CHAPTER – II

REVIEW OF RELATED LITERATURE

The review of literature is instrumental in the selection of the topic, formation of hypothesis and deductive reasoning leading to the problem. It helps to get a clear idea and more knowledge which supports the finding with regard to the problem under study.

The review of literature is instrumental in the formation of hypotheses and to get a full picture of what done with regard to the problem under study. Such a review brings about a deep and clear perspective of the overall field. Now a day the educational program of any type is characterized by reforms and innovative ideas. It seems to be necessary one to formulate such a reviews of various scholars works. This can bring out a deep insight and clear perspective of the overall field in such reviews. Such collected reviews have been presented in logical order, in order of importance and in sequence of merit. This chapter is a step to get full picture of what has been done and said with regard to the problem under study. The review of literature is given as follows.

2.1. STUDIES ON CIRCUIT AND RESISTANCE TRAINING ON PHYSICAL VARIABLES

Barfield J.P, et.al. (2007) reported that the Performance Index Evaluation (PIE) is a basketball-specific assessment of physical performance. The battery consists of items typically included in sport assessments, such as agility, endurance and power, but also addresses an often-overlooked performance component, namely, core strength. The purpose of this study was to examine the reliability (test-retest, interrater), validity (criterion-related, construct-related), and practice effect of the PIE among men's and

women's college basketball players. Test-retest estimates were moderate for men (intraclass correlation coefficient [ICC] = 0.79) and poor for women (ICC = 0.35), but interrater reliability was high (ICC = 0.95). Criterion-related validity evidence (i.e., relationship between PIE and playing time) was weak, but construct-related evidence was acceptable (i.e., college players had higher scores than high school players). A practice effect was also demonstrated among men. In conclusion, reliability of the battery should be improved before its use is recommended among college basketball players. Additionally, the battery does not appear to be a predictor of performance but does appear to distinguish between skill levels.

Silva and others (2011) assessed the validity (Study 1) and reliability (Study 2) of a novel intermittent running test (Carminatti's test) for physiological assessment of soccer players. In Study 1, 28 players performed Carminatti's test, a repeated sprint ability test, and an intermittent treadmill test. In Study 2, 24 players performed Carminatti's test twice within 72 h to determine test-retest reliability. Carminatti's test required the participants to complete repeated bouts of 5 × 12 s shuttle running at progressively faster speeds until volitional exhaustion. The 12 s bouts were separated by 6 s recovery periods, making each stage 90 s in duration. The initial running distance was set at 15 m and was increased by 1 m at each stage (90 s). The repeated sprint ability test required the participants to perform 7 × 34.2 m maximal effort sprints separated by 25 s recovery. During the intermittent treadmill test, the initial velocity of 9.0 km · h(-1) was increased by 1.2 km · h(-1) every 3 min until volitional exhaustion. No significant difference ($P > 0.05$) was observed between Carminatti's test peak running velocity and speed at VO(2max) (v-VO(2max)). Peak running velocity in Carminatti's test was

strongly correlated with v-VO(2max) ($r = 0.74$, $P < 0.01$), and highly associated with velocity at the onset of blood lactate accumulation ($r = 0.63$, $P < 0.01$). Mean sprint time was strongly associated with peak running velocity in Carminatti's test ($r = -0.71$, $P < 0.01$). The intraclass correlation was 0.94 with a coefficient of variation of 1.4%. In conclusion, Carminatti's test appears to be avalid and reliable measure of physical fitness and of the ability to perform intermittent high-intensity exercise in soccer players.

Henry and others (2011) studied the validity of a video-based reactive agility test in Australian footballers. 15 higher performance, 15 lower performance, and 12 no footballers completed a light-based reactive agility test (LRAT), a video-based reactive agility test (VRAT), and a planned test (PLAN). With skill groups pooled, agility time in PLAN (1346 ± 66 ms) was significantly faster ($P = .001$) than both reactive tests (VRAT = 1550 ± 102 ms; LRAT = 1572 ± 97 ms). In addition, decision time was significantly faster ($P = .001$; $d = 0.8$) in LRAT (278 ± 36 ms) than VRAT (311 ± 47 ms). The correlation in agility time between the two reactive tests ($r = .75$) was higher than between the planned and reactive tests ($r = .41$-$.68$). Higher performance players had faster agility and movement times on VRAT (agility, 130 ± 24 ms, $d = 1.27$, $P = .004$; movement, 69 ± 73 ms, $d = 0.88$, $P = .1$) and LRAT (agility, 95 ± 86 ms, $d = 0.99$, $P = .08$; movement, 79 ± 74 ms; $d = 0.9$; $P = .08$) than the nonfootballers. In addition, higher (55 ± 39 ms, $d = 0.87$, $P = .05$) and lower (40 ± 57 ms, $d = 0.74$, $P = .18$) performance groups exhibited somewhat faster agility time than nonfootballers on PLAN. Furthermore, higher performance players were somewhat faster than lower performance for agility time on the VRAT (63 ± 85 ms, $d = 0.82$, $P = .16$) and decision time on the LRAT (20 ± 39 ms, $d = 0.66$, $P = .21$), but there was little difference in PLAN agility time between these groups (15 ± 150 ms, $d = 0.24$, P

= .8). Differences in decision-making speed indicate that the sport-specific nature of the VRAT is not duplicated by a light-based stimulus. In addition, the VRAT is somewhat better able to discriminate different groups of Australian footballers than the LRAT. Collectively, this indicates that a video-based test is a more valid assessment tool for examining agility in Australian footballers.

Hopkins, Stick and Place cited by Safrit (1990) conducted the test on basketball to measure skill in rapidly **shooting** from specific positions and to a certain extent, **agility** and ball handing. The players begin the test with one foot behind any one of five markers, the foot markers are appropriate for grades 10, 11 and 12 and college. For upper elementary grades 5, 6, the markers are placed 9 feet from the target for grades 7, 8 and 9 markers are placed 12 feet from the target. On the signal ready, to the examinee takes the first of three 60 second trials. The ball is shot retrieved, dribbled to the next marker, and shot again. At least one shot must be taken from each of the five markers. Although most shots must be taken from the marker, four lay-ups are permitted during the testing period but no two may be taken in succession. They reported validity of r_{xy} = 0.37 to 0.91 for all ages on individual test items, using a criterion measure of two subjective ratings of skill in shooting and game performance. r_{xy} = 0.65 to 0.95 test battery as a whole. And reliability R_{xx}' = 0.87 to 0.95 for female (test – retest); R_{xx} = 0.84 to 0.95 for males (test – retest).

Hoffman and Kang, (2003) examined the effects of both intensity and volume of training during a 2 d. wk (-l) in-season resistance-training program (RTF) for American football players. Fifty-three National Collegiate Athletic Association Division III football players were tested in the 1 repetition maximum (1 RM) bench press asquat on

the first day of summer training camp (PRE) and during the final week of the regular season (POST). Subjects were required to perform 3 sets of 6-8 repetitions per exercise. Significant strength improvements in squat were observed from PRE (155.0 +/- 31.8 kg) to POST (163.3 +/- 30-° k§)> whereas no PRE to POST changes in bench press were seen (124.7 +/- 21.0 kg vs. 123.9 +/- 18.6 kg, respectively). Training volume and training compliance were not related to strength improvement. Further analysis showed that athletes training at > or = 80% of their PRE 1 RM had significantly greater strength improvements than athletes training at < 80% of their PRE 1 RM, for both bench press and squat. Strength improvements can be seen in American football players, during an in-season RTP, as long as exercise intensity is >or = 80% of the 1 RM.

Khlifa and others, (2010) conducted a study on The purpose of this investigation was to examine the effect of a standard plyometric training protocol with or without added load in improving vertical jumping ability in male basketball players. Twenty-seven players were randomly assigned to 3 groups: a control group (no plyometric training), plyometric training group (PG), and loaded plyometric group (LPG, weighted vests 10-11% body mass). Before and after the 10-week training program, all the players were tested for the 5-jump test (5JT), the squat jump (SJ), and the countermovement jump (CMJ). The PG and LPG groups performed 2 and 3 training sessions per week, during the first 3 and the last 7 weeks, respectively. The results showed that SJ, CMJ, and 5JT were significantly improved only in the PG and LPG groups. The best effects for jumps were observed in LPG ($p < 0.01$), which showed significantly higher gains than the PG ($p < 0.05$). In conclusion, it appears that loads

added to standard plyometric training program may result in greater vertical and horizontal-jump performances in basketball players.

Marques and others (2008) conducted a study on changes in strength and power performance in elite senior female professional volleyball players during the in-season: a case study. It is often recommended that in-season training programs aim to maintain muscular strength and power developed during the off-season. However, improvements in performance may be possible with a well-designed training regimen. The purpose of this case report is to describe the changes in physical performance after an in-season training regimen in professional female volleyball players in order to determine whether muscular strength and power might be improved. Apart from normal practice sessions, 10 elite female volleyball players completed 2 training sessions per week, which included both resistance training and plyometric exercises. Over the 12-week season, the athletes performed 3-4 sets of 3-8 repetitions for resistance and plyometric exercises during each training session. All sessions were supervised by one of the investigators as well as by the team head coach. Muscular strength and power were assessed before and after the 12-week training program using 4 repetition maximum bench press and parallel squat tests, an overhead medicine ball throw (BTd), as well as unloaded and loaded countermovement jumps (CMJs). Strength improved by 15% and 11.5% in the bench press and parallel squat, respectively ($p < 0.0001$). Distance in the BTd improved by 11.8% ($p < 0.0001$), whereas unloaded and loaded CMJ height increased between 3.8 and 11.2%. The current findings suggest that elite female volleyball players can improve strength and power during the competition season by implementing a well-designed training program that includes both resistance and plyometric exercises.

Guigan and others (2012) documented that the use of strength training designed to increase underlying strength and power qualities in elite athletes in an attempt to improve athletic performance is commonplace. Although the extent to which strength and power are important to sports performance may vary depending on the activity, the associations between these qualities and performance have been well documented in the literature. The purpose of this review is to provide a brief overview of strength training research to determine if it really helps improve athletic performance. While there is a need for more research with elite athletes to investigate the relationship between strength training and athletic performance, there is sufficient evidence for strength training programs to continue to be an integral part of athletic preparation in team sports.

Maio Alves and others (2010) analyzed in their study the short-term effects of complex and contrast training (CCT) on vertical jump (squat and countermovement jump), sprint (5 and 15 m), and agility (505 Agility Test) abilities in soccer players. Twenty-three young elite Portuguese soccer players (age 17.4 +/- 0.6 years) were divided into 2 experimental groups (G1, n = 9, and G2, n = 8) and 1 control group (G3, n = 6). Groups G1 and G2 have done their regular soccer training along with a 6-week strength training program of CCT, with 1 and 2 training sessions.wk, respectively. G3 has been kept to their regular soccer training program. Each training session from the CCT program was organized in 3 stations in which a general exercise, a multiform exercise, and a specific exercise were performed. The load was increased by 5% from 1 repetition maximum each 2 weeks. Obtained results allowed identifying (a) a reduction in sprint times over 5 and 15 m (9.2 and 6.2% for G1 and 7.0 and 3.1%, for G2; $p < 0.05$) and () an increase on squat and jump (12.6% for G1 and 9.6% for G2; $p < 0.05$). The results

suggested that the CCT induced the performance increase in 5 and 15 m sprint and in squat jump. Vertical jump and sprint performances after CCT program were not influenced by the number of CCT sessions per week (1 or 2 sessions.wk). From the obtained results, it was suggested that the CCT is an adequate training strategy to develop soccer players' muscle power and speed.

Paradisis, Bissas and Cooke, (2009) in their study examined the effects of sprint running training on sloping surfaces (3 degrees) on selected kinematic and physiological variables. Fifty-four sport and physical education students were randomly allocated to one of two training groups (combineduphill-downhill [U+D] and horizontal (H)) and a control group (C). Pre- and posttraining tests were performed to examine the effects of 8 wk of training on the maximum running speed (MRS), step rate, step length, step time, contact time, eccentric and concentric phase of contact time (EP, CP), flight time, selected posture characteristics of the step cycle, and 6-s maximal cycle sprint test. MRS, step rate, contact time, and step time were improved significantly in a 35-m sprint test for the U+D group (P<.01) after training by 4.3%, 4.3%, -5.1%, and -3.9% respectively, whereas the H group showed smaller improvements, (1.7% (P<.05), 1.2% (P<.01), 1.7% (P<.01), and 1.2% (P<.01) respectively). There were no significant changes in the C group. The posture characteristics and the peak anaerobic power (AWT) performance did not change with training in any of the groups. The U+D training method was significantly more effective in improving MRS and the kinematic characteristics of sprint running than a traditional horizontal training method.

Rinne MB, et.al. (2001) evaluate the test-retest and inter-rater reliability of nine selected tests for the following basic motor skills: balance, orientation, sense of rhythm, kinaesthetic precision and **flexibility.** Twenty-five healthy, non-sporting volunteers (14 men, 11 women, aged 36-72 years) were tested in three sessions at one-week intervals by two raters. For the tests of balance on a bar, tandem walking backwards and forwards and ball bouncing, the within-participant and between-session repeatability, as assessed by the intraclass correlation coefficient (ICC), was high (ICC 0.83-0.96), and for the rhythm test it was fair (ICC 0.70). The inter-rater reliability was also high for all the tests (ICC 0.88-0.96) except that for rhythm (ICC 0.76). In a test-retest design, these tests were sensitive enough to produce sufficient variation between participants in terms of differentiating between individuals. The learning effect was the most remarkable between the pretest and test sessions, and the reliability was better for the test-retest session although a statistically significant difference existed only for tandem walking forwards ($p<0.02$) and balance on a bar ($p<0.004$). The tests with quantitative scores had a smaller margin of error than those with qualitative scores. These tests provide reliable alternatives for assessing basic motor skills of non-sporting adults in the context of physical activity promotion.

Saez and othrs (2008) conducted a study on the effect of plyometric training on chair-rise, jumping and sprinting performance in three age groups of women. The main purpose of this study was to investigate the influence of 8-wk per iodized plyometric training (PT) on chair-rise, jumping and sprinting performance in three groups of women of different age (40-50; 50-60; 60-70 years). This study involved a group of 55 women between the ages of 40 and 70 with no PT experience participating in a gymnastic

program and recreational activity that did not involve jumping and who had participated since five years. All tests to determine the values of strength endurance, vertical jumping performance (VJP) and velocity were carried out before (PRE), after (POST) and following 8 weeks of rest (DETRAINING) of the 8 weeks of PT. The performance tests were completed in 3 days. The primary finding of this investigation indicates that low impact PT using moderate volume of jumps produced similar enhancements in the three age groups of women in jumping and chair-rise performance (30 CST) (ranging 15-24 %). There were no enhancements in 10 m-sprint time in any of the age groups. In addition, 8 weeks of detraining following an 8 week PT program resulted in similar decreases in chair-rise and jumping performance in all training groups, whereas no further changes were observed in 10-m sprint time. The low impact PT proposed appears to be an optimal stimulus for improving VJP and 30 CST during short-term training periods in untrained middle-aged and elderly women.

Sheppard JM, et.al. (2006) evaluated the reliability and validity of a new test of agility, the reactive agility test (RAT), which included anticipation and decision-making components in response to the movements of a tester. Thirty-eight Australian football players took part in the study, categorized into either a higher performance group (HPG) (n=24) or lower performance group (LPG) (n=14) based on playing level from the previous season. All participants undertook testing of a 10m straight sprint (10mSS), a 8-9m change of direction speed test (CODST), and the RAT. Test-retest and inter-tester reliability testing measures were conducted with the LPG. The intra-class correlation (ICC) of the RAT was 0.870, with no significant ($p<0.05$) difference between the test results obtained on the first and second test sessions using a t-test. A dependent samples

t-test revealed no significant ($p<0.05$) difference between the test results of two different testers with the same population. The HPG were significantly ($p=0.001$) superior to those of the LPG on the RAT, with no differences observed on any other variable. The RAT is an acceptably reliable test when considering both test-retest reliability, as well as inter-rater reliability. In addition, the test was valid in distinguishing between players of differing performance level in Australian football, while the 10mSS and CODST were not. This result suggests that traditional closed skill sprint and sprint with direction change tests may not adequately distinguish between players of different levels of competition in Australian football.

Stock and others (2011) studied to calculate test-retest reliability statistics for peak barbell velocity during the free-weight bench-press exercise for loads corresponding to 10-90% of the 1-repetition maximum (1RM). Twenty-one healthy, resistance-trained men (mean ± SD age = 23.5 ± 2.7 years; body mass = 90.5 ± 14.6 kg; 1RM bench press = 125.4 ± 18.4 kg) volunteered for this study. A minimum of 48 hours after a maximal strength testing and familiarization session, the subjects performed single repetitions of the free-weight bench-press exercise at each tenth percentile (10-90%) of the 1RM on 2 separate occasions. For each repetition, the subjects were instructed to press the barbell as rapidly as possible, and peakbarbell velocity was measured with a Tendo Weightlifting Analyzer. The test-retest intraclass correlation coefficients (model 2,1) and corresponding standard errors of measurement (expressed as percentages of the mean barbell velocity values) were 0.717 (4.2%), 0.572 (5.0%), 0.805 (3.1%), 0.669 (4.7%), 0.790 (4.6%), 0.785 (4.8%), 0.811 (5.8%), 0.714 (10.3%), and 0.594 (12.6%) for the weights corresponding to 10-90% 1RM. There were no mean differences between

the barbell velocity values from trials 1 and 2. These results indicated moderate to high test-retest reliability for barbell velocity from 10 to 70% 1RM but decreased consistency at 80 and 90% 1RM. When examining barbell velocity during the free-weight bench-press exercise, greater measurement error must be overcome at 80 and 90% 1RM to be confident that an observed change is meaningful.

Thomas and others, (2009) conducted a study to compare the effect of two plyometric training techniques on muscular power and agility in youth soccer players. Thirty males from as semiprofessional football club's academy were randomly assigned to 6 weeks of depth jump (DJ) or counter movement jump (CMJ) training twice weekly. Participants in the DJ group performed drop jump 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 treatments groups ($p=0.05$) the study concludes that both depth jump and counter movement jump (CMJ) plyometric are worthwhile training activities for improving power and agility in youth soccer players.

Taskin (2009) examined the effect of circuit training directed toward motion and action velocity over the sprint-agility and anaerobic endurance. A total of 32 healthy male physical education students with a mean age of 23.92 +/- 1.51 years were randomly allocated into a circuit training group (CTG; n = 16) and control group (CG; n = 16). A circuit training consisting of 8 stations was applied to the subjects 3 days a week for 10 weeks. Circuit training program was executed with 75% of maximal motion numbers in

each station. The FIFA Medical Assessment and Research Centre (F-MARC) test battery, which was designed by FIFA, was used for measuring sprint-agility and anaerobic endurance. Pre- and post-training testing of participants included assessments of sprint-agility and anaerobic endurance. Following training, there was a significant ($p < 0.05$) difference in sprint-agility between pre- and post-testing for the CTG (pretest = 14.76 +/- 0.48 seconds, posttest = 14.47 +/- 0.43 seconds). Also, there was a significant ($p < 0.05$) difference in anaerobic endurance between pre- and post-testing for the CG (pretest = 31.53 +/- 0.48 seconds, posttest = 30.73 +/- 0.50 seconds). In conclusion, circuit training, which is designed to be performed 3 days a week during 10 weeks of training, improves sprint-agility and anaerobic endurance.

Trzaskoma, Tihanyi and Trzaskoms, (2010) conducted a study on the effect of a short-term combined conditioning training for the development of leg strength and power. The aim of the study was to compare the effect of combined weight and pendulum training exercises with those isolated ones on muscle strength and vertical jump performance. A total of 38 young active men were divided into 4 groups performing different combinations of strength and power training and measured directly and 2 weeks after the training program. Weight training and pendulum swing exercises, involving lower body during dynamic bounces, were used. Results of 1 repetition maximum (1RM) in full squat and squat jump with the barbell, maximal force measured during countermovement jump (CMJ), and hip and knee flexor and extensor isometric strength were analyzed. Significant differences ($p <or= 0.05$) in strength test (1RM squat, hip and knee flexor and extensor strength) were found when performing weight training (1RM-10.2%; maximal torques-23.2%). Positive significant increase ($p <or= 0.05$) in all strength and power

parameters (maximal torques-from 2, 468.9 +/- 387.4 to 2, 712.4 +/- 501.6 Nxm; 1RM squat-from 93.9 +/- 15.0 to 111.4 +/- 15.6 kg; CMJ power-from 3, 050.7 +/- 478.5 to 3, 419.8 +/- 506.6 W; CMJ jump height-from 48.8 +/- 4.1 to 53.4+/-3.0 cm) after the training program was found when combined training was used. Seated safety position during the pendulum swing is responsible for significant training effect with reduced loads. Plyometric pendulum swing training combined with traditional training can be an alternative, effective method to increase muscle strength and power during short pre or in-season mesocycles.

2.2. STUDIES ON CIRCUIT AND RESISTANCE TRAIPHYSIOLOGICAL VARIABLES

Brown and others (2010) conducted a study on Oxygen consumption, heart rate, and blood lactate responses to an acute bout of plyometric depth jumps in college-aged men and women. Although plyometrics are widely used in athletic conditioning, the acute physiologic responses to plyometrics have not been described. The purpose of this study was to investigate the oxygen consumption, heart rate, and blood lactate responses to a single session of plyometric depth jumps. Twenty recreationally trained college-aged subjects (10 men, 10 women) participated in a single session of 8 sets of 10 box depth jumps from a height of 0.8 m with 3 minutes of passive recovery between each set. Plyometric depth jumping elicited 82.5 +/- 3.1% and 77.8 +/- 3.1% of the measured maximal oxygen consumption (O2max) for women and men, respectively, with no difference in oxygen consumption in ml/kg/min or percent O2max between sexes or sets. Heart rate significantly increased ($p < 0.05$) from 68.1 +/- 2.9 beatsxmin-1 at rest to 169.6 +/- 1.2 beatsxmin-1 during depth jumping. Sets 5 to 8 elicited a higher ($p < 0.05$) heart rate (173.3 +/- 1.3 beatsxmin-1) than sets 1 to 4 (164.6 +/- 1.8 beatsxmin-1). Women

exhibited a higher heart rate ($p < 0.05$) during sets 1 and 2 (169.9 +/- 2.8 beatsxmin-1) than men (150.7 +/- 4.4 beatsxmin-1). The blood lactate concentrations were significantly ($p < 0.05$) increased above resting throughout all sets (1.0 +/- 0.2 mmolxL-1 compared with 2.9 +/- 0.1 mmolxL-1), with no differences between sexes or sets. Plyometric depth jumping significantly increased oxygen consumption, heart rate, and blood lactate in both men and women, but no significant difference was found between the sexes. Plyometric depth jumping from a height of 0.8 m has similar energy system requirements to what Wilmore and Costill termed "Aerobic Power" training, which should enhance O2max, lactate tolerance, oxidative enzymes, and lactate threshold.

Cesar and others (2009) investigated the effect of local muscle endurance training on maximal oxygen uptake and ventilatory threshold in young women. Nineteen untrained women, ranging in age from 18 to 26 years, were included in the study and assigned to two groups: the control group (n = 10), and the resistance training group (n = 9). The following variables were obtained at baseline and after 12 weeks: body mass; maximal oxygen uptake, maximal heart rate, maximal oxygen pulse, oxygen uptake at the ventilatory threshold, heart rate at the ventilatory threshold, and oxygen pulse at the ventilatory threshold assessed by cardiopulmonary exercise testing on treadmill; 1-repetition maximum (RM) tests in bench press, latissimus pull down, military press, lying barbell extension, standing barbell curls, leg press, knee extension, and hamstring curl. The training group underwent resistance strength training. Loading during training followed the concept of maximum repetitions. Each session was defined as the performance of three sets of 15RM with a 60-second rest between sets and exercises. No significant changes were observed in the control group before and after 12

weeks ($p > 0.05$). All 1RM tests increased after training ($p < \text{or} = 0.01$) in the training group, but no significant change was observed in body mass ($p > 0.05$). Cardiopulmonary variables showed no significant differences before and after resistance training ($p > 0.05$). These findings indicate that the local muscle endurance training realized produces no improvement in cardiorespiratory capacity in young women.

Currell and Jeukendrup (2008) reported that performance testing is one of the most common and important measures used in sports science and physiology. Performance tests allow for a controlled simulation of sports and exercise performance for research or applied science purposes. There are three factors that contribute to a good performance test: (i) validity; (ii) reliability; and (iii) sensitivity. A valid protocol is one that resembles the performance that is being simulated as closely as possible. When investigating race-type events, the two most common protocols are time to exhaustion and time trials. Time trials have greater validity than time to exhaustion because they provide a good physiological simulation of actual performance and correlate with actual performance. Sports such as soccer are more difficult to simulate. While shuttle-running protocols such as the Loughborough Intermittent Shuttle Test may simulate physiology of soccer using time to exhaustion or distance covered, it is not a valid measure of soccer performance. There is a need to include measures of skill in such protocols. Reliability is the variation of a protocol. Research has shown that time-to-exhaustion protocols have a coefficient of variation (CV) of >10%, whereas time trials are more reliable as they have been shown to have a CV of <5%. A sensitive protocol is one that is able to detect small, but important, changes in performance. The difference between

finishing first and second in a sporting event is <1%. Therefore, it is important to be able to detect small changes with performance protocols. A quantitative value of sensitivity may be accomplished through the signal : noise ratio, where the signal is the percentage improvement in performance and the noise is the CV.

Davis and others (2011) observed the effects of a circuit training (CT; aerobic + strength training) program, with and without motivational interviewing (MI) behavioral therapy, on reducing adiposity and type 2 diabetes risk factors in Latina teenagers. Thirty-eight Latina adolescents (15.8 ±1.1 yrs) who are overweight/obese were randomly assigned to: Control (C; n=12), CT (n=14) or CT+MI (n=12). The CT classes were held twice a week (60-90 minutes) for 16 weeks. The CT+MI group also received individual or group MI sessions every other week. The following were measured at pre- and post-intervention: strength by 1-repetition max; cardiorespiratory fitness (VO2max) by submaximal treadmill test; physical activity by accelerometry; dietary intake by records; height, weight, waist circumference; total body composition by DEXA; visceral adipose tissue (VAT), subcutaneous adipose tissue (SAT) and hepatic fat fraction (HFF) by Magnetic Imaging Resonance (MRI); glucose/insulin indices by fasting blood draw. Across intervention group effects were tested using repeated measures ANOVA with post-hoc pairwise comparisons. CT and CT+MI participants, compared to Controls, significantly increased fitness (+16% & +15% vs. -6%; P=0.03), and leg press (+40% vs. +20%; P=0.007). Compared to Controls, CT participants also decreased waist circumference (-3% vs. +3%; P<0.001), SAT (-10% vs. 8%; P=0.04), VAT (-10% vs. +6%; P=0.05), fasting insulin (-24% vs. +6%; P=0.03) and insulin resistance (-21% vs. -4%; P=0.05). CT may be an effective starter program to reduce fat depots and improve

insulin resistance in Latino youth who are overweight/obese, while the additional MI therapy showed no additive effect on these health outcomes.

Schwesing and others (2011) documented that soccer has increasingly become a technical - tactical (speed of activity!) and athletic sport over the last years. Simultaneously the new training and contest conditions result in new challenges to sports science and sports medicine evaluation. Complex, sports specific field tests for soccer exist rarely and only in low quality. Development and evaluation of a standardised complexity test in soccer (FBKT) for assessment of the complex sports specific and league specific physical performance. Two regional German soccer teams (Verbandsliga [VL], Oberliga [OL]) (n = 27) were assessed with FBKT. The assessment included lactate levels, heart rate as well as time and error frequency (penalty time per error: 5 s) for defined activity series at defined time points (heart rate: rest, after round 1, prior to round 2, E 0, E 2, E 6, E 10, E 14; lactate: rest, E 2, E 6, E 10, E 14). The heart rate (hr (max) = 200 min (-1)) and metabolic rate (lactate (max) = 17.1 mmol/l) were very excessively high and did only partially differ between the groups (heart rate difference at rest p = 0.005, prior to round 2: p = 0.014, E 6: p = 0.042). Furthermore no significant differences occurred in the following parameters: recovery potential (hr (E0 - E14): p = 0.560; lactate (Max-Min): p = 0.448), technical error (p = 0.384), sprint (p = 0.499), slalom dribbling (p = 0.310), time round 1 (p = 0.119), shots on goal (p = 0.585) and crosses (p = 0.676). Significant difference were only found in the parameters time round 2 (p = 0.004), time round 1 and round 2 (p = 0.013), overall time (running)(time + penalty)(time) (p = 0.022) and speed dribbling (p = 0.005). Soccer specific complex loads generate very high physical demamds. Although complex, the FBKT proved to be

a practical assessment tool with high standardising potential. The FBKT gives plentiful information under competition - like conditions such as technical skills, speed, speed endurance or anaerobe capacity.

Spurrs, Murphy and watsford. (2003) conducted a study to examine whether changes in running performance resulting from plyometric training were related to alterations in lower leg muscles tedious stillness (MTS). 17 male runners were pre and post-tested for lower leg MTS, maximum isometric force, rate of force development, 5-bound distance test (5BT), counter movement jump (CMJ) height, RE, Vo (2 max), lactate threshold [Th (cla)], and a 3-km time. The subjects were randomly split into an experimental (E) group which completed 6 weeks of plyometric training in conjunction with their normal running training, and a control(C) group which trained as normal. Following the training period, the E group significantly improved 3-km performance and RE at each of the tested velocities, while no changes in Vo (2 max) or Th (la) were recorded. CMJ height, 5 BT and MTS also increased significantly. No significant changes were observed in any measures for the C group. The result clearly demonstrated that a 6-week plyometric programme led to improvements in 3-km running performance. It is postulated that the increase in MTS resulted in improved RE which is believed to make changes in 3km running performance, as there were no corresponding alternations in Vo (2 max) or Th (la).

2.3. STUDIES ON CIRCUIT AND RESISTANCE TRAINING ON PERFORMANCE VARIABLES

Ali (2011) reported that the ability to execute skilled movement patterns efficiently and effectively is the most important aspect of soccer performance and players must apply cognitive, perceptual and motor skills to rapidly changing situations. There

have been attempts to measure these parameters for talent identification (or development) purposes and skill acquisition and intervention research; the aim of this review is to examine the strengths and limitations of these tests. High levels of perceptual and cognitive skill are characteristics of those players who are able look in the right places for information and process this information efficiently before deciding on a suitable course of action. The motor skills required to successfully control, pass, dribble and shoot the ball at goal are fundamental skills of the soccer player and a variety of methods have been used to measure these aspects. The tests mentioned in this review vary in their complexity and the type of skill(s) they purport to measure. The assessment of choice must come down to a number of factors including cost, available time and space, number of athletes in the cohort and experience of researchers. Furthermore, consideration must be given to the aim(s) of the research/assessment and issues relating to validity and reliability.

Avery faigenbaum (2007) conducted a study to compare the effect of a six – week training period of combined plyometric and resistance training (or) resistance training on fitness performance in boys, (They aged ranged from 12-15 yrs). The resistance-training group performed static stretching exercises followed by resistance training whereas the plyometric and resistance group performed plyometric exercises followed by the same resistance training programme .The training duration per session for both group was 90 min .At baseline after training all participants were tested on the vertical jump. Long jump medicine ball toss, 9.1m sprint, pro agility, shuttle run and flexibility. The PRT group made significantly ($p<0.05$) greater improvements than RT in long Jump (10.8cm vs. 2.2cm), medicine bal toss (39.1 cm vs. 17.7cm) and pro agility, shuttle run time (-0.23sec vs. –0.02 sec) following training. These findings suggest that

the addition plyometric training to a résistance training program may be more beneficial than resistance training and static stretching for enhancing selected measures of upper and lower body power in boys.

Bullock and others (2012) evaluated the effect of 45min of soccer-specific exercise in the reactive motor skills test (RMST); a novel test which measures sprint, passing and reactive agility (RAT) performance. Forty-two high-level amateur male soccer players (age 18.5±3.5years) were recruited. Participants were familiarized with the RMST prior to initial testing. Participants undertook 10 repetitions of the RMST before and after 45D min of soccer-specific exercise using the Southborough Intermittent Shuttle Test. Eighteen of these participants repeated the RMST for test re-test reliability determination. Paired t-tests and effect size statistics were used to determine the effect of 45min of intermittent exercise on RMST performance. Reliability was assessed using the standard error of measurement. The exercise protocol resulted in moderate decreases of sprint (3.0±0.9%, mean±SD; 1.030±0.09 ES±90% Confidence Intervals; $p<0.00001$) and RAT performance (1.5±1.1%; 1.015±0.011; $p<0.05$), but improved passing task time (-2.7±1.2%; 0.973±0.012; $p<0.001$) and passing accuracy (3.6±3.3%; 1.036±0.33). Change in total test time was trivial. The test-retest coefficient of variation for the test was 2.4±0.8%. Soccer-specific exercise decreased sprint and reactive agility performance but improved technical skill performance on a novel, integrative and reliable test of soccer skill performance. Overall RMST performance time was largely unchanged.

Castllo and others (2010) investigated the efficacy of intermediate penalty kickers by comparing the effect of applying an automated WiFi system on the field of play to simulate a strategy that takes account of goalkeeper action (dependent) with

another for which goalkeeper strategy is irrelevant (independent). Intermediate penalty kickers (n=12) took a pretreatment test of 32 kicks in a "real-play" situation with intermediate goalkeepers (n=3). Two groups of kickers underwent 11 treatment sessions using different strategies and then were administered a post treatment test. The variables measured were the number of goals scored, whether the direction of the shot was the same or different from the direction of the goalkeeper's move (DDG), ball speed, and the duration of the kicking movement. Data suggested the goalkeepers had a greater capacity to identify advance cues when faced with independent strategy kickers and that dependent strategy kickers achieved lower ball speeds.

Chutara and others, (2008) conducted a study on the effect of concurrent endurance and circuit resistance training sequence on muscular strength and power development. The purpose of this study was to examine the influence of the sequence order of high intensity endurance training and circuit training on changes in muscular strength and anaerobic power. Forty eight physical education students (ages,21.4 +/-1.3 years) were assigned to w of 5 groups: no training controls (C, n =9), endurance training (E,n=10), circuit training (S,n=9), endurance before circuit training in the same session, (E+S,n=10), and circuit before endurance training in the same session (S+E n=10).subjects performed 2 sessions per week for 12 weeks. Resistance type circuit training targeted strength endurance (Weeks 1-6) and explosive strength and power (weeks 7-12). Endurance training sessions included d 5 repetition run at ate the velocity associated with Vo2 max (Vo2 max) for duration equal to 50 % of the time to exhaustion at vo2 max; recovery was for an equal period at 60 %^ vo2 max .Maximal strength in the half squat, in the 1-leg half squat and hip extension, and explosive strength and power in a5 jumps test and countermovement

jump were measured pre- and post testing. no significant differences were shown following training between the S +E and E+S groups for all exercise tests .however both S+E and E+S groups improved less than the S group in 1 repetition ,maximum ($p < 0.01$), right and left 1-leg half squat ($0<0.02$), 5 jump test ($p < 0.01$), peak jumping force ($p < 0.05$peak jumping power ($p<o,.02$) ,and peak jumping height ($p< 0.05$). The intra session sequence did not influence the adaptive response of muscular strength and explosives strength and power. Circuit training alone induced strength and power improvements that were significantly greater than when resistance and endurance training were combined, irrespective of the intra session sequencing.

Chtara and others (2008) conducted a study on Low and moderate plyometric training frequency produces greater jumping and sprinting gains compared with high frequency. The purpose of this study was to examine the effect of 3 different plyometric training frequencies (e.g., 1 day per week, 2 days per week, 4 days per week) associated with 3 different plyometric training volumes on maximal strength, vertical jump performance, and sprinting ability. Forty-two students were randomly assigned to 1 of 4 groups: control (n = 10, 7 sessions of drop jump (DJ) training, 1 day per week, 420 DJs), 14 sessions of DJ training (n = 12, 2 days per week, 840 DJs), and 28 sessions of DJ training (n = 9, 4 days per week, 1680 DJs). The training protocols included DJ from 3 different heights 20, 40, and 60 cm. Maximal strength (1 repetition maximum [1RM] and maximal isometric strength), vertical height in countermovement jumps and DJs, and 20-m sprint time tests were carried out before and after 7 weeks of plyometric training. No significant difference was observed among the groups in pre-training in any of the variables tested. No significant changes were observed in the control group in any of the

Variables tested at any point. Short-term plyometric training using moderate training frequency and volume of jumps (2 days per week, 840 jumps) produces similar enhancements in jumping performance, but greater training efficiency (approximately 12% and 0.014% per jump) compared with high jumping (4 days per week, 1680 jumps) training frequency (approximately 18% and 0.011% per jump). In addition, similar enhancements in 20-m-sprint time, jumping contact times and maximal strength were observed in both a moderate and a low number of training sessions per week compared with high training frequencies, despite the fact that the average number of jumps accomplished in 7S (420 jumps) and 14S (840 jumps) was 25 and 50% of that performed in 28S (1680 jumps). These observations may have considerable practical relevance for the optimal design of plyometric training programs for athletes, given that a moderate volume is more efficient than a higher plyometric training volume.

Diallo and others, (2001) examined the effectiveness of plyometric training and maintenance training on physical performances in prepubescent soccer on players was examined. Twenty boys aged 12-13 years were divided into two groups (10 in each): Jump group (JG) and control group (CG). JG trained 3 days/week during 10weeks, and performed various plyometric exercises including jumping, hurdling and skipping. 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: counter movement jump (CMJ), squat jump (SJ), drop jump (DJ), multiple 5 bounds (MB5) and repeated rebound jump for 15 seconds (RRJ 15). Running velocities included; 20, 30 and 40m (v20, v30, v40m). Body fat percentage (BF percent) and lean leg volume were estimated by anthropocentric before training; except for

Percent all baseline anthropometrics characteristics were similar between JG and CG. After the training program P max, CMJ, SJ, MB5, RRJ15 and v20M, 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 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.

Gorge et.al. (2002) and others conducted the study and its aims were to examine the release speed of the ball in maximal in-step kicking with the preferred and the non-preferred leg and to relate ball speed to bio mechanical differences observed during the kicking action. Seven skilled soccer players performed maximal speed place in kicks with the preferred and the non-preferred leg; their movements were filmed at 400 Hz. The inter-segmental kinematics and kinetics were derived. A coefficient of restitution between the foot and ball was calculated and rate of force development in the hip flexors and the knee extensors were measured using a kin-corn dynamometer. Higher ball speeds were achieved with the preferred leg as result of the higher foot speed and coefficient of restitution at the time of impact compared with the non-preferred leg. These higher foot speeds were caused by a greater amount of work on the shank originating from the angular velocity of the thigh. No differences were found in muscle moments or rate of force development. The difference in maximal ball speed between the preferred and the non-preferred leg is caused by a inter-segmental motion pattern and a transfer of velocity from the foot to the ball when kicking with the preferred leg.

Guadalupe- grau and others, (2000) conducted a study on the strength training combined with plyometric jumps in adults: sex differences in fat bone axis adaptations. Lepton and osteocalcin play a role in the regulation of the fat bone axis and may be altered by exercise. To determine whether osteocalicn reduces fat mass in humans fed ad labium and if there is a sex dimorphism in the serum osteocalcin and lepton responses to strength training, we studied 43 male (age 23.9 2.4 yr ,mean +/- SD) and 23 female physical education students (age 23.2 =/- 2.7 yr) . Subjects were randomly assigned to two groups: training (TG) and control (CG) .TG followed a strength combined with plyometric jumps training program during 9 week, whereas the CG did not train. Physical fitness, body composition (Dual –energy X ray absorptiomertry) .In the whole group of subjects (prêtraining), the serum concentration osteocalcin was positively correlated (r= o.29-0.42, $p < 0.05$) with whole body and regional bone mineral content , lean mass, dynamic strength, and serum free testosterone concentration (r=0.32).However,osteoclacin was negatively correlated with leptin concentration)(r= 0.37).fat mass (r= -0.31), and the percent body fat (r= -0.44) . Both sexes experienced similar relative improvements in performance, lean mass (+ 4-5 %), and whole body (+ 0.78 %) and lumbar spine bone mineral content (+ 1.2-2%), with training .Serum osteocalcin concentration was increased after training by 45 and 27% in men and women. Respectively ($p < 0.05$). Fat mass was not altered by training. Vastus laterals type II MHC compositional at the start of the training program predicted 25 % of the osteoclacin increase after training .Serum leptin concentration was reduced either training in women. In summer, while the relative effecter's strength training plus plyometric jumps in performance. Muscle hypertrophy, and osterogenesis are similar in men and women

serum leptin concentration is reduced only in women. The ostecalcin response to strength trainings is in reduced only in women. The osteocalcin response to strength training is, in part, modulated by the muscle phenotype (MHC isoform composition) despite the increase in osteocalcin, fat mass was not reduced.

Halland and Hoff (2003) stated that the aim of this experiment was to evaluate bilateral motor performance effects from training the non-dominant leg of competitive soccer players. The subjects were 39 soccer players, 15-20 years of age, performance-matched and randomly divided into a training group (n = 18) and control group (n = 21) both belonging to the same team. Both groups were tested by using the non-dominant leg for 8 weeks. Statistical analyses for the soccer-specific tests revealed that the experimental group improved significantly as compared to the control group from the pre-test to the post-test period in their use of the trained non-dominant leg. Somewhat unexpectedly, the experimental group also improved significantly in the tests, which made use of the dominant. The standardised foot-tapping tests revealed similar results. The results might be explained by improved generalized motor programmes, or from a dynamic systems approach, indicating that the actual training relates to the handling of all the information available to other subject in the solution and that the body self-organizes the motor performance. In professional soccer, a significant amount of training time is used to improve players' aerobic capacity. However, it is not known whether soccer specific training fulfils the criterion of effective endurance training to improve maximal oxygen uptake, namely an exercise intensity of 90-95% of maximal heart rate in periods of three to eight minutes. To determine whether ball dribbling and small group play are appropriate activities for interval training and whether

heart rate in soccer specific training is a valid measure of actual work intensity. Six well trained first division soccer players took part in the study. To test whether soccer specific training was effective interval training, players ran in a specially designed dribbling track, as well as participating in small group play (five a side). Laboratory tests were carried out to establish the relation between heart rate and oxygen uptake while running on a treadmill. Corresponding measurements were made on the soccer field using a portable system for measuring oxygen uptake. Exercise intensity during small group play was 91.3% of maximal heart rate or 84.5% of maximal oxygen uptake. Corresponding values using a dribbling track were 93.5% and 91.7%. No higher hear rate was observed during soccer training. It concluded that exercise using ball dribbling or small group play may be performed as aerobic interval training. Heart rate monitoring during soccer specific exercise is a valid indicator of actual exercise intensity.

Impelizzeri and others (2008) was conducted a study on the effect of plyometric training on sand versus grass on muscle soreness and jumping and sprinting ability in soccer players. The lower impact on the musculoskeletal system induced by plyometric exercise on sand compared to a firm surface might be useful to reduce the stress of intensified training periods or during rehabilitation from injury. The aim of this study was to compare the effects of plyometric training on sand versus a grass surface on muscle soreness, vertical jump height and sprinting ability. Parallel two-group, randomized, longitudinal (pretest-post-test) study. After random allocation, 18 soccer players completed 4 weeks of plyometric training on grass (grass group) and 19 players on sand (sand group). Before and after plyometric training, 10 m and 20 m sprint time, squat jump (SJ), countermovement jump (CMJ), and eccentric utilization ratio (CMJ/SJ) were

determined. Muscle soreness was measured using a Likert scale. No training surface x time interactions were found for sprint time ($p>0.87$), whereas a trend was found for SJ ($p = 0.08$), with both groups showing similar improvements ($p<0.001$). On the other hand, the grass group improved their CMJ ($p = 0.033$) and CMJ/SJ ($p = 0.005$) significantly ($p<0.001$) more than players in the sand group. In contrast, players in the sand group experienced less muscle soreness than those in the grass group ($p<0.001$). Plyometric training on sand improved both jumping and sprinting ability and induced less muscle soreness. A grass surface seems to be superior in enhancing CMJ performance while the sand surface showed a greater improvement in SJ. Therefore, plyometric training on different surfaces may be associated with different training-induced effects on some neuromuscular factors related to the efficiency of the stretch-shortening cycle.

Jovanovic and others (2011) evaluated the effects of the speed, agility, quickness (SAQ) training method on power performance in soccer players. Soccer players 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 information 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.

Kannekens and others (2011) documented that Talent identification and development implicate recognizing youth players who will be successful in the future and guiding them to the top. A major determinant of this success is tactical skills. To identify possible key factors that help in predicting success over time, this study assesses the tactical skills of 105 elite youth soccer players who participated in a talent development program at an earlier stage of their sport career (mean age 17.8±0.9). These skills were related to their adult performance level, specifically whether they became professionals (n=52) or amateurs (n=53). Defenders, midfielders and attackers completed the Tactical Skills Inventory for Sports with scales for declarative and procedural knowledge in either attacking or defensive situations. A logistic regression analysis was performed to identify the tactical skills that contribute to professional performance level in adulthood. Positioning and deciding appeared to be the tactical skill that best predicts adult performance level ($P<0.05$). This is especially true for midfielders, with the correct classification of elite youth players in the range of 80%. For players scoring high on this skill, the odds ratios indicated a 6.60 times greater chance that a player became a professional than players scoring low ($P<0.05$).

Koshida and others (2008) mentioned that previous studies have suggested that resistance training exercise under unstable conditions decreases the isometric force output, yet little is known about its influence on muscular outputs during dynamic movement. In their study they investigated the effect of an unstable condition on power, force, and velocity outputs during the bench press. Twenty male collegiate athletes (mean age, 21.3 +/- 1.5 years; mean height, 167.7 +/- 7.7 cm; mean weight, 75.9 +/- 17.5 kg) participated in this study. Each subject attempted 3 sets of single bench presses with 50% of 1 repetition maximum (1RM) under a stable condition with a flat bench and an unstable condition with a Swiss ball. Acceleration data were obtained with an accelerometer attached to the center of a barbell shaft, and peak outputs of power, force, and velocity were computed. Although significant loss of the peak outputs was found under the unstable condition ($p < 0.017$), their reduction rates remained relatively low, approximately 6% for force and 10% for power and velocity outputs, compared with previous findings. Such small reduction rates of muscular outputs may not compromise the training effect. Prospective studies are necessary to confirm whether the resistance training under an unstable condition permits the improvement of dynamic performance and trunk stability.

Langford and others (2007) in their study compared the effects of 10 weeks of resistance training with an isotonic bench press machine and 2 types of free-weight bench press exercises on several measures bench press strength. Specificity was investigated by comparing the ability to transfer strength gained from a type of training that differed from the mode of testing. Forty-nine men participated in the study. The subjects completed a pretest on the machine (MB), barbell (BB), isokinetic (IB), and log (LB) bench press to

determine baseline strength and completed 10 weeks of training on the MB, BB, or LB. The 3 groups were tested to see whether differential training effects occurred from pre- to posttest scores on the BB, MB, LB, and peak force on the IB. By multivariate analysis, the trial-by-group interaction was not statistically significant. The multivariate and subsequent univariate analyses of variance tests indicated statistically significant effects from pre- to posttest for peak force on the IB test and the BB, MB, and LB. Correlations among the strength tests were high (0.92 > or = r < or = 0.97) and moderate between the strength tests and IB peak force (0.62 > or = r < pr = 0.83). Mean 3 repetition maximum MB strength was 8% higher than BB strength, which was 3% higher than LB strength, indicating differences in the amount of stabilization required to control the resistance. The findings of this study showed that all 3 training groups significantly improved in strength during short-term training on the MB, BB, and LB. These data lend evidence that improved strength after training on the MB, BB, and LB equally transfers to strength gains on any of the 4 modes of testing. These results should be considered when including similar exercises varying in stability into the training program to improve strength.

Markovic and others, (2007) investigated on the effects of sprint and plyometric training on muscle function and athletic performance 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 andCMJ) 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 for 3 days a week: SG performed maximal sprints over distances of 10 -50 M., whereas PG performed bounce –type hurled 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 size ES were moderarate high ranged between 0.4 and 1.1. in addition, SG also improved isomeric squat strength.(10%ES=0.4) and SJ and CMJ power(4%ES 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 and athletic performance then 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.

Meylan and others (2009) conducted a study on the effects of in-season plyometric training within soccer practice on explosive actions of young players. In soccer, explosive actions such as jumping, sprinting, passing and changes of direction are essential to optimal performance not only in adults, but also in children's games. The purpose of the present investigation was to determine the influence of 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 was 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.

Mirkov (2008) documented that the soccer-specific field tests are popular among coaches due to their simplicity, validity, and minimal use of equipment. Nevertheless, there is a general lack of data about their reliability, particularly regarding the tests of anaerobic performance. Twenty professional male soccer players performed 3 consecutive trials of the tests of throwing-in and standing-kick performance (the distance measured) as well as on timed 10-m sprint, flying 20-m sprint, running 10 x 5 m, zigzag running with and without the ball, and the skill index (i.e., the ratio of the zigzag running without and with the ball). With the exception of the throwing-in and standing kick, the evaluated tests revealed high intraclass correlation coefficients (i.e., >0.80), small within-individual variations (coefficient of variation, <4%), and sample sizes for detecting a 2%

change in the tested performance that are either close to or below the standard size of a professional soccer squad. In addition to simplicity and face validity, most of the evaluated tests revealed high reliability. Therefore, the evaluated tests are recommended for sport-specific profiling and early selection of young athletes as well as for routine testing procedures that could detect effects of various intervention procedures. Regarding the throwing-in and standing-kick tests, direct measurement of the ball velocity (e.g., with a standard radar gun) is recommended.

Perez Gomez and others (2008) conducted a study on effects of weight lifting training combined with plyometric exercises on physical fitness, body composition, and knee extension velocity during kicking in football. The effects of a training program consisting of weight lifting combined with plyometric exercises on kicking performance, myosin heavy-chain composition (vastus lateralis), physical fitness, and body composition (using dual-energy X-ray absorptiometry (DXA)) was examined in 37 male physical education students divided randomly into a training group (TG: 16 subjects) and a control group (CG: 21 subjects). The TG followed 6 weeks of combined weight lifting and plyometric exercises. In all subjects, tests were performed to measure their maximal angular speed of the knee during in-step kicks on a stationary ball. Additional tests for muscle power (vertical jump), running speed (30 m running test), anaerobic capacity (Wingate and 300 m running tests), and aerobic power (20 m shuttle run tests) were also performed. Training resulted in muscle hypertrophy (+4.3%), increased peak angular velocity of the knee during kicking (+13.6%), increased percentage of myosin heavy-chain (MHC) type IIa (+8.4%), increased 1 repetition maximum (1 RM) of inclined leg press (ILP) (+61.4%), leg extension (LE) (+20.2%), leg curl (+15.9%), and half squat (HQ)

(+45.1%), and enhanced performance in vertical jump (all p < or = 0.05). In contrast, MHC type I was reduced (-5.2%, p < or = 0.05) after training. In the control group, these variables remained unchanged. In conclusion, 6 weeks of strength training combining weight lifting and plyometric exercises results in significant improvement of kicking performance, as well as other physical capacities related to success in football (soccer).

Ratamess and Kraener, (2007) The purpose of this investigation was to examine the combined effects of resistance and sprint/plyometric training with or without the Meridian Elite 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 per iodized 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.

Ronnestad and others (2008) compared the effects of combined strength and plyometric training with strength training alone on power-related measurements in professional soccer players. Subjects in the intervention team were randomly divided into 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.

Russell and others (2010) examined the reliability and construct validity of new soccer skills tests. Twenty soccer players (10 professional and 10 recreational) repeated trials of passing, shooting, and dribbling skills on different days. Passing and shooting skills required players to kick a moving ball, delivered at constant speed, towards one of four randomly determined targets. Dribbling required players to negotiate seven cones over 20 m. Each trial consisted of 28 passes, 8 shots, and 10 dribbles. Ball speed, precision, and success were determined for all tests using video analysis. Systematic bias was small (<9% in all measures) and all outcome measures were similar between trials. Test-retest reliability statistics were as follows: ball speed (passing, shooting, dribbling; coefficient of variation [CV]: 6.5%, 6.9%, 2.4%; ratio limits of agreement [RLOA]: 0.958 ×/÷ 1.091, 0.990 ×/÷ 1.107, 0.993 ×/÷ 1.039), precision (passing, shooting, dribbling; CV: 10.0%, 23.5%, 4.6%; RLOA: 0.956 ×/÷ 1.147, 1.030 ×/÷ 1.356, 1.000 ×/÷ 1.068), and success (passing, shooting, dribbling; CV: 11.7%, 14.4%, 2.2%; RLOA: 1.017 ×/÷ 1.191, 0.913 ×/÷ 1.265, 0.996 ×/÷ 1.035). Professional players performed better than recreational players in at least one outcome measure for all skills. These findings demonstrate the reliability and validity of new soccer skill protocols.

Sedano Campo and others (2009) conducted a study on effects of lower-limb plyometric training on body composition, explosive strength, and kicking speed in female soccer players. The aim of the present study was 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 this program would increase the jumping ability and kicking speed and that these 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.

Sunderland C, et.al. (2006) reported that high test retest reliability is essential in tests used for both scientific research and to monitor athletic performance. Thirty-nine (20 male and 19 female) well-trained university field hockey players volunteered to

participate in the study. The reliability of the in house designed test was determined by repeating the test (3 - 14 days later) following full familiarization. The validity was assessed by comparing coaches ranks of players with ranked performance on the skill test. The mean difference and confidence limits in overall skill test performance was 0.0 +/- 1.0 % and the standard error (confidence limits) was 2.1 % (1.7 to 2.8 %). The mean difference and confidence limits for the "decision making" time was 0.0 +/- 1.0 % and the standard error (confidence limits) was 4.5 % (3.6 to 6.2 %). The validity correlation (Pearson) was r = 0.83 and r = 0.73 for female players and r = 0.61 and r = 0.70 for male players for overall time and "decision making" time respectively. We conclude that the field hockey skill test is a reliable measure of skill performance and that it is valid as a predictor of coach-assessed hockey performance, but the validity is greater for female players.

Taipale and others (2010) examined the effects of periodized maximal versus explosive strength training and reduced strength training, combined with endurance training, on neuromuscular and endurance performance in recreational endurance runners. Subjects first completed 6 weeks of preparatory strength training. Then, groups of maximal strength (MAX, n=11), explosive strength (EXP, n=10) and circuit training (C, n=7) completed an 8-week strength training intervention, followed by 14 weeks of reduced strength training. Maximal strength (1RM) and muscle activation (EMG) of leg extensors, countermovement jump (CMJ), maximal oxygen uptake (VO(2MAX)), velocity at VO(2MAX) (vVO(2MAX)) running economy (RE) and basal serum hormones were measured. 1RM and CMJ improved ($p<0.05$) in all groups accompanied by increased EMG in MAX and EXP ($p<0.05$) during strength training. Minor changes occurred in VO(2MAX), but vVO(2MAX) improved in all groups ($p<0.05$) and RE in

EXP ($p<0.05$). During reduced strength training 1RM and EMG decreased in MAX ($p<0.05$) while vVO(2MAX) in MAX and EXP ($p<0.05$) and RE in MAX ($p<0.01$) improved. Serum testosterone and cortisol remained unaltered. Maximal or explosive strength training performed concurrently with endurance training was more effective in improving strength and neuromuscular performance and in enhancing VO (2MAX) and RE in recreational endurance runners than concurrent circuit and endurance training.

Vandendriessche and others (2012) reported the morphology (height, weight, body fat, body mass index), fitness (strength, speed, agility, flexibility), and soccer-specific (dribbling) and non-specific motor coordination skills (Körper KoordinationsTest für Kinder; KTK) of 78 Belgian international youth soccer players aged 15-16 years with varying biological maturity status. The more mature players (U16 and U17) possessed higher morphological measures and outperformed their later maturing peers (U16 Futures and U17 Futures) on almost all fitness tests. However, soccer-specific and non-specific motor coordination tests did not distinguish the more mature players from the later maturing players in both age groups. When adjusted for the confounder (age at peak height velocity), multivariate analysis of covariance revealed that several morphology- and fitness-related parameters did not differ between selection groups, again in both age groups. These findings indicate that biological maturation affects morphology and fitness more so than motor coordination skills. In conclusion, to prevent the dropout of promising late maturing players, we suggest avoiding one-dimensional approaches and to include measures of biological maturity status as well as maturity independent performance tests during the talent identification and selection process.

Villarreal and Gonzale, (2008) compared the low and moderate plyometric training frequency produces greater jumping and sprinting gains compared with high frequency, forty two students were randomly assigned to 1 of 4 groups: control 14 sessions of DJ training and 28 sessions of DJ training. The training protocols included DJ from 3 different heights 20,40and 60cm.Maximal strength, vertical height in counter movements jumps and DJs and 20m sprint timers tests were carried out before and after 7 weeks of plyometric training. No significant difference was observed among the groups in pre training in any of the variables tested .No significant changes were observed in the control groups in any of the variables tested at any point.. Short-term plyometric training using moderate training frequency and volume of jumps produce similar enhancements in jumping performance, but greater training efficiency compared with high jumping training frequency. In addition, similar enhancements in jumping performance, but greater training frequency. In addition, similar enhancements 20 m sprint time, jumping contact times and maximal strength were observed in both a moderate and low number of training sessions per week compared with high training frequencies, despite the fact that the average number of jumps accomplished in 7s was 25 and 50% of the that performed in 28s. These observations may have considerable practical relevance for the optimal design of plyometric training program for athletes, given that a moderate volume is more efficient than a higher plyometric training volume.

2.4. SUMMARY OF THE LITERATURE

The investigator has complied and reviewed the literature and professional reviews related to combined effect of circuit and resistance training on physical, physiological and performance variables of football players from the library of TNPESU and the material available on the internet to provide sufficient knowledge to the readers and comparative analysis of the present study. The reviews show that there is combined effect of circuit and resistance training on physical, physiological and performance variables. The investigator has found very sufficient studies made an analysis with combined effect of circuit and resistance training. Based on the review and the studies the researcher has chosen this topic as well as this reviews supported on this study. The investigator formulated suitable methodology in this research that is presented in chapter III.