CHAPTER I

INTRODUCTION

"Sports records are born not in stadia, but in scientific laboratories"
- Valentine Petrovsky

In modern times the growth of sports and physical education programmes in any country is much dependent on sports sciences. These sciences are known to have developed to a considerable extent in the developed countries. Kinanthropometry, exercise physiology, biomechanics, biochemistry, sports psychology, sports sociology, nutrition, sports medicine, pedagogics, and methods of training or coaching are some of the well known sciences in this regard. The standard of sports and competitive performance can develop through integral approach by use of knowledge from both applied and basic sciences.

Physical education and sports, being an integral part of education, have experienced the impact of scientific advancement. At present sportsmen have been able to give outstanding performance because of new scientifically based training methods and means of execution of sports exercises (sports techniques and
tactics), improvement of sports gear and equipment, and other components and systems of sports training. Even the most gifted sportsman will not produce outstanding results if he does not work persistently and systematically for higher achievement.

Scientific investigations and assessment of factors underlying performance in sports are the most important achievements of the present century. Intellectual environment has brought a revolution in every field, including sports. As in other fields, the world of sports is also ever expanding and continuously coming up through development of new techniques based on research.

To the physical educator, coach and sportsman an understanding of physical characteristics and the dynamics of motor fitness are becoming increasingly important. With an increased scientific knowledge of sports the trial and error methods, and application of guessing, become less than adequate in preparing high level sportsmen for competitions. Days are gone when "a Spyridon Lewis builds Olympic winning endurance by chasing his sheep across Greece hills" (Handerson, 1970).

Motor fitness is an inseparable part of sports performance and achievement. The quality of an individual sportsman's fitness in terms of its utilisation values is
directly proportional to his level of performance. In the arena of international competition, one can hardly differentiate between the top contenders from one another in terms of levels of fitness. However, the deciding factors sometimes remain with fitness in terms of its finer aspects.

Gymnastics is an art of performing various types of physical exercises and feats of skill, on different kinds of apparatus and also on the floor. To obtain optimum efficiency in this task, sports technique alone is not enough. In addition to skills, the gymnast has to achieve a very high level of physical, physiological and psychological fitness. Therefore, it is essential that physical education teachers, coaches, and gymnasts should be aware of the extent to which each of these variables may contribute to excellent performance in gymnastics. Once the relative importance of these variables is known, coaches and teachers will be able to utilize the training time effectively and concentrate on those factors only which directly influence performance in this sport.

Performance in different sports disciplines, including gymnastics, is influenced by so many factors
such as motor fitness, technique, tactics, physiological aspects and physique characteristics, etc. Motor fitness components play a vital role in achieving top level performance in different sports disciplines. To achieve international standard physical fitness and the best training of individuals are important factors (Hirata, 1979).

Salmela (1982) found that for advanced performance in gymnastics a high level of physical, physiological, and psychological abilities are required because gymnastics is a highly technical sports discipline. A gymnast has to perform a combination of very complicated movements and the performance is evaluated by a set criterion on the basis of the technique of the different complicated movements on various apparatus, including exercises on the floor. Any performer who likes to excel in gymnastics has to give full attention to the technical aspect which is of great importance due to the nature of different complicated skills involved.

To achieve mastery over these skills one has to lay due emphasis on the development of necessary physical abilities. In order to learn different movements and master them properly, a gymnast must possess sufficient amount of the abilities required. All gymnastic exercises are performed against a given resistance. Here the
A gymnast is required to lift his own body against gravity in different positions by applying force through the arms and legs. To perform these feats in a sequence on different apparatuses, one requires a definite level of strength in the arms, the shoulder girdle, the trunk and the legs. Beside these, there are certain hold parts which are executed purely with strength. To execute these strength dominating elements in a combination as per the programme laid down for a specific apparatus, a performer, in addition to strength, is faced with the problem of continuing the activity over a prolonged duration without any interruption, thus making the entire exercise a strength endurance dominating activity. Fukushima (1980) states that more than 60 percent of the movements performed by male gymnasts and 30 percent of the movements performed by female gymnasts are of a momentary supporting nature. These movements require a definite amount of strength. In the tumbling phase of floor exercises and the entire takeoff stage of horse vaulting need muscular strength.

Harre (1979) states the relative importance of strength in gymnastics. Cumming (1907) found the role
of "explosive strength" and "muscular endurance" in gymnastic performance on various apparatus. The physical manipulations undergone by the body of a gymnast during competition is considered to be much greater than those of any other sports discipline, including decathlon (Salmela, 1982).

In gymnastics there are a great many power movements are not required. Other than the specific requirements, a gymnast needs no special strength other than the ability to support his body-weight in a variety of supporting and hanging movements. It is helpful to have more than the minimum strength so that a gymnast may save himself if he is off balance and needs power to pull back. But he does not have to be a muscleman.

The motor performance qualities commonly recognised are strength, speed, power, agility, flexibility, reaction time, speed of movement, balance and coordination. In mos: sports, other factors such as physique, skill, training, rest, nutrition etc. being equal, speed becomes the deciding factor in one's ultimate performance. Several research studies indicate that speed is significantly related to power and it is more important than strength in athletics performance (Carpenter, 1938; Cureton, 1939).
Flexibility is known to be another important component for achieving top performance in gymnastics. Flexibility is the ability to perform movements with large amplitude. It is a prime prerequisite for executing good movements. In gymnastics a good performer, in addition to strength dominated exercises, is also expected to perform movements with wide amplitude. Strength dominated movements combined with wider amplitude are aesthetic, beautiful and elegant to watch. So a gymnast must possess a superior level of joint range of motion (ROM) in order to perform with amplitude and elegance. Lack of flexibility leads to injuries and various flaws in execution. Flexibility helps in generating more force which makes the execution of complicated gymnastic movements easier. It has also been revealed that flexibility contributes to power by increasing the distance over which force is applied. Moreover, flexibility is an essential part of life even for a common man who can avoid possible injury resulting from a fall or slip while performing his daily chores.

The execution of some of the gymnastic movements purely depends on the amount of flexibility, such as split sitting on the floor, stalder circle on the horizontal bar, scissors on the pommelled horse, etc. Therefore,
to achieve top performance a gymnast must be stronger as well as flexible. It has been a common belief that a high degree of flexibility is necessary in all athletic endeavours. Greater amount of flexibility decreases the expenditure of energy and reduces the resistance while performing gymnastic movements (Hellenic Olympic Committee, 1979).


Agility plays a vital role in all sports disciplines, especially in gymnastics. A gymnast must possess the ability to change the direction and movement of various parts of the body during the performance of a gymnastic routine.

Balance also plays an important role in gymnastics. Although the general contribution made by the eyes to balance may combine with other factors, such as the structure of the body, weight, etc., which are basic to balance, it is apparently statically independent of many
Gymnastics is one of the multifaceted sports with many performance requirements. The different events require a combination of athletic abilities, including speed, strength, power, flexibility, agility, endurance and technique. This complexity of needs requires scientific methods of training which attends to these demands. It appears reasonable, therefore, that scientific methods of training should be devised to improve performance continuously.

Human physique has always been a part of physical education and sports. Scientific evidence obtained from different investigations in the past have revealed that apart from other factors the performance of a sportsman in any sport is dependent on various characteristics of physique, physiology and body composition. Competitive gymnastics is a highly technical sports discipline. The advantageous characteristics of a gymnast's physique help him in the dynamic and powerful movements that he has to perform on various apparatuses, i.e. pommelled horse, roman rings, vaulting horse, parallel bars, horizontal bar and the floor.

Almost all physical educationists and sports scientists acknowledge that no two individuals are alike
in body shape, size and composition. Sportsmen differ significantly in these basic attributes and therefore these differences influence physical performance. Thus these attributes should be considered in judging an individual's potentialities for participating in sports because many factors contribute towards the making of a champion gymnast. Body size and type are two of these attributes. No coach in his right mind would attempt to make a champion out of just any body. No amount of training will transform a thick set, round-bellied individual into a champion (Singh, 1978).

Some persons are born with a high potential for physical fitness and work performance, while others are not. Certain body types may be of advantage in certain sports, and disadvantageous in others. DiGiovanna (1943) studied male gymnasts and concluded that the champion male gymnast was substantially shorter in height, leg length and hip width and considerably large in arm girth with greater muscular strength than an average person.

In an exercise where one's body must be moved, as in many gymnastic exercises such as chinups, pushups, etc, a large size will be disadvantageous. The taller gymnast is at a disadvantage because he has smaller strength-body weight ratio than the shorter gymnasts.
This is because shorter and lighter people are better able to control their body-weight (Levea et al., 1974; Bird, 1979). This means strength per pound tends to be higher for smaller individuals.

According to Gunney (1973), the taller gymnast has a centre of gravity higher off the ground than the shorter gymnast. Therefore, the taller gymnast must display a greater amount of precision in timing to achieve the same results as those of a shorter gymnast on the same skill. A six foot tall gymnast will need about 20 feet more area than a five foot tall gymnast to achieve the same results from a three step run in floor exercises which is to his disadvantage. Further, on swinging moves, a taller gymnast is at a greater distance away from the equipment which makes it difficult for him to do turns and connections plus less room to be creative. According to LeVeau and his associates (1974), the small stature of gymnasts results in a smaller moment of inertia about an axis in the transverse plane through the mass centre when compared with taller gymnasts. As a matter of fact, a shorter person is better able to perform "spinning" movements in free flight.

Also the moment of inertia of the total body about "other" axis such as on the horizontal bar would be less which also gives the shorter gymnast a mechanical
advantage. The heavier and taller person has a greater pressure per square inch on his hands and thus is more susceptible to blisters and shortens his workout time (Christensen, 1979). But the biomechanical requirements of the vault may be a disadvantage for the shorter gymnast because he has to raise his centre of gravity to a higher point before contacting the horse which requires a greater vertical velocity at take-off (LeVeau et al., 1974).

Carter (1970) considered that the morphological characteristics of athletes were of interest to human biologists, for competitive sports demand the utmost from the body and it is, therefore, reasonable to expect in athletes a demonstration of the relationship of structure and function. Parnell (1951) in an anthropometric study of athletes concluded that an individual's choice of athletics events might largely be due to characteristics probably inborn. Tanner (1964) examined the physique and body composition of Olympic track and field athletes and inferred that athletes are born not made. "The basic structure", he stated, "must be present for the possibility of being an athlete to arise". Physique is a factor in the success that may lead to inclusion in an olympic team or more negatively that lack of proper physique
make it almost impossible for an athlete to reach that degree. So it is evident that physique and body composition have an important role to play in the performance of various physical activities.

Normally a person starts taking part in sports discipline without proper guidance. It is thus sheer chance that his choice of the sports may be suitable to his inherent capabilities. Therefore, the failure to become a champion in most cases is inevitable. Thus there is an urgent need to provide counselling to those endowed with such suitable characteristics that form the basis of performance in sports. This may be one of the most important factors that can help in raising the standard of sports in most countries.

In the galaxy of sports sciences which include a wide range of areas, sports training as a science seems to have occupied an important place. Motor fitness and Kinanthropometry have made a considerable contribution in optimising the training procedures. However, in gymnastics these areas have not been sufficiently investigated.

India started with a very poor base in gymnastics while other countries had already achieved a high level
One of the reasons of India's poor performance in gymnastics at the international level may be improper selection at the base level and inefficient training because of inadequate research in different aspects related to performance.

In the past, investigators have made appreciable attempts to find out the relationship of different aspects connected with performance in different sports. But none of the scholars has tried to investigate the relationship of motor fitness components and anthropometric measurements to gymnastic performance at various levels. The rationale of this study is to fill up the existing gap in research that is important from the point of view of growth and development and performance in gymnastics.

**Statement of the Problem**

The purpose of the present study is to find out the relationship between selected motor-fitness components and anthropometric measurements to gymnastic performance at various levels of competitions. So the problem is stated as:

"Relationship of Selected Motor Fitness Components and Anthropometric Measurements to Gymnastic Performance at Different Levels of Competitions".
Objectives of the Study

1. To determine whether there is any relationship between selected motor fitness components and gymnastic performance at various levels, i.e. Senior National, All India Inter-University and National School games of India.

2. To find out the relationship between selected anthropometric measurements and gymnastic performance at various levels.

3. To study the differences in motor fitness components at various levels of performance.

4. To find out the differences in anthropometric measurements among gymnasts with varying levels of performance.

5. To develop prediction equations for different levels with regard to motor fitness components and anthropometric measurements.

Delimitations

1. The present study was limited to Indian gymnasts only.

2. The study was delimited to male gymnasts only.
3. The study was confined to those gymnasts who participated in Senior National gymnastic championship, All India Inter-University and National School games during the years 1986-87 and 1987-88.

4. The study was further confined to those gymnasts who qualified for competition 1b i.e. optional exercises on the basis of competition 1a i.e. compulsory exercises in Senior National, All India Inter-University and National School games, according to rules of gymnastic sports.

5. The study was delimited to the following selected motor fitness components:

   (i) Speed
   (ii) Agility
   (iii) Power of arms
   (iv) Arms strength endurance
   (v) Abdominal strength endurance
   (vi) Power of legs
   (vii) Flexibility of hip region
   (viii) Shoulder flexibility
   (ix) Spine flexibility
   (x) Dynamic balance
   (xi) Speed of movement
The study was further delimited to the following selected anthropometric measurements:

(i) Height
(ii) Weight
(iii) Sitting height
(iv) Leg length
(v) Arm length
(vi) Shoulder width
(vii) Chest width
(viii) Hip width
(ix) Arm circumference
(x) Chest circumference
(xi) Hip circumference
(xii) Thigh circumference
(xiii) Calf circumference.

Hypotheses

It was hypothesized that:

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

2. There would be significant relationship between selected anthropometric measurements and gymnastic performance at all the three different levels of competition.
3. Senior National gymnasts would be significantly better than All India Inter-University level and National School level gymnasts on the selected motor fitness components.

4. Inter-University level gymnasts would be superior to National School level gymnasts in all the selected motor fitness components.

5. Gymnasts of Senior National Group would significantly differ with All India Inter-University and National School level gymnasts on the selected anthropometric measurements.

6. Significant differences would exist among Inter-University level gymnasts and National School level gymnasts in all the selected anthropometric measurements.

Limitations

1. Due to shortage of time at all the three levels of competition, all the gymnasts could not be tested who qualified for competition (1b) on the basis of competition (1a).

2. No motivational technique was employed by the investigator to make the subjects to give their best performance in the selected motor fitness components and hence this may be treated as a limitation for the study.
Motor Fitness:

The term physical fitness and motor fitness are often used interchangeably, but motor fitness is actually the broader concept, including both physical fitness and motor ability factors (Baumgartner and Jackson, 1984).

Motor fitness is one's ability to perform efficiently basic motor skills involving such elements as power, agility, speed and balance (Johnson and Nelson, 1982).

**Speed**

Speed is the capacity of moving a limb or part of the body lever system or the whole body with the greatest possible velocity (Dick, 1980).

**Agility**

Agility is the physical ability which enables an individual to rapidly change body position and direction in a precise manner (Johnson and Nelson, 1982).

Agility is the ability of a person to change the direction without loss of speed.

**Power**

Power may be defined as the ability to release maximum force in the fastest possible time (Johnson and Nelson, 1982).
Strength Endurance

Strength endurance is the capacity of an individual to withstand fatigue in situations where the muscle groups being used are loaded heavily (Sodhi, 1984).

Flexibility

Flexibility is defined as the range of possible movement about a joint or a sequence of joints (Barrow and McGee, 1939).

Flexibility refers to the ability of an individual to move the body and its parts through as wide a range of motion as possible without undue strain to the articulations and muscle attachments.

Dynamic balance

Dynamic balance has been defined as the ability of the individual to control his body in a specific efficient posture while it is moving (Barrow and McGee 1939).

Dynamic balance refers to the ability of the individual to maintain balance during vigorous movements.

Speed of Movement

Speed of movement has been defined as the rate
at which a person can propel parts of his body through space (Johnson and Nelson, 1982).

It refers to the time taken from the presentation of stimulus to the completion of a small movement and is given by the sum of reaction time and movement time.

For the purpose of this study the speed of movement will be measured by the Nelson's Hand and Arm Reaction Test.

**Anthropometry**

Anthropometry is a branch of anthropology that is concerned with systematic measurements of the human body. It usually refers to linear dimensions of brain, skeleton and other organs. In the present study discussion is confined to the measurements associated with body build.

**Implications of the Study**

The findings of this study may have implications in the following way:

1. The results of the study may lead to the full understanding of the role played by anthropometric measurements and motor fitness components in achieving high performance efficiency.
2. The findings of this study are likely to provide guidelines for the selection of gymnasts at the beginning level.

3. The study will help coaches and physical education teachers in developing systematic and scientific programme.

4. The results of the study will educate the coaches, teachers of physical education and gymnasts by revealing the extent to which different components should be developed to train skillful gymnasts.

5. The findings of the study will help the coaches and teachers in selecting gymnasts at different levels by keeping in view their motor fitness components and anthropometric measurements.