CHAPTER - II

REVIEW OF RELATED LITERATURE

2.1. INTRODUCTION

This chapter describes the source of review of related literature. The researcher finds out some of the review of related literature which could be very supportive and strengthen this study. After going through the available literature, the investigator presented some of the observations and findings of the experts in this area.

The literature in any field forms the foundation upon which all future work will be built. If there is failure to build up on the foundation of knowledge provided by the review of literature, the researcher might miss some works already done on the same topic. The reviews are discussed under the following topics to have a better perspective about the selected independent variables.

2.2. Studies on Resistance Band Training

2.3. Studies on Core Training and

2.4. Studies on Speed Training

2.2. STUDIES ON RESISTANCE BAND TRAINING

Paditsaeree., Intiraporn., and Lawsirirat (2014) were investigated the effect of the additional elastic tubing to a barbell during a clean pull on peak power (PP), peak velocity (PV), and peak force (PF). Six competitive female weightlifters (Mean age = 16.7 ± 2.1 years) performed 3 sets of 3 repetitions of the clean pull at 90% of 1 repetition maximum (1RM). Testing was conducted on three separate days: day one without elastic tubing (NT) and the other two days with two elastic tubing loading conditions (T10 and T20), in random order. No Tubing (NT) represents a condition where all resistance was acquired from the barbell (90% of 1RM). T10 and T20 represent conditions of combining elastic tubing at 10% and 20% of the subjects' 90% 1RM with a barbell (90% of 1RM). One-way repeated measures analysis of variance (ANOVA) was used to assess loading conditions on PP, PV, and PF. The results showed that there was a significant increase in all variables-PP, PF, and PV-between T10 and NT and between T20 and NT ($p < 0.05$). The results reveal that adding a 10% increment to 90% of 1RM appears to be the optimal training condition for increasing power, force, and velocity during the clean pull.

Saeterbakken., et.al. (2014) were assessed the effects of adding elastic bands to free-weight squats on the neuromuscular activation of core muscles. Twenty-five resistance trained women with 4.6 ± 2.1 years of resistance training experience participated in the study. In randomized order, the participants performed 6 repetition maximum in free-weight squats, with and without elastic bands (i.e., matched relative intensity between exercises). During free-weight squats with elastic bands, some of the free weights were replaced with 2 elastic bands attached to the lowest part of the squat rack. Surface electromyography (EMG) activity was measured from the erector spinae, external oblique, and rectus abdominis, whereas a linear encoder measured the vertical displacement. The EMG activities were compared between the 2 lifting modalities for the whole repetition and separately for the eccentric, concentric, and upper and lower eccentric and concentric phases. In the upper (greatest stretch of the elastic band), middle, and lower positions in squats with elastic bands, the resistance values were approximately 117, 105, and 93% of the free weight-only trial. Similar EMG activities were observed for the 2 lifting modalities for the erector spinae ($p = 0.112-0.782$), external oblique ($p = 0.225-0.977$), and rectus abdominis ($p = 0.315-0.729$) in all analyzed phases. In conclusion, there were no effects on the muscle activity of trunk muscles of substituting some resistance from free weights with elastic bands in the free-weight squat.

Lorenz (2014) was discussed the Strengthening of the quadriceps is a central tenet of lower extremity rehabilitation, particularly after knee surgery. Quadriceps deficits after various knee procedures are well-documented. One method common to strength and conditioning circles is variable resistance training (VRT). VRT involves the use of heavy chains and elastic bands to facilitate gains in strength and power. Most of the application in strength training however has been on healthy, trained athletes. Sports physical therapists may use elastic bands for VRT to augment strength gains for the recovering athlete. The purpose of this manuscript is to provide a clinical suggestion for the use of VRT in athletic rehabilitation.

Joy., et.al., (2013) were examined variable resistance training within the context of a periodized training program, and to examine a greater load of variable resistance than has been examined in prior research. METHODS:: 14 NCAA Division II male basketball players were recruited for this study. Athletes were divided equally into either a variable resistance or control group. The variable resistance group added 30% of their one repetition maximum as band tension to their prescribed weight one session per week. Rate of power development, peak power, strength, body composition, and vertical jump height were measured pre and post treatment. RESULTS: No baseline differences were observed between groups for any measurement of strength, power, or body composition. A significant group by time interaction was observed for RPD, in which RPD was greater in VRT post training than in the control group. Significant time effects were observed for all other variables including squat 1RM, bench press 1RM, deadlift 1-RM, clean 3-RM, vertical jump, and lean mass. While there were no significant group X time interactions, the VRT group's percent changes and ESs indicate a larger treatment effect in the squat and bench press 1RM values and the vertical jump performed on the force plate and vertec. CONCLUSIONS: These results suggest that when using variable resistance as a component of a periodized training program, power and strength can be enhanced. Therefore, athletes whom add variable resistance to one training session per week may enhance their athletic performance.

Aboodarda., et.al., (2013) were identified the effect of additional elastic force on the kinetic and kinematic characteristics, as well as the magnitude of leg stiffness, during the performance of accentuated countermovement jumps (CMJs).Fifteen trained male subjects performed 3 types of CMJ including free CMJ (FCMJ; ie, body weight), ACMJ-20, and ACMJ-30 (ie, accentuated eccentric CMJ with downward tensile force equivalent to 20% and 30% body mass, respectively). A force platform synchronized with 6 high-speed infrared cameras was used to measure vertical ground-reaction force (VGRF) and displacement. Using downward tensile force during the lowering phase of a CMJ and releasing the bands at the start of the concentric phase increased maximal concentric VGRF (6.34%), power output (23.21%), net impulse (16.65%), and jump height (9.52%) in ACMJ-30 compared with FCMJ (all $P < .05$). However, no significant difference was observed in magnitude of leg stiffness between the 3 modes of jump. The results indicate that using downward recoil force of the elastic material during the eccentric phase of a CMJ could be an effective method to enhance jump performance by applying a greater eccentric loading on parallel and series elastic components coupled with the release of stored elastic energy. The importance of this finding is related to the proposition that power output, net impulse, takeoff velocity, and jump height are the key parameters for successful athletic performance, and any training method that improves impulse and power production may improve sports performance, particularly in jumping aspects of sport.

Shoepe, et.al., (2011) were assessed the effectiveness of variable resistance as provided through elastic plus free weight techniques in college aged males and females. Twenty novice lifters were randomly assigned to a traditional free weight only (6 males and 5 females) or elastic band plus free weight group (5 males and 5 females) and 9 more normally active controls (5 males and 4 females), were recruited to maintain normal activity for the duration of the study. No differences existed between control, free weight and elastic band at baseline for age, body height, body mass, body mass index, and body fat percentage. One-repetition maximums were performed for squat and bench press while both strength and power were assessed using isokinetic dynamometry. Elastic groups and free-weight groups completed 24 weeks of whole body, periodized, high intensity resistance (65-95% of one-repetition maximum) training three times/week. Training programs were identical except that the elastic group trained the barbell squat, bench press and stiff-legged dead lift with 20-35% of their total prescribed training loads coming from band resistance (assessed at the top of the range of motion) with the remainder from free weight resistance. A mixed-model analysis revealed that peak torque, average power and one-repetition maximums for squat were significantly greater after training for the elastic group compared to the control ($p<0.05$). In addition, the free weight group also showed significantly greater improvements over the control in peak torque and one-repetition maximums for squat and bench press. No significant differences were observed between the elastic band and free weight groups. Combined variable elastic band plus free weight exercises are effective at increasing strength and power similar to free-weights alone in novice college aged males and females. However, due to complexity in set-up and load assignment elastic adoption by novice lifters in an unsupervised situation is not advised.

Stevenson, et.al., (2010) were assessed the following measures during the free-weight back squat exercise with and without elastic bands: peak and mean velocity in the eccentric and concentric phases (PV-E, PV-C, MV-E, MV-C), peak force (PF), peak power in the concentric phase, and RFD immediately before and after the zero-velocity point and in the concentric phase (RFDC). Twenty trained male volunteers (age = 26.0 ± 4.4 years) performed 3 sets of 3 repetitions of squats (at 55% one repetition maximum [1RM]) on 2 separate days: 1 day without bands and the other with bands in a randomized order. The added band force equaled 20% of the subjects' 55% 1RM. Two independent force platforms collected ground reaction force data, and a 9-camera motion capture system was used for displacement measurements. The results showed that PV-E and RFDC were significantly ($p < 0.05$) greater with the use of bands, whereas PV-C and MV-C were greater without bands. There were no differences in any other variables. These results indicate that there may be benefits to performing squats with elastic bands in terms of RFD.

Shoepe., Ramirez., and Almstedt (2010) were determined the length vs. tension properties of multiple sizes of a set of commonly used elastic bands to quantify the resistance that would be applied to free-weight plus elastic bench presses (BP) and squats (SQ). Five elastic bands of varying thickness were affixed to an overhead support beam. Dumbbells of varying weights were progressively added to the free end while the linear deformation was recorded with each subsequent weight increment. The resistance was plotted as a factor of linear deformation, and best-fit nonlinear logarithmic regression equations were then matched to the data. For both the BP and SQ loading conditions and all band thicknesses tested, R values were greater than 0.9623. These data suggest that differences in load exist as a result of the thickness of the elastic band, attachment technique, and type of exercise being performed. Facilities should adopt their own form of loading quantification to match their unique set of circumstances when acquiring, researching, and implementing elastic band and free-weight exercises into the training programs.

Ghigiarelli, et.al., (2009)were explored the effects of a 7-week heavy elastic band and weighted-chain program on maximum muscular strength and maximum power in the bench press exercise. Thirty-six (n = 36) healthy men aged 18-30 years old, from the Robert Morris University football team, volunteered to participate in this study. During the first week, predicted 1 repetition maximum (1RM) bench press and a 5RM speed bench press tests were conducted. Subjects were randomly divided into 3 groups (n = 12): elastic band (EB), weighted chain (WC), and traditional bench (C). During weeks 2-8 of the study, subjects were required to follow the prescribed resistance training program. Mean and SD of the predicted 1RM bench press and 5RM speed bench press were computed. A two-factor (method X time) analysis was applied to identify significant differences between the training groups. Significance was set at alpha = 0.05. Results indicated a significant time ($p < 0.05$) but no group effect for both predicted 1RM (kg) and 5RM peak power tests (watts). Although not significant, results did show greater non-significant improvements in the EB (848-883 W) and WC groups (856-878 W) vs. control (918-928 W) when the 2 highest and greatest values were selected regarding peak power. The use of EB and WC in conjunction with a general off-season strength and conditioning program can increase overall maximum upper-body strength in a sample of Division 1-AA football players. These types of training modalities add a unique training style and more flexibility with respect to exercise prescription for athletes and strength practitioners.

Anderson., Sforzo., and Sigg (2008) were determined whether combined elastic and free weight resistance (CR) provides different strength and power adaptations than free weight resistance (FWR) training alone. Forty-four young (age 20 +/- 1 years), resistance-trained (4 +/- 2 years' experience) subjects were recruited from men's basketball and wrestling teams and women's basketball and hockey teams at Cornell University. Subjects were stratified according to team, then randomly assigned to the control (C; n = 21) or experimental group (E; n = 23). Before and after 7 weeks of resistance training, subjects were tested for lean body mass, 1 repetition maximum back squat and bench press, and peak and average power. Both C and E groups performed identical workouts except that E used CR (i.e., elastic resistance) for the back squat and bench press, whereas the C group used FWR alone. CR was performed using an elastic bungee cord attached to a standard barbell loaded with plates. Elastic tension was accounted for in an attempt to equalize the total work done by each group. Statistical analyses revealed significant ($P < 0.05$) between-group differences after training. Compared with C, improvement for E was nearly three times greater for back squat (16.47 +/- 5.67 vs. 6.84 +/- 4.42 kg increase), two times greater for bench press (6.68 +/- 3.41 vs. 3.34 +/- 2.67 kg increase), and nearly three times greater for average power (68.55 +/- 84.35 vs. 23.66 +/- 40.56 watt increase). Training with CR may be better than FWR alone for developing lower and upper body strength, and lower body power in resistance-trained individuals. Long-term effects are unclear, but CR training makes a meaningful contribution in the short term to performance adaptations of experienced athletes.

Colado., and Triplett (2008) were designed to determine whether different effects on functional capacity and body composition were produced by using different devices (elastic bands (EBs) versus weight machines (WMs)) with the same resistance training program. Forty-five healthy sedentary middle-aged women volunteers were chosen and randomly assigned to 1 of 3 groups: 21 subjects trained using EBs (EBG), 14 in trained using WMs (WMG), and 10 were controls (CG). Both exercise groups trained with a periodized muscular endurance program twice a week for 10 weeks, with a total of 6 exercises per session for the major muscle groups. Exercise intensity was equalized by jointly monitoring the same targeted number of repetitions (TNRs) and rate of perceived exertion in active muscles (RPE-AM). Functional capacity was assessed by using knee push-up (KPU) and 60-second squat (S) tests. Body composition was measured using an 8-polar bioelectrical impedance analyzer. The results for both the EBG and WMG show a decrease in fat mass ($p = 0.05$ and $p < 0.01$, respectively) and an increase in both the fat-free mass ($p < 0.05$ and $p < 0.01$, respectively) and the number of repetitions in the KPU ($p < 0.05$ and $p < 0.01$, respectively) and S tests ($p < 0.01$ in both). None of the variables measured for the CG varied significantly. It can be concluded that, independently of the device used, the combined monitoring of TNRs and RPE-AM can be a valid tool for controlling the resistance exercise intensity and can lead to healthy adaptations. EBs can thus offer significant physiological benefits that are comparable to those obtained from WMs in the early phase of strength training of sedentary middle-aged women.

Wallace., Winchester., and McGuigan (2006)were investigated the effect of elastic bands on peak force (PF), peak power (PP), and peak rate of force development (RFD) during the back-squat exercise (BSE). Ten recreationally resistance-trained subjects (4 women, 6 men, mean age 21.3 +/- 1.5 years) were tested for their 1 repetition maximum (1RM) in the BSE (mean 117.6 +/- 48.2 kg) on a Smith machine. Testing was performed on 2 separate days, with 2 sets of 3 repetitions being performed for each condition. Testing was conducted at 60% and 85% of 1RM with and without using elastic bands. In addition, 2 elastic band loading conditions were tested (B1 and B2) at each of the 2 resistances. No bands (NB) represents where all of the resistance was acquired from free-weights. B1 represents where approximately 80% of the resistance was provided by free-weights, and approximately 20% was provided by bands. B2 represents where approximately 65% of the resistance was provided by free-weights, and approximately 35% was provided from bands. The subjects completed the BSE under each condition, whereas PF, PP, and RFD was recorded using a force platform. There was a significant ($p < 0.05$) increase in PF between NB-85 and B2-85 of 16%. Between B1-85 and B2-85, PF was increased significantly by 5% ($p < 0.05$). There was a significant ($p < 0.05$) increase in PP between NB-85 and B2-85 of 24%. No significant differences were observed in RFD during the 85% conditions or for any of the measured variables during the 60% conditions ($p < 0.05$). The results suggest that the use of elastic bands in conjunction with free weights can significantly increase PF and PP during the BSE over free-weight resistance alone under certain loading conditions.

2.3. STUDIES ON CORE TRAINING

Tong, et.al. (2014) were compared the effects of two 6-week high-intensity interval training interventions. Under the control condition (CON), only interval training was undertaken, whilst under the intervention condition (ICT), interval training sessions were followed immediately by core training, which was combined with simultaneous inspiratory muscle training - 'functional' IMT. Sixteen recreational runners were allocated to either ICT or CON groups. Prior to the intervention phase, both groups undertook a 4-week programme of 'foundation' IMT to control for the known ergogenic effect of IMT [30 inspiratory efforts at 50% maximal static inspiratory pressure (P0) per set, 2 sets.d, 6 d.wk]. The subsequent 6-week interval running training phase, consisted of 3-4 sessions.wk. In addition, the ICT group undertook four inspiratory-loaded core exercises [10 repetitions. set, 2 sets. d, inspiratory load set at 50% post-IMT P0] immediately after each interval training session. The CON group received neither core training nor functional IMT. Following the intervention phase, global inspiratory and core muscle functions increased in both groups ($P<0.05$), as evidenced by P0 and a sport-specific endurance plank test performance (SEPT), respectively. Compared to CON, the ICT group showed larger improvements in SEPT, running economy at the speed of the OBLA, and 1-hr running performance (3.04% vs 1.57%, $P<0.05$). The changes in these variables were inter-individually correlated ($r\geq0.57$, $n=16$, $P<0.05$). Such findings suggest that the addition of inspiratory-loaded core conditioning into a high-intensity interval training program augments the influence of the interval program upon endurance running performance, and that this may be underpinned by an improvement in running economy.

Arnold, et.al., (2014)were compared sit to stand (STS) performance between older adults in a 9-week training program focusing on core stability exercises to enhance balance and postural control (EB) versus standard balance (SB) exercises. Repetitions in 30 seconds (STSreps) and kinematic performance (vertical and horizontal momentum, and margin of stability) were measured pre and post-intervention in 23 older adults with at least one fall risk factor. Although both groups combined improved STSreps ($p = .001$) and vertical momentum (.008), a significant between group difference was observed for completers only

(MANCOVA of post-test group differences, with pre-test scores as co-variants; p = .04). EB demonstrated a greater but non-significant improvement in vertical momentum (p=.095). In conclusion, core stability training added to SB did not result in STS reps improvement. Compliance may modify these results and future larger sample studies should evaluate the impact of core stability training on STS biomechanics.

Weston, et.al., (2014) were quantified the effects of a 12-week isolated core training programme on 50-m front crawl swim time and measures of core musculature functionally relevant to swimming. Twenty national-level junior swimmers (ten male and ten female, 16 ± 1 y, 171 ± 5 cm, 63 ± 4 kg) participated in the study. Group allocation (intervention [n=10], control [n=10]) was based on two pre-existing swim training groups who were part of the same swimming club but trained in different groups. The intervention group completed the core training, incorporating exercises targeting the lumbo-pelvic complex and upper region extending to the scapula, three times per week for 12 weeks. While the training was performed in addition to the normal pool-based swimming programme, the control group maintained their usual pool-based swimming programme. We made probabilistic magnitude-based inferences about the effect of the core training on 50-m swim time and functionally relevant measures of core function. Compared to the control group, the core training intervention group had a possibly large beneficial effect on 50-m swim time (-2.0%; 90% confidence interval -3.8 to -0.2%). Moreover it showed small-moderate improvements on a timed prone-bridge test (9.8%; 3.9 to 16.0%) and asymmetric straight-arm pull-down test (21.9%; 12.5 to 32.1%), there were moderate-large increases in peak EMG activity of core musculature during isolated tests of maximal voluntary contraction. This is the first study to demonstrate a clear beneficial effect of isolated core training on 50-m front crawl swim performance.

Sandrey and Mitzel (2013) determine the effects of a 6-week core-stabilization-training program for high school track and field athletes on dynamic balance and core endurance. High school in north central West Virginia. Thirteen healthy high school student athletes from 1 track and field team volunteered for the study. Subjects completed pretesting 1 wk before data collection. They completed a 6-wk core-stabilization program designed specifically for track and field athletes.

The program consisted of 3 levels with 6 exercises per level and lasted for 30 min each session 3 times per week. Subjects progressed to the next level at 2-wk intervals. After 6 wk, post testing was conducted. The subjects were evaluated using the Star Excursion Balance Test (SEBT) for posteromedial (PM), medial (M), and anteromedial (AM) directions; abdominal-fatigue test (AFT); back-extensor test (BET); and side-bridge test (SBT) for the right and left sides. Posttest results significantly improved for all 3 directions of the SEBT (PM, M, and AM), AFT, BET, right SBT, and left SBT. Effect size was large for all variables except for PM and AM, where a moderate effect was noted. Minimal-detectable-change scores exceeded the error of the measurements for all dependent variables. After the 6-wk core-stabilization-training program, measures of the SEBT, AFT, BET, and SBT improved, thus advocating the use of this core-stabilization-training program for track and field athletes.

Schilling, et.al., (2013) were discovered if core isometric endurance exercises were superior to core isotonic strengthening exercises and if either influenced specific endurance, strength, and performance measures. Ten untrained students were randomly assigned to core isometric endurance (n = 5) and core isotonic strength training (n = 5). Each performed three exercises, two times per week for six weeks. A repeated measures ANOVA was used to compare the measurements for the dependent variables and significance by bonferroni post-hoc testing. The training protocols were compared using a 2 × 3 mixed model ANOVA. Improvement in trunk flexor and extensor endurance ($p < 0.05$) along with squat and bench press strength ($p < 0.05$) occurred with the strength group. Improvement in trunk flexor and right lateral endurance ($p < 0.05$) along with strength in the squat ($p < 0.05$) were found with the endurance group. Neither training protocol claimed superiority and both were ineffective in improving performance.

Weston., Coleman and Spears (2013) were aimed to quantify the effect of an 8-wk isolated core training program on selected ball and club parameters during the golf swing and also the variability of these measures. Thirty-six club-level golfers were randomly assigned to an exercise (n = 18) or control (n =18) group. The exercise group participated in an 8-wk core training program, which included eight basic exercises. Both groups continued with their normal activity levels including golf. Baseline and post intervention measurements included club-head speed, backspin, sidespin, and timed core endurance. Baseline measures for club-head speed, backspin, sidespin, and core endurance test were 79.9 ± 8.4 mph, 3930 ± 780 rpm, 1410 ± 610 rpm, and 91 ± 56 s for the intervention group and 77.6 ± 8.8 mph, 3740 ± 910 rpm, 1290 ± 730 rpm, and 69 ± 55 s for the control group (mean ± SD). The effect of our core training, when compared with control, was a likely small improvement in club-head speed (3.6%; 90% confidence limits = ±2.7%) and a very likely small improvement in muscular endurance (61%; ±33%). The effect on backspin (5%; ±10%) and sidespin (-6%; ±20%) was unclear. Baseline variability for club-head speed, backspin, and sidespin (based on 10 swings per golfer) was 5.7% ± 5.3%, 43% ± 19%, and 140% ± 180% for the intervention group and 6.5% ± 5.3%, 53% ± 53%, and 170% ± 130% for control group. The effect of the intervention on within-subject variability was a moderate decrease for club-head speed, a small decrease for backspin, and a small increase for sidespin when compared with control. The benefits achieved from our isolated core training program are comparable with those from other studies.

Sharma, Geovinson, and Singh (2012) were established the effects of core strengthening exercise program on trunk instability in response to vertical jump performances and static balance variables in volleyball players. Forty state level volleyball players with trunk instability were randomly divided into two groups, control ([C] m=10; f=10) and experimental ([E] m=10; f=10). Modified double straight leg lowering test was used to check the degree of trunk instability. Counter movement jump, squat jump, spike jump and block jumps were used to measure jumping abilities and a wobble board test was used to test balance. Pre- and post-readings were noted before and after the nine-week training protocol and statistical data analysis was done using SPSS 16.After nine weeks of core stabilization training, trunk stability (P<0.001), block difference (BD) in block jump (P<0.01) were enhanced significantly comparing to (C) group using independent T test. Effect size Cohen's d score demonstrated better improvement of spike jump (d=0.25) and block jump (d=0.52) in (E) group. Other jumps and static balance were improved but non-significant when compared between groups. Nine-week strategic core strengthening exercise program increases trunk stability and in turn improves block difference (vertical jump parameter).

Shinkle, et.al., (2012) were developed a functional field test to assess the role of the core musculature and its impact on sport performance in an athletic population and (b) develop a functional field test to determine how well the core can transfer forces from the lower to the upper extremities. Twenty-five DI collegiate football players performed medicine ball throws (forward, reverse, right, and left) in static and dynamic positions. The results of the medicine ball throws were compared with several athletic performance measurements: 1 repetition maximum (1RM) squat, squat kg/bw, 1RM bench press, bench kg/bw, countermovement vertical jump (CMJ), 40-yd dash (40 yd), and proagility (PrA). Push press power (PWR) was used to measure the transfer of forces through the body. Several correlations were found in both the static and dynamic medicine ball throws when compared with the performance measures. Static reverse correlated with CMJ (r = 0.44), 40 yd (r = 0.5), and PrA (r = 0.46). Static left correlated with bench kg/bw (0.42), CMJ (0.44), 40 yd (0.62), and PrA (0.59). Static right also correlated with bench kg/bw (0.41), 40 yd (0.44), and PrA (0.65).

Dynamic left and Dynamic right correlated with CMJ, r = 0.48 and r = 0.40, respectively. Push press power correlated with bench kg/bw (0.50), CMJ (0.48), and PrA (0.48). A stepwise regression for PWR prediction identified 1RM squat as the best predictor. The results indicate that core strength does have a significant effect on an athlete's ability to create and transfer forces to the extremities. Currently, plank exercises are considered an adequate method of training the core for athletes to improve core strength and stability. This is a problem because it puts the athletes in a nonfunctional static position that is very rarely replicated in the demands of sport-related activities. The core is the center of most kinetic chains in the body and should be trained accordingly.

Hibbs, et.al., (2011) were established the repeatability of peak and average rectified EMG data during core training exercises and their interrelationship. Ten male highly trained athletes (inter-subject repeatability group; age, 18 ± 1.2 years; height, 176.5 ± 3.2 cm; body mass, 71 ± 4.5 kg) and one female highly trained athlete (intra-subject repeatability group; age; 27 years old; height; 180 cm; weight; 53 kg) performed five maximal voluntary isometric contractions (MVIC) and five core exercises, chosen to represent a range of movement and muscle recruitment patterns. Peak EMG and ARV EMG were calculated for eight core muscles (rectus abdominis, RA; external oblique, EO; internal oblique, IO; multifidis, MF; latissimus dorsi, LD; longissimus, LG; gluteus maximus, GM; rectus femoris, RF) using sEMG. Average coefficient of variation (CV%) for peak EMG across all the exercises and muscles was 45%. This is in comparison to 35% for the ARV method, which was found to be a significant difference ($P<0.05$), therefore implying that the ARV method is the more reliable measure for these types of exercise.

Five muscles were highly correlated ($R>0.70$; RA, EO, MF, GM, LG) between peak and ARV EMG suggesting, that for these core muscles, the two methods provide a similar evaluation of muscle activity. However, for other muscles (IO, RF, LD) the relationship was found to range from poor to moderate ($R=0.10$-0.70). The relationship between peak and ARV EMG was also affected by exercise type. Dynamic low and high-threshold exercises and asymmetrical low-threshold exercises had a moderate correlation between the variables ($R=0.74$-0.81), while the static exercise showed a poor correlation ($R=0.46$). It can be concluded that there are similarities between the two EMG variables, however due to the effect of type of exercise and muscle on the EMG data, both methods should be included in any future EMG study on the core musculature and core stability exercises.

Saeterbakken, Tillaar and Seiler (2011) were studied the effect of a sling exercise training (SET)-based core stability program on maximal throwing velocity among female handball players. Twenty-four female high-school handball players (16.6 ± 0.3 years, 63 ± 6 kg, and 169 ± 7 cm) participated and were initially divided into a SET training group (n = 14) and a control group (CON, n = 10). Both groups performed their regular handball training for 6 weeks. In addition, twice a week, the SET group performed a progressive core stability-training program consisting of 6 unstable closed kinetic chain exercises. Maximal throwing velocity was measured before and after the training period using photocells. Maximal throwing velocity significantly increased 4.9% from 17.9 ± 0.5 to 18.8 ± 0.4 m·s in the SET group after the training period ($p < 0.01$), but was unchanged in the control group (17.1 ± 0.4 vs. 16.9 ± 0.4 m·s). These results suggest that core stability training using unstable, closed kinetic chain movements can significantly improve maximal throwing velocity. A stronger and more stable lumbo pelvic-hip complex may contribute to higher rotational velocity in multi segmental movements. Strength coaches can incorporate exercises exposing the joints for destabilization force during training in closed kinetic chain exercises. This may encourage an effective neuromuscular pattern and increase force production and can improve a highly specific performance task such as throwing.

Freeman, et.al., (2010) explored the effectiveness of core stability training on balance and mobility. A multi-centre series of eight single case studies was undertaken. Eight ambulant individuals with stable MS participated in 16 face-to-face core stability training sessions, delivered by a neuro-physiotherapist, plus a daily home exercise programme. A range of outcomes were measured: 10-m timed walk, 12-item MS walking scale, timed get up and go, functional reach tests, timed single leg stance, visual analogue scales of two activities, and the Activities-specific Balance Confidence Scale. Visual analysis of trend, level and slope demonstrated improvement in five subjects (62%) in seven measures. This was confirmed by the two standard deviation band method of analysis for six measures. Analysis of group data (repeated measures within subjects analysis of variance) indicated significant improvement between baseline and intervention phases for timed walk ($p = 0.019$), MSWS-12 Scale ($p = 0.041$), forward ($p = 0.015$) and lateral reach ($p = 0.012$). In general, no further improvements were made following withdrawal of the intervention. This study provides preliminary evidence of the effectiveness of an 8-week core stability training programme in improving balance and mobility in ambulant people with MS. Variations in response to intervention are evident. Assessor-blinded randomized controlled studies are required to confirm these findings and determine patient characteristics which identify those who benefit most from this intervention.

Strongoli, Gomez, and Coast (2010) were evaluated the effect of 13 different abdominal exercises, ranging in difficulty, on trans-diaphragmatic pressure (Pdi), an index of diaphragmatic activity. Six healthy subjects, aged 22 to 53, participated. Each subject was instrumented with two balloon-tipped catheters to obtain gastric and esophageal pressures, from which Pdi was calculated. Prior to initiating the exercises, each subject performed a maximal inspiratory pressure (MIP) maneuver. Resting Pdi was also measured. The exercises were performed from least to most difficult, with five repetitions each. There was a significant difference between the exercises and the MIP Pdi, as well as between the exercises and resting Pdi ($p < 0.001$). The exercises stratified into three Pdi levels. Seven of the exercises yielded Pdi ≥ 50% of the Pdi during the MIP maneuver, which may provide a training stimulus to the diaphragm if used as a regular exercise. The Pdi measurements also provide insight into diaphragm recruitment during different core exercises, and may aid in the design of exercises to improve diaphragm strength and endurance. Key points provide 3-5 bullet points of the study. The study examined the effect of different core exercises of varying difficulty on activation of the diaphragm. We found that the exercises yielded different pressures, some of which were greater than 50% of the pressures generated during a maximal inspiratory maneuver. The difficulty of the exercise was not always correlated with the magnitude of the pressure. Some of these exercises should be easy enough for subjects in rehabilitation programs to perform and still generate high enough pressures to help strengthen the diaphragm.

Willardson., Fontana., and Bressel (2009) were compared the core muscle activity during resistance exercises performed on stable ground vs. the BOSU Balance Trainer. Twelve trained men performed the back squat, dead lift, overhead press, and curl lifts. The activity of the rectus abdominis, external oblique abdominis, transversus abdominis/internal oblique abdominis, and erector spinae muscles was assessed. Subjects performed each lift under three separate conditions including standing on stable ground with 50% of a 1-RM, standing on a BOSU Balance Trainer with 50% of a 1-RM, and standing on stable ground with 75% of a 1-RM.Significant differences were noted between the stable 75% of 1-RM and BOSU 50% of 1-RM conditions for the rectus abdominis during the overhead press and transversus abdominis/internal oblique abdominis during the overhead press and curl ($P < .05$). Conversely, there were no significant differences between the stable 75% of 1-RM and BOSU 50% of 1-RM conditions for the external obliques and erector spinae across all lifts examined. Furthermore, there were no significant differences between the BOSU 50% of 1-RM and stable 50% of 1-RM conditions across all muscles and lifts examined. The current study did not demonstrate any advantage in utilizing the BOSU Balance Trainer. Therefore, fitness trainers should be advised that each of the aforementioned lifts can be performed while standing on stable ground without losing the potential core muscle training benefits.

Nesser, et.al., (2008) were identified the relationships between core stability and various strength and power variables in strength and power athletes. National Collegiate Athletic Association Division I football players (height 184.0 +/- 7.1 cm, weight 100.5 +/- 22.4 kg) completed strength and performance testing before off-season conditioning. Subjects were tested on three strength variables (one-repetition maximum [1RM] bench press, 1RM squat, and 1RM power clean), four performance variables (countermovement vertical jump [CMJ], 20- and 40-yd sprints, and a 10-yd shuttle run), and core stability (back extension, trunk flexion, and left and right bridge). Significant correlations were identified between total core strength and 20-yd sprint (r = -0.594), 40-yd sprint (r = -0.604), shuttle run (r = -0.551), CMJ (r = 0.591), power clean/body weight (BW) (r = 0.622), 1RM squat (r = -0.470), bench press/BW (r = 0.369), and combined 1RM/BW (r = 0.447); trunk flexion and 20-yd sprint (r = -0.485), 40-yd sprint (r = -0.479), shuttle run (r = -0.443), CMJ (r = 0.436), power clean/BW (r = 0.396), and 1RM squat (r = -0.416); back extension and CMJ (r = 0.536), and power clean/BW (r = 0.449); right bridge and 20-yd sprint r = -0.410) and 40-yd sprint (r = -0.435), CMJ (r = 0.403), power clean/BW (r = 0.519) and bench press/BW (r = 0.372) and combined 1RM/BW (r = 0.406); and left bridge and 20-yd sprint (r = -0.376) and 40-yd sprint (r = -0.397), shuttle run (r = -0.374), and power clean/BW (r = 0.460). The results of this study suggest that core stability is moderately related to strength and performance. Thus, increases in core strength are not going to contribute significantly to strength and power and should not be the focus of strength and conditioning.

Navalta, and Hrncir (2007) were designed to assess the extent of the lactate response with core stabilization exercises following high-intensity anaerobic exercise. Subjects (N = 12) reported twice for testing, and on both occasions baseline lactate was obtained after 5 minutes of seated rest. Subjects then performed a 30-second Wingate anaerobic cycle test, immediately followed by a blood lactate sample. In the 5-minute post-exercise period, subjects either rested quietly or performed core stabilization exercises. A final blood lactate sample was obtained following the 5-minute intervention period. Analysis revealed a significant interaction (p = 0.05). Lactate values were similar at rest (core = 1.4 +/- 0.1, rest = 1.7 +/- 0.2 mmol x L(-1)) and immediately after exercise (core = 4.9 +/- 0.6, rest = 5.4 +/- 0.4 mmol x L(-1)). However, core stabilization exercises performed during the 5-minute post-exercise period reduced lactate values when compared to rest (5.9 +/- 0.6 vs. 7.6 +/- 0.8 mmol x L(-1)). The results of this study show that performing core stabilization exercises during a recovery period significantly reduces lactate values. The reduction in lactate may be due to removal via increased blood flow or enhanced uptake into the core musculature. Incorporation of core stability exercises into a cool-down period following muscular work may result in benefits to both lactate clearance as well as enhanced postural control.

Stanton, Reaburn, and Humphries (2004) were investigated the effect of a short-term Swiss ball training on core stability and running economy. Eighteen young male athletes (15.5 +/- 1.4 years; 62.5 +/- 4.7 kg; sigma9 skinfolds 78.9 +/- 28.2 mm; VO2max 55.3 +/- 5.7 ml.kg (-1).min (-1)) were divided into a control (n = 10) and experimental (n = 8) groups. Athletes were assessed before and after the training program for stature, body mass, core stability, electromyography activity of the abdominal and back muscles, treadmill

VO2max, running economy, and running posture. The experimental group performed 2 Swiss ball training sessions per week for 6 weeks. Data analysis revealed a significant effect of Swiss ball training on core stability in the experimental group ($p < 0.05$). No significant differences were observed for myoelectric activity of the abdominal and back muscles, treadmill VO2max, running economy, or running posture in either group. It appears Swiss ball training may positively affect core stability without concomitant improvements in physical performance in young athletes. Specificity of exercise selection should be considered.

2.4 STUDIES ON SPEED TRAINING

Barr, et.al. (2014) were find out the method of improving the lower body power of athletes is simulated hyper gravity. This method involves wearing a weighted vest at all times during the day for an extended period of time. There are no studies that have examined the effect of hyper gravity on speed or the benefit for rugby players. An experimental group (n=8) and control group (n=7) of national team rugby players took part in the study which consisted of rugby, conditioning, speed and strength sessions. The experimental group wore a weighted vest equating to 12% of their body mass for 8 days. All players were tested for speed and lower body power prior to, 2 days after and 9 days after the intervention. Speed testing involved the athletes completing 40 m sprints with timing lights and high speed video cameras assessing acceleration and maximal velocity sprinting kinematics. Lower body power was assessed using weighted countermovement jumps (CMJ). No group differences were found for sprinting speed at any point. The experimental group displayed a large decrease in acceleration ground contact time (-0.01 ± 0.005s, d=1.07) and a moderate increase in 15 kg CMJ velocity (0.07 ± 0.11 m/s, d=0.71). Individual responses showed that players in the experimental group had both negative and positive speed and power responses to the training intervention. Simulated hyper gravity for 8 days is likely ineffective at improving sprinting speed while undergoing standard rugby training.

Mehdizadeh, Arshi, and Davids (2014) were investigated the effect of running speed on local dynamic stability of forward and backward running on a treadmill. Fifteen healthy male participants took part in this study. Participants ran in forward and backward directions at speeds of 80%, 100% and 120% of their preferred running speed. The three-dimensional motion of a C7 marker was recorded using a motion capture system. Local dynamic stability of the marker was quantified using short- and long-term largest finite-time Lyapunov exponents (LyE). Results showed that short-term largest finite-time LyE values increased with participant speed meaning that local dynamic stability decreased with increasing speed. Long-term largest finite-time LyEs, however, remained unaffected as speed increased. Results of this study indicated that, as in walking, slow running is more stable than fast running. These findings improve understanding of how stability is regulated when constraints on the speed of movements is altered. Implications for the design of rehabilitation or sport practice programmes suggest how task constraints could be manipulated to facilitate adaptations in locomotion stability during athletic training.

Barr, et.al., (2014)were developed these qualities in senior and junior international rugby players. In part 1 of the study, a group of senior (n = 38) and junior (n = 31) players were tested for speed over 40 m. Initial sprint velocity (ISV), maximal sprint velocity (MSV), initial sprint momentum (ISM), and maximal sprint momentum (MSM) were calculated using 10-m splits. In part 2 of the study, a group of junior (n = 12) and senior (n = 15) players were tracked over a 2-year period for body mass, ISV, MSV, ISM, and MSM. In part 1, senior backs and forwards were not found to have significantly greater ISV and MSV than junior players but were found to have greater ISM and MSM. Forwards were found to have significantly greater ISM and MSM than backs but significantly lower ISV and MSV than backs. In part 2, no significant differences were found over the 2 years between senior and junior players, but greater effect sizes for juniors were generally found when compared with seniors for improvements in ISV (d = 0.73 vs. 0.79), MSV (d = 1.09 vs. 0.68), ISM (d = 0.96 vs. 0.54), and MSM (d = 1.15 vs. 0.50). Sprint momentum is a key discriminator between senior and junior players, and large changes can be made by junior players as they transition into senior rugby. Speed appears to peak for players in their early 20s but sprint momentum appears to be more trainable.

Elvira, et.al., (2014) were analysed the effect of movement speed on the kinematics and kinetics of curl-up, sit-up and leg raising/lowering exercises. Seventeen healthy, recreationally trained individuals (13 females and 4 males) volunteered to participate in this study. Four different exercise cadences were analysed: 1 repetition/4 s, 1 repetition/2 s, 1 repetition/1.5 s and 1 repetition/1 s. The exercises were executed on a force plate and recorded by three cameras to conduct a 3D photogrammetric analysis. The cephalo-caudal displacement of the centre of pressure and range of motion (ROM) of six joints describing the trunk and hip movements were measured. As sit-up and curl-up speed increased, hip and knee ROM increased. Dorsal-lumbar and upper trunk ROM increased with speed in the curl-up. Faster cadence in the sit-up exercise had minimal effect on trunk ROM: only the upper trunk ROM decreased significantly. In the leg raising/lowering exercise there was a decrease in the pelvic tilt and hip ROM, and increased knee flexion ROM. During higher speed exercises, participants modified their technique to maintain the cadence. Thus, professionals would do well to monitor and control participants' technique during high-speed exercises to maintain performance specificity. Results also suggest division of speed into two cadence categories, to be used as a reference for prescribing exercise speed based on preferred outcome goals.

Vescovi (2014) was examined the impact of maximum sprint speed on peak and mean sprint speed during youth female field hockey matches. Two high-level female field hockey teams (U-17, n = 24, and U-21, n = 20) were monitored during a 4-game international test series using global position system technology and tested for maximum sprint speed. Dependent variables were compared using a 3-factor ANOVA (age group, position, and speed classification); effect sizes (Cohen d) and confidence limits were also calculated. Maximum sprint speed was similar between age groups and positions, with faster players having greater speed than slower players (29.3 ± 0.4 vs 27.2 ± 1.1 km/h). Overall, peak match speed in youth female field hockey players reaches approximately 90% of maximum sprint speed. Absolute peak match speed and mean sprint speed during matches were similar among the age groups (except match 1) and positions (except match 2); however, peak match speed was greater for faster players in matches 3 and 4. No differences were observed in the relative proportion for mean sprint speeds for age groups or positions, but slower players consistently displayed similar relative mean sprint speeds by using a greater proportion of their maximum sprint speed.

Marques, et.al., (2013) were examined the effect of a six-week combined jump and sprint training program on strength-speed abilities in a large sample of youth competitive soccer players. It was hypothesized that the experimental training group would enhance their jumping and sprinting abilities. Enhancement of kicking performance was also hypothesized due to an expected increase in explosive strength established by a plyometric and sprinting regimen. Fifty-two young male soccer players playing at the national level (aged 13.4 ± 1.4 years, body mass 53.4 ± 11.7 kg, body height 1.66 ± 0.11 m) took part in the study. Half of the group underwent the plyometric and sprint training program in addition to their normal soccer training, while the other half was involved in soccer training only. The plyometric training group enhanced their running (+1.7 and +3.2%) and jumping performance (+7.7%) significantly over the short period of time, while the control group did not. Furthermore, both groups increased their kicking velocity after just six weeks of training (+3.3 vs. 6.6%). The findings suggest that a short in-season 6-week sprint and jump training regimen can significantly improve explosive strength in soccer-specific skills and that these improvements can be transferred to soccer kicking performance in terms of ball speed.

Milanović,et.al., (2013) were determined the effects of a 12 week conditioning programme involving speed, agility and quickness (SAQ) training and its effect on agility performance in young soccer players. Soccer players were randomly assigned to two groups: experimental group (EG; n = 66, body mass: 71.3 ± 5.9 kg; body height: 1.77 ± 0.07 m) and control group (CG; n = 66, body mass: 70.6 ± 4.9 kg; body height: 1.76 ± 0.06 m). Agility performance was assessed using field tests: Slalom; Slalom with ball; Sprint with 90° turns; Sprint with 90° turns with ball; Sprint with 180° turns; Sprint with backward and forward running; Sprint 4 x 5 m. Statistically significant improvements ($p < 0.05$) between pre and post training were evident for almost all measures of agility, with and without the ball, with the exception being the Sprint with backward and forward running. This suggests that SAQ training is an effective way of improving agility, with and without the ball, for young soccer players and can be included in physical conditioning programmes. Key points SAQ training appears to be an effective way of improving agility with and without the ball in young soccer players. Soccer coaches could use this training during pre-season and in-season training. Compared with pre-training, there was a statistically significant improvement in all but one measure of agility, both with and without the ball after SAQ training.

Shalfawi, et.al., (2013) were compared the effects of in-season combined resisted agility and repeated sprint training with strength training on soccer players' agility, linear single sprint speed, vertical jump, repeated sprint ability (RSA), and aerobic capacity. Twenty well-trained elite female soccer players of age ± SD 19.4 ± 4.4 years volunteered to participate in this study. The participants were randomly assigned to either the agility and repeated sprint training group or to the strength training group. All the participants were tested before and after a 10-week specific conditioning program. The pretest and posttest were conducted on 3 separate days with 1 day of low-intensity training in between. Test day 1 consisted of squat jump (SJ), countermovement jump (CMJ), and RSA. Test day 2 consisted of a 40-m maximal linear sprint and an agility test, whereas a Beep test was conducted on test day 3 to assess aerobic capacity. The agility and repeated sprint training implemented in this study did not have a significant effect on agility, although there was a tendency for moderate improvements from 8.23 ± 0.32 to 8.06 ± 0.21 seconds ($d = 0.8$). There was a significant ($p < 0.01$) and moderate-positive effect on Beep-test performance from level 9.6 ± 1.4 to level 10.8 ± 1.0, and only a trivial small effect on all other physical variables measured in this study. The strength training group had a positive, moderate, and significant ($p < 0.01$) effect on Beep-test performance from level 9.7 ± 1.3 to level 10.9 ± 1.2 ($d = 1.0$) and a significant ($p < 0.05$) but small effect ($d = 0.5$) on SJ performance (25.9 ± 2.7 to 27.5 ± 4.1 cm). Furthermore, the strength training implemented in this study had a trivial and negative effect on agility performance (d = -0.1). No between-group differences were observed. The outcome of this study indicates the importance of a well-planned program of conditioning that does not result in a decreased performance of the players, the great importance of strength and conditioning specialist in implementing the training program, and the importance of choosing the time of the year to implement such conditioning training programs. However, the fact that the present training program did not cause any decline in performance indicates that it is useful in maintaining the soccer players' physical performance during the competition period.

Johnson, et.al., (2013) were determined the effect of a high-speed treadmill (HST) with the use of a body weight support (BWS) system in a 6-week sport acceleration program (SAP) on female soccer athlete's 40-yard sprint time and maximal isometric knee flexor and extensor strength. Two treatment groups and one control group were created. Both treatment groups participated in a 12-session SAP. The first treatment group (n = 12) used a BWS system while running on a HST; the second group (n = 12) used a standard treadmill (ST) with no BWS system. The participants of the control group (n = 8), NT, did not participate in a sports acceleration program and did not alter their exercise routines outside of the study. An analysis of covariance was performed using baseline measures as the covariate. The 40-yard sprint times for both treatment groups were shown to improve significantly compared with the control group ($p < 0.001$). Isometric knee flexor strength showed a greater increase in the ST group ($p = 0.026$) than in the other 2 groups, whereas knee extensor strengths did not show significant differences between treatment groups and control group ($p > 0.05$). Participants in the ST group had a much higher rate (66%) of shin splints and foot pain throughout the study than those in the HST (8%) and NT (0%) groups. These results can help high school coaches and athletes determine the optimal treadmill training regime.

Cook, Beaven, and Kilduff (2013) were aimed to compare the effects of traditional or eccentric training with volume-matched training that incorporated over speed exercises. Twenty team-sport athletes performed 4 counterbalanced 3-week training blocks consecutively as part of a preseason training period: (1) traditional resistance training; (2) eccentric-only resistance training; (3) traditional resistance training with over speed exercises; and (4) eccentric resistance training with over speed exercises. The over speed exercises performed were assisted countermovement jumps and downhill running. Improvements in bench press (15.0 ± 5.1 kg; effect size [ES]: 1.52), squat (19.5 ± 9.1 kg; ES: 1.12), and peak power in the countermovement jump (447 ± 248 W; ES: 0.94) were observed following the 12-week training period. Greater strength increases were observed as a result of the eccentric training modalities (ES: 0.72-1.09) with no effect of the over speed stimuli on these measures ($p > 0.05$). Eccentric training with over speed stimuli was more effective than traditional resistance training in increasing peak power in the countermovement jump (94 ± 55 W; ES: 0.95). Eccentric training induced no beneficial training response in maximal running speed ($p > 0.05$); however, the addition of over speed exercises salvaged this relatively negative effect when compared with eccentric training alone (0.03 ± 0.01 seconds; ES: 1.33). These training results achieved in 3-week training blocks suggest that it is important to target-specific aspects of both force and movement velocity to enhance functional measures of power expression.

Sayers and Gibson (2012) were examined whether high-speed power training (HSPT) improved muscle performance and braking speed using a driving simulator. 72 older adults (22 m, 50 f; age = 70.6 ± 7.3 yrs) were randomized to HSPT at 40% one-repetition maximum (1RM) (HSPT: n = 25; 3 sets of 12-14 repetitions), slow-speed strength training at 80%1RM (SSST: n = 25; 3 sets of 8-10 repetitions), or control (CON: n = 22; stretching) 3 times/week for 12 weeks. Leg press and knee extension peak power, peak power velocity, peak power force/torque, and braking speed were obtained at baseline and 12 weeks. HSPT increased peak power and peak power velocity across a range of external resistances (40-90% 1RM; $P < 0.05$) and improved braking speed ($P < 0.05$). Work was similar between groups, but perceived exertion was lower in HSPT ($P < 0.05$). Thus, the less strenuous HSPT exerted a broader training effect and improved braking speed compared to SSST.

Cherif, et.al., (2012) were investigated the effect of a combined program including sprint repetitions and drop jump training in the same session on male handball players. Twenty-two male handball players aged more than 20 years were assigned into 2 groups: experimental group (n=11) and control group (n=11). Selection was based on variables "axis" and "lines", goalkeepers were not included. The experimental group was subjected to 2 testing periods (test and retest) separated by 12 weeks of an additional combined plyometric and running speed training program. The control group performed the usual handball training. The testing period comprised, at the first day, a medical checking, anthropometric measurements and an incremental exercise test called yo-yo intermittent recovery test. 2 days later, participants performed the Repeated Sprint Ability test (RSA), and performed the Jumping Performance using 3 different events: Squat jump (SJ), Countermovement jump without (CMJ) and with arms (CMJA), and Drop jump (DJ). At the end of the training period, participants performed again the repeated sprint ability test, and the jumping performance. The conventional combined program improved the explosive force ability of handball players in CMJ (P=0.01), CMJA (P=0.01) and DJR (P=0.03). The change was 2.78, 2.42 and 2.62% respectively. No significant changes were noted in performances of the experimental group at the squat jump test and the drop jump with the left leg test. The training intervention also improved the running speed ability of the experimental group (P=0.003). No statistical differences were observed between lines or axes. Additional combined training program between sprint repetition and vertical jump in the same training session positively influence the jumping ability and the sprint ability of handball players.

Meckel, et.al., (2012) were compared the effect of short-sprint repetition and long-sprint repetition training (SST, LST), matched for total distance, on selected fitness components in young soccer players. Thirty young (14-15 years) soccer players were randomly assigned to either the short-sprint training group or long-sprint training group and completed 2 similar sets of fitness tests before and after 7 weeks of training. The 2 training programs consisted of SST (4-6 sets of 4 × 50-m all-out sprint) and LST (4-6 sets of 200-m run at 85% of maximum speed), each performed 3 times a week. Before training, there were no baseline between-group differences in predicted VO2max, standing long jump, 30-m sprint time, 4 × 10-m shuttle running time, and 250-m running time. Both training programs led to a significant improvement in VO2max (predicted from the 20-m shuttle run, $p < 0.01$), with no between-group difference ($p = 0.14$). Both training programs also led to a significant improvement in the anaerobic fitness variables of 30-m sprint time ($p < 0.01$), 4 × 10-m shuttle running time ($p < 0.01$), and 250-m running time ($p < 0.01$), with no between-group differences. Neither of the training programs had a significant effect on standing long jump ($p = 0.21$). The study showed that long, near-maximal sprints, and short, all-out sprint training, matched for total distance, are equally effective in enhancing both the aerobic and anaerobic fitness of young soccer players. Therefore, to maintain a player's training interest and enthusiasm, coaches may alternate between these methods during the busy soccer season.

Tønnessen, et.al., (2011) were examine the effect of 10 weeks' 40-m repeated sprint training program that does not involve strength training on sprinting speed and repeated sprint speed on young elite soccer players. Twenty young well-trained elite male soccer players of age (±SD) 16.4 (±0.9) years, body mass 67.2 (±9.1) kg, and stature 176.3 (±7.4) cm volunteered to participate in this study. All participants were tested on 40-m running speed, 10 × 40-m repeated sprint speed, 20-m acceleration speed, 20-m top speed, countermovement jump (CMJ), and aerobic endurance (beep test). Participants were divided into training group (TG) (n = 10) and control group (CG) (n = 10). The study was conducted in the pre competition phase of the training program for the participants and ended 13 weeks before the start of the season; the duration of the pre competition period was 26 weeks. The TG followed a Periodized repeated sprint training program once a week. The training program consisted of running 40 m with different intensities and duration from week to week. Within-group results indicate that TG had a statistically marked improvement in their performance from pre to posttest in 40-m maximum sprint (-0.06 seconds), 10 × 40-m repeated sprint speed (-0.12 seconds), 20- to 40-m top speed (-0.05 seconds), and CMJ (2.7 cm). The CG showed only a statistically notable improvement from pre to posttest in 10 × 40-m repeated sprint speed (-0.06 seconds). Between-group differences showed a statistically marked improvement for the TG over the CG in 10 × 40-m repeated sprint speed (-0.07 seconds) and 20- to 40-m top speed (-0.05 seconds), but the effect of the improvement was moderate. The results further indicate that a weekly training with repeated sprint gave a moderate but not statistically marked improvement in 40-m sprinting, CMJ, and beep test. The results of this study indicate that the repeated sprint program had a positive effect on several of the parameters tested. However, because the sample size in this study is 20 participants, the results are valid only for those who took part in this study. Therefore, we advice to use repeated sprint training similar to the one in this study only in periods where the players have no speed training included in their program. Furthermore, the participants in this study should probably trained strength, however, benefits were observed even without strength training is most likely to be caused by the training specificity.

Hunter, et.al., (2011) were compared the effect of 2 repeated sprint training interventions on an intermittent peak running speed (IPRS) test designed for Australian Rules football. The test required participants to perform 10 × 10-m maximal efforts on an 80-m course every 25 seconds, for each of which the mean peak speed (kilometers per hour) was recorded to determine IPRS. The training interventions were performed twice weekly for 4 weeks immediately before regular football training. In the constant volume intervention (CVol), sprint repetition number remained at 10 ($n = 9$), and in the linear increase in volume (LIVol) intervention, repetition number increased linearly each week by 2 repetitions ($n = 12$). Intermittent peak running speed, 300-m shuttle test performance, and peak running speed were assessed before and upon completion of training. All measures were compared to a control group (CON; $n = 8$) in which players completed regular football training exclusively. Intermittent peak running speed performance in CVol and LIVol improved significantly ($p < 0.01$) by 5.2 and 3.8%, respectively, with no change in IPRS for CON. There were no differences in IPRS changes between CVol and LIVol. Additionally, peak running speed improved significantly ($p < 0.01$) by 5.1% for CVol, whereas 300-m shuttle performance improved significantly ($p < 0.01$) by 2.6% for LIVol only. Intermittent peak running speed, 300-m shuttle performance and peak running speed were improved after 4 weeks of training; however, progressively increasing sprint repetition number had no greater advantage on IPRS adaptation. Additionally, exclusive regular football training over a 4-week period is unlikely to improve IPRS, peak running speed, or 300-m shuttle performance.

Saraslanidis, et.al., (2011) were evaluated the effect of three pacing strategies upon performance of the 400-m sprint. Eight healthy male physical education students participated in this study. Each participant performed a 200-m maximal test (200(MAX)) and three 400-m running tests in a random counterbalanced design. The 400-m tests were run with the first 200-m pace set at 98% (400(98%)), 95% (400(95%)), and 93% (400(93%)), respectively, of the effort for 200(MAX). The stimulation of the lactate system was assessed by post-test blood lactate concentration (BLa). Running speed (RS) was controlled with time-keeping devices. Stride frequency (SF), stride length (SL) and lower extremity kinematics were acquired with video cameras operating at 100 fps at the 125 and 380-m marks of the tests. A two-way analysis of variance (ANOVA) with repeated measures was used to identify modifications caused by the pacing strategies used. Non-significant differences were revealed for BLa. The fastest 400-m race was run in 400(93%), but performance was not significantly different ($p > 0.05$) among the examined pacing strategies. RS, SF and SL had significantly ($p < 0.05$) lower values in the 380-m mark when compared with the 125-m mark. In 400(98%), both SF and SL decreased by approximately 13%, while SF and SL dropped 2.4 and 9.2%, respectively, in 400(93%). In conclusion, lower peak BLa and less unfavorable modifications of running mechanics were recorded in 400(93%), where time differential between the halves of the 400-m race was smaller, which eventually resulted in better performance.

Ben Sira, et. al., (2010) were investigated the effects of sprint training regimes of varying distance schedules on the oxygen delivery-extraction relationship were investigated in 15 young (22+/-1 years) healthy males national-level sprinters. During one session subjects performed four sprints, in a schedule of increasing distance order (100, 200, 300 and 400 m), and during the other session, in a schedule of decreasing distance order (400, 300, 200, and 100 m). All sprint bouts were performed on a treadmill at a speed of 22 km/h-1, which corresponds to 85% of subjects' maximal speeds. The order of the running sequences during sessions was balanced over subjects. During both sprint schedules, all variables except for oxygen extraction in the incremented training regime, increased significantly from rest to exercise. Training regimes were not different with regard to cardiac output and absolute oxygen uptake. However, the decreasing compared to the increasing scheme was characterized by significantly (P<0.05) higher mean values of heart rate (194.5+/-4.1 185.2+/-5.7 beats/min-1, respectively), oxygen extraction (54.3+/-3.8 and 47.1+/-3.4 mL/L-1, respectively) and lactate (10.6+/-0.5 and 9.2+/-0.7 mmol/L-1, respectively), while stroke volume was significantly (P<0.05) lower (100.4+/-4.5 and 109.7+/-4.4 mL, respectively).The present study indicates that in sprinters performing a similar distance at the same speed, but under different training regimes interplay exists between oxygen delivery and extraction, suggesting a link between the type of training scheme and physiological cardiovascular and skeletal muscle metabolic adaptations. This may explain the absence of differences between the conditions in absolute oxygen uptake and peak power output.

Mujika, Santisteban, and Castagna (2009) were examined the effects of 2 in-season short-term sprint and power training protocols on vertical countermovement jump height (with or without arms), sprint (Sprint-15m) speed, and agility (Agility-15m) speed in male elite junior soccer players. Twenty highly trained soccer players (age 18.3 +/- 0.6 years, height 177 +/- 4 cm, body mass 71.4 +/- 6.9 kg, sum skinfolds 48.1 +/- 11.4 mm), members of a professional soccer academy, were randomly allocated to either a CONTRAST (n = 10) or SPRINT (n = 10) group. The training intervention consisted of 6 supervised training sessions over 7 weeks, targeting the improvement of the players' speed and power. CONTRAST protocol consisted of alternating heavy-light resistance (15-50% body mass) with soccer-specific drills (small-sided games or technical skills). SPRINT training protocol used line 30-m sprints (2-4 sets of 4 x 30 m with 180 and 90 seconds of recovery, respectively). At baseline no difference between physical test performance was evident between the 2 groups ($p > 0.05$). No time x training group effect was found for any of the vertical jump and Agility-15m variables ($p > 0.05$). A time x training group effect was found for Sprint-15m performance with the CONTRAST group showing significantly better scores than the SPRINT group (7.23 +/- 0.18 vs. 7.09 +/- 0.20 m.s, $p < 0.01$). In light of these findings CONTRAST training should be preferred to line sprint training in the short term in young elite soccer players when the aim is to improve soccer-specific sprint performance (15 m) during the competitive season.

Harrison and Bourke (2009) were investigated whether an RS training intervention would enhance the running speed and dynamic strength measures in male rugby players.

Fifteen male rugby players aged 20.5 (+/- 2.8) years who were proficient in resisted sledge training took part in the study. The subjects were randomly assigned to control or RS groups. The RS group performed two sessions per week of RS training for 6 weeks, and the control group did no RS training. Pre- and post-intervention tests were carried out for 30-m sprint, drop, squat, and rebound jumps on a force sledge system. A laser measurement device was used to obtain velocities and distance measures during all running trials. The results show a statistically significant decrease in time to 5 m for the 30-m sprint for the RS group (p = 0.02). The squat jump and drop jump variables also showed significant increases in starting strength (p = 0.004) and height jumped (p = 0.018) for the RS group from pre- to post-testing sessions. The results suggest that it may be beneficial to employ an RS training intervention with the aim of increasing initial acceleration from a static start for sprinting.

Chaouachi, et. al., (2008) were examine the effect of stretch and sprint training on the acute effects of static stretching in 13-15 year olds. A total of 48 students were randomly divided into a sprint only and a stretch and sprint training groups who performed static stretching at the beginning and middle of the speed training sessions (6 weeks). Flexibility tests and 30-m sprints were performed before and after training. Sprint performance was evaluated with and without prior stretching. A main effect indicated that prior static stretching impairs sprint times at 10 (P = 0.01) and 30 m (P = 0.0005). Both groups improved times over 10 (0.7%; P = 0.04) and 30-m (1.5%; P = 0.0007) sprint distance after training. Stretch and sprint trained participants were more resistant to stretch-induced sprint deficits with 3.2% (P < 0.0001), 3.6% (P = 0.0002) and 1.3% (P < 0.0001) faster times at 5, 10, and 30 m, respectively, than the sprint only group. In conclusion, a stretch and sprint training program in 13-15 year olds diminished the detrimental effects of static stretching compared to a sprint only training program.

Kotzamanidis, et.al., (2005) were investigated the effect of a combined heavy-resistance and running-speed training program performed in the same training session on strength, running velocity (RV), and vertical-jump performance (VJ) of soccer players. Thirty-five individuals were divided into 3 groups. The first group (n = 12, COM group) performed a combined resistance and speed training program at the same training session, and the second one (n = 11, STR group) performed the same resistance training without speed training. The third group was the control group (n = 12, CON group). Three jump tests were used for the evaluation of vertical jump performance: squat jump, countermovement jump, and drop jump. The 30-m dash and 1 repetition maximum (1RM) tests were used for running speed and strength evaluation, respectively. After training, both experimental groups significantly improved their 1RM of all tested exercises. Furthermore, the COM group performed significantly better than the STR and the CON groups in the 30-m dash, squat jump, and countermovement jump. It is concluded that the combined resistance and running-speed program provides better results than the conventional resistance training, regarding the power performance of soccer players.

Stokes, et.al., (2004) were examined the effect of 6 weeks of prescribed sprint training on the human growth hormone (hGH) response to cycle ergometer sprinting. Sixteen male subjects were randomly assigned to a training (n=8) or a control (n=8) group. Each subject completed two main trials, consisting of two all-out 30-s cycle-ergometer sprints separated by 60 min of passive recovery, once before, and once after a 6-week training period. The training group completed three supervised sprint-training sessions per week in addition to their normal activity, whilst control subjects continued with their normal activity. In the training group, peak and mean power increased post-training by 6% (P<0.05) and 5% (P<0.05), respectively. Post-exercise blood pH did not change following training, but the highest post-exercise blood lactate concentrations were greater [highest measured value: 13.3 (1.0) vs 15.0 (1.1) mmol l(-1)], with lower blood lactate concentrations for the remainder of the recovery period (P<0.05). Post-exercise plasma ammonia concentrations were lower after training [mean highest measured value: 184.1 (9.8) vs 139.0 (11.7) micromol l(-1), P<0.05]. Resting serum hGH concentrations did not change following training, but the peak values measured post-exercise decreased by over 40% in the training group [10.3 (3.1) vs 5.8 (2.5) microg l(-1), P<0.05], and mean integrated serum hGH concentrations were 55% lower after training [567 (158) vs 256 (121) min microg l(-1), P<0.05]. The hGH response to the second sprint was attenuated similarly before and after training. This study showed that 6 weeks of combined speed- and speed-endurance training blunted the human growth hormone response to sprint exercise, despite an improvement in sprint performance.

Blazevich and Jenkins (2002) were determined the effects of 7 weeks of high- and low-velocity resistance training on strength and sprint running performance in nine male elite junior sprint runners (age 19.0+/-1.4 years, best 100 m times 10.89+/-0.21 s; mean +/- s). The athletes continued their sprint training throughout the study, but their resistance training programme was replaced by one in which the movement velocities of hip extension and flexion, knee extension and flexion and squat exercises varied according to the loads lifted (i.e. 30-50% and 70-90% of 1-RM in the high- and low-velocity training groups, respectively). There were no between-group differences in hip flexion or extension torque produced at 1.05, 4.74 or 8.42 rad x s(-1), 20 m acceleration or 20 m 'flying' running times, or 1-RM squat lift strength either before or after training. This was despite significant improvements in 20 m acceleration time ($P < 0.01$), squat strength ($P < 0.05$), isokinetic hip flexion torque at 4.74 rad x s(-1) and hip extension torque at 1.05 and 4.74 rad x s(-1) for the athletes as a whole over the training period. Although velocity-specific strength adaptations have been shown to occur rapidly in untrained and non-concurrently training individuals, the present results suggest a lack of velocity-specific performance changes in elite concurrently training sprint runners performing a combination of traditional and semi-specific resistance training exercises.

2.5. SUMMARY OF THE LITERATURE

The reviews were presented in three section such as Resistance Band Training, Core Training and Speed Training. This section gives an insight into the number and range of how the trainings has been influenced the various types of dependent variables.

In summary, studies on resistance band training, core training and speed training revealed much on various aspects of development through the usage of resistance band training. The studies reviewed in this section mostly in the disciplines of Physical Education, Medical Science, Dental, Physics, Library, Mathematics, Plant Physiology, Medical Anatomy and Physiology, Radiology and so forth.

The research studies reviewed were from many journals available in the websites such as **www.pubmed.gov**, and **ERIC** websites and so forth. All such websites employ Resistance Band Training, Core Training and Speed Training.