Chapter-II
REVIEW OF RELATED LITERATURE

Polemus et.al (1981) experimented to find the effect of various plyometric exercises on strength gains of collegiate football players. Plyometric drills, depth jumping from height of 45 cms more used in conjunction with weight training exercises over six weeks. Group A performed conventional weight training exercises and Group B performed weight and vest weight. Each group was assessed on their performance in power, bench press, half squat and military press. Group C shown significantly greater (0.01) level improvements for all four exercises. The average improvement for Group C in half squat was almost 60 kg (cited by Miller, 1981).

Brown et. al (1986) conducted a study to find out the effect of plyometric training on vertical jump performance of high school Basketball Players. For this purpose, they used 26 freshman and sophomore high school male basketball players as subjects, their mean height weight were 15+_ 0.7 years, 180.8+_ 7.9 cm and 67.9+ 8.1 kg respectively. Players at random were attached to a training (bench height – 45 cm), 3 days a week for 12 weeks. The control group performed only the regular basketball training. Prior to and after training, two forms of vertical jump sets (with arm swing and without arms swing) were conducted. (1)The researcher found that plyometric group improved in the vertical jump with arm assistance significantly (p<.05) more than the control group. (2)The two groups were not significant(p<.05)different in vertical jump without arm assistance.(3)In plyometric group , 57% of vertical jump gain was due to the jumping skill improvement, and 43% was due to strength gain. They concluded that plyometric training appears to enhance the coordination of the arms with strength development.

Miller (1986) investigated the contention that programme of plyometric exercises would improve the vertical jump performance of females. For this
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purpose 24 female physical education students acted as subjects and performed standardized vertical jump test prior to being assigned to one of 2 groups. The mean vertical jump score was same for each group. Group I trained with plyometric exercises and Group II acted as a controlled group. Subjects in plyometric group were trained once a week for 8 weeks. They performed 5 sets of 10 repetitions of depth jumps for a height of 50 cms. All subjects were retested at the end of 8 weeks period. Results showed that Group I had improved their vertical jump performance by more than 5 cms (t=2.89, df=22, p<0.01) whilst Group II had no significant changes. The investigator concluded that a gradual introduction to plyometric is unlikely to cause injuries.

Lynn et.al (1989) investigated a study on effect of aerobic and resistance training on fractionated reaction time and speed of movement. The purpose of the study was to evaluate the effect of aerobic and variable resistance exercise training on fractionated reaction time (RT) and speed of movement (SM) in elderly individuals, pre motor time (PMT), motor time (MT), total RT, and SM were measured in 49 healthy, untrained men and women, 70 to 79 years of age, before and after 6 months of training. Subjects were randomized into either a walk/jog (n = 17), a strength training (n = 20), or a control group (n = 12). Improvements in aerobic capacity were only weakly related to reduced total RT (r = 0.30, p < .05). Analysis of covariance revealed that there were no differences (p > .05) among the three groups after training with respect to PMT, MT, total RT, and SM. These findings indicate that 6 months of aerobic and strength training did not induce significant changes in RT or SM in this group.

Neil et.al (1994) conducted a study on long-term resistance training in the elderly: effects on dynamic strength, exercise capacity, muscle, and bone. For this purpose researcher examined the effects of 42 weeks of progressive weight-lifting training on dynamic muscle strength, peak power output in cycle
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ergometry, symptom limited endurance during progressive treadmill walking and stair climbing, knee extensor cross-sectional areas, and bone mineral density and content in healthy males and females aged 60–80 years, currently enrolled in a 2-year resistance training program. Subjects were randomized into either exercise (EX) or control (CON) groups (60–70 years: 38 males and 36 females; 70–80 years: 25 males and 43 females). EX trained several muscle groups twice per week for 42 weeks at intensities ranging from 50–80% of the load that they could lift once only (1 RM); CON did usual daily activities. After the 10 months there was no change in 1 RM strength in CON, but significant gains (mean increases up to 65%) in EX (no independent age or gender effects); 30% and 47% of the increase in 1 RM had occurred by 6 and 12 weeks, respectively. In EX, the 7.1% increase in peak cycling power output was significantly greater than in CON (+1.1%). The 17.8% improvement in symptom limited treadmill walking endurance was also greater than in CON (+3.4%), but the difference between groups during stair climbing was not significant (EX + 57%, CON + 33%). The cross-sectional areas of the knee extensors increased significantly by 5.5% in EX but were unchanged in CON. There were no changes in bone mineral density or content in either group. We conclude that long-term resistance training in older people is feasible and results in increases in dynamic muscle strength, muscle size, and functional capacity.

Stephen et.al (1995) investigated a study on effect of age on muscle hypertrophy induced by resistance training. The present study was done to test the hypothesis that men and women over 60 years old have a smaller hypertrophic response to resistance training than young adults. Cross-sectional areas (CSA) of muscle in the thigh and upper arm were determined before and after 3 months of progressive resistance training by magnetic resonance imaging (MRI) in 9 young (22–31 yr, 5 male and 4 female) and 8 old (62–72 yr, 4 male and 4 female) subjects. Strength was determined by 3-repetition-
maximum (3RM) testing. The amount of weight lifted during the training program was proportional to baseline strength. Mean pre-training 3RM strength, per cm\(^2\) CSA, was less in the older group for all muscle groups examined (16 ± 6% for elbow flexors, p < .02; 40 ± 7% for knee flexors, p < .001; 19 ± 9% for knee extensors, p < .05). Mean training-induced increases in muscle CSA were less in the older group for elbow flexors (22 ± 4% in young, 9 ± 4% in old, p < .05) and knee flexors (8 ± 2% in young, 1 ± 2% in old, p < .01), but not for knee extensors (4 ± 1% in young, 6 ± 2% in old). Mean training-induced increases in specific tension (ratio of 3RM strength to CSA) were similar in young and old groups for elbow flexors (21 ± 5% in young, 19 ± 5% in old) and knee extensors (38 ± 6% in young, 32 ± 14% in old), but were greater in the older group for knee flexors (28 ± 5% in young, 64 ± 13% in old, p < .02). Aging can attenuate the hypertrophic response of muscle groups to resistance training, when the training load is proportional to baseline strength. However, aging does not impair training-induced increases in specific tension.

Lyttle et al (1996) conducted a study on enhancing performance: maximal power versus combined weights and plyometrics training. This study examined the relative effectiveness of two leading forms of athletic training in enhancing dynamic performance in various tests. Thirty-three men who participated in various regional level sports, but who had not previously performed resistance training, were randomly assigned to either a maximal power training program, a combined weight and plyometric program, or a non-training control group. The maximal power group performed weighted jump squats and bench press throws using a load that maximized the power output of the exercise. The combined group underwent traditional heavy weight training in the form of squats, and bench press and plyometric training in the form of depth jumps and medicine ball throws. The training consisted of 2 sessions a week for 8 weeks.
Both training groups were equally effective in enhancing a variety of performance measures such as jumping, cycling, throwing, and lifting.

Tanaka et al. (1998) pursued study on impact of resistance training on endurance performance. A new form of cross-training, in accordance with the principles of training specificity, resistance and endurance training induce distinct muscular adaptations. Endurance training, for example, decreases the activity of the glycolysis enzymes, but increases intramuscular substrate stores, oxidative enzyme activities, and capillary, as well as mitochondrial, density. In contrast, resistance or strength training reduces mitochondrial density, while marginally impacting capillary density, metabolic enzyme activities and intramuscular substrate stores (except muscle glycogen). The training modalities do induce one common muscular adaptation: they transform type IIb myofibrils into IIa myofibres. This transformation is coupled with opposite changes in fibre size (resistance training increases, and endurance training decreases, fibre size), and, in general, myofibre contractile properties. As a result of these distinct muscular adaptations, endurance training facilitates aerobic processes, whereas resistance training increases muscular strength and anaerobic power. Exercise performance data do not fit this paradigm, however, as they indicate that resistance training or the addition of resistance training to an ongoing endurance exercise regimen, including running or cycling, increases both short and long term endurance capacity in sedentary and trained individuals. Resistance training also appears to improve lactate threshold in untrained individuals during cycling. These improvements may be linked to the capacity of resistance training to alter myofibre size and contractile properties, adaptations that may increase muscular force production. In contrast to running and cycling, traditional dry land resistance training or combined swim and resistance training does not appear to enhance swimming performance in untrained individuals or competitive swimmers, despite substantially increasing upper body strength. Combined swim and swim-
specific 'in-water' resistance training programmes, however, increase a competitive swimmer's velocity over distances up to 200 m. Traditional resistance training may be a valuable adjunct to the exercise programmes followed by endurance runners or cyclists, but not swimmers; these latter athletes need more specific forms of resistance training to realize performance improvement.

Jozsil et.al (1999) investigated a study on changes in power with resistance training in older and younger men and women. For this purpose, the investigator examined the influence of progressive resistance training (PRT) on muscle power output in 17 men and women aged 56–66 years, and compared their responses to 15 men and women aged 21–30 years. All subjects performed 12 weeks of PRT at a workload equivalent to 80% of the one repetition maximum (1RM). All training and assessments of 1RM and power were made on Keiser pneumatic resistance machines. Subjects performed five exercises, three sets per exercise, twice weekly. Muscle power was measured (isotonic ally) at resistances equivalent to 40, 60, and 80% of the 1RM, on the knee extension and arm pull machines. All subjects increased arm pull power similarly at 40 and 60% of 1RM, independent of age or sex. There was not a significant increase in arm pull power at 80% of 1RM. Older and younger subjects also had similar absolute increases in leg extensor power at 40 and 60% of 1RM, but men responded with greater absolute gains than women at these percentages ($p < .05$). The increase in leg extensor power at 80% of 1RM was similar in all groups. Older and younger subjects increased strength similarly in all exercises except the left knee extension. Independent of age, men increased strength more than women in all exercises except the double leg press. These data demonstrate that individuals in their sixth decade can still improve muscle power (and strength); however, men may realize greater absolute gains than women.
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**Havens et.al (2000)** pursued a study to determine the effect of Resistance Training and Specificity Training on Sprint Times compared to the effect of Natural growth development of Middle school age students. The purpose of this study was to determine how physical education teachers and coaches could best help students/athletes increase sprint speed, investigating whether running speed over short distances could be improved significantly through resistance training or specificity training for middle school age students. A total of 70, 7th and 8th grade students participated (40 males and 30 females). Students were randomly placed in one of three groups. Group one was the control group and participated in regular physical education activities. Group two was the specificity group, which performed sprints at the beginning of class 3 days a week for 9 weeks. Group three was the resistance group, which was trained for 5 days a week for a minimum of 15 minutes per session using weights and plyometric exercises along with resistance training. Each student completed a pretest which consisted of three 40-yard sprints, recording the best time. After the 9 week training period, students completed a posttest which also consisted of three 40-yard sprints, recording the best time. Results showed that speed did not increase significantly because of specificity training, but they increase with resistance training. Some gender effects were apparent.

**Fatouros et.al (2000)** investigated on evaluation of plyometric exercise training, weight training, and their combination on vertical jumping performance and leg strength. The purpose of this study was to compare the effects of 3 different training protocols? Plyometric training, weight training, and their combination on selected parameters of vertical jump performance and leg strength. Forty-one men were randomly assigned to 1 of 4 groups: plyometric training (n = 11), weight training (n = 10), plyometric plus weight training (n = 10), and control (n = 10). Vertical jump, mechanical power, flight time, and maximal leg strength were measured before and after 12 weeks of training. Subjects in each training group trained 3 days per week, whereas
control subjects did not participate in any training activity. Data were analyzed by a 2-way (4 vs. 2) analysis of variance (repeated-measures design). Results showed that all training treatments elicited significant (p < 0.05) improvement in all tested variables. However, the combination training group produced improvements in vertical jump performance and leg strength that were significantly greater than improvements in the other 2 training groups (plyometric training and weight training). This study provides support for the use of a combination of traditional and Olympic-style weightlifting exercises and plyometric drills to improve vertical jumping ability and explosive performance in general.

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

Kraemer et al. (2001) conducted study on effect of resistance training on women's strength/power and occupational performances. Untrained women aged (mean +/- SD) 23 +/- 4 yr were matched and randomly placed in total-body (TP, N = 17 and TH, N = 18) or upper-body resistance training (UP, N = 18 and UH, N = 15), field (FLD, N = 14), or aerobic training groups (AER, N = 11). Two periodized resistance training programs (with supplemental aerobic training) emphasized explosive exercise movements using 3- to 8-RM training loads (TP, UP), whereas the other two emphasized slower exercise movements using 8- to 12-RM loads (TH, UH). The FLD group performed plyometric and partner exercises. Subjects were tested for body composition, strength, power, endurance, maximal and repetitive box lift, 2-mile loaded run, and U.S. Army Physical Fitness Tests before (T0) and after 3 (T3) and 6 months of training (T6). For comparison, untrained men (N = 100) (MEN) were tested once. Specific training programs resulted in significant increases in body mass (TP), 1-RM squat (TP, TH, FLD), bench press (all except AER), high pull (TP), squat jump (TP, TH, FLD), bench throw (all except AER), squat endurance (all except AER), 1-RM box lift (all except aerobic), repetitive box lift (all), push-ups (all except AER), sit-ups (all except AER), and 2-mile run (all). Strength training improved physical performances of women over 6 months and adaptations in strength, power, and endurance were specific to the subtle differences (e.g., exercise choice and speeds of exercise movement) in the resistance training 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.
Nathan et.al (2002) pursued study on the effects of a 10-week, periodized, off-season resistance-training program and creatine supplementation among collegiate football players. Therefore, the purpose of this investigation was to determine the effects of periodized resistance training in conjunction with low-dose (LD) and high-dose (HD) creatine supplementation on strength, body composition, and anaerobic muscular endurance. Subjects were divided into 3 groups: LD, HD, and placebo (P). Testing took place pre-, mid-, and post supplementation for the following: weight, body composition (fat-free mass and fat mass), 1 repetition maximum squat, and anaerobic muscular endurance testing. Results revealed no significant differences in either creatine group when compared with the P group. However, significant differences were noted over time. These data suggested that 10 weeks of periodized resistance training was effective for causing changes in strength, body composition, and anaerobic muscular endurance.

Robert et.al (2003) pursued study on the effect of plyometric training on distance running performance. This study examined whether changes in running performance resulting from plyometric training were related to alterations in lower leg musculotendinous stiffness (MTS). Seventeen 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(2max), lactate threshold (Th(la)), and 3-km time. 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 (2.7%) and RE at each of the tested velocities, while no changes in VO (2max) or Th (la) were recorded. CMJ height, 5BT, and MTS also increased significantly. No significant changes were observed in any measures for the C group. The results 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. We speculate that the improved RE led to changes in 3-km running performance, as there were no corresponding alterations in VO (2max) or Th (la).

Nancy et.al (2003) conducted study on systematic review of progressive resistance strength training in older adults. For this purpose, randomized controlled trials were identified from searches of relevant databases and study reference lists and contacts with researchers. Two reviewers independently screened the trials for eligibility, rated their quality, and extracted data. Only randomized controlled trials utilizing PRT as the primary intervention in participants, whose group mean age was 60 years or older, were included. Data were pooled using fixed or random effect models to produce weighted mean differences (WMD) and 95% confidence intervals (CI). Standardized mean differences (SMD) were calculated when different units of measurement were used for the outcome of interest. 62 trials (n = 3674) compared PRT with a control group. 14 trials had data available to allow pooling of disability outcomes. Most trials were of poor quality. PRT showed a strong positive effect on strength, although there was significant heterogeneity (41 trials [n = 1955], SMD 0.68; 95% confidence interval [CI] 0.52, 0.84). A modest effect was found on some measures of functional limitations such as gait speed (14 trials [n = 798], WMD 0.07 meters per second; 95% CI 0.04, 0.09). No evidence of an effect was found for physical disability (10 trials [n = 722], SMD 0.01; 95% CI −0.14, 0.16). Adverse events were poorly investigated, but occurred in most studies where they were defined and prospectively monitored. PRT results in improvements to muscle strength and some aspects of functional limitation, such as gait speed, in older adults. However, based on current data, the effect of PRT on physical disability remains unclear. Further, due to the poor reporting of adverse events in trials, it is difficult to evaluate the risks associated with PRT.
Olivier et al. (2003) conducted a study on physiological and functional responses to low-moderate versus high-intensity progressive resistance training in frail elders. The purpose of this efficacy study was to measure the dose–response effect of a free weight-based resistance training program by comparing the effects of two training intensities (low-moderate and high) of the knee extensor (ke) muscles on muscle function, functional limitations, and self-reported disability. The authors conducted a single-blinded, randomized, placebo-controlled trial. Twenty-two institutionalized elders (mean age, 81.5 years) were assigned to either high-intensity strength training (hi; n = 8), low-moderate intensity strength training (li; n = 6), or weight-free placebo-control training (pc; n = 8). The hi group trained at 80% of their 1-repetition maximum and the li group trained at 40%. All groups performed 3 sets of 8 repetitions, 3 times per week for 10 weeks. Outcome measures included ke maximal strength, ke endurance, and functional performance as assessed by 6-minute walking, chair-rising, and stair-climbing tests, and by self-reported disability. Ke strength and endurance, stair-climbing power, and chair-rising time improved significantly in the hi and li groups compared with the pc group. Six-minute walking distance improved significantly in the hi group but not in the li group compared with the pc group. Changes observed in hi were significantly different from those observed in the li group for ke strength and endurance and the 6-minute walking test, with a trend in the same direction for chair-rising and stair-climbing. Changes in strength were significantly related to changes in functional outcomes, explaining 37% to 61% of the variance. These results show strong dose–response relationships between resistance training intensity and strength gains and between strength gains and functional improvements after resistance training. Low-moderate intensity resistance training of the ke muscles may not be sufficiently robust from a physiologic perspective to achieve optimal improvement of functional performance. Supervised hi, free weight-based training for frail elders appears to be as safe as lower intensity training but is more effective physiologically and functionally.
Kraemer et al. (2003) investigated a study to compare the physiological and performance adaptations between periodized and nonperiodized resistance training in women collegiate tennis athletes. Thirty women (19-1 yr) were assigned to either a periodized resistance training group (P), nonperiodized training group (NV), or a control group (C). Assessments for body composition, anaerobic power, VO2(max), speed, agility, maximal strength, jump height, tennis-service velocity, and resting serum hormonal concentrations were performed before and after 4, 6, and 9 months of resistance training performed 2-3 d.wk (-1). Nine months of resistance training resulted in significant increases in fat-free mass; anaerobic power; grip strength; jump height; one-repetition maximum (1-RM) leg press, bench press, and shoulder press; serve, forehand, and backhand ball velocities; and resting serum insulin-like growth factor-1, testosterone, and cortisol concentrations. Percent body fat and VO2 (max) decreased significantly in the P and NV groups after training. During the first 6 months, periodized resistance training elicited significantly greater increases in 1-RM leg press (9.2 vs 4.5 2%), bench press (22.5 vs 11.8%), and shoulder press (24.7 vs 18.6%) than the NV group. The absolute 1-RM leg press and shoulder press values in the P group were greater than the NV group after 9 months. Periodized resistance training also resulted in significantly greater improvements in jump height (50.9 vs 37.7%) and serve (29.5 vs 16.4%), forehand (22.3 vs 17.3%), and backhand ball velocities (36.4 vs 14.4%) as compared with nonperiodized training after 9 months. These data demonstrated that periodization of resistance training over 9 months was superior for enhancing strength and motor performance in collegiate women tennis players.

Kaur (2004) conducted a study on effects of selected Plyometric Training on Jumping and Running performance of Senior Secondary School Boys. For this purpose of the study, the investigator selected sixty boys ranging of age from 16-19 years taken from different sections of the tenth and twelfth standard of
GHG Khalsa Senior Secondary School, Guru Sar Sudhar, Ludhiana, Punjab. The subjects were randomly selected for various games in Hockey, Kabaddi, Handball and Football. The subjects were divided into 3 equal groups. The groups were named Experimental Group-I, II & Control Group. Each group consisted of twenty subjects. Plyometric exercises were planned for Experimental Group – I & II for 10 weeks. Exercise were conducted on the spot (vertical) for Group –I, and for distance in cyclic manner (horizontal) for Group-II. The control group was not allowed to participate in any of the training programme except in their routine physical education session.

Measurement for variables was taken at the beginning-pretest, after five weeks- mid-test and at the end of Experimental period, after 10 weeks-posttest. During data collection period, the subjects were not allowed to participate in any training/competition. All the tests were conducted at GHG Khalsa Senior Secondary School ground, Gurusar Sudhar, Ludhiana. The nine jumping and running variables were selected for the purpose of the study. The variables included 30 meters, 50 meters, 100 meters speed tests, 6X10 meters agility test and 1000 meters endurance tests. The Explosive strength tests were Standing Broad Jumps, three consecutive jumps, hop on right and left leg, and standing vertical jump.

The analysis of data on selected plyometric variables of the 3 groups Experimental Group I, II & Control group were selected randomly and not equated in way in relation to variables selected for the study. Hence, ANCOVA was applied for each variable separately, in order to determine the differences among selected groups. When differences were found significant by ANCOVA, the Scheffe’s Post-Hoc test was applied to assess the significant differences among the adjusted paired means. The level of significance to test the f-ratio, obtained by Analysis of Covariance was fixed at 0.05 level of confidence.
The study concluded that vertical plyometric jumping exercises lead to improvement in speed, strength and agility tests except 1000 meters run and hop on right and left leg. Horizontal plyometric training exercises lead to improvement in all test performance except 1000 meters run and hop on right and left leg. Vertical Plyometric Training indicates higher improvement in comparison to horizontal training. In 30 meters, 50 meters, 6X10 meters and standing vertical jump. Horizontal Plyometric Training indicates higher improvement in comparison to vertical training in 1000 meters, standing broad jump, hop right and left leg. A significant difference existed between vertical training exercises and horizontal training exercises in 30 meters, 6X10 meters, 3 consecutive jumps, hop on left leg and standing vertical jump after 5 and 10 weeks training. Plyometric training does not cause significant increase in performance in 1000 meters and hops on right and left leg. Regular training (in control group) causes significant change in speed (50 meters, 100 meters), agility (6X10 meters) and leg strength (SBJ and SVJ).

Iain et. al (2004) investigated on effect of 8-week combined weights and plyometrics training program on golf drive performance. The purpose of this study was to determine the effect of a combined weights and plyometrics program on golf drive performance. Eleven male golfers' full golf swing was analyzed for club head speed (CS) and driving distance (DD) before and after an 8-week training program. The control group (n = 5) continued their normal training, while the experimental group (n = 6) performed 2 sessions per week of weight training and plyometrics. Controls showed no significant (p > or = 0.05) changes, while experimental subjects showed a significant increase (p < or = 0.05) in CS and DD. The changes in golf drive performance were attributed to an increase in muscular force and an improvement in the sequential acceleration of body parts contributing to a greater final velocity being applied to the ball. It was concluded that specific combined weights and plyometrics training can help increase CS and DD in club golfers.
Brock et.al (2004) conducted a study on effect of Maximal Isometric and Isokinetic Resistance Training on Strength and Functional aim of the present study was to compare the Mobility in Older Adults. The changes in voluntary strength (isometric, concentric, and eccentric) and functional mobility in response to maximal isokinetic eccentric-only resistance training to those elicited by maximal isometric-only or maximal isokinetic women (73 ± 7 years) and 18 men (73 ± 5 years) completed a 12-week training program (three times per week) using a Biodex System 3 dynamometer. Primary outcome measures included peak isometric and isokinetic (concentric and eccentric) knee extensor strength, concentric work, concentric power, stair ascent and descent, and gait speed. Participants were randomly assigned to one of three training groups: isometric-only, isokinetic concentric-only, or isokinetic eccentric-only. All three training groups demonstrated an increase in peak isometric and isokinetic concentric and eccentric strength following 12 weeks of training ($p < .01$). Step time was positively influenced ($p < .03$) by all three training modes; however, gait speed was unchanged following 12 weeks of training. All three training groups experienced a significant increase in peak concentric work and concentric power ($p < .01$) with the concentric training group demonstrating the largest increases in both peak concentric work and concentric power when compared to the isometric and eccentric training. It was clear that all three resistance training programs (isometric, concentric, and eccentric) in older adults were effective in increasing strength, concentric work, and concentric power over the 12-week training period. Furthermore, 12 weeks of resistance training resulted in improved stair ascent and descent performance.

Gregory et.al (2005) pursued study on aquatic plyometric training increases vertical jump in female volleyball players. The purpose of this study was to examine the effects of APT on VJ and muscular strength in volleyball players. Nineteen female volleyball players (aged 15 1 yr) were randomly assigned to
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perform 6 wk of APT or flexibility exercises (CON) twice weekly, both in addition to traditional preseason volleyball training. Testing of leg strength was performed at baseline and after 6 wk, and VJ was measured at baseline and after 2, 4, and 6 wk. RESULTS: Similar increases in VJ were observed in both groups after 4 wk (APT = 3.1%, CON = 4.9%; both P < 0.05); however, the APT group improved by an additional 8% (P < 0.05) from week 4 to week 6, whereas there was no further improvement in the CON group (-0.9%; P = NS). After 6 wk, both groups displayed significant improvements in concentric peak torque during knee extension and flexion at 60 and 180 degrees x s (-1) (all P < 0.05). The combination of APT and volleyball training resulted in larger improvements in VJ than in the CON group. Thus, given the likely reduction in muscle soreness with APT versus land-based plyometrics, APT appears to be a promising training option.

Lephart et al (2005) investigated study on Neuromuscular and biomechanical characteristic changes in high school athletes: a plyometric versus basic resistance program. The purpose of this study was to investigate the effects of an 8 week plyometric and basic resistance training program on neuromuscular and biomechanical characteristics in female athletes. Twenty seven high school female athletes participated either in a plyometric or a basic resistance training program. Knee and hip strength, landing mechanics, and muscle activity were recorded before and after the intervention programs. In the jump-landing task, subjects jumped as high as they could and landed on both feet. Electromyography (EMG) peak activation time and integrated EMG of thigh and hip muscles were recorded prior to (preactive) and subsequent to (reactive) foot contact. Both groups improved knee extensor isokinetic strength and increased initial and peak knee and hip flexion, and time to peak knee flexion during the task. The peak preactive EMG of the gluteus medius and integrated EMG for the gluteus medius during the preactive and reactive time periods were significantly greater for both groups.
Chamari et al. (2005) investigated a study on endurance training and testing with the ball in young elite soccer players. In this study, we present a new test to assess aerobic performance in soccer by means of a specific dribbling track: the Hoff test. We further determined whether improvement in maximal oxygen uptake was reflected in increased distance covered in the Hoff test. In this study, 18 male soccer players (14 years old) were tested both in the laboratory and using the Hoff test before and after 8 weeks of soccer training. The distance covered in the Hoff test correlated significantly with maximum oxygen uptake, and improved by 9.6% during the 8 week training period, while maximum oxygen uptake and running economy improved by 12 and 10%, respectively. Backward multiple regressions showed maximum oxygen uptake to be the main explanatory variable for the distance covered in the Hoff test. The present study demonstrated a significant correlation between laboratory testing of VO$_{2\max}$ and performance in the Hoff test. Furthermore, training induced improvements in VO$_{2\max}$ were reflected in improved performance in the Hoff test. We suggest that it should be a goal for active U-15 soccer players to cover more than 2100 metres in the Hoff test, as this requires a VO$_{2\max}$ of above 200 ml/kg$^{0.75}$/min, which should serve as a minimum in modern soccer.

Rahimi & Behpur (2005) investigated on the effects of Plyometric, Weight and Plyometric-Weight Training on Anaerobic Power and Muscular Strength. The purpose of this study was to compare the effects of 3 different training protocols-plyometric training, weight training, and their combination on the vertical jump performance, anaerobic power and muscular strength. Based on their training, forty-eight male college students were divided into 4 groups: a plyometric training group (n=13), a weight training group (n=11), a plyometric plus weight training group (n=14), and a control group (n=10). The vertical jump, the fifty-yard run and maximal leg strength were measured before and after a six-week training period. Subjects in each of the training groups trained
2 days per week, whereas control subjects did not participate in any training activity. The data was analyzed by a 1-way analysis of variance (repeated-measures design). The results showed that all the training treatments elicited significant (P<0.05) improvement in all of the tested variables. However, the combination training group showed signs of improvement in the vertical jump performance, the 50 yard dash, and leg strength that was significantly greater than the improvement in the other 2 training groups (plyometric training and weight training). This study provides support for the use of a combination of traditional weight training and plyometric drills to improve the vertical jumping ability, explosive performance in general and leg strength.

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

**Rahimi et.al (2006)** examined evaluation of Plyometrics, Weight Training and their Combination on Angular Velocity. The purpose of this study was to
examine the effectiveness of six weeks of plyometric training, weight training and their combination on angular velocity during a 60-second test cycle ergometer. Based on their training, forty-eight male college students were divided into four groups: a plyometric training group (n=13), a weight training group (n=11), a plyometric plus weight training group (n=14), and a control group (n=10). The angular velocity was measured by a 15 and 60-second cycle ergometer test before and after a six-week training period. Subjects in each of the training groups trained two days per week, whereas the control subjects did not participate in any training activity. The data was analyzed by a one-way analysis of variance (repeated measures design). The results showed that all the training treatments elicited significant (P<0.05) improvement in angular velocity. However, the combination training group showed signs of improvement in the angular velocity that was significantly greater than the improvement of the other two training groups (plyometric training and weight training). It was concluded that a combination of traditional weight training and plyometric drills "complex training" enhance angular velocity production in cycling. Therefore, complex training may help improve performance in sprint cycling that requires angular velocity, angular acceleration and power.

Rahimi (2006) conducted study on effect of Moderate and High Intensity Weight Training on the Body Composition of Overweight Men. The optimal weight training intensity to improve body composition in overweight men is unclear. The purpose of this study was to determine the effect of 12 weeks of high intensity versus moderate intensity weight training of equal work output on body composition in overweight men (BMI = 25-29.9 kg/m2). Twenty sedentary men (age: 27 ± 0.5 year; Body weight: 84 ± 1.43 kg; BMI: 28.23 ± 1.11 kg/m) were randomized in two equal groups (n = 10): 1) moderate intensity exercise (MI; 5sets*6reps [60% (1RM-1repetition maximum)]); and 2) high intensity exercise (HI; 5sets*6reps [85% 1RM]). The weight training program was performed 3d.w. Relative body fat (% BF) was assessed by a
skin-fold caliper. Significant differences between and within the groups were analyzed using a two-way split-plot analysis of variance (ANOVA). Statistical significance was accepted at p<0.05. The two-way ANOVA showed statistically significant differences between HI and MI groups, therefore, the Scheffe Post-Hoc Test showed that there was a significant decrease (p<0.05) in the relative body fat (BF) (D = 27%), percent of body fat (%BF) (22%), BMI (D = 9.34%), and body weight (BW) (D = 6.51%) in the HI group during the course of the study than in the MI group. Also, comparison of means between the pre/post test showed statistically significant decreases in skinfold thickness (HI = 45%, p = 0.001; MI = 25%, p = 0.02), percent of body fat (HI = 41%, p = 0.001; MI = 23%, p = 0.04), BMI (HI = 21.5%, p = 0.001; MI = 13.7%, p = 0.03), and body weight (HI = 21.58%, p = 0.001; MI = 13.82%, p = 0.01) after participation in a 12-week weight training program. It is concluded that 12 weeks of HI weight training may be more effective in improving body composition than MI weight training in overweight young men with physical characteristics similar to the ones found in the present study.

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

Marios et.al (2006) pursued a study on effects of resistance training on the physical capacities of adolescent soccer players. This study examined the effects of a progressive resistance training program in addition to soccer training on the physical capacities of male adolescents. Eighteen soccer players (age: 12-15 years) were separated in a soccer (SOC; n = 9) and a strength-soccer (STR; n = 9) training group and 8 subjects of similar age constituted a control group. All players followed a soccer training program 5 times a week for the development of technical and tactical skills. In addition, the STR group followed a strength training program twice a week for 16 weeks. The program included 10 exercises, and at each exercise, 2-3 sets of 8-15 repetitions with a load 55-80% of 1 repetition maximum (1RM). Maximum strength (1RM leg press, bench-press), jumping ability (squat jump SJ, countermovement jump CMJ, repeated jumps for 30 seconds) running speed (30 m, 10 x 5-m shuttle run), flexibility (seat and reach), and soccer technique were measured at the beginning, after 8 weeks, and at the end of the training period. After 16 weeks of training, 1RM leg press, 10 x 5-m shuttle run speed, and performance in soccer technique were higher (p < 0.05) for the STR and the SOC groups than for the control group. One repetition maximum bench press and leg press, SJ and CMJ height, and 30-m speed were higher (p < 0.05) for the STR group compared with SOC and control groups. The above data show that soccer training alone improves more than normal growth maximum strength of the lower limps and agility. The addition of resistance training, however, improves more maximal strength of the upper and the lower body, vertical jump height, and 30-m speed. Thus, the combination of soccer and
resistance training could be used for an overall development of the physical capacities of young boys.

DiFrancisco et.al (2007) conducted a study on comparison of once-weekly and twice-weekly strength training in older adults. To investigate whether one set of exercises performed once a week was as effective in increasing muscle strength as training twice a week. For this purpose, 18 subjects (7 women and 11 men) aged 65–79 years were randomly assigned to two groups. Both groups performed one set of exercises to muscular fatigue; group 1 trained 1 day/week and group 2 trained 2 days/week on three lower and three upper body exercises for 9 weeks. The data were analyzed using a mixed model 2×2 analysis of variance. A significant main effect of time (p<0.001), but not group, on one-repetition maximum scores was observed. No significant interaction was observed between time and group and therefore no difference in strength changes between training once a week versus twice a week after 9 weeks. One set of exercises performed once weekly to muscle fatigue improved strength as well as twice a week in the older adult. Our results provide information that will assist in designing strength-training programmes that are more time and cost efficient in producing health and fitness benefits for older adults.

Faigenbaum et.al (2007) compared the effects of a six week training period of combined plyometric and resistance training (PRT, n = 13) or resistance training alone (RT, n = 14) on fitness performance in boys (12-15 yr). The RT group performed static stretching exercises followed by resistance training whereas the PRT group performed plyometric exercises followed by the same resistance training program. The training duration per session for both groups was 90 min. At baseline and after training all participants were tested on the vertical jump, long jump, medicine ball toss, 9.1 m sprint, pro agility shuttle run and flexibility. The PRT group made significantly (p < 0.05) greater improvements than RT in long jump (10.8 cm vs. 2.2 cm), medicine ball toss (39.1 cm vs. 17.7 cm) and pro agility shuttle run time (-0.23 sec vs. -0.02 sec)
following training. These findings suggest that the addition of plyometric training to a resistance training program may be more beneficial than resistance training and static stretching for enhancing selected measures of upper and lower body power in boys.

Kutty (2007) conducted a study on comparative effect of weight training and plyometric training on the skills of soccer players, twenty (N=20) men subjects were selected from Dr. Sivanthi Aditanar College of Physical Education, Tiruchendur. They were equally divided randomly into two groups. Group A underwent weight training programme, while group B underwent Plyometric training programme for 3 alternate days per week for a total period of six weeks. The data collected on the shooting and throw in skills from the subjects before and after the training as pre test and post test scores were statistically treated by applying dependent ‘t’ test. The results revealed that both the training methods were effective in improving the performance in the selected skills of soccer players.

Gregory et.al (2007) investigated on effects of two different short-term training programs on the physical and technical abilities of adolescent basketball players. This study evaluated and compared the effectiveness of two different off-season, short-term basketball training programs on physical and technical abilities of young basketball players. Twenty-seven adolescent basketball players (14.7+/-.0.5 years; Tanner stage: 3.5+/-.0.5) were randomly divided into a specialized basketball training group (SP, n=10), a mixed basketball plus conditioning training group (MX, n=10) and a control group (n=7). Training included five sessions per week (100-120 min each) and was performed for 4 weeks. Maximal oxygen uptake was similarly improved after SP (4.9+/-.1.8%) and MX (4.9+/-.1.4%), but there was no effect on ventilatory threshold. Peak and mean power output measured during the Wingate test were also improved by a similar magnitude after SP (21+/-.5%) and MX (15+/-.6%). Trunk muscle endurance was equally increased (SP: 23+/-.4%, MX: 25+/-.5%),
but arms endurance was improved significantly more after MX (50 +/- 11%) compared to SP (11 +/- 14%, p<0.05). Performance in four basketball technical skills was similarly increased (by 17-27%) in both groups, with a tendency for greater improvement of the SP groups in the technical skills of shooting and passing. These results indicate that a SP basketball training program, performed exclusively on-court was as effective as a MX training program in terms of aerobic and anaerobic fitness improvement. Furthermore, the decrease of the total on-court training time in the MX group resulted in a tendency for a smaller improvement of basketball technical skills. In conclusion, both SP and MX training are equally effective in order to limit and/or reverse the detraining effects that occur during the off-season in basketball.

Andrea et. al (2007) conducted a study on effect of Plyometric Training Versus Traditional Weight Training on Strength, Power, and Aesthetic Jumping Ability in Female Collegiate Dancers. Therefore, the purpose of this study was to compare the effects of plyometric training and traditional weight training on aesthetic jumping ability, lower-body strength, and power in collegiate dancers. Eighteen female dancers who were enrolled in a minimum of one intermediate or advanced hallet or modern class at Skidmore College volunteered to participate in the study. Twelve subjects were randomly assigned to a plyometric (n = 6) or traditional weight training (n = 6) group. The remaining six subjects served as a self-selected control group. The plyometric group performed 3 sets of 8 repetitions of 4 different lower-body plyometric exercises twice a week. The weight training group performed 3 sets of 6 to 8 repetitions of 4 lower-body isotonic exercises twice a week. The control group refrained from all forms of strength training. Each subject maintained her normal dance classes throughout the six week intervention. All subjects were tested prior to and following the six-week training period. Testing consisted of assessments of jumping skill and lower-body strength and power. Strength was assessed via 3 one-repetition maximum tests: leg press,
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leg curl, and leg extension. Power was assessed with a Wingate anaerobic power test and vertical jump height tests. Aesthetic jumping ability was assessed via an evaluation by dance faculty at Skidmore College on balloon, jump height, ability to point the feet in the air, and overall jumping ability. There were no differences in the descriptive measures of jumping ability, strength or power among the groups at the start of the study. The plyometric group significantly increased leg press strength (37%), standing vertical jump height (8.3%), and aesthetic jump height (14%). The weight training group significantly increased leg press strength (32%), leg curl strength (23%), mean anaerobic power (6%), aesthetic jump height (22%), and aesthetic ability to point the feet in the air (20%). No significant changes were seen in the control group. The results of this study indicate that either plyometric training or traditional lower-body weight training can be useful in improving variables applicable to dance. This study also supports the notion that short-term dance training alone may not be sufficient to elicit improvements in these variables.

Boraczynski et.al (2008) conducted a study to assess the effect on the strength-speed abilities of Basketball players. For conducting the study, fourteen players from a third league team participated in two study sessions, at the beginning of the preparation period and after 8 weeks of training. Between the examinations, the players took part in 84 training sessions, among which there were 25 plyometric training sessions. Biometric characteristics of the players age 20.3+_1.9 years old, body mass 84.4+_8.1 kg(I session) and 83.5+_7.7 kg(II session) (P<0.01), lean body mass 73.5+_7.3 kg(I) and 73.3+_7.1(II), fat mass 11.0+_1.9kg(I) and 10.1+_1.6kg(II) (p<0.01).

The strength-speed abilities were assessed with a test on a force plate consisting of 10 vertical jumps (CMJ), separated by a second break. The results show a statistically significant increase in the basic mechanical parameters: the height of the rise of body mass centre (Hmax) 0.425+_0.054m (I) and 0.464+_0.047m (II) (p<0.01), maximum jump velocity (Vmax)
2.829 ± 0.185 m/s (I) and 2.979 ± 0.160 m/s (II) (P < 0.01), maximum force 1336.9 ± 266.1 N (I) and 1437.5 ± 213.8 N (II) (P < 0.01), impulse of force (PF) 251.1 ± 31.4 N * s (I) and 268.3 ± 22.7 N * s (II) (P < 0.01), maximum power 2814.4 ± 615.4 W (I) and 2957.8 ± 579.8 W (II) (P < 0.01), maximum relative power 32.6 ± 5.4 W/kg (I) and 34.9 ± 5.1 W/kg (II) (P < 0.01), average power 1499.6 ± 356.9 W (I) and 1624.4 ± 329.5 W (II) (P < 0.01), relative average power 17.4 ± 3.2 W/kg (I) and 19.2 ± 3.0 W/kg (II) (P < 0.01). No change was observed in the take-off time Tto(s), or countermovement depth Gde (m). Thus, the 8-week basketball training, including the plyometric training resulted in considerable improvement in mechanical parameters of the strength-speed abilities of the players.

Santos et al. (2008) pursued a study on effects of complex training on explosive strength in adolescent male basketball players. The purpose of this study was to evaluate the effects of a complex training program, a combined practice of weight training and plyometrics, on explosive strength development of young basketball players. Twenty-five young male athletes, aged 14-15 years old, were assessed using squat jump (SJ), countermovement jump (CMJ), Abalakso test (ABA), depth jump (DJ), mechanical power (MP), and medicine ball throw (MBT), before and after a 10-week in-season training program. Both the control group (CG; n = 10) and the experimental group (EG; n = 15) kept up their regular sports practice; additionally, the EG performed 2 sessions per week of a complex training program. The EG significantly improved in the SJ, CMJ, ABA, and MBT values (p < 0.05). The CG significantly decreased the values (p < 0.05) of CMJ, ABA, and MP, while significantly increasing the MBT values (p < 0.05). Our results support the use of complex training to improve the upper and lower body explosivity levels in young basketball players. In conclusion, this study showed that more strength conditioning is needed during the sport practice season. Furthermore, we also conclude that complex training is a useful working tool for coaches, innovative
in this strength-training domain, equally contributing to a better time-efficient training.

Bent et al. (2008) pursued a study on short-term effects of strength and plyometric training on sprint and jump performance in professional soccer players. The purpose of this study was to compare the effects of combined strength and plyometric training with strength training alone on power-related measurements in professional soccer players. Subjects in the intervention team were randomly divided into 2 groups. Group ST (n = 6) performed heavy strength training twice a week for 7 weeks in addition to 6 to 8 soccer sessions a week. Group ST+P (n = 8) performed a plyometric training program in addition to the same training as the ST group. The control group (n = 7) performed 6 to 8 soccer sessions a week. Pretests and posttests were 1 repetition maximum (1RM) half squat, countermovement jump (CMJ), squat jump (SJ), 4-bounce test (4BT), peak power in half squat with 20 kg, 35 kg, and 50 kg (PP20, PP35, and PP50, respectively), sprint acceleration, peak sprint velocity, and total time on 40-m sprint. There were no significant differences between the ST+P group and ST group. Thus, the groups were pooled into 1 intervention group. The intervention group significantly improved in all measurements except CMJ, while the control group showed significant improvements only in PP20. There was a significant difference in relative improvement between the intervention group and control group in 1RM half squat, 4BT, and SJ. However, a significant difference between groups was not observed in PP20, PP35, sprint acceleration, peak sprinting velocity, and total time on 40-m sprint. The results suggest that there are no significant performance-enhancing effects of combining strength and plyometric training in professional soccer players concurrently performing 6 to 8 soccer sessions a week compared to strength training alone. However, heavy strength training leads to significant gains in strength and power-related measurements in professional soccer players.
Impellizzeri et al. (2008) pursued a study on the effect of plyometric training on sand versus grass on muscle soreness and jumping and sprinting ability in soccer players. 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 \times 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.

Villarreal et al. (2008) investigated 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
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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 differences were observed among the groups in pre-training in any of the variables tested. No significant changes were observed in the control group in any of the variables tested at any point. Short-term plyometric training using moderate training frequency and volume of jumps (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 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.

Gertjan et.al (2008) investigated on effect of specific resistance training on over arm throwing performance. The main purpose of this study was to compare the effect of a specific resistance training program (throwing movement with a pulley device) with the effect of regular training (throwing with regular balls) on over arm throwing velocity under various conditions. The training forms were matched for total training load, i.e., impulse generated on the ball or pulley device. Both training groups (resistance training n = 7 and regular training n = 6) consisted of women team handball players, and trained 3 times per week for 8 weeks, according to an assigned training program.
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alongside their normal handball training. An increase in throwing velocity with normal balls after the training period was observed for both groups (P = .014), as well as throwing with heavier balls and throwing like actions in the pulley device. Although the regular training group seemed to improve more (6.1%) in throwing velocity with normal balls than the resistance training group (1.4%), this difference was not statistically significant. These findings indicate that resistance training does not surpass standard throwing training in improvement of over arm throwing velocity.

Singh et.al (2009) conducted a study to compare the effect of plyometric training drills, executed in horizontal and vertical plane, on running speed. The study was conducted on 60 Hr. Secondary school boys belonging to various sports disciplines. The subjects were divided into three equal groups of 20 subjects each. Group I carried out training program me consisting of drills executed in vertical plane, Group II carried out drills in Horizontal plane and the third group was kept as control group. The training program me was carried out twice a week, for ten weeks. Control group carried out their daily physical education session. Considering the level of the boys, the load was not increased during the experimental period. ANOVA, ANACOVA and POST HOC statistical procedures were used to interpret the data. It was concluded that plyometric training, executed in vertical and horizontal plane, leads to improvement in running speed. The mean difference between the experimental groups, after 10 weeks training, is statistically significant. The drills carried out in horizontal plane are better than the drills carried out in vertical plane, for speed training. It is also understood that the training carried out for ten weeks, at constant volume, and with best possible effort, leads to continuous improvement in performance.

Yadav (2009) conducted a study to find out the comparative analysis of continuous running, interval running, and combination of continuous and interval training, on selected anthropometric variables (percentage of body fat
and body weight). This study tried to find out the type of training programme that had the maximum effect, on the above mentioned anthropometric variables of subjects. The study has been conducted on eighty male students, studying in class eleventh and twelfth of Govt. Sen. Sec. School Sec-27, Chandigarh, in the age group of 16-19 years. Four groups were formed, three experimental and one control group consisting of twenty students each. The experimental groups participated in three different training programmes i.e. continuous running, Interval running and combination of continuous and interval for ten weeks, and control group performed the routine work. The data was collected in the beginning and at the end of ten weeks experimental period in terms of pre and post test. The training schedule was prepared systematically and carefully, keeping the individual differences of the subjects, and loading principles in mind. Analysis of Covariance was applied to statistically analyze the data, where the F-ratio was found significant; Scheffe’s Post-hoc test was applied. From the results, it was found that the continuous running is the most effective training method of body fat reduction among all the selected programmes.

Stian et.al (2009) investigated a study on combined strength and endurance training in competitive swimmers. The aim of this study was to investigate the impact of a combined intervention among competitive swimmers. 20 subjects assigned to a training intervention group (n = 11) or a control group (n = 9) from two different teams completed the study. Anthropometrical data, tethered swimming force, land strength, performance in 50m, 100m and 400m, work economy, peak oxygen uptake, stroke length and stroke rate were investigated in all subjects at pre- and post-test. A combined intervention of maximal strength and high aerobic intensity interval endurance training 2 sessions per week over 11 weeks in addition to regular training were used, while the control group continued regular practice with their respective teams. The intervention group improved land strength, tethered swimming force and 400m freestyle
performance more than the control group. The improvement of the 400m was correlated with the improvement of tethered swimming force in the female part of the intervention group. No change occurred in stroke length, stroke rate, performance in 50m or 100m, swimming economy or peak oxygen uptake during swimming. Two weekly dry-land strength training sessions for 11 weeks increase tethered swimming force in competitive swimmers. This increment further improves middle distance swimming performance. 2 weekly sessions of high- intensity interval training does not improve peak oxygen uptake compared with other competitive swimmers.

Balasubramanian et.al (2009) pursued study on effect of weight training and physical exercises on bio-chemical variables among college football players. To achieve the purpose of this study, 20 male college Football players of Koviloor Andavar College of Sports Science, Tamil Nadu were selected as subjects. The selected subjects were divided into two groups. Group I. underwent the weight training exercises and Group II underwent the physical exercises. The subject’s age ranged from 20 to 25 years. The subjects were selected at random from the College Football players. The study was formulated as pre post test and pre experimental design. The weight training group had significant improvement in body cholesterol and improved triglyceride, HDL and LDL.

Muktamath et.al (2009) investigated a study on effect of fartlek training at different altitudes on selected physiological variables and 1500 metres performance. For this purpose, sixty college men students were selected as subjects from low, medium and high altitude colleges from Kumta (Karnataka). They were divided into three equal groups. The first group was called as low altitudes fartlek training group, the second group was called as a medium altitudes fartlek training group and the third group was called as a high altitudes fartlek training group. For all the groups initial and final test were measured for the selected physiological variables (Cardio respiratory
endurance, Anaerobic power, Breadth hold time) and 1500 meters running performance. Analysis of Co-variance (ANCOVA) statistics technique was used to analyze the above study.

Mikel et al. (2009) investigated on determining variables of plyometric training for improving vertical jump height performance: a meta-analysis. For this purpose, a meta-analysis of 56 studies with a total of 225 effect sizes (ESs) was carried out to analyze the role of various factors on the effects of plyometrics on VJH performance. The inclusion criteria for the analysis were a) studies using plyometric programs for lower-limb muscles, b) studies employing true experimental designs and valid and reliable measurements, and c) studies including enough data to calculate ESs. Subjects with more experience in sport obtained greater enhancements in VJH performance (p < 0.01). Subjects in either good or bad physical condition benefit equally from plyometric work (p < 0.05), although men tend to obtain better power results than women after plyometric training (p < 0.05). With relation to the variables of performance, training volumes of more than 10 weeks and more than 20 sessions, using high-intensity programs (with more than 50 jumps per session), were the strategies that seemed to maximize the probability of obtaining significantly greater improvements in performance (p < 0.05). To optimize jumping enhancement, the combination of different types of plyometrics (squat jump + countermovement jump + drop jump) is recommended rather than using only 1 form (p < 0.05). However, no extra benefits were found to be gained from doing plyometrics with added weight. The responses identified in this analysis are essential and should be considered by strength and conditioning professionals with regard to the most appropriate dose-response trends for optimizing plyometric-induced gains.

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

Wong et.al (2010) pursued a study on the effects of 12-week on-field combined strength and power training on physical performance among U-14 young soccer players. For this purpose, players were assigned to experimental (EG, n = 28) and control groups (CG, n = 23). Both groups underwent preseason soccer training for 12 weeks. EG performed CSPT twice a week, which consisted of strength and power exercises that trained the major muscles of the core, upper, and lower body. CSPT significantly (p < 0.05) improved vertical jump height, ball-shooting speed, 10 m and 30 m sprint times, Yo-Yo intermittent endurance run (YYIER), and reduced sub maximal running cost (RC). CSPT had moderate effect on vertical jump, ball-shooting, 30 m sprint, and YYIER, small effect on 10 m sprint, RC, and maximal oxygen uptake. YYIER had significant (p < 0.05) correlations with 10 m (r = -0.47) and 30 m (r = -0.43) sprint times, ball-shooting speed (r = 0.51), and vertical jump (r = 0.34). The CSPT can be performed together with soccer training with no concomitant interference on aerobic capacity and with improved explosive performances. In addition, it is suggested that CSPT be performed during the
preseason period rather than in-season to avoid insufficient recovery/rest or overtraining.

Nicolas et.al (2010) conducted a study on effect of plyometric vs. dynamic weight training on the energy cost of running. The purpose of this study is to compare the effects of 2 strength training methods on the energy cost of running (Cr). Thirty-five moderately to well-trained male endurance runners were randomly assigned to either a control group (C) or 2 intervention groups. All groups performed the same endurance-training program during an 8-week period. Intervention groups added a weekly strength training session designed to improve neuromuscular qualities. Sessions were matched for volume and intensity using either plyometric training (PT) or purely concentric contractions with added weight (dynamic weight training DWT). We found an interaction between time and group (p < 0.05) and an effect of time (p < 0.01) for Cr. Plyometric training induced a larger decrease of Cr (218 16 to 203 13 ml.kg.km) than DWT (207 15 to 199 12 ml.kg.km), whereas it remained unchanged in C. Pre-post changes in Cr were correlated with initial Cr (r = -0.57, p < 0.05). Peak vertical jump height (VJHpeak) increased significantly (p < 0.01) for both experimental groups (DWT = 33.4 6.2 to 34.9 6.1 cm, PT = 33.3 4.0 to 35.3 3.6 cm) but not for C. All groups showed improvements (p < 0.05) in Perf3000 (C = 711 107 to 690 109 seconds, DWT = 755 87 to 724 77 seconds, PT = 748 81 to 712 76 seconds). Plyometric training were more effective than DWT in improving Cr in moderately to well-trained male endurance runners showing that athletes and coaches should include explosive strength training in their practices with a particular attention on plyometric exercises. Future research is needed to establish the origin of this adaptation.

Bhuvanendhiran et.al (2010) conducted a study on effect of plyometric training on speed, stride length and stride frequency. The purpose of the present investigation was to find out the effect of plyometric training on speed, stride length and stride frequency. For this purpose, thirty men players from
various disciplines of games studying for Bachelors Degree in the Department of Physical Education and Sports Sciences, Annamalai University in the age group of 18 – 22 years were selected as subjects. The subjects were divided into two equal groups of fifteen subjects each. Group I underwent plyometric training and group II acted as control. The training period for this study was three days in a week for twelve weeks. The subjects were tested for speed, stride length and stride frequency at prior to and after the training period. The results were statistically analyzed by using analysis of covariance (ANCOVA). The results of the study revealed that better improvement was in speed, stride length and stride frequency due to plyometric training.

Maniazhagu et.al (2010) pursued a study on effects of isolated and combined effects of concurrent plyometric and circuit based plyometric training on selected physical and physiological variables among college men. The purpose of the study, 80 college men students were selected randomly from Ananda College, Devakottai, Tamilnadu as subjects. Their age ranged from 18 to 21 years. They were divided into four equal groups namely, Experimental group I, Experimental Group II, Experimental group III and Control group. In a week, three days, the Experimental group I underwent concurrent plyometric training, Experimental group II underwent circuit based of plyometric training, Experimental group III underwent combination of both the training and control group was not given any specific training. The variables chosen were namely, leg explosive power, cardio respiratory endurance, resting pulse rate and Vo2 max. They were assessed before and after the training period of 12 weeks. The analysis of covariance was used to determine of any significant difference was present among the four groups of the dependent variables. The study showed that the selected physical and physiological variables were significantly improved due to the influence of isolated and combined effect of concurrent plyometric training and circuit based plyometric training.
Touba et al (2010) pursued a study on effects of heavy resistance exercise on fatigue and recovery during period of 48h post-exercise in females. The objective of study was to establish the heavy resistance exercise volume and intensity to produce a fatigue effect of a 40% reduction in measured force variables and to establish the fatigue and recovery responses over 48-h period. Subjects were familiarized with the same testing procedures in the pilot study. All subjects performed three sets of six different exercises (lying leg curls, dumbbell lunges, barbell squats, leg extensions, leg presses) at an intensity corresponding to 70% of 1 RM (8-10 repetitions). A 1-min rest period was allowed between exercises and a 3-min rest period between sets. The isometric force measurements were also obtained 2 h, 24 h and 48 h recovery for maximal voluntary contraction (MVC) and rate of force development (RFD). The data showed that there was a significant main effect of time on MVC for both legs (p=0.001). Post hoc analysis revealed a significant difference between pre- and post-exercise (p=0.001), pre-exercise and 2 h, 24 h (p=0.002) but no significant difference for 48 h (p=1.00). A significant main effect of time on MVC (p<0.001) for the dominant leg. Pair wise comparisons showed a significant difference between pre- and post-exercise at 2 h (p=0.001), but no significant difference between pre-exercise and after 24 h and 48 h (p=1.00). The RFD for both legs (p<0.001). Post-hoc analysis revealed a significant difference between pre- and post-exercise (p=0.001) and at 2 h, but no significant difference among pre-exercise, 24 h and 48 h (p=1.00). There was a significant main effect of time on RFD (p<0.001) for the dominant leg. Pair wise comparisons showed a significant difference between pre- and post-exercise (p=0.000) but no significant difference between pre-exercise and 2, 24 and 48 h (p=1.00). In this study it was found that using both legs at 70% of 1 RM was still not enough for the desired reduction, so further studies should increase the intensity of 1 RM.
Azeem et.al (2010) conducted study on effect of weight training on sprinting performance, flexibility and strength. The purpose of the study was to find out the effect of weight training (WT) on sprinting performance, flexibility and strength of the 20 students. A 45 min WT schedule twice a week for 12 weeks was administered. The test considered were strength (1 RM for all the WT components), 50 m run and sit and reach. Speed is one of the variables which are associated with the fitness of the subjects. The analysis of the data reveals a significant (p<0.05) improvement sprinting performance with the mean±SD reading in the pre-test 0.43±0.07 s and in the post-test of 0.41±0.06 s. Flexibility improved (p<0.05) from pre to post test (26.7±9.3) and (31.8±8.4). Squat exercise increased (p<0.05) from pre to post test (75.5±15.1 kg) and (99.5±14.7 kg). The bench press exercise increased (p<0.05) from pre to post test (48.8±24.1) and (65.5±24.3 kg). Barbell front press exercise increased (p<0.05) from pre to post test (24.5±12.7 kg) and (34.4±12.4 kg). High pull downs improved the strength of the lats and back muscles, and the analysis points towards it with from pre to post test (39.5±11.1 kg) and (59.0±10.3 kg; p<0.05). Barbell curls exercise increased (p<0.05) the strength of the biceps muscles from pre to post test (17.3±7.3 kg) and (27.0±7.9 kg). The study has revealed that WT improved strength and also showed some improvement in speed and flexibility.

Kamalakkannan et.al (2010) investigated a study on Aquatic training with and without weights and its impact on agility and explosive power among volleyball players. The objective of the study was to investigate the impact of aquatic training with and without weights on agility and explosive power among volleyball players. Thirty male physically active and interested undergraduate Engineering volleyball players between 18 and 20 years of age volunteered as participants. Participants were randomly categorized into three groups of 10 each: Group I (control) was not exposed to any specific training/conditioning (CG); group II was involved in aquatic training (ATG)
and group III was given aquatic training combined with weights (ATWG). The aquatic training package was designed by the investigators and was administered for a period of 6 weeks, 3 days a week; a session each day, each session lasted 2 h. Both experimental groups underwent their respective experimental treatment. The aquatic training schedule was specifically designed to improve the fitness levels of the volleyball players. The weight training was meted out for 60 min to group III. Aquatic training and weights were given on alternative days. Agility (shuttle run) and explosive power (broad jump) were selected as variables for this investigation. The pre and post-test were conducted 1 day before and after the experimental treatment. Analysis of covariance was used to analyze the collected data. Scheffe’s test was used as a post-hoc test to determine which of the paired mean differ significantly. There was no significant difference in pre-test data of control and experimental groups: agility(s) CG 14.5±CG1.2; ATG 15.0±0.9; ATWG 14.3±0.8, post-test mean values were CG 14.5±1.2; ATG 14.9±0.9; ATWG 14.2±0.7. Pre-test explosive power (m) was CG 2.38±0.15; ATG 2.28±0.08; ATWG 2.28±0.19: Post-training mean values were: CG 2.38±0.11; ATG 2.35±0.08; ATWG 2.37±0.40. The results of the study reveal that both aquatic training and ATWG produced positive impacts on the agility and explosive power among volleyball players.

Myer & Faigenbaum (2010) conducted a study on resistance training among young athletes: safety, efficacy and injury prevention effects. Current research indicates that resistance training can be a safe, effective and worthwhile activity for children and adolescents provided that qualified professionals supervise all training sessions and provide age-appropriate instruction on proper lifting procedures and safe training guidelines. Regular participation in a multifaceted resistance training programme that begins during the preseason and includes instruction on movement biomechanics may reduce the risk of sports-related injuries in young athletes.
Villarreal et.al (2010) conducted study on 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-week periodized 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.

Robert et.al (2010) conducted study on whether plyometric training improve strength performance? A meta-analysis. Majority of the research suggests plyometric training (PT) improves maximal strength performance as measured by 1RM, isometric MVC or slow velocity isokinetic testing. However, the effectiveness of PT depends upon various factors. A meta-analysis of 15 studies with a total of 31 effect sizes (ES) was carried out to analyse the role of various factors on the effects of PT on strength performance. The inclusion
criteria for the analysis were: (a) studies using PT programs for lower limb muscles; (b) studies employing true experimental design and valid and reliable measurements; (c) studies including sufficient data to calculate ES. When subjects can adequately follow plyometric exercises, the training gains are independent of fitness level. Subjects in either good or poor physical condition, benefit equally from plyometric work, also men obtain similar strength results to women following PT. In relation to the variables of program design, training volume of less than 10 weeks and with more than 15 sessions, as well as the implementation of high-intensity programs, with more than 40 jumps per session, were the strategies that seem to maximize the probability to obtain significantly greater improvements in performance (p<0.05). In order to optimise strength enhancement, the combination of different types of plyometrics with weight-training would be recommended, rather than utilizing only one form (p<0.05). The responses identified in this analysis are essential and should be considered by the strength and conditioning professional with regard to the most appropriate dose-response trends for PT to optimise strength gains.

Riadh et.al (2010) investigated on effects of a plyometric training program with and without added load on jumping ability in basketball players. 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.

**Konstantinos et.al (2010)** conducted study on the effect of sprinting after each set of heavy resistance training on the running speed and jumping performance of young basketball players. The purpose of this study was to investigate the effect of a 10-week heavy resistance combined with a running training program on the strength, running speed (RS), and vertical jump performance of young basketball players. Twenty-six junior basketball players were equally divided in 2 groups. The control (CON) group performed only technical preparation and the group that followed the combined training program (CTP) performed additionally 5 sets of 8-5 repetition maximum (RM) half squat with 1 30-m sprint after each set. The evaluation took place before training and after the 5th and 10th weeks of training. Apart from the 1RM half squat test, the 10- and 30-m running time was measured using photocells and the jump height (squat, countermovement jump, and drop jump) was estimated taking into account the flight time. The 1RM increased by 30.3 1.5% at the 10th week of training for the CTP group (p 0.05). In general, all measured parameters showed a statistically significant increase after the 5th and 10th weeks (p 0.05). This suggests that the applied CTP is beneficial for the strength, RS, and jump height of young basketball players. The observed adaptations in the CTP group could be attributed to learning factors and to a more optimal transfer of the strength gain to running and jumping performance.

**Pargaonkar et.al (2011)** conducted a study on effect of the weight training programme for the skill development of volleyball for boys. For this purpose researcher used a simple –random group design. A sample of 60 male subjects was selected at random from New Habit High School for boys, Mumbai. The
subject’s age ranged from 12 to 14 years. The data collected were analyzed statistically by following 2x 3x4 Factorial ANOVA. The overall significance of the data was acceptable at the 0.01 level of confidence (F=3452.78, P<0.01). The results indicate that there must be significant difference in between the group and within the groups including their inter-actions. Significant Difference between control and experimental groups (F=15.72, P<0.05). The significant differences could also be traced for the values of Volleyball skill variable (F=32.16, p<0.01). Similarly the significance of differences in the Motor fitness were also evident (F=7.70, p<0.05). The value of interaction was also revealed statistically significant (F=6.42, p<0.05). Thus the Mean achievement in Motor fitness ability associated with selected variables of Volleyball skills was statistically significant and concluded that associated motor fitness variables of Volleyball players were also improved significantly as a result of selected weight training exercises. Finally, from the results it can be inferred that the weight training exercises imparted in this study for a period of 6 weeks was useful in improving the overall Volleyball skills level and associated Motor fitness.

Eduardo et.al (2011) investigated study on the effects of plyometric training followed by detraining and reduced training periods on explosive strength in adolescent male basketball players. The aim of this study were to determine the effects of (a) plyometric training on explosive strength indicators in adolescent male basketball players and (b) detraining and reduced training on previously achieved explosive strength gains. Two groups were formed: an experimental and a control group. The former was submitted to a 10-week in-season plyometric training program, twice weekly, along with regular basketball practice. Simultaneously, the control group participated in regular basketball practice only. At the end of this period, the experimental group was subdivided into 2 groups: a reduced training group and a detraining group. All participants were assessed on squat jump, countermovement jump, Abalakov

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test, depth jump, mechanical power, and medicine ball throw at the beginning and at the end of the 10-week in-season plyometric training and on weeks 4, 8, 12, and 16 of the in-season detraining and reduced training periods. In the first phase of the study, the experimental group significantly increased all the assessed indicators (p < 0.05). In the following phase and in general all the groups maintained the previously achieved results. In conclusion, plyometric training showed positive effects on upper- and lower-body explosive strength in adolescent male basketball players. Moreover, we can state that both detraining and a reduced training program indistinctly contribute to maintenance of strength levels. These results highlight the unique power that basketball-specific training seems to have on the sustainability and maintenance of sport performance.

Potdevin et al. (2011) conducted a study on effects of a 6-week plyometric training program on performances in pubescent swimmers. This study examined in pubescent swimmers the effects on front crawl performances of a 6-week plyometric training (PT) in addition to the habitual swimming program. Swimmers were assigned to a control group (n = 11, age: 14.1 ± 0.2 years; G (CONT)) and a combined swimming and plyometric group (n = 12, age: 14.3 ± 0.2 years; GSP), both groups swimming 5.5 h wk (-1) during a 6-week preseason training block. In the GSP, PT consisted of long, lateral high and depth jumps before swimming training 2 times per week. Pre and posttests were performed by jump tests (squat jump SJ, countermovement jump CMJ) and swim tests: a gliding task, 400- and 50-m front crawl with a diving start (V400 and V50, m s(-1)), and 2 tests with a water start without push-off on the wall (25 m in front crawl and 25 m only with kicks). Results showed improvement only for GSP for jump tests = 4.67 ± 3.49 cm; = 3.24 ± 3.17 cm; for CMJ and SJ, respectively; p < 0.05) and front crawl tests = 0.04 ± 0.04 m s (-1); = 0.04 ± 0.05 m s (-1); for V50 and V400, respectively; p < 0.05). Significant correlations were found for GSP between improvements in SJ and V50 (R =
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0.73, p < 0.05). Results suggested a positive effect of PT on specific swimming tasks such as dive or turn but not in kicking propulsion. Because of the practical setup of the PT and the relevancy of successful starts and turns in swimming performances, it was strongly suggested to incorporate PT in pubescent swimmers' training and control it by jump performances.

Aagaard et al (2011) pursued a study on effects of resistance training on endurance capacity and muscle fiber composition in young top-level cyclists. The present study examined the effect of 16 weeks of concurrent SE training on maximal muscle strength (MVC), contractile rate of force development (RFD), muscle fiber morphology and composition, capillarization, aerobic power (VO\(_{\text{2max}}\)) cycling economy (CE) and long/short-term endurance capacity in young elite competitive cyclists (n=14). MVC and RFD increased 12-20% with SE (P<0.01) but not E. VO\(_{\text{2max}}\) remained unchanged. CE improved in E to reach values seen in SE. Short-term (5-min) endurance performance increased (3-4%) after SE and E (P<0.05), whereas 45-min endurance capacity increased (8%) with SE only (P<0.05). Type IIA fiber proportions increased and type IIX proportions decreased after SE training (P<0.05) with no change in E. Muscle fiber area and capillarization remained unchanged. In conclusion, concurrent strength/endurance training in young elite competitive cyclists led to an improved 45-min time-trial endurance capacity that was accompanied by an increased proportion of type IIA muscle fibers and gains in MVC and RFD, while capillarization remained unaffected.

Sankarmani et al (2012) conducted a study on effectiveness of Plyometrics and Weight Training in Anaerobic Power and Muscle Strength in Female Athletes. Subjects were 40 intercollegiate athletes assigned to two training groups randomly: plyometric weight training and weight training. Each group completed a 6-week training program. There was more significant improvement in anaerobic power and muscle strength for the athletes trained with Plyometric weight training methods than weight training alone.
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was significant improvement of vertical jump height, 50 yard dash and 1RM squat performance in plyometrics and weight training group than the weight training group alone. Plyometric with weight training is more effective in improving vertical jump, 50 yard dash and 1 RM squat performance in athletes than the weight training alone.