Chapter II

REVIEW OF RELATED LITERATURE

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

Bucy\(^1\) conducted the study to find out the effect of three methods of training on physical fitness of male students at Rector High School. He equated the three groups consisting of 17 subjects each on the basis of AAPHER physical fitness test scores, age, weight, height and strength. Groups were assigned 11 weeks exercise programme in addition to regular physical education classes, three times a week. The isometric exercise group used eight exercises requiring nine minutes per day for five days a week. The calisthenics group had nine exercises, nine minutes a day for three days a week. The analysis of data was done by using t ratio. Results of the study showed that all the groups improved significantly in physical fitness, strength and weight. The isometric exercise group had significantly greater strength than the calisthenics exercise group.

\(^1\)Jessee A. Bucy, "Comparison of the Effect of Three Methods of Training on Physical Fitness," Completed Research in Health, Physical Education and Recreation 7(1965):34.
decreased in heart rate. There was no significant change in systolic and diastolic blood pressure and anxiety levels. A programme of exercise, moderate in intensity and under proper supervision, was found to improve the physical fitness of an orderly and to be safe and effective.

Fox and his associates\(^2\) compared a frequency training of four days to a programme of two workouts per week in an attempt to determine the frequency of interval training required to produce an improvement in cardio-respiratory endurance. The two groups of approximately 25 subjects each were young healthy male students who worked for seven weeks in an interval training programme. The four days per week programme consisted of two days as short distance running (55-220 yards) with as may as 16-20 repetitions and one day of both short and long distance running. The two days/week programme consisted of one day of short distance running and one day both long and short distance running. All running was performed

at a fixed pace with a given work to rest ratio. He found that cardio-respiratory fitness of young man can be improved by a seven week interval training programme with two workouts per week. He further concluded that such an improvement was similar to that obtained from the same programme with four workouts per week. The only difference between the two groups was found in recovery heart rate, the four days group showing greater improvement.

Capen[^3] experimented on systematic weight training to see the effect on strength, athletic power, muscular and cardio-respiratory endurance. Two groups of students were used in this study. Group A was attending weight training class while group B participated in a conditioning class. Both the groups did exercise twice a week for eleven weeks. The groups were tested in muscular endurance, muscular strength, cardio-respiratory endurance and athletic power prior to and after 11 weeks of training. Analysis of the data revealed that there were no significant differences between the two groups in muscular endurance. As would probably be expected, Group A programme gave greater general improvement in muscular strength than did group B. In power events, however, group B had

an initial test that averaged higher than group A. Yet group A improved significantly more in these "speed events" than did group B.

The purpose of this study was to investigate the effect of strength improvement on vertical jump ability. Berger\(^4\) conducted the experiment on 89 male college students who participated in four different training programmes. Group I (N-29) trained with 10-RM, Group II (N-20) with 50 to 60 percent of the 10-RM for ten repetition of jumping squats, group III (N-21) trained statistically, and group IV (N-19) trained by jumping vertically, subjects in all the groups trained for seven weeks three times weekly. Vertical jumping height was determined before and after seven week training period. The 't' test for paired observation was used with in groups to see improvement in the vertical jump height. Analysis of variance was employed to determine whether the groups differed significantly in improvement. Further comparison was made between groups by the 't' test if the analysis of variance test

was significant. It was concluded that the groups trained dynamically improved significantly more in vertical jump than the groups, trained statistically or trained strictly by jumping vertically.

Roy⁵ studied the effect of army conditioning exercises of varying repetitions upon the physical fitness indices of seventh and eighth grade boys. Improvement in physical fitness index scores were determined from exercise with the Army set I, series of calisthenics. Nine experimental conditions with five subjects in each, were established using three time lengths and three weekly exercise programmes. The exercise periods were five, ten and fifteen minutes in length, the combination of days were Tuesday, Thursday, Monday, Wednesday, Friday and all five of these days. Improvement was measured with the physical fitness index. The data were treated by analysis of variance significant differences in physical fitness index means were not obtained between any of these conditions as any combination of them (interaction). However, there was significant mean physical fitness index gain on the part of all subjects at the end of six weeks of calisthenics exercises.

Hugh and Maura\textsuperscript{6} enrolled 71 female volunteers in weight training courses at the Pennsylvania State University on the basis of initial strength, to 1 of 2 weight training groups or a control group for an eight week study. Group I (N=24) performed a progressive resistance weight training program employing 3 sets of the 6 RM weight, 3 times per week. Group 2 (N=23) performed a progressive speed training program in which 3 sets of 6 repetitions, using 25\% of their 1-RM weights, were performed as rapidly as possible 3 days per week. The control group (N=24) participated in testing only. The 1 RM bench press was used to measure strength. A similar movement was used for measuring speed (minimum resistance pressed as rapidly as possible) and power (resistance of 50-70\% of 1-RM pressed as rapidly as possible). Subjects were tested 3 times before training began; after four weeks; and at the end of the program ANOVA technique revealed that all groups were similar in strength and power prior to training but not in speed. Differences among

groups in final strength and power were determined using 2-factor ANOVA with repeated measures on 1-factor. ANOVA technique (to adjust for initial differences) disclosed differences among groups in final speed. Scheffe's test showed that only the weight training groups had significant increase in the 3 variables; no significant differences between groups were found, using Pearson's product moment coefficients, no relationship was found among the changes in strength, speed and power as a result of weight training.

Dintimen\(^7\) determined whether flexibility training programme, a weight training programme and the combination of both would effect running speed when used as supplementary training programme to the conventional method of training sprinters. One hundred and forty five subjects were randomly assigned to one of five training groups. Groups were tested for flexibility strength and running speed and after eight week training programme result showed that both weight training and flexibility training as

supplements to sprint training increased running speed significantly more than an unsupplemental sprint training programme.

Won⁸ in this study determined the relative effectiveness of interval weight training on the development of dynamic muscular strength, power and cardio-respiratory function. Sixteen subjects of the department of physical education at Oregon State University who registered for weight training class were selected for the study. Subjects were divided into two groups, Experimental Group (Interval weight training programme) Control Group (Circuit weight training programme). The training was limited to sixty minutes twice a week for six weeks. Both the groups were pre-tested and post tested for dynamic muscular strength, power and cardio-respiratory function.

Data was analyzed by the 't' test for related samples. The one way analysis of covariance was used to determine significant difference between group mean scores. The .05 level of significance was used to test the null hypothesis.

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From the results evaluation, it is concluded that:

1. six week of interval weight training produces significant increases in strength and power. 2. six weeks of interval training is superior to circuit weight training in producing squat strength. 3. six weeks interval training does not produce statistically significant improvement in cardio-respiratory function.

Gemar⁹ carried out the study to prove that plyometric exercise programme was better than a weight training exercise programme in improving leg power measured by vertical jump, standing long jump and forty meter sprint ability. The training protocol consisted of plyometric drills two times a week as weight training exercise three times a week for eight week period. Mean gains from the pre-test to post test for the weight training, plyometric training and control groups respectively were standing long jump 11.2 cm, 9.5 cm and .5 cm vertical jump = 23 cm, 1.78 cm and .2 cm and 40 meter sprint = -.21 seconds, -.2 seconds and -.03 seconds. The gain achieved 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

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treatment groups.

Cureton\textsuperscript{10} studied vital capacity of high school boys to determine whether it could be used as a strength test, a cardio-respiratory test, or only a test of thoracic size. He concluded that strength was only a small factor contributing to vital capacity and no positive relationship could be claimed between vital capacity and organic condition.

Harris\textsuperscript{11} studied the effects of isometric and isotonic training programme 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 each. The three groups were isotonic group, isometric group and control group. The analysis of variance was used as the statistical technique in the study. The results revealed significant differences in the measurement for leg speed, reaction time and flexibility.

\textsuperscript{10}T. Cureton, "Analysis of Vital Capacity as Test for Conditions of High School Boys," \textit{Research Quarterly} 7 (December 1936): 81-86.

\textsuperscript{11}Irvin Devid Harris, "The Effects of Isometric and Isotonic Training Programs on Selected Variables," \textit{Dissertation Abstracts International} 30 (December 1969): 2359.
Frost\textsuperscript{12} evaluated the effect of weight training (WT), a flexibility training (F) and combined weight training and flexibility (WF) on speed and agility. Thirtyfour male subjects were randomly assigned to groups to undergo training twice weekly for ten weeks. Weight training exercises were knee extension, flexions and leg presses. The flexibility group consisted of 2 sets of 5 static stretching exercises. Weight training and flexibility group performed one set of flexibility exercises proceeding weight training and one set following. ANOVA for different scores showed weight training and weight training flexibility groups made significant gains in leg strength. Weight training flexibility group was significantly superior for developing (40 yards dash) speed and agility than either method performed separately.

Alteri\textsuperscript{13} conducted a study on 63 college females between seventeen and twenty two years of age who were randomly assigned in one of the four running regimens

\textsuperscript{12}Lawrence P. Frost, "Effects of Weight Training, Flexibility Training, and Combined Weight Training and Flexibility Training on Strength, Speed and Agility," Completed Research in Health, Physical Education, Recreation and Dance 21 (1979):162.

described as (1) Interval Training two times per week, (2) Long slow-distance running three sessions per week, (3) Interval running three sessions weekly and (4) Long slow-distance running three sessions per week. The experiment was conducted for 10 weeks. He found significant changes for calf girth in group I and II. Skin folds for group I, II, III. Lower resting heart rate for group I and II, reduced diastolic blood pressure for group III and IV, improved duration of effect on the modified Balke Treadmill Test for group I, II and IV, improved distance covered on the Cooper’s 12 minute Run/Walk Test for women in all groups and increased maximum aerobic power for group III and IV.

Hanson\textsuperscript{14} investigated the effect of three selected weight training programmes on muscular strength, endurance, girth and cardio-vascular endurance. He selected 30 freshman and varsity football players from the 1968 South Dakota group used a modification of the Delormewatkins methods of training. The second group followed the traditional strength training method, while the third

group followed a circuit training programme. The training covered a period of seven weeks three times a week. Tests for muscular strength, endurance and girth were conducted before and after training. At the conclusion of the programme, all groups significantly improved on all the parameters and there was no significant difference between the groups.

Uppal\textsuperscript{15} conducted a study to determine the effects of interval training and two continuous load methods in cardio-respiratory and selected physiological parameters, eighty untrained subjects were divided into three experimental groups and the control group. One group was given interval training, the second group fartlek and the third group slow continuous running for a period of ten weeks. He found that all the three groups equal training effects on maximal oxygen up take, vital capacity, leg strength, positive breath holding time and negative breath holding time. Slow continuous and fartlek method resulted in significantly higher improvement in cardio-respiratory endurance when compared to interval training. Slow

\textsuperscript{15}Arun Kumar Uppal, "Comparative Effect of Two Duration Load Methods and Interval Running Method on Cardio-respiratory Endurance and Selected Physiological Variables," (Unpublished Doctoral Dissertation, Jiwaji University, Gwalior, 1980).
continuous running method and interval training were superior to fartlek in reducing resting pulse rate. However, all the three training did not show any significant difference in diastolic blood pressure after exercise, blood haemoglobin contents and red and white blood corpuscles.

Mathew and his associates\textsuperscript{16} attempted to determine which of the three interval training programmes would produce the better improvement in cardio-respiratory endurance as measured by maximum oxygen consumption. Harvard step test, the Army physical fitness test and time trial for the 220 and 880 yards run. The subjects of the investigation were placed in matched three groups. Each of the three groups worked for eight weeks in interval training programme administered five times per week, one hour per day. One group participated in a programme consisting entirely of short distance running (55 to 220 yards) with as many as 16 to 20 repetitions. The second group participated in a programme consisting of running relatively long distance (660 to 1320 yards) with not

more than five to six repetitions at a fixed pace with the same work-to-rest ratio as the short distance group. The third group trained by mixing both short and long distance running on an equal and alternating basis. They concluded that short repetitive running is necessary for maximum improvement of cardio-respiratory endurance, long less frequently repeated running is less necessary, then is short distance running, and both type of running are probably helpful for proper leg conditioning, reduction of leg injuries and for variety and motivational purposes.

Maneval\textsuperscript{17} studied the effect of variable resistance circuit weight training on cardio-vascular fitness and body composition for which 80 male subjects enrolled in physical education classes at Texas A & M University were selected to determine the effect of a 3 days per week, 8 weeks variable resistance weight training program on VO\textsubscript{2}, body composition, performance on a 2 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 high intensity circuit weight training group or a low intensity circuit weight training group. Training sessions were conducted on

Nautilus weight training equipment for a period of 8 weeks. It was concluded that the Nautilus regimens of high intensity or low intensity do not effect VO$_2$, body composition, resting heart rate, blood pressure, systolic tension time index or heart rate. The Nautilus regimens for 8 weeks does not effect the performance of the 2 mile run.

Nupp$^{18}$ assuming that reduction in mile run time would reflect the most effective method of cardio-respiratory developement. Trained students thrice a week for ten weeks. The group included, (a) increasing distance at a proportionate time, (b) leader controlled fartlek, (c) Interval training - 60 seconds fast running, 60 seconds jogging and (d) circuit weight training. First three groups made significantly greater percentage improvement in run time than did the weight training group. But they were significantly different.

Olsen$^{19}$ undertook the study of the effects of a set circuit weight training program on strength and muscular endurance of college men. 42 college age male

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enrolled in weight training classes, participated in the study. Pre and post tests for 1 RM strength, absolute muscular endurance, relative muscular endurance were given for the bench press and leg press. Treatment consisted of two workout sessions per week for 7 weeks. In each session subjects were required to complete two sets of 10 exercises. Both sets of an exercise were completed before a subject moved to the next activity. A work rest ratio of 20 sec 10 sec was used. Test retest procedure and pre and post test mean changes were analysed using Pearson's 'r' and dependent 't' analyses. Mean changes between pre and post tests for 1 RM strength in the bench press and leg press, absolute muscular endurance in the bench press and leg press and relative muscular endurance in the bench press were significant (P < .05). No significant changes were found for the test of relative muscular endurance in the leg press (P > .05).

Kenney\textsuperscript{20} investigated changes in cardio-vascular endurance, muscular strength and endurance, flexibility

and body fat in males and females after three months of circuit weight training and variable resistance training.

All subjects trained on the same equipment: hip and back, leg extension, leg curls, pullover, lateral raise, over head press, arm cross - decline press, biceps and triceps.

(1) Cardiovascular Endurance: The following conclusions were drawn. A significant difference existed between variable resistance training and circuit weight training for maximum VO₂ on the treadmill run, but not on the arm ergometer.

(2) Muscular Strength: No significant differences existed between circuit weight training and variable weight training groups on the cybex II.

(3) Muscular Endurance: The changes in muscular endurance were also not significant for either of the training group. The females were significantly (.001) weaker than males on right arm press.

(4) Flexibility: No significant differences existed between both the training groups for males and females for shoulder extension and trunk flexion.
(5) Body Fat: A significant difference existed between male and female groups on body fat.

Swensen\textsuperscript{21} investigated the effect of exercise intensity on the body composition of adult males. 15 volunteers were assigned to either a control, low intensity exercise (540 kpm/min.) or high intensity exercise (900 kpm/min.) group. The exercise groups rode bicycle ergometer 45 minutes per day, 5 days per week for 12 weeks. All subjects were asked to continue their normal dietary intake pattern throughout the study. The ANCOVA indicated that both groups lost a significant amount of fat with no significant change in LBM. Although both exercise groups lost a significant amount of fat, there was no significant difference between groups indicating that the fat loss was independent of the exercise intensity. This discrepancy appeared to be due to increase in the daily caloric intake of the high intensity group.

Couéy\textsuperscript{22} conducted a study to determine the effect of training at various heart rate intensities on cardio-respiratory fitness of fifty subjects who were divided in five equal groups. Four experimental groups trained on a motor driven treadmill 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 VO\textsubscript{2} max, maximum heart rate, resting heart rate and workload changes were examined by ANOVA from pre 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 70\% level in increasing the working capacity. 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.

Price and Fisher\textsuperscript{23} studied the effects of three weight training programmes on strength, endurance, girth

\textsuperscript{22}\textsuperscript{\textsuperscript{Richard B. Couey, "The Effect of Training at Various Heart Rate Intensities on Cardio-respiratory Fitness" Completed Research in Health Physical Education and Recreation 15 (1973):135.}

\textsuperscript{23}\textsuperscript{\textsuperscript{Sandra Price and Garth Fisher, "The Effect of Weight Training on Strength, Endurance, Girth and Body Composition in College Women," Research Quarterly 46 (March 1975):131.}}
measurement 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 measurements, a skinfold measurements and percent body fat in comparison to the control group.

Santo\(^2\text{4}\) selected 76 college age men to study the effect of physical conditioning programme on cardio-respiratory fitness of college age men, the subjects were divided into four different groups, three of which participated in different conditioning programme. One was a control group which had no formal physical conditioning programme. The different conditioning programme were:

(1) Cooper's aerobic programme, (2) Interval conditioning programme, (3) Regular physical education programme and fourth was control group. Cardio-respiratory fitness was measured by using Harvard Step Test, the twelve minute run/walk, a three minute shuttle run and one minute lateral jump. It was concluded that interval conditioning,

aerobic conditioning and regular physical education groups improved significantly in cardio-respiratory fitness in comparison to the control group.

Salvatore and Pellegrino\textsuperscript{25} conducted an experiment on 28 subjects to investigate the effects of selected weight training program on strength and body composition of untrained college males in 10 weeks program. Group E (N=20) weight trained twice per week, 40 minutes per session. Group C(N=8) participated in a golf and bowling class. Strength, girth and skinfold measures were made before and after the training period. Group E improved in all strength measures ($P \leq 0.01$) and increased 2 skinfolds and 3 girth. There was no difference between groups in skinfold or girth measures. The present study did not provide support for previous studies which found improvements in body composition with weight training.

Gentry\textsuperscript{26} carried out a study to determine the effects of a nine week aerobic jogging programme, on selected


cardio-vascular function of young male college students through a time course evaluation procedure. Pre-test and post test administered at the end of third, sixth and ninth weeks were employed in order to evaluate the effects of the training programme. Significant decreases were observed in resting diastolic blood pressure and study state heart rate. While no change occurred in exercise cardiac output, resting and exercise cardiac index and resting heart rate.

Michael and Gallon\textsuperscript{27} studied the changes of pulse rate and blood pressure during the physical training programme. Seventeen members of the Santa Barbara Varsity Basketball Team were used as subject. Member of the Barbara basketball team were tested periodically during and after the 1957-58 season. The change in physical conditioning were estimated by using a step test. During this period of time blood pressure and pulse rate were measured and studied to investigate the effect of basketball conditioning on these measurements. The resting and past exercise systolic blood pressure measurement

decreased significantly during training. These changes were significant after 16 weeks, while pulse rate changes indicated in sixth week.

To compare the effects of weight training Arko used 21 university students on various motor performance and physiological parameters. The independent variable type of weight training was performed in non-circuit fashion. The dependent variable comprising the pre-tests and post tests including sit and reach, sit-ups, land line walk test, standing long jump, agility run, bench step test, jump and reach, horizontal ladder hand walk, girth and skinfold measurements. Subjects were grouped according to pre-test 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 projected hypothesis was that the isokinetic device 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 mini-gym on one variable, the horizontal ladder hand walk.

In recent years, a method of plyometric (Exercises that cause a rapid lengthening of a muscle prior to contraction called depth jumping) has become a part of the training routine of many athletes. Clutch et al.\textsuperscript{29} described the effectiveness of exercise examined by conducting two experiments. Experiment-I undergraduate students in beginning weight training classes trained with three different jumping programme (1) Maximum vertical jumps (2) 0.3 M depth jumps and (3) 0.75 M and 1.10 M depth jumps. In addition, all groups also lifted weights.

In Experiment-II a weight training class and a volleyball team were divided into two groups. One group lifted weights and performed 0.75 and 1.10 M depth jumps. The other group only lifted weights. In Experiment-I the three training programmes resulted in increase in one

repetition (1 RM) squat strength, isometric knee extension strength and in vertical jump, however, there were no significant differences between treatments. In Experiment-II all groups made significant increases in vertical jump except the group of weight lifters, who did no jumping. It was concluded that depth jumps are effective but not more effective than a regular jumping routine.

Parks\textsuperscript{30} undertook a study to determine the effect of ten week physical fitness programme on selected physiological and psychological variables of elderly people of 65 to 82 years. The subject were 15 females, pre and post measurement were obtained for psychological variables by the scale trait anxiety inventory. The physiological variables measured were body composition, flexibility, heart rate and blood pressure. The subjects participated in the fitness programme half an hour in the morning three days a week for 10 weeks. Each exercise session began with 10 minutes of warming up followed by 15 minutes exercise of moderate intensity. It was found that 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.

Phillip\textsuperscript{31} compared the effect of two weight training systems, the traditional set system and the interval circuit system, on muscular strength, cardio-vascular endurance and allocated anthropometric measures of college men. Sixty subjects were involved in the study.

Both groups exercised thrice a week for nine weeks and were retested. Sample means and variances for all variables were computed for both pre and post test measures. With in the limitation of the sample, the procedures employed, the following conclusions seemed justified:

1. The traditional set system of weight training resulted in significant increase in strength, cardio-vascular endurance and anthropometric measures during nine week training period.

2. In interval circuit weight training system also resulted in increase, which are equal to or are significantly greater than those developed using set system.

3. Considering that the interval circuit requires 70 percent less work out time than the set system and interval circuit system results in equal anthropometric changes, equal or significant greater strength gains, and it improves cardio-vascular endurance to a significantly greater extent, thus system can be a valuable training technique for the physical educators working with student or athletes to achieve both the benefit of weight training and cardio-vascular training when limited time is a factor.

Anderson and Kearney\textsuperscript{32} carried out an experiment on forty three male college students were randomly assigned to the different training protocols to see their effects on muscular absolute strength and relative endurance. The protocols were: High resistance-low repetitions group (N=15) performed three sets of 6-8 RM 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 were trained with

the bench press exercise three times per week for nine weeks. Test of strength, absolute and relative endurance were administered before and after training. To ascertain over all effects of treatments a two-way (group test) ANOVA with repeated measures across test was employed. For specific location of significance, one - way ANOVAs and test for simple main effects were conducted. The turkey W- procedure post hoc test was used to identify significantly different group means. An $\alpha = .05$ probability level was used for all tests of statistical significance. Results revealed 20% improvement in maximum strength by the high resistance low repetition group was greater than the 8 and 5% gains reported for the medium resistance-medium repetition and low resistance-high repetition group, respectively. Relative, to absolute endurance. However, the 41%, 39% improvements 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 groups performance actually decreased by 7% after training and was significantly poorer than the 22% and 28%
improvements made by the other two groups. It was conclud-
ed that human skeletal muscle makes both general and
specific adaptations to a training stimulus, and the
balance of these adaptations is to some extent dependent
upon the intensity and duration of the training protocol
used.

Linderberg, Edward and Heath\textsuperscript{33} explained that few
studies have been concerned with the increase in strength
of large muscular movements involving complex skill due
to isometric contraction. Is the strength developed by
isometric contraction sufficient to improve a skill
demanding complex motor skill, coordination, flexibility
and body balance. This investigation was made to deter-
mine if the maximum isometric exercise programme would
improve standing broad jumping ability, a skill demanding
coop-ordination, flexibility, body balance and strength.

Seventy-six male 8 grade students were tested on the
standing broad jump. The subjects were than paired accor-
ding to broad jumping ability into two groups. The
experiment group participated in an isometric programme

\textsuperscript{33}Franklin A. Linderburg; Donald K. Edward and
William D. Heath, "Effect of Isometric Exercise on Standing
Broad Jumping Ability," \textit{Research Quarterly} 34 (December
consisting of 15 seconds, maximum contraction in an inverted leg press, once a day, 5 days a week for 6 weeks. Both groups retested at the end of six weeks programme. The data was treated by using 't' test for significance at the 5 percent level of confidence. It was concluded that neither the experimental nor the control group improved significantly in standing broad jumping ability.

Sharon\textsuperscript{34} to ascertain the effect of 2 contrasting speed of isokinetic training programmes upon performance of women in vertical jump. 48 varsity and second team collegiate volleyball players from 4 universities were randomly assigned a control group and isokinetic training group. After performing 3 sets of 10 leg press repetitions maximum 3 days/week for 8 weeks, on isokinetic speed controlled machine, the groups were compared on a strength measure and on vertical jump performance. Subjects from all schools were combined according to treatment effect for comparison purpose on the vertical jump. For the strength measure, the combined slow or past speed subject

\textsuperscript{34}L. Van Oteghenad Sharon, "Two Speeds of Isokinetic Exercise as Related to the Vertical Jump Performance of Women," \textit{Research Quarterly} 46 (March 1975): 78-84.
grouping formed an experimental treatment group which was compared to a combined control group. A 2 way ANOVA with repeated measure on each of the strength measure on 1 factor was applied to data obtained on the jump and on each of the strength measures. Results indicated, the slow and fast speed isokinetic groups were significantly superior to the control group on vertical jump performance, the slow speed isokinetic group improved significantly more in strength than the control group.

Stewart and Gutzin\textsuperscript{35} conducted an experiment on 24 normal healthy boys, aged 10-12 years to find out the effect of physical training on cardio-respiratory fitness. The training group numbered 13 and control group numbered 11 boys, each subject was tested twice; within 01 days before and 1 week after 8 weeks of training, the training was conducted with in the frame work of regular physical education classes. Training sessions were held 4 times for 40 minutes for the duration of 8 weeks. Training HR's averaged approximately 90% of the mean maximal HR. VO\textsubscript{2max} did not change significantly with training. The apparently high threshold for a training effect on the VO\textsubscript{2max} in children is probably related to their naturally active lives. The stresses induced by short-term training

probably small as compared to the overall activities of children. On the other hand submaximal heart rate during bicycle and treadmill exercise decreased significantly, with training. The $O_2$ cost of these submaximal tasks remained unchanged. The findings suggest that the use of $VO_2$ max as the only training criterion for cardio-respiratory fitness may be misleading. Since most work tasks proceed at a submaximal rate, and a training induced improvement at maximal efforts, perhaps submaximal physiological and performance measures are more important than maximal ones in the assessment of cardio-respiratory fitness.

Helling\textsuperscript{36} conducted an experiment on 63 college age women randomly assigned to three training programs (isotonic, isokinetic, jumping) and one control group. Each subject was given two pre tests and two post tests on a modified vertical jump test. Subjects trained 3 days per week for 6 weeks. Training for the isotonic group was performed on the universal weight machine. The

isokinetic group utilized a leaper machine and the vertical jump utilized tape maker hanging from the ceiling. Test retest reliability and producibilities were analyzed using Pearson's 'r' and dependent 't' analysis, respectively. All tests were found to be reliable and produciable. The ANOVA procedure, using the mean difference between pre and post test values was utilized to determine if significant difference had occurred among groups. A subsequent test, Turkey's W procedure was used as a post hoc analysis to determine between groups significant difference. The results of the multiple comparison test indicated that the isokinetic and isotonic training groups were the only treatments to significantly improve vertical jumping ability. It was also found that isokinetic training group increased significantly more on vertical jumping ability than did the isotonic training group.

Peter\textsuperscript{37} conducted the study to investigate the effect of an eight week weight training programme on the body composition and strength of preadolescent boys.

Eighteen weight training subjects and thirteen control subjects in the age from nine to fourteen years were selected for the study. Testing programs were administered which include rating the subjects on the tanner scale of sexual development, body composition determined by underwater weighing and eight table tension strength test. The training group participated in a warm up, seven exercise Delorme method weight training programme, and cooling down on three non-consecutive days per week. Both groups participated in regular aerobic physical education classes and other normal activities. A student's 't' test for correlated measures was used to determine the significance as pre-test and post test changes and 't' test for independent measure was used to assess between group differences at .05 level of significance.

The training group increased significantly in body weight \((t = 2.29, P < .05)\) and lean body mass \((t = 1.78, P < .05)\). A decrease in body fat occurred \((t = 1.62, P > .05)\) but it was not statistically significant.

Strength increased significantly in both groups except right elbow extension which did increase but not of statistical value for the control group. The mean strength value for the weight training group was greater than control group by an average of 7 pounds and it can be
augmented by weight training. However, the increase shown by the control group indicate that maturation and normal activity do effect the strength of pre adolescent boys.

Joewiley\textsuperscript{38} studied the effects of three selected weight training programme 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 nine weeks. ANOVA was the statistics used in this study. It was concluded that significant gains in strength and muscular endurance were the results of high resistance - low repetition, low resistance high repetition combination of both.

Carnell\textsuperscript{39} picked up 158 girls of eleventh and 12th grade who were randomly assigned to two groups. The experimental group performed four specifically selected exercises for the arm and shoulder and the control group participated in general conditioning exercises for a period


of 8 weeks or 20 class periods. Strength endurance was measured using the straight arm support on parallel bars for as long as possible. The experimental group experienced a significantly greater increase in strength endurance than the control group.

Mac⁴⁰ carried out the study on effects of an exercise program on self concept and physical fitness of Oklahoma state university commissioned peace officers. 24 male campus policemen were pre-tested and post tested on a battery of fitness tests and tennessee self concept scale. After the pre-test the subjects were given an individualized exercise prescription based on THR and asked to participate at least 3 times weekly for 16 weeks. If the subject failed to accomplish 2/3 of the duration or intensity of the recommended exercise he was classed as a non-participant. On the post test there were 11 participants and 13 non-participants. There was a significant decrease in family self concept of the participants. The participants improved significantly in maximum O₂.

flexibility, percent body fat, weight residual, MBC and resting heart rate. The only significant change in fitness scores among non-participants was a decrease in percent body fat.

Wrenn\textsuperscript{41} undertook the study to determine the effects of two weight training programs on body composition and cardio-respiratory fitness, to measure body composition he took 7 skinfolds, biacromial diameter, standing height and predicted percentage body fat and for cardio-respiratory fitness, heart rate at rest, during submaximal bicycle exercise and in recovery were assessed in modified circuit weight trianing, traditional weight training, and control group over 10 weeks two, 30 minutes sessions per week. There were 29 males college freshman students. The training was not sufficient to elecit significant changes in body composition as cardio-respiratory condition.

According to Hyman the estimation of functional capacity of the C-X and pulmonary system was based on the


Fig. 13. Measurement of Reaction Time.
during the 6 week experiment period. At the beginning and end of the experiment, all subjects cardio-vascular fitness was measured by the PWC 170 test. All subjects skeletal muscles strength was measured by the leg press, over head press and curls. The adjusted mean of each skeletal muscle strength test and the cardio-vascular test were compared. An ANCOVA and the Scheffe's test were utilised for each dependent variable in order to assess the significance of the differences between the three treatments. The specified strength training program did increase skeletal muscle strength of curls and over head press, but did not improve the cardio-vascular system in the strength training group.

In this study Young compared the effects of an experimental program to the present curricular of physical education on the physical fitness of 213 boys and girls of the Kern HS District. Pre and post tests were administered for each subject in the 1.5 mile run for aerobic endurance, the 440 yards for anaerobic endurance, the sit up and push up tests for strength and the sit and reach test

for flexibility. The comparison of mean with in each treatment were statistically analyzed by a co-related 't' test, the comparison of means between treatments were statistically analyzed by an ANOVA. Results showed that there were no significant differences between treatments for any of the five tests. The experiment treatment significance increased strength and flexibility while the present curricular of physical education significance increased flexibility.

The determination of functional capacity and physical fitness of the cardio-vascular system or the lungs, Hyman⁴⁵ however, stated that was still an exploratory and experimental stage. The situation was made urgent and dramatic by the more or less lack of correlation between change in structure and change of physiological function. It was clinically impossible for example, to evaluate an electro-cardiogram with functional endurance in any given heart. Individuals with grossly abnormal tracing may exhibit a high level of physical fitness. The reverse was equally true. Patients with normal ECGs may suffer from a number of cardiac disabilities such as pain, dyspnea and longestive failure. The paradox presented by

this disparity between objective pathology and endurance has become one of the challenging problem of general medicine and it was here that sports medicine by supplying the necessary physiological data has made possible the important advancement in the determination and measurement of cardio-respiratory endurance.

Toit\textsuperscript{46} administered training programme to two groups employing weight training and progressive run and noted that the running group showed a significant reduction in pulse rate, diastolic blood pressure and an increase in pulse pressure and basal oxygen consumption.

To carry out the study, Muntzing\textsuperscript{47} investigated and included 29 sedentary women who participated in study, 20-30 years (N=9), 31-40 years (N=10) and over 40 years (N=10). Two training programs were used. Each program involved walking and jogging four days a week for 12 weeks. Half of the subjects in each age group were randomly assigned to the 300 kilo calories (K Cal) per session


program. The dependent variables were: body weight, percentage body fat, maximum VO₂, 1.5 mile run, cholesterol, triglyceride, HDL, LDL, Glucose and Resting heart rate. It was found that adaptation of fitness variables to endurance exercise is dependent of age in sedentary women, and exercise involving expenditure of 150 K Cal and 300 K Cal produce similar effects on fitness parameter in sedentary women.

Sennewald⁴⁸ experimented on college women the effects of heavy resistance, low repetition training on strength and endurance. 16 experimental subjects completed 6 repetitions of elbow flexion against a 6 RM resistance three times per week for six weeks. All the experimental and control (N=11) subjects were pre and post tested by contracting maximally every other second for 5 minutes. The progressive resistance training enhanced muscular strength (P .05) but failed to alter endurance. Training also seemed to cause a slower rate of strength less but larger decrement during the fatigue task. The two component fatigue pattern was not altered by training.

Alexander\textsuperscript{49} in his study of the effect of conditioning on the motor fitness and cardio-vascular condition of college fifteen male students in a required programme of physical conditioning class were tested before and after eight weeks of training (Two half hours of actual work a week). The mean differences in all cardio-vascular and motor fitness items were either statistically not significant or of no biological practical importance. Students who started in fit condition became less fit. Those who were unfit at the start improved considerably, the middle group made no change.

The effect of an intermittent circuit weight training program on cardio-vascular fitness was investigated by William.\textsuperscript{50} A $2 \times 2$ factorial ANOVA, the first factor being experiment and control group, and the second factor comprised of pre and post testing was used to analyse the data. Appropriate F stop down procedures were used to analyse significance main effects. It was


\textsuperscript{50}McKinley William, "The Effect of An Intermittent Circuit Weight Training Program on Cardio-vascular Fitness," \emph{Completed Research in Health, Physical Education, Recreation and Dance} \textbf{21} (1979):120.
concluded that 8 weeks of intermittent circuit weight training causes significant increases in strength, but appears to have limited effects upon maximum VO₂ and steady state heart rate during arm and leg work. Maximum VO₂ (1/min) during arm work was significantly higher following training, however, when expressed as ml/kg/min the values for both the experiment and control groups were essentially unchanged. Steady state heart rate for both control and experiment groups were lower on the post test during both arm and leg work. The ANOVA revealed that during steady state arm work the groups were significantly different in the way they changed form pre to post test. However, follow up 't' tests indicated no significance between the two groups.

Smith\textsuperscript{51} carried out an experiment on 52 male and female students at North Carolina Central University. The variables measured for the beginner swimmers were breath holding, prone glide, arm stroke and crawl stroke and advance beginner swimmers treading water, front crawl and back stroke. Subjects was randomly divided into two

equal groups: The experimental group engaged in 6 weeks of circuit training and swimming, while the control group engaged 6 weeks of swimming only. Experimental subject circuit trained on 10 station universal gym, 3 days/week, 30 minute per day, completing the entire circuit twice each training session. They swam for the remaining 20 minute of the class period concentration on the pre-test skills. It was found that the circuit training had a significant effect on the performance skills of the experimental beginner swimmers based on the red cross progressive swimming test for beginner swimmers. But there was no significant difference between experimental and control advanced beginner swimmers.

Jackson\textsuperscript{52} randomly assigned seven male college subjects to train at each of the following heart rate levels 130, 145 and 160 beats per minute. The training programme consisted of 12 minutes of walking on the treadmill, four days per week for six weeks. The heart rate response to two weeks tests (a treadmill test and a

bicycle ergometer test) and the recovery heart rate from these two work tests were utilized as estimates of cardio-vascular fitness. It was concluded that improvement in cardio-vascular fitness is directly related to the heart rate training intensity and that training at an intensity of 145 beats per minutes or higher is necessary to improve cardio-vascular fitness.

Blattner\textsuperscript{53} worked on 48 college male volunteers and were tested for vertical jumping ability and randomly assigned to 1 of the following groups: control, isokinetic training or plyometric training. Subjects in the training groups trianed 3 times per week for 8 weeks. The isokinetic group did 3 sets of 10 repetitions of leg process per training session. The plyometric group did 3 sets of 10 repetitions of depth jumps from a height or 34 inches with added resistance beginning with weeks 3, 5 and 7 of 10, 15 and 20 lbs respectively. Subjects were then tested for vertical jumping ability. ANCOVA revealed that both experiment groups adjusted post test scores were significantly higher than those of the control group. However, there was no significant difference between the two experiment groups.

Pickle selected 48 volunteers subjects between 18 and 31 years of age. Four experiment conditions were: training for 5 weeks or 8 weeks at distances of 55-220 or 110-1320 yards. Total distance run per session was 1.5-2.25 miles. The interval running programs were designed to emphasize development of anaerobic and/or aerobic energy systems. Training sessions were 3 per week and the intensity of work outs was regulated by horus. Run test of 50 yards, 440 yards and 1.5 miles were used to measure improvement in efficiency of the ATP-PC, the lactic acid, and the aerobic energy systems respectively. ANCOVA was the statistical method used to analyze test results of 50 yard dash and 1.5 mile run. The 440 yard test scores were analyzed, through an ANOVA on the difference between pre and post test performance. The 1.5 mile test run resulted in a significant different in favour of the 8 week training program. However, there was no significant difference between training distance. Results revealed no significant differences on the 50 yard

dash on 440 yard run in regard to training distances or
duration of training.

Patterson\textsuperscript{55} divided all the subjects into 3
different groups, 18 women exercised 2 times per week,
and 17 women exercised 3 times per week for 12 weeks
14 women served as controls. Skinfolds were taken on the
right side of the body with a harpenden caliper at the
triceps, subscapula, abdomen and suprailiac. Three chest
electrodes were connected to a Burdick electrocardiograph
for continuous monitoring of the heart rate. After a
fifteen minutes quiet rest, the resting heart rate was
recorded. Physical work capacity assessed by a continuous
walking treadmill test to a heart rate of 180. Identical
tests were performed both before and after the 12 weeks
training program. Training sessions lasted 40 minutes
and consisted of a warmup of 5 minutes, 6 to 8 minutes
dance averaging 2\textsuperscript{\frac{1}{2}} minute each and a cool down of 5
minute. Post test data were analyzed using Dunn's a
prior procedure. Both experimental groups had significant

\textsuperscript{55} P. Patterson, "The Effects of Two or Three Time
per Week Rhythmic Conditioning Program on Resting Heart
Rate, Physical Work Capacity, and Skinfold Thickness in
College Women," \textit{Completed Research in Health, Physical
lower resting heart rate than the control group (P < .01) in the 3 times per week group as compared to either the two times per week group or control group. There was no significant difference between the three groups in the sum of skinfolds. It was concluded that rhythmic conditioning is an effective way to improve cardio-vascular efficiency and is a variable alternative to the more traditional fitness programs.

Buckbee\(^{56}\) selected 48 female college students who were randomly assigned to groups which underwent strength training with Nautilus equipment, universal equipment, universal equipment or free weight and either one set (10-12 RM) or 3 sets (3-5 RM). Subjects trained 3 days per week for six weeks. Subjects were pre tested and post tested for strength (RM) in the bench press, shoulder press and arm curl using the 3 different pieces of equipment, with an average score being used for analysis. The design was a 3 (Nautilus, universal and free weights)X2 (1 set and 3 sets) factorial arrangements, utilizing ANCOVA. Results showed that although the use of 3 types

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of equipment and the 2 regimens led to strength increases, no regime or equipment was superior to any other.

Thomas\textsuperscript{57} studied the effect of an interval training programme on aerobic, anaerobic and anthropometric parameters in women between thirty and thirty nine years of age. The interval training programme involved controlled running, calisthenics and weight training. The results allow the conclusions that all of the parameters but three that is weight, body surface area and elbow extension strength can be positively changed by providing a seven and one third week of submaximal interval training programme for women.

Thomas\textsuperscript{58} experimented to see the effects of progressive resistance exercise programme on strength and body composition. Fifty-two college women participated in the study, 20 women were in control group and 32 participated in an experiment of progressive resistance exercise for the duration of 10 weeks. The collected data were statistically analysed by using 't' test and


analysis of covariance. It was concluded that this programme of progressive resistance exercise produced marked increases in strength with no significant effects on muscle girth or body composition.

Baker\textsuperscript{59} conducted a study to determine the effect upon cardio-vascular efficiency that resulted from the programme of rope skipping and jogging. The Harvard step test was administered to 92 male students in order to determine their level of cardio-vascular efficiency. The subjects were randomly divided into two groups. Group I skipped rope 10 minutes daily for the six weeks and group II jogged 30 minutes daily for the same period of time. The conclusion of the study was that a daily 10 minutes programme of rope skipping and a daily 30 minutes programme of jogging will significantly improve cardio-vascular efficiency as measured by Harvard step test.

Rath\textsuperscript{60} conducted a study of the effect of different physical education programmes on the strength index of ninth grade boys. A test group, a control group and a


\textsuperscript{60}Emil Rath, "A Study of the Effect of Different Physical Education Programme on the Strength Index of Ninth Grade Boys," Research Quarterly 13 (May 1942):169.
basic control group were organised. The revised physical education programme used by the test groups has a distinctly on scientific basis. It consist of a time run and variation, rhythmic conditioning exercise, basic events and game fundamentals, greater physical development seems to have been achieved by the programme used by the test groups than by those in vague in the individual high school and used by the control group.

Leshkevitch et al.\textsuperscript{61} studied the influence of sequence of exercises in training undertaken in the development of the physiological foundation of speed, strength and endurance in youthful sportsmen, three groups of boys aged 12-14 were given physical training four times a week for three months to determine the effects of the sequence of exercises. The observed change suggest that the speed, strength, endurance is the optimal sequence.

The calisthenic exercise programme advocated for adults by the President's Council on physical fitness was

tested by Campney and Wowear\textsuperscript{62} for its effect on selected components of physical fitness. Nineteen subjects participated in the exercise programmes for 10 weeks. The training was proceeded and followed by measurements relative to the council objectives for the programme; strength, flexibility improved general appearance, endurance, coordination, and efficiency. Flexibility in males and a segment of the endurance complex in females appeared significant at the .05 level of confidence. When the differences observed from pre training to post training were exposed to non-parametric tests, but the significance did not appear in any of the other components of physical fitness except in isolated instances within a given component.

O'Shea\textsuperscript{63} undertook the experiment to determine the effect of six weeks progressive weight training programme on the development of muscle hypertrophy, using one exercise,


the deep-knee bend, with varying repetitions. 30 students from beginning weight lifting classes were randomly selected. After two week conditioning period, subjects were divided into three groups of 10 each for the controlled training period. The programs were as follows group A 3 set of 9-10 repetitions, group B 3 sets 5-6 repetitions and group C 3 sets of 2-3 repetitions. Individuals in each group handled maximum weight loads for the required number of repetitions. The effectiveness was determined by three measurements: (a) Thigh girth (b) Dynamic strength measured by I.R.M. on the deep knee bend and (c) Static strength as measured on the dynamometer. The results were graphically analyzed and percentage calculated. The data was also statistically treated using analysis of covariance. No significant differences were found between the three systems of training. All training procedures resulted in improvement of static and dynamic strength.

Dominick in his study compared the physical fitness of two 5th grade self contained classes. One with no physical education curriculum and the other with a curriculum of 15 minutes daily period of calisthenics.

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Physical fitness was determined by AAHPER Youth Fitness Test. Analysis of data was done with the help of 't' test, within group changes and between group differences. Post experimental results yielded (a) Some significant changes within group (b) No significant difference between groups and (c) One significant difference in mean change in favour of the experimental group (50 yard dash).

Nangle and Irwin$^{65}$ studied the effects of two types of weight training on circulo-respiratory endurance and related physiological factors. Sixty freshmen students at the university of Florida volunteered to serve as subjects in this experiment. They were divided into three groups. Two experimental and one control, consisting of 20 in each group. They were tested during moderate and all out exercise on a bicycle ergometer. Selected physiological responses and the cardio-respiratory endurance items were measured. An eight week training period followed, during which the experimental groups participated in weight

training programme and the control subjects practised archery or bait casting. After training, tests were again administered. Though there was indication of improved circulo-respiratory responses by the weight training groups, statistically treatment of the data revealed no significant difference among the three groups in their responses to exercises.

Ladiss\textsuperscript{66} studied the influence of physical education activities on motor ability and physical fitness on 1,013 freshman male students of the college. They are matched on physical fitness test mean and age in eight paralleled sections. The treatments included in the study were boxing, conditioning, swimming, tennis, gymnastics, volleyball, weight training and wrestling. They participated in their respective groups for a period of one semester. The Larson's motor ability test and Physical fitness test which was slightly modified for the Army, Air Force test were administered. At the end of the training the comparison was made within the groups and among the groups by F ratio and significant difference was obtained.

\textsuperscript{66}Car\l{}k W. Ladiss, "Influence of Physical Education Activities on Motor Ability and Physical Fitness of Fifth Grade Boys and Girls," \textit{Research Quarterly} 23 (October 1952): 295.
Shvartz\textsuperscript{67} used twelve subjects to determine the effect of isotonic and isometric exercises on heart rate using a military press in sitting position. The isotonic exercises were performed for 45 seconds with one half of the maximum resistance, and the isometric exercises were performed for 45 seconds with one half, two third, and maximum resistance. The results indicated that isometric exercises performed for 45 seconds with half of the maximum resistance could stimulate heart rate to the same extent that isotonic exercises could, using the same intensity and duration. The results also showed that increasing the load in isometric contraction resulted in a proportional increase in heart rate and increasing the load to maximum isometric contraction resulted in a near two fold increase in heart rate.

Boyd and Mechen\textsuperscript{68} studied the physiological effects of two variables resistance weight training programs on

\textsuperscript{67}Esar Shvartz, "Effects of Isotonic and Isometric Exercises on Heart Rate," \textit{Research Quarterly} 37 (March 1966): 121-125.

males and females with the age range from 18 to 35 years. The results revealed that all the groups gained significant increase in shoulder abduction (power and endurance) while the female group 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 measurement showed a significant increases in triceps and biceps measurements, work on treadmill showed significant increases in only the female endurance group.

Edward\(^\text{69}\) 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 week period at their respective exercises programme.

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 programmes in the measure of circulo-respiratory endurance.

Bain\textsuperscript{70} conducted the study on 10 members of the 1977 Springfield college men's cross country team. Subjects were trained to take heart rate and blood pressure measurements. Each subject took three measurements 3 times a day, each day of the season. In addition, each day's practice workout was rated for intensity. ANOVA was used to analyse the data from the treatment (intensity - high and low) by treatment (time of day-morning, afternoon and evening) by \textit{subjects} design. No differences ($P > .05$) were found for the systolic and diastolic blood pressure measurements, for heart rate, it was found that the afternoon and evening measurements were greater ($P < .05$) than the morning measurement. Intensity level did not seem to effect either heart rate or blood pressure.

Crews\textsuperscript{71} studied the interaction of frequencies and intensity of training as they effect the physical work capacity, cardio-vascular function and body composition of adult males. Forty six subjects from university of Mussorie, Columbia were tested on the following variables:

Physical work capacity, exercise and recovery heart rate, oxygen consumption, oxygen debt, respiratory quotient, ventilation equivalent and percentage body fat. Subjects were trained for seven weeks as members of six groups representing all possible combinations of three levels of frequencies of training (5,3,1 day) per week and two levels of maturity of training. Exercise heart rate of 150 or 120 beats/minute.

The results of the statistical analysis revealed absence of significant interaction effect for any of the dependent variables. Examination of the main effect disclosed significant 'F' ratio for intensity of training for the dependent variables physical work capacity, recovery heart rate at one, three and five minutes.

following a standard treadmill test and percent body fat. Inspection of the pre-test and post test means for three variables indicated greater training effect for the 150 intensity level with respect to physical work capacity and recovery heart rates.

The 120 intensity level produced a significantly greater decrease in percent body fat than the 150 heart rate group. Though the use of multiple comparison test it was shown that both five and three days a week group had significantly greater improvement than the one day per week group. There was no difference between five days and three days groups.

Sano\textsuperscript{72} selected five flexibility programs to see the effect on the development of shoulder and hip joint range of motion. He investigated 65 randomly selected male students a Brigham Young University (BYU) whoresistered for physical education 1973, "Beginning Gymnastics" during the winter semester 1975. The 5 flexibility methods being investigated were,1) Static, 2) Ballistic, 3) Relaxation Reflex, 4) The Sano method and 5) The

control group. Three statistical analysis were used to test the data for significance. The first analysis was to see if any difference existed among the treatment groups in any of the dependent variables at the beginning of the experiment. The second analysis was to compare effectiveness of the treatments in terms of improved flexibility. The third analysis was also concerned with a comparison of the treatment effects on each of the dependent variables. The null hypothesis stated that there would be no difference in the development of flexibility among the selected programs. A difference was found between the static flexibility group and dislocation with wound and shoulder angle.

Hayrettin measured the $O_2$ debt of 11 Oklahoma State University track man at the beginning and end of 20 weeks pre-season interval training programme. $O_2$ debt was measured by the open circuit method during a 30 minute recovery period following an all out treadmill.

run. A 't' test for $X-O_2$ debt change from 9.49 ltrs to 10.09 ltrs was not significant.

Deborch\textsuperscript{74} experimented on 107 female students at Hiawatha high school, Kirkland, Illinios on 7th, 9th, 10th grades to see the effect on jumping rope as a means of improving cardio-vascular endurance. Subjects in the 7th and 9th grade were randomly assigned experimental group while 8th and 10th graders became the control group. All subjects participated in similar physical education class activities during the 12 weeks study. The experiment subjects participated 5-10 minutes of rope jumping at the beginning of each class period. All classes met three times per week. All subjects completed a 12 minute run at the beginning and end of the study as a test of cardio-vascular endurance. ANCOVA revealed no significant difference between groups ($P > .05$).

Burke\textsuperscript{75} had a comparison between untrained college age males and females in selected physiological alterations


as a result of training. Experimental groups trained three times weekly for eight weeks at a (heart rate) intensity between 75% and 85% of HR maximum with total distance run held equal between sexes. MANOVA revealed a significant training effect for the experimental groups as well as a significant difference between sexes in response to training. Univariate ANCOVA revealed a significant effect for VO₂ max expressed in ml/kg. min⁻¹ and 1 min⁻¹, Vₑ max expressed in 1 min⁻¹ L/kg. min⁻¹, O₂ pulse at VO₂ max and weight. Sexes differences were found for Vₑ max (1. min⁻¹) and weight. No significant training effect was found for HR max or Vₑ at VO₂ max.

The purpose of Janice Lee's study was to determine the effects of body conditioning exercises in combination with apparatus instruction on the muscular strength, endurance, agility and flexibility of high school girls. Two freshman and two sophomore classes were used as subjects. At the beginning of the apparatus unit, the physical fitness was measured by the Washington performance test which included through the stick, pull ups,

curls ups, squat thrust, and the illinois agility run. During the six weeks instructional unit, on freshman and one sophomore class were given ten minutes of conditioning exercises before the apparatus instruction. The other two classes received only apparatus skill of the student. The results indicated that six weeks of apparatus instruction combined with ten minutes of conditioning exercises increased the physical fitness of high school girls without being detrimental to the learning of apparatus skills. Apparatus instruction alone did not increase the physical fitness but maintained it at a relatively high level.

Kistler\textsuperscript{77} studied to find the results of eight weeks of participation in a university physical fitness programme for men. A battery of five tests was administered at the beginning and at the end of eight week programme. Result showed a significant improvement in the physical fitness elements.

Ghanima\textsuperscript{78} conducted the study on sixty two students aged 15 to 16 years, enrolled in 10th grade physical education classes in the National Orthodox School Amman,


Jordan. One group of 31 students participated in designed exercise and rope jump programme (conditioning exercise) the second group of 31 students participated in sport activities, basketball, volleyball, team handball and ping pong.

All subjects participated in 18 sessions three times a week for 30 minutes in 6 weeks period. Pre and post test scores were recorded for one mile jog/walk, body composition, sit ups and flexibility tests.

The data was computed statistically by the paired 't' test, the independent sample 't' test and gain scores and a level of significance was set at .05 level. Subjects who participated in the exercise and rope jump programme proved significantly better in all four components than the subjects who participated in regular physical education classes.

Mark\textsuperscript{79} carried out the experiment on nineteen males and three female officers who participated in the 11 weeks programme to measure the effects of a super circuit exercise programme on officers of the Alabama University.

\textsuperscript{79}Norrell Philip Mark, "The Effects of an Eleven Week\textsuperscript{79}\textsuperscript{,}Super Circuit Exercise Programme on Selected Physiological and Psychological Measures of University of Alabama Police Officers," Dissertation Abstracts International 47 (December 1986):2078-A.
Protocol included nine resistance exercise stations inter spread with nine aerobic exercise stations. All subjects exercised for 27 minutes, alternating 20 seconds at each resistance station and 40 seconds at each aerobic station for three complete circuits. The training programme brought about the following changes and multivariate analysis revealed significant gains in cardio-vascular system 15%, resting and exercise recovery heart rate 7% and 13% respectively. There was significant increase in lower leg strength (7%), upper leg strength (15%), vertical jump (12.5%), and sit ups (37%). There was no significant change in push ups, sit and reach, grip strength, state anxiety, blood pressure or blood lipid. There was no favourable change in body composition. The programme was sufficient to bring changes in the majority of fitness variables tested. Cardio-vascular endurance, muscular strength muscular endurance and power.

Frank\textsuperscript{80} made this study to develop an individualized computerized off season conditioning programme for the area of strength, flexibility and endurance.

The strength programme is built upon a cycling concept to prevent over-training and involve three different phases the endurance, strength endurance, and maximum strength phase, moving from high repetitions, numerous sets and light resistance to fewer repetitions, fewer sets, and heavier resistance. As the athlete completes one cycle he obtains a new one repetition maximum upon which the percentage of the next cycle are based. The flexibility programme was based upon a series of static stretching exercises and the endurance programme involves aerobic, anaerobic and speed work.

The computer programme is accompanied by a user's manual. The computer prints out with in seconds (1) The individual athlete's strength programme including sets, repetitions, percentage, poundage and recovery period. (2) His flexibility program and (3) His endurance routine with the appropriate repetitions, distances, workout, and recovery periods.

Huntley[^1] made a study on physical fitness and motor ability to find out the effect of these selected physical

activities on 1961 subjects selected at random from first, second and third grade students, who are involved in this study. Out of the three experimental groups within each grade. An analysis of the results revealed that both physical fitness and motor ability attributes, excluding body reaction time can be significantly improved by structured physical education programme consisting of basic movement and rhythmic activities, games and gymnastics. It was further found that the greatest contribution of physical fitness and motor ability resulted in group participation in basic movement and rhythmic ability. The best contribution to physical fitness and motor ability resulted from participation in games and related activities.

Clarke and Vaccaro\(^8\) selected 15 boys and girls who were undertaking their first competitive age-group swimming training and studied before and after seven months of training and compared to a similar group of control subjects. Measurements were obtained on percent fat, lean body weight and somatotype and on tests of

muscular endurance and strength. No significant changes over controls were found for the body composition variables \((P > 0.05)\) or the measures of body strength \((P > 0.05)\) significant increase occurred in muscular endurance \((P < 0.05)\) but the rate of local muscular fatigue remained constant. It was concluded that the main effect of competitive swimming training is to increase muscular endurance, not muscular strength or component of body composition.

Pamela\(^{83}\) had a review of the literature from 1940 to the present, investigating the effects of localized 'Spot Reducing' exercises indicated that the issue continues to be controversial. He investigated on 23 women \((20-46\text{ years})\) volunteers. 12 women assigned experiment group while 11 served as sedentary control subjects. The experiment subjects exercised 3 days/week approximately 30 minute per session, for 8 weeks. Exercises were specific to the upper arm, waist, hip and thigh and consisted of a variety including isotonic, isometric

strength and localized muscular endurance regimes and flexibility exercises. Number of repetitions and the degree of difficulty increased throughout the program. Pre and post test body weight, skinfold thickness and body girth measurement were taken. All subjects weight fluctuations remained within 5% statistical technique included dependent and independent 't' tests and ANCOVA. There was a significant initial difference between groups at the abdominal skinfold site. Analysis of mean change indicated that there were no significant difference due to the exercise program for any of the 10 experiment variables.

Guenther[^84] studied the programmes of basic exercises on the side horse, parallel bars, horizontal bar and trampoline with respect to their effect on strength. Thirteen isometric and isotonic strength tests were administered to experimental and control groups before training began and after four and eight weeks of training. Subjects were intervened weekly concerning outside activities.

As a mean of minimizing the howthorne effect, control group subjects were given a place to identified as a special strength pill each week. Although strength gains occurred in all tests only five were statistically significant. The combined average strength showed improvement at the .01 level of probability, control group improvement was not statistically significant.

Wheeler\textsuperscript{85} selected 23 members of senior high school girls basketball team. Each team was devided into experiment and control group. The Experiment group trained 3 days/week for 8 weeks. Training consisted of 25 repetitions of equal extensions with maximum efforts at a fast speed performed on the mini gym leaper 16 X 6. A modified vertical jump test was administered before the onset of training. After 4 weeks at the end each subject had 5 trials at each test session. ANOVA with repeated measures found no significant differences between groups. It was concluded that an eight week isokinetic programme does not increase vertical jump height.

Greenberg\textsuperscript{86} studied the effects of two interval training programmes on running ability. Two experimental groups of twenty four subjects were employed in the training programme which was conducted three times weekly for seven weeks. Both the groups trained over distance of 110, 220 and 330 yds. In one group speed running was constant while the number of repetitions of each distance was increased. The second group ran a fixed number of repetition at progressively faster speed. Both experiment groups improved significantly over the control group. However, no significant difference in improvement of running ability of 440 yards distance was found between the experimental groups.

Vira and his associates\textsuperscript{87} trained students in nine groups employing different methods ranging from long uniform runs (25-30 minutes) to fast interval training (40-50 meters). They noted a significant increase in the heart volume as a result of interval training. A continuous run fartlek method was more effective in increasing


oxygen carrying capacity of the blood. Greatest reduction in 800 meter run time was made by the group training on a 15 slope (-27.6 sec). While the least reduction was made by long uniform running group (-13.6 sec). They concluded that the exclusive employment of one method did not provide development of the total organism and might ultimately improve performance.

Members of the women's swim team (N=15) at the University of California at Davis, mean age 18.6 years assessed at the beginning and at the end of 9 weeks competitive swimming season. Wade\(^88\) determined the body composition, pre and post training, by the hydrostatic weighing technique (22). Residual volume were assessed using the closed circuit oxygen dilution technique in a body position similar to that assumed during the weighing (20), percent body fat was calculated using the formula of Siri (17), percent body fat = \((495/D)-450\), where D = density (gm\(^{-3}\)). Height and total body weight measurements were also obtained for each individual. A significant increase, 1.052 to 1.054 gm\(^{-3}\), in body density

resulted in significant decrease in absolute body fat, 12.7 to 12.1 kg and relative fat, 20.4 to 19.6%. Skinfolds of the triceps, suprailliac and subscapula also decreased significantly. Suggesting the fat loss was mainly subcutaneous. The relation of the body composition changes to body insulation and sinking force while swimming are discussed.

Circuit training is relatively recent innovation in the field of fitness training. Limited experimental research has been carried out on its effects on components of physical fitness.

Howell, Hodgson and Sorenson\(^8^9\) selected two groups of 17 subjects in the required physical education were equated on the basis of the modified Harvard step test. Experimental group participated in circuit training twice a week for four weeks. Programme was consisted of 12 different exercises. Control group participated in the regular service programme of volleyball and badminton for approximately 30 minutes, twice a week. At the end of the

experiment period, all subjects were retested on the modified Harvard step test. 't' test was used to analyse the data statistically at the .01 level of confidence. The experimental group showed a significant improvement whereas control group did not show a significant improvement over a four weeks period. The final test between groups showed no significant differences.

The effect of different frequencies of weight training on muscular strength was studied by Corbett. Exercise frequency was compared after an equal length of time and after an equal number of training sessions. Secondary high school boys (N=28) were assigned to one of four groups, three of which were experimental and a control group. One of the experimental groups trained twice a day five days a week. Second, once a day five days a week and the third, three times a week. All groups used the same exercises. After six weeks of training the experimental groups showed significant increase in isotonic strength. No significant differences emerged when the experimental groups were compared after an equal number of training sessions.

Sayed\textsuperscript{91} studied ninth grade boys (N=149) by treating them in four groups (circuit training, weight training, Swedish exercises and no conditioning control). The conditioning programme was administered during the first ten minutes of each of 20 physical education class period three times a week over seven weeks. Activities for the rest of each class period considered of volleyball, wrestling and street hockey. ANOVA revealed with in group improvements and differences among the groups. There was no change in commulative performance and no difference in commulative standard scores. The rest "no conditioning" test revealed a decrease in pull up performance.

To determine the effect of selected fitness measures on skier performance, Zetterberg\textsuperscript{92} evaluated 3 ski teams Rocky mountain collegiate ski association on the Zetterberg ski test Battery for 1976-77 seasons and


recorded for statistical comparison. The conditioning factors and anthropometric measures studied were percentage of body fat, height, weight, resting heart rate, resting blood pressure, static balance, hand and feet reaction times, general body muscular endurance, leg power, arm and shoulder girdle strength, leg strength, abdominal muscular endurance, agility and cardio-vascular endurance. Giant slalom skiers, slalom skiers, cross country skiers and nordic jumpers were all considered in the study, both male and female. Statistical analysis was performed by same difference r at the .05 level. Conclusions were drawn in the areas of physiological attribute of skiers Vs college poors. Additionally intra team analysis of tests and ski season ranking found certain physical fitness measurements to significant influence skier performance. It was also found that the nordic jumper of greater height and/or weight in the study performed better than their poors.

Gregor\textsuperscript{93} studied the effect of a progressive weight training programme on the performance of swimming,

the 100 yards crawl stroke of male and female competitive swimmers between the age of ten and sixteen. The 40 subjects were divided into two groups. The experimental group was exposed to nine weeks of training in competitive swimming and progressive weight training. The control group participated in an identical competitive swimming programme. The group were tested on 100 yard crawl stroke and to evaluate weight training programme sixteen cable tension strength test was administered. It was concluded that the subjects who participated in the progressive weight training programme, significantly increased their performance in swimming the 100 yard distance using crawl stroke.

Lyle Jr.s\textsuperscript{94} investigation compared the effectiveness of a special exercise programme and a traditional programme in developing muscular strength, muscular endurance and cardio-vascular respiratory endurance.

The investigation was conducted on 18 male students of university of Texas. Two groups were formed. Group

one followed traditional programme, exercised five
times a week, 15 minutes each period over 10 weeks dura-
tion. Group II utilized speed exercise technique,
exercised three times a week, minimum of ten minutes
each period for six weeks. At the conclusion of ten
weeks period, performance data were obtained from following
test prior and after the ten weeks exercises and at the
additional six weeks programme, isometric test for trunk
flexion strength, isometric test for arm flexion and fare-
arm extension strength, sit up test for trunk flexion
endurance, push up test for arm flexion and farearm
extension endurance, 320 yards run to measure the cardio-
vascular respiratory endurance.

The data was analysed by the linear regression tech-
nique for covariance analysis. The following results were
obtained:

1) No significant difference were found in the
treatment effect of the two exercise groups.

2) Both programmes were successful in obtaining
high significant change as a result of training for the
development of muscular strength, muscular endurance and
cardio-vascular respiratory endurance.
3) Significant increase in muscles strength was obtained by calisthenic type of exercises.

4) The one day a week exercise period was not sufficient to maintain a level of achievement at the conclusion of ten weeks programme.

Swedburg\textsuperscript{95} studied 88 male college students by treating them with three different pace training methods namely, continuous running, interval running and continuous pace running and determined the effects of different training methods on Cooper's 12 minute test. The fourth treatment group was control which participated in no organised training during the experiment. The training was carried out for a period of eight weeks. It was concluded that gains of all the four groups were significant on Cooper's Twelve Minute Test. The interval and continuous pace training groups showed significant gains on the Cooper's Twelve Minute Test when compared to control group.

\textsuperscript{95}Randy Brent Swedburg, "A Comparison of Three Methods of Pace Training for Distance Running," \textit{Dissertation Abstracts International} 35:8 (February 1975):5101-5102-A.
Singh\textsuperscript{96} states that the conditional ability strength, speed, endurance and their complex forms are primarily dependent upon the energy liberation process of the centre nervous system. Out of all the conditional abilities, strength ability is perhaps the most important in sports, because the other conditional and co-ordinative abilities are affected to a greater or lesser extent by the strength ability.

Mookerjee\textsuperscript{97} investigated whether a systematic and scientific training regime of 15 weeks would positively effect some selected physiological parameters even though the experimental subjects were in a highly advanced condition state in the pre training stage. Twelve national level swimmers were selected from Netaji Subhas National Institute of Sports, Patiala selected physiological parameters were recorded before and after 15 weeks of training. The training programme was progressive in nature and administered by the institute coaches. There were two


\textsuperscript{97}Swapan Mookerjee, "Effect of Swimming Programme on Selected Physiological Parameters and Hyman's Cardio-Pulmonary Adynamic Index of Swimmers," (Unpublished Master's Thesis, Jiwaji University, 1987).
training sessions daily and training was given five days a week.

In order to ascertain significant changes between initial and final means the 't' test was employed. Mean change in maximum breath holding, maximum expiratory pressure, pulse rate, and haemoglobin percentage were found to be statistically insignificant at .05 level of confidence. His conclusions were:

1) 15 weeks training caused significant change in reduction of resting pulse rate, increase in maximum breath holding time, increase in haemoglobin concentration.

2) 15 week training did not have any significant effects on the selected parameters: vital capacity, blood pressure (systolic and diastolic) and skinfold thickness.

3) The duration of training was sufficient enough to bring Hyman's C.P. Adynamic Index of the subjects to a very high level (the level of highly trained international athletes).

4) The training programme in terms of quality and quantity was sufficient enough to bring about changes in selected physiological parameters of the subjects who were already highly conditioned in the pre-training period.
Lynn\textsuperscript{98} compared two methods of conditioning upon vertical jumping height and vertical jumping power of perspective female inter collegiate basketball players. In addition two test of leg power were compared, a bicycle ergometer test and new vertical jump test of leg power. In female caucasian university of Illinois student under took either weight lifting or jumping exercises designed to improve vertical jumping height and power in addition to a pre-season basketball conditioning program. Conditioning took place 3 days/week for 7 weeks. Seven other subjects served as control group. Data was collected before and after conditioning, but neither the jumping nor weight training exercises produced increase in jumping height or power ($P > .05$). Both series of exercises produced significance loss of percentage fat when accompanied by the pre-season conditioning program.