CHAPTER - II

REVIEW OF RELATED LITERATURE
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Review of related literature gives valuable insight to the investigator regarding the problem to be solved. The review of literature can be extremely helpful to the investigator in identifying the methods that have been successfully used to solve the particular types of problems. Valuable elements from other studies may include the characteristics of the participants, data collecting, testing procedure, statistical design and analysis and so forth. An analysis of the literature is a part of all types of researches and it was creatively help the investigator to know deeply about chosen study and related studies already done.

The literature in any field forms the foundation upon which all future frameworks will be built. Hence a study of relevant literature is an essential step to get detailed information, insight and a good comprehension of what has been done earlier with regard to the present problem under investigation.

In order to get a through knowledge about the proposed area of study, the investigator searched available research references, periodicals, journals, books and internet web sites. The following review provides a rationale and foundation for this research study.
Bravo et al. (2008) compared the effects of high intensity aerobic interval and repeated sprint ability training on aerobic and anaerobic physiological variables in male football players. Forty two participants were randomly assigned to either the interval training group or repeated sprint training group. The following outcomes were measured at baseline and after seven weeks of training: maximum oxygen uptake, respiratory compensation point, football specific endurance (Yo-Yo Intermittent Recovery Test), 10 meters sprint time, jump height and power, and repeated sprint ability. Significant group x time interaction was found for Yo-Yo Intermittent Recovery Test (p = 0.003) with repeated sprint training group showing greater improvement (from 1917 +/- 439 to 2455 +/- 488 m) than interval training group (from 1846 +/- 329 to 2077 +/- 300 m). Similarly, a significant interaction was found in repeated sprint ability mean time (p = 0.006) with only the RSG group showing an improvement after training (from 7.53 +/- 0.21 to 7.37 +/- 0.17 seconds) the group x time interactions were found. Significant pre-post changes were found for absolute and relative maximum oxygen uptake and respiratory compensation point (p < 0.05). These findings suggest that the repeated-sprint ability training protocol used in this study can be an effective training strategy for inducing aerobic and football-specific training adaptations.

Cristea et al. (2008) examined the effects of progressive strength and sprint training on regulation of muscle contraction at the whole muscle and single fibre levels in older sprint-trained athletes. Eleven men (52-78 years) were randomized to a training (n=7) or control (n=4) group. Experimental
group participated in a 20 week programme that combined sprint training with heavy and explosive strength exercises, while control group maintained their usual run-based training schedules. Experimental group improved maximal isometric and dynamic leg strength, explosive jump performance and force production in running. Specific tension and maximum shortening velocity of single fibres from the vastus lateralis were not altered in experimental group or control. Fibre type and myosin heavy chain isoform distributions remained unchanged in the two groups. There was a general increase in fibre areas in experimental group, but this was significant only in IIa fibres. The 10% increase in squat jump in experimental group was accompanied by a 9% increase in the integrated EMG of the leg extensors but the 21-40% increases in isometric and dynamic strength were not paralleled by changes in integrated EMG. Adding strength training stimulus to the training programme improved maximal, explosive and sport-specific force production in elite master sprinters. These improvements were primarily related to hypertrophic muscular adaptations.

De-Villarreal, Gonzalez-Badillo, and Izquierdo (2008) examined the effect of three different plyometric training frequencies (for example, one day per week, two days per week, four days per week) associated with three different plyometric training volumes on maximal strength, vertical jump performance, and sprinting ability. Forty two students were randomly assigned to one of four groups: control (n = 10, seven sessions of drop jump training, one day per week, 420 drop jumps), 14 sessions of drop jump training (n = 12,
two days per week, 840 drop jumps), and 28 sessions of drop jump training (n = 9, four days per week, 1680 drop jumps). The training protocols included drop jump from three different heights 20, 40, and 60 cm. Maximal strength (one repetition maximum and maximal isometric strength), vertical height in countermovement jumps and drop jumps, and 20 meters sprint time tests were carried out before and after seven weeks of plyometric training. No significant differences were observed among the groups in pre-training in any of the variables tested. No significant changes were observed in the control group in any of the variables tested at any point. Short term plyometric training using moderate training frequency and volume of jumps (two days per week, 840 jumps) produces similar enhancements in jumping performance, but greater training efficiency (approximately 12% and 0.014% per jump) compared with high jumping (four days per week, 1680 jumps) training frequency (approximately 18% and 0.011% per jump). In addition, similar enhancements in 20 meters sprint time, jumping contact times and maximal strength were observed in both a moderate and low number of training sessions per week compared with high training frequencies, despite the fact that the average number of jumps accomplished in 7S (420 jumps) and 14S (840 jumps) was 25 and 50% of that performed in 28S (1680 jumps). These observations may have considerable practical relevance for the optimal design of plyometric training programs for athletes, given that a moderate volume is more efficient than a higher plyometric training volume.
Harris, Cronin, Hopkins, and Hansen (2008) identified each subject's power max for an isoinertial resistance training exercise used for testing and training, and then they related the changes in strength to changes in sprint performance. The subjects were 18 well trained rugby league players randomized to two equal volume training groups for a seven weeks period of squat jump training with heavy loads (80% one repetition maximum) or with individually determined power max loads (20.0-43.5% one repetition maximum). Performance measures were one repetition maximum strength, maximal power at 55% of pre training one repetition maximum, and sprint times for 10 and 30 meters. Percent changes were standardized to make magnitude based inferences. Relationships between changes in these variables were expressed as correlations. Sprint times for 10 meters showed improvements in the 80% one repetition maximum group (-2.9 +/- 3.2%) and power max group (-1.3 +/- 2.2%), and there were similar improvements in 30 meters sprint time (-1.9 +/- 2.8 and -1.2 +/- 2.0%, respectively). Differences in the improvements in sprint time between groups were unclear, but improvement in one repetition maximum strength in the 80% one repetition maximum group (15 +/- 9%) was possibly substantially greater than in the Power max group (11 +/- 8%). Small-moderate negative correlations between change in one repetition maximum and change in sprint time (r approximately -0.30) in the combined groups provided the only evidence of adaptive associations between strength and power outputs, and sprint performance. In conclusion, it seems that training at the load that maximizes individual peak
power output for this exercise with a sample of professional team sport athletes was no more effective for improving sprint ability than training at heavy loads, and the changes in power output were not usefully related to changes in sprint ability.

Harrison and Bourke (2008) investigated whether a resisted sprint training intervention would enhance the running speed and dynamic strength measures in male rugby players. Fifteen male rugby players aged 20.5 (+/- 2.8) years who were proficient in resisted sledge training took part in the study. The subjects were randomly assigned to control or resisted sprint groups. The resisted sprint group performed two sessions per weeks of resisted sprint training for six weeks, and the control group did no resisted sprint training. Pre and post intervention tests were carried out for 30 meters sprint, drop, squat, and rebound jumps on a force sledge system. A laser measurement device was used to obtain velocities and distance measures during all running trials. The results show statistically significant decrease in time to five meters for the 30 meters sprint for the resisted sprint group (p = 0.02). The squat jump and drop jump variables also showed significant increases in starting strength (p = 0.004) and height jumped (p = 0.018) for the resisted sprint group from pre to post testing sessions. The results suggest that it may be beneficial to employ a resisted sprint training intervention with the aim of increasing initial acceleration from a static start for sprinting.

Ronnestad, Kvamme, Sunde, and Raastad (2008) compared the effects of combined strength and plyometric training with strength training alone on
power-related measurements in professional soccer players. Subjects in the intervention team were randomly divided into two groups. Group I strength training (n = 6) performed heavy strength training twice a week for 7 weeks in addition to six to eight soccer sessions a week. Group II strength training plus plyometric training (n = 8) performed a plyometric training program in addition to the same training as the strength training group. The results suggest that there are no significant performance-enhancing effects of combining strength and plyometric training in professional soccer players concurrently performing six to eight soccer sessions a week compared to strength training alone. However, heavy strength training leads to significant gains in strength and power-related measurements in professional soccer players.

Ronnestad, Kvamme, Sunde, and Raastad (2008) compared the effects of combined strength and plyometric training with strength training alone on power-related measurements in professional soccer players. Subjects in the intervention team were randomly divided into two groups. Group strength training (n = 6) performed heavy strength training twice a week for seven weeks in addition to six to eight soccer sessions a week. Group strength training plus plyometric (n = 8) performed a plyometric training program in addition to the same training as the plyometric group. The control group (n = 7) performed six to eight soccer sessions a week. The results suggest that there are no significant performance enhancing effects of combining strength and plyometric training in professional soccer players concurrently performing six to eight soccer sessions a week compared to strength training alone. However,
heavy strength training leads to significant gains in strength and power-related measurements in professional soccer players.

Salonikidis and Zafeiridis (2008) studied to compare the effects of plyometric training, tennis-specific drills training and combined training on performance in tennis-specific movements and power/strength of lower limbs. Sixty-four novice tennis players (21.1 +/- 1.3 years) were equally (n = 16) assigned to a control, plyometric training, tennis-specific drills training and combined training. Training was performed three times per week for nine weeks. Testing was conducted before and after training for the evaluation of reaction time (single lateral step), four meter lateral and forward sprints, twelve meter forward sprints with and without turn, reactive ability, power, and strength. It was concluded plyometric training improved fitness characteristics that rely more on reactive strength and powerful push-off of legs such as, lateral reaction time, four meter lateral and forward sprints, drop jump and maximal force. tennis-specific drills training improved all four meter and twelve meter sprint performances, whereas combined training appeared to incorporate the advantage of both programs and improved most tests items.

Venturelli, Bishop, and Pettene (2008) investigated whether coordination or repeated-sprint training better improved speed over 20 meters, with and without the ball. Sixteen soccer players (mean age 11 ± 0.5 years) were randomly assigned to a sprint-training group (n = 7) or a coordination training group (n = 9). The sprint training group trained twice a week for 12 weeks and performed 20 repetitions of 20 and 10 meters sprints; the
coordination-training group performed coordination training (e.g., speed ladder running) for the same training duration. Maximal jump height, anthropometric measures, and 20 meters sprint time, with and without ball, were evaluated before and after the training period. Statistical significance was determined using two-way ANOVA with repeated measure and Pearson test for correlation. Both groups improved speed without the ball: sprint training group = 3.75 ± 0.10 s to 3.66 ± 0.09 s (P < .05); coordination training group = 3.64 ± 0.13 s to 3.56 ± 0.13 s (P < .05), with no difference between groups. Sprint time with the ball pre and post training was 4.06 ± 0.11 s and 4.05 ± 0.19 s (P > .05) for sprint-training group and 4.04 ± 0.12 seconds and 3.82 ± 0.15 seconds (P < 0.05) for coordination training group, with a significant difference between groups post training (P < 0.05). There were significant correlations between sprint time without ball, coordination training group, and SJ. These data suggest that coordination training increases the speed with the ball more than typical repeated-sprint training. It can be hypothesized that running speed with ball improved more in coordination training group because this particular action requires improvements in coordination.

Yetter and Moir (2008) investigate the effects of performing heavy back squats and heavy front squats on the average speed during each 10 meters interval of 40 meters sprint trials. In a randomized, cross over design, 10 strength trained men performed a heavy back squats, heavy front squats or control treatment before performing three 40 meters sprint trials separated by three minutes. The heavy back squats and heavy front squats treatments
consisted of performing parallel back or front squats with 30%, 50%, and 70% of the subject's one repetition maximum after five minutes of cycling. The control treatment consisted of cycling for five minutes. The sprint trials were performed four minutes after completing the heavy back squats, heavy front squats or control treatments. Significant increases in speed were found during the 10 to 20 meters interval for the heavy back squats compared with the control treatment (mean difference, 0.12 m x s\(^{-1}\); 95% likely range, 0.05-0.18 m x s\(^{-1}\); P = 0.001). During the 30 to 40 meters interval, heavy back squats produced significantly greater speeds compared with the heavy front squats treatment (mean difference, 0.24 m x s\(^{-1}\); 95% likely range, 0.02-0.45 m x s\(^{-1}\); P = 0.034) and the control treatment (mean difference, 0.18 m x s\(^{-1}\); 95% likely range, 0.03-0.32 m x s\(^{-1}\); P = 0.021). The differing effects of the treatments may reflect different levels of muscular activation or different mechanical aspects of the squat exercises. Similarly, the multidimensional nature of sprint running means that other specific exercises may confer improvements in sprinting performance during other intervals. It is suggested that coaches could incorporate heavy back squats into the warm up procedure of athletes to improve sprinting performance.

Chen (2007) investigate the effects of five weeks 10 meters sprint and jump rope training on young Kendo players countermovement jump, squad jump, hit reaction time, hit movement time, and attack speed. The subjects were divided into 10 meters sprint, jump rope and control group. Each group has eight subjects. There are five events in pre test and post test.
Countermovement jump and squad jump are basic sports ability; hit reaction
time, hit movement time, and attack speed are specialty sports ability. It was
concluded that 10 meters sprint and jump rope training of five weeks on young
Kendo players squad and hit reaction time, countermovement jump and attack
speed, and hit reaction time all were not significantly relevant. The control
group of the lower limbs powers squad jump, hit reaction time, attack speed,
and hit movement time were not significantly relevant. The lower limbs powers
countermovement jump was significantly relevant to attack speed.

Impellizzeri et al. (2007) compared the effects of plyometric training on
sand versus a grass surface on muscle soreness, vertical jump height and
sprinting ability. Parallel two groups, randomised, longitudinal (pretest-post-
test) study. After random allocation, 18 soccer players completed four weeks of
plyometric training on grass (grass group) and 19 players on sand (sand group).
Before and after plyometric training, 10 meters and 20 meters sprint time, squat
jump, countermovement jump and eccentric utilization ratio were determined.
Muscle soreness was measured using a likert scale. Plyometric training on sand
improved both jumping and sprinting ability and induced less muscle soreness.
A grass surface seems to be superior in enhancing countermovement jump
performance while the sand surface showed a greater improvement in squat
jump. Therefore, plyometric training on different surfaces may be associated
with different training-induced effects on some neuromuscular factors related
to the efficiency of the stretch shortening cycle.
Ling (2007) investigated the effect of speed training of difference distance on 100 meters performance. Eighteen track athletes were involved in this study. Group A that was 30 meters training group involved nine athletes and group B that was 60 meters training groups involved nine athletes, athletes were assigned by 100 meter velocity and countermovement jump height. It was concluded that the performance of power of lower power of 30 meters training groups and 60 meters training groups had both progress that 30 meters training group was better than 60 meters training groups after four weeks training. The performance of reactive time of 30 meters training groups and 60 meters training groups had both progress that 30 meters training groups was better than 60 meters training groups after four weeks training. The performance of power of lower power of 30 meters training groups and 60 meters training groups had both progress that 30 meters training groups was better than 60 meters training groups after four weeks training. The speed, power of lower body and reactive time between groups don’t have significant correlation; 60 meters training groups had high significant correlation with T-2, T-3 of 30 meters training groups, 100 meters and reactive time had significant progress, but don’t have significant correlation.

Moir, Sanders, Button, and Glaister (2007) assessed the effect of periodized resistance training on accelerative sprint performance. Sixteen physically active men participated in a randomized controlled study. An experimental group \( (n = 10) \) completed an eight weeks periodized resistance training intervention, while a control group \( (n = 6) \) did not train. Pre and post

training measures of 20 meters straight-line sprint time, including a 10 meters split, maximum strength, and explosive strength, were recorded. Flight time, stance time, stride length, and stride frequency were quantified from digitized video recordings of the first three strides of the 20 meters sprint. Resistance training resulted in significant increases in maximum strength (parallel back squat: 19%) and explosive strength (6-10%). However, both groups increased 0-10 meters sprint times (experimental group = 6%; control group = 3%) while 10-20 meters times were reduced (experimental group = 7%; control group = 4%), highlighting the mechanical differences between the distinct sprint phases. The change during the 0-10 meters interval was accompanied by a reduction in stride frequency during the first three strides.

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10-20 meters times were reduced (experimental group = 7%; control group = 4%), highlighting the mechanical differences between the distinct sprint phases. The change during the 0-10 meters interval was accompanied by a reduction in stride frequency during the first three strides. Strength coaches should be aware that the potential benefits of increased muscular strength during short sprints are likely to be affected by mechanical specificity and that improvements in sprinting performance may not occur immediately after a period of resistance training.

Paradisis and Zacharogiannis (2007) investigated the effect of six weeks of whole body vibration training on sprint running kinematics and explosive strength performance. Twenty four volunteers (twelve women and twelve men) participated in the study and were randomised (n = 12) into the experimental and control groups. The whole body vibration training group performed a six week program (16-30 min·d⁻¹, three times a week) on a vibration platform. The amplitude of the vibration platform was 2.5 mm and the acceleration was 2.28 g. The control group did not participate in any training. Tests were performed Pre and post the training period. Sprint running performance was measured during a 60 meters sprint where running time, running speed, step length and step rate were calculated. Explosive strength performance was measured during a counter movement jump test, where jump height and total number of jumps performed in a period of 30 seconds. Performance in 10 meter, 20 meters, 40 meters, 50 meters and 60 meters improved significantly after 6 weeks of whole body vibration training with an overall improvement of 2.7%. The step length
and running speed improved by 5.1% and 3.6%, and the step rate decreased by 3.4%. The countermovement jump height increased by 3.3%, and the explosive strength endurance improved overall by 7.8%. The whole body vibration training period of six weeks produced significant changes in sprint running kinematics and explosive strength performance.

Ratamess et al. (2007) investigated to examine the combined effects of resistance and sprint/plyometric training with or without the meridian elyte athletic shoe on muscular performance in women. Fourteen resistance-trained women were randomly assigned to one of two training groups: an athletic shoe (N = 6) group or the Meridian Elyte (N = 8) group. However, when sprint endurance (the difference between the fastest and slowest sprint trials) was analyzed, there was a significantly greater improvement at 60 meters in the meridian elyte athletic shoe groups. These results indicated that similar improvements in peak sprint speed and jumping ability were observed following ten weeks of training with either shoe. However, high intensity sprint endurance at 60 meters increased to a greater extent during training with the meridian elyte athletic shoe.

Chen (2006) investigated the effects of the speed, agility, power, 100 meters, and 800 meters performance by dragging training and speed training in middle long distance adolescents runners. Eighteen middle-distance teenage runners were randomly assignment into dragging training and speed training groups; and nine with the same age students were as control group in the study. It is concluded with five kilo grams bearing dragging training had better effects
on the agility, power, and speed of 100 meters and 800 meters than that the peer speed training for the runners of teenager.

Chuang (2006) investigated the effect of 20 days vibration training and jump rope training on baseball players lower limbs power (countermovement jump), take off reaction time, base running velocity from home to first after batting and five meters base running velocity after batting of baseball players. Twenty six adult baseball players were involved in this study. It was concluded that the vibration and jump rope training can improve countermovement jump, take-off reaction time, base running velocity from home to first after batting, five meters base running velocity after batting, but base-running velocity from home to first after batting and five meters base-running velocity after batting were significant different between groups.

Kotzamanidis (2006) investigated the effect of plyometric training on running velocity and squat jump in prepubescent boys. Fifteen boys (11.1 +/- 0.5 years) followed a ten weeks plyometric program (jump group). Another group of 15 boys (10.9 +/- 0.7 years) followed only the physical education program in primary school and was used as the control group. Running distances (0-10 meters, 10-20 meters, 20-30 meters, and 0-30 meters), were selected as testing variables to evaluate the training program. The total number of jumps was initially 60 per session, which was gradually increased over a period of 10 weeks to 100 per session. Results revealed significant differences between control and jump groups in running velocity and squat jump. In jump group the velocity for the running distances 0-30, 10-20, and 20-30 m increased
(p < 0.05), but not for the distance 0-10 meter (p > 0.05). Additionally, the squat jump performance of the jump group increased significantly, as well (p < 0.05). There was no change in either running velocity or squat jump for the control group. These results indicated that plyometric exercises can improve running velocity and squat jump in prepubertal boys. More specifically, this program selectively influenced the maximum velocity phase, but not the acceleration phase.

Paradisis and Cooke (2006) examined the effects of sprint running training on sloping surfaces (3°) on selected kinematic and physiological variables has been studied. Thirty five students were split into four training groups (uphill-downhill, downhill, uphill, and horizontal) and a control group. Pre and post training tests were performed to determine the effects of six weeks training on the maximum running speed at 35 meters, step rate, step length, step time, contact time, eccentric and concentric phase of contact time, flight time, selected posture characteristics of the step cycle, and peak anaerobic power performance. Maximum running speed and step rate were increased significantly in a 35 meters running test after training by 0.29 m·s⁻¹ (3.5%) and 0.14 Hz (3.4%) for the combined uphill-downhill group and by 0.09 m·s⁻¹ (1.1%) and 0.03 Hz (2.4%) for the downhill group, whereas flight time shortened only for the combined uphill-downhill training group by six milliseconds (4.3%). There were no significant changes in the horizontal and control groups. Posture characteristics and peak anaerobic power were unaffected. It was suggested that the novel combined uphill-downhill training
method is significantly more effective in improving the maximum running velocity at 35 meters and the horizontal kinematics of sprint running than other methods.

Gre gory, Matthew, Jennifer, and Christopher (2005) examined the effects of aquatic plyometric training on vertical jump and muscular strength in volleyball players. Nineteen female volleyball players (aged 15 +/- 1 yr) were randomly assigned to perform six week of aquatic plyometric training or flexibility exercises (control) twice weekly, both in addition to traditional preseason volleyball training. Testing of leg strength was performed at baseline and after six week, and vertical jump was measured at baseline and after second, fourth and sixth week. The combination of aquatic plyometric training and volleyball training resulted in larger improvements in vertical jump than in the control group. Thus, given the likely reduction in muscle soreness with aquatic plyometric training versus land-based plyometrics, aquatic plyometric training appears to be a promising training option.

Kotzamanidis, Chatzopoulos, Michailidis, Papaiakovou, and Patikas (2005) investigated the effect of a combined heavy resistance and running speed training program performed in the same training session on strength, running velocity, and vertical jump performance of soccer players. Thirty five individuals were divided into three groups. The first group (n = 12) performed a combined resistance and speed training program at the same training session, and the second one (n = 11) performed the same resistance training without
speed training. The third group was the control group (n = 12). Three jump
tests were used for the evaluation of vertical jump performance: squat jump,
countermovement jump, and drop jump. The 30 meters dash and one repetition
maximum tests were used for running speed and strength evaluation,
respectively. It is concluded that the combined resistance and running-speed
program provides better results than the conventional resistance training,
regarding the power performance of soccer players.

Mercer, Bezodis, Russell, Purdy, and DeLion (2005) investigated
whether or not stride length influences the relationship between running
velocity and impact characteristics. Eight volunteers (mass=72.4 kg; height =
1.7 m; age = 25 years) completed two running conditions: preferred stride
length and stride length constrained at 2.5 meters. During each condition,
participants ran at a variety of speeds with the intent that the range of speeds
would be similar between conditions. During preferred stride length,
participants were given no instructions regarding stride length. During stride
length 2.5, participants were required to strike targets placed on the floor that
resulted in a stride length of 2.5 meters. Ground reaction forces were recorded
(1080 Hz) as well as leg and head accelerations (uni-axial accelerometers).
Impact force and impact attenuation (calculated as the ratio of head and leg
impact accelerations) were recorded for each running trial. Scatter plots were
generated plotting each parameter against running velocity. Lines of best fit
were calculated with the slopes recorded for analysis. The slopes were
compared between conditions using paired t-tests. Data from two subjects were
dropped from analysis since the velocity ranges were not similar between conditions resulting in the analysis of six subjects. The slope of impact force versus velocity relationship was different between conditions (preferred stride length: 0.178 BW/m·s\(^{-1}\); SL2.5: -0.003. The slope of the impact attenuation versus. velocity relationship was different between conditions (preferred stride length: 5.12; stride length 2.5: 1.39). Stride length was an important factor that determined impact force magnitude. It is likely that lower extremity posture is a determining factor influencing impact characteristics.

Murray et al. (2005) compared sprint performance over 10 and 20 meters when participants ran while towing resistances, weighing between 0 and 30% of body mass. The sample of 33 participants consisted of male rugby and soccer players (age 21.1 years, body mass 83.6 kg, height 1.82 meters). Each participant performed two sets of seven sprints over 20 meters using a Latin rectangular design. The times were recorded at 10 and 20 meters using electronic speed gates. The sprints of 13 players were video recorded to allow calculation of stride length and frequency. For both sprints, a quadratic relationship was observed between sprint time and resistance as sprint time increased from 2.94 seconds to 3.80 seconds from 0 to 30% resistance. This relationship was statistically significant but considered not to be meaningful for performance because, over the range of resistances used in this study, the quadratic model was never more than 1% (in terms of sprint time) from the linear model. The results show that in general there is an increase in sprint time
with an increase in resistance. No particular resistance in the range tested (0-30%) can be recommended for practice.

Nimphius, McBride and Erickson (2005) investigated to determine whether performing high force or explosive force movements prior to sprinting would improve running speed. Fifteen NCAA Division III football players performed a heavy-load squat, loaded countermovement jump or control warm up condition in a counterbalanced randomized order over the course of three weeks. The heavy-load squat protocol consisted of one set of three repetitions at 90% of the subject's one repetition maximum. The loaded countermovement jump protocol was one set of three repetitions at 30% of the subject's one repetition maximum. At four minutes post-warm-up, subjects completed a timed 40 meters dash with time measured at 10, 30, and 40 meters. The results of the study indicated that no significant differences were observed in the 10 meters or 30 meters split times between the three conditions. The data from this study suggest that an acute bout of low volume heavy lifting with the lower body may improve 40 meters sprint times, but that loaded countermovement jumps appear to have no significant effect.

Olmedillas et al. (2005) determined the effect of six weeks of weight-lifting training combined with plyometric exercises on vertical jump performance and maximal strength. Thirty-four physical educations students (24.2 ± 0.4 yr, mean ± SEM) were randomly assigned to the training group (n = 15) or non-training control group (n = 19). Training group subjects trained three times per week during six weeks by weight lifting and plyometric
exercises. It was assessed with a force plate. Similarly, one repetition maximum was calculated. Leg lean mass was assessed by dual energy x-ray absorptiometry. Differences were established using the corresponding statistical Student's t tests (p<0.05). The influence of lean mass changes on performance was assessed using bivariate correlation analysis. Six weeks strength training combined with plyometric exercises enhances leg muscle mass and improves both, maximal dynamic force (one repetition maximum) and countermovement performance in physical education students.

Zafeiridis et al. (2005) examined the effects of resisted and un-resisted sprint training programs on acceleration and maximum speed performance. Twenty two male students (age 20.1 +/- 1.9 y, height 1.78 +/- 7 cm, and weight 73 +/- 2 kg) completed resisted (n=11) or un-resisted (n=11) sprint training programs. The resisted group followed a sprint-training program with five kg sled pulling and the un-resisted group followed a similar sprint training program without sled pulling. Sprint training with five kg sled pulling for eight weeks improves acceleration performance (0(-2)0), while un-resisted sprint training improves performance in maximum speed phase (20-40) in non-elite athletes. It appears that each phase of sprint run demands a specific training approach.

Gray and Sauerbeck (2004) analyzed to improve the 40 yards sprint time in junior varsity and varsity high school football players. A four and half week speed training program was designed for 38 high school athletes. The athletes participated three days per week in the program. The program consisted of
specific form running on a 40 yards course at various downhill degrees of slope in addition to the normal workout of agility and lateral speed training. Each participant was timed on a flat track prior to the start of the training program and upon its completion. The overall results showed an average decrease in time in the 40 yards sprint of 0.188 seconds (range +0.01 to -0.9). All but five participants demonstrated an improved time. These results suggest that a standardized training program emphasizing acceleration, starting ability, stride rate, speed endurance, and stride length can improve performance in the 40 yards sprint.

Danion, Varraine, Bonnard, and Pailhous (2003) determined the role of stride frequency and stride length on those parameters. Eight healthy subjects walked on a treadmill using 25 different stride frequency and stride length combinations (0.95< stride length <1.5 meters, and 0.8< stride frequency <1.26 Hz). The results showed that spatial and temporal variabilities tend to increase in concert with respect to change in stride parameters. In addition, stride variability was found to be minimal at stride frequency =1 Hz; and to increase with smaller stride length. During additional trials, subjects walked freely at various speeds. Although it is generally hypothesized that freely chosen behaviors are optimal in terms of variability, our data showed that this is not always the case in human gait.

Blazevich and Jenkins (2002) determined the effects of seven weeks of high and low velocity resistance training on strength and sprint running performance in nine male elite junior sprint runners (age 19.0+/-1.4 years, best
100 meters times 10.89 +/- 0.21 s; mean +/- s). The athletes continued their sprint training throughout the study, but their resistance training programme was replaced by one in which the movement velocities of hip extension and flexion, knee extension and flexion and squat exercises varied according to the loads lifted (i.e. 30-50% and 70-90% of one repetition maximum in the high and low velocity training groups, respectively). There were no between group differences in hip flexion or extension torque produced at 1.05, 4.74 or 8.42 rad x s(-1), 20 m acceleration or 20 meters 'flying' running times, or one repetition maximum squat lift strength either before or after training. This was despite significant improvements in 20 meters acceleration time (P < 0.01), squat strength (P < 0.05), isokinetic hip flexion torque at 4.74 rad x s(-1) and hip extension torque at 1.05 and 4.74 rad x s(-1) for the athletes as a whole over the training period. Although velocity specific strength adaptations have been shown to occur rapidly in untrained and nonconcurrently training individuals, the present results suggest a lack of velocity specific performance changes in elite concurrently training sprint runners performing a combination of traditional and semi specific resistance training exercises.

Chelly and Denis (2001) determined sprint performance undoubtedly involves muscle power, the stiffness of the leg also determines sprint performance while running at maximal velocity. Results that include both of these characteristics have not been directly obtained in previous studies on human runners. That have therefore studied the link between leg power, leg stiffness, and sprint performance. The acceleration and maximal running
velocity developed by eleven subjects (age 16 +/- 1) during a 40 meters sprint were measured by radar. Their leg muscle volumes were estimated anthropometrically. Leg power was measured by an ergometric treadmill test and by a hopping test. Each subject executed maximal sprint acceleration on the treadmill equipped with force and speed transducers, from which forward power was calculated. A hopping jump test was executed at 2 Hz on a force platform. Leg stiffness was calculated using the flight and contact times of the hopping test. The treadmill forward leg power was correlated with both the initial acceleration ($r = 0.80$, $P < 0.01$) and the maximal running velocity ($r = 0.73$, $P < 0.05$) during track sprinting. The leg stiffness calculated from hopping was significantly correlated with the maximal velocity but not with acceleration. Although muscle power is needed for acceleration and maintaining a maximal velocity in sprint performance, high leg stiffness may be needed for high running speed. The ability to produce a stiff rebound during the maximal running velocity could be explored by measuring the stiffness of a rebound during a vertical jump.

Young, McDowell, and Scarlett (2001) determined if straight sprint training transferred to agility performance tests that involved various change of direction complexities and if agility training transferred to straight sprinting speed. Thirty six males were tested on a 30 meters straight sprint and six agility tests with 2-5 changes of direction at various angles. The subjects participated in two training sessions per week for six weeks using 20-40 meters straight sprints (speed) or 20-40 meters change of direction sprints (3-5 changes of 100
degrees) (agility). After the training period, the subjects were retested, and the speed training resulted in significant improvements (p < 0.05) in straight sprinting speed but limited gains in the agility tests. Generally, the more complex the agility task, the less the transfer from the speed training to the agility task. Conversely, the agility training resulted in significant improvements in the change-of-direction tests (p < 0.05) but no significant improvement (p > 0.05) in straight sprint performance. It was concluded that straight speed and agility training methods are specific and produce limited transfer to the other. These findings have implications for the design of speed and agility training and testing protocols.

Paavolainen, Hakkinen, Hamalainen, Nummela, and Rusko (1999) investigated the effects of simultaneous explosive-strength and endurance training on physical performance characteristics, 10 experimental and eight control endurance athletes trained for nine weeks. The total training volume was kept the same in both groups, but 32% of training in experimental and 3% in control was replaced by explosive-type strength training. A five-km time trial, running economy, maximal 20-meter speed ($V_{20\,m}$), and five jump tests were measured on a track. Maximal anaerobic (MART) and aerobic treadmill running tests were used to determine maximal velocity in the MART ($V_{\text{MART}}$) and maximal oxygen uptake ($O_{2\text{ max}}$). The 5K time, running economy, and VMART improved (P < 0.05) in E, but no changes were observed in control. $V_{20\,m}$ and five increased in experimental (P < 0.01) and decreased in control (P < 0.05). $O_{2\text{ max}}$ increased in control (P < 0.05), but no
changes were observed in experimental. In the pooled data, the changes in the 5K velocity during nine weeks of training correlated (P < 0.05) with the changes in running economy [O2 uptake (r = 0.54)] and VMART (r = 0.55). In conclusion, the present simultaneous explosive-strength and endurance training improved the 5K time in well-trained endurance athletes without changes in their O2 max. This improvement was due to improved neuromuscular characteristics that were transferred into improved VMART and running economy.

Delecluse (1997) analyzed generally that sprint performance, like endurance performance, can improve considerably with training. Strength training, especially, plays a key role in this process. Sprint performance will be viewed multidimensionally as an initial acceleration phase (0 to 10 meters), a phase of maximum running speed (36 to 100 meters) and a transition phase in between. Immediately following the start action, the powerful extensions of the hip, knee and ankle joints are the main accelerators of body mass. However, the hamstrings, the adductor magnus and the gluteus maximus are considered to make the most important contribution in producing the highest levels of speed. As heavy resistance training results in a fibre type IIb into fibre type IIa conversion, the coach has to aim for an optimal balance between sprint specific and nonspecific training components. To achieve this they must take into consideration the specific strength training demands of each individual, based on performance capacity in each specific phase of the sprint.
Jensen, Jacobsen, Hetland, and Tveit (1997) tested eight female handball players from the Norwegian national team were tested for maximal oxygen uptake, maximal isometric strength and maximal running velocity on four occasions during a year. The first test was made at the beginning of the preparation for a new season, the second in the middle of the preparation period, the third test at the beginning of the season for the national league, and the fourth test just before the most important tournament for the national team that year. Between first test and second test strength training had priority, between second test and third test endurance and sprint training had priority, and between third test and fourth test physical training was reduced. It was concluded with our training model, where strength training had priority in the first part of the training period, followed by a period where sprint and endurance training had priority, were able to increase both maximal oxygen uptake and maximal running velocity in female elite handball players in the period with the most important tournament.

Delecluse et al. (1995) analyzed the effect of high resistance and high velocity training on the different phases of 100 meters sprint performance. Two training groups (high resistance and high velocity) were compared with two control groups (run and passive). The high resistance (N = 22) and high velocity group (N = 21) trained three day per week one for nine weeks: two strength training sessions (high resistance or high velocity) and one running session. There was a run control group (N = 12) that also participated in the running sessions (one day per week) and a passive control group (N = 11).
Running speed over a 100 meters sprint was recorded every two meters. High velocity training resulted in improved initial acceleration (P < 0.05 compared with run, passive, and high resistance), a higher maximum speed (P < 0.05 compared with passive), and a decreased speed endurance (P < 0.05 compared to run and passive). The high velocity group improved significantly in total 100 meters time (P < 0.05 compared with the run and passive groups). The high resistance program resulted in an improved initial acceleration phase (P < 0.05 compared with passive).

Young, McLean, and Ardagna (1995) investigated the relationship between strength measures and sprinting performance, and to determine if these relationships varied for different phases of sprint running. Twenty (11 males and 9 females) elite junior track and field athletes served as subjects. Athletes performed maximum sprints to 50 meters from a block start and time to 2.5, 5, 10, 20, 30, 40 and 50 meters were recorded by electronic timing gates. The resultant forces applied to the blocks were obtained from two force platforms. Twenty seven measures of strength and speed strength (absolute and relative to bodyweight) were collected from the height jumped and the force-time curve recorded from the takeoff phase of vertical jumping movements utilizing pure concentric, stretch shortening cycle and isometric muscular contractions. Pearson correlation analysis revealed that the single best predictor of starting performance (2.5 meters time) was the peak force (relative to bodyweight) generated during a jump from a 120 degree knee angle (concentric contraction) (r = 0.86, p = 0.0001). The single best correlate of maximum
sprinting speed was the force applied at 100 ms (relative to bodyweight) from the start of a loaded jumping action (concentric contraction) \( (r = 0.80, p = 0.0001) \). Stretch shortening cycle measures and maximum absolute strength were more related to maximum sprinting speed than starting ability. It was concluded that strength qualities were related to sprinting performance and these relationships differed for starting and maximum speed sprinting.

**Summary of the Literature**

All the research studies were presented in the section prove that speed training, power training and so forth, contribute significantly for better developmental process. The research studies reviewed are from many journals available in the websites.

It was also observed from the review of literature that there is no research studies related to present study in combining the other training with speed training on speed parameters. This inference has motivated the researcher to undertake this study.

The review of literature helped the researcher from the methodological point of view too. It was learnt that most of the research studies cited in this chapter on content analysis and experimental design as the appropriate methods for finding out the lapses and remediation.