Chapter II

REVIEW OF RELATED LITERATURE

Research scholar has made sincere efforts to locate both critical and allied literature pertaining to the present study. Relevant studies reviewed from various sources have been cited below.

Ibrahim¹ conducted this study to determine the relative effectiveness of an uphill sprint of three degree (U.H.), a downhill sprint of two degree (D.H.) the combination of an up-hill and down hill sprint of three degrees and two degrees (U.D.) and a zero level sprint (L) upon maximum speed over a distance of a 30 metre dash, flying start over a distance of a 20 metre dash, stride length, stride frequency and sprinting technique and to observe the relationship between the improvement of maximum speed and increasing stride length, stride frequency and sprinting technique.

Fifty untrained male freshman volunteer students enrolled in the Sport Education College at Bagadad University, Bagadad, Iraq, were randomly selected from those with the criteria to serve as subjects for the study. The subjects were then assigned

randomly to one of four treatment groups and one control group. Consisting of ten subjects each. Pre-test were given in flying start, maximum speed, stride length, stride frequency, sprinting technique, age, height, body weight, leg length and percent body fat. Post-test were also given after an eight week progressive repetition training programme.

A multiple regression technique was used to determine if any significant relationship values existed between maximum speed and stride length, stride frequency, and sprinting technique, and between maximum speed, stride length, stride frequency and the selected anthropometric measurements mentioned above.

No significant differences were found between groups for flying start, maximum speed, stride length, stride frequency, and sprinting technique. Significant differences took place across time in flying start, maximum speed, stride length and sprinting technique. The four groups who were involved in training programme improved significantly in maximum speed, stride length, and sprinting technique from the pre test to the post test.

The U.D. training programmes increased stride frequency more than the U.H. and L. training programmes. The D.H. training programmes increased stride frequency more than the U.H. training programmes. Maximum speed was significantly released to stride length, stride frequency, sprinting technique, body weight and percent
body fat. Stride length was significantly related to height, body weight, percent body fat, and leg length.

In order to acquire the ability to run fast and cover over increasing distance, numerous adaptive changes of the structure and function of the body are required. It is not only enough to develop a relatively efficient leverage system for mobility of the legs but certain physiological modification are also required. Falls\(^2\) and Mathew and Fox\(^3\) in their research have shown that endurance training would develop all the requirements i.e. speed, aerobic capacity and anaerobic capacity essential for events where the performance time is the limiting factor.

In reviewing the progress in the sprinting and analysing the training methods of sprinting the following attract attention.

1. The functional and competitive structure of sprinting is usually divided in three important variables i.e. speed, strength and endurance. Unfortunately, the correlation between the three forms remained unsolved. Some researchers claims that such correlation exists and other deny it.


2. Opposing opinions are also common regarding the question of the development of general and specific speed. This is mainly concerned with transferability of general speed to a specific action which is considering that some speed exercises could have negative effects where as some strength or endurance exercises might influence positively the motion structures.

3. The exact requirement of speed training, strength training and endurance training for sprinting competition structure appears to be controversial and hence requires systematic invetigation.

4. The latest development of new speed level by using the stimulus of changing condition by setting new levels at assisted running (down hill) resisted running (up-hill dragging etc.) or being trained with mechanical resistance (weight training or multigym exercise) and to avoid fatigue during competition a proportionate amount of endurance training is a great requirement.

Wilcox\(^4\) conducted a study on comparison of two weight training methods designed to develop leg strength. The purpose of this study was to compare a vertical leg press method of developing by strength with a method utilizing bench squats, on selected college men students.

The subjects were divided into two groups, Group I utilised a vertical leg press machine and Group II used bench squats. Each group met twice a week for 50 minutes over a ten week period. The pre test and post test mean difference between groups different significantly favouring Group I, on the vertical leg press method with a respect to total leg strength and vertical jumping. The improvement of group I was statistically significant at or beyond the .01 level of confidence. Vertical leg press method of developing strength produced significant improvements in total leg strength produced significant improvement in total leg strength and vertical jumping or a method utilizing bench squats.

Dintiman\(^5\) notified the effects of various training programmes on running speed, the purpose of this study was to determine whether a flexibility training programme, a weight training programme or the combination of both would effect running speed when used as supplementary training programme in preference to the conventional method of training sprinters and 145 subjects randomly assigned to one of five training groups, were tested for flexibility by strength and running speed before and after an 8-week training period. Result showed that both weight training and flexibility training as supplement to sprint training increased running speed.

Significantly more than an un-supplemented sprint training pro-
gramme.

Tressel⁶ notified the effects of selected resistance exercise
programmes upon muscular strength and speed. This training devices
used were: correct - O - sizer, Exer - Genic and weight training.
Male college students (H - 12 G) were assigned to four groups
with the groups assigned to three treatment groups, plus one
control group assigned by random techniques. An initial and final
test was administered. Larson Muscular Strength test was used
as the measure of dynamic strength, McCloy Strength test for
boys was used to determine static strength a eletric timer was
used to measure speed. The results of this study disclosed that
the treatment were equally effective in improving dynamic and
static strength. All three experimental groups improved significantly
as compared to the control group in all the individual dynamic
strength measure and in the majority of the individual strength
measures.

Tansley⁷ has used training for a period of five weeks
prior to the start of the season to improve performance

⁶Lee J. Tressel, "The Effects of Selected Resistance
Exercise Programmes Upon Muscular Strength and Speed," Completed
Research in Health, Physical Education and Recreation 2 (1969):
116.

⁷John Tansley, "Glendale's Tow Training for Sprinters,"
Track Technique 78 (Winter 1980) : 2473.
significantly. He claimed that tow training increases the ability of the athlete to sustain top speed and tow training is used for all athletes in which speed is important. Long jumper, pole vaulters, hurdles, high jumper of both sexes have used it. All kinds of distances can be run with tow training. But is was found that 100 metres tows seems to work best.

Paish\textsuperscript{8} has expressed that running upon short slopes, sand hills, harness running, weight training etc. all of which will have the beneficial effect to the sprinters. By adopting a well balanced training programme including assisted speed activities, sprinting activities, specific strength training and pure strength training improved performance will result. Harness running is likely to be more beneficial to the sprinters.

Wilkin\textsuperscript{9} investigated whether with heavy exercise of the resistance type causes an incipient muscle bound condition, defined impart as improve speed of movement. 58 subjects were tested in speed of movement and again retested after the experimental

\textsuperscript{8} Wilf Paish, "Sprinting Speed," \textit{Track Technique} 56 (June 1974): 1797.

period. Thirty subjects were received the treatment and remaining 28 students served as control group. The analysis of data revealed that:

1. Weight training, over a period of semester has not showing and muscle bound affect in speed of movement.

2. Speed of movement does not improved during on semester training.

Sweeting\textsuperscript{10} conducted study on the effects of various running and weight training programmes on sprinting speed. Running, weight training, combined weight training and no training were given to 100 college men for 30 yards. Analysis of various showed that a systematic running programme increases sprinting speed significantly more than weight training or no training, with equal total training time, running alone was as effective as running plus weight training and weight training alone was not better than no training.

Barnes\textsuperscript{11} studied the effect of weight training on speed in 100 yard dash. Two groups of nine boys were acquated initially

\begin{itemize}
\item \textsuperscript{10} Rogert Sweeting, "Effects of Various Running and Weight Training Programmes on Sprinting Speed," Completed Research in Health, Physical Education and Recreation 6 (1964) : 83.
\item \textsuperscript{11} Richard Barnes, "The Effect of Weight Training on Speed in the 100 Yards," Completed Research in Health, Physical Education and Recreation 6 (1964) : 60.
\end{itemize}
on 100 yards dash time. One group had 14 weeks of physical education with basketball, tumbling, volleyball, didge ball and the other group spent on equal time in progressive weight training with three sets of eight repetitions in half squats, curls and full knee bents. Both groups ran two 100 yard dashes for three per week, fifteen minutes rest between. The main gain of physical education group was from 13.3. to 13.1 sec. and the mean gain of weight training group was 13.4 to 12.7 sec.

Ecker\textsuperscript{12} expressed that speed is the product of two factors, stride length and stride frequency. Increasing either factor (without an off setting decrease in the other factor) automically increase a runner's sprinting speed. From a training stand point, it appears that the stride length is more important of the two factors. Stride length can be increased by increasing the leg strength. Stride frequency, however, is largely an in born characteristic. Although it might be possible to improve stride frequency slightly through training, it appears that this improvement also brings about a corresponding shortening of stride length.

Renowned Russian Coaches Tabashnik and Timoschenko\textsuperscript{13}

\textsuperscript{12} Tom Ecker, "Improving Sprinting Speed through Strength Training," \textit{Athletic Journal} 55 (April 1975) : 12.

are of the opinion that the first two training years of young athletes read to the initial specialization stage. The main aim during these years is to assure many sided development and an improvement of general physical capacities. However, the development of speed capacities through maximum speed runs under standard conditions should not be over emphasized. For more effective in the use of uphill runs, up stairs runs, runs in sand and runs with a weighted vest, alternated with runs under normal conditions. At this stage, it is also to begin the learning of the basic elements of the sprint relay, while variety in training is achieved by games (basketball, soccer, handball etc.) that demands continued changes in running speed under different conditions. It is an excellent age for the development of movement speed, but the development of movement abilities must be proceeded by improvement of physical capacities. Strength and power at this stage are developed by bounding exercises, standing jumps, exercise with medicine balls and resistance, exercises (50 to 80 per cent of the athletes body weight). There must also be a lot of variety in the competition programme. Athletes at this stage are recommended to take part in long and triple jump, hurdles, medicine ball put, 30 and 60 metres sprint, as well as 150, 200, 3000 metres and relays.
Petrovski\textsuperscript{14} the coach of Valerity Borzov, double sprint winner in Munich Olympic Games opined that in each work out period, various means of training must be used for the sprinters, e.g., games, weight training, specific exercises, jumping and sprinting over various distances (30 - 60 - 100 - 150 - 200 - 300 - 400 and 800 metres.

All these forms of training are of the purpose of enabling the body to reach the major goal set for it i.e., the development of definite sprint speed and sprint endurance capacity. Besides specially selected activities, sprinters over distance of 30 and 40 metres from a crouch start and from a flying start at almost maximal (often) and maximal (seldom) speeds must be considered as the main methods for the development of absolute sprinting speed and sprint endurance.

Francis\textsuperscript{15} reported that training loads were very high among the top European athletes. For examples, 1980 Olympic 100 metres champion Allanwells used to perform several thousand push-ups and sit-ups each day. Some times in sets of thousands.


\textsuperscript{15} Charline Francis, "Report from the European Coaching Congress on Sprint and Hurdles," \textit{Track Technique} 86 (Fall 1983): 2741-2742.
with very short recovery 6 breaks. Kratochilova performed up to 250 tons of weights per week. Francis is also of the opinion that elastic strength is the most important form of strength that sprinter must possess. In order to enhance elastic strength properties, appropriate exercises must be chosen. Weight training is not fast enough or specific enough for this purpose. The most effective exercises are jump series over hurdles or up and down from boxes.

Uppal and Singh\textsuperscript{16} conducted a research study on comparative effects of Harness running, weight jacket running on leg strength, length of the stride and sprinting speed. The subjects for the study were 45 male students of classes tenth and eleventh. The average of the subjects was sixteen years. During the experimental period of six weeks, the group A trained using Harness running, group B performed running with weight jacket, group C did not perform any activity. Training was carried out thrice a week for both Harness running and weight jacket running. The subjects ran over a distance of 80 metres. After the six weeks experimental period the following conclusions were drawn:

1. Leg length can be effectively improved by administering a systematic resistance training programme comprising of Harness running and weight jacket running.

2. Harness running contributes to a significant increase in length of the stride.

3. Sprinting speed can be effectively improved by administering a systematic programme comprising of Harness running and weight jacket running.

4. Weight jacket running was not found effective in improving length of the stride.

5. No significant change in leg strength, length of the stride and sprinting speed in case of control group is obviously a reflection of their inactivity.

Verchoshansky and Chornosov\textsuperscript{17} of U.S.S.R. conducted two experimental study on the effects of jump exercises in sprint performance. In the first experiment, in the course of nine months, one group of novices mainly applied "short" jump (variants of single take-off with one or both legs and variant of three and five jumps from standing position) and the other group mainly long jump (series of jumps with one leg and changing legs (bouncing) over 30, 60, 100 metres and more).

Performance and the amount of quantity in sprint training (sprinting) were on the same level in both groups (20 person each).

\textsuperscript{17}J. Verchoshanky and G. Chornosov, "Jump Exercises in Sprint Training," \textit{Track Technique} 69 (June 1975): 1909.
Test for estimating speed and the level of power they applied time over various distances (30, 60, 100 metres) with flying and crouch start, distance for long and tripple and a series of 10 jumps, the bouncing over 50 metres as well as the number of running strides in place with in ten seconds. The experiment disclosed the different effects of training with jumping exercises. The group with the "short" jump considerable improved speed in runs with a crouch start upto 30 metres. The "long" jump produced considerable change in speed of long as well a short distances with flying start.

Second experiment of Verchoshanky and Chornowsov was with three groups of 20 persons each for a period of nine weeks. Group A carries out only "short" jumps, group B only "long" jump exercises. Group C applied both form of exercises. To control the change in running speed a specific power they used 18 tests. "Short" jumps exercises (Group A) guarantees a considerable increase in speed out of the crouch start. The "long" jump exercises (Group B) influence the ability to starting acceleration to a lower degree, but they obviously increase the maximal speed and speed endurance. Finally simultaneously applied "short" and "long" jump exercises guarantee an increase in starting acceleration, maximal speed and speed endurance almost to the same extent. Group C showed the greatest improvement in 100 metres sprint.
Following were the conclusions drawn:

1. Single and "short" jump exercises mainly influence the development of acceleration at the start, they also guarantee and increase in stride length and the sum of 10 strides (length) with start as well as an increase in stride frequency.

2. "Long" jump exercises contribute a great deal to an increase in maximal speed and speed endurance. In this respect bouncing over 50 metres with time trials are particularly effective.

3. The combination of "short" and long jump exercises in training offers but greatest training effect and a simultaneous development of specific power abilities in sprinting.

Otason\(^{18}\) in his article "Limiting factors in sprinting" is of opinion that sprint successes depend largely on the development of specific muscles responsible for the active driving action from the track. Accordingly the ankle flexors and leg and hip extensors receive particular attention in sprint training while the non specific muscle groups, not directly related to the drive are neglected. Research workers at the Sport Institute of while Russia disagree with the approach. They claim that undeveloped muscles that are not actively involved in the sprint action could well be the restricting link in the improvement of performances.

---

A study of 118 sprinters revealed that the strength of ankle flexors, lower leg extensors and upper leg extensors exceeded considerably the development of lower leg and upper leg flexors. It should also that weaker gained in strength as the sprint performances improved. A noticeable improvement in the strength of the lower and upper leg extensors in the strength of the lower and upper leg extensors (131 - 136 per cent) through sprint training indicated that sprinting develops these muscles and consequently the same muscle require attention in conditioning training. Further more injuries are obviously linked with uneven development of agonist and antagonist muscles, sprinters should avoid stressing one sided development and must find an optimal balance in strength and power training.

Gregory\textsuperscript{19} conducted a study on analysis of the comparative effects of down hill versus level training circuits on the running speed, stride length, stride frequency and leg strength. The subjects of the study were varsity soccer players. Two groups of subjects numbering nine each were randomly assigned for the study. The treatment period lasted five weeks during which the subjects ran fifteen to forty yard sprint at the beginning of each practice session. Pre and post tests were conducted. The findings

\begin{footnote}
\end{footnote}
of the study were as follows. The down hill method of training significantly improved the stride length. But down hill method of training did not significantly increase in running, speed, stride frequency and leg strength though some improvements were observed.

Lawman investigated the effect of tow training on the development of certain biomechanical factors of sprinting speed i.e. stride length, stride frequency and dynamic range of motion of the femoral shaft. All subjects (N = 25) were divided randomly into experimental group and control group. Training programme was established thrice a week for a six week period. After six weeks post test conducted for investigation showed that:

1. Subjects who were engaged in tow training significantly increased speed.

2. Control group did not significantly increase in speed and the only identified variable which showed a significant positive change was flexion of the femoral shaft.

3. Total sample (N = 25) significantly increased in speed, dynamic range of motion and femoral flexion.

Richardson selected 280 high school physical education males to investigate the effect of frequency and intensity of various training schedules on running performances. Three days per week practice schedule was found to be as effective as five days per week practice schedule for improving speed performance of the subjects.

Dale selected 42 male students of the basic physical education programme to study the relationship between shoulder strength and sprinting speed. All subjects were presented for speed and shoulder strength. A control group (Group I) and an experimental group (Group II) were randomly established.

Both groups participated in a sprint training programme two days each week for eight weeks. This programme involved repetitive sprinting at distance ranging from forty to eighty yards. In addition to the sprint training, the experimental group took part in a strength training programme. This programme also involved two sessions each week for eight weeks. The apparatus used in the strength training programme was an exer-genic exercises


which was adopted to provide continuous resistance throughout the sprinting arm movement. At the conclusion of the training programme, each subject was post tested for sprinting speed and shoulder strength. No significant difference ($P > .05$) was found to exist in the sprint speed movement of the groups, although the experimental group did show a mean groups although the experimental group did not show a mean improvement of .1554 seconds compared to a mean improvement of .0774 seconds in the control group, relative to shoulder strength, however, the experimental group experienced a significantly greater ($P < .05$) improvement than did the control group. The results of the data analysis revealed no significant relationship between sprint speed improvement and any of the selected variables.

Kaledin$^{23}$ conducted a test to find out the effects of work out programme of varying intensities would have on the programme of 14-16 years of age. He tested several components of intensity (distance, running speed, recovery) on members of the Leningrad Pioneer Palace Sports School who had averaged 3-5 years of previous training. Tests were conducted by using sports medicine and bio-mechanical procedures. Several training methods were employed to discover how these would develop

speed and how the body reacts to the training load. It was discovered right from the start that a mixture of short and relatively long distance runs with fixed recovery intervals had the best stimulus to the organism. The use of only short or long distances was less effective to develop speed and speed endurance. An optimum mixture of short and relatively long training distances was then tested by employing different recovery intervals. It revealed that short recoveries between repetition brought about better adjustment of the body and faster improving performances. It was also observed that recovery intervals influenced the changes in training load for more than the length of the distance (duration of work).

Uppal\textsuperscript{24} carried out a study on fifty-four girls students studying in ninth, tenth and eleventh classes, age between fourteen to seventeen years to see the effect of varied frequencies of speed training on sprinting speed. Acceleration runs were administered as a training means for improving speed. On the completion of the six week experimental period, the following conclusions were drawn:

1. To bring about significant improvement in sprinting speed at least three training units per week planned on alternate

\textsuperscript{24}A.K. Uppal, "The Effect of Varied Frequencies of Speed Training on Sprinting Speed," \textit{SNIPES Journal} 3 (July 1982): 37.
days are required.

2. For the development of sprinting speed training thrice a week was found to be as effective training five days a week.

3. Speed performance can be improved by training, thrice or five days in a week on a systematic programme of acceleration runs.

Jarver\(^{25}\) is of the opinion that all the sprinters have two common qualities. They tend to be powerful and possess great leg power. He has suggested some of the fundamental drills for the development of leg power and speed development as follows bouncing runs, pulling contests, pushing contest, horse driving, running against objects. For the speed development Jarver suggested gradual acceleration runs over 30 to 50 metres increasing the distance gradually upto 80 to 120 metres. He also recommended some of the typical exercises as under:

1. Gear change.

2. Meet in the centre (5-7 rept.) on a 100 metres long track marked in the centre by a flag.

3. Up hill accelerations (3-5 rept.).

4. Acceleration from walk (10-12 rept.) over 40-50 metres violent acceleration starts a marked point and continuous for

20-30 metres.

5. Catching a partner (10-12 rept.) with one partner jogging about 2 metres infront of the other.

6. Racing in pairs (10-12 rept.) starting with jog and accelerating violently from a marked starting position, such as standing, walking, kneeling, lying prone or on the back.

Dentiman\textsuperscript{26} has started the following research findings about the improvement of sprinting speed:

1. The speed of muscle contraction (single arm or leg movement is increased through strength training programmes.

2. Sprinting speed is significantly improved through strength training programme that are used as supplements to actual sprint training.

3. Weight training programmes designed to improve sprinting speed necessitate careful control of key variables (weight, speed of contraction, exercises, repetitions, sets, rest interval) for maximum effectiveness.

4. The ability to propel a stationary body into rapid movement requires a combination of strength and speed. Explosive power is related to speed, when the total movement time involved requires a subject to move from a stationary position to maximum speed.

\textsuperscript{26}George B. Dentiman, "Factors Affecting Sprinting Speed Part I," \textit{Track Technique} 58 (December 1974): 1840.
Jamaludeen\textsuperscript{27} compared the effects of differential races and pace races on sprinting speed. 45 students of Kerala were selected at random as subjects for the study. The average age of the subjects was 17 years ranging between 16 to 18 years. The subjects were randomly assigned to two experimental groups (A and B) and control group (C) each consisting of 15 subjects. During the differential races and Group B trained with pace races. The subjects trained thrice on alternate days. Time taken by the subjects for 60 metres was considered as the criterion measure. Following were the conclusions drawn:

1. Differential races and pace races are effective training means for improving sprinting speed.

2. Differential races and pace races produced equal training effects in improving sprinting speed.

3. Improvement of sprinting speed in the case of groups trained with differential races and pace races was significantly higher than the control group.

Helixon\textsuperscript{28} investigated the effect of a heavy resistance


training programme upon running and jumping performance of first year high school trackmen. Twenty four subjects were randomly assigned either to an experimental group which engaged in weight training five days a week for six weeks or to a controlled group which engaged in on weight training. Result showed no significant difference between the experimental and control group at the conclusion of the experiment.

Capen\textsuperscript{29} in his study to determine the effects of four methods of weight training on strength, utilised eight groups of university freshmen. He concluded that those methods which employ heavy weights so as to allow a maximum number of five executions are probably superior methods for the development of the muscular strength.

Remigino\textsuperscript{30} U.S. Olympic Track Coach has expressed an opinion that an overall muscular strength is essential for success in the dashes. The development of strength with emphasis on conditioning the hamstring and buttocks is most important since these are the muscles that deliver the power in driving from


the starting blocks and extending the hips and knees in acceleration. Building muscular strength can best be accomplished by setting up a regular strength programme early in the season. The use of weight, calisthenics and 2 to 4 miles of cross country running are especially beneficial early in the training schedule.

The data presented by Masley\(^{31}\) in their study it appears that the contention that weight training contributes to a loss of coordination and speed of movement was refused. Increased strength gained through a programme of weight training where moderate poundages and increased repetitions were practiced apparently bore association with increased strength produced better coordination or more rapid movement.

Turpin\(^{32}\) studied the effects of the frequency of running speed in Junior High School girls. Three seventh grade and three eighth classes were pre-tested on the 50 yard dash. One class from each grade level ran once a week, three times a week and five times a week. All the six classes were re-tested after eight week. No significant differences was found among the groups on 50 yard test.


Oyster\textsuperscript{33} studied fourteen sowmen champion tennis players on a high intensity weight training programme for seven weeks. Significant strength increases were found in the lower extremity measurement of ankle plantar flexion and hip flexion. All other strength measures, except elbow strength, showed increases although not significant. These strength increases were accompanied by concomitant decreases in all girth measurement calf girth, pectorals and lower arm girth decreased significantly. Three of the our skinfold measurement also decreased although not significantly. There was also a decreased in percent body fat and a alight decrease in weight. Neither of these were significant.

Thomas\textsuperscript{34} conducted study on the effect of acceleration runs and ins and outs run on sprinting speed. Forty five boys students between age of 13 - 16 years were selected as subjects. The subjects were divided into two experimental groups and one control group with 15 subjects in each. One of the experimental groups performed acceleration runs and other group did ins and outs for a period of eight weeks. A pre test and post test of


\textsuperscript{34}\textsuperscript{Baby Thomas, "Comparative Effects of Acceleration Runs and Ins and Outs on Sprinting Speed," (Unpublished Master's Thesis, Jiwaji University, 1981).}
50 metres run was ins and outs run are effective training means for improving sprinting speed and both the acceleration runs and ins and outs run have equal training effect in the improvement of sprinting speed.

Habel\textsuperscript{35} conducted a study to determine and compare the effects of up hill, down hill and level running programme on 10 K time peak torque and endurance of four muscle groups in trained males. Two different running programme were employed on three running grades. Percent of maximum heart rate determined the intensity throughout the 15 weeks study. Fifty four subjects completed this study and were included in one of the six groups (age 25-30) 220 yard down hill ($N = 9$); 220 yard up hill ($N = 9$); 880 yard down hill ($N = 7$); 880 yard up hill ($N = 10$). Dependent variables were 10 K time muscle torque and endurance for four muscle group. There was a significant differences in torque, 220 down hill and 880 up hill (dorsiflexion) between 880 and 220 yard distance in torque (plantor flexion), down hill and flat in torque (knee flexion) and down hill and up hill in endurance (knee flexion). It was concluded that down hill training could improve torque and endurance (knee flexion). A combination of up hill and down hill training can strengthen the dorsiflexion muscle group.

Englebrecht\textsuperscript{36} senior athletic coach of Great Britain pointed out that Soviet sprinters are increasingly pacing more emphasis on exercises of ballistic nature with medicine ball as a means of gaining explosive strength and coordination and so improving speed.

Edward\textsuperscript{37} revealed through his study the effect of isometric and dynamic weight training exercises upon strength and speed of movement. Ninety-six students were divided into two groups. One group of students did no weight training while the other group used isometric contractions, rapid contractions or slow contractions in six barbells exercises, performed three days a week for nine weeks. Initial and final strength scores and speed of movement scores against no resistance were obtained, gains in strength were accomapined by gain in movement speed with and without resistance but the difference between the exercise groups were not significant at the .05 level.

O'Shea\textsuperscript{38} studied the effects of varied short term weight

\textsuperscript{36}Rita Englebrecht, "Use of Medicine Ball in Sprint Training Exercises," \textit{Track Technique} 97 (Fall 1987) : 3088.


training programmes on improving performances in the 400 metre run. The prime physical factor's involved in achieving maximum performance in the 400 metres run are: muscular endurance, dynamic strength, and speed. Thirty students were selected by random sample from an intermediate weight training class at Oregon State University to participate in a 10 week project training three times per week. Group A 4-5 sets repetitions - 4 sets Group B 9 - 10 repetition - 4 sets Group C 14-15 repetitions - 4 sets. Analysis of data indicated that all three weight training programmes were effective in increasing muscular endurance and dynamic strength for 400 metres running.

Roy\textsuperscript{39} compared the effect of acceleration running, resistance running and sand running on sprinting speed, explosive leg strength and length of the stride. 60 boys of Tripura were selected at random as subjects for the study. Age group of subjects were fifteen to seventeen years. The subjects were divided at random in three experimental groups and one control group with 15 subjects each. Group A trained with acceleration run, Group B with resistance run and Group C with sand running, while control Group D did nothing. After a six week experimental period the following

conclusions were drawn:

1. Sprinting speed and explosive leg strength can be improved by administering a training programme of acceleration running, resistance running and sand running.

2. Length of the stride can be improved by administering a programme of resistance running and sand running, whereas acceleration running is not effective in improving the length of the stride.

3. Resistance running was superior to acceleration running and sand running in improving the length of the stride.

Purpose of Khanna's study was to determine the effect of acceleration runs and leg weighted runs on the improvement of speed. Subjects were thirty students of central school, Gwalior. The age of subjects ranged from 13 years and three months and 16 years and eight months. Data was collected in six weeks experiment during September and October, 1977.

After a few days of training in 50 metres dash the initial test was administered and their performance over 50 metres was recorded on the basis of initial performance. The subjects were divided into two homogenous groups.

---

During the experiment period of six weeks Group A performed acceleration runs and Group B performed leg weight runs, over a distance of 80 metres. The training was carried out three days a week. The mean gain made by both Groups A and B were not found satisfactory significant at .05 level of confidence. The difference in the final means made by Group A and B were also tested by 't' test. Group A showed an improvement of .083 seconds, over Group B. This difference was also not found significant of difference at .05 level of confidence the value should be more than 2.05. The following conclusions were drawn:

1. Speed can not be improved significantly by administering a training programme of acceleration runs and leg weight runs.

2. None of the two training method that is acceleration runs and leg weight runs proved superior to other in improvement of speed.

Bosen\textsuperscript{41} former Chief National Athletic Coach of India conducted and experiment with four sprinters, using a motor cycle with an attached handle behind it for the athlete to hold. They were pulled at speeds more than they were accustomed to in normal sprinting. Athletes had six weeks of conditioning training

\textsuperscript{41}Ken O. Bosen, "Experimental Speed Training," Track Technique 75 (Spring 1979): 2382.
and six weeks of pre-competitive speed training before the experiment training method was used. After six week of experimental period, the following conclusions were drawn:

1. The use of outside agent like a motor cycle does help in developing faster times over the short sprint distances.

2. Starting practice from block must force a part of the total training in order to overcome the imbalance from the forward lean body position and extra leg speed gained by the sprinters using this method.

3. This method not only increases speed which can result in fast times over a given distance, but also results in an increase in stride length, relaxation and general running form.

About 80 sprinters of varying standard from various novices of master's of sports were tested by Soviet Union Experts Werschoshan Skiu and Semjonow on a) "Relative Strength", the muscle actions in the binding and stretching of the individual joints of the legs, b) the capacity for the quickest possible development of an isometric (static) maximum strength (which encourages "explosive strength") and c) the speed of the development of a fully effective working range of the muscle (contraction).

which effects (or determine) "starting strength." In the course of the investigation it was shown that for all the dynamic characteristics four muscle groups (which are denoted in the subsequent test as the most important existing muscle group) bore the most relevance to the sprint performance. These are in their order of importance. Those of the thigh (guards), the planter flexors, these of the rear thigh (hamstring) and the dorsiflexors.

Manrah\textsuperscript{43} studied the effects of two progressive weight training programmes on strength speed and power of college females. Seventy one female volunteers enrolled in weight training courses as PSU were assigned, on the basis of initial strength, to one of two weight training group or a control group for an eight weeks study. Group I \((N = 24)\) performed a progressive resistance weight training programme employing three sets of six R.M. weight three times per week. Group II \((N = 23)\) performed a progressive speed training programme in which three sets of six repetitions using 25 per cent of their 1-RM weights, were performed as rapidly as possible, three days per week, the control group \((N = 24)\) participated interesting only. The 1-RM bench press was used to measure strength. A similar movement was used for measuring speed (minimal resistance pressed as rapidly

\textsuperscript{43} Mchygh Manrah, "The Effect of Two Progressive Weight Training Programmes on Strength, Speed and Power of College Females." Completed Research in Health, Physical Education and Recreation 21 (1975) : 186.
as possible) and power (resistance of 50.70% of 1-RM pressed rapidly as possible). Subjects were tested three times, before training began after four weeks, and at the end of the programme. 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 two factor. ANOVA with repeated measures on the one factor, ANOVA techniques (to adjust for initial differences) disclosed differences among groups in final speed. Scheffe's test showed that only the weight training group has significant increase in the three variables, no significant differences between groups were found using Pearson's Product Moment Coefficient, no relationship was found among the changes in strength, speed and power as a result of weight training.

Panny\(^{44}\) investigated the effects of resistance running on speed, strength, power, muscular endurance and agility. The training programme consisted of four fifty minute sessions power week for six weeks. Results indicated are:

1. A training programme of resistance running alone or supplemented by weight training, isometric contractions and repetitive sprinting would significantly increase speed, leg strength,

leg power, muscular endurance and agility.

2. Resistance running supplemented by isotonic leg exercises, isometric contractions, and repetitive sprinting will no improve standing broad jump ability as significantly as speed, leg strength, muscular endurance and agility.

3. Orthogonal comparison revealed upward trends in improvement of all variables during the six weeks training programme.

Rynda studied the effectiveness of interval training programme on the improvement of speed in running the 220 yard dash in young women. Thirteen healthy college women aged 19-22 years were divided into a group that had no special training programme, a group trained only with 50 yard sprints and a group trained on alternate days with 60 yards sprints and 300 yards runs four days per week. All the subjects were tested before and after the five weeks programme in the 220 yard dash, in leg strength, and for energy metabolism and heart rate in an all out and a standardised ten minutes treadmill run. The trained groups showed greater improvement than the un-trained group and improves significantly in all out and a standardised ten minutes treadmill run. The sprint training improved their maximum ventilation significantly and made a greater gain in leg strength.

Although this and the other gains were not significant.

Westcott\textsuperscript{46} carried out a study on female response to weight training. The purpose of this study was to compare the effects of three different systems on strength development in female subjects of different ages. The subjects were 14 females ranging from 18 years to 27 years of age. The results of this study demonstrate that girls and women who engage in systematic weight training can increase their muscular strength. Finally, the positive response to strength training exhibited by the pre-adolescent group should not go un-noticed. Strength training can be safe, enjoyable, and physically rewarding activity for girls. For others, the strength gains may provide a degree of confidence and a basis for further athletic achievement.

Chui\textsuperscript{47} compared the effects of isometric and dynamic weight training exercises on strength and on the speed of execution of single movement. Seventy-two male subjects formed three experimental groups and performed weight training exercises, Group I (Isometric Contraction Method), Group R (Rapid Dynamic


\textsuperscript{47}Edward F. Chui, "Effect of Isometric and Dynamic Weight Training Exercises Upon Strength and Speed of Movement," \textit{The Research Quarterly} 35 (October 1964): 246.
Contraction Method), and Group S (Slow Dynamic Contraction Method). Twenty-four male subjects formed the control group. A cable tensiometer was used to obtain eight strength scores for each subject. Speed of movement times against no resistance in six movements and against resistance in the same movements is specified increments was taken. Group I, Group R and Group S, gained in strength and at the same time gained in speed of movement measured against no resistance and resistance. Gains in strength and gains in speed of movement against no resistance and resistance made by the use of the one method are not significantly greater ($P = .05$) than gains made by the use of the other method.

Kusintz\textsuperscript{48} conducted a study on the effect of progressive weight training upon running speed and endurance. The dependent variables of running speed and endurance were measured before and after a twelve training programme by 50 yards dash for speed and 300 yards for endurance. The experimental group practiced weight training and running whereas controlled group practised only running. The conclusions were that programme of weight training and running proved more effective than running only in developing running speed and endurance as measured by 300 yards.

run. Individuals who begin training with initial low strength do not make greater gain in the dependent variable than those in with initial high strength.

Hines carried out a study of the effect of the calisthenic direct practice sprint training and weight training to the improvement of performance in baskets per minutes, dodging dribble, forty feet dash, jump shot, vertical jump and wall bounce tests. He found out that there was no significant difference among treatment groups on the basket per minute, 40 feet dash, jump shots, vertical jump, wall bounce and composite measure of the six criterion tests. Group sprint training was significantly superior to group direct practice and weight training on the dodging dribble test. Group calisthenics was superior to the direct practice on the dodging dribble test. All training produces significant improvement over 12 weeks experimental period on the basket per minute, dodging, dribble, 40 feet dash, vertical jump and wall bounce tests. Group calisthenics, direct practice and weight training produced significant improvement in the jump shot test. Group sprint training resulted in no significant changes on the jump shot test.

Hamak\(^{50}\) conducted a study to determine the effect of a selected progressive resistance running programme on circulo-respiratory efficiency power and free running speed. Forty-five male subjects were divided into three equated groups: interval running, resistance running (employing an exer-genic) and control group. The effects of a six week training programmes were determined by a pre-test, initial post-test and final post-test for oxygen debt rapid, power developed by the legs, free running speed and elapsed time for a 600 yard run. Significant improvement was found in oxygen debt rapid (.05 level) and elapsed time for a 600 yard run (.01 level) between the interval and control groups.

Chui\(^{51}\) carried out a study on the effect of systematic weight training on athletic power. He conducted his study with 50 subjects divided into two groups namely Group A 23 subjects and Group B 22 subjects. Group A increased the amount of the potential power through systematic weight training exercises whereas Group B did not show much consistent increase.


\(^{51}\)Edward F. Chui, "The Effect of Systematic Weight Training on Athletic Power," *Research Quarterly* 21 (October 1950) : 188.
Calloway\textsuperscript{52} conducted a study on coaches who lead athletes away from weight training either have limited knowledge of muscle development or will not take the time to understand strength and its relationship to sports.

The more powerful an athlete is the more successful, he or she will be in a given skill practicing sports is not enough. In order to gain extra power an athlete must work with an overload.

In order to have a successful weight lifting programme the single most important factor is the coach. He can have the most sophisticated weight equipment in the world but if he does not direct the programme from start to finish it will dis-integrate.

Corbett\textsuperscript{53} compared exercise frequency after an equal length of time and after an equal number of training session. S.H.S. boys (N = 28) were assigned to one of four groups, three of which were experimental and one control, one of the experimental groups trained twice a day five days/week, a second once a day five days/week, the third three times/week. All the three

\textsuperscript{52} Bill Calloway, "Weight Conditioning for Athletes," \textit{Athletic Journal} 57 (October 1976) : 50.

groups used the same basic isotonic programme to exercise the upper arm muscles. After 6 week of training of the experimental group displayed significant increase in isotonic strength. However, no significant differences between any of the experimental group emerged when compared after an equal number of training periods.

Les\textsuperscript{54} studied the effect of three selected training programmes on running speed. An initial test and re-test measuring running speed for thirty yards were administered to three experimental groups and one control group. Following the initial test, the experimental group received a particular running programme including repetition sprinting, interpersed sprinting and stair running in addition to a standard weight training programme. The controlled group received only weight training in each class period. The thirty yard dash test was re-administered after eight week of training. All groups improved significantly with no differences were noted among different groups.

Mendez\textsuperscript{55} investigated the relative effectiveness of two training programme i.e. progressive resistance exercise and sprint


training in the improvement of sprinting velocity was determined. Two random groups of subjects (N = 31) were formed: group 1 (N = 16) participated in a weight training programme using the Universal real runner a progressive resistance exercise machine while group II (N = 15) participated in a sprint training programme. Subjects were pre and post-tested on the 60 yards each time allowing one practice run by each students. The duration of the experiment was seven weeks, which included 20 periods of exercise. ANCOVA was used to determine significance of differences between the two groups (P .05). No significance difference were detected between the weight training and sprint training programmes. Both training programmes showed small but non-significant decreases in mean time for sprinting 60 yards.

Hooks\(^{56}\) has pointed out that weight training can improve strength and speed simultaneously. He suggested that weight training programme that over loads the muscle with enough weight to ensure strength gains, and at the same time enables the muscles to contract successfully with a burst of speed, will produced increased strength and speed.

Gregor\(^{57}\) studied the effect of a progressive weight training programme on the performance of swimming the 100 yard crawl stroke of male and female competitive swimmers between the ages of ten and sixteen. The forty subjects were divided into groups, the experimental group was exposed to nine weeks of training in competitive swimming and progressive weight training. The control groups were tested on 100 yard crawl stroke to evaluate weight training programme sixteen cable tension strength test was administered. It was concluded that the subject was participated in the progressive weight training programme significantly increased their performance in swimming the 100 yard distance using crawl stroke.

Jarver\(^{58}\) while explaining power, points out that mechanically speaking, power is the rate of doing work and could therefore say that in human performances, power is effectively a produce of strength and speed. (force and velocity). In the performance of physical skill, it may be more approximately described as ability to apply maximum force in the short time.

---


He also indicates that there are five main areas in the problem of development of muscular power like:

1. Application of force (strength development).
2. Development of speed movement.
3. Techniques involved in providing the right force-velocity relationship.
4. Employment of best ever system.
5. Coordination of movement.

The static and dynamic contractions many times may appear in combination in sports activities. This can be - 1) dynamic static muscle contraction in which the muscle first contract dynamically to cause the movement and then remain in static contraction to maintain the assumed body posture and (ii) static dynamic muscle contraction in which the muscle first contract statically then dynamically. These types of muscle contractions occur in various sports movements. While designing and selecting the exercise for the improvement of strength, one should be more specific and it may be expected that the combination of isometric and isotonic exercise may produce better result.