Chapter II

REVIEW OF RELATED LITERATURE

Sincere efforts have been made by the research scholar to locate literature related to this study. The relevant studies selected from various sources which the research scholar has come across are cited below.

Boleau conducted a study to find the effect of static, concentric and eccentric contraction training on the strength and girth of skeletal muscle. Forty four normal healthy male college students ranging in age from 17 to 20 acted as subjects. They were divided into four equal groups. The three experimental groups trained with static, concentric and eccentric exercise programme on three days a week for seven weeks using a six second bouts with a two minute rest between bouts. Pre and post training measurements of height, weight, dominant arm girth and isometric elbow flexion strength at an angle of 173°, 115° and 65° were taken on three alternate days. Resistance for training was

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two third of the maximal. Only control group failed to show statistically significant change at .05 level. After training the experimental groups differed significantly from the control group at .05 level but not from each other.

Smith conducted a study to determine by means of electromyography whether the action potential of the bicep and tricep differed significantly when the muscle were contracted isometrically, concentrically and eccentrically.

The subjects were 30 male college students selected on the basis of arm strength such that half were able to perform 5 or fewer pullups and half could perform 6 or more pull ups. Descriptive and electromyographical datas were collected on each subject. The bicep produced stronger action potential than the tricep on all 3 types of muscle contractions. There was no difference between the action potentials of isometric, concentric or eccentric muscular contractions for either biceps or triceps.

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Langton investigated the relative effectiveness of eccentric versus concentric strength training procedures and changes in static strength associated with changes in Reaction time and Movement time. Male college students (N=78) were divided into three groups: concentric, eccentric and control. No differences existed between the concentric and eccentric group where as significant differences existed between the control group and each of the experimental group on following parameters: movement time, static strength at 110°, static strength at 135° and static strength at 160°. Concentric and eccentric contraction training were both effective means improving static strength.

Danielson compared three group to find out the effect of concentric, eccentric and isometric training method on leg extension strength. A training and

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testing programme over a period of nine weeks had been given on an average training occurred three times a week. Isometric training was found most advantageous in improving strength than concentrically and eccentrically.

5Laycoe studied the effect of isometric and eccentric strength training programme on isometric leg strength. Forty five subjects were devided into three groups, matched according to initial isometric leg strength. One group was a non training control group, the second group trained eccentrically and third group trained isometrically. The training was three days per week for six weeks. Both the eccentric and isometric group showed significant increase in isometric leg strength over the control group but there were no difference between the two exercise groups.

Sotos conducted a study to determine the differences and size of the relationship between the degree of induced residual muscular soreness and concentric, eccentric and static contractions limb volume and muscular strength after 0, 24, 48 and 72 hours.

The subjects used were 60 volunteers, 53 women and 7 men and were assigned at random to one of the three groups (1) Concentric contraction group (2) Eccentric contraction group (3) Static contraction group. Maximum muscular strength and limb volume measurement were taken before exercise, immediately after the bouts and 24, 48 and 72 hours later soreness was measured by the subjects during the same time interval by means of a rating scale.

The result showed that eccentric contraction effected greater residual muscular soreness than concentric and static contractions with the peak occurring after 48 hours.

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Muscular strength decreased appreciably following eccentric contraction and remained depressed throughout the duration of the soreness period, while no significant differences in strength were found after concentric and static contraction. Limb volume increased in both, exercised and non exercised arms immediately after exercise regardless of the type of contractions after 24, 48 and 72 hours, however eccentric contractions effected continued elevated limb volume, while the return to the pre exercised values occurred after concentric and static contractions. Low correlation were obtained between limb volume and the degree of residual muscular soreness after concentric eccentric and static contractions and moderate negative relationship existed between muscular strength and soreness after eccentric contractions at a time when soreness had reached the peak.

7 Ferris conducted a study to find out the effect of eccentric and concentric—eccentric

contraction on measure of static and dynamic knee flexion strength as well as the 40, 50 and 60% relative static and dynamic knee flexion endurance on 28 male physical education majors ranging from 19 to 23 years of age. Subjects were assigned to 2 groups who were trained using eccentric and concentric eccentric contraction training for eight weeks followed Delorme's 3 set, 10 repetition 3 times/week progressive resistance exercise exercise routine. The only effects of either programme occurred on 5 of 6 measures of relative static endurance whereas eccentric contraction training and concentric - eccentric contraction training did not differ from each other in producing changes on knee flexion measures of static strength, dynamic strength and static and dynamic muscular endurance.

Komi studied the effect of eccentric and concentric muscle conditioning on tension and electrical activity of human muscle. Ten subjects

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8 Pavvo V. Komi, "Effect of Eccentric and Concentric Muscle Conditioning on Tension and Electrical Activity of Human Muscle."
served as controls and the rest were assigned to either an eccentric (N=11) or concentric (N=10) group. Experimental subjects went through a 7 week muscle conditioning programme in which they exerted either maximum eccentric or concentric contraction of their right forearm flexors 6 times daily 4 times a week. The average conditioning tension for the eccentric group was 40% greater than that of the concentric group. Several measurements were performed on each subjects before during and after the conditioning period. These included muscle tension and integrated EMG in maximal eccentric and concentric contractions and in submaximal (10%-90%) and maximal isometric contractions. The eccentric conditioning significantly increased isometric, eccentric and concentric tension. The concentric conditioning significantly increased only eccentric and concentric tension. On the average the eccentric conditioning increased muscle strength more than the concentric conditioning.
Michaels determine the effects of a concentric and an eccentric training programme on the vertical jump and also on concentric and eccentric leg strength of the quadriceps femoris muscle group. Subjects enrolled in collegiate PE classes were used. 2 groups, 1 concentric (N=14) and 1 eccentric (N=14) trained 3 days/week for 8 weeks and were pre and post tested on all 3 dependent variables. The vertical jump was also tested every 2 weeks throughout the training programme. Dependent 't' test within group for all dependent variables showed that the gain were significant. The concentric group gains on the concentric leg strength variable were significant at the .01 level. Anova of the between group XS on the eccentric leg strength variables was not significant. The eccentric leg strength variable indicated a significant F. A 2 x 4 repeated measure anova of the \( \bar{X} \) vertical jump scores indicated there was no significant difference in training programme, there was a significant difference in median vertical jump

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scores across the 4 testing periods, a trend analysis indicated a highly significant linear trend across the 4 testing periods but no significant quadratic or cubic trend and the interaction of treatment trials was no significant.

Friden and Sjostrom investigated to assess the effect of sustained eccentric training on muscle strength and structure. Nine male subjects (17-28 years) took part in an eccentric exercise training programme involving use of a modified bicycle ergometer. The subjects trained two to three times a week for two months; each time until exhausted. The subjects experienced pronounced soreness of the knee extensors paralleled by slight decrease in concentric power during the first two weeks of training. The symptoms of sore muscles gradually disappeared and after training a slight increase in maximal concentric power at all angular velocities was seen. The performed eccentric work (pre-post training increased from 1100 kpm (12 min) to 1650 kpm (30 min) i.e. by 375%). Most subjects improved in sprint performance,

but only slightly, neither the $V_{\text{O}_2 \text{ max}}$ nor the over all muscle morphology were affected.

Despite the large amount of work carried out no effect on central circulation was seen. The considerable improvement in endurance strength indicates that the muscle fibers adopted to the high tension developed during eccentric contractions. Therefore the adaptative mechanism needs to be further enlightened.

11 Hebel studied the effect of hill running on endurance and muscle strength. Fifty four subjects ranging from 25 to 30 years of age completed this study and were included in one of the six groups 220 yds downhill (N=9) 220 yrd flat (N=9); 220 yds uphill (N=9); 880 yds downhill (N=7) 880 yds flat (N=10); 880 yds uphill (N=10). Dependent variables were 10 K time, muscle torque and endurance for four muscle groups. It was concluded that downhill training could improve torque and endurance (knee flexion) and a combination of uphill and downhill training can strengthen the dorsiflexion muscle group.

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Marshall conducted a study to determine the effect of eccentric work and its comparative contribution in the development of power and strength. Three different strength training techniques were used and compared. Three groups of untrained subjects (male and females N=13) were trained for ten weeks using on the three prescribed methods. Pre-test and post test measures were taken for muscle girth, body fat percentage, performance on cybes at three different speed of arm flexion and leg extention and 1-RM strength tests using nautilus machines.

Result varied as to testing method used, when nautilus was used as a testing modality no significant differences by group were found. When cybex was used as testing modality using three different speeds (30°, 60° and 120° per second) the concentric only group performed significantly better than the eccentric only group and the concentric/eccentric group. For the females, no significant differences in response to training group were noted.

Mohammed and Ibrahim conducted a study to find out the relative effectiveness of an uphill sprint, a downhill sprint and a zero level sprint upon maximum speed over a distance of 30 meters; flying starts over a distance of 20 mts; stride length; stride frequency and sprinting technique. Fifty untrained male students of sports education college at Baghdad University, Baghdad, (Iraq) were randomly selected to serve as subjects. They were devided into four treatment and one control group. No significant difference were found between groups for flying start, maximum speed, stride length, stride frequency and sprinting technique. The four groups who were involved in training programme improved significantly in maximum speed, stride length and sprinting technique, from the pretest to the post test. The uphill-downhill training programme increased stride frequency more than the uphill and zero level training programme. The downhill training programme increased stride frequency more than the uphill training programme.

Ellenbecker, Davies and Rowinski conducted a study on concentric versus eccentric isokinetic strengthening of the rotator cuff. Twenty two male and female college varsity tennis players were trained for 6 weeks, one group had used eccentric isokinetic internal and external shoulder rotation and the second group, concentric isokinetic internal and external shoulder rotation. Subjects were pretested and post tested both concentrically and eccentrically, so that training overflow and specificity could be examined. Three maximally hit tennis serves made before and after training, which were analysed by high speed cinematography to obtain ball velocity served as functional performance measurement. Functional test analysis shown an increase in maximal serve velocity at a significant level of P<0.005 in the concentric group, with no significant (P>0.01) increase in the eccentric group.

Anderson compared the relationship among isometric, isotonic and isokinetic concentric and eccentric quadriceps and hamstring forces, were measured using a Kin com for each method of strength assessment. Force per body weight (F/bw) data were determined for each subject. The force which was the best predictor for 40-‐yd dash time was the right peak isokinetic concentric hamstring force at 60°/Sec (R=570). The force which was the best predictor for agility run time was the left overage isokinetic eccentric hamstring force at 90°/Sec.

There was no significant (P 0.05) correlations between any measured force and vertical jump. Eccentric muscle force was determined to be no better predictor of general athletic performance than muscle force assessed in other ways. However it may be a better predictor of some component of athletic performance such as agility. Even though there were significant correlation between force variables and performance measures Prediction equations were

formulated for 40 yd dash and agility run. It was concluded that because of the limited amount of variance in performances, explained by the force variables, force measures from a clinical tool such as the kincom should be used to meet clinical goals and not be interpreted as a measure of functional capacity of readiness.

16 Poulin et. al conducted a study to compare the strength of knee extensors and elbow extensors in young and older men under conditions of eccentric loading and concentric contractions. Twelve men ages 23 to 32 years and 12 ages 60 to 75 years were tested at two angular velocities of movement, 90 and 180 on a kincom isokinetic dynamometer. Compared to young men, older men had lower concentric peak torque values for elbow (31%) and knee (32%) extensors (P < 0.05). The older group showed lower eccentric peak torque on all elbow comparisons (21%). At the faster velocity, knee

extension eccentric peak torque did not differ from the younger men. Differences between the age groups were significantly less for the eccentric muscle action than for the concentric one. The observation of maintained eccentric strength in older men particularly at fast velocity, warrants research in defining the mechanism.

Berger conducted a study to determine the optimum number of repetition with which to train for quickest strength improvement. Nine groups consisting of a total of 199 male college students were tested before and after 12 weeks of progressive resistance exercise. Each group trained differently in repetition per set. Resistance employed were 2 RM, 4 RM, 6 RM, 8 RM, 10 RM and 12 RM for one set. The optimum number of repetition was found to be between 3 and 9.

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Rasch and Morehouse did adequate research in
isometric and isotonic training by comparing the
effect of pressing and curling dumbbells with a static
movement and isotonic movement exerted at two third of
each subjects strength. In this study, the strength
gains of the subjects, practicing isotonically were
significantly greater than for those employing
isometric contractions.

Marely studied the comparative effectiveness
of isometric and isticnic exercise in the development
of muscular strength, endurance and girth. Three
groups were used, one group trained with isometric
exercises, the second group used isotonic exercises
and the third group served as control.

18 Philip J. Rasch and Laurence E. Morehouse,
"Effect of Static and Dynamic Exercise on Muscular
Strength and Hypertrophy." Journal of Applied
Physiology 11 (1957):29.

19 William P. Marley, "The Comparative
Effectiveness of Isometric Exercises and Isotonic
Exercise in the Development of Muscular Strength,
Endurance and Girth." Completed Research in Health,
Subjects were tested several times before and after the ten week training programme. Isometric and isotonic exercises appeared equally effective in developing strength but isotonic exercise was more effective in developing muscle size, although size as measured was not proportional to strength.

Tony conducted a study on comparison of the effects of selected exercise, isometrics and isotonics on explosive power and leg strength. Dynamometric leg strength and sargent jump test were given to 22 Springfield college freshmen basketball candidates who were randomly divided into three groups that practiced separate exercise programmes three times a week for four weeks before being retested. Group A with eight subjects practiced squat jump, back board touches, run in place and jumping rope. They increased 40 pound in leg strength and 9" in jumping, on the average Group B (75) practiced isometric heel raised and three quarter knee bends and increased 43 pounds and 1.2" in jumping. Group C (75) with

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isotonic heel raises and three quarter squats increased 151 pounds and 1.6 inches. Analysis of covariance indicated that the mean gains were not significant at the .05 level.

21 O'shea undertaken a study to determine the effects of a six week progressive weight training programme on the development of strength and muscular hypertrophy, using one exercise, the deep knee bend, with varying repetition. Thirty students were chosen by random from beginning weight lifting classes at Michigan State University following a two week conditioning period the subjects were divided into three groups of ten each for the controlled training period. The programme were as follows: Groups A-3 sets of 9-10 repetitions, Group B-3 sets of 5-6 repetitions and Group C-3 sets of 2-3 repetitions. Individual in each group handled maximum weights loads for the number of repetition each was required to perform. The effectiveness of the programme was determined by three measurements: (a) thigh girth (b) dynamic strength as measured by one RM on the deep

knee bend and (c) static strength as measured on the
dynamometer. The results were graphically analysed
and percentages calculated. The data were also
statistically treated using analysis of covariance.
No significant differences were found between the
three systems of training. All training procedures
resulted in the improvement of static and dynamic
strength.

22Morris conducted the study in an attempt to
determine the comparing effects of isometric and
isotonic weight training methods, used as supplement
to interval distance running training of the quadriceps
muscle group and on performance in the middle distance
running event. Four groups of thirty subjects each
were obtained on the basis of sampling by random
selection and random assignments. After eight week
training programme the result showed that both
isometric and isotonic weight training improved

22McKinley William Morris. "The Effect of
Isometric and Isotonic Weight Training Exercises Upon
Quadriceps Strength and Performance in Middle Distance
Running Event." Dissertation Abstract International 28
(June 1969):4309-A.
quadricep strength and middle distance running time more than an unsupplemented interval middle distance running training programme. Further the result indicated that isometric weight training as a supplement to interval running training increased the strength of the quadricep muscle group as well as middle distance running time more than the isotonie training programme, when used as supplement to interval running training.

Philip studied the electromyographical analysis of specific muscles while used in performing selected isotonic weight training activities. The result of the study indicated that the muscle training of one muscle group increased the strength of the trained muscle and also that of the antagonist muscles. It was apparent that muscle which function antagonistically may contract simultaneously and muscle which acts as agonist antagonists and stabilizer may be voluntarily and intermittently contracted during a specific activity.

Mckethan studied the effect of a training programme involving isometric, istonic and a combination of isometric and istonic on quadriceps strength and vertical jumping ability. 24 male subjects were assigned to 3 experimental and control group. Vertical jumping performance was evaluated by the jump and reach procedure and cable tension tests were used to measure quadriceps strength. The training for the isometric group involved 16 seconds maximum isometric bout at each of 90°, 110° and 130° of knee extension. The isotonic group trained by utilizing maximum knee extension. The combined group trained by performing an isometric contraction at 90° and then completing the knee extension against isotonic resistance. The quadriceps strength of the isometric exercise group was greater than that of the control group. Other among groups comparisons were non-significant, within group gains in quadriceps strength occured for each of the three training Procedure and there were no difference among or within the groups in relation to vertical jumping ability.

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Staheli conducted a study on comparison of the effects of isokinetic and isotonic exercise methods on leg strength, vertical jump and thigh circumference. The isokinetic methods employed the Mini-Gym power racks. The isotonic method employed the olympic barbell and universal Gym leg press machine. Eighty male students were assigned randomly into four treatment groups as follows: Group A, power racks; Group B, leg press; Group C, squat and Group D control. Pre and post tests were administered on right and left knee extension strength, right and left hip extension strength, vertical jump and right and left thigh circumference.

Through an analysis of variance and Tukey's studentized range test significant differences were found and the following conclusion were drawn; (a) The power rack, leg press and olympic barbell group each showed significant improvement in all criteria measures; (b) No significant differences were detected among the leg press, olympic barbell or power rack groups.

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