Chapter II

REVIEW OF LITERATURE

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

Irwin and Nagle (1960) studied the effects of two types of weight training on cardio-respiratory endurance and selected physiological factors. Sixty freshman students of the University of Florida who volunteered to serve as subjects, were divided into three groups, two experimental and one control group. They were tested doing moderate and all out exercise on a bicycle ergometer. Selected physiological responses and the cardio-respiratory endurance times were measured. An eight week training program followed during which the experimental group participated in weight training program and the control subject participated in archery. After training, the tests were again administered. Though there was an indication of improved cardio-respiratory responses by the weight training group, statistical treatment of the data revealed no significant difference among three groups in their responses to the exercise.
Joe (1960) selected 40 Junior High School Boys participating in a weight training program, two days a week for six months. Seventeen boys served as a control group. The test items consisted of the junior Amateur Athletic Union physical fitness test, Anthropometric measurements, the California test for personality. The experimental group registered a significant difference at the .05 Level of confidence over the control group in anthropometric measurements and the five out of the six physical fitness tests, while no significant improvement was found in personality test.

Bemer and Bangerter (1961) selected eight male subjects of college age for the comparison of three programs of progressive resistance exercises. The subjects were divided into three groups and each group used a specific variation of progressive resistance exercise for an eight week period. Initial and final measurements of muscular circumferences and strength were taken. Data were statistically treated by analysis of variance. All the three methods show significant strength gain that were not significantly different from each other, while there was no significance in muscular circumference.

Harmon and Oxendine (1961) conducted a study to determine the effect of different lengths of practice periods in learning motor skills. Their groups of junior high school boys were selected and the practice period was
varied suitably as two circuits for the first group, five circuits for the second group and eight circuits for the third group. On each practice day all groups practiced two days per week for five weeks. After the third practice period, however, it was observed that groups using short practice period improved just as much as groups using longer periods. A significant correlation was also found between general intelligence scores and performance in the mirror tracing skill.

Berger (1962) 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.

Brown (1962) has conducted the study on the effect of circuit training on the physical fitness on Grade 5 girls. Two classes were tested on the AAHPER fitness test before and after eight weeks of regular physical education classes. The experimental class, chosen by chance, had a supplemental 10 minute circuit training program before each class. Both classes showed significant gain in total score. The experimental group showed significant gain on all tests.
except the 50 yard dash. The control group showed significant gain on all tests except the pull-ups (modified) and 50 yard dash. The mean difference between groups were not significant but the experimental class made greater gain except in the shuttle run. The supplemental circuit training produced generally better but not significantly better, results than the regular program.

Berger (1965) studied the effect of various weight training loads on strength. Seventy-nine male subjects were used in the study to determine which proportions of maximum strength (1 RM) used in training were effective for increasing strength as training with 1 RM. Three groups trained twice 9 week with 66, 80 or 90 percent of the 1-RM plus one weekly effect with the 1-RM. A fourth group training three time weekly with 1 RM. Fifth group with 66 percent of the 1 RM; a sixth group with 1 RM only once weekly and seventh group as acted control. After six weeks of training the group that trained with two-third of the 1 RM three time weekly and control group had mean strength scores which were significantly less than the means of the other groups.

Chui (1965) 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
McRraw and Burnham (1966) conducted a study on three groups of college men who participated for nine weeks in separate exercise programs to determine the relative effect of isotonic, isometric, and speed contraction on muscular strength and muscular endurance. Data examined by the multiple linear regression technique for variance analysis revealed little difference among programs for the group as a whole. Considerable difference among programs for the group as a whole. Considerable difference however were apparent when the subject's initial status on the attributes in question was considered.

O'Shea (1966) undertook a study to determine the effects of a six-week progressive weight training program on the development of strength and muscular hypertrophy, using one exercise, the deep knee bend, with varying repetition. Thirty students were chosen at 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 program was 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. Individuals in each group handled maximum weights loads for the number of repetitions each was required to perform. The effectiveness of the program 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 analyzed 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.

Charles (1967) conducted a study on the effect of selected explosive weight training exercises upon leg strength, free running speed and explosive power. He has taken an experimental group of 20 fresh male volunteers who were selected randomly from trampoline and hand ball classes. The experimental group went for a 5 week explosive weight training program with four sessions per week and three circuits of the exercises per session. The groups were tested before and after the program. The experimental group made significantly greater improvement in leg strength, but not in running speed or explosive power.

Thornton (1967) conducted a study on sixteen boys in grade VI who exercised five times a week for 6 weeks on either an isometric training apparatus or a horizontal bar (isotonic) to find the effects of isotonic and isometric strength training on pull-ups achievement. Each group was divided initially into four groups on the basis of chinning ability. They were re-tested midway and at the end of
training. Both highest and lowest groups made significant gains but the difference between the methods was not significant.

Bergerson (1967) studied the effects of state static training at various positions and dynamic strength training through a full range motion on strength, speed of movement, and power. The 96 male subjects were randomly assigned to three experimental groups that trained either isotonically with supine press through a full range of motion or asymmetrically at the extended position in the supine press and a control group. All three experimental groups showed significant gains in static strength at both positions.

Reynold's (1967) program for strength improvement of basketball players for off-season consisted of the following 12 exercises: clean and press, jump squat, leg extensions, leg curl, calf press, bench press, bent rowing, up-right towing, reverse curl, wrist curl, reverse wrist curl and leg raise. To help keep up strength and body weight gains made in the off-season an in-season maintenance workout consisting of 8 exercises is as follows: (This should be performed after basketball workouts) clean and press, jump squats, bench press, pull-down, side laterals, reverse curl, wrist curl and leg raise.

Kusinitz (1968) has conducted a study on the effect of progressive weight training upon running speed and
circulo-respiratory endurance. The dependent variables of running speed and endurance were measured before and after a 12 week training period as follows: speed 50 yard dash endurance: Mc Cloy endurance quotient and the 300 yards run; and muscular strength: the Mc Cloy strength index revision. The experimental group practiced progressive weight training and running while the control group practiced only running. The data were subjected to analysis of covariance, two-way factorial analysis of variance and persons' product moment correlation. The conclusions were: progressive weight training and running are more effective than running only in developing running speed and endurance as measured by the 300 yards run; and individuals who began training with initial low strength do not make greater gains in the dependent variables than those with initial high strength.

Waddle (1968) conducted a study on male students who participated in a training program of 3 days per week for 8 weeks. The exergenic and isometric programs contained exercises which used back, leg, arm and trunk muscles. The isometric exercises used were sit-ups, curls and running on the spot. The cable tennis meter was used on pre and post tests to measure strength of knee, elbow, back and hip flexors and extensors; and the Harward step test was used to measure cardiovascular endurance. All programs produced significant increase in cardiovascular endurance and in strength measurement. The exergenic program was found to be
significantly better than the isotonic program for building strength in the back and hip flexors, but not in the other muscle groups.

Morris (1969) 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 the sampling by random selection and random assignments. After eight weeks training program the result showed that both isometric and isotonic weight training improved quadriceps strength and middle distance running time more than an unsupplemented interval middle distance running training program. Further the result indicated that isometric weight training increased the strength of the quadriceps muscle group as well as middle distance running time more than the isotonic training program, when used as supplement to interval running training.

Herris (1969) studied the effects of isometric and isotonic training program 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 significant differences in the measurement for leg speed reaction time and flexibility. The Shcelfes 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.

Barker (1969) studied the effects of an isotonic and a combination isometric–isotonic exercise training program upon push-up performance. Thirty-four male university students were divided into 3 groups based on pretest push-up performance. Group I performed maximum repetition push-ups; group II performed maximum repetition combination isometric–isotonic push-ups and group III served as a control group. All subjects met twice a week for 6 weeks. Analysis of variance on post-test push-up performance was found significant at .01 level. Maximum repetition push-up performance was improved at near the same rate for both the maximum repetition push-up exercise program and the maximum repetition combination isometric–isotonic push-up exercise program.

Edward (1970) conducted a study on the effect of circuit training, weight training and interval training on circulo-respiratory endurance. Fifty-one college males from
developmental physical education classes at the University of Mexico were randomly assigned to one of the three exercises program. The subjects trained for a ten week period at their respective exercise programs. Pre-test and post-test measures of circulo-respiratory endurance were administered under same experimental conditions. The analysis of variance showed no significant differences between the three exercise programs in the measures of circulo-respiratory endurance.

Hensen (1970) conducted a study on the effect of three selected weight training programs on muscular strength endurance, girth and cardiovascular endurance. He took thirty freshmen and varsity football players from the 1968 South Dakota State University football teams who were randomly divided into 3 groups. One group used a modification of the Delorma-Watkins Method of training, the second group followed the traditional strength training method, while the third followed a circuit training program. Training covered a period of 7 weeks, 3 times a week. Tests for muscular strength endurance and girth were administered before the program began, at the end of 3 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.
O' Shea (1970) studied the effects of selected weight training program using varied repetitions on the development of strength muscle hypertrophy. Thirty students were chosen at random for a six week progressive weight training program. The subjects were divided into three groups of ten each. The programs 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. The effectiveness of the program was determined by the three measurements a) thigh girth, b) dynamic strength and c) determine the effect of 16 weeks of high intensity variable resistance. A control group consisting of 10 untrained males underwent the same evaluation procedures as the training group. Maximal oxygen uptake, cardiac output during sub maximal exercise and body composition were determined before and after training. It was concluded that the muscular strength increased markedly, as evidenced by a 44% average increase in the "one repetition 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.

Byrd and Hells (1971) trained six adult males for four weeks by daily isometric bouts, executing maximum grip strength and holding it until a 50% strength decrement. Time held as maximum strength were recorded for each bout. Pre
and post training resting blood flow, flow during 15 sec, 50% maximum grip strength contraction, and recovery hyperemia following the testing bout were measured. Finding concluded significant improvement in strength endurance and exercise blood flow.

Philip (1971) studied the electromyographical analysis of a 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 on 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 against antagonists and stabilizer may be voluntarily and intermittently contracted during a specific activity.

Berger (1973) in his study has mentioned that a decision with regard to the type of conditioning exercises to be included in a training program is based on the understanding of the primary physiological system and undergo stress during a game, and the kind of activities which best provide this type of stress during practice. The body adopts itself to the type of stress placed upon it. This physiological adaptation is necessary for physical conditioning to occur. The adaptation made by playing basketball is the best condition for the sport. Likewise, the running of a cross country athlete results in
physiological adaptation which is the best way for improving condition in that sport. No matter what the component of conditioning strength, endurance, flexibility or power, specificity of training applies. The best training to improve best performance is to practice the movement at the same rate and intensity as during an actual game situation.

Mckethan (1973) studied the effect of a training program involving isometric, isotonic and a combination of both isometric and isotonic 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 degrees of knee extension. The isotonic group trained by utilizing maximum knee extension. The combined group trained by performing an isometric contraction at 90 degree 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. Others among group comparisons were non-significant, within group gains in quadriceps strength occurred for each of the three training procedure and there were no difference among or within the groups in relation to vertical jumping ability.

Staheli (1974) 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 student range test significant differences were found and the following conclusions were drawn; (a) The power rack, leg press and Olympic barbell group each showed significant improvement in all criterion measures; (b) No significant differences were detected among the leg press, Olympic barbell or power rack groups.

Johnson (1975) conducted a study on the comparison of three progressive resistance programs for the development of strength. Seventy five college male students served as the subjects for the study. The three programs included isotonic, isokinetic and isometrics results indicated that no one program proved to be superior over the other two. This study indicated that isokinetic program had the greatest advantages for a school sitting or for individual
strength development. As the isokinetic training was given by well-designed machines which could control the resistance given to the particular muscle groups. Isokinetic and isotonic type of constructions against an overload caused a statistically significant increase in muscle strength. Isometric type of contraction also resulted in an increase in muscular strength.

Senders (1976) 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, 20 serving as control and 32 participating in 10 weeks of progressive resistance exercises. The data gathered were statistically analyzed using t-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.

Micheal (1977) determined the effects of a concentric and an eccentric training program on the vertical jump and also on concentric and eccentric leg strength of the quadriceps femurs muscle group. Subjects enrolled in collegiate PES classes were used. 2 groups, 1 eccentric (N=14) and 1 eccentric (N=14) trained 3 days/week for 8 weeks and were pre and post tested in all 3 dependent variables. The vertical jump was also tested every 2 weeks throughout the training program. 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 0.01 level. ANOVA of the between groups on the concentric leg strength variables was not significant. The eccentric leg strength variable indicated significant F. A 2 x 4 repeated measure ANOVA of the vertical jump scores indicated that there was no significant difference in training program, there was a significant difference in median vertical jump 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.

Crist (1977) conduct a study to determine whether there was a significant difference between three day a week and five day a week physical education program. The 't' test was used to analyze the data. The results obtained a significant difference in favour of these students who were involved in the five day a week physical education program over those involved in the three day a week program.

James (1978) investigated the effects of isotonic and isometric exercises on subjects in heart rate and blood pressure and sought to determine the relationship of their effects to physical work capacity. He reached the conclusion that both, isotonic and isometric exercises, resulted in significant changes in heart rate, systolic and diastolic
blood pressure and pulse pressure.

Arko (1979) conducted a study on the effects of weight training on selected physiological variables. To compare the results of weight training using mini-gym, nautilus and universal equipments by pretesting and post testing, this study used 21 university students on various motor performances and physiological parameters. The independent variable, three types of weight training was performed in a non circuit fashion. The dependent variables comprising the pretests and post tests included: sit and reach, sit-ups, hand line walk test, standing long jump, agility run, bench step test, jump and reach, horizontal ladder hand walk, girth and skinfold measurements. Ss were grouped according to pretests results by computing a composite score for each individual. The scores were ranked and groups formed by a matching design. The actual weight training was conducted for 6 weeks, 3 times per week, with the 3 weight training groups performing equated exercises on their respective pieces of equipment. The project hypothesis was that the isokinetic devices applying both concentric and eccentric contractions (nautilus) during training would produce the most significant results. The 'F' ratio for 10 of the variables produced no evidence that these observed different exceeded chance. Only the universal group showed significant improvement over nautilus and minigym on 1 variable, the horizontal ladder hand walk.
Hamsell (1979) undertook a study to determine whether a short exercise period, three times a week for eight weeks can increase abdominal strength and endurance of upper elementary school girls. The subjects (N=99) were randomly divided into four groups. The exercises selected in order of muscle action intensity were curl-up, conventional hook sit-ups and modified sit-ups, one of which was assigned to each of the three groups, while fourth group had mild generalized exercise and served as a control group. ANOVA was used to determine whether there was a significant differences between the groups. It was observed that the group performing the hook sit-ups showed a significant gain in abdominal strength and endurance. The modified hook sit-up which had the highest intensity rating was not significantly effective (P = 0.05).

Mckingley (1979) has conducted a study on the effect of an intermittent circuit weight training program on cardiovascular fitness. The effect of an intermittent circuit weight training program on cardiovascular fitness was investigated in this study. A 2x2 factorial ANOVA, the 1st factor being exp. and control groups, and second factor comprised of pre and post testing, was used to analyze the data. Appropriate F step down procedures were used to analyze sig. main effects. It was concluded that 8 weeks of intermittent circuit weight training causes sig. increases in strength, but appears to have limited effect upon Max.
Vo. (1/min.) during arm work was sign. higher following training, however, when expressed as m /kg/min. the values for both the exp. and control groups were essentially unchanged. Steady State HR for both control and exp. groups were lower on the post test during both arm and leg work. The ANOVA revealed that during steady state arm work the group were sig. diff. in the way they changed from pre to post test, however follow-up 't' tests indicated no sig. between the 2 groups.

Peter's (1979) study was designed to determine the effectiveness of muscular strength and power development using the external pulley system and free weight training method with slow and fast speed of training. Twenty five high school boys and seven girls were randomly assigned to four groups receiving three training sessions per seem over a seven week period. Each subject was tested for strength and power before and after training program. Analysis of covariance indicated that fast rate of training produced greater improvements in knee extensive strength (p.05) and a fast rate of training produced the best gain in vertical jump performance (P.05).

Spielman (1979) has conducted this study on the influences of isotonic and isokinetic weight training on vertical jumping proficiency. College males (N=28) were Ss in a study to investigate this. Isotonic and isokinetic training were assigned to the two exp. groups with the third
group serving as controls. Training for the exp. groups consisted of isotonic circuit training on a universal weight machine and isokinetic training on a Leaper machine. Data analysis included a reliability and reproductibility assessment and ANOVA to determining whether sig. mean changes had occurred between the groups. Tukey's W-procedure was used to identify the source of sig. changes. Mean scores for both exp. groups were sig. (P=0.05) difference from those of the controls. Although there was no sig. difference between mean performances of the 2 groups, the isokinetic group experienced a higher level of improvement (8.7 percent, 7.2 percent).

Oyster (1979) 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 flaxen and hip flaxen. All other strength measures, except elbow strength, showed increases although not significant. These strength increases were accompanied by concomitant decreases in all girth measurement (calf girth, pectorals and lower arm girth decreased significantly). Three of the four skinfold measurements also decrease in percent body fat and a slight decrease in weight. Neither of these were significant.

Rossook (1979) conducted a study on the comparison of the effects of a standard weight training program and
dynamic weight lifting program on muscular development of male college students. Forty four male students were divided into two groups and were assigned to one of the two training programs. The training programs was for a period of 9 weeks. Analysis of variance, t test and F ratio were the statistics involved in the study. The results 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 favoring the dynamic weight lifting group. There was no significant differences between the groups in the case of other parameters.

Young (1979) compared the effects of an experimental program of physical education to the present curriculum of physical education on the physical fitness of the Kern H.S. District, Pre and Post tests were administered to 213 boys and girls in 1.5 mile run for aerobic endurance, in 440 yards run for anaerobic endurance in sit-up tests for strength and sit and reach test for flexibility. Comparisons between treatments were no significant difference between treatments for any of the five tests.

Parks (1980) undertook a study to determine the effects of a ten week physical fitness program on selected physiological and psychological variables of elderly people of 65 to 82 years. The subjects were 15 females. Pre and
post measurements were obtained for psychological variables by the state-trait anxiety inventory. The physiological variables measured were body composition, flexibility, heart rate and blood pressure. The subjects participated in the fitness program half an hour in the mornings, three days a week for 10 weeks. Each exercise session began with 10 minutes of warming up followed by 15 minutes of exercises of moderate intensity. The last five minutes were used as a cooling off period. The 't' test for correlated samples was employed to determine if a significant difference existed between pre and post test measures on the physiological and psychological variables. The following significant changes were found:

1. The subjects decreased in percentage of body fat.
2. There was an increase in flexibility and
3. There was a decrease in heart rate. However there was no significant change in systolic and diastolic blood pressure and anxiety levels of the subjects.

Uppal (1980) selected 80 untrained subjects and divided them equally into three experimental and one control group, to determine the effect of interval training and two continuous load methods, cardio-respiratory and selected physiological parameters. One group was given interval
training, the second fartleg and the third slow continuous running, for a period of 10 weeks. The load was progressively increased. He found that all three groups had equal training effects on maximum oxygen uptake, vital capacity, leg strength, positive breath holding time and negative breath holding time, slow continuous and fartleg method indicated significant improvements in cardio-respiratory endurance when compared to interval training. Slow continuous training were superior to fartleg in reducing resting pulse rate. However, all these training method did not show significant difference in diastolic blood pressure.

Gillons (1981) conducted a study to examine the muscular strength 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 identical program of 18 sets of 9 maximum repetition in bench press lift for 9 weeks. The results revealed a highly significant improvement in muscular strength in the group that trained 5 days per week then groups with fewer 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.

Talwon (1981) conducted study to see the effect of
interval weight training on dynamic muscular strength, power and cardio operation function in male college students. The pre and post test control research design was employed in the study. The training was limited to sixty minutes twice a week and for six weeks. He concluded that six weeks of interval weight training produces significant increases in strength and power. Six weeks of interval weight is superior to circuit weight training in producing strength.

Anderson and Kearney (1982) investigated the effects of three resistance training programs on muscular strength and on absolute and relative muscular endurance. Forty-three male college students were randomly assigned to the training protocols. The high resistance-low repetition group (n=15) performed three sets of 6-8 RM (repetition maximum) per session. The medium resistance-medium repetition subjects (n=16) trained by doing two sets of 30-40 RM per session, while the low resistance-high repetition group (n=12) used a single set of 100-150 RM. All subjects trained with the bench press exercise three times per week for nine weeks. Tests of strength (1-RM) absolute and relative endurance were administered before and after training. Statistical analysis revealed that 20% improvement in maximum through by the high resistance-low repetition group was greater that the 8 and 5% gains reported for the medium resistance-medium repetition and low resistance high repetition groups, respectively. Relative to
absolute endurance, however, the 41% and 39% improvement registered by the low resistance-high repetition and medium resistance-medium repetition groups, respectively, were not significantly greater than the 28% gain reported for the high resistance-low repetition group. Results for the relative endurance test revealed that the high resistance-low repetition group's performance actually decreased by 7% after training and was significantly poorer than the 22% and 29% improvements made by the other two groups. It was concluded that human skeletal muscle makes both general and specific adaptations to a training stimulus, and that the balance of these adaptations is to some extent dependent upon the intensity and duration of the training protocol used.

Boyd (1983) studied the physiological effect of two variable resistance weight training programs on males and females with the age range from 16 to 35 years. The results revealed that all the groups gained significant increase 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.

Clutch and Wilton (1983) studied the effect of depth jump and weight training on leg strength and vertical jump. In experiment 1 undergraduate students in beginning weight training classes trained with three different jumping program (1) maximum vertical (2) 0.3 m in depth jump (3) 0.75 m x 1.10 m depth jumps. In addition all groups also lifted weights. In experiment 2 weight training class and the volleyball team at Brigham Young University Hawaii were divided into two groups. One group lifted weight and performed 0.75 and 1.20 m depth jumps. The other group only lifted weight. In experiment 1 the three training program resulted in increase in one repetition maximum (1RM) Squat strength, isometric knee, extension, strength and vertical group, except the group of weight lifter, who did no jumping. It was concluded that depth jumps are effective but not more effective than a regular jumping routine.

Gillespie (1983) 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 repetition, low resistance high repetition or combination of both.
Jackson and others (1985) compared the combination of functional isometrics and standard isotonic training with standard isotonic training program in an instructional sitting. Subjects were volunteer, college males enrolled in weight training classes of a required activity program. They were assigned to two training groups. The experimental group (n=31) trained for 10 weeks, 3 days per week, using a 6 to 8 RM lifting regimen on the bench press. The experimental group also followed an isometric program which consisted of 6 maximal voluntary contractions at a predetermined sticking point in the bench press (BP) exercise. A poor rack was adjusted to provide an immovable resistance. The Central Group (n=26) followed the same 6-8 RMBP lifting program as the experimental group but with no isometric component. All subjects were pre and post tested for 1 RMBP strength values. Analysis of data indicated no significant difference on the pretest between the experimental and control conditions, significant improvements for both groups, and on the post test the experimental group was significantly stronger than the control group. These results provide support for functional isometrics as an enhancement to standard isotonic training regimens where achievement of maximum strength is the goal.

Harward and others (1986) examined gender differences in upper and lower body strength as a function of lean body weight and the distribution of muscle and
subcutaneous fat in the upper and lower limbs. The subjects were physically active men (n=48) and women (n=15). The peak torques produced during shoulder flexion (SF) and knee extension (KE) were used as measure of upper body and lower body strength, respectively. Flexed arm girth, thigh girth, triceps skinfold and thigh skinfold were used to estimate the distribution of muscle and subcutaneous fat in the limb. Results of the ANOVA revealed that the overall strength of men was significantly greater than that of women. The SF and KE strength of women and men did not differ significantly when differences in lean body weight, arm girth, thigh girth, triceps skinfold and thigh skinfold were associated with high lean body weight and a large arm girth. Result of the multiple regression analysis indicated that for men substantial portion of the variance in both SF and KE strength was explained by lean body weight alone. Whereas strength variations in women were explained more adequately by including limb variables alongwith lean body weight.

Kenney (1986) investigated changes in cardiovascular endurance, muscular strength and endurance, flexibility and body fat in males and females after three months of Circuit Weight-Training (CWT) and Variable Resistance Training (VRT). All subjects trained on the same equipment: Hip and Back, leg extension, leg Curl, Pullover, Lateral Raise, overhead Press, Arm cross, Decline Press
(alternated with overhead press), Biceps and Triceps. Following a two week period to familiarize the subjects with the equipment, pre-testing was done for max VO-2 for arm ergometer cranking and treadmill run to exhaustion maximum lift (1-RM, on each Nautilus machine, muscular strength for leg extension and bench press at 600/second on the cybex II, muscular endurance for leg extension and bench press at 180 deg/second on the cybex II, flexibility for shoulder extension and trunk flexion and present body fat from sum of skinfolds. He concluded that high intensity training is better than low intensity training for improving max VO-2 on a treadmill; that males were significantly different from females for body fat reduction using Nautilus equipment; that males were significantly stronger than females on Hip & Back, leg extension, leg curl, arm cross, Decline Press, Cybex II leg press and Cybex II right arm press; that no differences existed between the CWT and VRT groups for muscular strength, muscular endurance, flexibility and body fat.

Marshall (1986) 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 cybex at three different speed of arm flexion and leg extension 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 deg., 60 deg. and 120 deg. 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.

Jun (1987) determined the relative effectiveness of interval weight training on the development of dynamic muscular strength, power and cardio-respiratory function. Sixteen male students were randomly assigned to either the experimental group (interval weight training program) or the control group (circuit weight training program). Training was limited to sixty minutes twice a week and continued for six weeks. All subjects were pre-tested and post-tested for dynamic muscular strength, power and cardio-respiratory function. The one way analyzing covariance was used to determine significant difference between group means scores. He concluded that six weeks of interval weight training produces significant increases in strength and power but does not produce a statistically significant improvement in
cardio-respiratory function.

Gemer (1987) determined if a polymetric exercise program was better than a weight training exercise program in improving leg power as measured by vertical jump, standing long jump and 40 mt. sprint ability. The training protocol consisted of polymetric drill two times in a week or weight training exercise three times in a week for an eight week period. Pretest, midtest and post test assessment were taken. Mean gain from the pretest to the post test for the weight training, polymetric training and control group respectively. Standing long jump = 11.2 cm, 9.5 cm and 0.5 cm. Vertical jump = 2.3 cm, 1.78 cm, 0.2 cm and 40 mt., Sprints=.21 sec.-.20 sec. and .03 sec. The gain achievement by both treatment groups were significantly (p < .05) greater than those experienced by the control group, but no difference existed between the gains attained by the two treatment groups. It was concluded that under the delimitation of the study, there is no difference between the two program in improving leg press.

Naghibzadeh (1987) investigated if circuit weight training could be an effective method to improve aerobic capacity as well as strength. The 47 female volunteers with a range of 17 to 36 years of age, were assigned to circuit weight training, jogging and control groups. Each subject was tested prior to and at the end of the 8 week training program on VO-2 maximum and 1-RM bench press and leg press.
The data were analyzed by use of multivariate ANCOVA. Based on the result of this investigation, there were 12% and 9.6% increased in VO2-maximum for the circuit weight training and jogging group respectively. The circuit weight training group improved 28.1% in leg press and 20.1% in bench press. There was no significant increase for the jogging group in strength parameter, however, there was a positive change in leg press. The control group did not change significantly in any variable. The conclusion of the study was that continuous circuit weight training is an excellent modality to develop aerobic fitness as well as strength.

Obermayer (1988) conducted a comparative study of the effects of three strength training programs on the development of rotational trunk strength. Fifty nine volunteers from weight training classes at the University were randomly assigned to three treatment groups, each subject underwent pretest and post-test rotational trunk strength evaluation on the isostation B-100 machine. All subjects in three groups participated in a 17 exercise general strength training program which excluded utilizing trunk muscle in concentric and eccentric interactions. He concluded that the most effective way to develop rotational trunk strength is to train the trunk muscle using resistance to runs rotation. (2) Although general strength training program that does not include trunk exercise or include nonspecific trunk exercise will result in rotational trunk
strength gain such programs are less effective than one which emphasized specific rotational trunk exercise.

An overview of the researches done in the area of training methods in general and strength training in particular, suggested that progressive resistance exercise produced marked increase in strength (Sender's 1976; Kusinitz 1968 and Barker 1969). However, it has been observed that in literature there is a contradiction over the superiority of any particular training method to improve strength characteristics. Talwon (1981) accepted interval weight training superior to circuit weight training whereas Neghibzaderh (1987) considered circuit weight training an excellent modality to develop strength. It has also been observed that human skeletal muscle makes both general and specific adaptations to a training stimulus, and that the balance of these adaptations is, to some extent, dependent upon the intensity and duration of the training protocol used.

In training protocol frequency of training or schedule of training is of utmost significance. Gillons (1981) is of the opinion that sequential strength improved resulted from increased frequency of training. However, few studies have been undertaken in this direction. But still there is a need to investigate scientifically to prove that the more frequent the stress, the greater adaptation.