CHAPTER II

REVIEW OF RELATED LITERATURE

Human knowledge has three phases ''Preservation, transmission and advancement'' This fact is of particular importance in research which operates as a continuous function of ever – closer approximation to the truth. Practically, all human knowledge can be found in books and libraries. Man builds upon the accumulated and recorded knowledge of the past. His constant adding to the vast store of knowledge makes possible progress in all areas of human endeavor.

For any research project to occupy a place in the development of a displine, the researcher must be thoroughly familiar with both previous theory and research. To assure this familiarity, every research project in the behavioural sciences has, as one of its early stage, a review of the article and research literature **(Sharma,1996)**.

The literature related to any problem helps the scholar to discover what is already known, which would enable the investigator to have a deep insight, clear perspective and better understanding of the chosen problem and various factors connected with the study. So a number of books, journals and website were referred. In the following pages, an attempt has been made to present briefly a few of the important research studies conducted as they have significant learning on the present study.

2.1 STUDIES ON PLYOMETRIC TRAINING

The studies related to effect of plyometric training on criterion measures used in the present study are as follows.

Plyometrics are another form of resistance training used to promote muscular power improvements in athletes. Examples of plyometric exercises are squat jumps, single and double leg hops, bounds, and single and double leg jumps. Plyometric training has been proposed by many as the link between power, strength and speed **(Adams et. al., 1992, Chu & Plummer, 1984; Hedrick & Andreson, 1996, Thomas,1983).** Plyometrics include any exercise that utilizes the stretch reflex to produce an explosive movement **(Chu, 1984).** The stretch shortening cycle is essentially an eccentric contraction followed immediately by a concentric contraction **(Chu, 1984, Henson, 1996).** During the eccentric phase of a drill/exercise, kinetic energy is generated and stored in the muscle and connective tissue, and muscle activation increases. This stored energy and increased muscle stimulation is used in the following concentric contraction for increased speed and force of the contraction **(Adams, 1992, Chu, 1984, Gambetta, 1998, Newton, 1994).** Plyometric exercises have been shown to be effective at increasing muscular power **(Adams et. al.,1992, Hedrick, 1994, Hedrick 1996, Lyttle, 1996, Wathen, 1993, Yessis, 1995).** It appears that weight training and plyometric training modify different capacities of the neuromuscular system, plyometric increases the muscles rate of eccentric force development, and resistance training increases concentric performance **(Wilson, 1996).**

To Study the effects of low-frequency, low-impact plyometric training on vertical jump (VJ) and kicking distance in female adolescent soccer players, sixteen adolescent soccer players were studied (age 13.4 ± 0.5 years) across 14 weeks. The control group (general soccer training only) had 6 subjects, and the plyometric training (general soccer training plus plyometric exercise) group had 10 subjects. All subjects were tested for VJ and kicking distance on 3 occasions: pre-test, 7 weeks, and 14 weeks. Data were analyzed using a 2 (Training) × 3 (Test) analysis of variance (ANOVA) with repeated measures on the factor test. No significant difference in kicking distance was found between groups at pre- test ($p = 0.688$) or 7 weeks ($p = 0.117$). The plyometric group had significantly greater kicking distance after 14 weeks ($p < 0.001$). No significant difference in VJ height was found between groups at pre-test ($p = 0.837$) or 7 weeks ($p = 0.108$). The plyometric group had a significantly higher VJ after 14 weeks ($p =0.014$). These results provide strength coaches with a safe and effective alternative to high-intensity plyometric training. Based on these findings, to increase lower-body power resulting in increased VJ and kicking distance, strength coaches should implement once-weekly, low-impact plyometric training programs with their adolescent athletes **(Rubley et al., 2011).**

To examine how explosive strength, kicking speed, and body composition are affected by a 12-week plyometric training program in elite female soccer players, the hypothesis was that the program would increase the jumping ability and kicking speed and that the gains could be maintained by means of regular soccer training only. Twenty adult female players were divided into 2 groups: control group (CG, n = 10, age 23.0 +/- 3.2 yr) and plyometric group (PG, n = 10; age 22.8 +/- 2.1 yr). The intervention was carried out during the second part of the competitive season. Both groups performed technical and tactical training exercises and matches together. However, the CG followed the regular soccer physical conditioning program, which was replaced by a plyometric program for PG. Neither CG nor PG performed weight training. Plyometric training took place 3 days a week for 12 weeks including jumps over hurdles, drop jumps (DJ) in stands, or horizontal jumps. Body mass, body composition, countermovement jump height, DJ height, and kicking speed were measured on 4 separate occasions. The PG demonstrated significant increases ($p < 0.05$) in jumping ability after 6 weeks of training and in kicking speed after 12 weeks. There were no significant times x group interaction effects for body composition. It could be concluded that a 12-week plyometric program can improve explosive strength in female soccer players and that these improvements can be transferred to soccer kick performance in terms of ball speed. However, players need time to transfer these improvements in strength to the specific task. Regular soccer training can maintain the improvements from a plyometric training program for several weeks **(Vaeyens et al.,2009).**

The hypothesis in a study was that the addition of an 8-week lower limb plyometric training program (hurdle and depth jumping) to normal in-season conditioning would enhance measures of competitive potential (peak power output [PP], jump force, jump height, and lower limb muscle volume) in junior soccer players. The subjects (23 men, age 19 ± 0.7 years, body mass 70.5 ± 4.7 kg, height 1.75 ± 0.06 m, body fat 14.7 ± 2.6%) were randomly assigned to a control (normal training) group (Gc; n = 11) and an experimental group (Gex, n= 12) that also performed biweekly plyometric training. A force-velocity ergo meter test determined PP. Characteristics of the squat jump (SJ) and the countermovement jump (CMJ) (jump height, maximal force and velocity before take-off, and average power) were determined by force platform. Video-camera kinematic analyses over a 40-m sprint yielded running velocities for the first step (VS), the first 5 m (V5m) and between 35 and 40 m (V max). Leg muscle volume was estimated using a standard anthropometric kit. Gex showed gains relative to controls in PP ($p < 0.01$); SJ (height $p < 0.01$; velocity $p < 0.001$), CMJ (height $p < 0.001$; velocity $p < 0.001$, average power $p < 0.01$) and all sprint velocities ($p < 0.001$ for V5m and V max, $p < 0.01$ for VS). There was also a significant increase ($p < 0.05$) in thigh muscle volume, but leg muscle volume and mean thigh cross-sectional area remain unchanged. We conclude that biweekly plyometric training of junior soccer players (including adapted hurdle and depth jumps) improved important components of athletic performance relative to standard in-season training. Accordingly, such exercises are highly recommended as part of an annual soccer training program **(Chelly et al., 2010).**

To compare ground reaction forces (GRF) and contact times (GCT) between 2 lateral plyometric exercises: lateral alternative leg hopping (HOP), and speed lateral footwork

(SPEED). 16 professional male soccer players (age:24.6±5.5 years; and BMI: 21.7±2.2 kg.m - 2) participated in this within- participant repeated measures study. 3-dimensional GRF data were measured by force platform. Our study revealed significant differences between the 2 lateral plyometric exercises in all kinetics parameters (F=573.7, P<0.01). HOP produced significantly longer GCT (0.45 s vs. 0.23 s, P<0.01, large effect), significantly higher values (P<0.05, large effect) in peak force (3.31 vs. 2.47 Body Weight [BW]), peak rate of force development (0.94 vs. 0.29 BW/s), and impulse (0.76 vs. 0.31 BW.s) except for peak force in the medial-lateral (P<0.05, medium effect) and impulse in the anterio-posterior direction (not significant, small effect). Therefore, SPEED is an exercise that aims to increase step frequency because of its short GCT (< 0.25 s) while HOP increases leg strength and power **(Wong et al., 2012).**

The aim of a study was to compare the effects of two plyometric training techniques on power and agility in youth soccer players, twelve males from a semiprofessional football club's academy (age = 17.3 +/- 0.4 years, stature = 177.9 +/- 5.1 cm, mass = 68.7 +/- 5.6 kg) were randomly assigned to 6 weeks of depth jump (DJ) or countermovement jump (CMJ) training twice weekly. Participants in the DJ group performed drop jumps with instructions to minimize ground-contact time while maximizing height. Participants in the CMJ group performed jumps from a standing start position with instructions to gain maximum jump height. Post training, both groups experienced improvements in vertical jump height (p < 0.05) and agility time (p < 0.05) and no change in sprint performance (p > 0.05). There were no differences between the treatment groups (p > 0.05). The study concludes that both DJ and CMJ plyometrics are worthwhile training activities for improving power and agility in youth soccer players **(Thomas et al.,2009).**

In a study aimed to determine if six weeks of plyometric training can improve an athlete’s agility, the subjects were divided into two groups, a plyometric training and a control group. The plyometric training group performed in a six week plyometric training programme and the control group did not perform any plyometric training techniques. All subjects participated in two agility tests: T -test and Illinois Agility Test, and a force plate test for ground reaction times both pre and post-testing. Univariate ANCOVAs were conducted to analyze the change scores (post – pre) in the independent variables by group (training or control) with pre scores as covariates. The Univariate ANCOVA revealed a significant group effect F2, 26 = 25.42, p=0.0000 for the T-test agility measure. For the Illinois Agility test, a significant group effect F2, 26 = 27.24, p = 0.000 was also found. The plyometric training group had quicker post test times compared to the control group for the agility tests. A significant group effect F2, 26 7.81, p = 0.002 was found for the Force Plate test. The Plyometric training group reduced time on the ground on the post test compared to the control group. The results of this study show that plyometric training can be an effective training technique to improve an athlete's agility **(Michael et al., 2006).**

To study the effect of five different training stimuli on sprinting ability and strength productions, sixty physical education students were randomly assigned to five experimental groups: all types of training (A), full-squat (B), parallel-squat (C), loaded countermovement jumping (D) and plyometric training (E). Participants in each group trained three days a week for a total of seven weeks. Sprint performance (30m), maximal dynamic strength (1RM) (kg) and velocity of displacement in the concentric phase of full-squat (m/s) were measured before and after seven weeks of training.Pre-training results showed no significant differences among the groups in any of the variables tested. After seven weeks no significant improvement in sprint performance was found, however, significant improvement in maximal dynamic strength, velocity of displacement were observed in all the groups: combined methods group A (20%), heavy-resistance group B (11%), power-oriented group C (17%), ballistic group D (14%) and plyometric group E (6%).A combined training approach using full-squat, parallel-squat, loaded countermovement jumping and plyometric training results in a light improvement in maximal strength, velocity of displacement and sprint performance and the resemblance between movement patterns and the velocity of displacement common to the training and testing methods also contributes to greater performance improvement **(Requena et al.,2012).**

To investigate the effect of 6 week plyometric training program on agility of collegiate soccer players, 30 students selected from C.S.J.M. University, Kanpur were selected as subjects. Their age ranged between 20 to 25 years. The selected subjects were randomly divided into two groups each group consists of 15 students, namely experimental group „A" and control group „B". Plyometric training for 6 week was assigned to experimental group, A", and control group „B" does not under gone any type of experimental training. All the training programmes were scheduled for three days per week for a period of 6 week. The agility measured by the help of T Test. The data collected from the plyometric training group „A", and control group „B" on the criterion measures i.e., agility was statistically analyzed by the application of analysis of covariance (ANCOVA).The mean of pre test for plyometric training group (14.61) and control group (14.73). Further the mean of post test for plyometric training group (14.35) and control group (14.99). The result of ANCOVA shows that there was significant effect of 6 week plyometric training group agility of collegiate soccer players. In the light of finding it was concluded that plyometric training improved agility of collegiate soccer players **(Raj kumar ,2013).**

To investigate the Effects of 10 weeks participation in a Ploymetric Training programme on Selected Physiological Variables, 80 numbers of adolescent students were studied. The Results of the study indicated that the Ploymetric training programme have yielded positive changes by the subjects. The pre-test and post-test comparisons in respect of all the selected Physiological variables were positive and significant at 0.05 level of significance **(Mishra,2010).**

To investigate the effects of a short-term in-season plyometric training program on power, agility and knee extensor strength, male soccer players from a third league team were assigned into an experimental and a control group. The experimental group, beside its regular soccer training sessions, performed a periodized plyometric training program for six weeks. The program included two training sessions per week, and maximal intensity unilateral and bilateral plyometric exercises (total of 40 – 100 foot contacts/session) were executed. Controls participated only in the same soccer training routine, and did not perform plyometrics. Depth vertical jump height, agility (Illinois Agility Test, T Agility Test) and maximal voluntary isometric torque in knee extensors using Multicont II dynamometer were evaluated before and after the experiment. In the experimental group small but significant improvements were found in both agility tests, while depth jump height and isometric torque increments were greater. The control group did not improve in any of the measures. Results of the study indicate that plyometric training consisting of high impact unilateral and bilateral exercises induced remarkable improvements in lower extremity power and maximal knee extensor strength, and smaller improvements in soccer- specific agility. Therefore, it is concluded that short-term plyometric training should be incorporated in the in-season preparation of lower level players to improve specific performance in soccer **(Márk et al.,2013).**

To evaluate the effects of the speed, agility, quickness (SAQ) training method on power performance in soccer players, the subjects were assigned randomly to 2 groups: experimental group (EG; n= 50) and control group (n= 50). Power performance was assessed by a test of quickness—the 5-m sprint, a test of acceleration—the 10-m sprint, tests of maximal speed—the 20- and the 30-m sprint along with Bosco jump tests—squat jump, countermovement jump (CMJ), maximal CMJ, and continuous jumps performed with legs extended. The initial testing procedure took place at the beginning of the in-season period. The 8-week specific SAQ training program was implemented after which final testing took place. The results of the 2-way analysis of variance indicated that the EG improved significantly (p,0.05) in 5-m (1.43 vs. 1.39 seconds) and in 10- m (2.15 vs. 2.07 seconds) sprints, and they also improved their jumping performance in countermovement (44.04 vs. 4.48 cm) and continuous jumps (41.08 vs. 41.39 cm) performed with legs extended (p,0.05). The SAQ training program appears to be an effective way of improving some segments of power performance in young soccer players during the in-season period. Soccer coaches could use this in- formation in the process of planning in-season training. Without proper planning of the SAQ training, soccer players will most likely be confronted with decrease in power performance during in-season period **(Fiorentini et al.,2011).**

In soccer, explosive actions such as jumping, sprinting, and changes of direction are essential to optimal performance not only in adults, but also in children's games. The purpose of the investigation was to determine the influence of a short-term plyometric training within regular soccer practice on explosive actions of early pubertal soccer players during the in-season. Fourteen children (13.3 +/- 0.6 years) were selected as the training group (TG) and 11 children (13.1 +/- 0.6 years) were defined as the control group (CG). All children were playing in the same league and trained twice per week for 90 minutes with the same soccer drills. The TG followed an 8-week plyometric program (i.e., jumping, hurdling, bouncing, skipping, and footwork) implemented as a substitute for some soccer drills to obtain the same session duration as CG. At baseline and after training, explosive actions were assessed with the following 6 tests: 10-meter sprint, agility test, 3 vertical jump tests (squat jump [SJ], countermovement jump [CMJ], contact test [CT] and multiple 5 bounds test [MB5]). Plyometric training was associated with significant decreases in 10-m sprint time (-2.1%) and agility test time (-9.6%) and significant increases in jump height for the CMJ (+7.9%) and CT (+10.9%). No significant changes in explosive actions after the 8-week period were recorded for the CG. The current study demonstrated that a plyometric program within regular soccer practice improved explosive actions of young players compared to conventional soccer training only. Therefore, the short-term plyometric program had a beneficial impact on explosive actions, such as sprinting, change of direction, and jumping, which are important determinants of match-winning actions in soccer performance **(Meylan et al.,2009).**

The purpose of this study was to evaluate the effects of sprint training on muscle function and dynamic athletic performance and to compare them with the training effects induced by standard plyometric training. Male physical education students were assigned randomly to 1 of 3 groups: sprint group (SG; n = 30), plyometric group (PG; n = 30), or control group (CG; n = 33). Maximal isometric squat strength, squat- and countermovement jump (SJ and CMJ) height and power, drop jump performance from 30-cm height, and 3 athletic performance tests (standing long jump, 20-m sprint, and 20-yard shuttle run) were measured prior to and after 10 weeks of training. Both experimental groups trained 3 days a week; SG performed maximal sprints over distances of 10-50 m, whereas PG performed bounce-type hurdle jumps and drop jumps. Participants in the CG group maintained their daily physical activities for the duration of the study. Both SG and PG significantly improved drop jump performance (15.6 and 14.2%), SJ and CMJ height (approximately 10 and 6%), and standing long jump distance (3.2 and 2.8%), whereas the respective effect sizes (ES) were moderate to high and ranged between 0.4 and 1.1. In addition, SG also improved isometric squat strength (10%; ES = 0.4) and SJ and CMJ power (4%; ES = 0.4, and 7%; ES = 0.4), as well as sprint (3.1%; ES = 0.9) and agility (4.3%; ES = 1.1) performance. We conclude that short-term sprint training produces similar or even greater training effects in muscle function and athletic performance than does conventional plyometric training. This study provides support for the use of sprint training as an applicable training method of improving explosive performance of athletes in general **(Markovic et al.,2007).**

In adult population, stretch-shortening cycle exercise (plyometric exercise) is often used to improve leg muscle power and vertical jump performance. In children, limited information regarding this type of exercise is available. The purpose of this study was to examine the effectiveness of plyometric training and maintenance training on physical performances in prepubescent soccer players. Twenty boys aged 12-13 years was divided in two groups (10 in each): jump group (JG) and control group (CG). JG trained 3 days/week during 10 weeks, and performed various plyometric exercises including jumping, hurdling and skipping. The subsequent reduced training period lasted 8 weeks. However, all subjects continued their soccer training. Maximal cycling power (P max) was calculated using a force-velocity cycling test. Jumping power was assessed by using the following tests: countermovement jump (CMJ), squat jump (SJ), drop jump (DJ), multiple 5 bounds (MB5) and repeated rebound jump for 15 seconds (RRJ15). Running velocities included: 20, 30 and 40 m (V20, V30, V40 m). Body fat percentage (BF percent) and lean leg volume were estimated by anthropometry. Before training, except for BF percent, all baseline anthropometric characteristics were similar between JG and CG. After the training programme, P max ($p<0.01$), CMJ ($p<0.01$), SJ ($p<0.05$), MB5 ($p<0.01$), RRJ15 ($p<0.01$) and V20 m ($p<0.05$), performances increased in the JG. During this period no significant performance increase was obtained in the CG. After the 8-week of reduced training, except P max ($p<0.05$) for CG, any increase was observed in both groups. These results demonstrate that short-term plyometric training programmes increase athletic performances in prepubescent boys. These improvements were maintained after a period of reduced training **(Diallo et al.,2001).**

Plyometric training (PT) is a widely used method to improve muscles' ability to generate explosive power. Plyometric may improve skill performance of soccer players; however it is not clear. The aim of this study was to investigate the effect of PT on skill performance in soccer players. Twenty soccer players participated in this study as subjects. The subjects were randomly assigned to PT group (n=10, age: 22.5 ± 0.5 years) or control group (n=10, age: 22.4 ± 0.5 years). The PT group performed 8 weeks lower extremities PT besides the soccer team training. The control group performed only the soccer team training during the study. The results showed that the time of sprint running test, dribbling, agility with and without ball and VO2max improve after PT **(Abolghasem et al.,2014).**

The purpose of this study was to find out the efficiency of composed plyometric training program on youth volleyball players force capabilities in their usual training period. The plyometric training program was applied during 16 week period where was attended twenty-one 12-19 years old youth volleyball players. Twelve of them were female and nine male volleyball players. There were three control testings. All subjects participated in following tests: standing long jump, depth leap long jump, medicine ball throws up in 10 seconds, medicine ball overhead throws forward against the wall in 10 seconds, maximal vertical jumps to the maximal height in 10 seconds, maximal vertical jump height. Testing results statistical analysis has shown athletes legs and arms speed force reliable improvement. Standing long jump, depth leap long jump and maximal vertical jump height test results, what has shown legs explosive power, has not shown remarkable reliable difference ($P>0.05$). Medicine ball throws and maximal vertical jumps to the maximal height in 10 seconds, what show speed force improvement, showed reliable difference ($P<0.01$) **(Karin and Boris, 2011).**

To investigate the effects of plyometric training on the development of jumping agility, an experimental research program was carried out on a sample of 38 cadet volleyball players. Following the general principles of plyometric training, individual training programs were constructed. In order to evaluate the effects of plyometric training on the development of jumping agility, six variables were used. For the purpose of this research, all six tests for the evaluation of jumping agility were validated. The experiment was realized in the second part of the preliminary period, and lasted for six weeks with two to three training sessions per week. The training of the control group involved technical- tactical exercises. The data were processed with the help of a univariate and multivariate analysis of covariance. On the basis of the research results and the discussion, we can with great certainty conclude that the exercise model that was used, as the basic factor of the experimental group, made a statistically significant contribution to the difference in the increase in jumping agility in comparison to the control group which used technical-tactical exercises for the development of jumping agility **(Jovanović et al., 2012).**

To determine the effect of plyometric training on the explosive strength of cadet volleyball players, six-week plyometric training program during the second half of the preliminary period of the annual training cycle was conducted. The sample consisted of 46 subjects aged 16 (± 6 months). The experimental group consisted of 23 volleyball players, with an average height of 186.35 ± 8.52 and average weight of 70.57 ± 8.98. The control group consisted of 23 high school students, with an average height of 177.35 ± 4.80 and body weight of 68.91 ± 6.48, who had not been exposed to the plyometric method as part of their physical education classes. The sample of measuring instruments consisted of eight tests of explosive leg strength: the two-foot takeoff block jump, the right foot takeoff block jump, the left foot takeoff block jump, the two-foot takeoff spike jump, the right foot takeoff spike jump, the left foot takeoff spike jump, the standing depth jump and the standing triple jump. Using a multivariate and univariate statistical method, we were able to determine a statistically significant difference in explosive strength in favor of the experimental group. We determined an increase in explosive strength for the two-foot and single foot takeoff jumps **(Vladan et al., 2008).**

The purpose of the study was to determine the effects of a six-week plyometric high and low-intensity training on the explosive power of lower limbs in volleyball players. The research was conducted on a sample of 30 volunteers of the Sports Club at Gdansk University of Technology in Gdansk. Before the experiment, the players were divided into two homogeneous groups. After two weeks of an introductory common stage, each group followed a plyometric regime of different intensity. The results showed that the high- developing the explosive power in the volleyball players. The largest significant improvement was observed for the vertical jump with arm swing (11% in HIJG and 3.8% in LISG). The strongest correlations were registered for the maximal power and the total mechanical work obtained in the Wingate test (r=0.83), and the power of jumps during attacks and blocks (r=0.78).The experiment confirmed high effectiveness of the training loads applied in the experiment, in particular in the high-intensity program **(Zbigniew et al., 2014).**

The plyometric training has proved its efficiency, it remains generally unknown whether a limited amount of plyometric training could improve movements in subjects who already demonstrate high level of performance. Three different training regimens were performed in order to study effects of plyometric training on elite junior basketball players. While control group (CG) participated only in the regular midseason training activity, another two groups performed a limited amount of plyometric training employing drop jumps from the height of either 50 cm (EG-50) or 100 cm (EG-100). The height of the maximal vertical jump (CMJ), as well as the maximal voluntary force (F) and the rate of force development (RFD) of hip and knee extensors were tested prior to and after the training. An increase in CMJ (4.8 and 5.6 cm in EG-50 and EG- 100, respectively), as well as in F of hip extensors and RFD of knee extensors was observed in both experimental groups, while no significant changes were recorded in CG. When the pretest scores were used as a covariate, both experimental groups demonstrated higher increase in CMJ and RFD of knee extensors then CG. However, no differences were observed between EG-50 and EG-100. The multiple correlation between four isometric parameters and CMJ revealed R2=0.29.A limited amount of plyometric training could improve jumping performance in elite junior basketball players and this improvement could be partly related with an increase in F of hip extensors and RFD of knee extensors. However, neither of the two initial heights of the applied drop jumps proved to be more effective **(Matavulj et al.,2001).**

The purpose of the study was to evaluate the effects of high-intensity plyometric training program on dynamic balance, agility, vertical jump, and sprint performance in young male basketball players. Sixteen semi-professional basketball players participated in this study. Subjects were divided into two groups: plyometric training (PL; n = 8) and control group (CG; n = 8). Plyometric training took place 2 days a week for 6 weeks including depth jump, squat depth jump, and depth jump to standing long jump. Star Excursion Balance Test (SEBT), vertical jump (VJ), standing long jump (SLJ), 4 × 9- m shuttle run, T-test, Illinois Agility Test, and 20-m sprint were measured at pre- and post- training. The PL demonstrated significant improvement ($P < 0.05$) in VJ (~23%), SLJ (~10%), 4 × 9-m shuttle run (~7%), T-test (~9%), Illinois Agility test (~7%), and 20-m sprint (~9%) after a 6- week of training and compared to CG. There were not significant changes ($P > 0.05$) in SEBT, but PL showed ~4% improvement. It could be concluded that a 6-week high-intensity plyometric program can improve power, agility, sprint and balance in young male basketball players. Also, this study provides support for coaches and basketball players who use this training method at the preparation (conditioning) phase (**Arazi and Asadi, 2012).**

The purpose of the study was to examine the effects of 8 weeks' plyometric training on active jump, squat jump and 30 m sprint in 13-15-year- old football players. The study consisted of 24 volunteer football players from Pamukkale Sport Club U-13 and U-15. Participants were assigned equally to either the control group (Age = 13.71 ± 0.53 years old, BH = 1.63 ± 0.06 m, BM = 53.07 ± 3.76 kg) or the training group (Age = 13.69 ± 0.55 years old, BH =1.63 ± 0.08 m, BM = 55.00 ± 12.85 kg). Before the training program, all players' anthropometric measurements were taken. All players performed active jump, squat jump and 30 m sprint test, and pre- and post-test results were recorded. The training group carried out a basic training program plus a set of plyometric exercises twice a week for 8 weeks. The control group carried out the basic training program only. Pre- and post-test results were analyzed using repeated measures analysis of variance (ANOVA) procedures. The result of the study reveals that there was significant difference at 0.05 levels. Based on findings of the research, it can be concluded that plyometric exercise increased active and squat jump ($F = 32.64$; $p = 0.000$ and $F = 10.01$; $p = 0.005$) but there was no significant effect on 30 m sprint performance ($F = 2.34$; $p = 0.14$). Also it can be concluded that plyometric training increased explosive and elastic power **(Alptekin et al., 2012).**

Plyometrics (also known as "plyos") is a type of exercise training designed to produce fast, powerful movements, and improve the functions of the nervous system, generally for the purpose of improving performance in sports. Plyometrics has been shown across the literature to be beneficial to a variety of athletes. Benefits range from injury prevention, power development and sprint performance amongst others. Plyometric exercise involves and uses practicing plyometric movements to enhance tissues abilities and train nerve cells to stimulate a specific pattern of (muscle contraction) so the muscle generates as strong a contraction as possible in the shortest amount of time. Low-intensity variations of plyometrics are frequently utilized in various stages of injury rehabilitation, indicating that he application of proper technique and appropriate safety precautions can make plyometrics safe and effective for most people. Plyometric exercises involve an increased risk of injury due to the large forces generated during training and performance, and should only be performed by wel-conditoned individuals who are under supervision. The purpose was to determine the effect of Plyometrics exercises on cardio-vascular capacity and playing ability of inter-collegiate cricket players of Sant Gadge Baba Amravati University, Amravati. The study was delimited to 30 male inter-collegiate players in the age ranging from 18 to 28 years. The players were divided into two equal groups (i.e. experimental and control group) on the basis of the mean performance of pre-test score. Two tests were performed on the subjects i.e.

coppers 12 minute run and walk and three Judges playing ability test. To determine the significant difference t-test was employed and level of significance was set at 0.05 level of confidence. After analysis of data it has been concluded that, there was no significant difference found in vascular endurance and cricket playing ability among control group. The significant effect was observed in experimental group on cardio-vascular endurance and cricket playing ability, because of training schedule of players. In the post test of control and experimental group significant difference found in cardio-vascular endurance, Of side bating ability, Defend bating ability, Length bowling ability, Full length bowling ability and Overall playing ability. But insignificant in fielding ability **(Abhay and Buchha, 2014).**

A study was conducted on a sample of 30 volunteers of the Sports Club at Gdansk University of Technology in Gdansk. Before the experiment, the players were divided into two homogeneous groups. After two weeks of an introductory common stage, each group followed a plyometric regime of different intensity. The results showed that the high-intensity program was more efficient than the low-intensity program in developing the explosive power in the volleyball players. The largest significant improvement was observed for the vertical jump with arm swing (11% in HIJG and 3.8% in LISG). The strongest correlations were registered for the maximal power and the total mechanical work obtained in the Wingate test (r=0.83), and the power of jumps during attacks and blocks (r=0.78). The experiment confirmed high effectiveness of the training loads applied in the experiment, in particular in the high-intensity program **(Jastrzebski et al., 2014).**

To determine if six weeks of plyometric training can improve an athlete's agility, subjects were divided into two groups, a plyometric training and a control group. The plyometric training group performed in a six week plyometric training program and the control group did not perform any plyometric training techniques. All subjects participated in two agility tests: T-test and Illinois Agility Test, and a force plate test for ground reaction times both pre and post testing. Univariate ANCOVA were conducted to analyze the change scores (post - pre) in the independent variables by group (training or control) with pre scores as covariates. The Univariate ANCOVA revealed a significant group effect $F_{2,26} = 25.42$, $p=0.0000$ for the T-test agility measure. For the Illinois Agility test, a significant group effect $F_{2,26}= 27.24$, $p = 0.000$ was also found. The plyometric training group had quicker posttest times compared to the control group for the agility tests. A significant group effect $F_{2,26} = 7.81$, $p = 0.002$ was found for the Force Plate test. The plyometric training group reduced time on the ground on the posttest compared to the control group. The results of this study show that plyometric training can be an effective training technique to improve an athlete's agility **(Michael et al., 2006).**

The purpose of the investigation was to find out the effects of two modes of resistance training on speed leg explosive power and anaerobic power of male college students. To achieve this purpose, 45 male students were selected from Alagappa Arts College, Karaikudi, Tamil Nadu as subjects. Their age ranged from 18 to 25 years. They were divided into three equal groups of 15 subjects each and assigned to experimental group I, experimental group II and control group. In a week, the experimental group I underwent plyometric training, experimental group II underwent circuit training and control group was not given any specific training. All the subjects underwent the test of speed, leg explosive power and anaerobic power. They were assessed before and after the training period of 8 weeks. The analysis of covariance was used to analyze the data. The study revealed that the speed, leg explosive power and anaerobic power were significantly improved due to the influence of two modes of resistance training **(Maniazhagu et al.,2010).**

To compare the effects of 10 week of training with traditional back squats or one of two forms of plyometric training loaded jump squats or drop jumps on vertical jump performance, two types of vertical jump tests were performed: 1) a counter-movement jump in which the subjects started from a standing position, performed a rapid crouch, and then jumped for maximal height, and 2) a jump from a static crouching position, i.e., with no counter movement. All training groups except the drop-jump group produced significant increases in vertical jump performance. For the counter-movement jump, the group that trained with loaded jump squats produced the greatest improvement (18%), which was significantly greater than that for the drop-jump group (10%) or for the weight- trained group (5%). For the static crouch jump, the group trained with loaded jump squats increased jump height by 15%, which was significantly greater than the increase for the drop-jump group (7.2%) and for the weight training group (6.8%). These results were similar to those obtained by (**Berger., 1963),** who also found that training with jump squats loaded at 30% of maximum resulted in greater increases in vertical jump than did training programmes consisting of traditional weight training, drop-jump training, or isometric training **(Wilson et al.,1993).**

It was proved experimentally that an eight week training model using the plyometric method can have an effect on the statistically relevant increase in the explosive type strength of the leg muscles, which in turn leads to an increase in the vertical jump of a block, spike and the long jump **(Toplica et al.,2004).**

A study was conducted on the effects of plyometric jump training in females, decreased impact forces and increased hamstrings torques in female athletes with plyometric training. The effect of a jump-training programme on landing mechanics and lower extremity strength was assessed in females involved in jumping sports. Responses to a six-week training programme were compared to untrained males. The programme was designed to decrease landing forces by teaching neuromuscular control of the lower limb during landing and to increase vertical jump height. Training produced a 9.2% increase in vertical jump. Landing training decreased impact forces by reducing medial and lateral torque at the knee, increased power, and decreased hamstrings strength imbalances. Performance can be increased and injury potential decreased if plyometric training is performed along with landing technique instruction with females **(Hewett et al.,1966).**

To examine the complex training effect of combined bench press and medicine ball throws demonstrating improved plyometric performance in the complex condition. More specifically, one study sought to determine whether or not upper body power could be enhanced by performing a heavy bench press set prior to an explosive medicine ball put. Subjects included 10 college age males with experience performing the bench press. Subjects performed a seated medicine ball put before and four minutes after performing the bench press with a 5RM load. Results indicate a significant increase medicine ball put distance of 31.4 cm (no standard deviation available) following the 5RM bench press compared to the medicine ball put before the bench press. Researchers also report a strong correlation between improvement in medicine ball put distance and 5RM bench press strength **(Evans et al.,2000).**

Plyometric training (PT) programs are widely used to improve explosive actions in soccer players of various ages, although there is debate about optimal training duration and time course of improvement. Twenty-two early to mid- puberty elite soccer players were assigned to a control group (CG, n = 10, regular soccer training) or a plyometric training group (PTG, n = 12, regular soccer training substituted with 2 PT sessions each week). Both groups trained for 16 weeks during the in-season period. Control group performed only tests at baseline and after intervention, whereas PTG performed additional tests after 4, 8, and 12 weeks. During each test, subjects' performances in speed (10 and 30 m; 5 and 20 m), agility, shuttle run, multiple 5 bounds (MB5), and standing long jump (LJ) were recorded. The PTG showed improved performance in 20-m sprint time (−3.2%), agility time (−6.1%), MB5 distance (+11.8%), and LJ distance (+7.3%) (all, $p \leq 0.05$) after 16 weeks. All these improvements were higher compared with CG (all, $p \leq 0.05$). The time course of improvement in the PT group showed that 20-m sprint time improved after 16 weeks ($p = 0.012$); agility after 4 (p = 0.047) and 8 weeks (p = 0.004) but stopped after 12 weeks (p = 0.007); MB5 after 8 (p = 0.039), 12 (p = 0.028), and 16 weeks (p < 0.001); and LJ improved after 4 (p = 0.045), 12 (p = 0.008), and 16 weeks (p < 0.001). Plyometric training seems to be an appropriate training tool to enhance some but not all explosive actions. The results indicate that the duration of a PT program is highly dependent on what type of explosive actions should be improved, or whether several explosive actions should be improved at the same time **(Sohnlein et al.,2014).**

2.2 STUDIES ON RESISTANCE TRAINING

Resistance training has been shown to improve not only the force production of a muscle, but also muscular power **(Adams et. al., 1992; Baker, 1996; Holcomb et. al, 1996; Newton & Kraemer, 1994).** However power production gained from high load, slow speed lifting is thought to be restricted mainly to the initial stages of training **(Stone, 1993).** As resistance increases, the effect of maximum strength has on power production increases, with its greatest benefit seen in situations where an athlete must overcome high levels of inertia, as in early stages of movements when implements or equipment are moved or thrown **(Stone, 1993).** Knowing this, coaches should plan for more power lifting (heavy load low speed lifting) type practices early in the off season training programme and work toward more powerful lifting cycles which would incorporate more high speed lifting exercises. Maximum strength during the season for best performances. As far as resistance training and increased movement speed is concerned, some research support the hypothesis that heavy resistance training will increase movement speed, while others feel prolonged heavy workloads might actually decrease speed **(Ebben & Blackard, 1997 and Yessis, 1994).**

Two other forms of resistance training used in strength and power development in athletic programmes are maximum power training, and Olympic lifting (clean and jerk, and the snatch) and Olympic assistance lifts (e.g. power clean, high pull, jerks, power snatches etc.). Maximum power training is a technique where the lift is accelerated through the full range of motion using a weight approximately 30% of maximum force **(Lyttle, 1996).** This training technique has been shown to improve athletic performance more than traditional heavy resistance training or plyometric training **(Lyttle, 1996).** Olympic lifting has become popular as a power training technique and as a method to improve an athlete's vertical jump performance **(Canavan et. al., 1996, Garhammer, 1993, Garhammer & Gregor, 1992, and Hedrick,1996).** Competitive style lifting has also been shown to increase muscular power in athletes **(Baker, 1996, Garhammer, 1993; Headrick, 1994; Headrick &**

Anderson,1996; Newton & Kraemer, 1994, Pearson, 1998, Canavan et. al., 1996). This is in contrast to power lifting (high load slow movement speed), which has a marked decrease in power output as performance in the sport improves **(Garhammer, 1993).** The bench press, back squat and dead lift are the three power lifting competitive lifts, and are popular in strength and conditioning programmes. As the loads in these lifts increase or improve the speed of movement drastically decreases, which actually results in a decreased power output in contrast to Olympic style lifts **(Garhammer, 1993).**

A study was conducted on the effect of resistance training on women's strength/power and occupational performances for which they examined the strength, power, and military occupational task performances in women. Untrained women aged (mean +/- SD) 23 +/- 4 yr were matched and randomly placed in total (TP, N = 17 and TH, N = 18) or upper-body resistance training (UP, N = 18 and UH, N = 15), field (FLD, N = 14), or aerobic training groups (AER, N = 11). Two per iodized resistance training programmes (with supplemental aerobic training) emphasized explosive exercise movements using 3- to 8-RM training loads (TP, UP), whereas the other two emphasized slower exercise movements using 8- to 12-RM loads (TH, UH). The FLD group performed plyometric and partner exercises. Specific training programmes resulted in significant increases in body mass (TP), 1-RM squat (TP, TH, FLD), bench press (all except AER), high pull (TP), squat jump (TP, TH, FLD), bench throw (all except AER), squat endurance (all except AER), 1-RM box lift (all except aerobic), repetitive box lift (all), push-ups (all except AER), sit- ups (all except AER), and 2-mile run (all). Strength training improved physical performances of women over 6 months and adaptations in strength, power, and endurance were specific to the subtle differences (e.g., exercise choice and speeds of exercise movement) in the resistance training programmes (strength/power vs strength/hypertrophy). Upper and total body resistance training resulted in similar improvements in occupational task performances, especially in tasks that involved upper-body musculature. Finally, gender differences in physical performance measures were reduced after resistance training in women, which underscores the importance of such training for physically demanding occupations **(Kraemer et al.,2001).**

To study the potential of in-season heavy upper and lower limb strength training to enhance peak power output (W peak), vertical jump, and handball related field performance in elite male handball players who were apparently already well trained, and to assess any adverse effects on sprint velocity, twenty- four competitors were divided randomly between a heavy resistance (HR) group (age 20 ± 0.7 years) and a control group (C; age 20 ± 0.1 years). Resistance training sessions were performed twice a week for 8 weeks. Performance was assessed before and after conditioning. Peak power (W (peak)) was determined by cycle ergo meter; vertical squat jump (SJ) and countermovement jump (CMJ); video analyses assessed velocities during the first step (V(1S)), the first 5 m (V(5m)), and between 25 and 30 m (V(peak)) of a 30-m sprint. Upper limb bench press and pull-over exercises and lower limb back half squats were performed to 1-repetition maximum (1RM). Upper limb, leg, and thigh muscle volumes and mean thigh cross-sectional area (CSA) were assessed by anthropometry. W(peak) (W) for both limbs ($p < 0.001$), vertical jump height ($p < 0.01$ for both SJ and CMJ), 1RM ($p < 0.001$ for both upper and lower limbs) and sprint velocities ($p < 0.01$ for V(1S) and V(5m); $p < 0.001$ for V(peak)) improved in the HR group. Upper body, leg, and thigh muscle volumes and thigh CSA also increased significantly after strength training. We conclude that in- season biweekly heavy back half-squat, pull-over, and bench-press exercises can be commended to elite male handball players as improving many measures of handball-related performance without adverse effects upon speed of movement **(Hermassi et al.,2011).**

To investigate the effects of voluntary maximal leg strength training on peak power output (Wpeak), vertical jump performance, and field performances in junior soccer players, twenty-two male soccer players participated in this investigation and were divided into 2 groups: A resistance training group (RTG; age 17 +/- 0.3 years) and a control group (CG; age 17 +/- 0.5 years). Before and after the training sessions (twice a week for 2 months), W peak was determined by means of a cycling force-velocity test. Squat jump (SJ), counter movement jump (CMJ), and 5-jump test (5-JT) performances were assessed. Kinematics analyses were made using a video camera during a 40-m sprint running test and the following running velocities were calculated: The first step after the start (V(first step)), the first 5 m (V(first 5 meters)), and between the 35 m and 40 m (V(max)). Back half squat exercises were performed to determine 1-repetition maximum (1-RM). Leg and thigh muscle volume and mean thigh cross-sectional area (CSA) were assessed by anthropometry. The resistance training group showed improvement in Wpeak ($p < 0.05$), jump performances (SJ, $p < 0.05$ and 5-JT, $p < 0.001$), 1-RM ($p < 0.001$) and all sprint running calculated velocities ($p < 0.05$ for both V(first step) and V(first 5 meters), $p < 0.01$ for V(max)). Both typical force-velocity relationships and mechanical parabolic curves between power and velocity increased after the strength training program. Leg and thigh muscle volume and CSA of RTG remained unchanged after strength training. Back half squat exercises, including adapted heavy loads and only 2 training sessions per week, improved athletic performance in junior soccer players. These specific dynamic constant external resistance exercises are highly recommended as part of an annual training program for junior soccer players **(Fathloun et al.,2009).**

To investigate the effects of a manual resistance training (MRT) program on muscular strength and endurance and to compare these effects with those of an identically structured weight resistance training (WRT) program, 84 healthy college students were randomly assigned to either an MRT (n = 53, mean +/- SD: age 25.6 +/- 6.0 years, height 170.1 +/- 8.1 cm, body mass 73.9 +/- 16.0 kg, and body fat 24.6 +/- 8.7%) or WRT (n = 31, mean +/- SD: age 25.5 +/- 5.2 years; height 169.6 +/- 10.1 cm, body mass 75.0 +/- 17.4 kg, and body fat 24.7 +/- 8.5%) group and engaged in a 14-week training program. Each participant's performance was assessed before and immediately after the 14-week training period. Muscular strength was assessed by the one-repetition maximum (1RM) bench press test and the 1RM squat test. Muscular endurance was recorded as the maximum number of repetitions performed with 70% of pre training 1RM for the bench press and squat exercises. There were no significant differences between the MRT and WRT groups at baseline for muscular strength ($p > 0.36$) or muscular endurance ($p > 0.46$). Compared with baseline values, the 14-week training programs produced significant ($p < 0.001$) improvements in muscular strength and muscular endurance of the MRT and WRT groups. However, no significant difference was observed between the MRT and WRT groups for muscular strength ($p > 0.22$) or for muscular endurance ($p > 0.09$) after training. The improvements in muscular strength and muscular endurance after a 14-week MRT program in the present study were similar to those produced by a WRT program, and well-designed MRT exercises seem to be effective for improving muscular fitness **(Dorgo et al., 2009).**

To find out the effects of a progressive resistance training program in addition to soccer training on the physical capacities of male ado-lescents, eighteen soccer players (age: 12–15 years) were separated in a soccer (SOC;n9) and a strength-soccer (STR;n9) training group and 8 subjects of similar age constituted a control group. All players followed a soccer training program 5times a week for the development of technical and tactical skills. In addition, the STR group followed a strength training program twice a week for 16 weeks. The program included 10 exercises, and at each exercise, 2–3 sets of 8–15 repetitions with a load 55–80% of 1 repetition maximum (1RM). Maximum strength ([1RM] leg press, bench-press), jumping ability (squat jump [SJ], countermovement jump [CMJ], repeated jumps for 30 seconds) running speed (30 m, 10 5-m shuttle run), flexibility (seat and reach), and soccer technique were measured at the beginning, after 8 weeks, and at the end of the training period. After 16 weeks of training, 1RM leg press, 10 5-m shuttle run speed, and performance in soccer technique were higher (p 0.05) for the STR and the SOC groups than for the control group. One repetition maximum bench press and leg press, SJ and CMJ height, and 30-m speed were higher (p 0.05) for the STR group compared with SOC and control groups. The above data show that soccer training alone improves more than normal growth maximum strength of the lower limps and agility. The addition of resistance training, however, improves more maximal strength of the upper and the lower body, vertical jump height, and 30-m speed. Thus, the combination of soccer and resistance training could be used for an overall development of the physical capacities of young boys **(Christou Marios et al.,2006).**

To investigate the effect of a 10-week heavy resistance combined with a running training program on the strength, running speed (RS), and vertical jump performance of young basketball players, twenty-six junior basketball players were equally divided in 2 groups. The control (CON) group performed only technical preparation and the group that followed the combined training program (CTP) performed additionally 5 sets of 8-5 repetition maximum (RM) half squat with 1 30-m sprint after each set. The evaluation took place before training and after the 5th and 10th weeks of training. Apart from the 1RM half squat test, the 10- and 30-m running time was measured using photocells and the jump height (squat, countermovement jump, and drop jump) was estimated taking into account the flight time. The 1RM increased by 30.3 +/- 1.5% at the 10th week of training for the CTP group ($p < 0.05$), whereas the CON group showed no significant increase (1.1 +/- 1.6%, $p > 0.05$). In general, all measured parameters showed a statistically significant increase after the 5th and 10th weeks ($p <0.05$), in contrast to the CON group ($p > 0.05$). This suggests that the applied CTP is beneficial for the strength, RS, and jump height of young basketball players. The observed adaptations in the CTP group could be attributed to learning factors and to a more optimal transfer of the strength gain to running and jumping performance **(Tsimahidis et al., 2010).**

Various studies have demonstrated that resistance sprint (RS) training can produce significant changes in running speed and running kinematics. The longer-term training adaptations after RS training remain unclear. The purpose of this study was to investigate whether an RS 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 RS groups. The RS group performed two sessions per week of RS training for 6 weeks, and the control group did no RS training. Pre- and postintervention tests were carried out for 30-m 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 a statistically significant decrease in time to 5 m for the 30-m sprint for the RS 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 RS group from pre- to post-testing sessions. The results suggest that it may be beneficial to employ an RS training intervention with the aim of increasing initial acceleration from a static start for sprinting **(Harrison and Bourke 2009).**

Resistance training in untrained adolescents can positively effect health- related fitness as well as improve muscular power and sports performance. The impact of resistance training on adolescent athletes is less clear. The purpose of this review is to determine the effectiveness of resistance training programs on muscular power and sports performance in adolescent athletes. Systematic review and meta-analysis of previously published studies investigating resistance training in adolescent athlete populations. A systematic search of Medline, Embase, and sport databases was conducted on 21st March 2011 to identify studies evaluating resistance training programs on power and sports performance in adolescent athletes. Thirty-four studies were identified. All but two of the studies reported at least one statistically significant improvement in an galactic muscular power outcome. The most common indicators of galactic power were vertical jump (25 studies) and sprint running (13 studies) performance. Fourteen studies provided data to allow for pooling of results in a meta-analysis. A positive effect was detected for resistance training programs on vertical jump performance (mean difference 3.08 [95% CI 1.65, 4.51], Z=4.23 [P<0.0001]). There is sufficient evidence to conclude that resistance-training interventions can improve muscular power in adolescent athletes. A positive effect on sports performance attributable to participation in resistance training was reported by almost half the included studies, however limited objective evidence to support these claims was found. Improvements in motor performance skills, such as jumping, are widely stated as indicators of improvements in sporting performance **(Harries et al.,2012).**

The current perception among highly competitive endurance runners is that concurrent resistance and endurance training (CT) will improve running performance despite the limited research in this area. The purpose of this review was to search the body of scientific literature for original research addressing the effects of CT on distance running performance in highly competitive endurance runners. Specific key words (including running, strength training, performance, and endurance) were used to search relevant databases through April 2007 for literature related to CT. Original research was reviewed using the Physiotherapy Evidence

Database (PEDro) scale. Five studies met inclusion criteria: highly trained runners (>or= 30 mile x wk (-1) or >or= 5 d x wk(-1)), CT intervention for a period >or= 6 weeks, performance distance between 3K and 42.2K, and a PEDro scale score >or= 5 (out of 10). Exclusion criteria were prepubertal children and elderly populations. Four of the five studies employed sport- specific, explosive resistance training, whereas one study used traditional heavy weight resistance training. Two of the five studies measured 2.9% improved performance (3K and 5K), and all five studies measured 4.6% improved running economy (RE; range = 3-8.1%). After critically reviewing the literature for the impact of CT on high-level runners, we conclude that resistance training likely has a positive effect on endurance running performance or RE. The short duration and wide range of exercises implemented are of concern, but coaches should not hesitate to implement a well-planned, periodized CT program for their endurance runners (Yamamoto et al.,2008). training by comparing training with a slower repetition speed to training with a conventional repetition speed. Slower repetition speed may effectively increase intensity throughout the lifting phase while decreasing momentum. Two studies were done with untrained men (N=65) and women (N=82), (mean age=53.6) who trained two to three times per week for eight to 10 weeks on a 13 exercise Nautilus circuit performing one set of each exercise. Participants exclusively trained using regular speed repetitions for 8 to 12 repetitions per set at 7 sec each (2 sec lifting, 1 sec pause, 4 sec lowering) or a Super Slow training protocol where they completed 4 to 6 repetitions per set at 14 sec each (10 sec lifting, 4 sec lowering). All of the participants were tested for either the 10 repetition- maximum (RM) weight load (regular-speed group) or the 5-RM weight load (slow-speed group).In both studies, Super-Slow training resulted in about a 50% greater increase (p<0.001) in strength for both men and women than regular speed training. In Study 1, the Super-Slow training group showed a mean increase of 12.0 kg and the regular speed group showed an increase of 8.0 kg increase (p<0.001). In Study 2, the Super-Slow training group showed a 10.9 kg increase and the regular speed group showed an increase of 7.1 kg (p<0.001).Super-Slow training is an effective method for middle-aged and older adults to increase strength. Although studies still need to be done with at-risk populations, repetition speed should be considered when prescribing resistance training **(Westcott et al.,2001).**

To compare the effects of a low repetition-heavy load resistance training program and a high repetition-moderate load resistance training program on the development of muscular strength and muscular endurance in children eleven girls and 32 boys between the ages of 5.2 and 11.8 years. In twice-weekly sessions of resistance training for 8 weeks, children performed 1 set of 6 to 8 repetitions with a heavy load (n = 15) or 1 set of 13 to 15 repetitions with a moderate load (n = 16) on child-size exercise machines. Children in the control group (n = 12) did not resistance train. One repetition maximum (RM) strength and muscular endurance (repetitions performed post training with the pre training 1-RM load) were determined on the leg extension and chest press exercises. One RM leg extension strength significantly increased in both exercise groups compared with that in the control subjects. Increases of 31.0% and 40.9%, respectively, for the low repetition-heavy load and high repetition- moderate load groups were observed. Leg extension muscular endurance significantly increased in both exercise groups compared with that in the control subjects, although gains resulting from high repetition-moderate load training (13.1 +/- 6.2 repetitions) were significantly greater than those resulting from low repetition-heavy load training (8.7 +/- 2.9 repetitions). On the chest press exercise, only the high repetition-moderate load exercise group made gains in 1- RM strength (16.3%) and muscular endurance (5.2 +/- 3.6 repetitions) that were significantly greater than gains in the control subjects. These findings support the concept that muscular strength and muscular endurance can be improved during the childhood years and favor the prescription of higher repetition- moderate load resistance training programs during the initial adaptation period **(Faigenbaum et al.,1999).**

To determine the effect of 7 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 m 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 1-RM 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 m 'flying' running times, or 1- RM squat lift strength either before or after training. This was despite significant improvements in 20 m acceleration time ($P < 0.01$), squat strength ($P < 0.05$), iso kinetic 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 non concurrently 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 **(Blazevich and Jenkins 2002).**

The effect of resistance training on blood pressure and other cardiovascular risk factors in adults was studied. Randomized, controlled trials lasting ≥4 weeks investigating the effects of resistance training on blood pressure in healthy adults (age ≥18 years) and published in a peer-reviewed journal up to June 2010 were included. Random- and fixed-effects models were used for analyses, with data reported as weighted means and 95% confidence limits. We included 28 randomized, controlled trials, involving 33 study groups and 1012 participants. Overall, resistance training induced a significant blood pressure reduction in 28 normotensive or prehypertensive study groups [-3.9 (- 6.4; -1.2)/-3.9 (-5.6; -2.2) mm Hg], whereas the reduction [-4.1 (-0.63; +1.4)/-1.5 (-3.4; +0.40) mm Hg] was not significant for the 5 hypertensive study groups. When study groups were divided according to the mode of training, isometric handgrip training in 3 groups resulted in a larger decrease in blood pressure [-13.5 (-16.5; -10.5)/-6.1(-8.3; -3.9) mm Hg] than dynamic resistance training in 30 groups [-2.8 (-4.3; -1.3)/-2.7 (-3.8; -1.7) mm Hg]. After dynamic resistance training, Vo(2) peak increased by 10.6% ($P=0.01$), whereas body fat and plasma triglycerides decreased by 0.6% ($P<0.01$) and 0.11 mmol/L ($P<0.05$), respectively. No significant effect could be observed on other blood lipids and fasting blood glucose. This meta-analysis supports the blood pressure-lowering potential of dynamic resistance training and isometric handgrip training. In addition, dynamic resistance training also favorably affects some other cardiovascular risk factors. Our results further suggest that isometric handgrip training may be more effective for reducing blood pressure than dynamic resistance training. However, given the small amount of isometric studies available, additional studies are warranted to confirm this finding (**Cornelissen et al.,2011).**

To assess the effects of a lower- and upper-body 10-week in-season resistance training program on explosive strength development in young basketball players,twenty-five adolescent male athletes, aged 14-15 years old, were randomly assigned to an experimental group (EG; n = 15) and a control group (CG; n = 10). The subjects were assessed at baseline and after training for squat jump (SJ), countermovement jump (CMJ), Abalakov test, drop jump, and seated medicine ball throw (MBT). The EG showed significant increases ($p <0.05$) in all the variable scores. Conversely, the CG significantly decreased ($p <0.05$) in SJ, CMJ, and Abalakov test scores and significantly increased in the results of MBT test ($p < 0.05$). The groups were similar on pretest, but significant differences ($p < 0.05$) occurred on posttest in all the variables. The results of this study show that a 10-week in-season resistance training program with moderate volume and intensity loads increased vertical jump and MBT performance in adolescent male basketball players. Coaches should know that such a short resistance training program specifically designed for young basketball players induce increased explosivity levels, which are essential to a better basketball performance, with no extra overload on adolescents' skeletal muscle development **(Santos and Janeira, 2012).**

To determine the effects of seven iso kinetic strength and endurance training• programme on untrained females aged 20 to 34 years. Body composition, maximal oxygen consumption and power were assessed at pre and post training for three exercising groups. Maximal oxygen consumption significantly incteased21% to 15% in the strength - endurance group and endurance group, respectively. Power values for the strength endurance group d creased for the left leg extension, for both legs combined and when expressed relatively to total body weight. The strength group demonstrated numerous power in cteases. Other changes in physiological parameters were not significant for the various groups. No changes were recorded in body composition variables for any group The decline in power observed in the strength- endurance group and the lack of significant in c•reasin power noted in the endurance group suggests that training designed to improve power and strength should not incor- porate endurance exercise **(Pohlman, 1982).**

To examine the adaptations of arm and thigh muscle hypertrophy to different long-term periodized resistance training programmes and the influence of upper body resistance training, eighty-five untrained women (mean age = 23.1+/- 3.5 yr) started in one of the following groups: total-body training [TP, N = 18 (3-8 RM training range) and TH, N = 21 (8-12 RM training range)], upper- body training [UP, N = 21 (3-8 RM training range) and UH, N = 19, (8-12 RM training range)], or a control group (CON, N = 6). Training took place on three alternating days per week for 24 weeks. Assessments of body composition, muscular performance, and muscle cross-sectional area (CSA) via magnetic resonance imaging (MRI) were determined pre-training (T1), and after 12 (T2) and 24 weeks (T3) of training. Results of the study were: arm cross-sectional area increased at T2 (approximately 11%) and T3 (approximately 6%) in all training groups and thigh CSA increased at T2 (approximately 3%) and T3 (approximately 4.5%) only in TP and TH. Squat one-repetition maximum (1RM) increased at T2 (approximately 24%) and T3 (approximately 11.5%) only in TP and TH and all training groups increased 1 RM bench press at T2 (approximately 16.5%) and T3 (approximately 12.4%). Peak power produced during loaded jump squats increased from T1 to T3 only in TP (12%) and TH (7%). Peak power during the ballistic bench press increased at T2 only in TP and increased from T1 to T3 in all training groups. Finally he concluded that training specificity was supported (as sole upper-body training did not influence lower- body musculature) along with the inclusion of heavier loading ranges in a periodized resistance-training programme. This may be advantageous in a total conditioning programme directed at development of muscle tissue mass in young women **(Kraemer et al., 2004).**

A study was conducted on the effects of ballistic training on pre-season preparation of elite volleyball players. The purpose of this study was to determine whether ballistic resistance training would increase the vertical jump (VJ) performance of already highly trained jump athletes (sixteen male volleyball players from a NCAA division I team participated in the study). A Vertex was used to measure standing vertical jump and reach (SJR) and jump and reach from a three-step approach (AJR). Several types of vertical jump tests were also performed on a plyometric power system and a force plate to measure force, velocity, and power production during vertical jumping. The subjects completed the tests and were then randomly divided into two groups, control and treatment. All subjects completed the usual preseason volleyball on-court training combined with a resistance training programme. In addition, the treatment group completed 8 wk of squat jump training while the control group completed squat and leg press exercises at a 6RM load. Both groups were retested at the completion of the training period. The treatment group produced a significant increase in both SJR and AJR of 5.9+/-3.1% and 6.3+/-5.1%, respectively. These increases were significantly greater than the pre-test to post- test Changes produced by the control group, which were not significant for either jump. Analysis of the data from the various other jump tests suggested increased overall force output during jumping, and in particular increased rate of force development were the main contributors to the increased jump height. These results lend support to the effectiveness of ballistic resistance training for improving vertical jump performance in elite jump athletes **(Newton et al.,1999).**

To study on muscular adaptations in response to three resistance training regimens: specificity of repetition maximum training zones, thirty two untrained men [mean (SD) age 22.5 (5.8) years, height 178.3 (7.2) cm, body mass 77.8 (11.9) kg] participated in an 8-week progressive resistance-training programme to investigate the "strength endurance continuum". Subjects were divided into four groups: a low repetition group (low rep, n = 9) performing 3-5 repetitions maximum (RM) for four sets of each exercise with 3 min rest between sets and exercises, an intermediate repetition group (into rep, n = 11) performing 9-11 RM for three sets with 2 min rest, a high repetition group (high rep, n = 7) performing 20-28 RM for two sets with 1 min rest, and a non-exercising control group (con, n = 5). Three exercises (leg press, squat, and knee extension) were performed 2 days/week for the first 4 weeks and 3 days/week for the final 4 weeks. Maximal strength [one repetition maximum,1RM), local muscular endurance (maximal number of repetitions performed with 60% of 1RM), and various cardio respiratory parameters (e.g., maximum oxygen consumption, pulmonary ventilation, maximal aerobic power, time to exhaustion) were assessed at the beginning and end of the study. In addition, pre-training and post- training muscle biopsy samples were analyzed for fiber type composition, cross- sectional area, myosin heavy chain (MHC) content, and capillarization. Maximal strength improved significantly more for the low rep group compared to the other training groups, and the maximal number of repetitions at 60% 1RM improved the most for the high rep group. In addition, maximal aerobic power and time to exhaustion significantly increased at the end of the study for only the high rep group. All three major fiber types (types I, IIA, and IIB) hypertrophied for the low repetitions and intermediate repetitions groups, whereas no significant increases were demonstrated for either the high repetitions or control groups. However, the percentage of type IIB fibers decreased, with a concomitant increase in IIAB fibers for all three resistance-trained groups. These fiber-type conversions were supported by a significant decrease in MHC II accompanied by a significant increase in MHC II. No significant changes in fiber-type composition were found in the control samples. Although all three training regimens resulted in similar fiber-type transformations (IIB to IIA), the low to intermediate repetition resistance-training programmes induced a greater hypertrophic effect compared to the high repetition regimen. The high repetitions group, however, appeared better adapted for sub maximal, prolonged contractions, with significant increases after training in aerobic power and time to exhaustion. Thus, low and intermediate RM training appears to induce similar muscular adaptations, at least after short-term training in previously untrained subjects. Overall, however, these data demonstrate that both physical performance and the associated physiological adaptations are linked to the intensity and number of repetitions performed, and thus lend support to the "strength-endurance continuum **(Campos et al., 2002).**

The literature on resistance training proposes that light loads (30% 1 RM) and heavy loads (85% 1 RM) are the appropriate loads to improve dynamic athletic performance, usually the vertical jump. In these formulations, body weight is seldom considered. It could be an important factor. This investigation used male soccer players performing half-squats under different treatments. A control group (N = 10), a body-weight alone group doing simulated training without external loads (N = 11), a group using an external load of 30% of 1 RM squats (N = 10), and group using an external load of 85% of 1 RM squats (N =10) When performing the exercises in the treatment groups, emphasis was placed on the maximal mobilization of force in the concentric portion of the half- squat. Training was 4 x 5 repetitions, three times per week for seven weeks. After each squat training, 3 x 5 vertical counter-movement jumps were performed. In both externally loaded groups, 1 RM increased. Vertical jump improved only in the highest training load group but only when the vertical jump was performed with a 50-kg weight. Vertical jump measures did not improve in outweighed or light-loaded jumping protocols. The highest power production occurred when jumping without any external load. Sprinting tests of 10 and 40 m improved only in the highest-load training group. It was concluded that improving vertical jumping height involved more than just the training load in resistance training. The specificity of the training effects of resistance exercises is again demonstrated in this investigation. There is little to no carry-over of training benefits to actual dynamic performance. However, why Sprint times improved and the specifically targeted vertical jump did not is not addressed. One could propose that sprinting is improved by strength training, but since the training employed only the half-squat, which is more related to vertical jumping and less so to sprinting, the effects are puzzling. The Effects of strength training activities on the performance of a dynamic vertical jump are minimal at best **(Hoff et al.,2000).**

The effects of four weeks of in-season strength and power training on the ability to rapidly develop force during jumping were evaluated in 12 division I female volleyball players. Testing occurred before and after a traditional strength and power training experience. The dependent variable was force created by the concentric portion of a squat jump. Normal training and competitions occurred during the training period. Time to peak force decreased, peak force increased, and average concentric force increased. There was no change in the rate of force development, a component of improved speed. Athletes were stronger as a result of the experience while "speed" of force development did not change. Since no control group was used in this study, one is set to ponder whether the strength gains were "retraining gains", because the study implies that no strength training had occurred in-season. If pre- season strength training was experienced and then stopped, resulting in strength- detraining, it is possible that the observed changes in this investigation were re-adaptations and possibly unrelated to performance. If strength gains from pre- season training were appropriate for volleyball, their use in training and competitions should have stimulated them to be maintained and additional strength training would have resulted in little to no further gains. Additional in- season strength training improves existing strength in females if they are not undergoing concurrent strength training. The question as to whether the strength gains transfer to improved performance was not answered **(Robertson et al., 2001).**

On the factors of training for development of vertical jump, the explosive strength is a characteristic of performance that is common in many sporting endeavors. However, training very frequently includes reduced velocity "strength" training which develops capacities which are only appropriate for a very few activities (e.g., power lifting).Weight or strength training is often required because it is believed to improve explosive strength. Research has shown that it does increase explosive power in individuals who begin training with average strength. However, it has little benefit for explosive strength performances for individuals with previously trained or above average levels of strength. Training with heavy loads (70-120% of 1 RM) improves maximal isometric strength but not the maximal rate of force development. In some cases it might even reduce the ability of the muscles to develop force rapidly. On the other hand, light load training with an accent on speed of movement increases an athlete's ability to rapidly develop force. A typical total-body explosive movement (e.g., vertical jump)requires force to be developed in a time period between 200 and 350 mts. Most of the heavy-strength training-induced increases in force-producing potential cannot be realized over such a short time. Heavy strength training is of little benefit to already strong individuals who wish to perform explosive Movements **(Kraemer et al., 1994).**

To study on strength and power training in young male Baseball players who did not improve functional performance, two groups of 10 pre-pubescent and pubescent male baseball players trained three times per week for 12 weeks using a variety of general free weight and machine exercises designed for both strength and power acquisition. For the experienced, notice and control groups respectively the following gains were recorded; leg press – 41%, 40 % and 14% and bench press 23%, 18% and 0 %. Both training groups were significantly better than the control group. Similarly the two training groups improved in vertical jump **(Hetzler et al., 1997).**

A study was conducted on three groups totaling 48 college students who were trained with progressive resistance exercise for a period of nine weeks three times a week. Each group trained with a different programme using the bench press lift. Groups I trained with the 2 – RM for six sets, group – II with the 6-RM for three sets and group – III with the 10 RM for three sets each training session. The 1 – RM for the bench press lift was determined before and after the nine week training period. A comparison was made between groups – II (39-6R and II (3g – 10RI) after nine week of training. In both the studies, group – II had a higher mean than group – III, but the mean differences were not significant. In both the studies, group – II had a higher mean than group – III but the mean difference were not significant. In Berger's study, training continued up to 12 week and at that time the mean of group – II was significant higher than the group – III mean. It is probable that the continuation of the present study to 12 weeks would have resulted in significant differences between groups II and III. The results of this study is that training for nine weeks, three times a Week with heavy for few repetitions per set and numerous sets is not more effective for improving strength than training with lighter loads for more repetitions per set and fewer sets **(Berger, 1963).**

2.3 STUDIES ON COMBINED RESISTANCE AND PLYOMETRIC TRAINING

Adaptations by the neuromuscular system are very specific. Therefore training programmes should include movements which mimic those used in sport. Slow contractions train the muscular system, while fast contractions stimulate the nervous system **(Canavan, 1996). Wilson et. al. (1996).** proposed that plyometric and strength training train different components of the neuromuscular system. It is logical then, to train optimally for competition in power sports, both fast and slow contractions, as well as plyometrics, should be included in the training programme. This will ensure that all aspects of the neuromuscular system are addressed. This concept is being put to use today in combined resistance training and plyometric-type programmes, and have been shown in many studies to be more effective at improving muscular strength and power than either plyometric or resistance training alone **(Adams et. al., 1992, Baker, 1996, Canavan et. al., 1996, Garhammer & Gregaor, 1992, Hedrick, 1996, Hedrick & Anderson, 1996, Newton & Kraemer, 1994, Stone 1993, Yessis, 1994, Yessis, 1995).** So it appears that training contractile and neural/elastic components of the musculature from combined training does in fact offer an improved training stimulus it is this concept that complex training is built from **(Baker, 1996).**

The effectiveness of plyometric training is well supported by research . Complex training has gained popularity as a training strategy combining weight training and plyometric training. Anecdotal reports recommend training in this fashion in order to improve muscular power and athletic performance. Recently, several studies have examined complex training. Despite the fact that questions remain about the potential effectiveness and implementation of this type of training, results of recent studies are useful in guiding practitioners in the development and implementation of complex training programmes. In some cases, research suggests that complex training has an acute ergogenic effect on upper body power and the results of acute and chronic complex training include improved jumping performance. Improved performance may require three to four minutes rest between the weights training and plyometrics sets and the use of heavy weight training loads. The combination of plyometric training and weight training are thought to be useful for developing athletic power. More specifically, complex training alternates biomechanically similar high load weight training exercises with plyometric exercises, set for set, in the same workout. An example of complex training would include performing a set of squats followed by a set of jump squats. Anecdotal sources have described the application of complex training

Resistance and plyometric training programs have demonstrated consistent improvements in running economy (RE) in trained and untrained adults in the absence of improvements in maximal oxygen consumption. The purpose of the study was to investigate the effect of a 10-week combined resistance-plyometric training program on the RE and V[Combining Dot Above]O2max in female soccer players. Fifteen Division 1A female soccer players (age 19.0 ± 0.7 years; height 1.67 ± 0.1 m; weight 61.7 ± 8.1 kg) performed a treadmill test for V[Combining Dot Above]O2max and RE at the end of a competitive season (PRE) and after a 10-week training program (POST). Isometric strength was measured in knee flexion and extension. Resistance training was conducted 2nd week on nonconsecutive days; plyometric training was conducted separately on different nonconsecutive days. Eleven subjects were included in the PRE-POST analysis (age 19.0 ± 0.8 years; height 1.67 ± 0.5 m; weight 59.9 ± 6.7 kg). Descriptive statistics were compared using analysis of variance with repeated measures with a Bon ferroni adjustment, and significance was set at $p < 0.05$. A significant increase occurred after training in the V[Combining Dot Above]O2peak (10.5%; $p = 0.008$), time to fatigue (6.9%; $p = 0.017$), and interpolated maximal speed (3.6%; $p = 0.016$), despite there being a decrease in the maximal respiratory exchange ratio (2.9%; $p = 0.001$). There was no significant change in the RE at 9 km•h; however, there was a significant decrease in the percentage of the V[Combining Dot Above]O2peak at 9 km•h (-5.6%; $p = 0.02$). Maximal isometric strength of knee flexors and extensors did not change. The results suggest a plyometric- agility training program may increase the V [Combining Dot Above]O2peak in female soccer players; however, the effect on RE was equivocal. **(Grieco et al., 2012).**

To compare the effects of a six week training period of combined plyometric and resistance training (PRT, n = 13) or resistance training alone (RT, n = 14) on fitness performance in boys (12-15 yr). The RT group performed static stretching exercises followed by resistance training whereas the PRT group performed plyometric exercises followed by the same resistance training program. The training duration per session for both groups was 90 min. At baseline and after training all participants were tested on the vertical jump, long jump, medicine ball toss, 9.1 m sprint, pro agility shuttle run and flexibility. The PRT group made significantly ($p < 0.05$) greater improvements than RT in long jump (10.8 cm vs. 2.2 cm), medicine ball toss (39.1 cm vs. 17.7 cm) and pro agility shuttle run time (-0.23 sec vs. -

0.02 sec) following training. These findings suggest that the addition of plyometric training to a resistance training program may be more beneficial than resistance training and static stretching for enhancing selected measures of upper and lower body power in boys. We have demonstrated that the addition of plyometric training to a resistance training program was more effective than resistance training and static stretching in improving upper and lower body power performance in boys. Our findings highlight the potential value of combined fitness training in a conditioning program aimed at maximizing power performance in youth, at least in the short- term. Owing to the growing popularity of youth strength and conditioning programs, additional long-term trials should be undertaken to explore the neuromuscular mechanisms responsible for training-induced adaptations in youth and investigate the effects of different types of training on diverse populations of children and adolescents **(James et al.,2007).**

To investigate the effect of plyometric versus resistance training (PT vs. RT) on sprint and skill performance in young soccer players, thirty elite soccer players participated in this study as subjects. The subjects were randomly assigned to PT group (n=10, age: 19.1 ± 1.7 years), RT group (n=10, age: 18.0± 0.81) or control group (n=10, age: 18.8 ± 1.5 years). The PT group performed 8 weeks lower extremities PT besides the soccer team training. The RT consisted of 2-4 sets of weight training for 4 stations and at an intensity corresponding to 60-90% of 1-RM in each station by 6-12 repetitions besides the soccer team training. The control group performed only the soccer team training during the study. The results showed that the time of sprint running test and dribbling improve after PT and RT ($P<0.05$). For accuracy of shooting no significant change was observed after 8 weeks PT and RT. In conclusion, although the time of sprint running test and dribbling improve after PT and RT, these training have not effective to improve accuracy of shooting in young soccer players **(Asghar et al., 2012).**

The purpose of this investigation was 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 2 training groups: (a) an athletic shoe (N = 6) (AS) group or (b) the Meridian Elyte (N = 8) (MS) group. Training was performed for 10 weeks and consisted of resistance training for 2 days per week and 2 days per week of sprint/plyometric training. Linear periodized resistance training consisted of 5 exercises per workout (4 lower body, 1 upper body) for 3 sets of 3-12 repetition maximum (RM). Sprint/plyometric training consisted of 5-7 exercises per workout (4-5 plyometric exercises, 40-yd and 60-yd sprints) for 3-6 sets with gradually increasing volume (8 weeks) followed by a 2-week taper phase. Assessments for 1RM squat and bench press, vertical jump, broad jump, sprint speed, and body composition were performed before and following the 10-week training period. Significant increases were observed in both AS and MS groups in 1RM squat (12.0 vs. 14.6 kg), bench press (6.8 vs. 7.4 kg), vertical jump height (3.3 vs. 2.3 cm), and broad jump (17.8 vs. 15.2 cm). Similar decreases in peak 20-, 40-, and 60-m sprint times were observed in both groups (20 m: 0.14 vs. 0.11 seconds; 40 m: 0.29 vs. 0.34 seconds; 60 m: 0.45 vs. 0.46 seconds in AS and MS groups, respectively). However, when sprint endurance (the difference between the fastest and slowest sprint trials) was analyzed, there was a significantly greater improvement at 60 m in the MS group. These results indicated that similar improvements in peak sprint speed and jumping ability were observed following 10 weeks of training with either shoe. However, high- intensity sprint endurance at 60 m increased to a greater extent during training with the Meridian Elyte athletic shoe **(Ratamess et al., 2007).**

To compare 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 2 groups. Group ST (n = 6) performed heavy strength training twice a week for 7 weeks in addition to 6 to 8 soccer sessions a week. Group ST+P (n = 8) performed a plyometric training program in addition to the same training as the ST group. The control group (n = 7) performed 6 to 8 soccer sessions a week. Pretests and posttests were 1 repetition maximum (1RM) half squat, countermovement jump (CMJ), squat jump (SJ), 4-bounce test (4BT), peak power in half squat with 20 kg, 35 kg, and 50 kg (PP20, PP35, and PP50, respectively), sprint acceleration, peak sprint velocity, and total time on 40-m sprint. There were no significant differences between the ST+P group and ST group. Thus, the groups were pooled into 1 intervention group. The intervention group significantly improved in all measurements except CMJ, while the control group showed significant improvements only in PP20. There was a significant difference in relative improvement between the intervention group and control group in 1RM half squat, 4BT, and SJ. However, a significant difference between groups was not observed in PP20, PP35, sprint acceleration, peak sprinting velocity, and total time on 40-m sprint. The results suggest that there are no significant performance-enhancing effects of combining strength and plyometric training in professional soccer players concurrently performing 6 to 8 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 et al., 2008).**

To examine the effects of on-field combined strength and power training (CSPT) on physical performance among U-14 young soccer players, Players were assigned to experimental (EG, n = 28) and control groups (CG, n = 23). Both groups underwent preseason soccer training for 12 weeks. EG performed CSPT twice a week, which consisted of strength and power exercises that trained the major muscles of the core, upper, and lower body. CSPT significantly (p ,0.05) improved vertical jump height, ball-shooting speed, 10 m and 30 m sprint times Yo-Yo intermittent endurance run (YYIER), and reduced sub maxima running cost (RC). CSPT had moderate effect on vertical jump, ball-shooting, 30 m sprint, and YYIER, small effect on 10 m sprint, RC, and maximal oxygen uptake. YYIER had significant (p , 0.05) correlations with 10 m (r = 20.47) and 30 m (r = 20.43) sprint times, ball-shooting speed (r = 0.51), and vertical jump (r = 0.34). The CSPT can be performed to gather with soccer training with no concomitant interference on aerobic capacity and with improved explosive performances. In addition, it is suggested that CSPT be performed during the preseason period rather than in-season to avoid insufficient recovery/rest or overtraining **(Karim et al.,2010).**

The aim of this study was to evaluate and compare the effects of two short-term off-season conditioning training programs on fitness performance in young basketball players. Twenty-one young basketball players, aged 12-13 years, volunteered to participate in this study. The participants were randomly assigned to a strength training group (ST, n = 10) or a combined plyometric and strength training group (CT, n = 11). The ST group performed free full court basketball play followed by strength training, whereas the CT group performed plyometric exercises followed by the same strength training program. Young basketball players were assessed before and after a six-week training period on the vertical jump, long jump, medicine ball toss, 20 m sprint, 4 x 15 m standing start running and stand and reach flexibility. The CT group made significantly ($p < 0.05$) greater improvements than the ST group in the vertical jump (3.2 cm vs. 0.6 cm), long jump (10.3 cm vs. 2.2 cm), 20 m sprint (-0.2 sec vs. 0.0 sec), 4 x 15 m standing start running (-0.41 sec vs. -0.05 sec) and the medicine ball toss (40.7 cm vs. 18.2 cm) following the training. The results of this study demonstrate that a short-term plyometric and strength training program significantly increases motor performance skills in young basketball players **(Ognjenat et al.,2012).**

To find out the effects of Plyometric Training and Resistance Training on Specific Speed of Basketball Players, 60 male basketball players of West Bengal who had participated in various national/ inter-varsity/ state level tournaments in basketball were selected. Their age ranged from 18-23 years. Specific Speed was selected as a dependent variable and plyometric training and resistance Training was considered as Independent Variables. For the study pre test-post test randomized group design comprising of two experimental groups (n=20 in each group) namely plyometric training group (PT) and resistance training group (RT) and one active control group (n=20) were adopted. To test the Specific Speed of basketball players, 20 meter dash Test was used. To compare the effects of plyometric training and resistance training on speed of basketball players, Analysis of co-variance (ANCOVA) was used. The level of significance was set at 0.05. The result revealed that there was significant effect of both the plyometric and resistance training programme on specific speed of basketball players **(Andrejić, 2012).**

The purpose of the present study was to investigate the effect of plyometric and resistance training on agility, speed and explosive power in soccer players. 30 male soccer players aged 18-25 voluntarily participated in the study. They were randomly assigned in plyometric (n=15) and resistance (n=15) groups. Both groups performed selected soccer-specified plyometric and resistance training for 8 weeks. Data was analyzed using paired t-test, independent t-test, and covariance statistical methods. The results showed that levels of agility, speed, and explosive power in plyometric training group (p=0.0001), and agility and explosive power in resistance training group (p=0.0001) were significantly improved in post-test compared to pre-test. Between-groups comparison showed better records in agility, speed and explosive power for plyometric compared with resistance training group after eight weeks (respectively p=0.032, p=0.0001 and p=0.002). According to the results, it can be concluded that both plyometric and resistance training exercises increase agility and explosive power and reduce sprint time in football players. Plyometric exercises also showed more favorable effects on study variables compared with resistance exercises. Therefore, these types of training methods are suggested to soccer players and coaches for improving speed and performance skill **(Eskandar et al.,2014).**

To examine the effects of plyometric and resistance training on the explosive power and the amount of young male volleyball players' strength in Guilan province, the participants included 45 volleyball players, 15-22 years old, who were randomly divided into three groups: two training groups and one control group. Among the two training groups, one was engaged in plyometric and the other in resistance exercise training (six weeks, two times per week).The control group was doing its common volleyball training. Variables under measurement consist of strength and explosive power. We found that after a six weeks training, there were significant differences between the average of explosive power and strength in both groups of plyometric and resistance training in comparison to control group($P \leq 0.05$). The researcher observed that there was a significant difference in the average of explosive power and strength within both plyometric and weight groups from pre to post-test ($p \leq 0.05$). The amount of improvement in resistance training group was more than plyometric group **(Aghajani et al.,2014).**

The health enhancing properties of physical activity are evidence-based and widely accepted for children and adolescents. Today many children and adolescents are engaged in specific sports and that causes great attention of coaches to use safe and appropriate methods. Volleyball is of the most popular sports among this group. Because of powerful and explosive movements as well as high-repeated jumps and landings suitable training program should be considered to improve performance and prevent injuries in children and adolescents. The aim of this study is to review studies about resistance training, plyometric training and combined training and effects of these training methods on physical fitness in children and adolescents. Our investigation begun with search engine and scientific databases with keywords in three section; title and abstracts, articles and finally references. Primary research articles were selected if they (a) included outcomes of a resistance, plyometric and combined training intervention, (b) included volleyball training protocols, (c) included children and adolescents 8–18 years of age. Review show that resistance training would enhance physical performance as well as plyometrics training. Improvements in motor performance skills, such as jumping, are widely stated as indicators of improvements in sporting performance. Although combination of resistance and plyometrics is a useful methods for jumping improvement little is available about the effects on children and adolescents **(Fattahi and Sadeghi, 2015).**

To examine the chenges in muscular strength, muscular endurance, muscular power, speed, agility, cardio-respi- ratory endurance and body composition in college age soccer players following a twenty weeks training were examined. The study concluded that all the muscular power, speed, agility and cardio-respiratory endurance improved significantly, whereas a reduction in fat percentage was also seen **(Amusa and Sohi, 1985).**

The effect of weight training and plyometric on vertical jump ability was studied. From the results it was concluded that the traditional weight training increases vertical jump performance, but not to the same extent as plyometric training with loaded jump squats. He gave explanation for the less effect of weight training is that the weight being lifted is decelerating for a considerable proportion of the movement. On the other hand plyometric training by drop jumping or by performing weighted jump squats allows athletes to use "compensatory acceleration" whereby they can complete the entire movement at high velocity **(Hatfield, 1989).** In comparing heavy weight training with the use of lighter weight and explosive jumps, most studies have found the latter to be more effective **(Hakkinen & Komi, 1985b; Komi et. al., 1982; Wilson et. al.,1993). (Elliott et al., 1989).**

The effects of plyometric, strength training, and body weight exercises on the power, strength, and endurance capacities of the trunk muscles were examined. Training sessions occurred twice per week for five weeks (a total of 10 training sessions). Plyometrics use two physiological properties of muscle, the stretch reflex and storage of elastic energy. When a rapid lengthening of a muscle occurs just prior to rapid shortening, a more powerful contraction results. Plyometrics significantly increased power (8.6%) and strength (45.9%). Strength training increased power (7.3%) and strength (82.5%). Body weight increased strength only (21.9%). Both plyometrics and strength training were as effective as each other. This study showed the rapid and substantial gains that can be made when plyometric or strength training is confined to a restricted set of muscles. No inference should be made that these improvements will be transferred to any other activity (**Kubachka et al., 1966).**

To examine the effect of upper body plyometric training, using medicine balls, and upper body conventional weight training on baseball throwing velocity and strength levels as assessed by a 6-RM bench press, twenty-four junior development baseball players took part in an 8 week training study in conjunction with their baseball training. They were randomly allocated to one of three groups: a medicine ball training group, a weight training group, and a control group. The first group performed explosive upper body medicine ball throws, the weight training group performed conventional upper body weight training, and the control group only performed their normal baseball training. Pre-training and post- training measurements of throwing velocity and 6-RM bench press were recorded. The weight training group produced the greatest increase in throwing velocity and 6-RM strength. The medicine ball group showed no significant increase in throwing velocity but did show a significant increase in strength. For this group of non-strength-trained baseball players, it was found more effective to implement a weight training programme rather than medicine ball training to increase throwing velocity **(Robert and Kerry,1994).**

To compare dynamic push-up (DPU) and plyometric push- up (PPU) training programmes on 2 criterion measures: (a) the distance achieved on a sit-ting, 2-handed medicine ball put, and (b) the maximum weight for 1 repetition of a sitting, 2-handed chest press, thirty-five healthy women completed 18 training sessions over a 6-week period, with training time and repetitions matched for the DPU (n = 17) and PPU (n = 18) groups. Dynamic push-ups were completed from the knees, using a 2-second-up–2-second-down cadence. Plyometric push-ups were also completed from the knees, with the subjects allowing themselves to fall forward onto their hands and then propelling themselves upward and back to the starting position, with 1 push-up completed every 4 seconds. The PPU group experienced significantly greater improvements than the DPU group on the medicine ball put (p = 0.03). There was no significant difference between groups for the chest press, although the PPU group experienced greater increases **(Jeffery et al.,2000).**

A study was conducted on the effect of plyometric, weight and plyometric-weight training on anaerobic power and muscular strength. The effect of three different training protocols -plyometric training, weight training, and their combination on the vertical jump performance, anaerobic power and muscular strength. Based on their training, 48 male college students were divided into four groups. Plyometric training group(n=13),a Weight training group (n=11), Plyometric plus weight training group(n=14) and a control group (n=10) The vertical jump,50 yard run and maximal leg strength were measured before and after a six-week training period. The subjects of the each training group were trained for 2 days per week, whereas control subjects did not participate in any training activity. The data were analyzed by a one-way analysis of variance (repeated measure design). The results showed that all the training treatments elicited significant ($p<0.5$) improvement in the entire tested variable. However the combination training group showed signs of improvement in the vertical jump performance, the 50 yard run, and leg strength that was significantly greater than the improvement in the other 2 training groups (plyometric, weight training groups). This study provides support for the use of combination of traditional weight training and plyometric drills to improve the vertical jump ability, explosive performance in general and leg strength **(Rahimi et al., 2005).**

Clutch et. al., 1983; Delecluse et al., 1995; Duke and BenEliyahu,1992; Fatourous et. al., 2000; Ford et. al., 1983; Lyttle et. al., 1996; McLaughlin, 2001; Polhemus and Burkherdt, 1980; Potteiger et. al., 1999; and Vossen et. al., 2000) demonstrated an enhancement of motor performance associated with plyometric training combined with weight training or the superiority of plyometrics, compared to other methods of training. The evidence indicates that the combination weight training and plyometrics are effective. One way to combine the two forms of training is complex training or the contrast method. Recent studies have evaluated this type of training with mixed results **(Adams et al.,1992).**

To quantify the differences between complex and non-complex plyometric exercises one acute study compared electromyographic (EMG) and kinetic variables, such as ground reaction forces, associated with the medicine ball power drop performed before and following a set of 3-5 RM bench press. More specifically, subjects performed the power drop exercise lying supine on a bench press bench that was mounted to a force platform. Subjects caught and forcefully threw the ball upward with horizontal flexion/adduction of the shoulders and extension of the elbow in a movement that is similar to the bench press with the exception that the medicine ball is projected into free space. Results from this study revealed no significant difference for mean or maximum ground reaction force and integrated EMG for the muscles evaluated in each power drop condition. In other words, the medicine ball power drop performed in the complex training condition was equally effective, but not superior, in eliciting motor unit activation or force output compared to the same exercise performed before the 3-5RM bench press set in the non-complex condition **(Ebben et al., 2000).**

The use of complex training as a method of combining weight and plyometric exercises during the same training session is growing in popularity, despite limited scientific support for its efficacy was examined. The purpose of this study was to examine the effect of a set of high-load bench press exercises (BP) on a subsequent set of medicine ball power drop exercises (MBPD) via mean ground reaction force, maximum ground reaction force, and mean electromyography (EMGint). Ten male (19 ± 1.4 years) NCAA Division 1 basketball players with experience in weight and plyometric training performed plyometric exercises under 2 randomly determined conditions. One condition included a BP followed immediately by a MBPD. The other condition included only the MBPD. Mean ground reaction force, maximum ground reaction force, and EMGint were recorded during the MBPD for both conditions. Results indicated that no significant differences exist for mean ground reaction force, maximum ground reaction force, and EMGint for the pectoralis major and triceps muscles between the MBPD and the BP plus MBPD conditions. These results indicate that there is no heightened excitability of the central nervous system. However, there also appears to be no disadvantage of performing high- load weight training and plyometric exercises in complex pairs. Therefore, advantages of performing weight and plyometric exercises in the same training session **(Jensen et al., 1999).**

It was evaluated that the counter movement jumps (LCMJ) could be enhanced if proceeded by a set of five repetition maximum (5 RM) half squats. Subjects performed two sets of five LCMJ, one set of 5 RM half squats, and one set of five LCMJ with four minutes rest between all sets. The jump height for the LCMJ after the squat was 40.0 cm ± 3.5cm compared to a pre-squat jump height of 39.0 ± 3.3 cm, resulting in a 2.8% improvement in jump performance. The authors indicate that there was a significant correlation between the 5 RM load and jump performances. Results suggest that for complex training, a high load weight training exercise performed four minutes before a power exercise increased the performance of the power exercise, especially for stronger individuals **(Young et al., 1998).**

In a Study examining the effects of a three-week complex training programme with seven divisions I college female basketball players, Pre and post test results reveal improvement in the 300 m shuttle, 1 mile run, VO2 max, 20 yd dash, pro agility run and the t-test, reverse leg press and back squat. The data show that the complex training programme was effective in eliciting statistically significant improvement in the 300-meter shuttle. However, the research design does not appear to have evaluated the effectiveness of non-complex training combinations of plyometrics and weight training or used a control group (Gonzalez et al., 2000). group who performed all of the weight training exercises after the plyometric exercises, each group performed the same 7 week routine except the complex training group performed the plyometric exercises in a superset with biomechanically similar resistance training exercises, whereas the other group performed the plyometric exercises separately, following the resistance training exercises. Subjects included seventy eight division I college football players. Subjects were pre and post-tested with a variety of tests including percentage of body fat, bench press, squat, power clean, medicine ball throw, broad jump, and vertical jump. Both groups demonstrated improvement in all eight of the tests. However, the complex training group demonstrated significant between group vertical jumps improvements (2.8 cm) compared to the non-complex training group (0.1cm) **(Zepeda et al., 2000).**

To determine the influence of a short-term combined plyometric and sprint training (9-weeks) within regular soccer practice on explosive and technical actions of pubertal soccer players during the in-season.Twenty-six players were randomly assigned to 2 groups; control group (CG) (soccer training only), and combined group (CombG) (plyometric+acceleration+dribbling+shooting). All players trained soccer four times per week and the experimental groups supplemented the soccer training with a proposed plyometric-sprint training program for 40 minutes (two days per weeks).10-m sprint, 10-m agility with and without ball, CMJ and Abalakov vertical jump, ball-shooting speed and Yo-Yo IE test were measured before and after training. The experimental group followed a 9-week plyometric and sprint program (i.e., jumping, hurdling, bouncing, skipping, and footwork) implemented before the soccer training. Baseline-training results showed no significant differences between the groups in any of the variables tested. No improvement was found in the control group, however, meaningful improvement was found in all variables in the experimental group: CMJ (ES=0.9), Abalakov vertical jump (ES=1.3), 10-m sprint (ES=0.7-0.9), 10-m agility (ES=0.8-1.2) and ball-shooting speed (ES=0.7-0.8).A specific combined plyometric and sprint training within regular soccer practice improved explosive actions compared to conventional soccer training only. Therefore, the short-term combined program had a beneficial impact on explosive actions, such as sprinting, change of direction, jumping and ball-shooting speed which are important determinants of match-winning actions in soccer performance. Therefore, we propose modifications to current training methodology for pubertal soccer players to include combined plyometric and speed training for athlete preparation in this sport **(Ferrete et al., 2015).**

Ample evidence has shown that the resting heart rate decreases over time with endurance training. This reduction in the resting heart rate stems from development of the parasympathetic nervous system in endurance athletes. Other, related adaptive changes in the heart's physiology include: decreased resting blood pressure, increased cardiac output the amount of blood the heart pumps each minute and increased stroke volume the amount of blood ejected by the heart with each heart beat **(Creswell., 2010).**

The measurements of the resting heart rate, over time, can be very useful The resting heart rate will gradually decrease during a training cycle. The resting heart rate will gradually increase during a period of absolute or relative recovery An "unexplained" increase in the resting heart rate during a training cycle may be an indication of poor recovery **(Lamberts,. 2010).**

It is known in medical circles for nearly 20 years that HRR is a useful index of cardiovascular fitness. The whole area of HRR and its clinical implications is a subject of current investigation, but it is well established that HRR is a strong predictor of both cardiovascular-related and all-cause mortality in healthy adults **(Lamberts,.2010).**

The typical endurance athlete will be aware of HRR, at least informally, and particularly how it manifests during an interval workout. With a heart rate monitor, it's easy to get a general sense of how quickly the heart rate returns to baseline after a period of sub maximal or maximal exercise. It's only in recent years, though, that investigators have begun to study HRR rigorously as it relates to endurance athletes and recovery **(Lamberts,.2010).**

Complete recovery of the heart rate may take an hour after light activity, several hours after long-duration aerobic exercise, and perhaps 24 hours after intense exercise. One easy way to measure HRR is to measure the change in heart rate during the first minute after sub maximal exercise: a drop in heart rate of 15-20 beats per minute might be typical and a value less than 12 would be unfavorable **(Lamberts,.2010).**

A 2010 report by Lambert and colleagues at the University of Cape Town formalized the use of HRR in a study of well-trained cyclists. They used an HRR measurement protocol that consisted of a 15-minute period of cycling on a trainer (6 minutes at 60% max heart rate, 6 minutes at 80% max heart rate, and 3 minutes at 90% max heart rate) and HRR was defined as the change in heart rate during the first minute after stopping exercise **(Lamberts,.2010).**

The investigators made several important observations about HRR:A slight increase in HRR accompanies fitness gain during a training cycle .An unexpected increase in HRR may indicate fatigue due to training A decrease in HRR during a training cycle may indicate overtraining As you can see, HRR may well be a physiologic parameter that can be used to gauge the effects of training as well as the readiness to race **(Lamberts,.2010).**

First, take your pulse while you're relaxed. On average, the resting heart rate is between 60 and 100 beats per minute. Exercise to reach your target heart rate, which is 60 to 80 percent of 220 minus your age. Once your heart rate is with in the target range, stop exercising and measure your heart rate immediately. Rest for two minutes and take your pulse again. The difference between the two numbers indicates your recovery rate zone. A difference of 66, for example, is a healthier recovery rate than 22.basically, the faster your heart can return to its resting rate after exercise, the better shape you are in. your biological age might even be lower than your chronological age **(Lamberts,.2010).**

2.4 STUDIES ON SKILL PERFORMENCE

The relationships between football playing ability (FPA) and selected anthropometric and performance measures were determined among NCAA Division I-A football players (N = 40). Football playing ability (determined by the average of coaches' rankings) was significantly correlated with vertical jump (VJ) in all groups (offense, defense, and position groups of wide receiver- defensive back, offensive linemen-defensive linemen, and running back-tight end-linebacker). Eleven of 50 correlations (groups by variables), or 22%, were important for FPA. Five of the 11 relationships were related to VJ. Forward stepwise regression equations for each group explained over half of the criterion variable, FPA, as indicated by the R(2) values for each model. Vertical jump was the prime predictor variable in the equations for all groups. The findings of this study are discussed in relation to the hypothesis. Strength and conditioning programmes that facilitate the capacity for football players to develop forceful and rapid concentric action through plantar flexion of the ankle, as well as extension of the knee and hip, may be highly profitable. **(Sawyer et al., 2002).**

This study examined the effects of exercise-induced fatigue on soccer skills performed throughout simulated match play.Fifteen academy soccer players completed a soccer match simulation (SMS) including passing, dribbling, and shooting skills. Precision, success rate, and ball speed were determined via video analysis for all skills. Blood samples were obtained before exercise (preexercise), every 15 min during the simulation (15, 30, 45, 60, 75, and 90 min), and 10 min into half-time.Preliminary testing confirmed test-retest repeatability of performance, physiological, and metabolic responses to 45 min of the SMS. Exercise influenced shooting precision (timing effect: P = .035) and passing speed (timing effect: P = .011), such that shots taken after exercise were 25.5 ± 4.0% less accurate than those taken before exercise and passes in the last 15 min were 7.8 ± 4.3% slower than in the first 15 min. Shot and pass speeds were slower during the second half compared with the first half (shooting: 17.3 ± 0.3 m•s-1 vs 16.6 ± 0.3 m•s-1, P = 0.012; passing: 13.0 ± 0.5 m•s-1 vs 12.2 ± 0.5 m•s-1, P = 0.039). Dribbling performance was unaffected by exercise. Blood lactate concentrations were elevated above pre exercise values throughout exercise (time of sample effect: P < .001).These findings demonstrate that soccer-specific exercise influenced the quality of performance in gross motor skills, such as passing and shooting. Therefore, interventions to maintain skilled performance during the second half of soccer match play are warranted **(Russell et al.,2011).**

The aim of the study was to examine the effect of fatigue, developed during prolonged high-intensity intermittent exercise, on the performance of soccer shooting and dribbling skill. Methods: Nine semiprofessional soccer players with a mean age of 20.7 ± 1.4 years volunteered to participate in the study. Participants completed a slalom dribble test and the Laugh borough Soccer Shooting Test (LSST), before and directly following the performance of three 15-min bouts of a modified version of the Lough borough Intermittent Shuttle Test (LIST). Results: Mean heart rates and mean 15-m sprint times remained unchanged across the three bouts of the LIST. Following the LIST slalom dribbling time increased significantly by 4.5 ± 4.0% (P = .009), while the mean total points scored during the LSST was significantly reduced by 7.6 ± 7.0 points (P = .012). When fatigued the frequency of shots in the LSST achieving the highest score of 5 points was reduced by 47% while the frequency of shots achieving the lowest 0 point score increased by 85%. Conclusion: Results show that while 45 min of exercise caused no decrements in sprint performance there were significant reductions in the ability to perform soccer-specific skills. Both the speed (dribbling time) and accuracy (shot performance) with which soccer- specific skills were executed was impaired following exercise replicating one- half of a soccer match **(Keeron et al.,2009).**

To determine the influence of a short-term combined plyometric and sprint training (9-weeks) within regular soccer practice on explosive and technical actions of pubertal soccer players during the in-season, twenty-six players were randomly assigned to 2 groups; control group (CG) (soccer training only), and combined group (CombG) (plyometric+acceleration+dribbling+shooting). All players trained soccer four times per week and the experimental groups supplemented the soccer training with a proposed plyometric-sprint training program for 40 minutes (two days per weeks).10-m sprint, 10-m agility with and without ball, CMJ and Abalakov vertical jump, ball-shooting speed and Yo-Yo IE test were measured before and after training. The experimental group followed a 9-week plyometric and sprint program (i.e., jumping, hurdling, bouncing, skipping, and footwork) implemented before the soccer training. Baseline-training results showed no significant differences between the groups in any of the variables tested. No improvement was found in the control group, however, meaningful improvement was found in all variables in the experimental group: CMJ (ES=0.9), Abalakov vertical jump (ES=1.3), 10-m sprint (ES=0.7-0.9), 10-m agility (ES=0.8-1.2) and ball-shooting speed (ES=0.7-0.8).A specific combined plyometric and sprint training within regular soccer practice improved explosive actions compared to conventional soccer training only. Therefore, the short-term combined program had a beneficial impact on explosive actions, such as sprinting, change of direction, jumping and ball-shooting speed which are important determinants of match-winning actions in soccer performance. Therefore, we propose modifications to current training methodology for pubertal soccer players to include combined plyometric and speed training for athlete preparation in this sport **(Ferrete et al.,2015).**

Top soccer players do not necessarily have an extraordinary capacity in any of the areas of physical performance. Soccer training is largely based on the game itself, and a common recruitment pattern from player to coach and manager reinforces this tradition. New developments in understanding adaptive processes to the circulatory system and endurance performance as well as nerve and muscle adaptations to training and performance have given rise to more effective training interventions. Endurance interval training using an intensity at 90-95% of maximal heart rate in 3- to 8-minute bouts have proved to be effective in the development of endurance, and for performance improvements in soccer play. Strength training using high loads, few repetitions and maximal mobile sation of force in the concentric mode have proved to be effective in the development of strength and related parameters. The new developments in physical training have important implications for the success of soccer players. The challenge both for coaches and players is to act upon the new developments and change existing training practice **(Hoff et al.,2004).**

The predictive values of selected variables in determining the ability to play basket ball in small high school were investigated. Measures included speed, agility, upper arm strength power, ball handling ability, reaction time, shooting ability, passing ability, height, weight, age and previous experience. The criterion was the rating of the basketball playing ability of each squad member by his coach. The most important variables were experience, ball handling ability, passing ability and shooting ability. The weighted index with R = .76 was basketball ability score = (1.54) number of years of experience + (1.23) score on speed dribble + (.26) score on wall volley+ (.15) score on shooting test- 1 0.11 **(Holland,1965).**

The relationship of agility to performance in women's intercollegiate basketball was investigated The hypothesis that high positive relationships would exist between items of the test (M.C. Cauliff Agility Components Test) and performance were not supported. The lack of evidence to support the hypothesis was attributed to some unexpected peculiarities of the sample and several recommendations were made for continued investigation **(Gallagher, 1970).**

The purpose of the study was to find out the relationship of selected motor traits and anthropometric variables to performance m AAHPER basketball skill test, to establish relationship between selected motor traits and anthropometric variables to performance in AAHPER basketball skill test. The coefficient of correlation 'r' was used. The finding of this study indicated that performance in AAHPER basketball skill test was significantly related to agility, cardiovascular, endurance, explosive strength, height and cural index, whereas performance in AAHPER basketball skill test were not significantly related to speed, grip strength,back, flexibility, weight and ponderal index, on the basis of the findings of the study the following conclusions may be drawn: I) explosive power, agility and cardiovascular endurance are the key motor traits that underline performance of skills in basketball 2) height as well as the relative leg length measurement (crural index)are the mam anthropometric characteristics with contribute of skills in basketball.3)The motor traits of speed grip strength and flexibility are not the prime factors for performance of skills in basketball. 4) Excess body weight has restricting effect on basketball performance **(Sinha,1984).**