Chapter II

REVIEW OF RELATED LITERATURE

A review of the research reports related to the present study that the reason scholar could gather, is presented in this chapter in order to provide the back ground material to evaluate the significance of this study as well as to interpret its findings.

Price and fishes\(^1\) studied the effects of three weeks weight training programe on strength, endurance, girth measurements and body composition. Seventy six female students were randomly divided into four groups with each of the four classes.

After the treatment period, the three experimental groups experienced significant increases in strength and muscle endurance, and significant increases in the three of the seven girth measures, all skin fold measurements and percent body fat in comparison to the control group.

Mc peak\(^2\) studied the effects of an interval training program on aerobic, anaerobic and anthropometric parameters in women between thirty and thirenine years of age. The interval training program involved controlled running calisthenics and weight training. The results allow the

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conclusion that all of the parameters but three that is weight, body surface area and elbow flexion strength can be positively changed by providing a seven and one third week of submaximal interval training programme for women.

Edelstein\(^3\) studied the change in strength, girth and adipose tissue of the upper arm resulting from daily and alternate day progressive weight training. The conclusion was that the strength and girth of the exercised arm increased in both group and the adipose tissue decreased, but the final mean differences were not significant.

Hosler\(^4\) studied the electro myographic, strength and girth alterations in selected male and female subjects consequent to a seven week strength improvement program. The two experimental groups considered of nineteen male and twenty three female volunteers. The two control groups were of eight males and twelve females. According to the date collected and analyzed, the following conclusions were drawn:

1. The experimental design of the investigation demonstrated that surface electromyorgrams were reliable for both male and female subjects in a test re-test situation.

2. Following a particular seven week strength improvement

\(^3\) Elliott S. Edelstein. "Changes in Strength, Girth and Adipose Tissue of the upper arm resulting from daily and alternate day progressive weight training" Completed research in Health. Physical Education and Recreation 7 (1965), 99

\(^4\) Willin Wolker, Hosler. "Electromyographic, strength and girth alterations in Elected male and female subjects consequent to a seven week strength improvement program" Dissertation abstracts international 36 (January 1976), p. 327.
program, both male and female subjects significantly increased their quadriiceps strength. However, only the male subjects experienced a significant increase in their high girths during the same period.

3. Consequent to strength training both men and women demonstrated a significant decrease in the action potential required to extend the lower leg against a sixteen pound load. However only men showed a significant decrease in action potential required for lower leg extension against a twenty six pound load.

There was no significant association between quadriiceps action potential and quadriiceps strength for either male or female subjects.

Sanders\textsuperscript{5} studied the effects of a program of progressive resistance exercise on strength muscle girth and body composition of college women. Fifty two college women participated in the study. Twenty serving as control and thirty two participating in ten weeks of progressive resistance exercises. The data gathered were statistically analysed using test and analysis of covariance. It was concluded that this program of progressive resistance exercise produced marked increases in strength, with no significant effects on muscle girth or body composition.

Hansen\textsuperscript{6} studied the effect of be Lorme Hatkins method of training.

\textsuperscript{5} Rose Thoman, Sandero, "The effects of a program of progressive resistance exercise on strength, muscle girth and body composition of college women" Dissertation abstracts international 36 (May 1976), 7276.

\textsuperscript{6} Leslie C. Hanson, "The effects of three selected weight training programs on muscular strength, endurance, girth and cardio-vascular endurance" Completed research in health, Physical Education and Recreation 12 (1976), 205
traditional strength training and circuit training program on muscular strength, endurance, girth and cardio-vascular endurance of thirty inter-varsity football players. They were divided into three groups. Training covered a period of seven weeks, three times a week. Tests of muscular strength, endurance and girth were administered before the program began, at the end of three weeks of training and at the conclusion of the training program. All groups significantly improved on all the parameters and there was no significant difference between the groups.

Harris\(^7\) studied the effects of isometric and isotonic training programs on leg extension strength, leg extension power, leg speed, leg reaction time, muscular girth of the calf, thigh, hip and leg flexibility. Sixty male students were divided into three groups of twenty. The three groups were isotonic group, isometric group and a control group. Analysis of variance was used as the statistical analysis in the study. The results revealed a significant difference in the measurement for leg speed, reaction time and flexibility. The scheffes test indicated that the isotonic training methods made more significant contribution to leg extension strength and girth of the hips than did isometric training. A conclusion of the statistical treatment indicated that there was not enough statistically significant evidence to support the hypothesis that one training method could be selected over the other.

\(^7\) Irvin David Harrish, "The effects of Isometric and Isotonic training programs on selected variables" Dissertation abstracts international 30 (December 1969), 2359.
Oyster studied fourteen women champion tennis players on a high intensity weight training program for seven weeks. Significant strength increases were found in the lower extremity measurements of ankle planter flexion and hip flexion. All other strength measures, except elbow strength, showed increases although not significant. These strength increases were accompanied by decreases in all girth measurement (calf girth, pectoralis and lower arm girth) decreased significantly. There of the four skinfold measurements also decreased although not significantly. There was also a decrease in percent body fat and a slight decrease in weight. Neither of these were significant.

Boyd studied the physiological effect of two variable resistance weight training programs on males and females with the age range from 10 to 35 years. The results revealed that all the groups gained significant increases in shoulder abduction (power and endurance) while the female groups were the only group to increase in strength. Body composition results indicated significant increases for all groups in body density and lean body weight (except female strength). Girth measurements results showed significant increases in thigh and biceps for all groups. Skinfold measurements showed a significant decrease in tricep and bicep measurement. Work on treadmill showed significant increases in only the female endurance group.

8. Nancy Oyster, "Effects of Heavy resistance weight training program on college women athletes" Journal of sports medicine and physical fitness 19 (March 1979), 79.
Shea\textsuperscript{10} studied the effects of selected weight training programs using varied repetitions on the development of strength and muscle hypertrophy. Thirty students were chosen at random for a six week progressive weight training programme. The subjects were divided into three groups of ten each. The programmes were as follows: Group A-3 sets of 9-10 repetitions, Group B-3 sets of 5-6 repetitions, and Group C-3 sets of 2-3 repetitions. The effectiveness of the program was determined by three measurements - a) thigh girth b) dynamic strength and c) static strength. Analysis of covariance revealed significant differences between the three systems of training. All training procedures resulted in the improvement of static and dynamic strength.

Logen\textsuperscript{11} carried out a study on the effects of energetic exercises and weight training exercises upon upper arm and shoulder strength for women. It was concluded that a weight training program and a systematic easier program produced significant increase in selected measures of upper arm and shoulder strength.

Terbisan\textsuperscript{12} studied the effects of set repetitions combinations on strength gain using isotonic strength training in females with age range from 18 to 35 years. Analysis of the data using covariance indicated that

\textsuperscript{10} Pat O'Shea, "Effects of selected weight training programs using varied number of repetitions on the development of strength and muscle hypertrophy" Strength and Health 38 (June 1970), 32.

\textsuperscript{11} Marty Ann. Engen, "The effects of Exer-Genie exercises and weight training exercises upon upper arm and shoulder strength for women" Completed research in Health, Physical Education and Recreation 10 (1965), 64.

\textsuperscript{12} Donna Jeon. Terbisan, "The effects of set repetition combinations on strength gain using isotonic strength training in female" Dissertation abstracts international 430 (November 1982), 1470.
the strength training groups increased in strength when compared to the control group, but there was no difference in strength between training groups. The absolute maximum strength gain also increased in relative strength ratio. The body composition of the subjects changed by increasing in lean body mass. There was no significant changes in skin fold and girth measurements.

Helling\textsuperscript{13} investigated the effect of isotonic training, isokinetic training and jumping practice on the vertical jump performance of college age women. Sixty three college female were assigned to three training programs (isotonic, isokinetic and jumping) and one control group. Each subject was given two pre-tests and two post tests on a modified vertical jump test. Subjects trained three days per week for six weeks. An over was the statistical treatment used in this study. The results revealed that isokinetic and isotonic training groups were the only treatments to significantly improve vertical jump ability.

Mekethen and Nayhaw\textsuperscript{14} studied the effects of nine weeks training program involving isotonics, isometrics and combined isometric and isotonic on quadriceps strength and vertical jump performance. Isotonic significantly increased quadriceps strength, while an isometrically trained

\textsuperscript{13} T. R. Helling, "Effects of Isotonic training, Isokinetic training and jumping practice on the vertical jump performance of college age women" Completed research in Health, Physical Education and Recreation 23 (1981), 223.

\textsuperscript{14} J. P. Mekethen, J. L. Mayhow, "Effects of Isometrics, Isotones and combined Isometrics and Isotones on Quadriceps strength and vertical jump" Journal of sports medicine and physical fitness 14 (September 1974), 224.
group did not significantly differ from control group. Combined isometric – isotonic effected subjects with low pre-training quadriceps strength training to a greater extent than it did there with high intial strength.

Tucker\textsuperscript{15} studied the effect of a systematic weight training program on sprintess start in track ten colleges sprinters were timed over a distance of fifteen yards from a normal starting position for sprinters. An experimental group performed three weight training exercises, three days a week. The control group participated in regular track workout. A post test was administrerd after eight weeks. There was no significant difference in mean gains between the two groups for reaction time. However, there was a significanance difference in favour of the experimental group in the mean gains for acceleration time.

Flynn\textsuperscript{16} studied leg strength, leg power and sprinting speed on twenty two college men to compare the difference between exercising each leg individually and both leg simultaneously. Results indicate that the weight training methods which employ one leg at a time and both legs simultaneously will improve leg strength and power. There is also an indication that exercising each leg individually is better for the development of leg strength then exercising both legs simultaneously. Neither method significantly improved sprinting speed.

\textsuperscript{16} Paul D. Flynn, "Leg strength. Leg power and sprinting speed as affected by a selected weight training program" Completed research in Health, Physical Education and Recreation 15 (1973),124.
Sarnes\textsuperscript{17} studied the effect of weight training on speed in hundred yards clash. Two groups of 9 boys were equal initially on hundred yard time one group had fourteen week of physical education with basket ball tumbling, volleyball, dodge ball and the other group spent equal time in progressive weight-training with three set of eight reputations. In half squats, curls and full knee bends. Both groups ran two hundred yards dashes for times per week. The mean gain of the physical education group was from 13.3 to 13.1 seconds and the mean gain of weight training group was from 13.4 to 12.7 seconds.

Seay\textsuperscript{18} studied the effects of on eight week training programme on cardiovascular fitness. Thirty six made college students under went in eight week nautilus training program. They were assigned to one of the four groups, control groups, only Neutilus training group, combined training group. Nautilus training and off season soccer practice and spring training group. The stastics involved were analysis of convariance A test and F Ratio. In conclusion, an eight week Nautilus training program was found to be beneficial in significantly increasing cardiovascular fitness. In addition, submaximal heart rates were appreciably lowered though changes in resting heart rates did not significantly change at the .01 level. There were also changes in resting blood pressure as a result of training program.

\textsuperscript{17} Richard Sarnes. "The effects of weight training on speed in the 100 Yard Dash" Completed research in Health, Physical Education and Recreation 6 (1964), 60.

\textsuperscript{18} William Jesse Seay. "The effects of on sight weak Neutilus training program on Cardiovascular fitness" Dissertation abstracts international 39 (February 1979), 4809.
Capen\textsuperscript{19} studied the effects of systematic weight training on strength, athletics power, muscular and cardio-respiratory endurance. Two groups of students were used in this study. Group A attending weight training class while group a participated in a conditioning class. Both the groups met twice week for eleven weeks. The groups were tested in muscular endurance, muscular strength, cardio-respiratory endurance and athletic power prior to and after twelve weeks of the experimental period. Analysis of the data received that there was no significant differences between two groups in muscular endurance or in circulo-respiratory endurance. As would probably be expected group. Programme gave greater general improvement in muscular strength then did group B program. In power events however group a had intial test that over aged higher then group. As yet group a improved significantly more in there “speed events” than did

Covey\textsuperscript{20} studied to determine the effect of training at various heart rate intensity on cardio – respiratory fitness of fifty subjects who were divided into five equal groups. Four experimental groups were trained on a motor driven tread mill at 60,70,80 or 90. Intensity levels for a distance of one mile, four days a week for a period of six weeks one group served as the control group. maximum vo2 max, maximum heart

\textsuperscript{19} Edward K. Capen, "The effects of systematic weight training on power, strength and endurance" Research Quarterly 21 (May 1950), 83.

\textsuperscript{20} Richard B. Covey. "The effects of training at various Heart rate intensities on cardiorespiratory fitness" Completed research in Health, Physical Education and Recreation 15 (1973), 135.
rate, resting heart rate and workload changes were examined by anova from pre-test and post test. The 90% level was found to be better than other levels studied in reducing resting heart rate. Work load changes occurred at 70,80, and 90% intensity levels with 80 and 90% levels better than the 70% level in increasing the capacity to do work. The threshold level for effecting change was found to be the 70% level with optimum level of intensity for effecting greatest gains was found to occur at the 80% level of intensity.

Hurley et Al\textsuperscript{21} conducted a study on thirteen healthy, untrained (age 44 ± 1 year, range 40-55 years) to determine the effect of sixteen week of high intensity variables resistance, Nautilus strength training on cardio vascular function. A control group consisting of then untrained males under went the same evaluation procedure as the training group. Maximal oxygen uptake, cardiac out during sub-maximal exercise and body composition were determined before and after training. It was concluded that the muscular strength increased marked, as evidenced by a 44% average increase in the "one repitation maximum” in the various exercises. Body weight and percent fat did not change with training, though fat free weight did increase significantly, maximal oxygen uptake did not change significantly in any of the groups.

Meneval\textsuperscript{22} studied eighty males subject to determine the effects of a three day per week, eight week variables resistance weight training program in $\text{VO}_2$ max, body composition, performance and two mile run, resting heart rate, exercise heart rate, time to 170 heart rate, blood pressure and systolic tension time index. Subjects were randomly assigned to a high intensity circuit weight training equipment for a period of eight week. It concluded that the Nautilus segments of high intensity or low intensity does not effect the performance of two mile run.

Chui\textsuperscript{23} studied the effect of isometric and dynamic weight training exercises upon strength and speed of movement. It was observed from the study that gain in strength were accompanied by gain in movement speed without resistance but the difference between the exercise groups were not significant at 0.5 level.

Masley et al\textsuperscript{24} studied weight training in relation to strength, speed and co-ordination. Sixty nine subjects were distributed as follows: 24 in weight training group, twenty six in the control (Volley ball) group and 19 in the control (sports lecture) group. The weight training program was for a period of eight weeks. It was concluded that a similar period

\textsuperscript{22} Mark W. Meneval "The effects of variable resistance circuit weight training on cardiovascular fitness and body composition" Completed research in Health. Physical Education and Recreation 24 (1982), 90. 

\textsuperscript{23} Edward F. Chui, "Effects of Isometric and dynamic weight training exercises upon strength and speed of movement" Completed research in Health. Physical Education and Recreation 7 (1965), 59. 

\textsuperscript{24} John W. Masley, Ar a Hairabedian and Donald H. Donaldson "Weight training in relation to strength, speed and co-ordination" Research Quarterly 24 (October 1953), 308.
of volley ball or in activity. A larger increase in speed and co-ordination resulted from six weeks of weight training than the other groups. Increased strength gain through training with weights was apparently associated with increased muscular co-ordination and speed of movement.

Payne\textsuperscript{25} conducted a study to determine the influence of strength on speed of movement in eighth grade girls. Seventy two eight grade girls were divided into two experimental groups, one using an isometric exercise program, the other using an isotonic program. A control group played lead up games during the experimental period. Prior to training, correlations indicated a rather high relationship between static strength and speed of dominant arm movement. Following training there was little relationship between static strength and speed of specific arm movement. The results of the training program indicated an increase in the mean performance in all three groups with isotonic group being superior.

Masaey and Chaudet\textsuperscript{26} conducted a study on the effect of systematic heavy resistance exercise on the range of movement in certain selected joints of young male adults. An experimental group (n=13) trained with weights for approximately six months during which the control group

\textsuperscript{25} L. Anne Payne, "The influence of strength on speed of movement in eight grade girls" Research Quarterly 39 (October 1968), 653.

\textsuperscript{26} Benjamin H. Massey and Horman L. Chaudet, "Effects of systematic, Heavy resistive exercise on range of joint movement in young male adults" Research Quarterly 27 (March 1956), 41.
(n=13) participated in a general physical education activities. Weight training did not have an appreciable effect upon range of joint movement throughout the body. A significant decrease did take place in the ability of the experimental group to move the extended arm from a position at the side of the body, backward in the anterior posterior plane.

Larson et al.\textsuperscript{27} studied muscle strength and speed of movement in relation to age and muscle morphology. Maximus values for isometric strength, dynamic strength and speed of movement in the quadriceps muscle was measured in 114 male’s subjects who were between 11 and 70 years of age. Isometric and dynamic strength increased up to the third grade, remained almost constant to the fifth grade and decreased with increasing age. To chemical changes in the muscles tissue such as decreased proportion of type II fibres and selective hypertrophy of the type II fibre were seen with increasing age.

Zorbas and Kerpovich\textsuperscript{28} conducted a study on the effect of weight lifting upon the speed of muscular contraction. Six hundred men, whose ages ranged from 18 to 30 years acted as the subject for the study. They were divided into two groups, a control group and an experimental group.

It was concluded that the weight lifting group was faster in there rotary motions of the arm then the non-weight lifters. The non weight


\textsuperscript{28} William S. Lorbes and Pater V. Karpovich. "The effects of weight lifting upon the speed of muscular contractions" Research Quarterly 22 (May 1951). 145.
lifters from spring field college were faster than their non-lifters from the liberal arts college. This is probably because they engage in physical activity more than the students of Liberal Arts College.

Jutton\textsuperscript{29} studied the effectiveness of specific abdominal exercises on reduction of segmental volume and subcutaneous fat of the abdomen region in college women. The volunteer female subjects enrolled in gymnastics, volley ball, swimming and ice skating at masoorie. They were tested initially and after the training period of six weeks for subcutaneous fat. They were divided randomly into control and experimental group. It was concluded that the specific abdominal exercises was significantly more effective in reducing segmental abdominal volume than generalized exercises when body weight remained unchanged in college women during a six week, three days per week exercise program on adipose tissue in the abdominal region however was not significantly reduced by either specific or generalized exercise when body weight remained unchanged. There was low positive relation ship between abdominal volume and adipose tissue.

Katch\textsuperscript{30} at all studied the effects of a twenty seven days sit up exercise training program on adipose cell size and adiposity. Fat biopries were taken from abdomen, subscapular and gluteal slides by needle


aspiration in thirteen experimental and six control male subjects before and after a fix day per week progressive training segment. Repeated measure anova revised significant decreases in cell diameter at three biopay sites, but there is no significant difference in the rate of change (pre to post) in cell diameter between cities for the experimental and control group. Body weight, total body fat, fat folds and girths remained unstirred. The results revealed that the conventional sit up does not pre parentally reduced adipose cell size or subcutaneous fat thickness in the abdominal region to a greater extent compared to other adipose sites. Significant change in fat cell size may occur in the absence of changes in fat cell size may occur in the absence of changes in fat folds, girth, total body composition.

Mayhew and Gross\textsuperscript{31} studied the body composition changes in young women with the high intensively training. Seventeen college women under went a comprehensive weigh training program of 40 minutes session three days a week for nine weeks. Significant increases in total body potassium, lean body mass, flexed bisceps, forearm girth and shoulder width resulted from training also relative fat and chest dept was decreased while skin fold thickness and body weight were uneffectted. Over the same period, a sedentary control group showed no significant changes analysis test. It was concluded that high resistance weight training

\textsuperscript{31} Mayhew and Gross, "Body composition changes in young women with High Resistance Training" Research Quarterly (December 1974) cited by H. Harrision Clarke, Physical Fitness Newsletter series XXI No. 7 (March 1975) 6.
comencehance feminine body composition without commitment maculating
effects or marked changes in body weight.

Olson & Adelestein\textsuperscript{32} studied the spot reduction of subcutaneous
adipose tissue. Skin fold measurements were taken on both arms of 32
high school boys. One arm served as control, the other arm completed
three sets of 7 RM curls and three sets of 7 RM schedule for six weeks.
The results indicate that hard exercise in a specific area of the arm
causes reduction of the adipose tissue in that arm.

Mohr\textsuperscript{33} conducted a study on thirty women, aged 18 through 45
in Iowa City, IOWA to determine changes in waist line, abdominal girth
and subcutaneous fat following segment of six isometric abdominal
constructions held for 6 seconds each. The exercises were done daily
for a period of four weeks, with no additional change in weight. Significant
reductions were obtained in girth, subcutaneous fat at the waist line and
the level of the abdomen.

Hilburn\textsuperscript{34} studied the effect of weight training on gaining of weight.
Sixty boys were divided into two equal groups. The weight training
group used to standard exercises with 2 set of 8-12 reputations. Pull
ups, sit ups with weight and rops skipping. The control group had basket

\textsuperscript{32} Arne L. Olson and Elliott Adelestein. "Spot reduction of subcutaneous Adipose Tissue" Research
Quarterly 39 (October 1969), 667.

\textsuperscript{33} Dorothy R. Mohr, "Changes in Waistline and Abdominal Girth and subcutaneous fat following
Isometric exercises" Research Quarterly 36 (May 1965), 165.

\textsuperscript{34} Dick Hilburn, "The effects of weight training on gaining weight" Completed research in Health,
Physical Education and Recreation 6 (1964), 41.
ball, stunts, tumbling, dodge ball and track and field. From November to May the weight training group made a mean gain from 112.6 to 124.716 and the control group gained from 113.5 to 117.81 pounds.

Beasley\textsuperscript{35} studied the effects of isometric training on skeletal muscle hypertrophy. Fifteen young adult male rats were selected as subjects and randomly assigned to three groups of five rats each. One group was given isometric training, the second group isotonic training and the third group served as the control group. The results of data showed that if 1) Both isotonic and isometric muscle contractions against an over load caused a statically significant increase in muscles fibre, 2) Both the training program against an over load caused a statically significant effect on total body weight 3) Both the training program had no significant effect on total body weight 4) There were no significant correlations between muscles fibre diameter, muscle weight, strength and body weight.

Weise\textsuperscript{36} studied the effect of heavy resistance weight lifting on serum levels of testosterone and androstenedione in adult men and women. The data were statistically analysed using a two factor, mixed, design Anova. It was concluded that a sex difference exist in the testosterone level response to weight lifting with adult males having much greater response than that found in adult females. It was also concluded

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that the androstenediolous level response to weight lifting is similar in
adult males and females.

Devies\textsuperscript{37} Studied the chronic effects of isokinetic and all kinetic
training on muscle force, endurance and muscular hypertrophy. One
hundred and seventy six high school males were randomly assigned to
eleven treatments. Two groups trained all dynamically (weight training)
and nine groups trained is dynamically. The resulting data indicated
significant difference at extention force in favour of isodynamic training
group. While significant differences were also found at the same criterion
velocity, criterion 1RM force, criterion of work capacity and dynamic
endurance in favour of constant load dynamic training group.

Manghan et al.\textsuperscript{38} Studied the relationship between the cross.
Sectioned area (csa) And maximum and voluntary isometric strength of
the knee extensor muscle of untrained subjects (control group, n = 30),
a group of successful sprinters (n = 6). All subjects were male aged
between 20 and 41 years. In the control group muscle strength was
found tobe positively condated with lean body mass and the muscles of
the csa. However inspite of there significant relationship, there was
considerable variability between subjects. The sprinters were significantly
stronger than endurance runners, but neither of the athletic group. Muscle

\textsuperscript{37} Arthur Hesling Devies, "Chronic effects of Isokinetic and Alkokinetic training on muscle, force,
\textsuperscript{38} R. J. Maughan Jennifer S. Watson and J. Weir. "Relationship between muscle strength and
muscle cross-sectional area in male sprinter and Endurance runners" European journal of applied
csa was greater in sprinters than in marathon runners but this difference was not significant. The ratio of muscle strength to csa in the control group varied from 7.07 to 13.54. All the trained subjects tall within the normal range, but the sprinters muscle were stronger per unit csa normal range, but the sprinters muscles were stronger per unit csa than the muscles of marathon runners.

Jackson\(^{39}\) conducted a study to determine the amount of strength gained in quadriceps muscles. Before hypertrophy occurred. Matched paires were formed from twenty six volunteers in swimming class. One member of each pair was assigned randomly to control groups which swim for 7.5 weeks. The experimental group also swim, had supplemental progressive resistance exercise there times a week. All were measured for height, weight girth of left thigh and strength of left knee extensors. Correlations between volume displacement and thigh girths were highly positive significant differences in favour of the experimental group were found for girth and strength. Exercises were discontinued for the experimental group when a consistent increase in girth of one centimeter or of volume displacement of 3 centimetre of waist level occurred one subject exhibited this change in four weeks. Six in five weeks three in six weeks and three in seven weeks.

\(^{39}\) Hell C. Jackwon, "Determination of amount of strength gained in the Quadricaps muscle before hypertrophy occurs" Completed research in Health, Physical Education and Recreation 5 (1963), 52.
Marchetti et al\textsuperscript{40} studied the effects of enclo-genous and oxogenous testosterone on the compensatory hyper-trophy of the plantaris and soleus muscles in the rate. The rate confirmed that enclo-genous testicular hormones did not have any effect on work included hyper trophy. On the other hand, the administration of high doses of oxogenous testosterone showed a myotrophic effect, highly stastically significant on this hypertrophy. The same results were obtained either in a short period of treatment (7 Days) or in a long one (14 days).

Weise et al\textsuperscript{41} conducted a study to determine if sex difference exists in the androgen response to heavy resistance exercise, serum testosterone (T) and androstero-dione (A) concentrations were measured in 20 men and 20 women before and during a two hour period following 30 minutes of weight lifting. It was concluded that men have a greater absolute endrostro-dious response to weight lifting is similar in men and women.

Conyea\textsuperscript{42} studied the role of exercise including increases in skeletal muscle fibre number. Twenty cats were conditioned to weights with their right fore limb against increasing resistance to receive a food reward.

\textsuperscript{40} N. Marchetti, F. Figures, N. Candeloro, S. Fevilli, "Effect of Testosterone on Compensatory Hypertrophy of not skeletal muscles" Journal of sports medicine and physical fitness 20 (March 1980), 19

\textsuperscript{41} Lawrence N. Weiss, Kirk J. Cureton and Frederick N. Thompson, "Comparison of Serum Testosterone and Androstenedione responses of weight Lifting in men and women" European Journal of applied Physiology 50 (March 1983), 413.

\textsuperscript{42} William J. Conyea, "Role of Exercise in Inducing Increasing in skeletal muscle fiber number" Journal of applied Physiology respiratory environmental and Exercises Physiology 49 (March 1990), 421.
Sixteen cats were used as controls. The cats under went training for 34 weeks for the flexon carpiradials muscle. There was a 20.5% increase in the number of muscle fibre of the exercised. The increase in fiber, possibly due to fibre splitting was restricted to those cats lifting weights greater than one kg. There was significant increase in oxidative fibre diameters for the low resistance exercise group, whereas the high resistance group exhibited increased diameter in all fibre types. It was included that there was no significant shift of fiber types or fiber proportions when compared with controls.

Costill et al\(^{43}\) Studied the adaptation in skeletal muscle following strength training. Even men were studied before and after seven weeks of isokinetic strong the training to determine its effects on muscle enzyme and fiber composition. Findings revealed that training four times a week achieved similar gains in peak torque for both legs at training velocity and at slower speeds. Fatigue ability of the knee extensor muscles was similar in both legs after training. Biopsy specmen showed significant changes in the percentage of the muscle area composed of type I and type II and fibers as a result of both strength training programme.

Hakkinen and komi\(^{44}\) Studied the influence of strength training on the mechanical characteristics of human skeletal muscle. Fourteen male


subject went through training of combined heavy concentric and eccentric contracting three times a week for 16 weeks. The force time curves produced during mechanical parameters. The results revealed that strength training caused significant increase in various mechanical parameters in positive work phases of vertical and drop jump. No change in the elastic properties the muscle were observed as judged from the different between the counter movement and squat jumps when training was followed by a 8 week detraining period a great decrease in maximal force took place but only minor changes were observed in fast force production.

Lander et al.\textsuperscript{45} Compared selected parameters during on isokinetic and isotonic bench prers. Six highly skill males served as the subjects Two way anova revealed that there were significant differences for all characteristics ribeing the time and position of the initial peak force between the iso kinetic and Isotonic conditions. Significant difference in average force value were found for the three positions of the curve with isotonic being greater during the first and last phases.

Seager\textsuperscript{46} conducted a study on the comparison of isotonic and iso kinetic supplemental weigh programs for basketball players. The subjects were thirty varsity baseball players that were randomly assigned to one of the three exercises groups of ten each. The data were analyzed


using the anova for repeated measures and t tests whenever necessary while all the groups increased in strength, there was no significant differences between groups in five strength tests. Following the season, the results of post tests indicated that the isokinetic group with no maintenance program during the season had significant decreases in knee extension, hip flexion strength. The isotonic group without a maintenance program did not show significant decreases in strength.

Johnson\textsuperscript{47} conducted a study on the comparison of three progressive resistance program for the development of strength. Seventy five college male students served as the subjects for the study. The three programs included isotonic, isometric and isometrics results indicated that no one programe proved to be superior over the other two. This study indicated that isokinetic program had the greatest advantages for a school setting of for individual strength development As the isokinetic training was given by well designed machines which could control the resistance given to the particular groups. Isokinetic and Isotonic type of contractions against an overload caused a stastically significant increase in muscle strength. Isometric type of contraction also resulted in an increase in muscular strength.

Ressook\textsuperscript{48} Conducted a study in the comparison of the effects

\textsuperscript{47} Maurice Allen, Johnson, "A comparision of three progressive resistance ororgrams for the development of strength" Dissertation Abstracts International 35 (January 1975), 4228-A.

\textsuperscript{48} Moayyed Essat Ressook, "A comparison of the effects of a standard weight training and a dynamic weight lifting program on the muscular development of male college students" Dissertation Abstracts International 40 (December 1979), 3188.
of a standard weight-training program and dynamic weight-lifting program on muscular development of male college students. Forty four male students were divided in to two groups and were assigned to one of the two training programs. The training programme was for a period of nine weeks. Analysis of variance at test and f ratio were the statistics involved in the study. The result revealed that both groups had significant improvement in muscular strength, muscular power muscular endurance and the selected girth measures after nine weeks of training. In comparison between the two groups a highly significant difference was found in muscular strength favouring the dynamic weight lifting group there was no significant differences between the group in the case of other parameters.

Gillespie\textsuperscript{49} Studied the effects of three selected weight training programs on strength and muscular endurance. Sixty two healthy male volunteers were randomly assigned to one of the three groups who trained thrice a week for 9 weeks. Anova was the statistics used in this study. It was concluded that significant gains in strength and muscular endurance were the result of high resistance low repition, low resistance high repetition or combination of both.

Gillan\textsuperscript{50} Conducted a study to examine the muscular strength

\textsuperscript{49} Joe Willey Gillespie, "The effects of three selected weight training programs on strength and muscular Endurance" Dissertation Abstracts International 44 (December 1983), 1723.

\textsuperscript{50} G. Mckensie Gillam, "Effects of frequency of weight training on muscle strength Enhancement" Journal of sports medicine and physical fitness 21 (March 1981), 432.
responses to five different weight training frequencies per week. Seventy-five male volunteers high school subjects were randomly assigned to train either 1 day, 2 days, 3 days, 4 days, or 5 days, per week. All groups trained on an identical program of 18 sets of 9 maximum repetition in bench press lift for nine weeks. The results revealed a highly significant improvement. In muscular strength in the group that trained five days per week than groups with favour training frequencies per week. Sequential strength, improvements resulted from increased frequency of training. It was concluded that the more frequent the stress, the greater adaptation.

Bruess\textsuperscript{51} studied the number of isotonic exercises periods per week necessary for maintenance of an established level of muscular strength. The male subjects enrolled in one of the five freshman physical education classes and the treatments were assigned to four classes while the fifth class remained as a control group. The following conclusions were drawn:

1. After six week isotonic training program, participating in no isotonic weight training sessions for six week period result in the maintenance of an established level of isotonic strength.

2. After a six week isotonic training program, participating in

\textsuperscript{51} Clint Edward Bruess, "The number of Isotonic exercise periods per week necessary for the maintenance of an established level of muscular strength" Dissertation Abstracts International 30 (September 1969), 999.
isotonic weight training sessions two or three times per week for a following six week period will result in a significantly higher level of isotonic strength then will one time a week or not participating at all.

3. A level of isotonic strength established over a six week period can be again significantly increased over a following six week period by working out three times a week gradually increasing the overload.

4. Even though a 12 week isotonic training and maintenance program tends to result in a significant increase in upper arm girth, the program shows conflicting results from an anthrometric stand point. The relationship between isotonic strength and anthropometric measurements is therefore unclear.

5. There is slow positive relationship between isotonic and isometric strength.