Chapter II

REVIEW OF RELATED LITERATURE

The research studies and literature having relevance to the present study and are available in the libraries of the Lakshmibai National College of Physical Education, Gwalior, Sports Authority of India, New Delhi, Netaji Subhas National Institute of Sports, Bangalore and Patiala have been presented in this chapter.

Jarver\(^1\) 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 contest, 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. Jarver, also recommended some of the typical exercises as under: (1) Gear changes, (2) Meet in the centre (5-7 rept.) on

\(^1\)Jess Jarver, Athletics Fundamentals, pp. 18-19.
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 at a marked point and continues 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 line. All these exercises can be performed from various starting positions, such as standing, walking, kneeling, lying prone or on the back.

Dintiman² has stated 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 programmes 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.

Dintiman\(^3\) also discussed some specialized programmes for the improvement of sprinting speed in his article entitled "Factors Affecting Sprinting Speed," Part-II. These are: Down-hill running, Towing, Treadmill running, Training on Up-hill and Staircase sprinting.

Uppal\(^4\) carried out a study on fifty four girl students studying in ninth, tenth and eleventh classes, age between fourteen to seventeen years to see the effect

\(^3\)George B. Dintiman, "Factors Affecting Sprinting Speed, Part - II," Track Technique 59 (March 1975):1069.

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 weeks 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 days are required.

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

Paish has expressed that, running up on short slopes, sandhills, 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

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activities, specific strength training and pure strength training, improved performances will result. Harness running, is likely to be more beneficial to the sprinters.

Dale\(^6\) selected 42 male students of the basic physical education programme to study the relationship between shoulder strength and sprinting speed. All subjects were pretested for sprinting 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 distances 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 exerciser 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 improvement of the groups, although the experimental group did show a mean improvement of .1554 second compared to a mean improvement of .0774 second 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.

Thomas\(^7\) conducted a study on the effect of acceleration runs and Ins and Outs runs on sprinting speed. Forty five boy students between the age group of 13-16 years were selected as subjects. The subjects were divided in 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 50 metres run was administered. Analysis of data showed both acceleration runs and Ins and Outs run are effective training means for improving sprinting speed and both the acceleration runs and Ins and Outs runs have equal training effect in the improvement of sprinting speed.

Jamaludeen\textsuperscript{8} 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 eight weeks experimental period group A trained with Differential races and Group B trained with Pace races. The subjects trained thrice on alternate days. The 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.

Roy\textsuperscript{9} 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 the 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 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\textsuperscript{10} study was to determine the effect of Acceleration Runs and Leg Weight Runs on the improvement of speed. Subjects were 30 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 homogeneous groups.

During the experimental 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 gains made by both groups A and B were not found statistically 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 .093 seconds, over Group B. This difference was also not found significant at .05 level of confidence. The value of 't' for difference between means of two groups obtained was .381. For significance of difference at .05 level of confidence the value should be more than 2.05.

The following conclusions were drawn:

1. Speed cannot be improved significantly by administering a training programme of Acceleration Runs and Leg Weight Runs.

2. None of the two training methods that is Acceleration Runs and Leg Weight Runs proved superior to other in improvement of speed.
Richardson\textsuperscript{11} 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.

Turpin\textsuperscript{12} studied the effects of the frequency of running speed in Junior High School girls. Three, seventh grade and three eighth grade classes were pre-tested on the 50 yard dash. One class each 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 weeks. No significant difference was found among the groups on 50 yard test.

Uppal and Singh\textsuperscript{13} conducted a research study on

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comparative effects of Harness Running and 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 age 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 strength 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 the case of Control Group is obviously a reflection of their inactivity.

Ecker\textsuperscript{14} expresses 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) automatically increases a runner's sprinting speed. From a training standpoint, 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 inborn 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.

Bosen\textsuperscript{15}, former Chief National Athletic Coach of India conducted an experiment with four sprinters,

\begin{quote}
\textsuperscript{14}Tom Ecker, "Improving Sprinting Speed through Strength Training," \textit{Athletic Journal} 55 (April 1975): 12.
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\textsuperscript{15}Ken O Bosen, "Experimental Speed Training," \textit{Track Technique} 75 (Spring 1979): 2382.
\end{quote}
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 and six weeks of pre-competitive speed training before the experimental training method was used. After six weeks of experimental period, the following conclusions were drawn.

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

2. Starting practice from blocks must form 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 sprinter using this method.

3. This method not only increases leg 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.

Tansley has used tow training for a period of

five weeks prior to the start of the season to improve performances significantly. He claimed that tow training increases the ability of the athlete to sustain top speed and tow training produces stride length of up to 10 ft. or longer. Tow training is used for all athletes in which speed is important. Long jumpers, Pole Vaulters, Hurdlers, High Jumpers of both sexes have used it. All kinds of distances can be run with tow training. But it was found that 100 metres tows seems to work best.

Dintiman\(^ {17}\) is of the opinion that although running speed is considered mostly an innate quality, it has been well established that it can be improved through training. The strength of the muscles involved in the running action determines, to some extent the maximum speed of the individual. One cannot hope to achieve success in sprinting without the muscular strength, necessary for legs to move with speed.

Heighton\(^ {18}\) opines that if speed is to be developed,

\(^{17}\)George B. Dintiman, "Increasing Running Speed Through Flexibility and Weight Training Programme," Scholastic Coach 34:6 (February 1965): 40.

strength development is a must because once strength is developed, other components of physical fitness will be automatically developed up to some extent as strength is a must to perform any type of activity. He suggests weight training as a better method for development of speed, agility and endurance.

Tabaschnik and Sultanov\(^\text{19}\) in their studies indicated that each sprinter has individual speed dynamics, shown in different combinations of stride frequency and stride length, acceleration capacity, ability to relax, etc. These individualities depend largely on genetic differences as well as physical development and training levels of an athlete. In principles, therefore, it is possible to exploit the sprinter's individual differences by applying different training methods, load and intensities of training in order to specialize in one particular distance.

Day\(^\text{20}\) investigated the effects of three training


programmes of running speed. The experimental groups received particular running performance including repetition sprinting, interspersed sprinting and stair running in addition to a standard weight training programme. The control group received only the weight training programme in each class period. All groups improved significantly in their running speed with no differences noted between the groups.

Henry\textsuperscript{21} stated that the reaction time is of very little importance in sprinting.

Apart from strength, sprinters are given lot of flexibility exercises. Tipton\textsuperscript{22} in his book "Track and Field Athletics" has emphasised the need of flexibility for a sprinter and has suggested variety of exercises for the improvement of flexibility. He is also of the opinion that flexibility can bring about beneficial effects on sprinting speed, speed of movement and acceleration speed.

\textsuperscript{21}Franklin M. Henry, "Research on Sprint Starting," \textit{Athletic Journal} 32 (February 1952): 25.

Kent conducted a study to compare the effects of isometric and isotonic exercise methods on leg strength. Both training methods produced significant improvement in leg strength. No significant difference was detected between the two methods.

Rynda studied the effectiveness of two interval training programmes 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 untrained group and improved significantly in all out


run time. 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.

Kusintz\textsuperscript{25} conducted a study on the effects of progressive weight training upon running speed and endurance. The dependent variables of running speed and endurance were measured before and after a twelve weeks training programme of 50 yards dash for speed and 300 yards for endurance. The experimental group practised weight training and running whereas control group practised only running. The conclusions were that programme of weight training and running proved more effective than running only, in developing 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 variables than those with initial high strength.

Verchoshansky and Chornowsov\textsuperscript{26} of U.S.S.R. conducted


\textsuperscript{26} J. Verchoshansky and G. Chornowsov, "Jump Exercises in Sprint Training," \textit{Track Techniques} 69 (June 1975): 1909.
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" jumps (variants of single take offs with one or both legs and variants of three and five jumps from standing position) and the other group mainly "long" jumps (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 persons each). Test for estimating speed and the level of power they applied: time over various distances (30, 60, 100 metres) with flying and crouch start, distances for long and tripple jump and a series of 10 jumps, time of bouncing over 50 metres as well as the number of running strides in place within 10 seconds. The experiment disclosed the different effects of training with jumping exercises. The group with the "short" jumps considerably improved speed in runs with a crouch start up to 30 metres. The "long" jumps produced considerable changes in speed of long as well as short distances with flying start.

Second experiment of Verchoshansky and Chornowsov was with three groups of 20 persons each for a period of nine weeks. Group A carried out only "short" jumps,
Group B only "long" jump exercises. Group C applied both forms of exercises. To control the changes in running speed and specific power they used 18 tests.

"Short" jump exercises (Group A) guarantee a considerable increase in speed out of the crouch start. The "long" jump exercises (Group B) influence the ability of 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 an 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 the greatest training effect and a simultaneous development of specific power abilities in sprinting.

Delores\textsuperscript{27} investigated effect of toe strength and flexibility on free running speed. He took women college students and tested them in toe strength, ankle strength, leg strength, toe flexibility, ankle flexibility and free running speed prior and immediately following a four week exercise programme designed to increase toe strength. Result of the study revealed that there was significant gain in four of the strength tests and running speed and significant loss in leg strength, toe and ankle flexibility.

Winningham\textsuperscript{28} studied the effect of training with ankle weight on 120 male college students in running speed.

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\textsuperscript{27} Mann Delores, "The Relationship of Toe Strength and Flexibility to Free Running Speed," \textit{Completed Research in Health, Physical Education and Recreation} 10 (1967): 96.

\textsuperscript{28} Sam N. Winningham, "Effect of Training with Ankle Weight on Running Skill," \textit{Completed Research in Health, Physical Education and Recreation} 8 (1966): 94.
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The subjects significantly decreased their running times.

Cullaugh\textsuperscript{29} studied the effect of hand weight in starting practice and speed of sprinter. Forty three freshman male students from two physical education service classes served as subjects. The controlled group participated in pre and post-test only. Experimental group one and two participated in similar sprint programme, except for three pounds hand weight runs for experimental group second. Each group was tested prior to and at the end of a six weeks training programme. The test was a 50 yards dash from starting blocks employing a bunch start. The controlled group and experimental groups one and two made significant improvement in running speed during the experimental period. There was no significant differences between the improvements made by each of the three groups.

Ansoe\textsuperscript{30} studied the effects of three types of


weight training on starting time, running time and performance time for the fifteen and fifty yard dashes. The purpose of the study was to compare the effects of three programmes of weight training in terms of starting time, running and performance time for 15, 35 and 50 yards, back strength and leg strength. The subjects (N=92) were assigned to the following groups: Static contraction group, dynamic contraction group (6 lift maximum), dynamic contraction group (15 lift maximum), physical conditioning group and control group. Conclusions were that no one of the group activities had any more effect on starting time than any other. The use of weight training programmes was superior to no weight training for improvement in running time and performance time for the 15 yard dash. The use of dynamic weight training programmes was superior to no weight training for improvement in running time for 50 yards.

Remigino, 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

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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 fall. The use of weight, calisthenics, and 2 to 4 miles of cross country running are especially beneficial early in the training schedule.

Francis\textsuperscript{32} reported that training loads were very high among the top European athletes. For example, 1980 Olympic 100 meters champion Allan Wells used to perform several thousand push-ups and sit-ups each day, sometimes in sets of 1,000 with very short recovery breaks. Kratochvilova 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 the 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.

\textsuperscript{32}Charlie Francis, "Report from the European Coaching Congress on Sprint and Hurdles," \textit{Track Technique} 86 (Fall 1983): 2741-2742.
Panny carried out a study to investigate the effects of Resistance Running on Speed, Strength, Power, Muscular Endurance and Agility. Training programme was supplemented by isotonic, isometric and repetitive sprinting. Hundred and twenty students were divided in four groups. Group A, resistance running, supplemented by isotonic leg exercises; Group B, resistance running supplemented by isometric leg exercises. Group C - resistance running supplemented by repetitive sprinting; and Group D - Control group, resistance running only. The training programme consisted of four fifty minutes sessions per week for six weeks.

Results indicated that 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.

The purpose of Rae's study was to determine the effects of two interval running programmes on college women when performed for durations of five or eight weeks. The effects were measured by running times on field tests of 50 yards, 440 yards and 1.5 miles. Forty eight subjects were randomly assigned to four equal groups which were then randomly assigned to the four experimental conditions. By the end of training the group size had been reduced from 12 to 10.

The four experimental conditions were: training programme R-1 for five weeks, training programme R-1 for eight weeks, training programme R-2 for five weeks and training R-2 for eight weeks.

The R-1 training programme was made up to distances of 55, 110 and 220 yards. The programme was designed to emphasise development of anaerobic efficiency. The R-2 training programme involved distances of 110, 220, 660, 880 and 1320 yards. This programme was designed to develop the anaerobic and aerobic energy systems.

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34 Rickel, Donna Rae, "The Effect of Two Interval Running Programmes and Duration of Training of Selected Running Tests by College Women," Dissertation Abstracts International 39 : 10 (April 1979): 6024-A.
Subjects participated in workouts, three times per week. The 50 yard dash was to measure the improvement in efficiency of the ATP-PC anaerobic energy system. Result revealed no significant differences on the 50 yard dash in regard to training method or duration of training.

Engelbrecht\textsuperscript{35} Senior Athletic Coach of Great Britain pointed out that, Soviet Sprinters are increasingly placing 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{36} 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 contraction, rapid contractions or slow contraction 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.

\textsuperscript{35}Rita Engelbrecht, "Use of Medicine Ball in Sprint Training Exercises," \textit{Track Technique} 97 (Fall 1987): 3086.

Gains in strength were accompanied by gain in movement speed with and without resistance but the difference between the exercise groups were not significant at .05 level.

Dudley\textsuperscript{37} conducted a study to determine the effect of the weight of the football uniforms on speed and agility. The uniforms were classed as heavy (18-1/16 Lbs.), medium (16-3/16 Lbs.), and light (14-1/2 Lbs.). The subjects performed 2 speed run and a agility run with the uniforms and without a uniform. The selected football uniforms had an effect on the speed and agility of the subjects. In almost all group comparisons, as the uniform weight decreased, speed and agility performances were faster. The strength index of the players had a significant effect on speed, but did not effect agility.

Lee\textsuperscript{38} administered a study on seventy seven students to compare the effects of four selected physical

\textsuperscript{37}Rogers Wm. Dudley, "A Study to Determine the Effect of the Weight of Football Uniforms on Speed and Agility," Completed Research in Health, Physical Education and Recreation 10 (1968): 111.

education activities on selected physical performance of college male freshmen. The activities selected for this study were elementary courses in volleyball, soccer, tennis and conditioning. The classes met twice a week for a period of twelve weeks. And at the conclusions it appears that subjects engaged in soccer and volleyball activities showed significant improvement at the .05 level of confidence on the test of the 50 yard dash.

Renowned Russian Coaches Tabashnik and Timoschenko are of the opinion that the first two training years of young athletes lead to the initial specialisation 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 is the use of uphill runs, upstairs runs, runs in the sand and runs with a weighted vest, alternated with runs under normal conditions. At this stage it is also time to begin the learning of the basic elements of the sprint relay, while

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variety in training is achieved by games (basketball, soccer, handball etc.) that demand continual 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 preceded by improvement of physical capacities. Strength and power at this stage are developed by bounding exercises, standing jumps, exercises with medicine balls and resistance exercises (50 to 80% 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 jumps, hurdles, medicine ball put, 30 and 60 metres sprint, as well as 150, 200, 300 metres and relays.

Petrovski40 the Coach of Valeriy Borzov, Double sprint winner in Munich Olympic Games opined that in each workout period, various means of training must be used for the sprinters e.g., games, weight training, specificity exercises, jumping and sprinting over various distances (30-60-100-150-200-300-400 and 800 metres).

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All these forms of training are for the purpose of enabling the body to reach the major goal set for it, i.e., the development of a definite sprint speed and a sprint - endurance capacity. Besides specially selected activities, sprints over distances of 30 and 60 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.

About 80 sprinters of varying standard from novices to masters of sports - were tested by Soviet Union Experts Werschoshanskiu and Semjonow\textsuperscript{41} on a) "Relative strength" the muscle actions in the bending 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 determines) "Starting Strength". In the course of the investigation it was shown that for all the

\textsuperscript{41} Juri Werschoshanskiu and W. Semjonow, "Strength Training for Sprinters," \textit{Track Technique} 54 (December 1973): 1717.
dynamic characteristics, four muscle groups (which are denoted in the subsequent test as the most important existing muscle groups) bore the most relevance to the sprint performance. These are in their order of importance: Those of the thigh (quads), the plantarflexors, those of the rear of the thigh (hamstring) and the dorsiflexors.

Helison\textsuperscript{42} studied 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 control group which engaged in no weight training. Result showed no significant difference between the experimental and control group at the conclusion of the experiment.

Hamak\textsuperscript{43} conducted a study to determine the effect of a selected progressive resistance running programme


on free running speed, circulo-respiratory efficiency and power. Male subjects (N=45) were divided into three equated groups namely, interval running, resistance running (employing an Exer-Genic) and control. The effects of a six weeks training programme were determined by a pre-test, initial post-test, and final post-test for free running speed, power development by the legs, oxygen debt repaid, and elapsed time for a 600 yard run. Significant improvement was found in oxygen debt repaid (.05 level) and elapsed time for a 600 yard run (.01 level) between the interval and control groups.