CHAPTER - II
REVIEW OF RELATED LITERATURE

In this chapter a brief review of studies that have appeared in various magazines, journals and books as available in Libraries of Lakshmibai National Institute of Physical Education, Gwalior and Netaji Subhas National Institute of Sports, Patiala has been presented. Only those studies which were most relevant to the problem being attempted by the investigator have been cited in chronological order. Some of the studies are related to isokinetic procedures whereas in some studies isotonic procedures have also been adopted to assess the performance or performance factors.

Carlson (1968) took male college students (N = 47) who were divided into three groups based on level of athletic achievement in the sports of football, swimming and cross country. The tests administered to each subject were a strength test of right elbow flexors and relative load isometric endurance test of the right elbow flexors while no difference in holding time were found between the three groups. Significant strength difference were noted. Theoretical consideration was given to differences in holding time which existed when subjects with high strength levels were compared to subjects with low strength levels.

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. Similarly, torque differences between boys and girls were present for elbow extensors at 120°/sec when adjusting for differences in height and concluded by size (Height & weight) age had a significant effect on the ratio at 120°/sec but not at 30°/sec.

Clarke and Mannign (1980) have studied properties of isokinetic fatigue at various movement speeds in adult males. They selected eight male subjects age 20-28 years. They were engaged in three fatigue bouts using isokinetic dynamometer. Maximum knee extension contraction were given. 100 repetitions were given at a rate of 30 repetitions per minute. Three contraction speeds chosen were 120, 160 and 200° /seconds.

They concluded that peak torque at 120°/sec was greater, that peak torque various inversely with movement speed and the pattern of decrement is independent of the speed. Time to peak torque does not appear to change significantly across trials in isokinetic fatigue.

Jerz (1980) studied two stipulated bouts of exercise for the development of strength and anaerobic power in college team (N = 18) pre and post tests. Strength scores were obtained isometrically, using method employed by Clarke, for leg extension and flexion, anaerobic power scores were assessed according to methods employed my Margaria. ANOVA indicated both treatment groups significantly improved in strength when compared to the control group, (P < 0.05). Significant difference between treatment groups were observed at the 115 degree angle of leg extension, varying slow bouts of isokinetic exercise. No
significant differences were observed between treatment group for leg flexion and anaerobic power.

Seventeen female inter-collegiate volleyball and basketball athletes volunteered as subjects and were randomly assigned by Sentilles (1980) to either an isotonic or isokinetic group. Subjects were pre and post tested by use of Clarke's cable strength tests. Both groups followed an eight weeks weight programme, the isotonic group using an universal trainer and the isokinetic group a power machine exercise stations consisted of bench press, lat pull, shoulder press, hamstring curl and quadriceps lift, statistical analysis, which consisted of a two tailed "t" test and student "t" test revealed that isotonic measures were superior to isokinetic procedures in developing or maintaining strength fitness in elbow flexion, shoulder flexion and shoulder abduction (P < 0.05). There was significant improvement on the shoulder press, quadriceps left and hamstring curl within the isokinetic group (P < 0.05) Isotonic training procedures were concluded to be superior to isokinetic methods for maintaining and developing strength fitness in female athletes.

Tesch and Davies et. al. (1980) conducted a study on U.S. cross country skier and found that male athletes ratio of knee flexion to knee extension at 45°/sec. speed in 61% (1 : 1. 63) where as in females it is 57% (1 : 1. 75) and the ratio at 240°/sec speed in male is 76% (1 : 1. 32) and in female 84% (1 : 1.19). He further stated that the strength ratio in upper and lower extremities is 40% (1 : 2.45) in male and 33% (1 : 3. 06) in females.
Davies et. al (1981) conducted a study on 91 professional football players (age 24.2 yrs, height 186 cm., and weight 97.99 kg.) for non specific peak torque for quadriceps and hamstring at 45, 180, 240°/sec and 300°/sec. In addition to quadriceps/weight ratio (Lbs), Height/weight ratios, hamstring quadriceps ratio was determined for each subject by position defensive line, defensive back, offensive line and offensive back etc. Mean ratios were as follows:

<table>
<thead>
<tr>
<th>Hamstring/Quadriceps</th>
<th>45°/sec</th>
<th>300°/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offensive line</td>
<td>51.0</td>
<td>75.2</td>
</tr>
<tr>
<td>Defensive line</td>
<td>64.9</td>
<td>80.4</td>
</tr>
<tr>
<td>Over all</td>
<td>60.9</td>
<td></td>
</tr>
</tbody>
</table>

Kirkendall and others (1981) carried out a study on 91 professional football players to determine the power curve of the quadriceps muscle group. 53 Veterans and 38 Rookies under going pre season physical examinations were assessed for non specific peak quadriceps torque at 45, 180, 240 and 300°/sec on a cybex II isokinetic dynamometer. Torques were converted to absolute (ft. lbs. sec\(^{-1}\), kg\(^{-1}\)) power units and grouped according to position. Peak torque at 45°/sec were highest in offensive line (269.7 ft. lbs) and lowest in wide receivers (187.1 ft. lbs). In terms of absolute power linebackers and offensive line obtained the greatest values (285 ft. lbs. sec\(^{-1}\)) with wide receivers having the lowest (218 ft. lbs. sec\(^{-1}\)). In relative power, offensive backs were the highest and
offensive line was the lowest (3.2 and 2.41 ft. lbs. sec\(^{-1}\), kg\(^{-1}\) respectively). Of interesting was the profile of the power curve. All positions except kickers, showed either identical or reduced power values from 240\(^{0}\)/sec to 300\(^{0}\)/sec indicating that the power curve levels off or declines at the highest test speeds. Peak power values for quarterbacks were attained at 180\(^{0}\)/sec. These profiles, while at different numerical levels are not characteristics of high power athletes. These data indicated that isokinetic peak power values could be obtained in this sample of football players and that the power curve did not resemble published relationships demonstrated for high power athletes.

Clarkson (1982) conducted a study, the relationship among isokinetic endurance initial strength level and fiber type. In this study knee extension isokinetic peak torque was assessed at angular velocity 0,30,80 and 240/sec. and endurance was assessed by so consecutive contractions of 180/sec. in eight college men. Also muscle fiber type of the vastus lateralis was determined and related to isokinetic strength and fatigue ability to determine the influence of initial strength on isokinetic endurance. The 60 serial isokinetic contractions were assessed after subjects performed bicycle exercise designed to affect initial strength level. The peak torque at 180\(^{0}\)/sec. at the start of the 50 contractions differed over the three conditions, also the pattern of three types of isokinetic fatigue were remarkably similar. Thus the initial strength level across the treatment did not affect the rate of fatigue. Thus factors other than, or in addition to fiber type and initial strength must influence
the rate of isokinetic fatigue.

Davies, Gould and Ross (1982) used cybex tests in their study on 113 college football players (226 knees) and found that 69% and 77% quadriceps/hamstring strength ratio at 60°/sec and 240°/sec speeds respectively.

Costain and William (1984) concluded in their study on adolescent female soccer players that extension peak torque values are greater than flexion peak torque values of 30° and 180°/sec speed. No significant difference in either hamstring or quadriceps torque was noted at fast or slow speeds when comparing dominating and non-dominating leg. It was also found that peak torque level decreases from the slow speed to the fast speed for both the quadriceps and hamstrings in both dominating and non-dominating legs.

Davies and Others (1984) conducted a study on class II cyclists and presented isokinetic normative data as follows:

<table>
<thead>
<tr>
<th>Muscle group</th>
<th>Speed</th>
<th>Peak torque Mean</th>
<th>Angle of peak torque Mean</th>
<th>Quadriceps/hamstring ratio Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quadriceps</td>
<td>60°/sec</td>
<td>162.0 Ft. lbs.</td>
<td>57.5 Deg.</td>
<td>55%</td>
</tr>
<tr>
<td>Hamstring</td>
<td>&quot;</td>
<td>93.5 &quot;</td>
<td>35 &quot;</td>
<td></td>
</tr>
<tr>
<td>Quadriceps</td>
<td>240°/sec</td>
<td>90.8 &quot;</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Hamstring</td>
<td>&quot;</td>
<td>62.5 &quot;</td>
<td>47</td>
<td>68.2%</td>
</tr>
</tbody>
</table>

Schlinkman (1984) has conducted test on 342 school football
players and has given norms for the school football players derived from Cybex Data Reduction Computer (CDRC). The norms are at 60°/sec. speed quadriceps in 113% and hamstring is 60% of the body weight percentage and quadriceps/hamstring ratio is 54%. At 240°/sec. speed quadriceps is 64% and hamstring is 42% of the body weight percent. The quadriceps hamstring ratio is 66% and at 300°/sec. speed quadriceps is 54% and hamstring 36% and quadriceps/hamstring ratio is 67%.

Thorland et.al. (1984) has conducted a study on isokinetic leg flexion and extension strength of elite adolescent female track and field athletes. He has taken 62 elite adolescent female track and field athletes and tested them on Cybex 11 isokinetic dynamometer at 180°/sec. The result of this study was that throwers 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. Given these results, in certain situations expression of relative strength may be preferred to absolute strength for comparison of female competitors.

Davies (1985) studied 223 patients with various knee pathologies. Cybex isokinetic computerized machine was used. Standard positioning with additional hip and chest straps were used for stabilization. Testing was done at 60°/sec., 180°/sec. and 300°/sec. speed. Means for quadriceps peak torque acceleration energy, total work and average power were measured and calculated. Bilateral comparisons to the uninvolved extremity demonstrated these values. At 60°/sec. ligamentous 19%
patellofemoral 20% meniscus 29% and 180°/sec. ligamentous 18%
patellofemoral 9% and meniscus 14% and 300°/sec. Ligamentous 18%
patellofemoral 9% and meniscus 14%.

Siewert et. al., (1985) compared the torque acceleration energy changes of the quadriceps following six week training programme. Twentyfour normal voluntary subjects were divided into 3 separate exercise groups. Each group performed 10 repetitions at the velocities of 60, 90, 120, 150 and 180 degree per seconds three times a week for six weeks.

Each group was pre and post tested at 60, 180 and 300 degree/sec. Data analysis included a standard t-test for significance between the difference of 2 means and analysis of variance and co-variance with repeated measures design.

Results demonstrated a statistical significance pre and post-test for the torque acceleration energy of the quadriceps group of 180 and 300 degree/sec. Also there was a direct linear relationship between average torque acceleration energy of the quadriceps and velocity for all groups.

Teagle, et. al., (1985) had studied the correlation between the flexibility of the quadriceps and hamstring and the strength of these muscles.

Eight subjects between the age of twenty and thirty years were tested using both legs. Flexibility tests included the 90°/90° test, straight leg raise, hip flexor, rectus femoris, abductor, hip internal rotation and
hip external rotation were conducted. Following this each leg was tested on Cybex II isokinetic dynamometer in the standard sitting knee position at 60, 180, and 300 degree/sec. speed.

A statistical analysis of the mean differences for the normal flexibility group versus the flexibility deficit group for the quadriceps and hamstring peak torque and flexion and extension torque. Acceleration energy resulted in no significant difference. However all the values for normal flexibility group were greater than the mean values for the deficit group.

David et. al., (1987) studied 15 baseball pitchers, 15 non-athletes and 15 swimmers and their bilateral strength was measured with a Cybex II isokinetic dynamometer. In this findings dominant side values were higher than non-dominant side. These bilateral relationship illustrate a neuromuscular adaptation that can be attributed to a specific skill rather than to normal dextral activities.

Davies (1987) had evaluated the quadriceps muscle functional performance in normal subjects and patients with previous knee pathology. 38 patients were taken and their uninvolved knee served as controls. Eleven patients had sustained ACL (Anterior curciate ligament) or MCL (Medical cruciate ligament) or combination of ACL/MCL sprain. Nine patients, two with bilateral involvement, had various pattellofemoral syndrome. Cybex testing using standard protocol was used. EMG was simultaneously recorded from the motor points of the rectus femoris and vastus medialis obigues during the dynamic testing. The mean torque
acceleration energy were analysed. They reported that at 60°/sec. Ligamentous injury 5.38 and at 180°/sec. 17.70 and 300°/sec. 25-26 and peltallofemoral syndrome at 60°/sec. 5.05 and at 180°/sec. 17.13 and at 300°/sec. 27.37.

Antol et. al., (1990) studied strength and jump height in figure skaters. Eighteen junior elite figure skaters were filmed while performing axel and double axel jumps. These same skaters were assessed for strength of shoulders, knees and hips at multiple angular velocities using a Cubex II system. The height of the jumps was significantly correlated with strength data. Knee extension at 240° deg/sec and shoulder abduction at 300 deg/sec were shown to be most important strength parameters in determining the height of the jump. This information may be useful for designing strength training programmes for figure skaters.

Anderson et. al., (1991) tried to compare the relationship among isometric, isotonic and isokinetic concentric and eccentric quadriceps and hamstring forces and three components of athletic performance in college aged, male athletes. Athletic performance was assessed using vertical jump performance, 40 yard dash time and agility run time. Findings showed there were no significant correlations between any quadriceps or hamstring force and vertical jump. It was concluded that isokinetic eccentric quadriceps and hamstring forces were no better predictors of athletic performance than muscle forces assessed in other ways. However, they may be more predictive of more specific components of performance.
Chawla (1992) in his unpublished work analysed the hamstring/quadriceps strength ratio in school football players and found that the angle of peak torque is different in right and left quadriceps at all speeds and the hamstring is weaker than the quadriceps at all speeds in the right and left limbs.

Gail, et. al.,(1992) studied relationship of timed sit up tests to isokinetic abdominal strength. The subjects performed concentric and eccentric isokinetic trunk flexion tests and sit up test. The finding of the study was that a weak relationship existed between isokinetic measure of abdominal strength and timed sit up scores. It was concluded that the timed sit up scores are not valid predictors of isokinetic abdominal strength.

Chawla (1994) conducted a study on 80 subjects to find out the quadriceps/hamstring strength ratio in ball team games. The data was collected on 20 subjects each from football, handball, basketball and volleyball. He found that there is no difference in peak torque ratio of quadriceps/hamstring between dominating and undominating leg in all four cases. Quadriceps peak torque was higher than the peak torque of hamstring in case of dominating and undominating leg at all speeds. Volleyball group had higher peak torque as compared to the other three groups. There was no difference in peak torque among other three in respect of quadriceps and hamstring at all three speeds.

William and Murphy (1995) examined the efficacy of several tests of muscular strength and power in their capacity to be related to
performance, their ability to effectively discriminate between individuals of different performance levels. Thirty healthy subjects performed the maximal tests of muscular function (i) vertical jump (ii) isokinetic knee extension (iii) isometric rate of force development. The isokinetic and vertical jump tests were significantly related to performance. However, the isometric rate of force development test was an ineffective assessment modality.