of different levels of achievement was subjected to statistical analysis and it was presented in this chapter.

ANTHROPOMETRIC VARIABLES

Table 3

Mean (*sd*) and results of ANOVA for height among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 154.43 \pm 8.15 | B | 18.241 | 1 | 18.241 | 0.267 | .610 |
| High achievers (17) | 153.76 \pm 9.26 | W | 1846.121 | 27 | 68.375 | | |
| Low achievers (12) | 155.37 \pm 6.55 | T | 1864.362 | 28 | - | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on height are 153.76 \pm 9.26 and 155.37 \pm 6.55 respectively. Levene's test has shown that the variance is not significant since $p = 0.103$. So Homogeneity of variance is assumed. The results of the ANOVA on height showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 3*). Since the obtained F ratio of 0.267 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on height. From the mean value it was observed that low achievers are found to be greater in height than high achievers which can be confirmed by Box plots presented in Figure 1.

Figure 1
Height of high and low achievers field hockey players

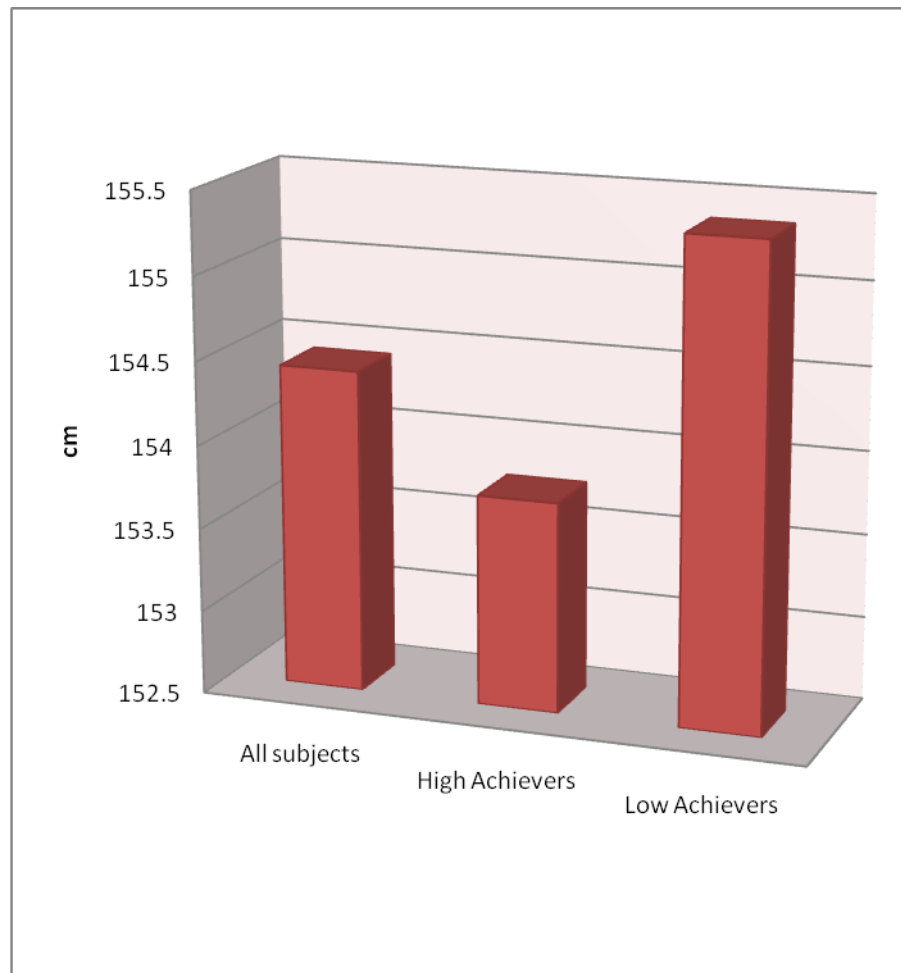


Table 4

Mean (*sd*) and results of ANOVA for weight among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 39.09 \pm 6.33 | B | 16.836 | 1 | 16.836 | .411 | .527 |
| High achievers (17) | 38.45 \pm 6.14 | W | 1106.702 | 27 | 40.989 | | |
| Low achievers (12) | 40.00 \pm 6.76 | T | 1123.539 | 28 | - | | |

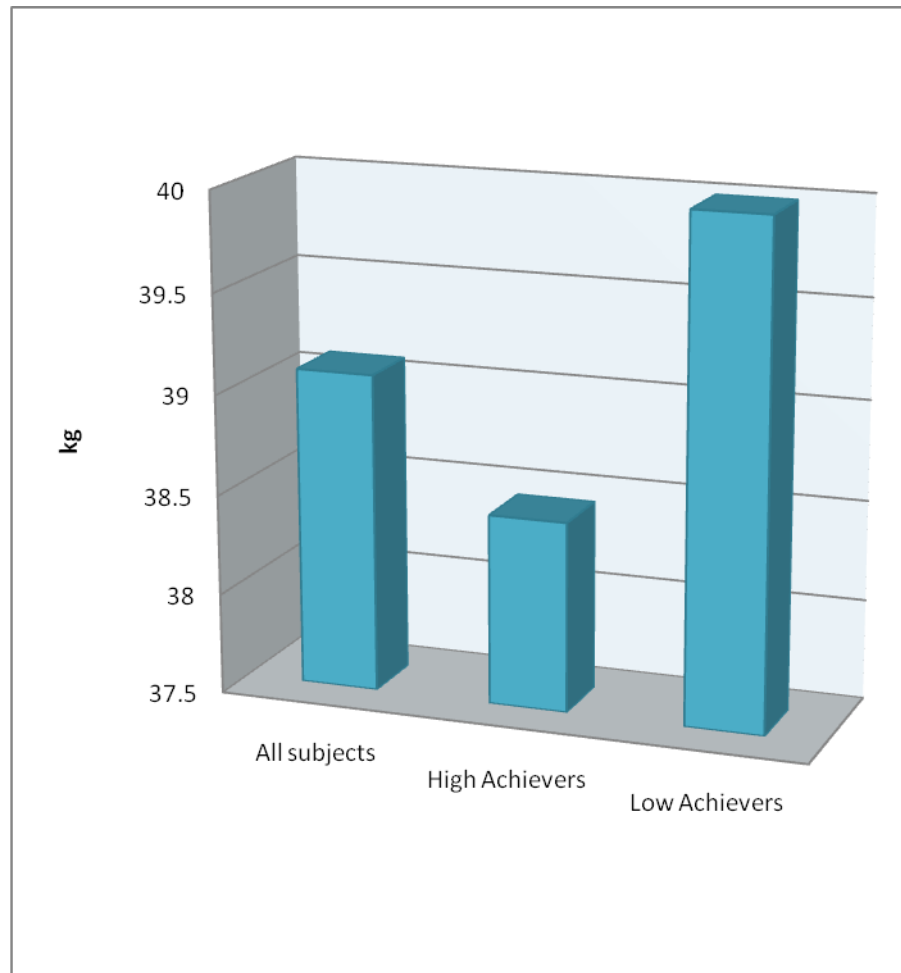
SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on weight are 38.45 \pm 6.14 and 40.00 \pm 6.76 respectively. Levene's test has shown that the variance is not significant since $p = 0.737$. So Homogeneity of variance is assumed. The results of the ANOVA on weight showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 4*). Since the obtained F ratio of 0.411 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on weight. From the mean value it was observed that low achievers are found to be greater in weight than high achievers which can be confirmed by Box plots presented in Figure 2.

Figure 2
Weight of high and low achievers field hockey players



BODY COMPOSITION

Table 5

Mean (*sd*) and results of ANOVA for percent body fat among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 8.55 \pm 3.16 | B | 32.755 | 1 | 32.755 | 3.581 | .069 |
| High achievers (17) | 7.65 \pm 3.20 | W | 246.938 | 27 | 9.146 | | |
| Low achievers (12) | 9.81 \pm 2.73 | T | 279.692 | 28 | - | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on percent body fat are 7.65 \pm 3.20 and 9.81 \pm 2.73 respectively. Levene's test has shown that the variance is not significant since $p = 0.739$. So Homogeneity of variance is assumed. The results of the ANOVA on percent body fat showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 5*). Since the obtained F ratio of 3.581 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on percent body fat. From the mean value it was observed that high achievers are found to be lesser in percent body fat than low achievers which can be confirmed by Box plots presented in Figure 3.

Figure 3
Percent body fat of high and low achievers field hockey players

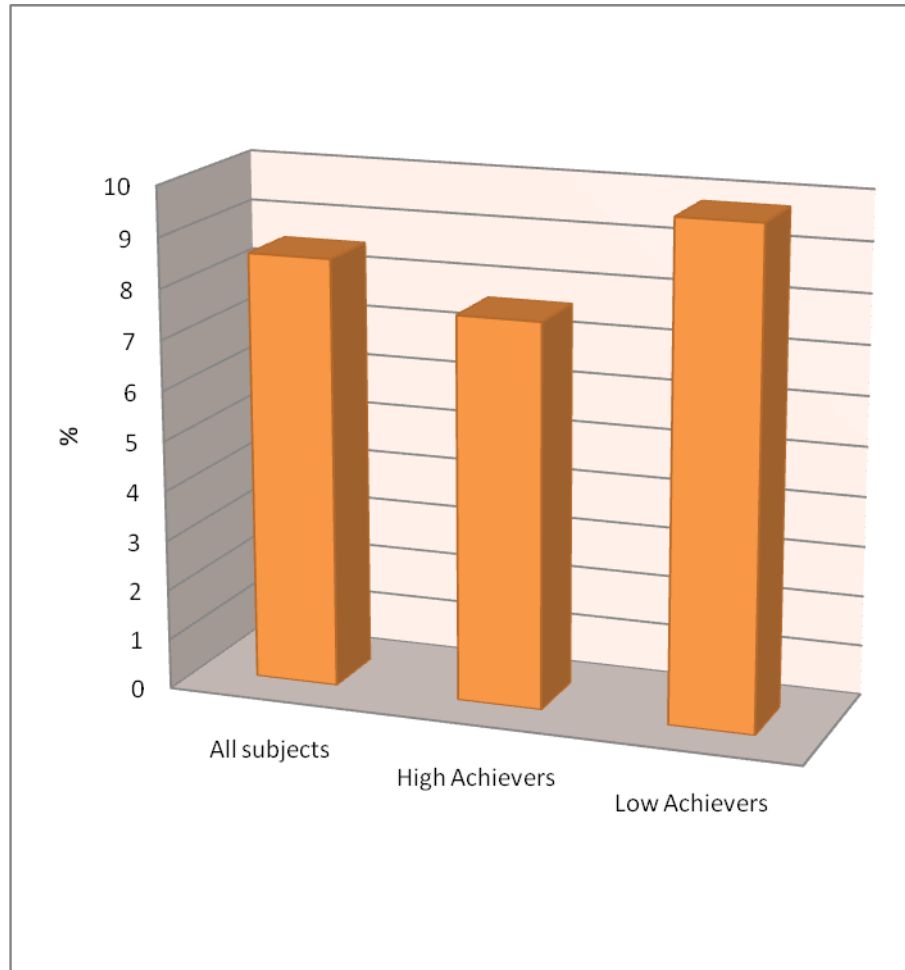


Table 6

Mean (*sd*) and results of ANOVA for lean body mass among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 38.39 \pm 6.21 | B | 118.368 | 1 | 118.368 | 3.321 | .080 |
| High achievers (17) | 40.09 \pm 6.22 | W | 962.444 | 27 | 35.646 | | |
| Low achievers (12) | 35.99 \pm 5.58 | T | 1080.812 | 28 | | | |

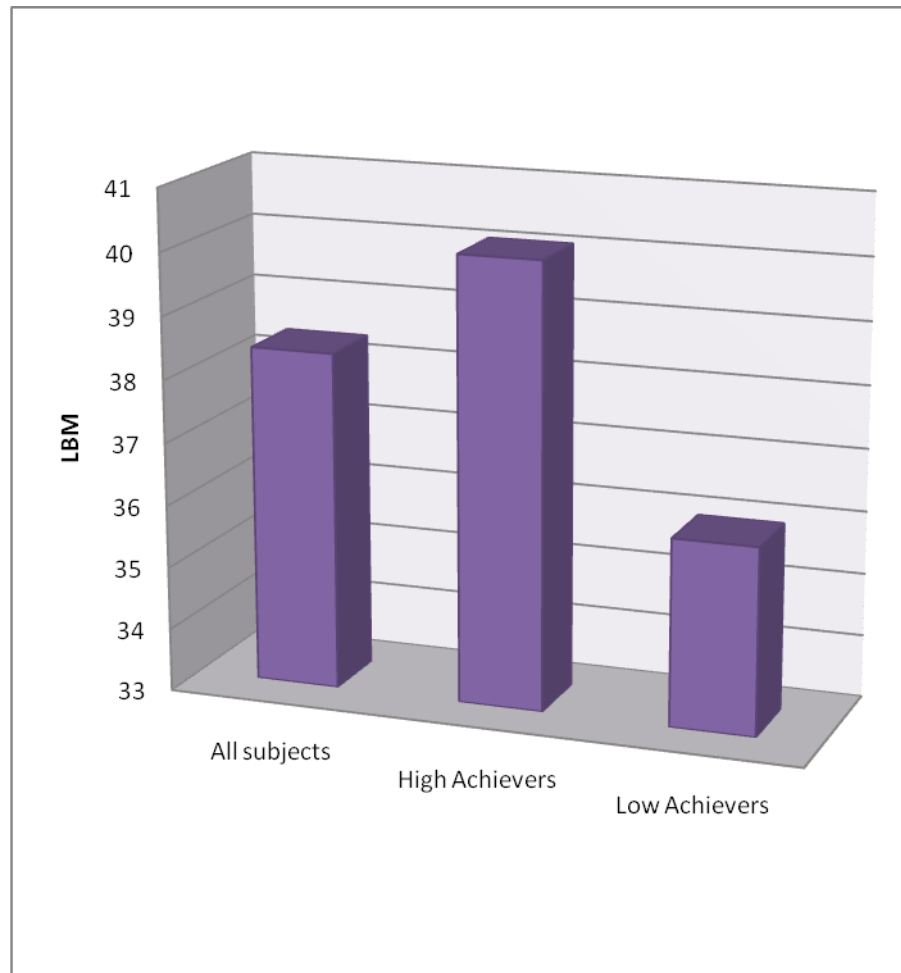
SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on lean body mass are 40.09 \pm 6.22 and 35.99 \pm 5.58 respectively. Levene's test has shown that the variance is not significant since $p = 0.403$. So Homogeneity of variance is assumed. The results of the ANOVA on lean body mass showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 6*). Since the obtained F ratio of 3.321 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on lean body mass. From the mean value it was observed that high achievers are found to be greater in lean body mass than low achievers which can be confirmed by Box plots presented in Figure 4.

Figure 4
Lean body mass of high and low achievers field hockey players



SOMATO TYPE**Table 7**

Mean scores (*sd*) and ANOVA of somatotypes of field hockey players classified by level of performance

| | Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|------------|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Endomorph | Total subjects (29) | 1.68 \pm 0.62 | B | .954 | 1 | .954 | 2.594 | .119 |
| | High achievers (17) | 1.53 \pm 0.64 | W | 9.930 | 27 | .368 | | |
| | Low achievers (12) | 1.90 \pm 0.54 | T | 10.884 | 28 | | | |
| Mesomorphy | Total subjects (29) | 3.19 \pm 0.78 | B | 1.679 | 1 | 1.679 | 2.940 | .098 |
| | High achievers (17) | 3.39 \pm 0.80 | W | 15.415 | 27 | .571 | | |
| | Low achievers (12) | 2.90 \pm 0.68 | T | 17.093 | 28 | | | |
| Ectomorphy | Total subjects (29) | 4.72 \pm 0.81 | B | .132 | 1 | .132 | .194 | .663 |
| | High achievers (17) | 4.66 \pm 0.83 | W | 18.350 | 27 | .680 | | |
| | Low achievers (12) | 4.80 \pm 0.81 | T | 18.482 | 28 | | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

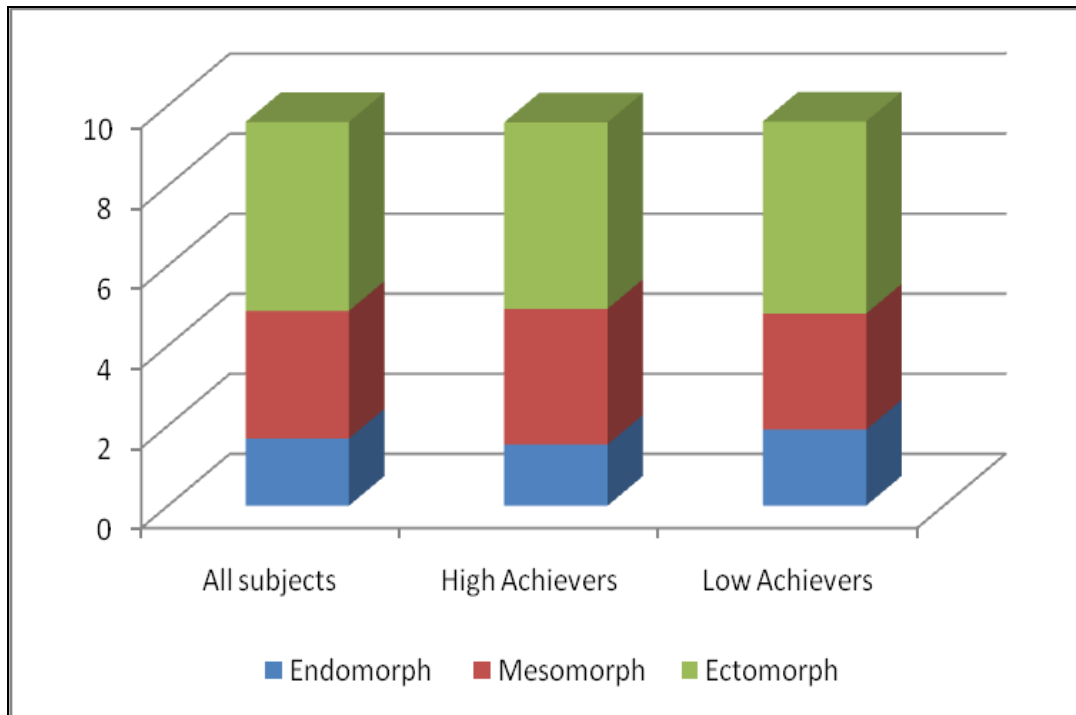
Table 7 show that field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh, showed mesomorphic ectomorph (1.68 - 3.19 - 4.72). when they are classified into two groups based on performance level high achiever showed mesomorphic ectomorph (1.53 -3.39 - 4.66) and low achievers also possessed mesomorphic ectomorph (1.90 - 2.90 - 4.80). The somatotype of high and low achievers is mesomorphic ectomorph because ectomorphy is dominant, with mesomorph second in dominance. ANOVA was employed to

know the difference between high and low achievers hockey players on Somatotype (*see Table 7*).

The obtained p value for endomorph - 0.608, mesomorph - 0.614 and ectomorph - 0.894 in Levene's test has shown that the variance is not significant. So Homogeneity of variance is assumed. The study also reveals that there is no significant difference on endomorph, mesomorph and ectomorph of high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 7*). Since the obtained F ratio of endomorph - 2.594, mesomorph - 2.940 and ectomorph - 0.194 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27.

Inference

It can be concluded that there is no significant difference between the high and low achiever on endomorph, mesomorph and ectomorph. From the mean value it was observed that high achievers are found to be less in endomorph and ectomorph than low achievers and high achievers dominate in mesomorph than low achievers which can be confirmed and presented in Figure 5.

Figure 5**Somatotype of high and low achievers field hockey players**

BIOMOTOR

Table 8

Mean (*sd*) and results of ANOVA for speed among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 4.97 \pm 0.24 | B | .282 | 1 | .282 | 5.178* | .031 |
| High achievers (17) | 4.89 \pm 0.24 | W | 1.468 | 27 | .054 | | |
| Low achievers (12) | 5.09 \pm 0.21 | T | 1.749 | 28 | - | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

*Significant at 0.05 level of confidence

The mean value and standard deviation of high and low achievers on speed are 4.89 \pm 0.24 and 5.09 \pm 0.21 respectively. Levene's test has shown that the variance is not significant since $p = 0.606$. So Homogeneity of variance is assumed. The results of the ANOVA on speed showed a significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 8*). Since the obtained F ratio of 5.178 is greater than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is accepted since $p > 0.05$.

Inference

It can be concluded that there is a significant difference between the high and low achiever on speed. From the mean value it was observed that high achievers are found to be greater in speed than low achievers which can be confirmed by graphical presentation in Figure 6.

Figure 6
Speed of high and low achievers field hockey players

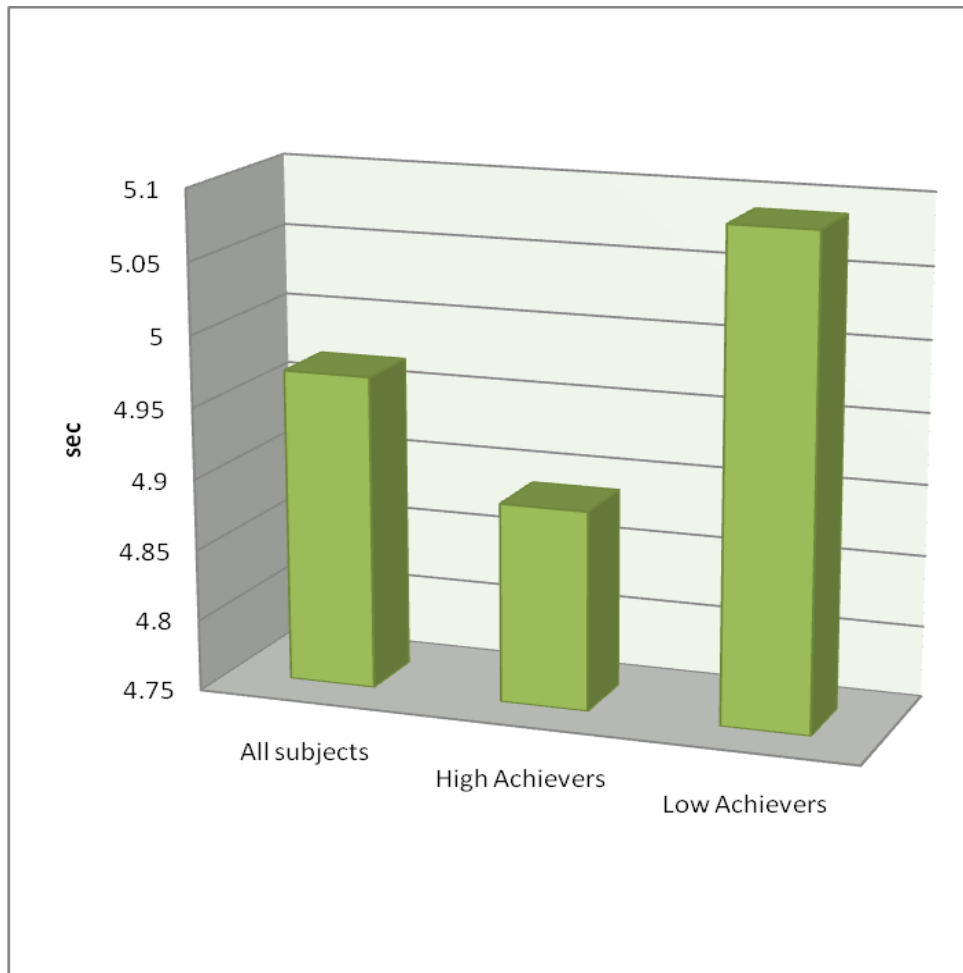


Table 9

Mean (*sd*) and results of ANOVA for power among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|------------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 194.65 \pm 16.49 | B | 249.120 | 1 | 249.120 | .913 | .348 |
| High achievers (17) | 197.11 \pm 15.39 | W | 7367.431 | 27 | 272.868 | | |
| Low achievers (12) | 191.16 \pm 18.03 | T | 7616.552 | 28 | - | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on power are 197.11 \pm 15.39 and 191.16 \pm 18.03 respectively. Levene's test has shown that the variance is not significant since $p = 0.451$. So Homogeneity of variance is assumed. The results of the ANOVA on power showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 9*). Since the obtained F ratio of 0.913 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on power. From the mean value it was observed that high achievers are found to be greater in power than low achievers which can be confirmed by graphical presentation in Figure 7.

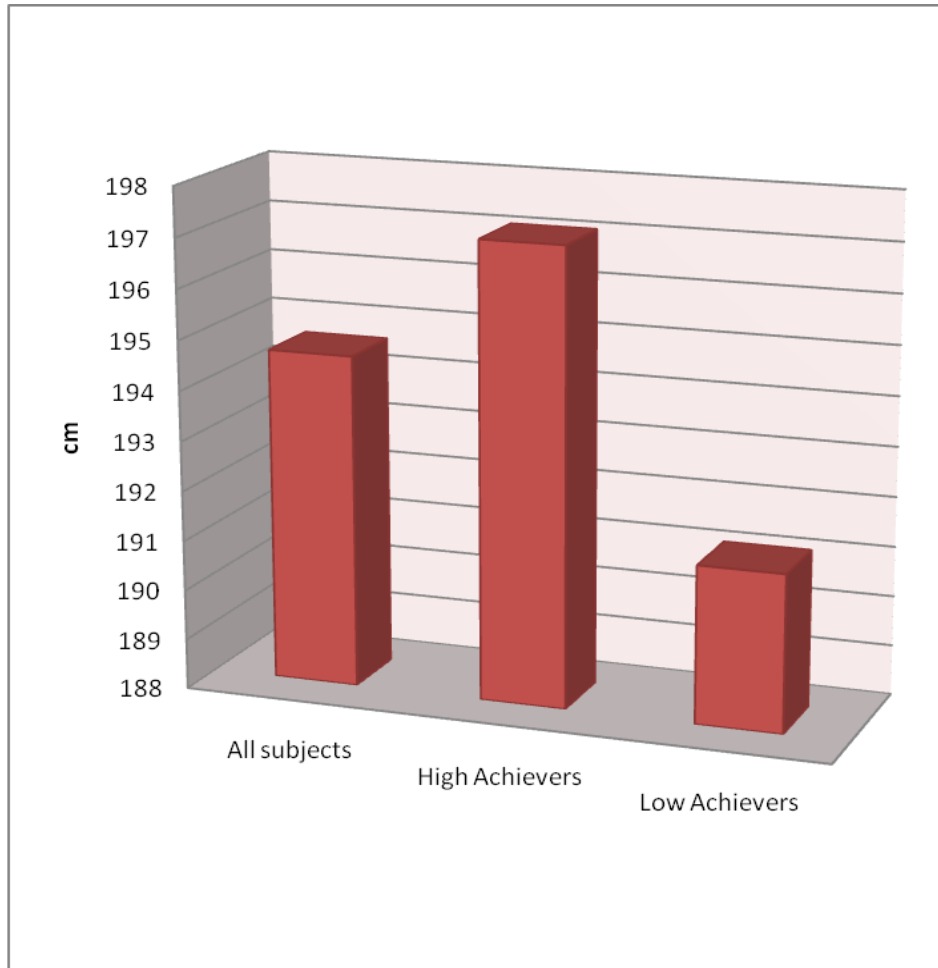
Figure 7**Power of high and low achievers field hockey players**

Table 10

Mean (*sd*) and results of ANOVA for agility among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 17.58 \pm 0.99 | B | .977 | 1 | .977 | .983 | .330 |
| High achievers (17) | 17.42 \pm 0.98 | W | 26.846 | 27 | .994 | | |
| Low achievers (12) | 17.79 \pm 1.01 | T | 27.824 | 28 | - | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on agility are 17.42 \pm 0.98 and 17.79 \pm 1.01 respectively. Levene's test has shown that the variance is not significant since $p = 0.696$. So Homogeneity of variance is assumed. The results of the ANOVA on agility showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 10*). Since the obtained F ratio of 0.983 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on agility. From the mean value it was observed that high achievers are found to be greater in agility than low achievers which can be confirmed by graphical presentation in Figure 8.

Figure 8
Agility of high and low achievers field hockey players

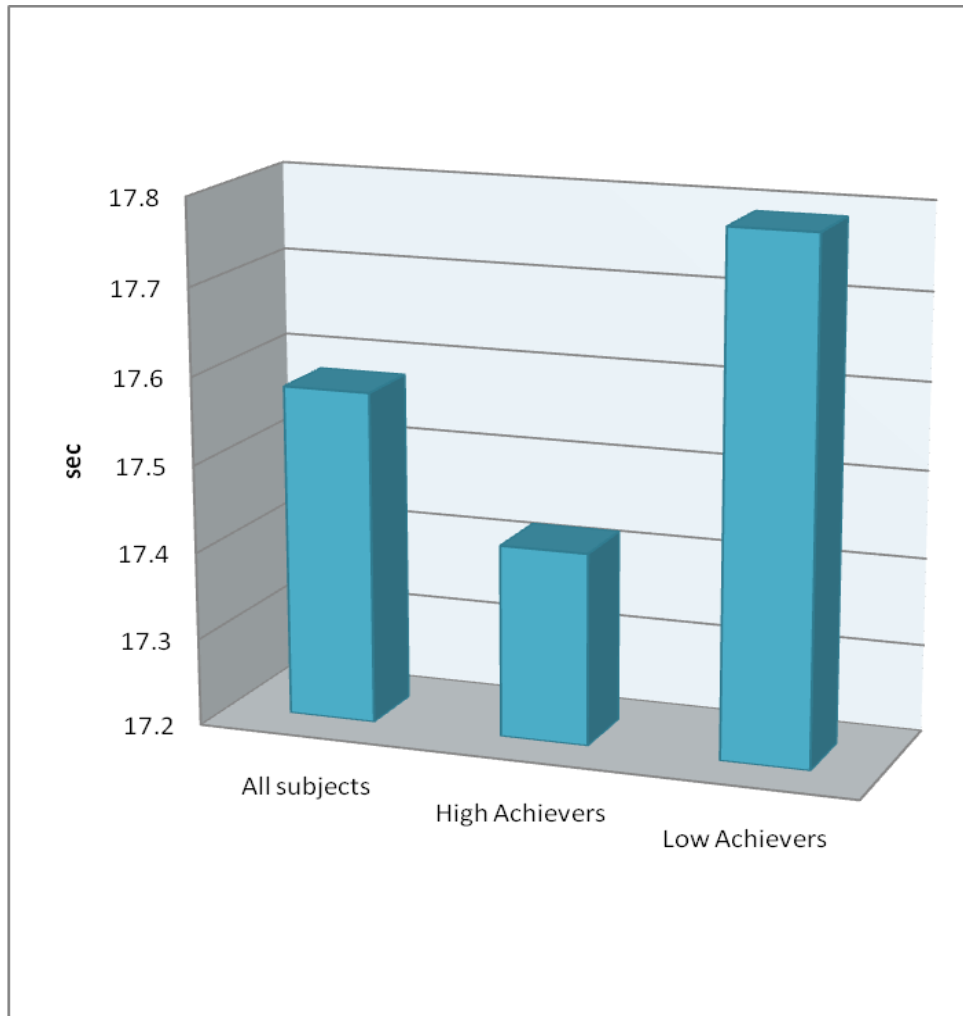


Table 11

Mean (*sd*) and results of ANOVA for flexibility among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 12.45 \pm 5.39 | B | 25.055 | 1 | 25.055 | 1.082 | .307 |
| High achievers (17) | 12.57 \pm 4.95 | W | 625.152 | 27 | 23.154 | | |
| Low achievers (12) | 12.39 \pm 6.19 | T | 650.207 | 28 | - | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on flexibility are 12.57 \pm 4.95 and 12.39 \pm 6.19 respectively. Levene's test has shown that the variance is not significant since $p = 0.245$. So Homogeneity of variance is assumed. The results of the ANOVA on flexibility showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 11*). Since the obtained F ratio of 0.000 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on flexibility. From the mean value it was observed that high achievers and low achievers performed similarly in flexibility which can be confirmed by graphical presentation in Figure 9.

Figure 9
Flexibility of high and low achievers field hockey players

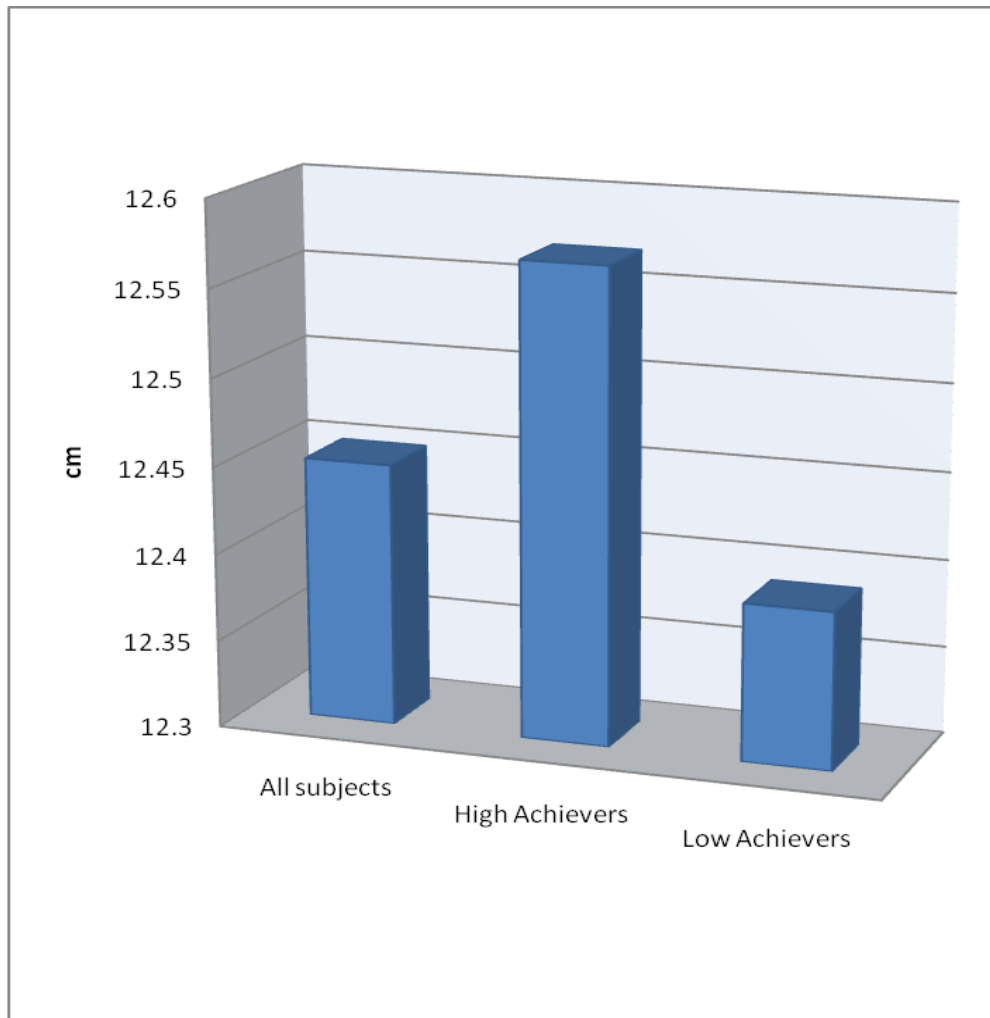


Table 12

Mean (*sd*) and results of ANOVA for back strength among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 82.44 \pm 18.11 | B | 1892.447 | 1 | 1892.447 | 7.001* | .013 |
| High achievers (17) | 89.23 \pm 17.55 | W | 7298.725 | 27 | 270.323 | | |
| Low achievers (12) | 72.83 \pm 14.66 | T | 9191.172 | 28 | | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

* Significant at 0.05 level of confidence

The mean value and standard deviation of high and low achievers on back strength are 89.23 \pm 17.55 and 72.83 \pm 14.66 respectively. Levene's test has shown that the variance is not significant since $p = 0.452$. So Homogeneity of variance is assumed. The results of the ANOVA on back strength showed a significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 12*). Since the obtained F ratio of 7.001 is greater than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is accepted since $p > 0.05$.

Inference

It can be concluded that there is a significant difference between the high and low achiever on back strength. From the mean value it was observed that high achievers are found to be greater in back strength than low achievers which can be confirmed by graphical presentation in Figure 10.

Figure 10
Back strength of high and low achievers field hockey players

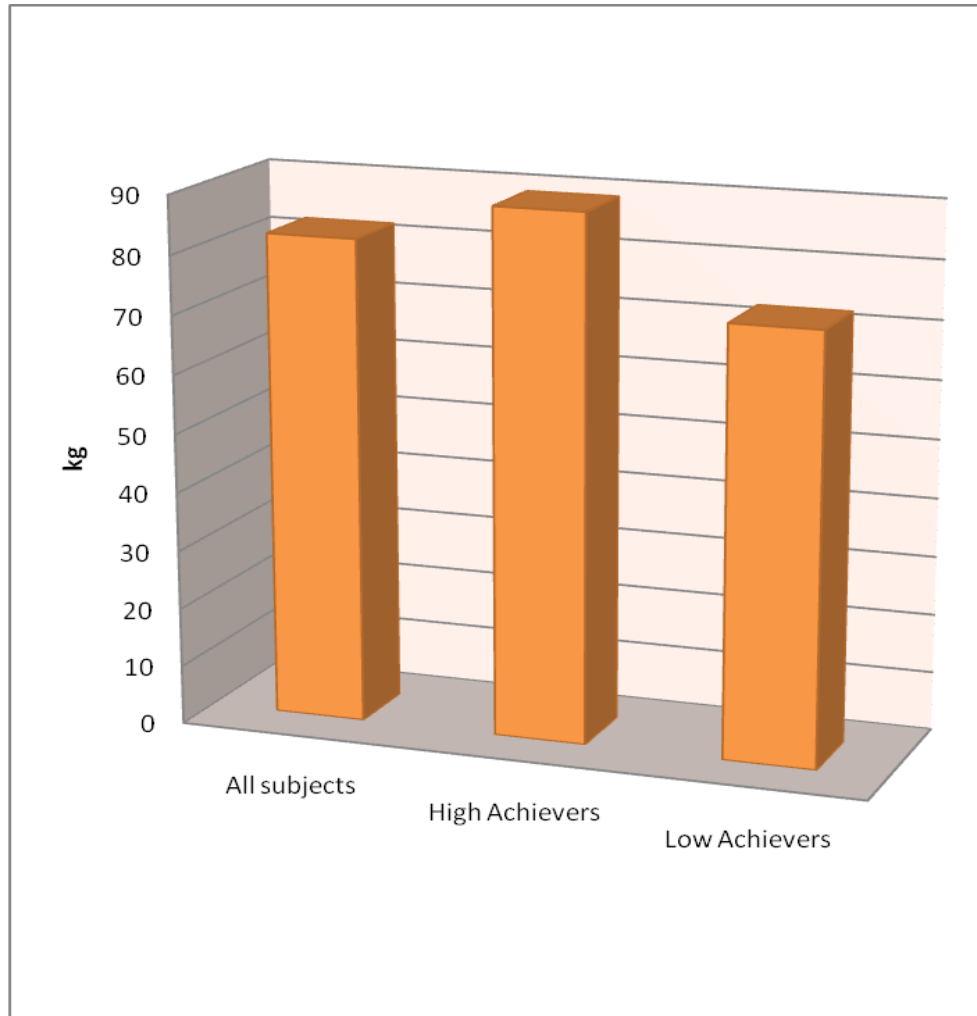


Table 13

**Results of ANOVA for shoulder strength among field hockey players
classified by level of performance**

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 22.06 \pm 4.30 | B | 50.391 | 1 | 50.391 | 2.910 | .099 |
| High achievers (17) | 23.17 \pm 4.17 | W | 467.471 | 27 | 17.314 | | |
| Low achievers (12) | 20.50 \pm 4.14 | T | 517.862 | 28 | - | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on shoulder strength are 23.17 \pm 4.17 and 20.50 \pm 4.14 respectively. Levene's test has shown that the variance is not significant since $p = 0.525$. So Homogeneity of variance is assumed. The results of the ANOVA on shoulder strength showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 13*). Since the obtained F ratio of 2.910 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on shoulder strength. From the mean value it was observed that high achievers are found to be greater in shoulder strength than low achievers which can be confirmed by graphical presentation in Figure 11.

Figure 11
Shoulder strength of high and low achievers field hockey players

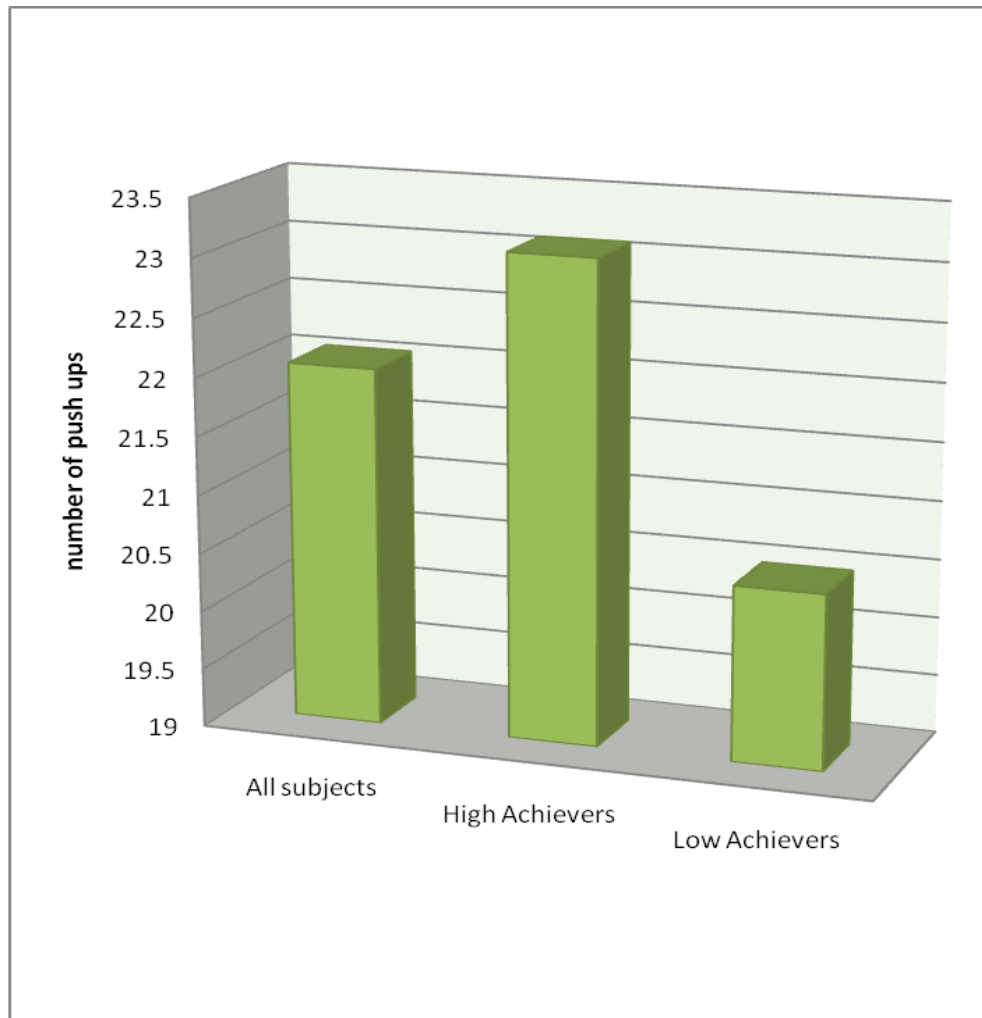


Table 14

Mean (*sd*) and results of ANOVA for abdominal strength among field hockey players classified by level of performance

| Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Total subjects (29) | 22.62 \pm 4.27 | B | 15.519 | 1 | 15.519 | .846 | .366 |
| High achievers (17) | 23.23 \pm 4.13 | W | 495.309 | 27 | 18.345 | | |
| Low achievers (12) | 21.75 \pm 4.49 | T | 510.828 | 28 | - | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

The mean value and standard deviation of high and low achievers on abdominal strength are 23.23 \pm 4.13 and 21.75 \pm 4.49 respectively. Levene's test has shown that the variance is not significant since $p = 0.920$. So Homogeneity of variance is assumed. The results of the ANOVA on abdominal strength showed no significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 14*). Since the obtained F ratio of 0.846 is less than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is rejected since $p < 0.05$.

Inference

It can be concluded that there is no significant difference between the high and low achiever on abdominal strength. From the mean value it was observed that high achievers are found to be greater in abdominal strength than low achievers which can be confirmed by graphical presentation in Figure 12.

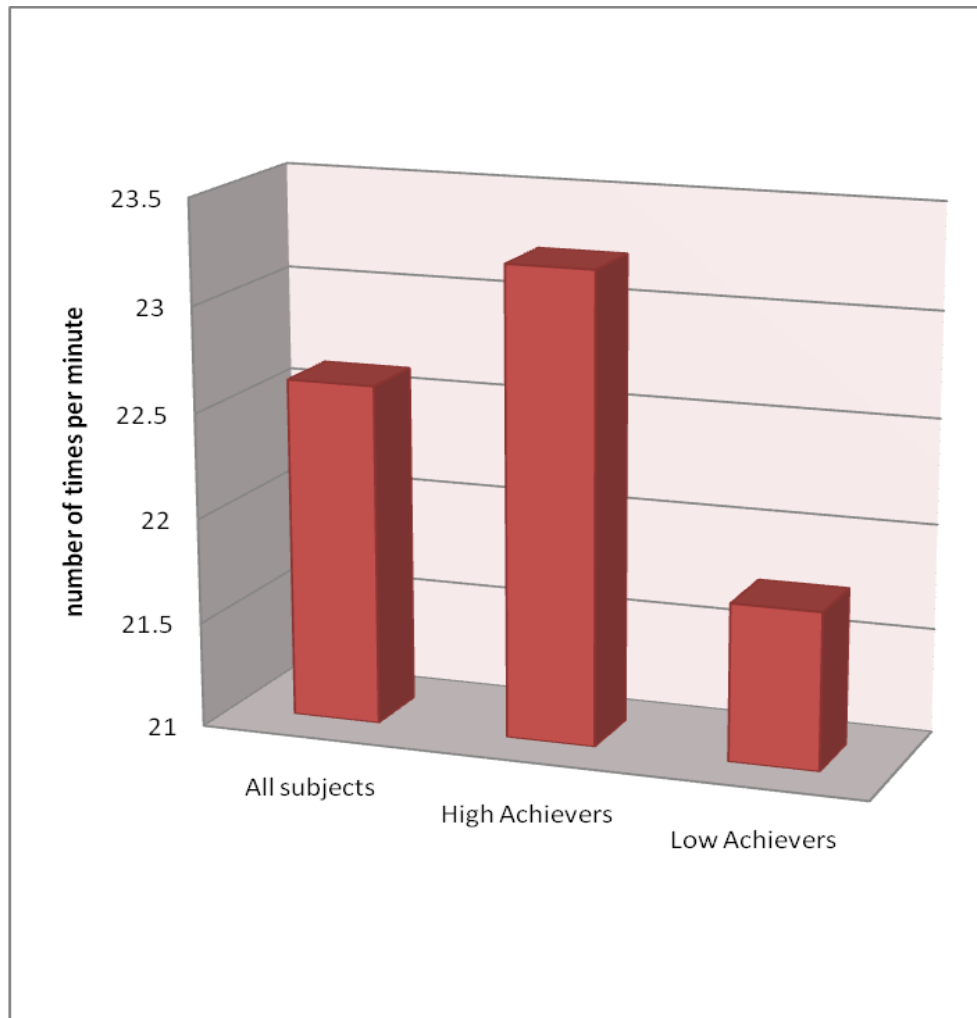
Figure 12**Abdominal strength of high and low achievers field hockey players**

Table 15

Mean scores (*sd*) and ANOVA of grip strength of field hockey players classified by level of performance

| | Groups | Mean \pm <i>sd</i> | SOV | Sum of square | df | Mean square | F ratio | <i>P</i> value |
|--------------------------|---------------------|----------------------|-----|---------------|----|-------------|---------|----------------|
| Left hand grip strength | Total subjects (29) | 30.03 \pm 6.68 | B | 319.578 | 1 | 319.578 | 9.264* | .005 |
| | High achievers (17) | 32.82 \pm 6.61 | W | 931.387 | 27 | 34.496 | | |
| | Low achievers (12) | 26.08 \pm 4.58 | T | 1250.966 | 28 | | | |
| Right hand grip strength | Total subjects (29) | 29.27 \pm 7.62 | B | 388.994 | 1 | 388.994 | 8.478* | .007 |
| | High achievers (17) | 32.35 \pm 7.76 | W | 1238.799 | 27 | 45.881 | | |
| | Low achievers (12) | 24.91 \pm 4.99 | T | 1627.793 | 28 | | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

* Significant at 0.05 level of confidence

The mean value and standard deviation of high and low achievers on left and right hand grip strength are 32.82 \pm 6.61, 26.08 \pm 4.58; 32.35 \pm 7.76 and 24.91 \pm 4.99 respectively. Levene's test for left and right hand grip strength has shown that the variance is not significant since $p = 0.075$ and 0.068. So Homogeneity of variance is assumed.

The results of the ANOVA on left and right hand grip strength showed a significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 15*). Since the obtained F ratio of 9.264 and 8.478 is greater than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is accepted since $p > 0.05$.

Inference

It can be concluded that there is a significant difference between the high and low achiever on left and right hand grip strength. From the mean value it was observed that high achievers are found to be greater in left and right hand grip strength than low achievers which can be confirmed by graphical presentation in Figure 13.

Figure 13
Left and right hand grip strength of high and low achievers field hockey players

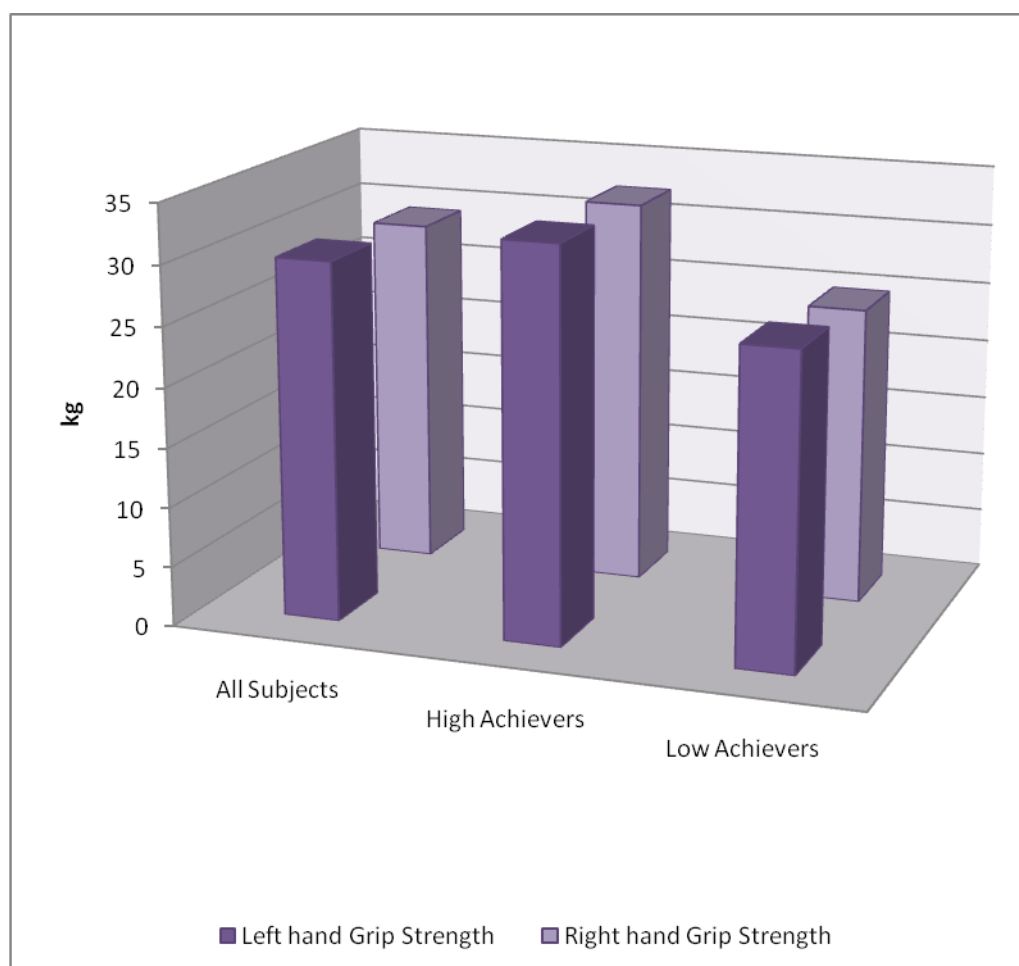


Table 16

Results of ANOVA for aerobic capacity among field hockey players classified by level of performance

| Groups | Mean \pm sd | SOV | Sum of square | df | Mean square | F ratio | P value |
|---------------------|------------------|-----|---------------|----|-------------|---------|---------|
| Total subjects (29) | 58.19 \pm 3.27 | B | 48.282 | 1 | 48.282 | 5.166* | .031 |
| High achievers (17) | 59.28 \pm 3.38 | W | 252.350 | 27 | 9.346 | | |
| Low achievers (12) | 56.66 \pm 2.51 | T | 300.632 | 28 | | | |

SOV – Source of variance, B – Between groups, W – Within groups, T – Total

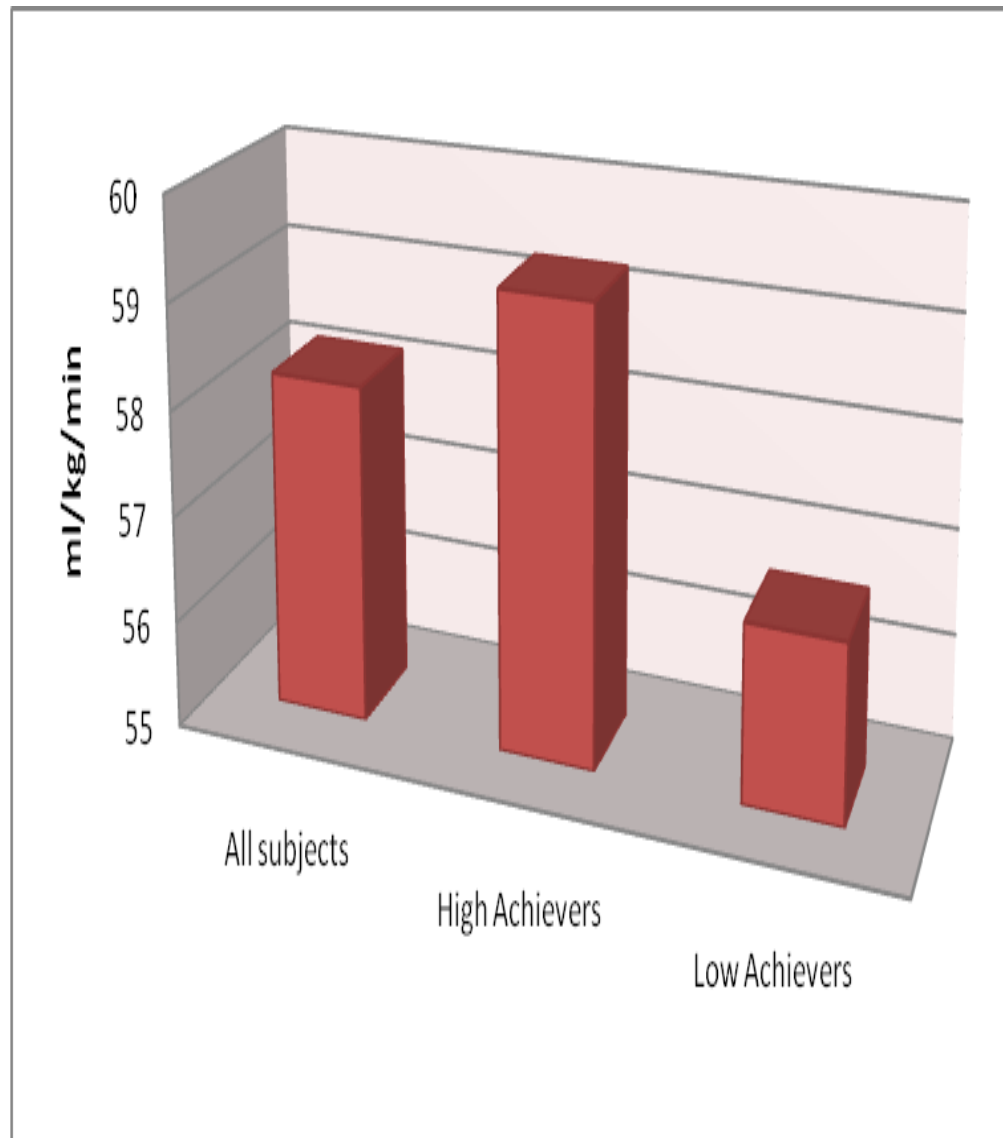
* Significant at 0.05 level of confidence

The mean value and standard deviation of high and low achievers on aerobic capacity are 59.28 \pm 3.38 and 56.66 \pm 2.51 respectively. Levene's test has shown that the variance is not significant since $p = 0.230$. So Homogeneity of variance is assumed. The results of the ANOVA on aerobic capacity showed a significant difference between high and low achievers field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh (*see Table 16*). Since the obtained F ratio of 5.166 is greater than the required table value of 4.20 at $\alpha = 0.05$ for the df of 1 and 27. Hence the null hypothesis is accepted since $p > 0.05$.

Inference

It can be concluded that there is a significant difference between the high and low achiever on aerobic capacity. From the mean value it was observed that high achievers are found to be greater in aerobic capacity than low achievers which can be confirmed by graphical presentation in Figure 14.

Figure 14
Aerobic capacity of high and low achievers field hockey players



In order to realize the criterion variables that contribute to the classification of players as high achievers and low achievers, discriminant analysis was appraised, and thereby unstandardized canonical discriminant function coefficients is used to derive the regression equation that classifies players to the categories namely: high achievers and low achievers based on their basal characteristics. Further, multiple correlation was computed to know the collective influence of determinants on level of achievement and then multiple regression equation was derived.

Table 17
Regression analysis of data on selected criterion variables

| Step | Number of Variables | Variable | Tolerance | F to Remove | Wilks' Lambda |
|------|---------------------|--------------------|-----------|-------------|---------------|
| 1 | 1 | Left Grip Strength | 1.000 | 9.264 | |
| 2 | 2 | Left Grip Strength | .828 | 12.540 | .985 |
| | | Weight | .828 | 3.131 | .745 |
| 3 | 3 | Left Grip Strength | .770 | 7.553 | .827 |
| | | Weight | .822 | 2.478 | .698 |
| | | Aerobic Power | .929 | 1.162 | .665 |
| 4 | 4 | Left Grip Strength | .702 | 3.441 | .665 |
| | | Weight | .820 | 1.943 | .629 |
| | | Aerobic Power | .752 | 2.512 | .643 |
| | | Mesomorphy | .782 | 2.192 | .635 |
| 5 | 5 | Left Grip Strength | .623 | 5.370 | .616 |
| | | Weight | .811 | 2.148 | .546 |
| | | Aerobic Power | .524 | 5.695 | .623 |
| | | Mesomorphy | .626 | 4.591 | .599 |
| | | Sit-ups | .508 | 3.804 | .582 |
| 6 | 6 | Left Grip Strength | .611 | 3.637 | .540 |
| | | Weight | .075 | 2.878 | .524 |
| | | Aerobic Power | .523 | 4.707 | .563 |
| | | Mesomorphy | .250 | 5.758 | .585 |
| | | Sit-ups | .500 | 4.047 | .549 |
| | | Height | .065 | 1.692 | .499 |

In the above table, the tolerance level is a measure of linear dependency between one variable and others. The tolerance value of $< .001$ indicates high level of linear dependency, which will prevent that variable from entering into the equation. The above table shows which variables were included in the final discriminant function. The variables included in the analyses have higher the acceptable tolerance level (.001) and have F values greater than 1.15. Wilks' Lambda is a step wise operation that is based on minimizing the Wilks' Lambda after each new variable has been entered into the regression equation. The criteria for entry into regression equation is $F > 1.15$ and the criteria for removal from equation once a variable has been entered if its contribution to the equation drops below a designated level of $F < 1.00$. Wilks' Lambda is designed to indicate whether a particular variable contributes significantly to explaining additional variance in the dependent variable.

The table 17 further reveals the number of variables in the discriminant equation at each step. Thereby, the multivariate analysis of included variables in the analyses is tested for significance, and it is not the variance of each new variable's unique contribution.

Table 18
Test of equality of group covariance matrices using Box's M

| GROUP | | Rank | Log Determinant | Box's M | Approx. F | df1 | df2 | Sig. |
|----------------------|----------------|------|-----------------|---------|-----------|-----|----------|------|
| 1.00 | High Achievers | 6 | 12.423 | 44.117 | 1.561 | 21 | 2056.766 | .050 |
| 2.00 | Low Achievers | 6 | 7.736 | | | | | |
| Pooled within-groups | | 6 | 12.148 | | | | | |

Table 18 reveals the test of the multivariate normality of the data. The Rank (6) of the covariance matrix indicates that this is a 6 x 6 matrix, the number of variables in the discriminant equation. The natural log of the determinant of high achievers and low achievers covariance matrices is 12.423 and 7.736 respectively. Pooled within groups covariance matrix composed of the means of each corresponding value within the two 6 x 6 matrices of the high achievers and low achievers groups is 12.148.

The Box's M value of 44.117 is a measure of multivariate normality, based on the similarities of the determinants of the covariance matrices for the high achievers and low achievers groups. The approximate F value of 1.561 reveals that the determinants from the two levels of the dependent variable (*high and low achievers*) didn't differ considerably as the significance value is 0.05, and thereby it suggests that the obtained data is found to be multivariate normal.

Table 19
Analysis of unstandardized canonical discriminant
function coefficients

| Variable | Coefficient |
|--------------------|-------------|
| Height | .173 |
| Weight | -.265 |
| Sit-ups | -.178 |
| Mesomorphy | 1.647 |
| Left Grip Strength | .112 |
| Aerobic Power | .259 |
| (Constant) | -36.004 |

Table 19 shows the list of coefficients and the constant of the discriminant equation. Each subject's discriminant score would be computed by entering their variable values for each of the 6 variables in the equation. The discriminant equation was as follows:

$$\begin{aligned}
 D = & -36.004 + 0.173 (\text{Height}) - 0.265 (\text{Weight}) - 0.178 (\text{Sit-ups}) \\
 & + 1.647 (\text{Mesomorphy}) + 0.112 (\text{Left Grip Strength}) \\
 & + 0.259 (\text{Aerobic Power})
 \end{aligned}$$

Table 20
Eigenvalues and Wilks' Lambda

| Eigen value | % of Variance | Cumulative % | Canonical Correlation | Test of Function | Wilks' Lambda | Chi-square | df | Sig. |
|-------------|---------------|--------------|-----------------------|------------------|---------------|------------|----|------|
| 1.157(a) | 100.0 | 100.0 | .732 | 1 | .464 | 18.449 | 6 | .005 |

a First 1 canonical discriminant functions were used in the analysis.

The Eigen value of 1.157 is the proportion of variance explained by each factor for the first (1) canonical discriminant function. The % of variance and cumulative % of the function always accounts for 100%. The correlation between high achievers and low achievers for discriminant scores is high as the obtained canonical correlation of 0.732 is higher than the table value of 0.367 required for significance at df 27 and 2, which indicates that canonical discriminant function discriminates the two different levels of dependent variables (*high achievers and low achievers*) well.

To conduct a discriminant analysis that predicts membership into two groups based on the dependent variable categories (*high & low achievers*) and creating the discriminant equation with inclusion 6 of 18 independent variables selected by step wise procedure based on the minimization of Wilks' lambda at each step with an F-to-enter of 1.15 and an F-to-remove of 1.00.

The Chi-square value of 18.449 denotes that there is a significant difference between high achievers and low achievers based on the discriminant function.

Table 21
Functions at group centroids

| GROUPS | Function |
|----------------|----------|
| | 1 |
| High Achievers | .872 |
| Low Achievers | -1.235 |

Table 21 reveals the unstandardized canonical discriminant functions evaluated at group means. The high achievers and low achievers mean values for the function 1 were 0.872 and – 1.235 respectively.

Figure 15

Graphical illustration of discriminant scores of high achievers

Canonical Discriminant Function 1

GROUPS = High Achievers

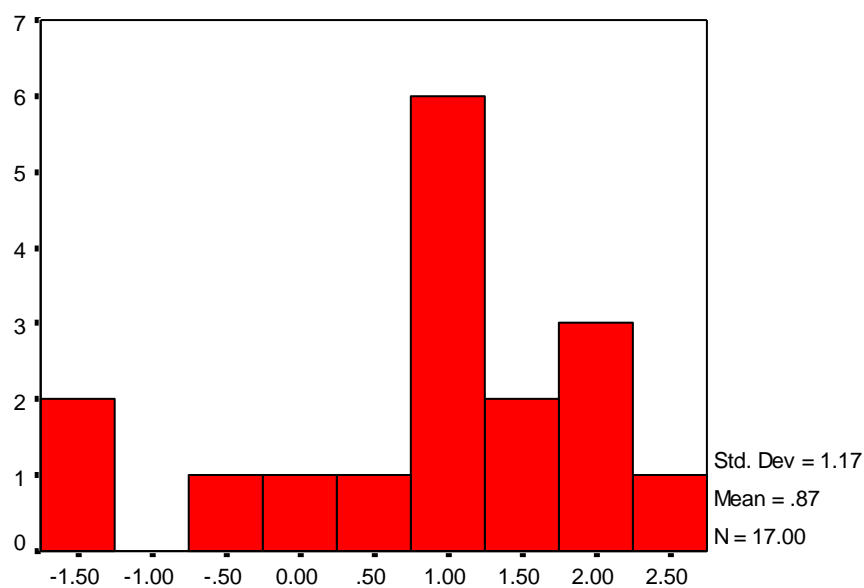


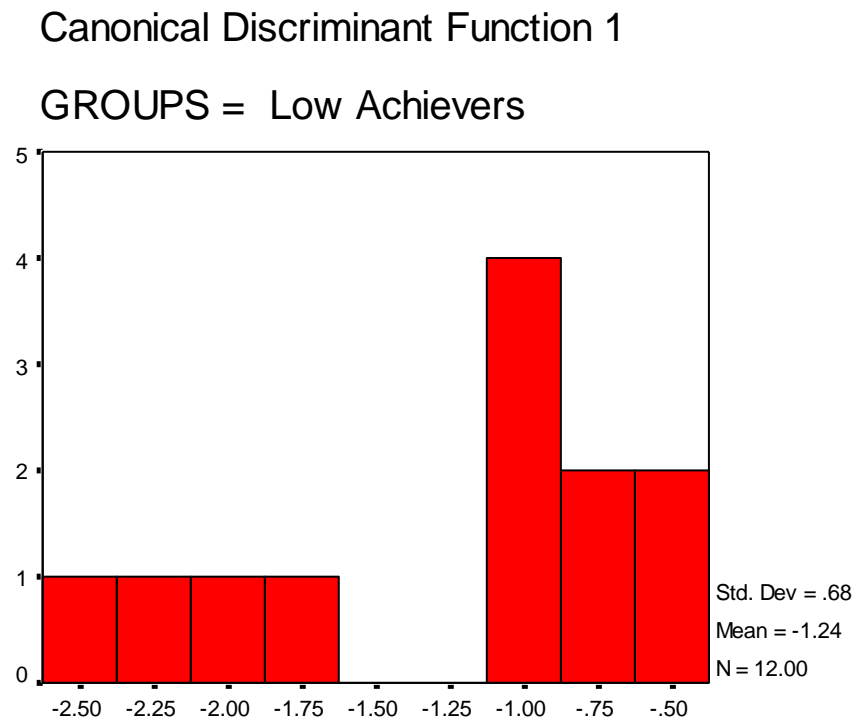
Figure 16**Graphical illustration of discriminant scores of low achievers**

Table 22

Casewise statistics information about group membership for each subjects, probability of group membership and discriminant scores

| Subject Number | Actual Group | Predicted Group | Squared Mahalanobis Distance to Centroid | Discriminant Scores |
|----------------|--------------|-----------------|--|---------------------|
| | | | | Function 1 |
| 1 | 1 | 2** | 6.639 | -1.705 |
| 2 | 1 | 1 | 5.369 | 1.082 |
| 3 | 1 | 1 | 4.209 | 0.816 |
| 4 | 1 | 1 | 4.292 | 0.836 |
| 5 | 1 | 1 | 10.416 | 1.992 |
| 6 | 1 | 1 | 4.079 | 0.784 |
| 7 | 1 | 1 | 8.693 | 1.713 |
| 8 | 1 | 1 | 10.759 | 2.045 |
| 9 | 1 | 1 | 3.562 | 0.652 |
| 10 | 1 | 1 | 2.200 | 0.248 |
| 11 | 1 | 1 | 4.480 | 0.881 |
| 12 | 1 | 2** | 5.034 | -1.372 |
| 13 | 1 | 1 | 13.780 | 2.477 |
| 14 | 1 | 1 | 5.169 | 1.038 |
| 15 | 1 | 2** | 1.677 | -0.423 |
| 16 | 1 | 1 | 8.693 | 1.713 |
| 17 | 1 | 1 | 10.759 | 2.045 |
| 18 | 2 | 2 | 6.423 | -1.662 |
| 19 | 2 | 2 | 3.719 | -1.056 |
| 20 | 2 | 2 | 1.950 | -0.524 |
| 21 | 2 | 2 | 3.685 | -1.048 |
| 22 | 2 | 2 | 8.753 | -2.086 |
| 23 | 2 | 2 | 1.677 | -0.423 |
| 24 | 2 | 2 | 9.321 | -2.181 |
| 25 | 2 | 2 | 10.811 | -2.416 |
| 26 | 2 | 2 | 2.395 | -0.675 |
| 27 | 2 | 2 | 3.646 | -1.037 |
| 28 | 2 | 2 | 2.395 | -0.675 |
| 29 | 2 | 2 | 3.646 | -1.037 |

** Misclassified Subjects

In table 22, the subjects numbered 1, 12 & 15 actually belong to the group membership of high achievers, but the analysis predicts them to be in the group membership of low achievers based on their respective discriminant scores of -1.705 , -1.372 and -0.423 .

The discriminant score of the data collected for high achievers and low achievers is illustrated in the scatter plot as presented in figure 17.

Figure 17

Graphical illustration of discriminant scores

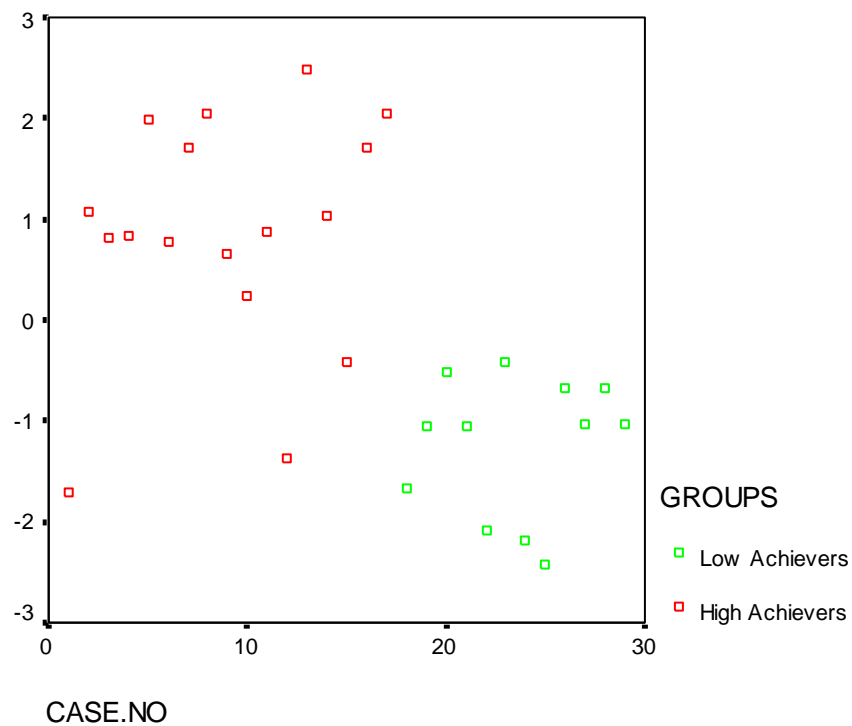


Table 23
Classification results

| | | GROUPS | Predicted Group Membership | | Total |
|----------|-------|----------------|----------------------------|---------------|-------|
| | | | High Achievers | Low Achievers | |
| Original | Count | High Achievers | 14 | 3 | 17 |
| | | Low Achievers | 0 | 12 | 12 |
| | % | High Achievers | 82.4 | 17.6 | 100.0 |
| | | Low Achievers | .0 | 100.0 | 100.0 |

Table 23 summarizes the number and percentage of subjects classified correctly and incorrectly as high achievers and low achievers. It is found that fourteen (14) of seventeen (17) subjects classified as high achievers is correct, while three (3) of them were incorrect as the analysis predicts them to be as low achievers. Furthermore, it is found that all the twelve (12) subjects classified as low achievers were correct. Thereby 89.7% of original grouped cases (*subjects*) were correctly classified.

Discussion on Findings

Since the ancient times, it has been believed that a suitable physique is important to achieve success in particular sports (Powers & Howley, 1997). Judging the performance of the human body by its size, shape and form has been a topic of great concern. In the present day of tough competition, when scientific

principles are applied for training of athletes, the size, the shape and the form of the body coupled with its efficiency in performance have been given more importance especially from the point of view of identifying, selecting and developing the talent in sports (Khanna *et al.*, 1992; Reilly *et al.*, 1990). Recent researches in this field of sports sciences have clearly established that various physical activities demand different body size and proportions that is why top level sports men of different sportive events have been found to possess different physique and morphologic characteristics (Singh *et al.*, 2003). The present work compared the morphophysiological and biomotor variables in a sample of field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh, India.

Anthropometry

The result of the study showed that there is no significant difference between high and low achievers hockey players from RDT Hockey Academy on height and weight, it indicates that groups are closely linked to one another. The result showed that low achievers are taller and heavier than high achievers. According to Mignardi and Ruscello, (1993) stated that height does not seem to have a crucial role in performance and in selection of the field hockey players. However, one of the important issues for the sportsmen is the amount of weight their body can bear without affecting their performance and the excess of fat, which is harmful in terms of performance.

Several studies from Hungary stated that when athletes are grouped by their athletic (*sport*) performance, no significant differences can be observed between their height and body mass. A similar finding is obtained in our study.

This finding is in par with some (Eiben *et al.* 1977; Mészáros *et al.* 1980; Szmodis & Mészáros 1980; Szabó & Mészáros 1980; Mohácsi & Mészáros 1982, 1986; Szabó *et al.* 1984; Famosi 1985, 1986; Famosi *et al.* 1987) of the earlier studies.

Body Composition

The estimation of body composition permits the quantification of gross size of an individual into two major structural components namely fat mass and lean body mass (Durnin & Womersley, 1947; Siri, 1956). This accurate appraisal provides an important baseline to develop an effective training program. The body composition especially in an athlete is a better guide for determining the desirable weight rather than using the standard height-weight-age table of normal population due to the presence of high proportions of muscular content their total body composition (Beunen & Malina, 1988; Reilly *et al.*, 1990). In addition, body fat plays an important role for the assessment of physical fitness of the players.

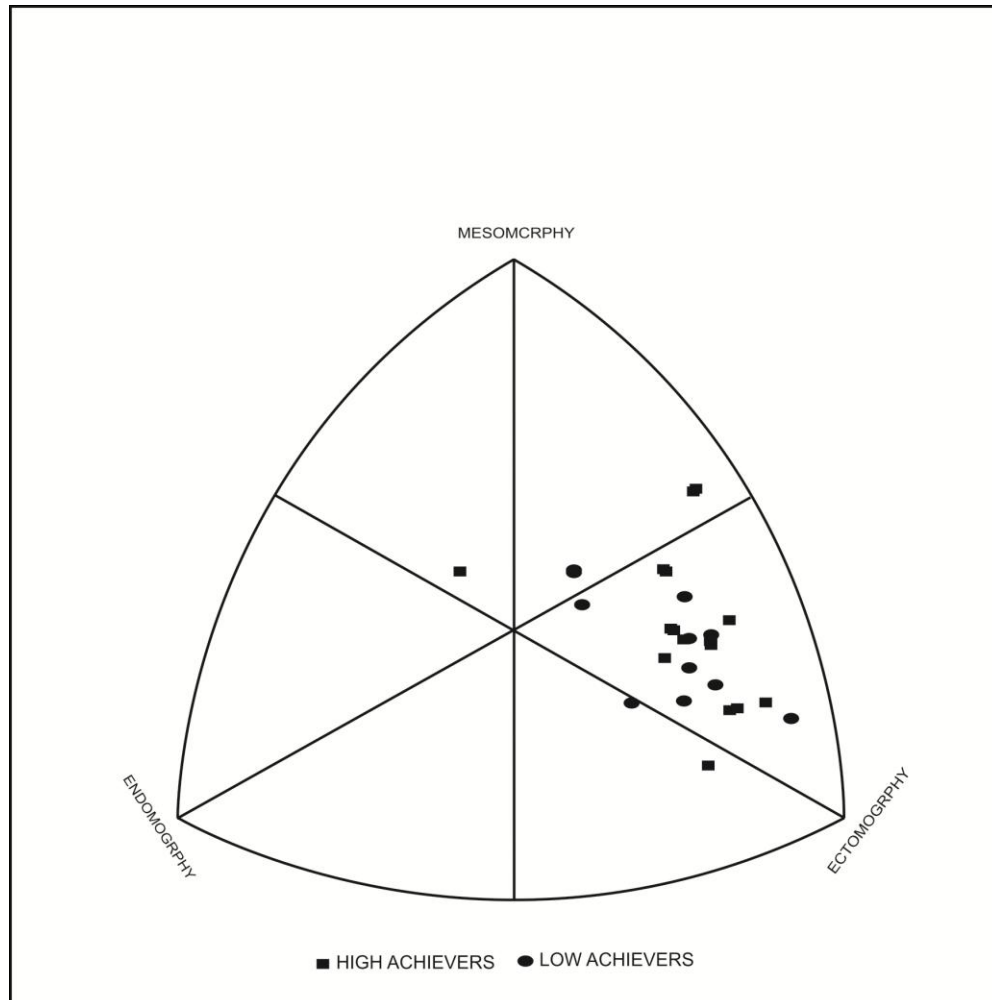
The present data of percent body fat accords with the proposal that percent body fat value among high and low achievers hockey players should be within the range of 6-14% and 6-15%, respectively (Wilmore & Costill, 1999). Percent body fat level of high achievers is 7.65 and low achiever is 9.81. As mentioned earlier low achiever is heavier than high achievers thereby their percent body fat level is higher than high achievers. The percent body fat content is greater in low achievers will act as a hindrance in their performance (Bandyopadhyay, 2007; Bandyopadhyay & Chatterjee, 2003; Chatterjee *et al.*, 2005).

The high achievers (40.00) lean body mass is greater than low achievers (35.99), who will therefore achieve better performance since the more the lean body mass the greater will be the energy output and the higher will be the cardiorespiratory fitness (Bandyopadhyay, 2007; Bandyopadhyay & Chatterjee, 2003; Chatterjee *et al.*, 2005). These are the two reasons for differentiating RDT hockey academy players as high and low achievers on performance aspect: greater percent body fat and lower lean body mass existing among low achievers.

Somatotype

Heath and Carter defined somatotype as the current physical characteristics of an individual. It is an explicit shape regardless of the body size. It describes the specific body shapes and the comparative body components. Moreover, somatotype may change. Somatotype is determined as the characteristics of the exterior figuration and the physique style. It is a precise summary and evaluation of the overall figuration features. In other words, body shape type or somatotype is a general descriptor of physical appearance and it is defined as the quantification of the present shape and composition of the human body.

In this study, somatotype values of the field hockey players from RDT Hockey Academy, Anantapur, Andhra Pradesh, are determined as 1.68 - 3.19 - 4.72 (*mesomorphic ectomorph*); the value of high achievers group as 1.53 - 3.39 - 4.66 (*mesomorphic ectomorph*); and the values of the low achievers group as 1.90 - 2.90 - 4.80 (*mesomorphic ectomorph*).

Figure 18**Somatotype of high and low achievers hockey players**

The somatotype of high and low achievers is mesomorphic ectomorph because ectomorphy is dominant, with mesomorph second in dominance (*Figure 18*). McArdle, *et al.*, (1986) and Toriola, *et al.*, (1985) stated that sportsmen have mesomorphic—ectomorph scores. Similar somatotypes are seen in RDT hockey academy players. In this study, it is also found that no significant difference was elicited in between high and low achievers in somatotype components.

Biomotor variables

Speed, power, agility and flexibility

Match analyses at the elite level make clear that field hockey is a high intensity non-continuous game in which the physiological demands are considerable, placing it in the category of 'heavy exercise' (Ghosh *et al.*, 1991; Reilly & Borrie, 1992). Physiological components of expertise include aerobic and anaerobic capacity (Wilmore & Costill, 1999). Specific for field hockey is the intermittent running, e.g. the alternation of accelerating and decelerating, and the many changes of direction while sprinting (Patel *et al.*, 2002; Spencer *et al.*, 2004). In this study high achievers found to better when compared to low achievers in speed. Conversely the body mass of high achievers found to low when compared with low achievers. This difference might have influenced by low percent body fat and greater lean body mass seen in high achievers when compared to low achievers.

Reilly *et al.* (2000) indicated that measures of agility, speed, and power were the most important indicators of talent in soccer. These findings are in line with Deshaies *et al.* (1979), who made clear that anaerobic power, speed, agility successfully discriminated between elite and sub-elite ice-hockey players. In our study, speed measures distinguished most clearly between the two groups of talented field hockey players. The analyses revealed that the groups could be discriminated on the basis of stature and body mass. In this study, high achievers tended to be shorter and lighter than the low achievers, one cannot rule out that

the most mature children were performing best at this age, since no maturity measures were taken.

The sit and reach test is used to determine the joint range of motion and flexibility of the muscles around the hip joint (*the test simultaneously examines the flexibility of the lower back and hamstrings*). The reliability of the test has been documented previously (Johnson & Nelson, 1979). Flexibility was important to the hockey players and good flexibilities helped to reduce injuries. The result of the study showed that no difference is elicited between high and low achievers in flexibility of the muscles around the hip joint. Chin *et al.* (1992) stated that the poor flexibility of the players indicated their tight hamstrings which might be caused by the training program.

Strength

Strength is the central component of a field hockey training program (Ebben *et al.*, 2004; Spencer *et al.*, 2004; 2005). Upper body strength allows players to shoot more powerfully and pass over a greater range of distances. In field hockey grip strength may have importance in handling the stick during execution of different skills in practice and competition. Many activities in field hockey are forceful and explosive (*e. g. tackling, jumping, hitting the ball, turning and changing pace*). The power output during such activities is related to the strength of the muscles involved in the movements. Thus, it might be beneficial for a hockey player to have a high muscular strength, which also diminishes the risk of injury (Reilly & Borrie, 1992; Gorger *et al.*, 2001). The results of the present study have shown a significant difference in back and grip muscles

between high and low achievers field hockey players. Similar observation has been reported by many researchers (Ebben *et al.*, 2004; Spencer *et al.*, 2004; 2005).

Aerobic capacity

Aerobic capacity certainly plays an important role in modern field hockey and has a major influence on technical performance and tactical choices. The present study showed a difference between high and low achievers hockey players in aerobic capacity ($VO_2\text{max}$). The high achievers show greater aerobic capacity than low achievers field hockey players. It might be due to the short duration of the training in high achievers group of players (Wilmore & Costill, 2005). Age may be a limiting factor too (Wilmore & Costill, 2005). High achievers showed lower percent body fat and greater lean body mass. High achievers achieve better performance since the more the lean body mass produced greater energy output and the higher will be the cardiorespiratory fitness (Bandyopadhyay & Chatterjee, 2003; Chatterjee *et al.*, 2005).

Categorization of hockey players

The considerable difference between high achievers and low achievers on speed, back strength, left hand grip strength, right hand grip strength and aerobic power is in line with the findings of Elferink-Gemser *et al.*, (2006); Gabbett, *et al.*, (2007); Elferink-Gemser, *et al.*, (2007).

Six variables were considered in the discriminant equation. The discriminant equation derived as follows is in par with the findings of Nieuwenhuis, Spamer, and van Rossum (2002).

$$\begin{aligned}
 D = & -36.004 + 0.173 (\text{Height}) - 0.265 (\text{Weight}) - 0.178 (\text{Sit-ups}) \\
 & + 1.647 (\text{Mesomorphy}) + 0.112 (\text{Left Grip Strength}) \\
 & + 0.259 (\text{Aerobic Power})
 \end{aligned}$$

The canonical discriminant function that ensures in categorizing the hockey players as high achievers and low achievers, and the Chi-square value of 18.449 thereto denotes that there is a significant difference between high achievers and low achievers based on the discriminant function. These findings were in relation with the observations of Keogh, Weber and Dalton (2003) and Gabbett, *et al.*, (2007).

Discussion on Hypotheses

Earlier, the investigator formulated three hypotheses: in which the first hypothesis stated that there may be significant difference on selected criterion variables between high achievers and low achievers. This first hypothesis has been accepted in the case of speed, back strength, left hand grip strength, right hand grip strength and aerobic power as significant difference exists between high achievers and low achievers. In the second hypothesis it was stated that the selected criterion variables may contribute to the classification of hockey players as high achievers and low achievers. The obtained canonical correlation of 0.732 indicates that canonical discriminant function ensures in categorizing the hockey players as high achievers and low achievers. Thereby, the second has been accepted and the null hypothesis has been rejected. Furthermore, in the third hypothesis it was stated that the multiple regression equation may significantly

predict hockey players of different levels of achievement from selected criterion variables. This hypothesis has been accepted and the null hypothesis has been rejected, as the obtained Chi-square value of 18.449 denotes that there is a significant difference between high achievers and low achievers based on the discriminant function.