CHAPTER – II

REVIEW OF RELATED
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In general literature survey has served as guideline to identify the general trends of the present study. Since effective research is based upon past knowledge this review helps to do much better. The salient aspects related to study are briefly discussed under this chapter.

2.1 STUDIES ON RESISTANCE TRAINING

Proft. E et al. (1987) conduct a study on strength training and performance in soccer players. Although it has been extensively demonstrated that strength training improves performance and that strength characteristics are probably sport specific, there is little literature available concerning strength training of soccer players and its influence on their performance. Oberg et al. (1986) and Carbri et al. (1987) found significant differences strength between soccer players and non-soccer players. Moreover, Oberg and co-workers (1986) could even demonstrate differences between high and lowe level soccer players. Both studies agree that soccer players are generally stronger that non-soccer player and that soccer player have better fast-speed strength capabilities. It has also been confirmed that soccer players have a better kick performance than non-soccer players and that kick performance and concentric strength of the knee extensors and eccentric strength of the knee flexors are significantly correlated. In addition, concentric strength of the hip flexors and eccentric strength of the hip extensors are also significantly correlated with kick performance. It is reasonable, therefore, to suppose that training the strength of the leg muscles might be of benefit to soccer players. Consequently, the aim of
the present study was focused on the influence of strength training on performance in soccer kicking. A total of 22 male soccer players, divided into adult soccer players (ASP) and young soccer players (YSP) and 20 male non-soccer players (NSP) were included in the experimental design (Table 1). Eleven soccer players (ASP: n=6; YSP: n=5) were asked to participate in a strength training programme, consisting of multiple repetitions at 80% of the maximal voluntary effort of different leg muscles, in addition to the normal soccer training. The programme lasted one full soccer season, twice a week, each session lasting for half an hour. Kick performance was measured on the soccer field. All subjects were asked to perform a maximal kick.

Isometric strength of knee flexors and extensors, and hip flexors and extensors, was measured by means of an isokinetic dynamometer (KIN-COM, Chattex Corp., TN) at a constant speed of 3.65 rad s⁻¹, during concentric and eccentric work. Additionally, there functional performance tests were carried out for measuring explosive power. These were the vertical jump, the standing long jump and the triple jump on one leg. The tests described were performed at three different occasions: before, in the middle and at the end of the training period.

Comparing strength before and after the training period the strength training group of the soccer players (both ASP and YSP) showed a significant increase not only in concentric and eccentric strength, but also in kick performance. Apparently, the strength training programme had a greater influence on eccentric strength development, for the strength increase seems to be higher than in concentric work. After strength training, the soccer players
demonstrated an increase in eccentric strength training, the soccer players demonstrated an increase in eccentric strength of the knee flexors by 77% (10% for the non-strength training group) and an increase in concentric strength of the knee extensors by 25% (2% for the non-strength training group). Concentric strength of the hip flexors and eccentric strength of the extensors increased respectively by 15% and 35% (5% and 10% without strength training). The non-strength training group, however, did not show an increase in kick performance. The age ranges tested did not seem to significantly influence the results. Both the ASP and YSP groups showed the same tendencies already mentioned. The correlations between strength and kick performance improved only in the strength training group. At the end of the training period, the correlation between kick performance and (i) concentric strength of the knee extensors and (ii) eccentric strength of the knee flexors improved dramatically, by fifteen and twenty percent respectively. Where as the non strength training group did not demonstrate an improvement of these relationships. In adolescent soccer players, the correlation between the kick performance and functional performance tests (i.e. the vertical jump) increased from $r = 0.62$ to $0.75$. However, in adult soccer players, the relationship was significantly high only at the end of the training period ($r = 0.69; p < 0.05$).

Massimo Venturelli et al. (2007) conduct a study on strength training for young soccer players. During a soccer match, the most interesting actions are represented by high intensity work, such as sprints, jumps and shots. A significant relationship has been observed between 1RM and acceleration, jump test and 30 m sprint results and a variety of training methods are used to increase strength and power, in sports demanding explosive force development.
Knowledge concerning the strength training methods for young soccer players was scarcely documented to show if different methods induced diverse results. Many authors empathize the importance of strength for soccer players (Hoff, et al., 2004; Cometti, et al., 1988; Gauffin, et al., 1989), but we never find a similar training approach, any studies had showed if a different strength training methods induced diverse results. The aim of these study was to evaluate which are the best strength training methods for young soccer players and analyze the differences in 1RM, 20 m sprint, jump, after 8 weeks of training conducted in 3 different methods: GrA=incremental overloads, GrB=free weight, GrC=combined overloads and free weight. 21 elite soccer players, selected from team Chievo Verona, mean age 17.6 ± 0.4 was randomly assigned to GrA=7 or GrB=7 otherwise in GrC=7. GrA training was based on incremental exercise by leg press, leg extension at 60-90% 1RM-12 to 4 rep. GrB training was based on 8-10 series of plyometric training, jumps and 20m sprint on steep street. GrC training was based on exercise by leg press, leg extension, jumps and 20m sprint on steep street. One way ANOVA & t-test was used to examine differences from groups and training effect. GrA = SJ+2% (p>.05), CMSJ+3% (p>.05), 1RM+30% (p<.05), 20mSprint+3% (p<.05). GrB = SJ+4% (p>.05), CMSJ+6% (p>.05), 1RM+5% (p>.05), 20mSprint+3% (p>.05). GrC = SJ+18% (p<.05), CMSJ+13% (p<.05), 1RM+37% (p<.05), 20mSprint+3% (p<.05). The diverse training induced no statistical differences in 20m sprint result (F=0.08; p=.949). In SJ and CMSJ tests there was significant differences from GrC Vs GrA & GrB (F=10.9; p=.001) & (F=4.3; p=.029). In 1RM GrA and GrC saw a statistical differences to GrB (F=5.79;
The results of this study suggested that a 8 weeks of combined training based on exercise by leg press, leg extension at 80% 1RM, 4-6 series of jumps and sprints on steep street, improved squat jump, counter movement squat jump, 1RM and 20m sprint tests. For young elite soccer players these training seem to be better than free weight training and incremental overload training in gym. These results are diverse from precedents studies (Wisløff, et al., 1998, Hoff, et al., 2004; Hoffman, et al., 2005; Whitney, et al., 2005;) and underline that for young soccer players is better a multilateral training for improving strength. The differences among the training are probably induced by the bigger muscle recruitment on the combined training. A combination of general and specific resistance-training methods can be recommended to develop the neuromuscular factors contributing to sports skills requiring strength and power (Kotzamanidis, et al., 2005).

Lehance Cedric, Binet Johnny, Bury Thierry and Croisier Jean-Louis et al. (2007) studied the Muscular strength and functional performances in elite and junior elite soccer players: What does preseason testing really teach us. Muscle strength and anaerobic power of lower extremities are neuromuscular variables that influence performance in many sports activities, including soccer. Despite frequent contradiction in the literature, it may be assumed that muscle strength and balance play a key role in targeted acute muscle injuries. The purpose of the present study was to provide and compare preseason muscular strength and power profiles in professional and junior elite soccer players throughout the developmental years 15-21. 57 elite and junior elite male soccer players were assigned to three groups: PRO, n=19; U-21, n=20 and U-17, n=18. Players benefited from knee flexors and extensors isokinetic testing consisting
in concentric and eccentric exercises. A context of lingering muscle disorder was defined using statistically selected cutoffs. Functional performances were evaluated throughout squat jump and 10m sprint. PRO ran faster and jumped higher than the U-17 (p<0.05). Individual isokinetic profile permitted the identification of 32/57 (56%) subjects presenting lower limbs muscular imbalance. 36/57 players were identified as having sustained a lower limbs previous major injury. Of these 36 players, 23 still showed significant muscular imbalance (64%). Quadriceps and hamstring peak torques (means ± SD, in Nm) for all modes of contraction and. New trends in rational training could focus more on the imbalance risk and implement antagonist strengthening aimed at injury prevention. Such an intervention would not only benefit athletes recovering from injury, but also uninjured players. An interdisciplinary approach involving the trainers, physical coach, and medical staff is important to consider in implementing a prevention program.

Özlem Öner Coşkun et al.(2007) studied the effect of age on isokinetic concentric and eccentric strength of knee muscles in soccer players. Soccer is widely considered to be the most popular sport in the world. Several injuries have shown that muscle strength is affected by several parameters such as height, body mass, dominant leg and age. The purpose of this study was to investigate the effect of age groups and the difference of dominant and non-dominant leg on concentric and eccentric isokinetic peak torque of quadriceps and hamstring muscles strength in men soccer players. (19.71± 3.8 years) soccer players participated. The players were divided in to four groups as 15-17 years (n=34), 18-20 years (n=35), 21-23 years (n=16), 24>-years (n=17). Concentric and eccentric isokinetic quadriceps and hamstring muscle strength
was measured at angular velocities of 60 degree/seconds (5 repetitions). Our results showed the effect of age had no significant difference on concentric and eccentric peak torque values between four age groups. Dominant leg hamstring concentric peak torque values were greater than non-dominant leg peak torque values (p<0.01). No significant difference was found for eccentric peak torque values (p>0.05). The results presented that muscle strength may not be affected by age. The concentric muscle strength value of the dominant leg is expected to be higher than that of the non-dominant leg. Following studies should be carried out with increased number of age groups and number of players.

Juan Mercel et al. (2007) conduct a study on assessing explosive strength in young soccer players. Explosive strength (power) is apparently one of the factors that determine sporting achievement in actions such as kicking the ball, jumping, sprinting and dribbling (Cometti et al., 2001). Players of a high level who display superior speed, agility and strength show a greater probability of success in handling the ball when faced with rivals (Esposito et al., 2004). The aim of this study was to investigate interactions of physical condition and technical skill in young soccer players. Fifty-six soccer players with 3 years of experience in soccer training (aged between 8-12 years) were asked to perform slalom with a ball (with the dominant and non-dominant leg), explosive force of the upper and lower body, speed and precision at which the ball was kicked (with either the dominant or non-dominant leg), and speed over 20 m were assessed by an electronic timekeeping system (0.001s), photocells, sound sensor and strength platform (Wisløff et al., 2004). Differences between the dominant and non-dominant leg were established in the slalom and ball-kicking tests (12.75±1.75% and 14.82±0.87% respectively; p<.05). The results of the group
(10-12 years, n=28) were significantly better than those of the group (8-9 years, n=28) in all physical and technical variables (p<.05). Kicking the ball with either leg was significantly correlated with other physical variables [CM J; r=.70; p<.001 / ABK; r = .37, p<.001 / upper limb force; r = .60, p<.001/ 20 m speed; r = -.56, p<.001]. The assessments showed in physical and technical tests with regard to age groups. It appears that older players and those with more training experience influence the results. Kicking speed with either leg presents positive correlations with the jumping tests and negative correlations with speed. A positive correlation for precision is only found with the dominant leg.

Zekiye Nisa Özerbek et al. (2007) examined the effect of Isokinetic strength of quadriceps-hamstring muscle in soccer players playing in different leagues. Soccer requires high muscular performance on legs. Muscle strength imbalances contribute to knee injuries. The quadriceps and hamstring muscle strength are important in running, kicking and stabilizing of knee. Isokinetic strength evaluation is common in the sports medicine. Muscle strength imbalances contribute to knee injuries. The aim of this study was to compare the concentric and eccentric isokinetic quadriceps and hamstring muscle strength among the professional soccer players according to their playing league. One hundred and forty five professional soccer players in concentric (1st league n=74, 2nd league n=51, 3rd league n=20) and 130 players in eccentric test (1st league n=59, 2nd league n=51, 3rd league n=20) participated in this study. Concentric and eccentric strength of quadriceps and hamstring in both legs was assessed using a Biodex at 60°/s (Peak torque, peak torque/body weight and hamstring quadriceps ratio). RESULTS Concentric and eccentric muscle strength were different between the leagues. Concentric and eccentric
strength values of quadriceps in both leg were higher in the 1st league than 2nd -3rd league (p<0.05). Same values of concentric hamstring in both legs in the 3rd league teams were less and eccentric hamstring and ratio values were higher in the 2nd league than the others (p<0.05). Muscle strength imbalances contribute to knee injuries. The results showed that the muscle strength of players can be related to their playing league because soccer teams have different strength training programs. Specific eccentric exercises for quadriceps and hamstring muscle should be supported into the soccer player’s training program. Therefore; knee injuries can be prevented.

Thiago Santi Maria1 et al. (2007) conduct a study on effects of 6 week aerobic power training in indoor soccer players under-20. The indoor soccer is characterized with intermittent activity that requires many different energetic sources due to the necessary changes in the intensity of the game. High intensity actions (high intensity run, fast direction changes, dribbles) are alternate to rest periods (walk or light intensity run), covering 6000 meters (Moreno, 2001). Some studies presented that aerobic fitness is important to high intensity exercises as indoor soccer. The aim was to describe the maximum consumption of oxygen after 6 weeks of training for some indoor soccer athletics under-20. Twenty one male Brazilian indoor soccer players 17.99±1.07years, 67.58±9.19kg, 177.63±5.60cm) participated this study, excluding the goalkeepers. The measures were made in the beginning and in the end of 6 weeks of trainings. To get the VO2max participants had to join Yoyo Endurance Test with the procedure described by Bangsbo (1996). Components were analyzed through the described statistic, delta percent and of “t” test for dependent samples. The significance level used was p < 0.05 Between the
before and after training it was possible to verify some increases at the aerobic power performance (7.23±3.82%; \( p=0.044 \)), showing VO2max increases of 50.58±3.16 ml/kg/min for 54.20±3.38 ml/kg/min after training. These results suggested that there were increases in the maximum consumption of the oxygen in under-20 indoor soccer players after 6 weeks of training. And besides that, it was noted that the training effects with interval stimulus of high intensity of VO2max developed important increases in the aerobic power of the indoor soccer players.

Kraemer et al. (2001) conducted a study on effect of resistance training on women's strength/power and occupational performances. The results they were observed are: Strength training improved physical performances of women over six 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 programs (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.

Elliott et al. (1989) studied on the effect of weight training and plyometric on vertical jump ability. From the results, he has 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 smaller effect of weight training as 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, 1985; Komi et al., 1982; Wilson et al., 1993).

Toji et al. (2004) studied on the effect of training with a combination of different loads (multiple-load training) on the force-velocity and force-power relationships was examined with training programs that included maximal isometric contraction F max and concentric contraction of the elbow flexor muscles. Twenty one male college students were placed into three equal training groups (G (30 + 60), G (30 + 100), and G (30 + 60 + 100)) and performed multiple-load training three days per week for eight weeks. The training load was a set fraction of the maximal isometric strength (% Fmax). The G (30 + 60) group performed six repetitions of elbow flexion at thirty and sixty percentage Fmax. The G (30 + 100) group performed six repetitions at 30% Fmax and six five-second Fmax loads. The G (30 + 60 + 100) group performed four repetitions at 30 and 60% Fmax and four 5-second Fmax loads. After training, Fmax and maximal velocity significantly increased (p < 0.05) in all three training groups. The increases in maximal power were significantly (p < 0.05) different between the G (30 + 60 + 100) group (52.9%) and the G(30 + 100) group (24.2%). These results suggest that multiple-load training programs
with four to six repetitions are effective for improving muscle power and velocity of the elbow flexors.

Hoff et al., (2000) conducted a study on resistance training loads and the literature 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 stimulated training without external loads (N = 11), a group using an external load of 30% of 1 RM squats (N = 10), and a 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 fifty-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 ten and forty 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.
2.2 STUDIES ON PLYOMETRIC TRAINING

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

W. Gregson and R. Wrigley (2007) conduct a study on the effects of a tenweek plyometric training intervention on ten meters sprint and vertical jump performance in elite junior professional soccer players. The ability to produce explosive lower body power is an important determinant of performance in soccer. Plyometric training represents an effective method for the development of muscular strength and power. Little information, however, currently exists on the volume of plyometric training needed to induce improvements in performance. To examine the effect of one weekly structured plyometric training session over a ten week in-season training period on ten meters sprint and vertical jump (VJ) performance in elite junior professional soccer players.

Twelve soccer players completed a 10m sprint (Limits of agreement (LOA) 0.01 ± 0.09 s) and VJ (LOA 0.7 ± 2.1 cm) test on two occasions, ten weeks apart. Six players were randomly allocated to an experimental (Exp) or control (Cont) group. Over the ten week period the Exp group completed one plyometric session per week in addition to normal training whilst the Cont group completed normal training only. The change in 10m sprint performance (Exp -0.04 + 0.02 s, Cont 0.00 + 0.02 s; p=0.04) was significantly greater in the Exp group following the ten week training period (p=0.011). No difference in VJ performance (Exp 1 + 1 cm, Cont 0 + 1 cm; p=0.028) was observed between the two groups (p=0.155). The present findings demonstrate that one plyometric training per week over a ten week in-season training period leads to significant
improvements in ten meters sprint time in elite junior soccer players. This training stimulus may act as an efficient training stimulus during the in-season period when training time is limited.

Kubachka et al (1966) studied the effects of plyometric training and strength training on the muscular capacities of the trunk. The effects of plyometric, strength training, and body weight exercises on 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 increases power (8.6%) and strength (45.9%). Strength training increases 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.

Diallo et al (2000) examined the effectiveness of plyometric training and maintenance training on physical performances in prepubescent soccer players. Twenty boys aged twelve and thirteen years were divided in two groups (ten in each): jump group (JG) and control group (CG). JG trained 3 days/week during ten weeks, and performed various plyometric exercises including jumping, hurdling and skipping. The subsequent reduced training period lasted for eight weeks. However, all subjects continued their soccer
training. Maximal cycling power (Pmax) 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. As results, before training, except for BF percent, all baseline anthropometric characteristics were similar between JG and CG. After the training programme, Pmax (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 eight week of reduced training, except Pmax (p<0.05) for CG, no increase was observed in both groups. These results demonstrated that short-term plyometric training programmes increase athletic performances in prepubescent boys.

2.3 STUDIES ON COMBINED TRAINING

Matheus Fontes et.al (2007) conduct a study on Intensity of four types of elite soccer training sessions. Several researchers have been studying the physiology of soccer. However, most studies have focused on official and friendly games and few have analyzed the intensity of training sessions. Specific soccer training has been used to train technical and tactical aspects of soccer. Nevertheless, these kinds of training also impose a significant workload on the cardiovascular and metabolic systems. The participants were 10 professional players of a first division Brazilian Soccer club. Heart Rate (HR) was monitored during three of each type of training sessions: technical drills
(TEC), tactical drills (TAC), modified games (MG) and practice games (PG). HRmax was determined during a field test (3x600m increasing intensity). The 4mM (Heck et al., 1985) anaerobic threshold (AT), was determined by linear interpolation. Comparisons were made using a one-way ANOVA and the differences were identified through Tukey’s post-hoc. The significance level was set at p<0.05. The players had a mean HRmax of 192 ± 11 bpm and mean AT of 176 ± 10 bpm (91.7 ± 1.4 %HRmax). The TEC was significantly less intense than TAC, MG and PG (Table 1). No differences were found between TAC, RFG and FG. This study showed that the TEC had a lower intensity when compared to the other types of training sessions. This result corroborates with the findings of Eniseler (2005). We speculated that the MG would have a higher intensity than the other types of training sessions analyzed. However, even though the field size was reduced, increasing the contact with the ball, the intensity may have been lower because the numbers of high intensity activities were reduced.

Katrin Kaarna and Ants Nurmekivi (2007) conduct a studied on Possibilities of evaluating complex training load influence in junior soccer players. Soccer imposes demands on aerobic and anaerobic systems (Reilly, 1999). The assessment of player’s aerobic performance could be of interest for coaches in order to evaluate and programme their training. Aerobic capacity can be developed by exercises with or without a ball. A widespread exercise with a ball is small game 3v3, 4v4 etc. (Balsom, 1998). It is important to vary training loads in youth training. According to this the aim of the study was to provide a comparative evaluation of the effect of complex training (game + running load + game) on player’s aerobic capacity and establish connections between
objective (HR, BLA) and subjective (PE, PRR) criteria in evaluating the effect of different loads. The subjects were twenty male soccer players. The test consisted of an eight minute game 4vs4, an eight minute running load and game of eight minute. HR was measured with Polar sport tester (Finland). BLA samples were obtained after loads and analysed with Lactate analyser (Japan). For evaluating the PE after loads the Borg CR ten scale was applied. PRR Scale (Karu et al., 2000) was used to obtain readiness ratings for next load. Mean HR values after 1st game and running were similar and on anaerobic threshold level. Whereas, mean BLA concentrations after 1st game and running, differed significantly (7.0±2.9 and 5.0±2.1mmol•l⁻¹; p<0.05) Higher BLA concentrations after 1st game and running imposed readiness for the next load (r=-0.71 and -0.85; p<0.05). In almost the same HR the metabolic reaction to the loads differed significantly. So, to proceed only from HR metabolic shifts in organism may be underestimated. So, using complex objective (HR, BLA) and subjective (PE, PRR) markers to evaluate the loads the changes in the organism of players could be specified and the development of their aerobic endurance could be managed better.

Asier Zubillaga et. al (2007) conduct a study on analysis of high intensity activity in soccer highest level competition. The analysis of the physical activity during competition is a basic referent when establishing the means and loads of training. Bibliography determines volume and intensity of the player’s activity during the match as essential parameters in the rating of effort, and the activity that the player performs at a high intensity as a key to distinguish the player’s strain level. The objective of this research was to describe and compare the high intensity physical performance of the players.
during European professional leagues' competition, taking into account their playing position. The AMISCO system has been used to register player's performance. From the record of one hundred and ninety four matches in the highest competitive level in the 2003-04 season, we have considered a sample of 6112 entries: Wide Fullback (N=1326), Centre fullback (N=1388), Pivot (N=1187), Centre midfield (N=215), Wide Midfield (N=1032), Centre forward (N=275), Striker (N=689). An ANOVA test on one Factor has been done. The descriptive analysis of the results showed the obtained values (average and standard deviation) for each of the defined position in each half. The average of the total distance run over by the players has been 5,598Km, with a standard deviation of 0.481Km. The confidence interval of 95% for the average has been between 5,586 and 5,610Km. Significant differences were found between plating positions (p <0.05). In conclusion, we have shown that the playing position of player determines his activity on the field.

Gregory Bogdanis1 et al. (2007) studied the effects of a hypertrophy and a maximal strength training program on speed. Recent studies, have shown a strong relationship between maximal half-squat strength and movement velocity (Wisloff et al, 2004) and suggested that training using heavy weights (>85% 1 RM) may be preferable for soccer players (Hoff and Helgerud, 2002). However, no study has compared this type of training with a program using lower loads commonly used for resistance training in soccer. The purpose of the present study, which had Ethical Committee approval, was to examine the outcomes of two different resistance training programs (half-squat) performed three times/week for six weeks during the pre-season period. One program was designed to promote muscle hypertrophy (H, 4 sets x 12 reps, with 70% 1RM)
and the other aimed to increase maximal strength (S, 4 sets x 5 reps, with 90% 1RM). Eighteen male soccer players were divided in two equal groups. The force-velocity characteristics [maximal force at zero pedal speed (Fo) and maximal pedal speed (Vo)] of each player were determined using short maximal sprints on a Monark cycle ergometer against different loads (Arsac et al. 1996). Maximal half squat strength and fieldtest performance was measured before and after training. Maximal squat strength increased significantly more in the S compared to the H group (9.9±1.2% and 17.3±1.9%). Lean leg volume was increased only in the H group (by 4.3±0.8%), but was unchanged in the S group. Fo was increased only in the S group. Improvement in squat strength was correlated with improvement in ten meter sprint time (r=0.67 P<0.01) and vertical jump (r=0.63 P<0.01).

Ayse Kin-Isler et al. (2007) conduct a study on compared the relationship between isokinetic knee strength, anaerobic performance and sprint ability in players of American football has a complex composition and involves combination of factors like anaerobic performance, strength and sprinting abilities. During the game like many other field sports, players perform multiple sprints that require explosive muscular contraction which involve muscular strength and anaerobic power and capacity. The purpose of the study was to evaluate the relationship between isokinetic knee strength, anaerobic performance and sprint-ability in American football players. A total of twenty eight American football players from a university team participated in this study. Isokinetic knee extension and flexion torques were determined at 60°.s-1, 150°.s-1 and 240°.s-1 (Cybex 770 Norm, USA). Wingate Anaerobic Power Test was used to determine the anaerobic performance, and sprint-ability of the
players was assessed by single-sprint and repeated-sprint ability tests. Results indicated significant correlation between 60°.s-1 extension and peak (r=0.491) and mean (r=0.466) powers. Similarly 150°.s-1 knee extension was correlated with peak (r=0.559) and mean (r=0.522) powers. 240°.s-1 knee flexion was found to be positively correlated with peak power (r=0.418) while 240°.s-1 knee extension was found to be positively correlated with peak (r=0.581) and mean (r=0.502) powers. Similar to previous studies (Baker et al 1999a and 1999b), the isokinetic knee strength, anaerobic power and capacity were significantly correlated. As a conclusion it could be said that the isokinetic strength plays an important role in anaerobic power and capacity of American football players. However, these findings also suggested that factors other than strength might contribute to the sprint ability.

Baker et al (2005) studied on the acute effect on power output of alternating an agonist and antagonist muscle exercise during complex training. The efficient coordination of agonist and antagonist muscles is one of the important early adaptations in resistance training, responsible for large increases in strength. Weak antagonist muscles may limit speed of movement; consequently, strengthening them leads to an increase in agonist muscle movement speed. In the midst of this, as to fill the gab of finding the effect of combining agonist and antagonist muscle exercises into a power training session, the study was carried out to determine if a training complex consisting of contrasting agonist and antagonist muscle exercises would result in an acute increase in power output in the agonist power exercise. As results, although the power output for the Con group remained unaltered between test occasions, the significant 4.7% increase for the Antag group indicates that a strategy of
alternating agonist and antagonist muscle exercises may acutely increase power output during complex power training.

Rahman et al (2005) conducted a study on the effect of plyometric, weight and plyometric-weight training on anaerobic power and muscular strength. The effects of three different training protocols namely plyometric training, weight training, and their combination on the vertical jump performance, anaerobic power and muscular strength. The results of this study 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 fifty yard run, and leg strength that was significantly greater than the improvement in the other two 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. It has also been substantiated by the results of the studies of Polhemus and Burkherdt, 1980; Clutch et al., 1983; Ford et al., 1983; Adams et al., 1992; Duke and BenEliyahu, 1992; Delecluse et al., 1995; Lyttle et al., 1996; Potteiger et al., 1999; Fatourous et al., 2000; Vossen et al, 2000 and McLaughlin, 2001) as 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.

Ebben et al (2000) in his an attempt to quantify differences between complex and non-complex plyometric exercises, one acute study compared
integrated EMG for the muscles and kinetic variables, such as ground reaction forces, associated with the medicine ball power drop performed before and following a set of three to five 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.

Jensen et al (1999) examined the effect of a set of high-load bench press exercises (BP) on a subsequent set of medicine ball power drop exercises via mean ground reaction force, maximum ground reaction force, and mean electromyography (EMG_{int}). Results of this study indicated that no significant differences exist for mean ground reaction force, maximum ground reaction force, and EMG_{int} for the pectoralis major and triceps muscles between the medicine ball power drop exercises and the BP plus medicine ball power drop exercises conditions. These results indicate 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, complex training may be a useful training strategy.
because of the organizational advantages of performing weight and plyometric exercises in the same training session.

Evans et al (2000) examined the complex training effect of combined bench press and medicine ball throws demonstrating improve plyometric performance in the complex condition. More specifically, the one of to determine whether the upper body power could be enhanced by performing a heavy bench press set prior to an explosive medicine ball put. Subjects included ten college age males with experience performing the bench press. Subjects performed a seated medicine ball put before and after four minutes, 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 reported that there was a strong correlation between improvement in medicine ball put distance and 5RM bench press strength.

Young et al (1998) in his study, demonstrated a potential acute complex training effect. He 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.

Zepeda et al. (2000) examined the effectiveness of a complex training group compared to a group who performed all of the weight training exercises after the plyometric exercises. Each group performed the same seven week routine except the complex training group performed the plyometric exercises in a superset with biomechanical 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).

Radcliffe et al. (1999) in their study suggested that the recent acute complex training may be effective for upper body, and lower body training it may be more effective for males. Additionally, prerequisite strength and the intensity of the load (RM) used in the weight training portion of the complex may be important in eliciting a complex training effect during the plyometric condition (Young et al. 1998).

Burger et.al. (2000) concluded in his study which is contrast to the effectiveness of complex training was demonstrated in part, with male division
I college football players. In this case, researchers found that the complex training group demonstrated significant improvement in the vertical jump performance. Evidence suggests that jumping ability seems to demonstrate an acute improvement in response to complex training stimulus according to the findings of Young et al. (1998) as well as improving as a result of a chronic complex training stimulus.

2.4 STUDIES ON SKILL PERFORMANCE

Barker (2001) examined the effect of an in-season of concurrent training on the maintenance of maximal strength and power in professional and college-aged rugby league football players. Fourteen professional and fifteen college-aged rugby league players were observed during a lengthy in-season period to monitor the possible interfering effects of concurrent resistance and energy-system conditioning on maximum strength and power levels. All subjects performed concurrent training aimed at increasing strength, power, speed, and energy-system fitness, as well as skill and team practice sessions, before and during the in-season period. The college-aged rugby league players group significantly improved repetition maximum bench press (1RM BP) strength, but not bench throw (BT Pmax) or jump squat maximum power (JS Pmax) over their 19-week in-season.

Sawyer et al (2002) studied on the relationship between football playing ability and performance measures. 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 fifty 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. Strength and conditioning programs 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.

Hironari Shinkai et al. (2007) studies focused on Ball-foot interaction in impact phase of instep soccer kick. Ball impact technique is essential for successful in instep soccer kicking. However, to date, only a few studies focused on ball impact phase, in which plantar flexion motion of the foot was solely reported (Asai et al., 1995; Nunome et al., 2006). Furthermore, no study has examined the behavior of the ball during ball impact that would be related to motion of the foot during ball impact. The aims of this study were to illustrate the three-dimensional motion of the foot (plantar / dorsal flexion, abduction / adduction, inversion / eversion) and the motion of center of gravity of the ball during ball impact, and to examine the interaction between the motion of the foot and the ball behavior during ball impact. Eleven experienced male soccer players participated in this study. To analyze the interaction between foot and ball in detail, two ultra high-speed video cameras (NAC Inc., Tokyo, Japan) were used to capture the motion of kicking limb and ball at 5000
Ball deformation and position of center of gravity of the ball were calculated from the lateral side image. The foot was plantar flexed, abducted and everted during contact with the ball. In particular, the foot was dorsal flexed slightly at the beginning of the impact, and begins to plantar flexed after middle of the impact. The peak force acing on the foot almost coincides with the peak ball deformation, and magnitude of peak force reached approximately 2700 N. In this study it was seen that the foot was forced into plantar flexion by the force of the ball. The ball velocity exceeded foot velocity when the ball was maximally deformed. It can be suggested that the foot can not directly increase the ball velocity after this moment, nevertheless the foot contact with the ball.

Hiroyuki Nunome et al.(2007) studied An alternative feature of impact phase kinematics of instep kicking in football. Biomechanical data associated with impact situations involving large accelerations can be prone to error due to inadequate data processing (Knudson et al. 2001) and sampling rate. For football kicking, the movement data at or just before initial ball contact could suffer from such problems, which would affect true kinematics of lower limb motion during ball impact phase. The purpose of this study was to describe the more representative kinematics of kicking motion through ball impact phase by exploring the influence of both sampling rate and smoothing procedures. Nine male footballers performed maximal instep kicking. The lower limb motion was three-dimensionally captured at 1000 Hz. The displacements were smoothed by a new time-frequency filtering (TFF). Also the co-ordinates were re-sampled (250 Hz) and smoothed by Butterworth digital filter using a 10 Hz cut-off (RSF) to resemble typical sampling and processing conditions used in the
literature. The shank angular velocity was found to be increased during the final phase of kicking (TFF). Meanwhile, a totally different curve (apparent decrease in the shank angular velocity before ball impact) was created when the conventional filtering at ten Hz cut-off was applied on the re-sampled coordinates (RSF). This nature has been consistently observed in the most of previous studies. Practically, coaches often recommended players to kick as if kicking through the ball. However, in literature no evidence was shown to support this type of instruction from a biomechanical point of view. The present study was the first to strongly support the above practical advice of kicking by clearly illustrating the true kinematics of the shank during kicking.

Goran Sporis, Vlatko Vucetic and Igor Jukic (2007) studied How to evaluate full instep kick in soccer; Soccer performance such as kicking performance is dependent on a myriad of factors such as technical/biomechanical, tactical and physiological aspects. One of the reasons for soccer being so popular and common worldwide is that players do not necessarily need to have extraordinary level of endurance, strength, power and flexibility but need to possess some level of the ability to be efficient during a soccer game. The purpose of this article was to present a way on how to evaluate the full instep kick in soccer. The instep kick test is comprised of three parallel tests; the ball speed test (km/h measured by stalker radar gun, Texas), the full instep kick accuracy test (goal divided into six fields) and the full instep kick technique test (seven aspects of the full instep kick). The sample was comprised of elite male soccer players, members of first league clubs in the Croatian League (n=21), age 22.13±0.85. Reliability of kicking performance test was determined by reliability analysis (alpha) and test-retest. (p < 0.05). Ball
Velocity was measured using the radar gun (Stalker-Pro, Texas). All tests had normally distributed data. Mean ball velocity measured by radar was 104,4 (4,38) km/h. Reliability coefficient alpha and test-retest analysis for all three tests was 0.96. Results of elite Croatian male and female soccer players in full instep kick test the soccer full instep kick test with parallel evaluation of technique, ball accuracy and speed was a very good diagnostic procedure. A similar test could be used for the evaluation of other soccer kick types.

Pinar Arpinar-Avsar, A.Ruhi Soylu and Seref Cicek (2007) studied Analysed the Consistency of the lower limb acceleration patterns during inside and instep soccer kicks. The inside kick is the most frequently used technique when a shorter and precise pass or shot is required, whereas the instep kick is used when a faster ball speed must be generated. The difference in accuracy of the inside and instep kick might be explained by repeatability of acceleration patterns. The repeatability of the kicks might be evaluated by acceleration waveforms. Therefore, the aim of this study was to examine the consistency of the lower limb acceleration patterns of these two soccer kicks. Thirteen male soccer players (between 15-16 years old) performed four trials for each type of kick. Acceleration data were collected by tri-axial accelerometers fixed on subjects’ knee and ankle. The RMS SD (precision error) of the four trials was calculated for three axes. Were there no difference among acceleration curves among trials, the RMS SD would yield a value of 0, corresponds highest repeatability. Comparisons were made between the two kicks using Student t-tests. Differences in the RMS SD values of acceleration waveforms measured at knee were statistically significant for all axes between inside and instep kicks, whereas it was only significant for x- and y-axis at ankle (p<0.05). Correlation
coefficient between RMS SD values at knee and ankle in the relevant limb was higher for instep kick. The findings of this study revealed that the inside kick with smaller precision error have higher consistency considering the acceleration patterns of the lower limb. Since the waveform demonstrates different acceleration deceleration patterns for segments, it might also be used to evaluate consistency in proximal-distal sequence between different types of kick.

Thorsten Sterzing, Janina Kroicher and Ewald M. Hennig (2007) Conducted a study on Kicking velocity: Barefoot kicking superior to shod kicking. Full instep kicking in soccer has received wide attention in biomechanical research (Barfield et al., 1998). There are just a few contributions on the influence of soccer shoes on kicking velocity (Amos et al., 2002). Soccer shoes evoke different ball velocities during full instep kicking. So far, the basic consideration that a shoe is an additional artificial interface between foot and ball during kicking has been neglected. Anecdotally, shod kicking is reported to be inferior compared to barefoot kicking already in 1971 (Plagenhoef, 1971). This study aimed to examine the general influence of a shoe in the kicking procedure, as it is necessary to know whether a soccer shoe acts as an enhancing, reducing or neutral piece of equipment in fast kicking. Features like mechanical support and protection of the foot had to be addressed. Five shoe/kicking conditions were tested: Adidas (AAA), Nike (NNN), subject’s own (OSC), sock (SOC), barefoot (BAR). Peak ball velocity was measured by a Stalker Pro radar gun. GRFs and HSV were taken. 19 subjects performed six full instep kicks in each condition. A pain rating (1 - low, 9 - high) and a velocity ranking of perceived ball velocity (1 - highest speed, 5 -
lowest speed) was required. The ANOVA showed higher ball velocity for barefoot compared to shod kicking (Figure 1). Perception data showed that barefoot and sock conditions were perceived most painfully. Although perceiving highest pain in the foot condition, subjects kicked faster compared to the shod conditions. The more painful a kicking condition was perceived the lower the condition was ranked for ball velocity. Means and standard errors for ball velocity and perception parameters. Soccer shoes do not generally provide support for fast kicking. Pure anatomical structures perform better in a full instep kicking situation than the functional unit of foot and shoe does. At initial ball contact, a bigger plantar flexion angle at the talus joint results in higher foot rigidity and less give during the collision in barefoot kicking, as high speed video pictures suggest.

2.5 STUDIES ON PERIODIZATION

Sione et al. (1981) compared a non periodized program vs. a strength/power periodized program that progressed from high volume and low intensity to lower volume and higher intensity training. Both groups increased the resistance used during training at their own rate. The periodized group increased significantly more than the nonperiodized group in one repetition maximum (1 RM) parallel back squat and vertical jump power using the Lewis formula (4.9 x body mass [kg] x vertical jump [m]) but not in vertical jump ability (centimeters improvement). In addition, the periodized group demonstrated a significantly greater increase in lean body mass and decrease in percent body fat than the nonperiodized group.
A second study published in the early 1980s (Siowers et al., 1983) utilized untrained college age males as subjects. Training consisted of performing either 1 x 10, 3 x 10, or a strength/power periodized program for seven weeks. Total body mass did not change significantly in any group. One RM bench press and back squat ability significantly increased in all training groups, with the periodized group demonstrating a significantly greater increase in 1 RM squat ability than the other two training groups. Only the periodized group showed a consistent significant increase in vertical jump ability and vertical jump power throughout the training period and a significant increase after all seven weeks of training. The results of this study do support the conclusion that short-term periodized training does increase 1 RM strength and vertical jump ability in untrained males to a greater extent than single and multiple set, nonperiodized training.

Willoughby et al. (1992) examined the effects in trained young men of two nonperiodized programs and a periodized program on 1 RM strength in the bench press and back squat. The results of the study showed that, in order for continued gains in 1 RM strength to occur, the weight used in training must be increased as strength gains occur. The results support that, in trained subjects, a periodized program results in greater 1 RM strength gains than nonperiodized multiple set programs.

Willoughby (1993) published a second paper on the effectiveness of periodized training. A unique aspect of this study was that, for the first eight weeks of training, there was no significant difference in training volume between any of the groups. After week eight, the periodized group’s training
volume, due to the decrease in repetitions performed, was significantly lower than the nonperiodized group's. Interestingly, at week eight of training, all groups had significantly increased their 1 RM for both exercises, but there was no significant difference between any of the groups. Only after week eight, when the periodized group's training volume was decreased significantly compared to the other two groups, did significant differences between groups in 1 RM ability start to become apparent. This indicates that the decrease in training volume may in part be responsible for the greater improvement in 1 RM strength and that it may take up to eight weeks of training in trained subjects for periodized programs to show superior results compared to nonperiodized programs.

Kraemer et al. (1997) compared a one-set program has been to a strength/power periodized program over fourteen weeks of training in Division III college football players. The one-set program consisted of nine exercises all performed using weight machines. All exercises were formed for eight–ten repetitions at an eight–ten RM weight with forced repetitions at the conclusion of each set. The periodized program consisted of twelve predominantly free-weight exercises and followed a traditional strength/power periodized format. The one-set program resulted in significant increases in 1 RM bench press and vertical jump ability. However, no significant change in 1 RM hang clean or power during a Wingate test was shown due to the one-set training. The periodized training resulted in significantly greater increases in 1 RM bench press and hang clean ability, vertical jump ability, and power during the Wingate test than did the one-set program. The one-set program resulted in a significant decrease in percent fat determined by skinfold measurement but no
significant change in total body mass. The periodized group showed a significant decrease in percent body fat and gain in total body mass, with both of these changes being significantly different from the one-set program. It can also be speculated that, due to the significantly greater decrease in percent fat and increase in total body mass of the periodized group, a significantly greater increase in lean body mass occurred in the periodized group compared to the onset group. The results of this study do show that a periodized free-weight program does result in greater changes in 1 RM strength, vertical jump ability, percent body fat, lean body mass, and total body weight than a one-set, machine-oriented program. The use of machines for the one-set program does limit the interpretation of the results to the comparison of a one-set, machine program to a periodized free-weight program.

Comparison of a single-set program performed three times per week with a periodized program performed four times per week over twenty-four weeks of training has also been reported (Kraemer et al. 1997). Division III college football players comprised both training groups. The single-set training consisted of performing one set of eight to ten repetitions at an eight–ten RM weight with each set followed by forced repetitions. Two different total body workouts of ten exercises each, were performed on alternating days of training, during the single-set training. The periodized training was a type of nonlinear periodization consisting of two different training sessions, each performed, two times per week. The nonlinear periodized training resulted in, significantly greater changes in percent body fat (skinfolds), total body weight, and all variables examined for strength, power, and high intensity endurance. The results support the concept that periodized training does result in greater fitness
gains than a varied one-set program. However, the generalizability of the study's conclusions is limited by several factors, including differences in training frequency and use of different exercises by the two training groups.

Kraeme et al (2000) investigation was to examine the effect of volume of resistance exercise on the development of physical performance abilities in competitive, collegiate women tennis players. Twenty-four tennis players were matched for tennis ability and randomly placed into one of three groups: a no resistance exercise control group, a periodized multiple-set resistance training group, or a single-set circuit resistance training group. No significant changes in body mass were observed in any of the groups throughout the entire training period. However, significant increases in fat-free mass and decrease in percent body fat were observed in the periodized training group after 4, 6, and 9 months of training. A significant increase in power output was observed after 9 months of training in the periodized training group only. One-repetition maximum strength for the bench press, free-weight shoulder press, and leg press increased significantly after 4, 6, and 9 months of training in the periodized training group, whereas the single-set circuit group increased only after 4 months of training. Significant increases in serve velocity were observed after 4 and 9 months of training in the periodized training group, whereas no significant changes were observed in the single-set circuit group. These data demonstrate that sport-specific resistance training using a periodized multiple-set training method is superior to low-volume single-set resistance exercise protocols in the development of physical abilities in competitive, collegiate women tennis players.
Blazevich and Jenkins (1993) examined varying movement velocities in hip flexion and extension, knee extension and flexion and the squat. Subjects trained for seven weeks, lifting either 30-50% of or 70-90% 1 RM for the high and low velocity groups respectively. No significant differences were found in sprint performance, 1RM squat or hip extension and flexion torque between the groups even though the subjects from both groups elicited significant improvements in these variables.

Hoff and Helgerud (2002) recommend a low number of repetitions per set (4-6), and 3-4 sets of each exercise, to increase strength and power without increasing bodyweight through hypertrophy. In their study soccer players trained three times per week for eight weeks, performing four sets of five repetitions per exercise. They found increases in 1RM half-squat, rate of force development and sprinting performance. In this, and another study using a similar protocol. (Helgenid et al.,2002)] no comparisons were made with a slow, moderate-repetition weight training group, and therefore no real conclusion can be drawn from these studies as to the relative efficacy of such methods. However, as noted previously, when such explosive protocols have been compared with slow weight training in other studies, no advantage has been found from such training. Also, the great preponderance of scientific evidence does not suggest any advantage from performing multiple sets of an exercise, contrary to the advice of Hoff and Helgerud. For example, in a review of thirty five studies.