Chapter II

REVIEW OF RELATED LITERATURE

In this chapter review of literature pertinent to the present investigation is presented in order to provide background material for under taking the research study. Both critical and allied literature were reviewed and abstracts of relevant studies are cited here as under.

Pankonin\(^1\) investigated the relationship of selected measures of Tennis ability. Randomly selected college women from seven beginning Tennis classes were tested in agility, balance, hand-eye coordination, grip strength, height and arm and shoulder strength. The criterion of Tennis ability was the combined T-score from the Dyer test, Broer-Miller forehead backhand test and skill rating by three judges. The most economical predictor of Tennis ability combined agility, balance and arm and shoulder girdle strength for \( r \) of 0.62. Adding height and grip strength improved the co-efficient of correlation slightly although the correlation of grip strength and hand eye coordination with Tennis ability, were not significant.

Macbeth\(^2\) studied the effects of interval and continuous step training on attitudes, cardiovascular fitness, and Tennis skills of beginning Tennis students. This study was compared by ANOVA. Sixty


five students were placed into two experimental groups and one control group, with the experimental groups receiving a 10 minutes training session twice a week for 10 weeks. Participation in the step training programmes did not affect the student's attitude towards Physical Education or Tennis skills. The programmes were successful in bringing about an increase in cardiovascular fitness of students.

Dorothy\textsuperscript{3} conducted a study on the effectiveness of a specific conditioning programme on selected Tennis skills of women intercollegiate Tennis players. Twenty-two women intercollegiate Tennis players were ranked and matched by the Hewitt achievement test and randomly placed into control and experimental groups. The control group participated in the regular women's intercollegiate Tennis practice. While the experimental group, in addition to the regular Tennis practice, participated twice a week in a continuous and strenuous 20-minutes conditioning programme. It was found that both groups improved significantly in cardiovascular efficiency, but there was no significant difference between the two groups. The experimental group did improve significantly in Tennis skills, while the control group did not.

Renata\textsuperscript{4} had made an attempt to determine if an increase in arm strength of college women students would occur through the use

\textsuperscript{3} Dobie Dorothy, “Effectiveness of a Specific Conditioning Programme on Selected Tennis skills of Women Intercollegiate Tennis players,” \textit{Completed Research in Health, Physical Education and Recreation.} 10 (1968) :122.

\textsuperscript{4} Mariorino, Renata, “The Effects of a Strength Building Programme on the Forehand and Backhand Drives in Tennis” \textit{Completed Research in Health, Physical Education and Recreation.} 12 (1971) :44
the Exer-Genie exerciser and so, whether the increase in strength would enhance the execution of the forehand and backhand drives of beginning Tennis players. The modified Broer and Miller forehand and backhand and the wall bounds tests were given. The result proved that there is no significant improvement in strength in the experimental group.

Diann\textsuperscript{5} investigated the effects of class participation in beginning Tennis, Bowling, Fencing and Golf on the heart rates of college women. The heart rate responses of each subject taken during a rest and walk run programme and during normal physical education class participation were measured by a portable telemeter system. The walk-run programme results indicated that the golf activity group responded to same activity with greater rise in heartbeat than the bowling and Tennis groups. No significant differences were found among the groups in their pulse rates.

Ronnie\textsuperscript{6} compared the effects of different methods of training and detraining of the strength and speed of college men. Male students enrolled in 4 Tennis classes were tested on 4 items of Clarke-Schopf strength test. Students were randomly assigned to 3 groups, Group 'A' ran one mile and Group 'B' ran 440 yards dashing, Group 'C'

\textsuperscript{5} Laing, Diann, "The Effects of class Participation in Beginning Tennis, Bowling, Fencing and Golf on the Heart rates of College Women." \textit{Completed Research} 2(1969):227

\textsuperscript{6} Harris Ronnie, "A Comparison of the Effects of Different Methods of Training and Detraining of the Strength and Speed of College Men." \textit{Completed Research in Health, Physical Education and Recreation.} 3 (1971): 23
participated in Tennis. After 6 weeks training period students did not
train for two and half weeks. No significant differences were found for
trunk extension, knee extension and ankle plantar flexion. Significant
differences were found in two items. Group C significantly improved
their shoulder extension.

Ayed⁷ conducted a study to examine the effects of a six
week plyometric training programme on selected physiological and
physical fitness parameters, twenty four basketball players (14-18
years) were utilised to perform an aerobic power and anaerobic
capacity tests. Before the treatment was given, a pre test was
conducted for experimental and control groups following the six weeks
treatments the subjects were tested once more on the previously
mentioned test. The result reveal that the plyometric training
administered in this investigation can significantly improve explosive
power. Further more the findings of this study suggest that plyometric
does not elicit alternations either improving leg muscle strength or in
improving power output measured by the WnAT.

Leslie⁸ compared two progressive strength training protocol
for improving the strength and flexibility of the quadriceps and hamstring
muscular complex of high school weight training students. Sixty men of

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⁷ Al-Ahmed Ayed, "The Effets of Plyometrics on Selected Physiological and Physical
Fitness Parameters Associated with High School Basketball players" Dissertation
Abstracts International 51:2 (August 1990): 446 – A.
⁸ George Leslie, " A Comparison of Two Progressive Strength Training Protocol A
Plyometric Exercise Protocol and Two Flexibility Protocol for Improving Quadriceps
and Hamstring Muscular Complex" Dissertation Abstracts International 53:11 (May
1993): 3841 – A.
16-18 years of age volunteered for a six week, 3 days a week, strength and flexibility study. All protocols significantly increased strength and flexibility.

Verhoskauksiy⁹ emphasised the need of depth jumping in the training of jumpers. The reason given by him is the following: during take off in the jump, the extensor muscle fulfill yielding work (the phase of amostisation) in the beginning and later over coming work (phase of active take off) in young athletes and in older competitors the character of this work has a substantial difference. The older athlete has less friction of the legs in the ankle joints and more quickly extends the leg than the beginner. His muscle switch more quickly from yielding work to over coming work and more quickly develop maximum dynamic strength which is also greater than the beginners. Because of this it can be said that reactive ability of the nerve muscle is higher, with the understanding that this muscles have the ability to fulfill effective work of an explosive character immediately after the significant loading in the amostisation phase. He likewise has the speed in switching the muscle from yielding to over coming work.

Wilson¹⁰ study was performed to determine which of three theoretically optimal resistance-training modalities in the greatest

⁹ Yuri Verhoskauksiy "Depth Jumping in the Training of Jumps" Track Technique 51 (March 1973): 16-18

enhancement in the performance of a series of dynamic athletic activities. The three training modalities include: (1) traditional weight training, (2) plyometric training, (3) explosive weight training, at the load that maximised mechanical power output. 64 previously trained subjects were randomly allocated to four groups that included the above 3 training modalities and a control group. The experimental groups trained for 10 weeks performing either heavy squat lifts, depth jumps or weighted squat jumps. All subjects were tested prior to training, after 5 weeks of training and at the competition of the training period. The test items included (1) 30mts sprint (2) vertical jumps performance with and without counter movement (3) maximal cycle test (4) iso-kinetic leg extension test, and (5) isometric test. The experimental group which trained with the load maximised mechanical power achieved the best overall results in enhancing dynamic athletic performance recording statistically significant (P<0.05) improvements on most test items and showing statistically superior results from the two other training modalities on the jumping and the iso-kinetic test.

Holcomb\textsuperscript{11} investigated the biomechanical analysis of a modified plyometric programme and a test of the programme's effect on power and the vertical jump. The purpose of the research was to develop a depth jump that would isolate and increase the contribution of the hip extensors as well as the ankle and knee extensors. College

\textsuperscript{11} William Roberts Holcomb, "Biomechanical Analysis of a Modified Plyometric Programme and a Test of the Programme's Effect on Power and Vertical Jump", Dissertation Abstracts International 53: 7 (January 1993) :2290-A
Aged males performed the counter movement jump and depth jumps while being filmed, and ground reaction forces were collected to determine joint movements, power and work about the joints. All variables were greater with the depth jumps and on ANOVA showed that a total of 27 of the 33 comparisons were significantly different (p<0.05). The pre and post test comparisons showed improvement from pre to post test in both peak power and vertical jump. For the counter movement test jump, the peak power increased in all the training groups but decreased in the control. Analysis of variance with repeated measures showed no significant differences.

Lees\textsuperscript{12} investigated the effect of drop height in the performance of plyometric training. 30 male subjects were asked to perform drop jumps from heights of 0.12, 0.24, 0.36, 0.46, 0.58 and 0.68m as well as counter movement jumps and squat jumps. They performed their jumps on a kistler force plat form, and the resultant force trace was integrated to calculate negative displacement of the total body center of gravity (CG), net height rise of the CG, maximum vertical force, maximum vertical velocity and peak instantaneous power output derived from the product of force and velocity. The results showed that the best performance in all measured parameters was for the drop height of 0.12m. This finding differed from results of similar studies reported in the literature by others. These findings were

\textsuperscript{12} A Lees "Optimal Drop Height for Plyometric Training" \textit{Ergonomics} 37:1 (January 1994): 141-143.
interpreted in terms of a skill and co-ordination element in the performance of plyometric movements, in contrast to a natural biomechanical response to imposed load, and the state of muscle training and competency.

Don\textsuperscript{13} conducted a study on effect of weight training and rebound training on performance in the vertical jump. Three groups each of six boys were equated on the basis of an initial Sargent jump test, height and weight. One group did weight training thrice a week with three sets of 5-10 repetitions maximum. One group did rebound training thrice a week. In eight weeks the person gains in vertical jump were respectively 7 and 21, but none of the differences between or with in the group was significant.

Stuart and Larry\textsuperscript{14} randomly assigned 48 male volunteers, to one of the 3 groups. Each group was randomly assigned to each of the three treatments. Group–I trained with isokinetic exercise and Group–II trained with plyometric exercise and Group – III was control. Subjects in both experimental groups trained three times per week for 8 weeks. The plyometric group performed three sets of ten repetitions of depth jumps from a height of 34 inches. Prior to and at the end of training period all subjects were given a vertical jump and reach test.


\textsuperscript{14} Stuart and Larry, "Effects of Isokinetic and Plyometric Training on Vertical Jump Performance" Research Quarterly 2 (1979): 584.
Results showed that both the training groups improved significantly in vertical jump capacity. However no significant difference existed between training groups.

Crowder\textsuperscript{15} conducted a study on the effects of plyometric push-ups on arm and shoulder power. Thirty-four college males were tested upon upper body power (medicine ball throw). The subjects were randomly assigned to two workout groups. All subjects participated in strength training classes, which occurred 3 days a week. Each of the three classes had roughly the same number of subjects assigned of each of the two groups. The Subjects in Group-I performed traditional style pushups. The subjects in Group-II treated with plyometric push ups. At the end of nine weeks training the subjects in the second group were performed 16 additional pushups. The result proved that the plyometric training influenced in development of shoulder power.

\textsuperscript{15} Kritpet\textsuperscript{16} investigated to examine the effectiveness of a six week strength-training programme consisting of squat and plyometric exercises on vertical jump performance, static and dynamic muscular strength and muscular power production in college age adults. 15 male and two female college students served as subjects for this study. 9 subjects trained with only squat exercises, 8 subjects trained with

\textsuperscript{15} Vernon Crowder, "The Effects of Plyometric Push-ups on Upper Body Power" \textit{Track Technique} 124 (1993): 3959

combined squat and plyometric exercises. All subjects trained twice a week for 6 weeks. A pre-test and post-test were conducted before and after the training. The result of the training programme, indicated a significant mean increase from the pre-test to post-test for the vertical power jump within the combined squat and plyometric training. Static strength significantly decreased from the pre-test level to the post-test level within the squat training programme. Hamstring strength and hamstring powers were significantly different within both training programmes. There were no differences in the gains achieved by two training programmes.

Dutko\textsuperscript{17} conducted a study, the purpose of which was to compare two progressive strength training protocols, a plyometric exercise protocol and two flexibility protocols of the quadriceps and hamstring muscular complex of high school weight training students. Sixty men of 16-18 years age volunteered for a 6 weeks, 3 days a week, quadriceps, hamstrings muscular complex strength and flexibility study. All training protocols, significantly increased left quadriceps, and left hamstrings strength. However, the flexibility protocol static stretching was more effective in producing strength of the hamstrings.

\textsuperscript{17} George Leslie Dutko, "A Comparison of Two Progressive Strength Training Protocols, A Plyometric Exercise Protocol and Two Flexibility Protocols for Improving the Quadriceps and Hamstring Muscular Complex, Strength and Flexibility of High School Weight Training Students" \textit{Dissertation Abstracts International} 53:11 (May 1993): 3641 – A.
Germar\textsuperscript{18} investigated to determine if a plyometric exercise programme was better than a weight training exercise programme in improving leg power as measured by vertical jump, standing broad jump and 40 meters sprint ability. The training protocol consisted of plyometric drills two times a week, weight-training exercises three times a week for an eight weeks period. Pre-tests, middle-test and post-test assessments were taken. The gains achieved by both treatment groups were taken. The gains achieved by both treatment groups were significantly greater than those experienced by the control group; but no difference existed between the gained attained by the two treatment groups.

Quarles\textsuperscript{19} conducted a study to compare the increase in leg power of a rope-jumping group of subjects with a stair running group of subjects. He selected college men for his study. All subjects trained thrice a week for 6 weeks in their specific area. A Pre-test and post-test were conducted before and after the training. Result found that the stair running group showed a significant gain in leg power while the rope-jumping group did not show any significant gain.


Bluker\textsuperscript{20} randomly selected 29 men, physical education majors and assigned them an exercise. Either leg strength was tested with dynamometer, vertical jump with the vertical power jump test, running speed with the specially designed electronic timing device. They exercised three times weekly for 4 weeks with progressively repetitions but has no significant effects on vertical jumping ability or running speed. Leg strength was not correlated significantly with vertical jump and running speed on either tests.

Michal\textsuperscript{21} studied 45 boys, selected randomly for the comparative effect of depth jump and jump squat on vertical jumping ability. Training for 8 weeks was given, thrice a week. The height of the box was 3 feet and he found that depth jump and jump squat improved the vertical jumping ability. He also found that depth jumps are more strenuous as compared to jump squat. Depth jump group has shown higher performance.

Smith\textsuperscript{22} conducted a research on the relationship between explosive leg strength and performance in vertical jump. The leg strength of 70 college men was measured in a position designed to involve the power thrust of the major muscle groups used in vertical


\textsuperscript{22} Leon E. Smith, "Relationship between Explosive Leg Strength and Performance in Vertical Jump" \textit{Research Quarterly 32} (May 1961): 405.
jump. The subjects then performed a modified Sargent jump that used no arm snap. Although the reliability of all measures was high, individual differences in the ratio of tested strength to body mass showed only a low and non-significant correlation with jumping performance. The results are interpreted to support the hypothesis that strength exerted against a dynamometer involves a different neuromotor pattern than strength exerted by the muscle during a movement.

Gray, Start and Walsh\textsuperscript{23} studied with the previous development of a new test of leg power based on scientific principles, the problem of the components of the term muscular power was investigated. A test of leg speed using the bicycle ergometer was refined and had a test-re-test reliability of 0.969 when subsequently used on the experimental sample of 62 adult males. The factors of leg speed and leg power were then compared and a correlation of 0.472 was established. This was mathematically lower than figures relating speed and power obtained by previous researchers in this field, and was probably due to the difference in the criterion measures together with a sample and experimental error.

Bedi\textsuperscript{24} selected 32 young males, ages 19 to 26, who performed a series of maximal effort vertical jumps after dropping from a variable height step on to a force plate. Five trials were performed

\textsuperscript{23} R.S. Gray, K.B. Start; and A. Walsh, "Relationship between Leg Speed and Leg Power" \textit{Research Quarterly} 33 (May 1962): 395

\textsuperscript{24} John F. Bedi, "Increasing in Jumping Height Associated with Maximal Effort Vertical Depth Jumps" \textit{Research Quarterly for Exercise and Sports} 58 (March 1987): 11.
from each of eight heights of 0, 25, 35, 45, 55, 65, 75 and 85 cms. Subjects were classified into two groups, volleyball players (N=12) and non-jumpers (N=20) based upon their current physical activity. Measures of the rise of the center of mass, vertical velocity at take off, total time on the platform, and total vertical impulse were obtained. The result showed the volleyball players jumped higher than the physical education students in all conditions. No significant differences in the height of the vertical jump within groups were evident when jumping after a prior drop. There was no difference on the results, if the best or average performance at each drop height were analysed.

Brown\textsuperscript{25} has conducted the study on the effect of circuit training on the physical fitness on Grade V girls. Two classes were tested on the AAHPER fitness test before and after eight week of regular physical education classes. The experimental class, chosen a 10 minutes circuit training programme before each class. The circuit-training group showed a significant gain on all tests except the 50 yard dash.

Simmons\textsuperscript{26} studied the effect of circuit training upon Cardio-vascular condition and motor performance. 15 male students in required physical education course in circuit training showed statistically


significant mean improvement in nine to fourteen cardio-vascular variables and in all 13 motor fitness variables. The training was done twice in a week in 30 minutes period and lasted 12 weeks.

Shaw\textsuperscript{27} conducted a study on comparison of three modes of testing for improved $\text{Vo}_2\text{max}$ and strength after the nautilus circuit-training programme. Measured by either arm cranking, leg cranking or arm-leg cranking the training protocol was conducted 3 times a week for 8 weeks. Testing was performed on a Schwinn Airdyne cycle ergometer. Differences were detected between arm cranking, arm-leg cranking tests, in both groups however there was no significant effect of circuit training on strength and $\text{Vo}_2\text{max}$ as measured by any of the three modes. It is possible that a long training period or an increase number of sets in the daily programme may result in development on strength and $\text{Vo}_2\text{max}$ in novice subjects.

Benerakis\textsuperscript{28} is conducted a study on the training effect of an upper body circuit-training programme on heart rate and oxygen uptake. Training programme extended to eight weeks. Subjects included 8 college students (5 men, 3 women) with a control group of 4 men and 4 women. Training consisted of 8 exercises one circuit a day. Subjects exercised at a percentage of their body weight for a specific number of

\textsuperscript{27} Brad Shaw, "The Effect of Circuit Training on Comparison of Three modes testing for Improved $\text{Vo}_2\text{max}$ and Strength," \textit{Completed Research in Health, Physical Education and Recreation} 28 (1984): 32.

repetitions as developed by Vitace (1973). Control and experimental groups were pre and post tested using physical work capacity test on bicycle ergometer. Result showed that following the training period, the experimental group showed no significant decrease in resting heart rate but significant increase was in Vo2max of the group.

Foley29 conducted a study on the effect of circuit training programme on predicted oxygen uptake of pre pubescent children. A continuous sub max bicycle ergometer test for prediction of maximal oxygen uptake was used to determine the effect of 8 weeks of training on 15 volunteers students age 10-11 years. Subjects for the study were randomly selected from an elementary school V Grade class. The experimental group trained three times per week for 8 weeks in a circuit training programme at a target rate of 70% of age predicted Vo2max for 30 minutes per section acting as a control group, 12 students participated in organised game and sport activities for equivalent periods of time. A pre test and post test design utilizing ANCOVA revealed no significant difference at the 0.05 level between groups. It was concluded that although improvement is evident in the experimental group it was equated whether the results were attributable to the training programme.

Smith\(^{30}\) studied the effect of circuit training on the performance skill of beginners and advanced beginner swimmers. Subjects were 52 male and female students at North Carolina Central University. The variables measured for beginner swimmers were breathing, prone glide, arm stroke and crawl stroke, and advanced beginner swimmers, treading water, front crawl, and back stroke. Students were randomly divided into 2 equal groups. The experimental group engaged in 6 weeks of circuit training and swimming, while the control group engaged in 6 weeks of swimming. It was found that circuit training had a significant effect on the performance skills of the experimental beginner swimmers.

James\(^{31}\) compared the effect of circuit training and isometric exercises on treadmill performance. 3 groups of college students were equated on the basis of the Balke Treadmill test. All three groups attended required Physical Education classes in which badminton was the activity twice a week for 5 weeks. In addition Group A did circuit training Group B did isometric exercises three times a week, and Group C acted as a control group. Ten minutes of circuit training or isometric exercise in addition to badminton was no more effective in improving treadmill performance time than badminton alone. Circuit training


caused a greater improvement in treadmill performance than isometric exercises.

Eric\(^{32}\) compared the relative effectiveness of interval circuit training compared with three other methods of fitness training in a school Physical Education programme. 4 groups of junior high school boys were matched on initial scores of the Larson Dynamic muscular strength and modified Harward step tests plus Mccloy's classification Index. Each followed a different training pattern for eight-class periods spread over two months. The interval circuit running group showed significant improvement in combined Harward and Larson tests scores over circuit training and conventional Physical Education groups. There were no other differences shown between groups.

Edward\(^{33}\) conducted a study on the effect of circuit training, weight lifting and interval training on circulo-respiratory endurance. Fifty one college males from developmental Physical Education classes at the university, of New Mexico were randomly assigned to one of the three-exercise programme. The subjects trained for ten weeks period at their respective exercise programmes. Pre-test and Post-test measures of circulo-respiratory endurance were administered under same experimental condition. The ANOVA showed no significant differences.

\(^{32}\) Banister, Eric, "The Relative Effectiveness of Interval, Circuit training Compared with Three Method of Fitness Training in a school Physical Education Programme." \textit{Completed Research in Health, Physical Education and Recreation} 6(1964):43

between the three exercise programmes in the measures of circu-
respiratory endurance.

Randall\textsuperscript{34} conducted a study in which students were
distributed among 3 groups, one group (N=30) used interval running
second group (N=30) had circuit training in addition to interval running
and 3\textsuperscript{rd} group (N=20) acted as the control. The training programme
were designed to improve the ability of subjects to run a half mile by a
improving their conditioning and teaching a sense of pace. The
experiment was conducted over an 8 weeks period. The interval-
running group and circuit training groups were significantly faster than
the control group. No significant difference was found between the
interval running group and the circuit-training group.

\textquotes Olsenn\textsuperscript{35} investigated the effects of a set circuit-training
programme on strength and muscular endurance of college age men
42 college males participated in the study. Pre-test and Post-tests for
strength and absolute muscular endurance and relative muscular
endurance were given for the bench press and leg press. Treatment
consisted of 2 workout sessions per week for 7 weeks. Test, re test
procedures and pretest and posttest mean changes were analysed
using Pearson Correlation and dependent t- analyses. Absolute

\textsuperscript{34} Kirk Randall, “The Effects of Circuit training on running the Half mile.” Completed Research in Health, Physical Education and Recreation 12 (1970): 186

muscular endurance in the bench press and leg press, and relative muscular endurance in the bench press were significant, non-significant changes were found for the test of relative muscular endurance in the leg press.

Santo and Del\textsuperscript{36} conducted a study to find the effect of physical conditioning programme on selected physiological components of college men. The subjects were 76 men from a junior college. They were divided into four different groups who participated in a different physical conditioning programmes. One was a control group, which has no formal physical conditioning programme. The experimental groups improved significantly in cardiovascular fitness in comparison to the control group.

\textsuperscript{37} Choleking studied the effect two training programmes on selected physiological variables on college women. The physiological reactions measured were the pulse rate, respiration rate, respiration amplitude, minute volume of respiration and oxygen consumption. The cardiovascular reaction was measured by counting the pulse rate. All variables improved during the four-week training period regardless of training programme prescribed. Both training programmes were of

\textsuperscript{36} Santo and Frank Del, "A Study of the Effect of Physical Conditioning Programmes on Selected Physiological Components of College Aged Men". \textit{Dissertation Abstracts International} 36 (June 1976): 7928A.

sufficient duration and intensity to effect changes in post exercise scores.

Namara\textsuperscript{38} investigated the effects of three conditioning programme selected Physical and physiological parameters of college students. Cardiovascular endurance was one of the physical parameters in physical fitness training programme at Boaston University Army's physical training programme, weight training programme and calisthenics groups were given treatment for ten weeks, three days in a week for a total of 23 hours. Pre-test and post-test measures were collected separate group sessions. It is of interest to note that female improved as much on all training methods as did the marks for all variables, although there were no statistically significant difference among the training methods.

Tremblay\textsuperscript{39} conducted a study on the effect of the upper body specific circuit training on Grade V children. 57 healthy male and female subjects from 2 Grade V classes made up to the study population. One class control group 12 males and 13 females and another class of experimental group 18 males and 11 females. Testing and intervention took place during regularly scheduled Physical Education classes where occurred 3 time per week. They were given

\textsuperscript{38} Micheal Namara, "The Effects of Three Conditioning Programme on Selected Physical and Physiological Parameters of College Students." \textit{Dissertation Abstracts International} 38 (December 1978): 7212A

with 3.5 minutes of upper body circuit training in each physical education class. This procedure was continued for seven weeks. The result proved that there was a difference between control, experimental group in strength, strength endurance, and power. There were no difference found between groups or between sexes for any of anthropometric variables.

Naghizadesh\textsuperscript{40} investigated a study to determine if circuit training could be an effective method to improve aerobic capacity as well as strength. 47 female volunteers were assigned to circuit training, jogging and control groups. Each subject was tested prior and at the end of eight weeks training period on $V_{O2}\text{max}$ and IRM bench press and leg press. Based on results of this investigation there was a 12\% and 9.6\% increase in $V_{O2}\text{max}$ for the circuit training and jogging group respectively. The circuit-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 parameters however there was a positive change in leg press. The control group did not change significantly in any variable.

Joshkatz\textsuperscript{41} conducted a study on the effect of 6 weeks, low intensity nautilus circuit training programme on resting blood pressure and strength in females. 26 healthy untrained females were studied. 13

\textsuperscript{40} Naghibzadesh, "The Effect of Circuit Training on Aerobic Capacity and Strength". Completed Research in Health, Physical Education and Recreation 30 (1987): 144.

females acted as experimental group and 13 females acted as control group. An attempt was made to determine if strength increase would have an effect of reducing resting blood pressure. The result was low intensity circuit training did not increased strength, and blood pressure in healthy females. But they suggested that high intensity circuit programme may develop the strength and blood pressure.

Scott\textsuperscript{42} conducted a study on comparison of a circuit strength training programme and a sport activity programme as measured by performance on the AAHPERD youth fitness test. 54 male subjects were participated in the study (11-14 years of age) circuit training group participated in a combination of weight training and sport activities. While sports activity group participated in a straight sports activity programme. The result proved the circuit training group improved in pull-ups, shuttle run, standing broad jump and 50 yard dash the sports activity group improved in sit- ups, shuttle run, standing broad jump and 50 yard dash.

Bangerter\textsuperscript{43} investigated to determine what relative contribution each of the three components of the lower extremities made to the vertical jump. A jump reach form of the vertical jump, with a reliability coefficient of 0.925 was of the three components of leg

\textsuperscript{42} M.G. Scott, "Comparison of Circuit Strength Programme and a Sport Activity Programme as Measured by Performance on the AAHPERD Youth Fitness Test" Completed Research in Health, Physical Education and Recreation 27 (1982): 64.

isolation and weekly workloads for progressive resistance exercise programme were used to validate strength gains.

Berger\(^4^4\) conducted a study to determine the effect of explosive strength improvement on vertical jump ability. 89 male college students participated in 4 different training programmes. Group – I (N=29) trained with 10 RM, Group – II (N=20) with 50-60 percent of 10 RM for 10 repetitions of jumping squats, Group – III (N=21) trained statically, Group-IV (N=19) trained by jumping vertically, occurred 3 times a day for 7 weeks. The group that trained dynamically, improved significantly more in vertical jump than the groups that trained statically or trained strictly by jumping vertically.

Charles\(^4^5\) conducted a study on the effect of circuit 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 handball classes. The experimental group went for a 5 week, circuit training programme of 8 stations with four sessions per week. The groups were tested before and after the programme. The experimental group made significantly greater improvement in leg strength and explosive power but not in running speed.


Wooden\textsuperscript{46} conducted a study on the effect of a Circuit training programme on body composition, muscular endurance and muscular strength in untrained females. Seventeen untrained females volunteered for either the experimental group (N=13) and the control group (N=4). All subjects were pre and post-tested. The experimental group participated in circuit training programme. The result proved that there was no significant difference in total body weight change between groups, but there was a significant difference in change for body density, percentage of body fat, lean body weight, muscular endurance and muscular strength between groups as a result of the circuit training programme.

Tompkins\textsuperscript{47} studied the effect of circuit breaker programme on middle school boys. According to him this programme is one of the best programme to develop the power ability in school students. Results showed a significant improvement on leg, shoulder and arm power of middle school level boys.


\textsuperscript{47} Tompkins Richard D. "Plyometric through the Grades" Track and field Quarterly Review of Jumps 94 (1994): 56.