CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS AND SUGGESTIONS

SUMMARY

The purpose of the study was to examine the relationship of selected motor fitness components and anthropometric measurements to gymnastic performance at different levels of achievement. Based on this purpose, the study was confined to three achievement levels, i.e., Senior National level, All India Inter-University level, and National School level. Three main objectives were identified and, consequently, the study was planned and conducted in relation to these objectives, which were:

1. To study the relationship of selected motor fitness components and anthropometric measurements to gymnastic performance at different levels.

2. To compare the subjects belonging to the three levels of achievement on the selected motor fitness components and anthropometric measurements.

3. To develop prediction equations for gymnastic performance separately at the three levels with regard to selected motor fitness components and anthropometric measurements.
On the basis of these objectives the following hypotheses were framed and tested:

1. There will be significant relationship between selected motor fitness components and gymnastic performance at various levels.

2. There will be significant relationship between selected anthropometric measurements at various levels.

3. Significant differences will exist in motor fitness components of gymnasts at different levels.

4. There will be significant differences in anthropometric measurements of gymnasts at different levels.

The study was conducted on 140 male gymnasts who participated in competitions held at three different levels during the years 1986-87 and 1988. The split up of the subjects was 50, 40, and 50 for Senior National, All India Inter-University, and National School levels respectively. Only top 50 gymnasts each out of those who had qualified for competition 1b from competition 1a for two levels, were selected for the study. At the Inter-University level only 40, who had qualified
for competition lb, i.e., optional exercises, were selected. Those subjects who participated at more than one level were eliminated.

Motor fitness components selected were speed, agility, arms power, arms strength endurance, abdominal strength endurance, legs power, flexibility of hip region, shoulder flexibility, flexibility of spine, dynamic balance and speed of movement which were measured by 30m run, shuttle run, 6 lb medicine ball throw, chin-ups, bent knee sit-ups, Sargent Jump, Forward to rear split, side split, shoulder rotation, bridge up test, modified bass dynamic balance test and Nelson's speed of movement test respectively. Selected anthropometric measurements of height, sitting height, leg length, arm length, weight, shoulder width, chest width, hip width, arm circumference, chest circumference, hip circumference, thigh circumference and calf circumference were taken by anthropometric rod, weighing machine, sliding caliper and flexible steel tape respectively. The reliability of the data was established by using the test-retest method.

Correlational statistics was applied to study the relationship of selected motor fitness components and anthropometric measurements to gymnastic performance.
at different levels. The zero order correlation, partial as well as multiple correlation were computed separately for each level. For comparing the subjects on the selected motor fitness components and anthropometric measurements ANOVA (F-ratio) was employed and in case of significant F-ratios Sheffe's test of post hoc differences was applied to examine the significance of differences between all the paired means. The obtained relationships and differences were tested for significance at .05 level of significance. Multiple Regression analysis was used to develop prediction equations.

Analysis of data revealed that there were significant relationship of gymnastic performance and certain selected motor fitness components and anthropometric measurements at Senior National level:

- Speed ($r = -.686$), Agility ($r = -.510$), Arms power ($r = .617$), Arms strength endurance ($r = .778$), Abdominal strength endurance ($r = .792$), Legs power ($r = .600$), flexibility of hip region ($r = -.560$, -.514), shoulder flexibility ($r = -.546$), Dynamic balance ($r = .704$), Weight ($r = -.372$), Height ($r = -.382$), Leg length ($r = -.356$), Arm length ($-.353$), Hip width ($r = -.525$) and Hip circumference ($r = -.505$). The relationships between speed of movement, spine flexibility, sitting
height, shoulder width, chest width, arm circumference, chest circumference, thigh circumference and calf circumference to gymnastic performance at senior National level were however, not found statistically significant at .05 level. With regard to Inter-University level significant relationships were obtained between gymnastic performance and motor fitness components and anthropometric measurements as follows: Speed (r = -.639), Agility (r = -.413), Arms power (r = .568), Arms strength endurance (r = .727), Abdominal strength endurance (r = .685), legs power (r = .423), flexibility of hip region (r = -.385, -.426), Dynamic balance (r = .565), and speed of movement (r = -.477). The relationships of shoulder flexibility, spine flexibility and all anthropometric measurements were not found statistically significant. At National school level, gymnastic performance correlated significantly to motor fitness components as follows: Speed (r = -.466), Agility (r = -.409), Power of arms (r = .575), Arms strength endurance (r = .732), Abdominal strength endurance (r = .851), Legs power (r = .334), Flexibility of hip region (r = -.376, -.409), Spine flexibility (r = -.315), and dynamic balance (r = .949). The relationships of shoulder flexibility, speed of movement and
all other anthropometric measurements to gymnastic performance were, however, not found statistically significant except arm circumference, which was found significantly correlated with gymnastic performance ($r = .398$).

The analysis of data pertaining to partial correlations showed that the motor fitness components of strength endurance, dynamic balance, power, speed, agility, flexibility of hip region and shoulder flexibility underlie the performance in gymnastics at all the three different levels as against other selected motor fitness components. The partial correlational analysis further exhibited significant relationships of selected anthropometric measurements and gymnastic performance as follows: The anthropometric measurements of height, weight, hip width, hip circumference, arm length and leg length correlated significantly but negatively, whereas chest circumference showed positive significant correlation with gymnastic performance at the Senior National level. At the National School level only weight, arm circumference, and shoulder width showed significant correlation with gymnastic performance. But at the All India Inter-University level none of the anthropometric measurements exhibited significant correlation with gymnastic performance when the effect of the one or the other measurement was held constant.
From the multiple correlational analysis it was observed that at the Senior National level motor fitness components of abdominal strength endurance, dynamic balance, legs' power, arms strength endurance, shoulder flexibility, flexibility of hip region, and power of arms contributed the most to gymnastic performance ($R = .920$); also the anthropometric measurements: Hip width, chest circumference, hip circumference, leg length, chest width, thigh circumference, arm circumference, calf circumference, sitting height, shoulder width and arm length contributed significantly to gymnastic performance ($R = .735$). At the All India Inter University level arms strength endurance, abdominal strength endurance, speed of movement, agility, power of arms, shoulder flexibility, flexibility of spine and legs power contributed significantly to gymnastic performance ($R = .881$), and the anthropometric measurements: calf circumference, height, arm circumference, chest circumference, shoulder width, hip width, thigh circumference, chest circumference, leg length and arm length ($R = .652$) did not correlate significantly with gymnastic performance as the computed value was below the required value of significance. At the National School level, abdominal strength endurance, dynamic balance, arms strength endurance, flexibility of hip region, arms power and running speed contributed the most to gymnastic
The anthropometric measurements: arm circumference, shoulder width, leg length, hip circumference, hip width, chest width, height, arm length, calf circumference, weight, and sitting height contributed significantly to gymnastic performance ($R = .776$).

Multiple regression analysis results for motor fitness components and anthropometric measurements for all the three levels are mentioned in the following equations:

**Motor Fitness Components of Senior National Level:**

$$x_c = b_5x_5 + b_{11}x_{11} + b_6x_6 + b_4x_4 + b_9x_9 + b_7x_7 + b_3x_3$$

$$x = .252x_5 + .160x_{11} + .440x_6 + .302x_4 + (-.229x_9) + (.246x_7) + .177x_3$$

**Motor Fitness Components of All India Inter University Level:**

$$x_c = b_4x_4 + b_5x_5 + b_{12}x_{12} + b_2x_2 + b_3x_3 + b_9x_9 + b_{10}x_{10}$$

$$+ b_6x_6$$

$$x_c = .329x_4 + .261x_5 + (-.152x_{12}) + (-.135x_2) + .289x_3$$

$$+ (-.159x_9) + (-.144x_{10}) + .898x_6$$

**Motor Fitness Components of National School Level:**

$$x_c = b_5x_5 + b_{11}x_{11} + b_4x_4 + b_8x_8 + b_3x_3 + b_1x_1$$

$$x_c = .490x_5 + .209x_{11} + .176x_4 + (-.123x_8) + .105x_3$$

$$+ (-.727x_1)$$
Anthropometric measurements of Senior National Level:

\[ x_c = b_9 x_9 + b_{11} x_{11} + b_{12} x_{12} + b_5 x_5 + b_8 x_8 + b_{13} x_{13} + b_{10} x_{10} \]
\[ + b_{14} x_{14} + b_4 x_4 + b_7 x_7 + b_6 x_6 \]
\[ x_c = .193 x_9 + .556 x_{11} + (-.668 x_{12}) + (-.460 x_5) + (-.232 x_8) \]
\[ + .371 x_{13} + (-.253 x_{10}) + (-.140 x_{14}) + (-.276 x_4) + .222 x_7 \]
\[ + (-.129 x_6) \]

Anthropometric measurements of All India Inter University Level:

\[ x_c = b_{14} x_{14} + b_3 x_3 + b_{10} x_{10} + b_7 x_7 + b_9 x_9 + b_{13} x_{13} + b_{11} x_{11} \]
\[ + b_5 x_5 + b_6 x_6 + b_{1} x_{1} \]
\[ x_c = .326 x_{14} + .475 x_3 + (-.440 x_{10}) + .302 x_7 + (-.219 x_9) \]
\[ + (.294 x_{13}) + (.245 x_{11}) + (-.242 x_5) + (-.149 x_6) + .964 x_1 \]

Anthropometric measurements of National School level:

\[ x_c = b_{10} x_{10} + b_7 x_7 + b_5 x_5 + b_{12} x_{12} + b_9 x_9 + b_8 x_8 + b_3 x_3 + \]
\[ b_6 x_6 + b_{14} x_{14} + b_2 x_2 + b_{1} x_{1} + b_4 x_4 \]
\[ x_c = .380 x_{10} + .696 x_7 + .393 x_5 + (-.122 x_{12}) + .748 x_6 + (-.364 x_8) \]
\[ + .941 x_3 + (-.327 x_6) + .173 x_{14} + .267 x_2 + (-.188 x_1) \]
\[ + (-.179 x_4) \]
Analysis of variance (F-ratios) were computed to establish the differences among all the three levels. From the findings it was clear that the subjects belonging to different levels considered in this study differed significantly on all the motor fitness components except speed of movement. From Sheffe's test of post hoc differences it was concluded that the Senior National Gymnasts were significantly superior to both the Inter-University and the National School level gymnasts in the motor fitness components of power of arms, abdominal strength endurance; and speed, agility, arm strength endurance, abdominal strength endurance and legs power respectively. The Inter-University gymnasts were significantly better than the National School level gymnasts in agility, power of arms, arms strength endurance, and leg power. But no significant differences were seen among all the three levels of speed of movement. The analysis of data further revealed that there were significant differences in the Senior National and National School gymnasts on the anthropometric
measurements of weight, height, sitting height, shoulder width, chest width, hip width, arm circumference, chest circumference, hip circumference, thigh circumference and calf circumference except arm length and leg length. Inter-University gymnasts also differed from the National School level gymnasts on all the anthropometric measurements except arm length. But no significant differences were observed between the Senior National and the All India Inter-University level gymnasts.

CONCLUSIONS

Within the limitations of the present study, the following conclusions were drawn:

1. The motor fitness components of speed, agility, power of arms, arms strength endurance, abdominal strength endurance, legs power, flexibility of hip region, shoulder flexibility and dynamic balance correlated significantly with gymnastic performance at the Senior National level.

2. At the Inter-University level, the motor fitness components of speed, agility, arms power, arms strength endurance, abdominal strength endurance, legs power, flexibility of hip region, dynamic
balance and speed of movement showed significant correlation with gymnastic performance.

3. For the National School level, the motor fitness components of speed, agility, arms power, arms strength endurance, abdominal strength endurance, legs power, flexibility of hip region, flexibility of spine and dynamic balance correlated significantly with gymnastic performance.

4. Spine flexibility and speed of movement at the Senior National level; shoulder flexibility and spine flexibility at the Inter-University level; shoulder flexibility and speed of movement at the National School level were not related to performance in gymnastics.

5. Among the anthropometric measurements, weight, height, leg length, arm length, hip width, and hip circumference were related to gymnastic performance significantly but negatively at the Senior National level. The other anthropometric measurements did not correlate to gymnastic performance significantly at the Senior National level. At the All India Inter-University level the selected anthropometric measurements did not correlate to gymnastic performance significantly.
6. At the National School level only arm circumference showed significant positive correlation with gymnastic performance, whereas all other measurements did not correlate to gymnastic performance significantly.

7. Results of partial correlation revealed:

a) The motor fitness components of strength endurance, dynamic balance, power, speed, agility, flexibility of hip region and shoulder flexibility were significantly related to gymnastic performance at all the three levels.

b) At the Senior National level, anthropometric measurements of height, weight, hip width, hip circumference, arm length and leg length correlated significantly but negatively except chest circumference which resulted in significant positive correlation with gymnastic performance.

c) At the National School level, weight, arm circumference and shoulder width resulted in significant positive correlation with gymnastic performance, but at Inter-University level none of the anthropometric measurement showed significant correlation with gymnastic performance.
8. The results of multiple correlation revealed that the combined motor fitness components were significantly related to gymnastic performance at all the three levels of achievement. Anthropometric measurements also correlated significantly to gymnastic performance at the Senior National level and the National School level. However, no such relationship was found at the Inter-University level.

9. Results of Analysis of Variance revealed:

a) The Senior National gymnasts were superior to both the Inter-University and National School level gymnasts in motor fitness components of power of arms, abdominal strength endurance; and speed, agility, arms strength endurance, abdominal strength endurance and legs power respectively.

b) The Inter-University level gymnasts were also better than the National School level gymnasts in agility, power of arms, arms strength endurance, and legs power.

c) No significant differences were observed among all the three levels for speed of movement.
d) There were no significant differences between Senior National and Inter-University level gymnasts in all the selected anthropometric measurements.

e) The Senior National gymnasts differed from the National School gymnasts in all the anthropometric measurements except arm length and leg length.

f) The Inter-University level gymnasts also differ from the National School gymnasts in all the anthropometric measurements except arm length.

**IMPLICATIONS**

The implications of the study are as follows:

1. While selecting gymnasts for different levels, performance in motor fitness components should be taken into consideration.

2. Coaches and teachers should also consider the selected anthropometric measurements, which were found significantly related to performance in gymnastics for selection of gymnasts at all levels.

3. While designing training programmes more emphasis should be put on the development of those motor
fitness components which have been found significantly related to gymnastic performance.

4. Initial selection of gymnasts should be made in the light of the findings of this study.

SUGGESTIONS FOR FURTHER RESEARCH:

1. It is suggested that the present study may be conducted on our sub-junior level gymnasts.

2. It is recommended that similar studies may be undertaken on women gymnasts at different levels.

3. Similar studies may be conducted on other games and sports where the criteria used for measuring success in game performance are different.

4. A similar study may be conducted on gymnasts belonging to different races separately.

5. It is recommended that similar study may be conducted on gymnasts by involving psychological, sociological and functional variables in addition to motor fitness components and anthropometric measurements.

6. Some other motor fitness variables may be looked into for investigations.
7. Apart from anthropometric measurements mentioned in this study, other anthropometric measurements and ratios may also be studied.

8. Gymnasts of different levels may be compared with other sportsmen regarding motor fitness components and anthropometric measurements.

9. Indian gymnasts may be compared with gymnasts of other advanced countries regarding motor fitness components and anthropometric measurements.