CHAPTER - I
INTRODUCTION

Sports science has played a very important role in the improvement of sports performance. Theory and methods of training as a subject based on the informations received from other sports sciences and experiences of the coaches and physical education teachers, deals with sports training process. Sports training is a process of preparation of the sportsman for successful participation in the competition. The whole process which never ends is based on the scientific principles. Assessment of performance or performance determining factors for better control and regulation of training process is an important area of theory and methods of training.

In the past muscular abilities were mainly tested through isotonic or isometric testing procedures. Isometric means contraction of the muscles without movement and isotonic means contraction against a fixed resistance, which makes possible to measure capacity only at the weakest point in the range of motion. Also the speed at which as subject can perform an isotonic test is quite slow, compared to the speed at which muscles are used functionally.

In the late 1960's the concept of isokinetic exercise was developed by James Perrine which proved to be a revolution in exercise training and rehabilitation. Instead of the traditional exercises which involves a constant weight of resistance performed at variable speeds, Perrine
developed the concept of isokinetics which involves a dynamic pre-set fixed speed, with resistance that is totally accommodating throughout the range of motion (ROM). Since the inception of isokinetics, this form of testing and exercise has become increasingly popular in clinical, athletic and research setting (Davies, 1987).

Isokinetic exercise is a genuine accommodating resistive exercise and is a refinement of the controlled motion concept. It occurs against a load which allows movement at a mechanically fixed rate of speed and offers a resisting force directly proportional to the magnitude of the input at every given point of the range. By controlling the movement speed, energy dissipation due to acceleration, is prevented and consequently channelled into the resistive force. Loading a dynamically contracting muscle with a special governing device so that speed is fixed and resistance is variable and proportional to muscular capacity at every point in the range of motion (Perrine, 1968).

The use of isokinetic testing equipment to measure human performance has been in vogue and its results reported in scientific literature for two decades mainly. In the clinical setting, isokinetic testing and conditioning programmes are widely utilized as evaluation and rehabilitation tools. Isokinetic exercises and strength training are theorized to be superior to isometric or isotonic resistance training because an isokinetic contraction offers maximal resistances to the muscle throughout the full range of motion. This has important clinical ramifications when dealing with injury evaluation and rehabilitation (John, A. et al, 1991).
Muscular performance in the healthy athlete can be indirectly determined by a participant's level of achievement in his/her particular sports. Evaluation of the injured athlete, however, frequently requires more specific information regarding the affected muscle groups. In contemporary practice such information is commonly collected through isokinetic testing procedures. While isokinetic may produce a variety of different muscle performance data, peak torque is the most widely used parameter to evaluate muscle function. For isokinetic assessment purposes peak torque is operationally defined as single greatest torque output produced during contraction by a muscle or muscle group (Bandy and Timm 1992).

There are certain qualities which are essential to athletic success without these qualities, an athlete has little chance of reaching the higher levels. The requirements of each event should be analysed to determine which characteristics are necessary for top performance. Once these components have been selected, a test can be devised to measure them (Smith, 1981). Perhaps by reason of the apparent simplicity of the long jump, power and strength training have been relatively neglected for long jump as compared to other athletic events.

Strength, speed and endurance are the three factors which are involved in any scheme of training and top class athletes would lay more emphasis on one or the other factor depending upon the nature of event for which training schedule is arranged.

In sports the sportsman has to overcome resistance either caused
by external factors (wind, water, friction, equipment etc.) or the resistance caused by one's own body weight. Better performance in speed, endurance, technique, tactics and coordinative abilities is not possible without a certain level of strength (Singh, 1984).

Strength as an important factor in all games and sports is a complex factor which depends upon the capacity of the muscles for contraction and upon the stimulus given by the nervous system, size and shape of the muscles (Uppal and Ray, 1988).

Sports activities are putting different level of demands on strength abilities. Higher throwing, putting and take off speeds in team games and athletic events, faster actions in combative sports and higher acceleration in running and cycling needs higher strength in shortest possible time. As quicker and faster mobilisation of strength in training is known as explosive strength.

In long and triple jump take off after a faster approach, is mainly determined by jumping strength which is a combination of speed and strength. The jumping strength is needed not only for a stronger take off but it also improves the acceleration ability.

According to Baursfield and Schroter (1979) the performance in all jump events in track and field is based on explosive strength which is known as jumping strength for the jumpers and is related to reactive strength ability.

As the revolution in science and technology continues to progress, the gap between the escalating human activity demands.
Chui (1950) published a report on strength development using weights, various systems and methods of developing different kinds of strength such as isotonic, isometric and isokinetic and also different schedules of resistance training and circuit training. Strength as one of the factors of various training methods plays an ever increasing role in the modern system of training. Strength is created by contraction of a muscle fibers. The contraction results due to the proteins present in the muscle, mainly actomyosin. Strength can be developed through systematic weight training. This is the most important condition for achieving good performance in all kinds of competitions.

The development of specific strength for each specific sport can be achieved through specific training. A great progress has been made in this field during recent years. In the past, athlete began his training in the fine weather and continued until the end of the autumn. He then retired during the winter. Today things have changed, training never stops and it is exhausting and continuous around the year with varying intensity, duration and resistance to suit one's sport. This is the reason why records are broken in every competition. This is due to the fact that method of increasing the specific quality of strength for each sport are continuing to improve. The conclusion is that the strength factor dominates more and more, the modern system of training.

The knee joint is a master-piece of anatomic engineering, placed in each supporting column of the body, it is subject to severe stresses and strains in its combined functions of weight bearing and locomotion.
It meets requirements made of it with remarkable efficiency. To take care of the weight bearing stresses, it has massive condyles; to facilitate locomotion it has a wide range of motion; to resist the lateral stresses due to the tremendous lever effect of the long femur and tibia, it is reinforced at the sides by strong ligaments; to combat the downward 'pull of gravity and to meet the demands of such violent locomotor activities as running and jumping, it is provided with the powerful musculature. It would be difficult indeed to find a mechanism better adopted for meeting the combined requirements of stability and mobility of the knee joint (Luttgens and Wells 1976).

The movements which occur at the knee joint are primarily flexion and extention. A slight amount of rotation can take place when the knee is in the flexed position and the foot is not supporting the weight. The muscles acting on the knee joint are classified as anterior and posterior according to relation of their distal tendos to the transverse axis of the joint (Luttgens and Wells, 1976).

Twelve muscles act on the knee joint. These may be divided into three groups; hamstring group (semitendinosus, semi membranosus, biceps femoris), quadriceps femoris group (Rectus, femoris, vastus lateralis, vastus intermedias, vastus medialis) and unclassified group (sartorius, gracilis, poplitius, gastrocnemius, plantaris) (Rosch and Burke, 1978).

Till today lot of work has been done on the use of iso-kinetic exercises for the purpose of rehabilitations, testing and training of the sportsman. Schlinkman (1984) conducted tests using cybex isokinetic
machine to find out the hamstring/quadriceps strength ratio and prepared norms for the school football players.

Sentilles (1980) compared isokinetic off season training programme to an off season isotonic training programme in relation to development and maintenance of strength fitness in female athletes. Isotonic training procedures were concluded to be superior to isokinetic training methods for development and maintenance of strength in female athletes.

William (1984) conducted a study by flexon and extension strength of elite adolescent female track and field athletes. He found that the thrower tended to be stronger in absolute strength. However when expressed relative to body weight there were few differences in leg strength between these female competitors in the track and field events.

Thomas (1979) conducted study on 28 boys and 28 girls, age 7 - 13 years for the knee and elbow flexors and extensors and found significant sex differences for the knee flexors and extensors torque value of 120°/sec. independent of body weight. He also found that body size (height & weight) and age had a significant effect on the ratio at 120°/sec. but not at 30°/sec.

Isokinetic exercises due to the non-availability of isokinetic machines and complicated procedures are not very common in India. Chawla (1992) conducted study by using cybex 340 isokinetic machine in which quadriceps/hamstring strength ratio in school football players was analysed and found that the angle of peak torque was different in right and left quadriceps at all speeds and the hamstring was weaker.
than the quadriceps at all speeds in the right and left limbs.

Chawla (1994) conducted study on 80 subjects (20 subjects each from football, basketball, handball and volleyball) and found that there was no difference in peak torque ratio of quadriceps between dominating and non-dominating leg in cases of all the four groups. Volleyball group had higher peak torque ratio as compared to other groups in respect of peak torque strength in quadriceps and hamstring for both dominating and non-dominating leg at all speeds except in cases of hamstring at 180°/sec.

David et al (1987) studied 15 Baseball Pitchers, 15 non athletes and 15 swimmers and their bilateral strength was measured with a cybex II iso-kinetic dynamometer. In his findings dominant side values were higher than non-dominant side. These bilateral relationship illustrate a neuromuscular adaption that can be attributed to specific skill rather than to normal dextral activities.

No work has been done so far in India to find out the hamstring/quadriceps strength in track and field athletes. Thus the researcher was motivated to conduct a study on Indian track and field athletes to investigate and compare strength of quadriceps of right leg with hamstring of right leg and hamstring of right leg with hamstring of left leg and also to compare quadriceps/hamstring strength ratio of right and left leg and to compare quadriceps and hamstring strength ratio of throwers, sprinters, jumpers and middle distance runners. In addition to this the angle of peak torque and torque acceleration energy was also measured and compared.
STATEMENT OF THE PROBLEM

"COMPARISON OF HAMSTRING AND QUADRICEPS STRENGTH RATIO OF NATIONAL TRACK AND FIELD ATHLETES".

DEFINITION AND EXPLANATION OF THE TERMS

PEAK TORQUE

This is the highest torque value seen from all repetitions and all points in the range of motion (Maximum strength values achieved during test).

ANGLE OF PEAK TORQUE

This is the angle at which the peak torque occurs (Davies, 1987).

TESTING AT 60°/SEC SPEED

This is the speed at which the maximum strength is tested. Strength is defined in a variety of ways including the maximum force with one contraction or the maximum weight lifted in one repetition. In the context of iso-kinetic testing, strength is defined as any velocities at or below 60°/sec. It has been recommended that regular testing below 60°/sec. should be avoided because of stress on joint, and speeds less than 60°/sec are not functional (Davis, 1987).

TESTING AT 180°/SEC. AND 240°/SEC. SPEED

This is the speed at which power is being tested. Power is defined as the ability to produce force through a range of motion in a particular time. Velocity spectrum test provides information regarding the status of
the muscle under different rates of tension and functional speeds. The reason for testing at the fast contractile velocities (180°/sec. - 300°/sec) is because the angular velocities of various activities are very fast and the studies by Davies et al 1980, Wyatt and Edward et. al. 1981 state that the fast angular velocities are very common in sports (Davies, 1987).

**TORQUE ACCELERATION ENERGY (TAE)**

This is a measure of the "Explosiveness" of a muscle contraction. This is the total work in first 1/8 of a second (Davies, 1987).

**HAMSTRING/QUADRICEPS STRENGTH RATIO**

The ratio between agonists and antagonists muscle group is known as unilateral peak torque ratio. For every test pattern, the 340 automatically calculates the normally weaker muscle group peak torque as a percentage of the normally stronger muscle group peak torque. This calculations is performed for every test speed. In the present study the hamstring muscle group is considered to be the weaker muscle group where as quadriceps is the stronger muscle group. So the hamstring peak torque value divided by quadriceps peak torque value and multiplied by 100 gives us hamstring/quadriceps strength ratio value.

**OBJECTIVES**

The objectives of the study was:

1. To find out hamstring/quadriceps strength ratio in dominating and non dominating legs in track and field athletes.

2. To compare the hamstring and quadriceps of dominating and
non-dominating legs.

3. To compare the hamstring and quadriceps strength ratio of throwers, jumpers, sprinters and middle distance runners.

4. To prepare norms for different groups.

DELIMITATIONS

1. The study was delimited to junior and senior national level male track and field athletes, attended national camps at SAI, NS NIS, Patiala.

2. The study was delimited to flexion and extension movements of knee joint only.

3. For the isokinetic leg strength tests only cybex 340 system available in sport science faculty of SAI, NS NIS, Patiala was used.

HYPOTHESES

The isokinetic system has made it possible to test the functional capacity of muscle in motion and to measure the agonistic and antagonistic muscle at the same time. Much work has been done on knee flexion and extension. Different authors have studied different aspects of the knee movements. The studies have been conducted to find out the strength ratio of hamstring and quadriceps and to find out the difference in the injured knee and the normal knee in sports and clinical usage. Many rehabilitation technique have been developed.

The researcher being a sports person, is dealing with the problems faced by coaches and sportsmen in competitive sports. The present investigation involves track and field events and was attempted to find
out the solutions relevant to the problem. It was hypothesised that:

1. There may be a significant peak torque difference between hamstring and quadriceps of dominating and non dominating leg.

2. There may not be a significant strength ratio difference in between dominating and non dominating leg.

3. There may be a significant peak torque difference among different groups.

SIGNIFICANCE OF THE STUDY

The present study will be significant to the coaches and sportsmen of track and field events in the following way:

1. The study will highlight the state of knee flexors and extensors of the track and field athletes.

2. The study will provide a useful information to the coaches to develop training programmes.

3. The study will also help the athletes to assess their state of strength ratio.

LIMITATIONS

The subjects of the study were having different nature of habits, diet, personal exercises routine. They were from different places and having different socio economic status. It was treated as limitation of present study.