CHAPTER - II

REVIEW OF RELATED LITERATURE
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The review of literature is instrumental in the selection of the topic, formulation of hypothesis and deductive reasoning leading to the problem. It helps to get a clear idea and support the findings with regard to the problem under study. Thirumalaisamy (1995)

Any study would not be completed without the study of the related past. For each and every study, the tradition of the past should not be overlooked so that the individuals' present attempt could be relevant to the past. Otherwise it won't fit in place with the past. Moreover, it is the best help one can get from the review as one can get ideas of the prevailing tests.

In order to support the presentation of the analysis of the study, the research scholar collected research reference materials from various books and journals. The following materials collected from the views expressed by various personalities provide the back ground to the study and help to understand the effects of varied intensities, frequencies and densities of bench step training on selected motor ability components, physiological variables and the performance of 400 metres run.

STUDIES ON BENCH STEP TRAINING

Johnson, Johnson and Winner (1993) compared the peak vertical ground forces loading rates and impulses produced when performing two distinct steps at three different bench heights but with the same stepping cadence. Fifteen male and female volunteers (mean age 24 years) randomly performed bench stepping at a rate of 30 lifts per minute under six conditional standard sagital bench stepping and straddle bench stepping each at bench heights of 6-8 and 10 inches. The subjects performed under each condition for 45s with measurements taken at approximately 30s with rest bouts between trials. An
AMTI force platform operating at 15000HZ recorded the ground forces. Mean peak vertical ground forces ranged from 1.4 to 1.74 BW. With the standard (STR) 6 inch step producing the smallest and standard 10 inch the largest force. Mean peak vertical impulses (PVI) ranged from 0.1097 BWs for STR inches to 0.1417 BWs for STR 6 inches to 13,7606 BWS for STR 10 minutes. Mean PVLRs ranged from statistical analysis revealed numerous differences for the various combinations. For example, STR 6 inch bench stepping produced significantly greater in PVGFs and PVIs and PVLRs than both STD 8 and 10 inch stepping and smaller PVLRs than STR 8 an 10 inch stepping while STD 10 inch stepping was significantly greater in PVGFs and PVIs than all STR stepping heights. It was concluded that bench stepping performed from a 6 inch bench produced generally smaller PVGFs, PVIs and PVLRs when compared to greater bench heights and would likely decrease the chances for foot and shank injuries when compared to repeated stepping from greater heights. STD 10 inch bench stepping imposed the greatest loads on the ground foot during descent and would likely increases the chances for injury to the foot and shank when compared to other conditions. The subjects appeared to be more cautious when performing the STR step, particularly at 10 inches and likely imposed more eccentric loading on the bench leg, hip and knee extensors to control the body’s descent. Little caution was shown when performing the standard step movement due to greater familiarity of the subject’s with this action.

Doss (1992) conducted a study to find out the influence of step up and bounding exercises on the sprinters performance. For the purpose of this study, the investigator selected 90 school boys at random belonging to the age group of 14 -15 years. The subjects were divided into 2 equal experimental groups and assigned step up exercises to one group and bounding drills to another group. Both the groups were given training for 6 week, three times per week. It was found out that there was significant improvement in the performance of 100 meters sprint through step up exercise group and bounding exercise group. It was also proved that the mean gain of experimental group two (bounding exercise group) had greater than the experimental group one (step up exercise group). Hence bounding exercises have more effect on the performance of 100 meters sprint than step up exercises.
Retna Raj (1994) conducted a study on the effect of varied frequencies of bench step exercise on selected physical and physiological variables. To achieve the purpose of the study, ninety boys were selected at random from State Bank Officers Administration Higher Secondary School and divided into three groups namely experimental group I (two days per week training), experimental group II (three days per week training) and the control group were not given treatment. The experimental groups were given exercise in varied frequencies of eight weeks. The score was measured before and after the treatment periods for the physical and physiological variables. Such as speed, agility, explosive power, breath holding time, resting pulse rate and mean arterial blood pressure. To find out the significant difference between the groups, the analysis of covariance technique were applied. It was found out that varied frequencies of bench step exercises significantly improved the explosive power, breath holding time, resting pulse rate and mean arterial blood pressure. However it was also found out that the bench step exercise did not bring any significant improvement on speed and agility.

Faria (1990) conducted on forty college men who were randomly divided into three training groups and one control group, a study of selected cardiovascular adaptations to four week of training bouts eliciting either 120-130, 140-150 or 160-170 heart rates training consisted of bench stepping until the assigned heart rate was elicited five days per week. Significant changes were found in the analysis of pre-post 180 work capacity (PWC-180). Analysis of group difference revealed that the 140-150 and 160-170 training group's improvement was significantly different from other group. No other difference was statistically significant. No change were noted on recovery heart rate. The study supported the hypothesis that when training to improve one's physical capacity to do work the severity of the training effect is related but not proportional to intensity of the training.

Whitney (1993) and others studied step aerobic utilisation of differing arm movement patterns and step heights to influence exercise intensity. The purpose of this study was to investigate the effect of 4 commonly used arm movement patterns (arm at side pulling action arm, pulling action arm front, pulling action arm
overhead at 3 different step heights 4, 8 and 12 inches. Eighteen females 20 to 30 years old volunteered as subjects and participated in 3 separate exercise sessions. Each session consisted of exercising at one step height at which the four arm movements were randomly performed for 5 min. Subjects rested between each arm movement/pattern until heart rate was within 10 beats of resting heart rate. Cadence was set at 30 arm movements and steps/minutes. To test the effect of arm position for each step height. Tukey's post hoc tests were used to investigate any significance. Results were similar at each step height for all variables arm action front and pulling arm action overhead were significant greater than arm side. Pulling action low and pulling action overhead were not significant greater than pulling action arm low and pulling action arm front, within each step height VO₂ varied up to 8 ml/kg/minute and heart rate upon 206 bpm, depending upon the arm movement, with pulling action arm overhead soliciting the greater VO₂. Differences between step heights, for each arm movement, were all significant difference. For a given arm movement VO₂ was 40 and 90 and greater for the 8 and 12 inch steps, when compared to the 4 inch step. These data indicate that by manipulating arm movements and step height, step aerobics can provide and adequate training stimulus for wide range of fitness levels.

Anbunath (1996) conducted a study on effects of varied intensities and frequencies of bench step training on selected motor ability components, physiological and performance variables of school sprinters. To facilitate the study sixty three male students in the age group of twelve to thirteen years were selected as subjects. In the first factorial analysis homogeneity of variance of all the pre test scores were tested. In the second factorial analysis the significant difference between the post hoc test was used to find out the paired mean difference. Four days of frequencies of training improved the speed, anaerobic power and pulse rate greater than the three days and two days frequencies.

Kravitz et al., (1993) conducted a study on aerobic dance which continues to enjoy wide spread popularity with estimates of over 23 million adult participants. Numerous aerobic dance styles and variations have been developed. The new
aerobic exercise modality is step training or step aerobics, which is a modification of aerobic dance using a stepping bench ranging in height from 10.2-30.5 cms. A study was conducted to examine the physiological effects of eight weeks of step training with (N=12) and without (N=12) hand weights. The main effects of step training resulted in significant (P<0.05) overall improvements in VO2 max (38.29±1.05 to 41.32±0.95 ml kg⁻¹/min⁻¹). Arm flexion strength (30.73 ± 1.83 to 35.08 ± 1.73 n/m) forearm flexion strength (26.89 ± 1.13 to 29.29 ± 1.14 n/m) and extension strength (28.13 ± 1.26 to 31.07 ± 1.38 n/m).

Ponnulingam (1998) studied the effects of graded bench step exercise on cardio Respiratory responses among the inter collegiate kabaddi players. He has taken ninety college men students as subjects and their age was between 18 to 25 years. He divided them into three groups as experimental group I and II and control group and also he implied tow methods of bench step exercise. In the first method of graded bench step exercise the subject was performed the bench exercise for three minutes with fifteen cadence per minute, that was followed by twenty cadence per minute. Then it was followed by twenty five cadence per minute for three minutes and that was followed by thirty cadence per minute for three minutes. In the second method the subject performed for three minutes with twenty five cadence per minute that was followed by thirty five cadence per minute for three minutes and that was followed by forty cadence per minute for three minutes. And it was concluded that the resting pulse rate, vital capacity, breath holding time, respiratory rate and pulmonary ventilation was improved by the influence of graded I and II bench step exercise and the pulse rate, vital capacity, breath holding pulmonary ventilation and respiratory rate was improved greater by II bench step exercise than the graded I bench step exercise.

Kalpana (2002) conducted a study on the effects of varied intensities of bench step training on selected motor ability components and physiological variables among university women volleyball players. To facilitate the study forty women university volleyball players were selected at random from various colleges and they were divided into four equal groups at random basis. After 6 weeks of training final test was conducted. It was found out that the varied intensities of bench step training did not bring any significant improvement on resting pulse rate, speed, agility and anaerobic power among university women volleyball players.
STUDIES ON VARIED INTENSITIES

Edwards et. al (1990) conducted the study on relaxation effects of acute exercise by varying intensity. The purpose of this study was to monitor psychological and physiological changes following exercise of low, moderate, vigorous and maximal intensity. Ten sedentary female students were recruited, 8 received medical clearance for participation, subjects performed a VO2 max test on treadmill using the Bruce protocol. 3 treadmill exercise sections with workload monitored by VO2 and a non exercise sections with workload monitored by VO2 and a non exercise resting control of 15 minutes duration were randomly assigned. VO2 and two EMG measures (Arm and Leg) were mentioned for 10 minutes pre and 60 minutes post session. The physiological data were averaged in to 10 minutes blocks of trials. Further four psychological measures poms TA, and v scales, and a rating of perceived relaxation were obtained at the end of the 10 minutes resting baseline and at 60 minutes post session of the physiological data, tension in the arm and leg decreased over time. At 10 minutes post exercise, baseline decreased 44% and 38% respectively. Analysis of the psychological measures also revealed a decrease from pre to post exercise for the SAE, TA and RPR. Psychological measures were least favorable following to exercise control and most favourable following maximal exercise. In addition the ‘R’ value for ml/kg/min indicated that subjects untrained in muscle relaxation. These findings further suggest that both psychological and physiological benefits accure from brief exercise regardless of intensity.

Hang (1991) study was designed to measure the effect of various intensities of leg-press exercise and squat exercise on HGH release. Young 24±7 years of age, M lifters (n=3) served as Ss for this study. After a 1 RM was established on the Wt sled and squat rack they completed a 3RM, 10RM or 25RM workout using a 3 set protocol. Each workout (3, 10 or 25RM) was performed on a separate day and leg press and squat exercises were separated by 3 wks. Blood was taken from an anticubital vein prior to exercise (Pre exercise, after warmup and post exercise 4, 8, 16 min). The serum was means for hGH levels. The results indicate that (1) high intensity exercise of a short duration will not elicit a hGH response indicating that exercise duration is more
important than exercise intensity, (2) the HGH output, depends on exercise intensity when exercise duration is sufficient to elicit HGH response, and (3) the increased lactic acid during resistance exercise did not relate to HGH levels.

The purpose of Miura's (1995) study was to determine the aerobic training intensity from the maximal and submaximal running exercise in 21 untrained adult men. To accomplish this, he evaluated the relationship between physiological (oxygen intake and heart rate) and physical parameters (running speed) of training intensity, and determined the training intensity at the submaximal exercise. Oxygen intake and heart rate were measured by a treadmill test. The maximal oxygen intake (vo2 max), and the aerobic threshold (AerT) and anaerobic threshold (AT) were measured to determine respiratory gas exchange. Running capacity was measured by a 12 - min running and treadmill test. For the maximal exercise, there was a significant correlation (r=0.88, p<0.01) between vo2 max and 12 min running distance (speed). In addition, the oxygen intake and heart rate at AerT and AT in the submaximal exercise were linearly correlated with running speed. Three levels of training intensity submaximal exercise were termed light, moderate and heavy, Since AerT was the lower limit intensity and AT was the upper limit, we took the middle of their values as the moderate intensity. The end point for the determination of the training intensity at the submaximal exercise was estimated to be 85% vo2 max and 180 beats min -1.

Fry et.al (1992) stated that the vitro lymphocyte function and the mobilisation peripheral blood leucocytes was examined in eight trained subjects who undertook an incremental exercise test to exhaustion and a series of interval training sessions. Venous blood samples were obtained before the incremental test, immediately after and 30, 60 and 120 min after the test. Interval training sessions were undertaken on separate days and the exercise intensities for each of the different sessions were 30%, 60%, 90% and 120% of their maximal work capacity respectively, as determined from the incremental exercise test. There were 15 exercise periods of 1 - min duration separated by recovery intervals of 2 min in each session. Venous blood samples were obtained immediately after each training session, significant increases in lymphocyte
subpopulations (D3+, CD4+, CD8+ CD20+ and CD56+) occurred following both maximal and supramaximal exercise. This was accompanied by a significant decrease in the response of cultures of peripheral blood lymphocytes to concanavalin A (ConA), a T-Cell mitogen. The state of lymphocyte activation in vivo as measured by CD25+ surface antigen was not, however, affected by acute exercise. The total number of lymphocytes, distribution of lymphocyte subpopulations are in vitro lymphocyte response to con A had returned to pre exercise levels within half an hour of termination of exercise but serum cortisol concentrations had not begun to fall at this time. There was a significant decrease in the CD4+CD8+cells (CD8+ T-Lymphocytes). Decreased responsiveness of T-cells to T-cell mitogens, post exercise, may have been the result of decrease in the percentage of T-cells in post exercise mixed lymphocyte cultures rather than depressed cell function. The cause of this was an increase in the percentage of natural killer cells which did not respond to the T-cell mitogen. The results indicated that while a substantial immediate in vitro 'Immunomodulation occurred with acute exercise, this did not reflect an immuno suppression but was rather the result of changes in the proportions of reactive cells in mono nuclear cell cultures. We have also demonstrated that the degree of the change in distribution of lymphocyte subpopulation numbers and responsiveness of peripheral blood mononuclear cells in the vitro mitogen reactions increased with increasing exercise intensity. Plasma volume changes may have contributed to some of the changes seen in leucocyte population and subpopulation numbers during and following exercise.

Gaesser, Cooper and Good Fellow (1991) had conducted a study to test the hypothesis that adaptations to high intensity exercise could be achieved following very low intensity training 11 subjects (5 males, 6 females, 21+1, 64.2 + 3kg, 171.5 + 3cm) exercised on a cycle and ergometer 4 days / week for 5 weeks 60 minutes / session at an intensity of 36.4 + 1.7 vo2 peak (61.2 + 1.2 percent max HR = 42.7 + 2.0 percent heart rate reserve) pre and post training responses to incremental and high intensity constant load exercise (10 min at a power eliciting 85 percent VO2 peak) were compared with those of an age and gender matched control group values for all post tests were not different from pre tests. VO2 peak was unchanged following training the trained group
demonstrated significant reductions during the post test constant load exercise about for VE, Vo2, HR, VCo2 and blood lactate. They concluded that 5 weeks (twenty 60 minutes sessions) of training at 36 percent vo2 peak results in significant adaptations in the cardio respiratory and blood lactate responses to high intensity court load exercise. They interpret this as evidence that very low intensity training improves tolerance for high intensity exercise. Since vo2 peak was not increased this parameter may not be a useful index to document adaptation, to this type of training. Thus very low intensity exercise training (as described herein) may improve capacity for high intensity exercise without a measured increase in maximal aerobic power.

Cohen (1992) undertook a study to determine the cause and effect relationship, if any between varying intensities of aerobic interval exercise and beneficial changes in the plasmalipid constituency. The effect of varying intensities of aerobic interval training on lipid fractions, body weight, body composition and cardiorespiratory functions were studied in 49 sedentary male Brooklyn College faculty in the age group of 30 to 63. The subjects were trained three times per week for 12 weeks on the stationary bicycle ergometer. The training included a two minute warm up followed by 30 minutes of cycling at 85 percent, 75 percent and 65 percent of the individuals maximum heart rate and concluded by a 3 minute cool down. The analysis of covariance F-test showed that there were no significant difference in lipid levels among group as a result of 12 week conditioning programme.

Williamson (1999) stated that the purpose of his investigation was to determine whether there were differences in the magnitude of insular cortex activation across varying intensities of static and dynamic exercise. Eighteen healthy volunteers were studied: eight during two intensities of leg cycling and ten at different time periods during sustained static handgrip at 25% maximal voluntary contraction or postexercise cuff occlusion. Heart rate, blood pressure (BP), perceived exertion, and regional cerebral blood flow (rCBF) distribution data were collected. There were significantly greater increases in insular rCBF during lower (63±1.7%; P<0.05) and higher (13.3±3.8%; P<0.05) intensity cycling and across time during static handgrip 4-5 min, 8.6±2.8%; P<0.05).
Insular rCBF was decreased during post exercise cuff occlusion (5.5±1.2%; P<0.05) with BP sustained at exercise levels. Right insular rCBF data, but not left, were significantly related, with individual BP changes (r²=0.80; P<0.001) and with ratings of perceived exertion (r²=0.79; P<0.01) during exercise. These results suggest that the magnitude of insular activation varies with the intensity of exercise, which may be further related to the level of perceived effort or central command.

Romijn (2000) studied eight endurance-trained women at rest and during exercise at 25, 65, and 85% of maximal oxygen uptake. The rate of appearance (Ra) of free fatty acids (FFA) was determined by infusion of [2H2] palmitate, and fat oxidation rates were determined by indirect calorimetry. Glucose kinetics were assessed with [6, 6-2H2] glucose. Glucose Ra increased in relation to exercise intensity. In contrast, whereas FFA Ra was significantly increased to the same extent in low- and moderate-intensity exercise, during high-intensity exercise, FFA Ra was reduced compared with the other exercise values. Carbohydrate oxidation increased progressively with exercise intensity, whereas the highest rate of fat oxidation was during exercise at 65% of maximal oxygen uptake. After correction for differences in lean body mass, there were no differences between these results and previously reported data in endurance-trained men studied under the same conditions, except for slight differences in glucose metabolism during low-intensity exercise we conclude that the patterns of changes in substrate kinetics during moderate-and high-intensity exercise are similar in trained men and women.

Mulla et.al., (2000) conducted a study to examine whether the relative workload or the absolute work performed is the major determinant of the lipid mobilization from adipose tissue during exercise. A second purpose was to determine the co-ordination of skeletal muscle and adipose tissue lipid metabolism during a 3 h post-exercise period. Six subjects were studied twice. In one experiment, they exercised for 90 minutes at 40% of maximal O2 consumption (O2 max) and in the other experiment they exercised at 60% O2 max for 60 min. For both experiments, catheters were inserted in an artery, a subcutaneous abdominal vein and a femoral vein. Adipose tissue metabolism
and skeletal muscle (leg) metabolism were measured using Fick's principle. The results show that the lipolytic rate in adipose tissue during exercise was the same in each experiment. Post-exercise, there was a very fast decrease in lipolysis, but it began to increase about 1 h post-exercise and remained elevated for the following 2 h. The increase in post-exercise non-esterified fatty acid (NEFA) mobilization was greater after 60% exercise than after 40% exercise. It is concluded that the lipolytic rate in abdominal subcutaneous adipose tissue during exercise is the same whether the relative workload is 40% or 60% of maximum. Post-exercise, there is a substantial lipid mobilization from adipose tissue and only a small fraction of this taken up in the lower extremities. This leaves a substantial amount of NEFAs for either NEFA/TAG (triacylglycerol) recirculation post-exercise or immediate oxidation.

Thirumalaisamy (1991) conducted a study on comparative effect of varied intensities of interval training on selected physiological and haematological variables among university sportsman. In this study forty five university sprinters were selected and divided into 3 equal groups, ANCOVA statistical technique was employed. The study showed that 60% intensities of interval training had reduced the resting pulse rate and increased the RBC haemoglobin content and cardiorespiratory endurance than 50% and 70% of interval training.

Allen, Hollman and Boutellier (1993) studied the effects of aerobic and anaerobic training on lipoprotein concentration in 45 healthy untrained men. Thirty three subjects exercised four times per week during nine weeks on a bicycle ergometer. Sixteen trained with an intensity above the anaerobic threshold (blood lactate concentration 4 mmol l⁻¹) and 17 trained with an intensity below the aerobic threshold. In addition, twelve subjects served as control groups. The calculated caloric expenditure of the two training groups was similar. In all three groups, total cholesterol, total high density lipoprotein (HDL). HDL, subfractions (HDL2, HDL3) and low density lipoprotein (LDL) were measured. Training had a significant influence on HDL, HDL2, LDL / HDL HDL2 / HDL3 and cholesterol / HDL. With anaerobic training three variables changed in the opposite direction compared with aerobic training which influenced the
lipoprotein profile in the desired direction. Cholesterol, HDL3 and LDL did not alter during the nine weeks of training. After nine weeks of training, the higher the blood lactate concentration during exercise (representing training intensity) was the higher resting LDL / HDL ratio was found. The correlation between these two variables was highly significant. They conducted the training above the anaerobic threshold has no or even negative effects on blood lipoprotein profiles. Therefore beneficial adaptations in lipoprotein profile must be achieved with moderate training intensities below the anaerobic threshold.

STUDIES ON VARIED FREQUENCIES

Thirumalaisamy (1995) conducted a study on the effect of varied intensities and frequencies of treadmill training on selected motor ability, physiological and performance variables. Sixty inter-collegiate male long distance runners were selected as subjects at random and their age was between 18 to 25 years. Two different intensities and frequencies selected for this study were 10km/Hour and 15 Km/Hour and also 2 days per week training and 3 days per week training respectively. Initial test was conducted for selected motor ability components such as speed, leg explosive power and agility, physiological variables such as pulse rate, anaerobic power and cardiorespiratory endurance and also 1500 metres running performance. The post test were conducted after six weeks of treatment in the above variables (2 x 2) factorial design was used to analyze the result. The findings of the study shows that 15 km/hour intensities or treadmill training is better for the improvement of the above said variables. Also the three days frequency is better for the improvement of above variables than two days frequency training. The combined effect of 2 days and 3 days training showed that the above variables were improved significantly due to the influence of varied intensities and frequencies of training.

Dressendorfer et.al. (1995) stated that the convalescent period after myocardial infarction (MI) has been associated with a "Spontaneous" improvement in functional aerobic capacity that may be because of normal recovery process unrelated to formal exercise training. The purpose of this
study was to determine whether the frequency of formal training sessions is an important variable affecting the magnitude of improvement in cardiorespiratory fitness during phase II cardiac rehabilitation. The effect of exercise training frequency on cardiorespiratory fitness was evaluated during a 5 week early (phase II) cardiac rehabilitation program in 50 low risk, male patients recovering from acute MI. Baseline graded treadmill tests to fatigue endpoints with direct measurements of maximal oxygen uptake (VO₂ max), were administered 4 weeks after MI. The subjects were then randomly assigned to either a control group (n=12) and restricted to "very light" physical activity (requiring < 50% of VO₂ max) at home, or to one of three training groups which, in addition to very light home activity, performed moderately intense (approximately 70% of VO₂ max) aerobic exercise for 30 to 35 minutes either once per week (n=13), twice per week (n=13), or three times per week (n=12) in the hospital based phase II program. The four groups were similar in age, clinical status and use of beta and clucium channel blockers. Submaximal and maximal cardiorespiratory responses were initially similar in all four groups. each of the four groups demonstrated significant (P<0.05) increase in maximal treadmill duration of follow up. The spontaneous improvement in treadmill duration in the control group, in the absence of formal exercise training, may simply reflect recovery from the acute cardiac event. Those training two and three sessions per week also showed significant comparable decreases in submaximal exercise heart rate and rate pressure product and similar increases in maximal treadmill duration and VO₂ max. Results suggest that two exercise sessions per week is as effective as three per week for cardiorespiratory conditioning in the early weeks of phase II cardiac rehabilitation.

Mani Azhagu (2001) conducted a study on the effects of varied intensities and frequencies of plyometric training on speed, stride length, stride frequency and anaerobic power among university men sprinters. To achieve the purpose of this study, 40 men students were selected at random from St. Joseph College, Trichy belonging to the age group of 18 to 21 years. They were divided into 4 equal groups of 10 subjects each and assigned to experimental group I (80 percent intensity with 5 days frequency), experimental group II (80 percent intensity with 3 days frequency), experimental group III (70 percent intensity
with 5 days frequency) and experimental group IV (70 percent intensity with 3
days frequency) respectively. Analysis of co-variance and Scheffe's post-hoc
test were used to test the significant mean differences among the experimental
groups. It was found out that 80 percent intensity with 5 days frequency of
plyometric training would significantly improve the selected dependent variables,
such as, speed, stride length, stride frequency and anaerobic power greater
than 80 percent intensity with 3 days frequency, 70 percent intensity with 5
days frequency and 70 percent intensity with 3 days frequency of plyometric
training among university men sprinters. This study reveals that high intensity
and high frequency of plyometric training contributed to the improvement of
speed, stride length, stride frequency and anaerobic power among university
men sprinters.

Mary Reethamal (1994) conducted a study on effects of varied
frequencies of circuit training on muscular performance of college women. For
the purpose of the study, ninety girls were selected at random and their age
ranged from 16 to 19 years and their were divided into three equal groups of 30
each as one control and two experimental groups. The researcher selected
speed, explosive power, strength and agility as the variables for the study. To
compare the statistical data ANCOVA was employed. It was found out that the
muscular performance such as speed, explosive power, muscular strength and
agility were significantly improved due to the influence of 3 days and 5 days
circuit training among college women.

Celarely and Others (1984) conducted a study on the effect of two day
and three day per week aerobic dancing programme on maximal oxygen uptake.
In this study, 18 female college students enrolled in an aerobic dance class
were randomly assigned to one of his experimental group. A group of seven
students enrolled in physical education badminton courses volunteered to serve
as sedentary controls. Individuals who had been previously trained or those
engaged in any type of physical training were excluded from the study. Training
for both group was conducted between the hours 4.00 p.m. to 6.00 p.m. two or
three times weekly for the period of ten weeks. The subjects were also instructed
not to participate in outside class activities. He concluded that three days aerobic
dance group per week improved better in maximal oxygen uptake that two
days aerobic dance training per week.
Saroja (2000) conducted a study on the effect of varied intensities and frequencies of circuit training on selected motor ability components, physiological, haematological and performance variable among school girls. To facilitate the study forty girls from Govt. Girls High School, A. Kalappur were selected as subjects at random and their age was between fourteen and fifteen years. They were divided into four equal groups namely experimental group I (70 percent intensity with 3 days frequency), experimental group II (70 percent intensity with 5 days frequency), experimental group III (80 percent intensity with 3 days frequency) and experimental group IV (80 percent intensity with 5 days frequency). The subjects were involved with their respective intensities and frequencies of circuit training for a period of eight weeks.

The findings were, speed, leg explosive power, resting pulse rate, anaerobic power and 400 metres running performance were significantly improved due to the influence of varied intensities and frequencies of circuit training.

Mahendran (2002) conducted a study on effect of varied intensities and frequencies of wind sprint training on selected motor ability components, physiological variables and performance of 100 metres sprint of school boys. To facilitate the study 45 students of Muthiah Alagappa Matriculation School, Kottaiyur were selected as subjects at random and they were divided into nine equal groups. And they were involved in the training for eight weeks and data were collected and found out the significant difference.

The finding was, significant improvement in speed, leg explosive power, anaerobic power, pulse rate and 100 metre dash performance due to the varied intensities and frequencies of wind sprint training.

Vaithilingam (1997) conducted a study on the effect of varied frequencies progressive staircase training on the performance of selected athletic events. To facilitate the study ninety male students in the age group of fourteen and fifteen years of Govt. High School, Membalam, Thanjavur were selected at random as subjects and were divided into three groups namely control group, two days
per week training group and three days per week training group. Two groups participated in the staircase training programme for a period of six weeks. The findings of the study was, significant improvement in the 100 metres dash, long jump, shotput and 1500 metres performance due to the varied frequencies of staircase training.

Perumal (1992) conducted a study on the effect of 5BX physical fitness plan on selected physical fitness components such as body fat percent and grip strength among adolescent boys. For the purpose of the study, 90 boys were selected at random between 13 to 14 years of age. They were divided into three groups namely one control and two experimental. Arm strength, shoulder girdle flexibility, abdominal endurance, cardiorespiratory endurance, leg explosive power, agility, speed, body fat percent and static strength were selected as variables. To compare this ANCOVA technique was employed. It was found out that experimental group 'B' (5BX fitness plan five days a week) and the experimental group 'C' (5BX fitness plan three days a week) improved the selected physical fitness components.

STUDIES ON DENSITY

Hutterly (1969) investigated the effects of varied intervals of rest between warm up and performance on 440 yard dash. Subjects performed on the 440 yard dash after participating in a standard warm up. Each subject performed an equal number of trials after rest intervals of one minute, four minutes and ten minutes. Scores for performances were not significantly better (0.05 level) for any one time interval, therefore it was concluded that the selected intervals for rest had equal effect upon performance.

Nakao et. al (1995) investigated the effect of a long term weight lifting programme characterised by high intensity, low repetition and long rest period between sets on maximal oxygen consumption (VO₂ max) and to determine the advantage of this programme combined with jogging. 26 male untrained students were involved in weight training for a period of 3 years. The VO₂ max and body composition of the subjects were examined at beginning and 1 year,
2 year (T₂) and 3 years after (T₃) the training of the group, 19 subjects performed the weight lifting programme 5 days each week for 3 years (W-group), 4 subjects performed the same weight lifting programme for 3 years with an additional running programme consisting of 2 miles of jogging once a week during 3rd year (R₁ - group) and 3 subjects performed the weight lifting programme during the 1st year and the same combined jogging and weight lifting programme as the R₁ group during the 2nd and 3rd years (r₂ group). The average VO₂ max relative to their body mass of the W-group decreased significantly during the 1st year, followed by an insignificant decrease in the 2nd year and leveling off in the 3rd year. The average VO₂ max of the W-group at T₂ and T₃ was 44.2 and 441.1 ml.kg⁻¹ min⁻¹, respectively. The tendency of VO₂ max changes in the R₁ and R₂ groups was similar to the W-group until they started the jogging programme, after which they recovered significantly to the initial level with in a year of including that programme and they then leveled off during the next year. Lean body mass estimated from skin fold thickness had increased by about 8% after 3 years of weight lifting. The maximal muscle strength, defined by total Olympic lifts (snatch and clean and jerk), of these three groups increased significantly and there was no significant difference among the amounts of the increase in the three groups.

STUDIES ON SPEED

Uppal and Lakew (1990) attempted a study on selection of talent in track and field based on motor fitness components. The subjects were randomly selected from Scindia school, Gwaliar. The average age of the subjects was 16 years. The motor fitness components selected for this study were (a) speed 950 mts, run) (b) strength (standing broad jump) (c) endurance (12 min, run/walk) (d) agility 9shuttle run); (e) flexibility (sit and reach and shoulder rotation). The statistical procedures employed were Pearson's Product Moment Correlations, multiple correlations and regression equation analysis. The results indicated that a significant relationship was found between speed, explosive strength and in 100 mts. run, explosive strength and cardio-respiratory endurance, speed and explosive strength and long jump abdominal strength and arm and shoulder girdle strength in shot put performance.
Radharupa (1995) conducted a study on comparative analysis of selected physiological variables and motor ability components among the college football, hockey and handball players. In this study 30 players each in football, hockey and handball were selected as subjects from university arts and science college, Warangal, at randomly and the age was between 18 and 25 years. The findings of the study showed that the college football players had a greater agility, speed and cardiorespiratory endurance than the hockey and handball players. The college hockey players had lesser pulse rate than the handball players. The handball players showed greater breath holding time and anaerobic power than the hockey and football players.

Raghavelu (1990) conducted a study on the effect of plyometric exercises on selected physical fitness components of higher secondary school boys in modern city. To achieve the purpose of this study, 100 male students belonging to the age group of 15 to 17 years were selected as samples. The subjects were divided into two equal groups (n=50), namely experimental group and control group. The training schedule was from Monday to Friday for a period of six weeks. The experimental group was assigned to plyometric exercise training and the control group was not involved in any training. It was found out that the plyometric training would significantly improve the physical fitness components such as speed, power, agility and flexibility. It was also proved that there was no significant improvement on physical fitness components of the control group.

Najeebullah (1997) conducted a study on the comparative effect of plyometric training on the performance of long jump and sprinting. To achieve the purpose of the study, 50 college men students of 17-19 years age from Sri Sarvodaya College, Nellore, Andhrapradesh were selected randomly. After the selection of the subjects, they were divided into two equal groups called long jump group and sprint group, consisting 25 boys (n=25) in each group. Selected plyometric exercises were given as training to both the experimental groups, three days in a week for a period of six weeks. ANCOVA was used a statistical technique to find out the significant mean difference due to the effect of training. It was found out that plyometric training should significantly improve the performances of both long jump and sprinting but the significant improvement level was more on long jumpers when compared to sprinters.
Satyanarayana Reddy (1993) conducted a study on the relative effects of plyometric training and weight training followed by plyometric training on power, speed, average stride length and frequency of stride. To achieve the purpose of this study, 45 school boys aged 15 to 16 years were selected and they were divided into three equal groups (n=15) and gave experimental treatment to group one and two by keeping the third group as control group. Group I has undergone plyometric training, group II has undergone weight training followed by plyometric training and the control group was kept away from experimental treatments. After 12 weeks of training with three days in a week, the study was concluded that the plyometric training and weight training followed by plyometric training would significantly improve the selected dependent variables, such as, power, speed, stride length and stride frequency greater than the control group. Further it was concluded that there was no significant difference existed between the two experimental groups.

Murugesan (1999) conducted a study on the effects of autogenic training and physical exercises on selected motor ability components, physiological variables and bowling accuracy in cricket. To facilitate this study, 60 cricket players from Erode district between 20 to 25 years of age were randomly selected as subjects and divided into three equal groups namely experimental group I, experimental group II and control group. The pre test was conducted all the three groups on selected motor ability components namely speed, power and physiological variables such as pulse rate, breath holding time and performance variable bowling accuracy performance. The post test was recorded at the end of the sixth week. ANCOVA was employed to find out the significant mean differences between the experimental groups and control group. It was found out that speed, leg explosive power and bowling accuracy performances were significantly improved due to the six weeks of autogenic training and physical exercises for cricket players of twenty to twenty five years of age. It also revealed that the pulse rate and breath holding time were significantly improved due to the six weeks of autogenic training and physical exercises among cricket players. However physical exercises significantly improved the speed, leg explosive power and bowling accuracy greater than the autogenic training.
Keller (1987) conducted a study on supplementary aerobic training on sprinters. The purpose of the study was to determine whether additional aerobic training over and above the primary aerobic training typical of collegiate sprinters, had effect on sprint times and other measures of anaerobic and aerobic training had some positive effects with respect to certain measures of explosive power and submaximal aerobic capacity these theoretically beneficial changes were not heart rate, while no change occurred in exercise cardio output resting and exercise cardio index and resting heart rate.

James (1981) studied the effect of break in training on sprinting speed. He conducted a study on some selected eighth standard school boys ranging in age 12 to 16 years, as measured by 50 metre run test. After training for one month and conducted a test and found improvement in sprinting speed. Then conducted a test after a break of one month and tests were taken on each week end. A break in training of one week duration did not show marked changes in sprinting speed of boys students. Break in training in two more weeks training deteriorated sprinting speed performance of the students. In the duration of break in training extends upto four weeks, the effect proved by training period of six week are almost elimination and sprinting performance of subjects returned to the pretraining level or in some cases goes even below the pretraining level.

STUDIES ON LEG EXPLOSIVE POWER

Kakkinen (1993) conducted a study on ten female basketball players in order to examine changes in a physical fitness profile during a 22 week official competition season. Specific explosive type strength training (1-2 sessions per week) was utilised throughout the season. The study shows significant (P<0.05) increase occurred during the season both in the average power output during the first 15 session work in an anerobic jumping test and in the maximal vertical jumping heights in the squat jump (from 21.7±2.3 to 24.2±2.4cms).

Sahayaraj (1990) conducted a study to investigate effect of depth jump and hurdle leap drills on leg explosive power. For this study, 90 students belong to the age group of 12 to 15 years were selected as subjects and divided then
into three equal groups such as depth jump group, hurdle leap exercise group and control group. The two experimental groups were given their respective experimental for a period of 6 weeks with three times a week training and the control group was not given any training. It was observed that there was significant improvement in the standing broad jump in both the experimental groups due to depth jump and hurdle leap exercise trainings. It was also found out that depth jump and hurdle leap exercises had great effect on the beginners among high school boys. It was also revealed that explosive power gained as a result of directed depth jump and hurdle leap exercises significantly improved the performance in standing broad jump.

Balachandran (1989) conducted a study on the effects of plyometric training on the vertical jumping ability among high school volleyball players. To achieve the purpose of the study 60 male school boys were selected and they were divided into two equal groups namely experimental group and control group (n=30). The experimental group was given the treatment of depth jumping exercises for a duration of 6 weeks. It was found out that strength gains in lower extremities as a result of directed depth jumping exercises training. It also revealed that depth jumping exercises were significantly improved the vertical jumping performance among volleyball players.

Pen (1989) compared the effects of depth jumps and vertical jumps complained with other types of training on vertical jumps and shot put performance. For this purpose, 39 college students were randomly assigned to one of the three groups. Group one performed depth jumps from a height of 90cms, group two performed vertical jump upto the height of 90cms, group three (control group) performed maximum vertical jumps. Subjects in each group were trained with respective programmes two times a week for a period of 12 weeks. Prior to and at the end of training period all subjects were tested on vertical jumps and shot put performance. The results showed that all groups improved significantly in vertical jump capacity. Further, the subjects of the two experimental groups also improved their shot put performance.

Mullai (1987) conducted a study the effect of selected plyometric exercises on the performance of long jump. To achieve the purpose of the
study, 70 male students were selected as subjects from the YMCA sports high school and they were divided into two equal groups namely experimental group and control group. The experimental group was given experimental treatment with selected plyometric exercises after taking pretest scores of the group. After a period of six weeks training with three times a week, post test was conducted. The control group was not given any training. It was concluded that the selected plyometric exercise training contributed to the significant improvement in long jump performance among school boys.

Clutch, et.al., (1983) conducted a study to determine the effect of depth jumps and weight training on leg strength and vertical jump for which two experiments were conducted. In the first experiment at the beginning of the weight training classes, undergraduate students were trained with three different jumping programmes. One maximum vertical jumps, two 0.20mts depth jumps and three 0.75mts and 1.10mts depth jumps, in addition, all groups lifted weights also. In experiment two, a weight training class and the Volleyball team at Bribham Young University, Hawal were divided into two groups. One group lifted weights and performed 0.75 and 1.10mts depth jumps. The other group only lifted weights. In experiment one, the three training programmes resulted in increase in one repetition maximum (IRM) squat strength, isometric knee extension strength and vertical jump. However, there is no significant difference between treatments. In experiment two, group one made significant increase in vertical jump except the group of weights lifters who did no jumping. It was considered that depth jumps were effective but not more effective than a regular jumping routine.

Viswalingam (1993) conducted a study on the comparative effect of aerobic exercises on selected physical and physiological variables between normal and visually handicapped boys. For the purpose of this study he has selected 30 normal boys and 30 visually handicapped boys. The normal boys were tested in connection with physical and physiological variables and were given aerobic exercises for six weeks and the visually handicapped boys were tested and were given the exercises training. To find out the comparative effect
between normal and visually handicapped boys in physical and physiological variables, 't' test was employed for significance. There was no significant difference for both normal and visually handicapped boys in breath holding time. There was significant difference between the normal and visually handicapped boys in agility, power, strength, pulse rate and vital capacity.

Radhakrishnan (1998) conducted a study on the effect of super circuit exercise programme on selected physical and physiological variables among college men students. For the purpose of the study, 60 undergraduate students were selected as subjects from Thiagarajar College, Madurai. Their age group ranged from 18 to 20. They were divided into two equal groups on random basis in which one was control group and other was experimental group. The investigator selected physical variables such as, agility, strength and flexibility and physiological variables such as pulse rate, vital capacity and breath holding time. To compare the physical and physiological variables ANCOVA technique was employed. It was found out that super circuit exercise programme brought out significant improvement in agility, strength, flexibility pulse rate and vital capacity. However, it was also found out that the super circuit exercise programme did not bring any significant improvement on breath holding time.

STUDIES ON RESTING PULSE RATE

Uptan and sagar (1983) conducted a study to compare the physiological profiles on highly trained middle age women distance runner with sedentary middle aged women. Thirty eight women who had run at least one Marathon and were currently training for another comprised the training group thirty five women who and not participated in the aerobic exercise programme within the past five years comprised the central group. Body composition included height, weight and percentage of body fat, forced vital capacity, forced expiratory volume for one second and maximum voluntary ventilation with the subjects in the standing position were measured using spirometer and blood pressure was measured by the spygmomanometer. All subjects were similar in weight and height but untrained subjects in total body weight. The women runners had significantly greater maximum aerobic power. The trained women had significantly lower resting pulse rate.
Anban (1993) conducted a study of selected physical, physiological and psychological variables between the Jawahar Novodaya Vidyalaya students of Nicobar and Karaikal (Union Territory of India). For this purpose, he selected two groups of thirty students each from the two schools. Speed, agility and strength were the physical variables he selected to compare the two groups. Pulse rate, blood pressure and breath holding time were the physiological variables. 't' test was the statistical measure employed. He concluded that physical and physiological fitness of the Nicobar students were dominant over Karaikal students whereas the students from Karaikal were dominant in the psycho variables.

Thirumalaisamy (1990) conducted a comparative study of selected motor ability components and physiological variables among the university basketball, volleyball and soccer players. In this study twenty players each in basketball, volleyball and soccer were selected as subjects at random and their age was between 18 and 23 years. It was concluded that the soccer players had lesser pulse rate, greater vital capacity, breath holding time, cardiorespiratory endurance than volleyball and basketball players.

Rayappan (1994) conducted a study on comparative analysis of selected motor ability physiological and psychological variables among hilly, coastal and plain area boys of three from each area were selected on each age group. This comprised twenty five students on each age group. The study revealed that the hilly area boys were better in speed, resting pulse rate than the plain and coastal area boys. The coastal area boys showed significant differences in leg length and breath holding time than hill and plain area boys.

Kubendran (2002) conducted a study on the effects of anaerobic and plyometric training on health, speed, explosive power, agility, breath holding time, resting pulse rate, anaerobic power among college men athlete. To achieve the purpose of this study 45 men students from American College, Madurai was selected. They were assigned into three groups of which one group served as anaerobic training group, second group served as plyometric training group,
and the third group served as control group. After six weeks of training, the study was concluded that the breath holding time and speed were significantly improved due to the influence of six weeks anaerobic training. Anaerobic training significantly improved the selected dependent variables such as breath holding time and speed greater than the plyometric training. Anaerobic training and plyometric training did not improve the selected dependent variables such as resting pulse rate anaerobic power, explosive power and agility among college men athletes.

Judith Jee (1991) studied the effect of an eight week water aerobic programme on selected physiological measurement of female participants aged eighteen to twenty five years. The previously secondary subjects were divided into control group (n=29) and the experimental group participated in a progressive water aerobic dance programme three times per week for eight weeks. Each subject was pre and post tested on using heart rate, resting systolic blood pressure, resting diastolic blood pressure, body weight and percentage of body fat. Analysis of covariance was used to determine if any significant difference between the two groups existed on the variables. The result of this study indicated a significant difference at the 0.05 level heart rate between the groups. No difference were found in wither systolic or diastolic pressure, body weight or percentage of body fat. It was concluded that waster aerobic dance need to be of sufficient intensity to increase fitness in young sedentary individuals.

STUDIES ON ANAEROBIC POWER

Nummila and Rusko (1992) had conducted a study to investigate whether the sprint training induced changes in the different components of anaerobic performance capacity determined by the maximal anaerobic running power (MARP) test. Male sprint runners (n=34) performed the MARP test before and after the 10-12 weeks training during the pre competitive season. In the MARP test the sprinters ran Nx20s on a treadmill and the speed was increased by 0.38 m.s⁻¹ for each consecutive run until exhaustion. Blood lactate concentrations were
determined during the 100s recovery between the runs. The maximum speed at
3mm and 10mm blood lactate levels and the peak blood lactate concentration
were determined. In addition, 12 subjects ran a maximal 30m speed test before
and after the training period to determine their maximum running speed on a
track. Training data were analysed from the training records. During the training
period $Vo_2$ max increased, the correlation analyses revealed that the high volume
of lactic speed endurance training influenced negatively $Vo_2$ max and blood
lactate concentration. On the other hand the volume of interval training at low
intensity (aerobic) correlated positively with the change of $Vo_2$ max. It was
concluded that the results of the MARP test reflect the sprint training induced
changes in the anaerobic performance capacity.

Housh (1992) conducted a study on the relationship between anaerobic
running capacity and peal plasma lactates. Twelve adult males ($X$ age ± SD =
21.9 ± 11.2 year) performed a critical velocity test from which anaerobic running
capacity was determined and maximal treadmill running test from which peak
plasma lactate was determined from post exercise blood samples taken at one
minute intervals. The result indicated that aerobic running capacity ($X$ ± SD =
0.18 ± 0.04 km) was not significantly $r = 0.06$, $P > 0.05$) correlated with peak
plasma lactate (9.3 ± 1.8 mm). These findings are indirect indicator of anaerobic
capabilities.

Ton (1994) conducted a study on the effect of seat to pedal distance on
anaerobic power and capacity in recumbent cycling. The purpose of this
investigation was determine the effect of systematic changes in seat to pedal
distance on cycling peak anaerobic power (PA) and anaerobic capacity (AC)
recumbent cycling. Nineteen male recreational cyclists (ages 20-33 years)
were tested in five seat to pedal distance (90,95,100,105 and 110 of the total
leg length from the greater trochanter of the right femur to the ground). The
seating position was defined by a 75 degree angle formed between the seat
tube and a vertical line, with the seat-backrest, perpendicular to the ground.
Minimum maximum mean and range of subjects knee and ankle angles were
determined for each condition. All subjects were tested in each of the five
condition according to a randomly determined, sequence, with a minimum of 16 hours rest between test session. The wingate anaerobic cycling test was used to Monark cycle ergometer with a resistance of 8th gm/kg of the subjects bodymass (5.0 joules pedal rev/kg bm). During the test each subject was strapped to the seat backrest at the waist and hips, pedal toe-clips were worn and a micro switch on - line with a macpaq analog to digital convert interfaced to a macIntosn SE microcomputer was used to monitor and record ergometer pedal revolutions. Repeated measures ANOVA and post hoc-test revealed that AP and AC in the 100, 105 and 110% seat to pedal distance were significantly greater than threat in the 90 and 95% condition. No significant difference were found in AP or AC between the 100,105 or 110% seat to pedal distance with changes in seat to pedal distance, a quadratic and linear function was found to best describe the trend in AP or AC respectively. It was concluded that there is a range of seat to pedal distance that will maximum AP and AC in a recumbent cycling position, and it is suggested that these seat to pedal distance be considered in the development of faster and more effective human powered vehicles power. The trained women had significantly lower resting pulse rate.

Coleman et. al (1994) conducted a study on nine college basketball athletes to determine the effects of season of computation on the aerobic and anaerobic energy resources. Pre and post season variables of resting and recovery heart rates performance of treadmill test (time),maximal oxygen intake and the scores of Margaria anaerobic capacity test (vertical jumping velocity) were studied. Analysis of data yielded non-significant decrease in recovery heart rate. Treadmill performance time, VO\textsubscript{2} max a non-significant increase in resting heart rate and anaerobic power and significant increase in vertical velocity from pre and post test. The result of this investigation suggest that the training in basketball was of efficient intensity to maintain cardiorespiratory functions and improve anaerobic performance.

Passvolainen et.al., (1994) purported to investigate neuromuscular and energy performance characteristics of anaerobic power and capacity and the development of fatigue. Ten endurance and ten sprint athletes performed a
new maximal anaerobic running power test (MARP), which consisted of \(n \times 20\)-s runs on treadmill with 100-s recovery between the runs. Blood lactate concentration \((L)_{a-b}\) was measured after each run to determine submaximal and maximal indices of anaerobic power (P3 mmol. 1-1, P5 mmol. 1-1, P10 mmol. 1-1 and Pmax) which was expressed as the oxygen demand of the runs according to American College of sports medicine equation: the oxygen uptake \((\text{mlkg}^{-1} \cdot \text{min}^{-1}) = 0.2x \text{velocity} (\text{m}, \text{min}^{-1}) + 0.9 \times \text{slope of treadmill} (\text{franc}) \times \text{velocity} (\text{m}, \text{min}^{-1}) + 3.5\).

The height of rise of the center of gravity of the counter movement jumps before (CMJ rest) and during (CMJ) the MARP test, as well as the time of force production (TF) and electromyographic (EMG) activity of the leg muscles of CMJ performed after each run were used to describe the neuromuscular performance characteristics. The maximal oxygen uptake \((\text{VO}_{2\text{ max}})\), anaerobic and aerobic thresholds were determined in the \(\text{VO}_{2\text{ max}}\) test, which consisted of nx3-min runs on the treadmill.

Numila (1993) experimented on a new maximal anaerobic running power (MARP) test that was developed. It consisted of 0.20s runs on a treadmill with a loos recovery between the runs. During the first run the treas mill speed was 3.97 m/s and the gradient 5 degrees. The speed of the treadmill was increase by 0.35 m/s for each consecutive run until exhaustion. The height of the counter movement jumps and blood lactate concentration \([(L)_{a-b}]\) were measured after each run submaximal \((L)_{a} = 3 \text{m}, \text{mol}, \text{wlo} \text{ m.mol.} \text{ and W.max respectively were calculated and W was expressed in oxygen equivalents according to the American College of sports medicine equation. Thirteen male athletes whose times over 400m ranged from 47.985 to 54.70s served as subjects. In the MARP test the speed at exhaustion was 6.89 (SD 0.28) M.S. corresponding to \(aw\) maximal of 118 (SD 5) ml.Kg x Min. The peak \((L)_{a}\) after exhaustion was 17.0 (sd 1.6) m.mol 1.1. A significant correlation \((r=0.89, p<0.001)\) was observed between the \(w\) and \(max\) and the 400m speed. It was concluded that the new method allows evaluation of several determinants of maximal anaerobic performance including changes in the force generation, capacity of leg muscles and \((L)_{a}\) relative to the speed of the sprint running at submaximal sprinting speed was suggested as describing the maximal anaerobic sprinting economy.
Nindal et al., (1995) conducted a study to substantiate on the little data that exist for upper and lower body mechanical power capability of adolescent athletes. This study compared arm (A) and leg (L) anaerobic peak and mean power (PUP and MP) of 20 male and 20 female adolescent athletes after normalization for body mass (BM), fat-free mass (FFM), and lean A and L cross-sectional area (CSA). Power outputs were assessed by the Wingate anaerobic test. FFM and CSA were estimated via anthropometry. No significant (P<0.05) differences existed between the sexes in Tanner Sexual maturity, chronological age or overall training activity. Males and higher (P<0.001) absolute PP(W) (L 694 vs 442; A 494 vs 309) and MP (L 548 vs 307; A 337 vs 214). Ratio normalization and ANCOVA were used to remove the influence of body size differences. Ratio normalization showed that males had greater leg PP/BM, MP/BM, MP/FFM, MP/CSA, as well as arm PP/BM and MP/BM, whereas all leg and arm PP and MP ANCOVA adjusted means for BM, FFM and CSA except arm MP adjusted for FFM, were significantly (P<0.01) higher for males than females. It was concluded that factors other than muscle mass, possibly qualitative in nature are responsible for the sex difference in anaerobic performance of adolescent athletes.

STUDIES ON PERFORMANCE VARIABLE

Deason et al., (1991) at the Louisiana State University examined the relationship between physiological and body composition characteristics and performance in an 800 meters run. Measurement of body composition, \( V_{\text{O}_2} \) max, running economy, and performance times for 100 and 300 meters dashes were obtained on 11 track athletes. The data offer additional support for the notion that much of the intramuscular ATP produce and utilized during an 800 meter run comes from anaerobic metabolic pathway.

Stafford (1992) and Others conducted a study on carbohydrate-electrolyte replacement improved distance running performance in the heat. In this study the effects of a 7% carbohydrate-electrolyte dried (E) and an artificially sweetened Placebo (P) on performance and physiological function were
compared during a 40km run in the heat. Eight highly trained male runners completed two runs on a measured outdoor course. The first 35km of each run was performed at self-selected training pace and the last 5km at race effort under a counterbalance double blind design, subjects consumed 400ml on either CE or P. 30 min prior to exercise and 250 ml every 5km thereafter during the run Rectal temperature, heart rate, rating of perceived exertion, sweat rate and respiratory exchange ratio were similar during the run for CE and P. Serum Na⁺, K⁺, Cl⁻¹ total protein osmolarity, blood lactate, urea nitrogen and % change in plasma volume were also similar for both drink conditions: however blood Glucose was significantly higher (P<0.01) with CE. Running performance in the last 5km was significantly faster (P<0.03) during CE (21.9 min) compared with P (24.4) subjects reported no differences in stomach upset, bloating or nausea between and CE. Results indicate the CE replacement elicits similar thermo regularly and physiological responses during prolonged running in the heat but increases run performance and blood glucose when compared with P.

Guezenne et.al., (1994) purported to evaluate effects on physical performance of three levels of energy intake during a 5-day period of prolonged physical exercise and relative sleep deprivation. A group of 27 male soldiers were randomly assigned to three groups receiving either 1800 kcal 24 h⁻¹ (7560 kj, Ic), 3200 kcal 24 h⁻¹ (13440 kj, mc) or 4200 kcal 24 h⁻¹ (17,640 kj, HC). They took part in a 5 day combat course (CC) of heavy and continuous physical activities, with less than 4h sleep per day. Performance capacity was tested must before and at the end of CC. maximal oxygen uptake (VO₂ max) was determined during an exhausting incremental exercise test on a cycle ergometer. Anaerobic performance was measured form the time during which exercise could be maintained at Supra maximal loads on a cycle ergometer. After CC, the subjects received L.C. exhibited a 14% decrease in power output at exhaustion in the incremental exercise test (from 325 (SEM8) to 278 (SEM a) W, P< 0.001) and a significant decrease in VO₂ max of 8% (from 3.74 (SEM 0.06) to 3.45 (SEM 0.05) 1min⁻¹ P<0.05). The remaining two experimental groups demonstrated the same mechanical and metabolic performances on 1 days and 5. Anaerobic performance was not influence by energy intake and
the field course. Blood samples were obtained at rest on days 1 and 5. At the end of CC, the data demonstrated a significant decrease in blood glucose concentration in (P<0.01) for CC diet only.

Lawrence (1988) conducted a study on the effect of bouncing run on triple jump performance. For this study 60 schoolboys were selected as subjects and experimental treatment hop and step exercise and bouncing exercises were given to the experimental group subjects for a period of six weeks with three times in a week. It was found out that the explosive power gained as a result of bouncing run exercises significantly improved the performance of triple jump. It was also found out that the hopping length, striding step, co-ordination of hop step and jump were significantly improved due to the six weeks of training.

Reilly (1991) evaluated world records for running distances from 1500m to 5000m during the 1985 season were set between 1900 and 2300 hours. Prior to the javelin throw by Fatima whitebread at the 1986 European championships, the last world record in the track and field to be set in the morning was by shotputter Charles fonville over 30 years ago. Most of the best athletic performances are the French national championships were reported to occur in the afternoon. Heats and qualifying events frequently take place in the morning, championship finals were usually scheduled for the evening. The environmental temperature is low in the evening. The environmental temperature is usually more favorable to performance in the evening; his study showed significant difference in performance level produced are different times during a 24 hour period.

Arnheim (1985) attempted to prove that altitude training effected improvement of performance at sea level. Intermittent sea level stays of few or as long as 11 days results in better performance and did not interfere with altitude acclimatization. There appears to be a considerable variability between individuals in respect to tolerate an intense performance tempo for long period of time at high altitudes. This probability explains the failure of some top class athletes to perform as well as they can near sea level.
Kumar (1992) conducted a study on the comparative effect of plyometric training and skipping exercises on the performance of high jump. To achieve the purpose of this study, 90 higher secondary school boys belonging to the age group of 14 to 16 years were selected and they were divided into three equal groups, namely plyometric training group, skipping exercises group and control group. The experimental groups were given treatments and the control group was not given any training for a period of six weeks duration with three days in a week training. The plyometric group was given depth jump from 40 cm box for first 3 weeks and from 50 cm boy for the last 3 weeks. For skipping exercise group, skipping with high knee action and skipping with double leg were given. It was found out that there was significant improvement in high jump performance in the two experimental groups due to plyometric training and skipping exercise. It was also showed that there was no significant improvement in high jump performance in the control group. The study reveals that the plyometric exercises and skipping exercises had great effect on the beginners.

SUMMARY

The scholar has made sincere attempts to extensively review literature of the related areas. In the process, all works of the past in all of the dependent and independent variables of the present study, have been covered. Attempt was also made to review and record most recent of studies conducted in the related areas.