Chapter II

REVIEW OF RELATED LITERATURE

The literature related to the problem has been presented in this chapter. Review of literature has been confined to the website of www.pubmed.com.

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

The purpose of the study was to investigate the relative effects of theraband and weight training followed by speed training on strength and speed parameters. There are numbers of studies touching the topic that has been pursued and some of the most important reviews are presented in this chapter for clear understanding.

The reviews of the literature have been classified under the following headings.

1. Studies on Theraband Training

2. Studies on Medicine Ball Training
Studies on Theraband Training

**Boyer B.T. (1990)** compared the strength and body composition changes produced by three different strength training programs: isotonic, involving free weights; compound variable resistance, involving Nautilus (P.O. Drawer 809014, Dallas, Texas); and linear variable resistance, utilizing the Soloflex (570 NE 53rd, Hillsboro, Oregon) device. Thirty-two female subjects performed pre- and posttests for strength utilizing the one repetition maximum (1 RM) test on three exercises from each of the training programs. Subjects were pre- and post tested on four skin fold thicknesses, percentage of body fat and body girths. The subjects utilized one of three training programs three times a week for 12 weeks. All three modes of training were found to significantly increase strength levels. Subjects who trained with free weights or Nautilus performed at significantly higher levels when tested for 1 RM on exercises included in their training program. Strength gains of the Nautilus training group were significantly higher than those of the Soloflex training group on the free weight leg press 1 RM test. It was concluded that the three training programs produced comparable changes in body composition and strength, with training specificity in strength gains.

**Baker, D., Wilson, G., Carylon, R. (1992)** examined Sixteen healthy females participated in this study to measure the strength improvement of the shoulder external rotators following a 6 week program of progressive resistance exercise using Thera-band as the sole strengthening device. Strength was measured using peak, isokinetic torque. There was found to be no significant difference between the pre and post-test, peak torque values of the control and experimental groups at 60/sec. It was concluded that did not support the
hypothesis that Thera-band will increase strength following this type of exercise program. The clinical relevance of this finding will be discussed.

Skelton, Young, Greig & Malbut (1995) determined the effects of 12 weeks of progressive resistance strength training on the isometric strength, explosive power, and selected functional abilities of healthy women aged 75 and over. Subjects were matched for age and habitual physical activity and then randomly assigned into either a control or an exercise group. Fifty-two healthy women were recruited through local and national newspapers. Pre- and post training measurements were obtained from 20 exercisers (median age 79.5, range 76 to 93 years) and 20 controls (median age 79.5, range 75 to 90 years). In conclusion, progressive resistance exercise can produce substantial increases in muscle strength and in power standardized for body weight in healthy, very old women. However, isolated increases in strength and LEP/kg may confer only limited functional benefit in healthy, independent, very old women.

Topp, Mikesky, Dayhoff & Holt (2002) examined the effects of a 14-week resistance training program on the ankle strength, training intensity, postural control, and gait velocity of older adults. Forty-two older adults (mean age = 72), 21 in the resistance and control groups, completed the 14-week project. The resistance training group participated in 14 weeks of resistance training three times per week using elastic bands (Theraband) for resistance. Isokinetic ankle strength, training intensity, postural stability, and gait velocity were measured prior to and following the 14-week intervention. Following the training, the resistance group exhibited improved ankle dorsiflexion, training resistances, and gait velocity, but showed no change in plantar flexion or postural control. Finally, when adjusted
for baseline differences, subjects in the resistance training group demonstrated no changes in
the dependent measures over the control group.

**Page JL., Ben A., Robert B., Robert C., Robert C. (1993)** investigated twelve
collegiate baseball pitchers performed a moderate intensity isotonic dumbbell strengthening
routine for 6 weeks. Six of the 12 subjects were randomly assigned to an experimental group
and placed on a Theraband® Elastic Band strengthening routine in a functional-diagonal
pattern to emphasize eccentric contraction of the posterior rotator cuff, in addition to the
isotonic routine. The control group (n = 6) performed only the isotonic exercises. Both
groups were evaluated on a KIN-COM® isokinetic dynamometer in a functional diagonal
pattern. In conclusion, there was no difference in the two groups at 180°/s; both decreased (8
to 15%). Theraband was effective at 60°/s in functional eccentric strengthening of the
posterior rotator cuff in the pitching shoulder.

**Treiber, Lott., Duncan, Slavens & Davis (1998)** determined whether a 4-week
isotonic resistance training program using Theraband elastic tubing and lightweight
dumbbells would significantly increase concentric shoulder rotator strength or velocity of
serve or both in a group of elite-level tennis players. Twenty-two male and female versity
college tennis players were randomly assigned to control or 4-week training groups. Subjects
were pre- and post tested in concentric internal and external rotation torque using an iso-
kinetic dynamometer. Functional performance was assessed before and after training by
recording the peak and average velocities of eight maximal serves. It was concluded that,
resistance training using Theraband tubing and lightweight dumbbells may have beneficial
effects on strength and functional performance in college-level tennis players.
Christopher & Hughes (1999) investigated the relationship between tubing length and tubing tension for 6 colors of Thera-Band tubing (each color representing a different level of resistance) and to estimate the resistive shoulder torque provided during shoulder abduction exercise. Nine male and 6 female subjects performed shoulder abduction, using 6 colors of tubing. A strain gauge attached at the fixed end of the tubing directly measured the tension generated during stretch. For each color of tubing, each subject momentarily held a position at 30°, 60°, 90°, 120°, and 150° of abduction. Shoulder joint abduction, limb segment position, and tubing length were analyzed by means of the Peak Motion Measurement System. Simple linear regression equations predicted tubing tension from percent change in tubing length at the joint angle positions. A 2-way (5 X 6) repeated-measures ANOVA determined the mean differences in tubing tension across tubing colors at the shoulder abduction positions. Thera-Band tubing provides linear resistance during shoulder abduction, but the resistive torque provided by the tubing mimics isotonic exercise.

Page P., and Ellenbecker T. (2003) investigated the effectiveness of more functional closed-chain exercises on activation of the peroneus longus while measuring EMG activity. They evaluated closed-chain plantar flexion (heel raises) with a 5 pound laterally-directed resistance provided by a yellow Thera-Band resistance band placed around the middle of the foot. A yellow band stretched to 200% of its resting length will produce a force of 5 pounds. The EMG activity of the peroneus longus during this exercise was compared to a heel raise without resistance and open-chain eversion against a 5 pound cuff weight placed around the mid foot. The researchers found that the Thera-Band-resisted heel raise produced 8% more muscle activation than the standard heel raise, and 40% more activation than conventional isotonic eversion. These findings support a more
biomechanically-specific exercise using Thera-Band elastic bands for functional strengthening of the peroneus longus. The authors concluded that this exercise “may facilitate more effective training outcomes from programs targeting the peroneus longus,” although more research is needed to confirm this assumption.

Rogers ME, Sherwood HS, Rogers NL, Bohlken RM. (2002) determined the efficacy of such a program, 22 African-American women aged 62-94 years were recruited from a senior center in the Wichita urban community. Sixteen women (age = 74.8 +/- 8.8 yr) participated in exercise training (3 days per week for 4 weeks) and 6 women (age = 74.7 +/- 4.5 yr) served as controls. Training consisted of chair-based exercises using elastic resistance bands (upper and lower body) and dumbbells (upper body). This study suggests that exercising with equipment that costs only a few dollars per participant improves upper and lower body fitness in older African-American women who live in an urban setting.

Alan, Mikesky, Robert Topp, Janet Wigglesworth, David Harsha & Jeffrey Edwards (2005) investigated the efficacy of, and the adherence to, a 12-week home-based progressive resistance training program for older adults utilizing elastic tubing. Sixty-two adults (mean age, 71.2 years) qualified to participate in the study. Subjects were randomly assigned to either the exercise (E) (n=31) or non-exercise (NE) group (n=31). Pre-and post-testing included isokinetic (1.05 rad • s –1) concentric/eccentric knee extension/flexion strength testing and flexibility measures of the hip, knee, and ankle. The E group trained three times per week, performing one to three sets of 10–12 repetitions for each of 12 resistance exercises. The exercises involved muscles of both the lower and upper body. These results suggest that home-based resistance training programs utilizing elastic tubing
can serve as a practical and effective means of eliciting strength gains in adults over the age of 65.

**Ghigiarelli, and Jamie Jude (2006)** explored the effects of a seven 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 males 18-30 years old from the Robert Morris University football team volunteered to participate in this study. During the first week, predicted one repetition maximum (1RM) bench press and a five repetition (5RM) maximum speed bench press tests were conducted. Subjects were randomly divided into three groups (n=12): elastic band (EB), weighted chain (WC) and control (C). Subjects were oriented to the elastic band (EB) and chain weighted (WC) bench press prior to pretesting. During weeks 2 through 8 of the study, subjects were required to follow the resistance training program designed for using the EB and WC for seven weeks. All other components of normal spring training and conditioning remained the same. Means and standard deviations of the predicted 1RM bench press and 5RM speed bench press were computed in the first and ninth week of the program. A two factor (method X time) analysis was applied to identify significant differences between the training groups. Statistical significance was set at $\alpha = 0.05$. It was concluded that the use of EB and WC in conjunction with a general seven week off season strength and conditioning program can increase overall maximum upper body strength in a sample of Div 1-AA football players.

**Jim Stoppani Kirksville & Missouri (2007)** discussed rehabilitating sports injuries. The La Crosse researchers had 10 trained male and female subjects lift 85% of their one-rep max (85% 1RM) on a Smith machine squat for two sets of three reps using a weighted Smith
machine bar or a weighted Smith machine bar with 20% of the weight being applied by exercise bands. They concluded that this was a significant increase, one that could have serious implications on overall strength and power gains. It was concluded that shared by the Truman State study in which trained athletes performed bench presses twice a week for five weeks. One group did two freeweight bench press workouts per week and the other group did one freeweight bench press workout and one bench press workout using elastic bands. The group using the elastic-band training increased their max bench press significantly more than the group performing just freeweight training.

Wallace, Winchester & McGuigan (2007) 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. It was concluded 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. The greatest differences are observed during the higher loading conditions, with the B1-85 condition appearing to be optimal for athletic performance of the ones we tested.
Anderson, C. E., & Sforzo, G. A., Sigg, J. A. (2008). 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. In conclusion, 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 & Triplett (2008) compared the effects of a resistance exercise program in 15 year old boys and girls using either elastic or isotonic free weight resistance compared to a control group. During the 8-week program, both groups trained twice a week with a PE teacher with a 1:15 instructor-to-participant ratio. They began each session with 5 minutes of aerobic activity and dynamic stretching. Resistance exercises were performed for 2 sets of 8 to 12 reps (Weeks 1-4 = 10-12 reps; Weeks 5-8 = 8-10 reps) with 60 second rests between sets. The 10 strengthening exercises were performed in 40-50 minutes in the same order.
Both groups used the Borg scale at 15-18 with an 8-12RM; in other words, participants used a resistance with each exercise that caused fatigue with the last repetition with an exertion level of 15-18 for 8 to 12 repetitions. Participants were tested for body composition and upper and lower body strength (1 RM test) before and after the 8-week study. After 8 weeks, both resistance training groups significantly increased their upper and lower body strength, and improved their body composition compared to the control group. It was concluded that, there was no significant difference between the elastic and isotonic groups. Percent increase in strength after training program. While the isotonic group had slightly higher gains than the elastic group, the adherence rate and dropout rates were lower in the elastic tubing group.

**Kyungmo Han, Mark. Ricard & Gilbert Fellingham (2009)** determined the effectiveness of a 4-week elastic resistance exercise program on balance in subjects with and without a history of sprained ankles. Several researchers have suggested that improving balance may help alleviate the symptoms of functional ankle instability and reduce the rate of recurrent ankle sprains. Forty subjects (20 males, 20 females; 20 subjects with chronic ankle instability [CAI], 20 healthy) participated in the study. Ten subjects (5 males, 5 females) from each CAI and healthy group were randomly assigned to either the exercise or control group, resulting in a total of 4 groups. Total travel distance of the center of pressure, monitored using a force platform, was measured before training, after 4 weeks of training, and at a 4-week follow-up. It was concluded that, there were no interactions between gender, ankle sprain history, or training groups. Balance significantly improved in subjects with and without a history of ankle sprains following 4 weeks of elastic resistance exercises. Mean improvement in balance for the exercise group following training, reflected through a decrease in total travel distance, was −11.1 cm (95% confidence interval: −14.0 to −8.2 cm).
Colado, Garcia-Masso, Pellicer, Alakhdar, Benavent & Cabeza-Ruiz (2010) assessed effects of a short-term resistance program on strength in fit young women using weight machines/free weights or elastic tubing. 42 physically fit women (21.79±0.7 years) were randomly assigned to the following groups: (i) the Thera-Band (®) Exercise Station Group (TBG); (ii) the weight machines/free weights group (MFWG); or (iii) the control group (CG). Each experimental group performed the same periodised training program that lasted for 8 weeks, with 2-4 sessions per week and 3-4 sets of 8-15 submaximal reps. It was concluded that resistance training using elastic tubing or weight machines/free weights have equivalent improvements in isometric force in short-term programs applied in fit young women.

Michael Rogers (2010) examined the effect of theraband training. 39 older adults were randomly assigned to a control group or a group using the Thera-Band Exercise Station. The exercise group performed a 12-week circuit training program combining strength and aerobic exercises 3 days per week. After the program, the exercise group had significant improvements in functional fitness and in body composition, whereas the control group did not. Interestingly, the improvements seen with the Exercise Station group were similar to the results the researchers found in a separate study using hydraulic resistance machines. Their findings may have important implications in delivering cost-effective group-based exercise for older adults.

Phil Page (2010) examined the effect of Thera-Band Exercise. The exercise group performed a 12-week circuit training program combining strength and aerobic exercises 3 days per week. After the program, the exercise group had significant improvements in
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Shoepe, Ramirez & Almstedt (2010) 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. It was concluded 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.

Stevenson and Mark Warpeha (2010) 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. It was concluded that there may be benefits to performing squats with elastic bands in terms of RFD. Practitioners concerned with improving RFD may want to consider incorporating this easily implemented training variation.

**Studies of Medicine Ball Training**

**Stockbrugger, B. A., & Haennel, R. G. (2003)** examined the factors contributing to performance of a backward overhead medicine ball throw (B-MBT) across 2 types of athletes. Twenty male volleyball players (jump athletes) and 20 wrestlers (nonjump athletes) were evaluated on 4 measures of power, including B-MBT, chest medicine ball throw (C-MBT), countermovement vertical jump (CMJ), and power index (PI). The athletes also completed 3 measures of strength: a 1-repetition-maximum (1RM) bench press (BP), a 1RM leg press (LP), and combined BP + LP strength. It was concluded that, the interaction of upper- and lower-body strength and power in the performance of a B-MBT appears complex, with the contributing factors differing for athletes with divergent skill sets and performance demands.

**Salonia, M. A., Chu, D. A., Cheifetz, P. M., & Freidhoff, G. C. (2004)** determined whether or not a relationship existed between upper-body power and class level among female club gymnasts. Sixty female gymnasts between the ages of 10 and 11 and between
class levels 5 and 8 participated in the study. The distance of a medicine-ball throw was used to measure upper-body power. Three types of throws--overhead forward throw, overhead backward throw, and chest pass--were performed with a 6-lb rubber medicine ball. The mean distances of 2 trails were calculated and categorized into age group and class level. An analysis of variance design was used to determine the relationship between mean throw distances and throw type, age, and class level. No significant differences were found between mean throw distances and throw type, age, or class level. The results of this study show no relationship between upper-body power of female gymnasts and throw type, age, and class level.

Stanton Robert., Reaburn Peter, R., & Humphries Brendan. (2004) 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; [SIGMA]9 skinfolds 78.9 +/- 28.2 mm; VO2max 55.3 +/- 5.7 ml[middle dot]kg1[middle dot]min1) 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, electromyographic activity of the abdominal and back muscles, treadmill VO2max, running economy, and running posture. 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.
Mayhew Jerry, I., et al (2005) determined the relationship of the backward overhead medicine ball (BOMB) throw to power production in college football players. Forty National Collegiate Athletic Association Division II college football players were studied at the end of an 8-week off-season conditioning program for power output determined from a counter-movement vertical jump on a force plate and for maximal distance in the standing BOMB throw. Therefore, the BOMB throw may have limited potential as a predictor of total body explosive power in college football players.

Avery, D., Falgenbaum., Patrick. (2006) examined the effects of medicine ball training on the fitness performance of high-school physical education students. Sixty-nine high-school students participated in a 6-week medicine training program during the first 10 to 15 minutes of each physical education class. A group of 49 students who participated in physical education lessons but not medicine ball training served as controls. Performance on the shuttle run, long jump, sit and reach flexibility, abdominal curl, medicine ball push-up, and medicine ball seated toss was assessed at baseline and post-training. Students who participated in the medicine ball training program made significantly greater gains on all fitness tests as compared to the control group. These data suggest that medicine ball training can enhance selected measures of speed, agility, power and muscular endurance when incorporated into a high school physical education class.

Gabbett, T., Georgieff, B., Anderson, S., Cotton, B., Savovic, D., & Nicholson, L. (2006) investigated the effect of a skill-based training program on measurements of skill and physical fitness in talent-identified volleyball players. Twenty-six talented junior volleyball players (mean +/- SE age, 15.5 +/- 0.2 years) participated in an 8-week skill-based training
program that included 3 skill-based court sessions per week. Skills sessions were designed to develop passing, setting, serving, spiking, and blocking technique and accuracy as well as game tactics and positioning skills. Coaches used a combination of technical and instructional coaching, coupled with skill-based games to facilitate learning. Subjects performed measurements of skill (passing, setting, serving, and spiking technique and accuracy), standard anthropometry (height, standing-reach height, body mass, and sum of 7 skinfolds), lower-body muscular power (vertical jump, spike jump), upper-body muscular power (overhead medicine-ball throw), speed (5- and 10-m sprint), agility (T-test), and maximal aerobic power (multistage fitness test) before and after training. These findings demonstrate that skill-based volleyball training improves spiking, setting, and passing accuracy and spiking and passing technique, but has little effect on the physiological and anthropometric characteristics of players.

Ikeda, Y., Kijima, K., Kawabata, K., Fuchimoto, T., & Ito, A. (2006) examined the factors contributing to performance of a side medicine-ball throw (S-MBT) and a fast side medicine-ball throw (FS-MBT) and to analyze some of the factors which account for the difference in side medicine ball throw performance between the sexes. Sixteen males and ten females were evaluated by S-MBT, FS-MBT, isometric maximal trunk rotation torque (IMTRT), One repetition maximum of Parallel Squat (1RM(PS)) and Bench Press (1RM(BP)), Bench Press peak power (BP(PP)), Static Squat Jump peak power (SSJ(PP)) and vertical jump height. Males demonstrated significantly greater scores than females in all measurements. These results suggested that the contributing factors of S-MBT and FS-MBT performance were different in males and females. Hence, the side medicine-ball throw test
would be useful to examine the trunk rotation power of male athletes, but may have a limited potential as a predictor of trunk rotation power for female athletes.

Wilcox, J., Larson, R., Brochu, K. M., & Faigenbaum, A. D. (2006) determined whether the performance of explosive-force movements before bench-press exercise would improve 1-repetition-maximum (1RM) strength. Twelve male college athletes participated in 3 testing sessions separated by at least 5 days of rest. During each testing session, the 1RM was assessed on the bench-press exercise. After a general warm-up, subjects performed a specific warm-up that consisted of submaximal sets with increasing loads on the bench-press exercise before attempting a 1RM lift. During the first testing trial, subjects performed a series of 1RM attempts with increasing loads until their 1RM was determined. During the second and third testing trials, subjects performed in a counterbalanced randomized order either 2 plyometric push-ups or 2 medicine-ball (3 to 5 kg) chest passes 30 seconds before each 1RM attempt. These data suggest that an acute bout of low-volume, explosive-force upper body movements performed 30 seconds before a 1RM attempt might enhance bench-press performance in athletic men.

Cochrane, D. J., & Hawke, E. J. (2007) investigated whether upper-body vibration would be able to augment muscular attributes for climbing performance. Twelve healthy active climbers volunteered for the study. All participants underwent 3 treatments--arm cranking (AC), upper-body vibration (UBV), and non-UBV (NUBV)--in a balanced random order, conducted on separate days. Upper-body vibration was generated via a commercialized electric-powered dumbbell with a rotating axis that delivered oscillatory movements to the shoulders and arms. The UBV treatment consisted of performing 5 upper-
body exercises for a total duration of 5 minutes. The UBV frequency was set at 26 Hz, amplitude 3 mm. For the NUBV treatment, the participants performed the exact exercises and time constraints as UBV; however, the vibration dumbbell was set at 0 Hz and 0 mm amplitude. The third treatment consisted of AC, which was performed at 75 k.min(-1) for 5 minutes. Pre- and post muscular performance measures of medicine ball throw, hand grip strength, and a specific climbing maneuver were performed after each treatment. There were no significant treatment differences on medicine ball throw, hand grip strength, and the specific climbing maneuver. Acute UBV exposure did not demonstrate the expected potential neuromuscular enhancements on the climbing performance tests selected for this study.

**Faigenbaum, A. D., (2007)** evaluated the efficacy of an after-school resistance training program on improving the physical fitness of middle school-age boys. 22 boys (M = 13.9 yr., SD = .4 yr.) participated in a periodized, multiple-set, 9-wk. (2x/week) resistance training program. All subjects were pre- and post-tested on their 10-repetition maximum squat, 10-repetition maximum bench press, vertical jump, medicine ball toss, flexibility, and also percentage of body fat and the progressive aerobic cardiovascular endurance run (PACER). Statistical analysis indicated that subjects significantly improved performance on the squat (19%), bench press (15%), flexibility (10%), vertical jump (5%), medicine ball toss (12%), and the PACER (36%). Although this design minus a control group limits interpretation, this after-school resistance-training program can improve muscular fitness and cardiovascular fitness in boys and should be replicated with appropriate experimental controls.
Szymanski David, J., Szymanski Jessica, M., Bradford Jason, T., Schade Ryan, L., & Pascoe David, D. (2007) examined the effect of 12 weeks of medicine ball training on high school baseball players. Forty-nine baseball players (age 15.4 +/- 1.2 years) were randomly assigned using a stratified sampling technique to 1 of 2 groups. Group 1 (n = 24) and group 2 (n = 25) performed the same full-body resistance exercises according to a stepwise periodized model and took 100 bat swings a day, 3 days per week, with their normal game bat for 12 weeks. Group 2 performed additional rotational and full-body medicine ball exercises 3 days per week for 12 weeks. Pre- and post-testing consisted of a 3 repetition maximum (RM) dominant and nondominant torso rotational strength and sequential hip-torso-arm rotational strength (medicine ball hitter's throw). A 3RM parallel squat and bench press were measured at 0 and after 4, 8, and 12 weeks of training. These data indicate that performing a 12-week medicine ball training program in addition to a stepwise periodized resistance training program with bat swings provided greater sport-specific training improvements in torso rotational and sequential hip-torso-arm rotational strength for high school baseball players.

Szymanski, D. J., et al (2007) examined the effect of torso rotational strength on angular hip (AHV), angular shoulder (ASV), linear bat-end (BEV), and hand velocities (HV) and 3 repetition maximum (RM) torso rotational and sequential hip-torso-arm rotational strength (medicine ball hitter's throw) in high school baseball players (age 15.4 +/- 1.2 y). Participants were randomly assigned to 1 of 2 training groups. Group 1 (n = 24) and group 2 (n = 25) both performed a stepwise periodized resistance exercise program and took 100 swings a day, 3 days a week, for 12 weeks with their normal game bat. Group 2 performed additional rotational and full-body medicine ball exercises 3 days a week for 12 weeks. A
3RM parallel squat and bench press were measured at 0 and after 4, 8, and 12 weeks. Participants were pre- and posttested for 3RM dominant and nondominant torso rotational strength and medicine ball hitter's throw. Angular hip velocities, ASV, BEV, and HV were recorded pre- and posttraining by a motion capture system that identified and digitally processed reflective markers attached to each participant's bat and body. These data indicate that performing additional rotational medicine ball exercises 2 days a week for 12 weeks statistically improves baseball performance variables.

Szymanski, D. J., Szymanski, J. M., Bradford, T. J., Schade, R. L., & Pascoe, D. D. (2007) examined the effect of 12 weeks of medicine ball training on high school baseball players. Forty-nine baseball players (age 15.4 +/- 1.2 years) were randomly assigned using a stratified sampling technique to 1 of 2 groups. Group 1 (n = 24) and group 2 (n = 25) performed the same full-body resistance exercises according to a stepwise periodized model and took 100 bat swings a day, 3 days per week, with their normal game bat for 12 weeks. Group 2 performed additional rotational and full-body medicine ball exercises 3 days per week for 12 weeks. Pre- and post-testing consisted of a 3 repetition maximum (RM) dominant and nondominant torso rotational strength and sequential hip-torso-arm rotational strength (medicine ball hitter's throw). A 3RM parallel squat and bench press were measured at 0 and after 4, 8, and 12 weeks of training. These data indicate that performing a 12-week medicine ball training program in addition to a stepwise periodized resistance training program with bat swings provided greater sport-specific training improvements in torso rotational and sequential hip-torso-arm rotational strength for high school baseball players.
Kohmura, Y., Aoki, K., Yoshigi, H., Sakuraba, K., & Yanagiya, T. (2008) studied the relationship between the physical fitness of college baseball players found from 6 field tests and a performance evaluation by coaches was investigated. The purpose was to ascertain whether the results would be similar to those obtained in a previous study. The subjects of the study were 43 college baseball players (mean age, 20.7 +/- 1.4 years; mean athletic career, 10.9 +/- 2.6 years). Referring to the previous study, the field tests of physical fitness were composed of 6 items: throwing distance, back strength, medicine ball throwing, standing long jump, T-test, and base running. For capabilities in batting, fielding, and running, the coach's evaluation was expressed by T scores. The results of the analysis indicated that those players with high evaluation scores had significantly better test results in comparison with those players who were rated low in the evaluation. Although the multiple regression models of the previous study were associated with a middle goodness of fit, a significant correlation was found between physical fitness found in the field tests and performance.

Marques, M. C., Tillaar, R. v., Vescovi, J. D., & González-Badillo, J. J. (2008) described the changes in physical performance after an in-season training regimen in professional female volleyball players in order to determine whether muscular strength and power might be improved. Apart from normal practice sessions, 10 elite female volleyball players completed 2 training sessions per week, which included both resistance training and plyometric exercises. Over the 12-week season, the athletes performed 3-4 sets of 3-8 repetitions for resistance and plyometric exercises during each training session. All sessions were supervised by one of the investigators as well as by the team head coach. Muscular strength and power were assessed before and after the 12-week training program using 4
repetition maximum bench press and parallel squat tests, an overhead medicine ball throw (BTd), as well as unloaded and loaded countermovement jumps (CMJs). The current findings suggest that elite female volleyball players can improve strength and power during the competition season by implementing a well-designed training program that includes both resistance and plyometric exercises.

**Santos, E. J., & Janeira, M. A. (2008)** evaluated 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), Abalakov 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. 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.

**Gordon, B. S., Moir, G. L., Davis, S. E., Witmer, C. A., & Cummings, D. M. (2009)** investigated the relationship of flexibility, power, and strength to club head speed (CHS) in male golfers. Fifteen golfers (mean age +/- SD: 34.3 +/- 13.6 years) with a handicap of <=8 volunteered for the study. Following a standardized warm-up, subjects proceeded to hit 5 wiffle golf balls with a 5 iron while their CHS was measured. Rotational
trunk flexibility was measured on a trunk rotator machine. An index of total body rotational power was measured through a hip toss with a 3-kg medicine ball while an 8-repetition maximum (RM) on a pec deck machine was used to measure chest strength. Pearson correlations were used to assess the magnitude of the relationships between CHS and the measures of flexibility, power, and strength. Partial correlations were then run to assess the effect of handicap on the observed relationships. The results of this study show that strength of the chest in the pec deck motion and total body rotational power significantly correlate with CHS in male golfers. This information can be used by practitioners to develop training programs and field tests for golfers.

**Hoffman, J. R., et al (2009)** examined the efficacy of periodization and to compare different periodization models in resistance trained American football players. Fifty-one experienced resistance trained American football players of an NCAA Division III football team (after 10 weeks of active rest) were randomly assigned to 1 of 3 groups that differed only in the manipulation of the intensity and volume of training during a 15-week offseason resistance training program. Group 1 participated in a nonperiodized (NP) training program, group 2 participated in a traditional periodized linear (PL) training program, and group 3 participated in a planned nonlinear periodized (PNL) training program. Strength and power testing occurred before training (PRE), after 7 weeks of training (MID), and at the end of the training program (POST). Significant increases in maximal (1-repetition maximum [1RM]) squat, 1RM bench press, and vertical jump were observed from PRE to MID for all groups; these increases were still significantly greater at POST; however, no MID to POST changes were seen. These data indicate that longer periods of training may be needed after a long-
term active recovery period and that active recovery may need to be dramatically shortened to better optimize strength and power in previously trained football players.

Ikeda Yusuke., Miyatsuji Kazutaka., Kawabata Koichi., Fuchimoto Takafumi., & Ito Akira. (2009) compared the electromyogram (EMG) activity of the trunk musculature for long throwers and short throwers during the side medicine-ball throw. The study consisted of 2 sessions. Thirty athletes performed the side medicine-ball throw (S-MBT) in the first session. The top 5 subjects (long throwers) and the worst 5 subjects (short throwers) in the performance of the S-MBT proceeded to the second session. These subjects performed the fast side medicine-ball throw (FS-MBT) and the isometric maximal trunk rotation torque (IMTRT) test after applying surface electrodes bilaterally to the following muscles: pectoralis major, rectus abdominis, external oblique, and latissimus dorsi. The examination of EMG activity in each muscle group for long throwers and short throwers revealed that the major difference between the 2 groups is EMG activity of the left external oblique. These results suggest that the EMG activity of the external oblique on either side is an important factor for FS-MBT.

Marques, M. C., van den Tillaar, R., Gabbett, T. J., Reis, V. M., & González-Badillo, J. J. (2009) investigated the anthropometric and strength characteristics of elite male volleyball athletes and to determine if differences exist in these characteristics according to playing position. A group of 35 professional male team volleyball players (mean +/- SD age: 26.6 +/- 3.1 years) participated in the study. Players were categorized according to playing position and role: middle blockers (n = 9), opposite hitters (n = 6), outside hitters (n = 10), setters (n = 6), and liberos (n = 4). Height, body mass, muscular
strength (4 repetition maximum bench press and 4 repetition maximum parallel squat tests), and muscular power (overhead medicine ball throw, countermovement jump) were assessed. These results demonstrate that significant anthropometric and strength differences exist among playing positions in elite male volleyball players. In addition, these findings provide normative data for elite male volleyball players competing in specific individual playing positions. From a practical perspective, sport scientists and conditioning professionals should take the strength and anthropometric characteristics of volleyball players into account when designing individualized position-specific training programs.

Matthews, M., O’Conchuir, C., & Comfort, P. (2009) investigated the acute effect of high-load and low-load complex training on upper-body performance-determined by the flight time of a basketball push-pass. Twelve competitive male athletes (21.8 +/- 4.5 years, 82.0 +/- 11.7 kg, 181.6 +/- 5.6 cm), with at least 6 months weight training experience and no musculoskeletal disorders, undertook 3 testing conditions. Condition 1 involved 5 repetitions at 85% of a 1 repetition maximum (1RM) bench press; Condition 2 involved 5 repetitions of a 2.3-kg medicine ball push-pass; and Condition 3 was the control, where participants rested for the equivalent time of the other conditions (approximately 20 seconds). Results with the lower load showed greater variation, with some individuals responding and others not. Because there appears to be an individual potentiation response to lighter loads, we recommend that, when equipment is limited, athletes and coaches experiment with a range of loads when performing contrast training.

Santos, E. J., & Janeira, M. A. (2009) assessed and compare the effects of detraining and of a reduced training program on upper- and lower-body explosive strength in
adolescent male basketball players. To study this, 15 subjects, aged 14 to 15 years old, were randomly assigned to 1 of the 2 following groups: reduced training (RT; n = 8) and detraining (DTR; n = 7). The participants were assessed on squat jump (SJ), countermovement jump (CMJ), Abalakov test (ABA), depth jump (DJ), mechanical power (MP), and medicine ball throw (MBT) after a 10-week in-season complex training program (T0) and at the end of 4 (T4), 8 (T8), 12 (T12), and 16 (T16) weeks of detraining and of the reduced training periods. In conclusion, 16 weeks of detraining or of reduced training allow for the maintenance of the gains previously achieved by the application of a 10-week in-season complex training program. However, the lack of differences between detraining and reduced training leads to the conclusion that regular basketball practice can sustain by itself the previously achieved explosive strength gains, considering its mainly explosive characteristics.

**Carothers Kyle., et al (2010)** examined the strength benefits of an eccentric-only protocol versus a standard and concentric-only protocol in a multi-joint lift (bench press). Additionally, a secondary purpose was to examine the same protocol's ability to elicit power benefits (seated medicine ball put). Forty-Two men with recreational resistance training experience (>6 months at least two times per week) performed two sessions a week for 6 weeks utilizing the bench press exercise. Subjects were tested for concentric, standard and eccentric 1-RM pre and post study. Subjects were randomized into one of three groups, eccentric-only (ECC), standard (ECCON) or concentric-only (CON). Subjects performed 4 sets of 4-8 repetitions with 80% of their 1-RM in the repetition type characterized by their group. Subjects moved up 5% when 4 sets of 8 repetitions were completed successfully. Rest time between sets was fixed at 3-5 minutes. Subjects were also tested for power using a 3-kg
seated medicine ball put for distance pre and post study and for body composition using air density plethysmography (Life Measurement Inc., Bod Pod, Concord, CA). These results suggest that eccentric muscle actions are underutilized in standard resistance training protocols. This evidence could indicate that athletes possessing low levels of eccentric strength may have a diminished capability to perform the stretch-shortening cycle (SSC); the SSC is a sequence of movements utilizing an eccentric muscle action immediately followed by a concentric muscle action in order to produce a more forceful concentric muscle action. The SSC is commonly used in athletic activities like running, jumping and throwing.

**Judge Lawrence, W., Bellar David., & Glickman Ellen, L. (2010)** examined the potentiation effect of throwing a heavy medicine ball on subsequent standing shot put performance. The participants were five college-aged female shot putters. A within subjects design was used to compare the possible potentiation effects of throwing a heavy medicine ball prior to a competition shot put. Participants reported to the gymnasium on four separate occasions. On the first visit, participants became familiar with the technique of the standing shot put throw, and a maximal throw for height with a heavy medicine ball beginning from the ground. On the second through forth visits participants warmed up (~ 15 min of dynamic stretching) and then completed five, maximal effort, standing throws with a competition indoor shot put (4kg). Each attempt was preceded by one of three randomly assigned treatments. The treatments included a maximal throw for height with either an 8kg or 18.2kg medicine ball, or no medicine ball throw (control). Though the findings were not significant a trend existed for a reduction in performance with the increased weight of the pre-throw medicine ball. Further research is needed to determine the impact of an athlete's strength and training status on pre-activity protocols utilizing post activation potentiation.
Szymanski David, et al. (2010) examined the effects of 8 weeks of medicine ball (MB) training on bat swing velocity (BV) and batted-ball velocity (BBV) of novice, college-aged students. Sixty male and female kinesiology students were randomly assigned to 1 of 3 training groups. Group 1 (n = 20; men = 10; women = 10) was the control. Group 2 (n = 20; men = 10; women = 10) performed 5 rotational MB exercises for 1 set of 10 repetitions each (50 total MB throws per day) 3x/wk for 8 weeks (1200 total MB throws). Resistance began at 0.9 kg (2 lb) and increased by 0.9 kg (2 lb) each week until week 5 (4.5 kg or 10 lb MB), then it decreased by 0.9 kg (2 lb) for the next 3 weeks. By week 8 the resistance was 1.8 kg (4 lb). The protocol progressively became heavier in resistance in an attempt to increase force production, and then became progressively lighter to increase velocity of movement. Group 3 (n = 20; men = 9, women = 11) performed the same 5 rotational MB exercises for 2 sets of 10 repetitions each (100 total MB throws per day) 3x/wk for 8 weeks (2400 total MB throws). Instantaneous BV and BBV were recorded by a SETPRO SPRT5ATM chronograph and Speed TracTM radar gun while hitting a ball off a batting tee. Dominant and non-dominant grip strength was measured with a JamarTM hand dynamometer. Rotational power was measured by a 0.9 kg (2 lb) MB hitter's throw and 2.7 kg (6 lb) MB side toss. Women also performed a 1.8 kg (4 lb) MB side toss since their mean body mass was significantly less than the men's mean body mass. Leg power (vertical jump) was measured with a VertecTM. Therefore, it is recommended that individuals swing a standard baseball or softball bat to practice bat swing mechanics. Since the individuals in this study did not swing bats, future research should examine the effects of supplemental MB training while swinging bats.
Szymanski, D. J., et al (2010) investigated the relation between anthropometric and physiological variables to linear bat swing velocity (BV) of 2 groups of high-school baseball players before and after completing a 12-week periodized resistance exercise program. Participants were randomly assigned to 1 of 2 training groups using a stratified sampling technique. Group 1 (n = 24) and group 2 (n = 25) both performed a stepwise periodized resistance exercise program and took 100 swings a day, 3 d·wk-1, for 12 weeks with their normal game bat. Group 2 performed additional rotational and full-body medicine ball exercises 3 d·wk-1 for 12 weeks. Fourteen variables were measured or calculated before and after 12 weeks of training. Anthropometric and physiological variables tested were height, body mass, percent body fat, lean body mass (LBM), dominant torso rotational strength (DTRS) and nondominant torso rotational strength (NDTRS), sequential hip-torso-arm rotational strength measured by a medicine ball hitter's throw (MBHT), estimated 1 repetition maximum parallel squat (PS) and bench press (BP), vertical jump (VJ), estimated peak power, angular hip velocity (AHV), and angular shoulder velocity (ASV). These data show that significant relationships do exist between height, body mass, LBM, rotational power, rotational strength, lower body power, upper and lower body strength, AHV, and ASV to linear BV of high-school baseball players. Strength coaches may want to consider using this information when designing a resistance training program for high-school baseball players. Those recruiting or scouting baseball players may want to use this information to further develop ways of identifying talented players. However, one should be cautious when interpreting this information when designing strength training programs for high-school baseball players to increase linear BV.
Santos, E. J., & Janeira, M. A. (2011) determined 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 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 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.

Szymanski, J. M., Szymanski, D. J., Britt, A. T., & Cicciarella, C. F. (2011) examined TV of high school (HS) baseball players over an 8-week preseason training program while participating in 6d/wk of baseball practice. METHODS: Twenty-one HS baseball players (age = 15.8 +/- 1.0 yr) were randomly assigned by a stratified sample technique to 1 of 2 training groups. Group 1 (n = 10) and Group 2 (n = 11) performed the same progressive full-body resistance exercises while training 3x/wk for 8 wk according to a stepwise periodized model prior to the start of their spring baseball season. Additionally,
Group 1 performed a progressive throwing program with a standard 5 oz baseball, while Group 2 performed an over-weighted throwing program with a 7 oz and 5 oz ball at a 2:1 ratio (heavy and standard). Volume began at 54 throws and increased by 6 throws every 2 weeks for the 8-week study. By week 7 the volume was 72 throws. All training was conducted while the HS baseball team was practicing 6 d/wk. TV was measured with a Jugs radar gun. Bat velocity was recorded with a SETPRO SPRT5A, while batted-ball velocity was recorded with a Stalker Pro radar gun. One repetition maximum (1 RM) parallel squat and bench press were measured with standard Olympic weights. Total grip strength was measured with a Jamar hand dynamometer. Leg power (vertical jump) was measured with a Vertec. Rotational power was measured with a Sports Pro radar gun as players performed a 2.7 kg medicine ball side toss. The implementation of an over-weighted (7 oz) medicine ball training program at a 2:1 ratio (heavy and standard) did not increase TV during the preseason when players were throwing daily at practice.

**Van den Tillaar, R., & Marques, M. C. (2011)** determined if different throwing programs based upon velocity (throwing with a regular sized soccer ball), resistance (throwing with heavy medicine ball), or a combination of both with the same workload would enhance 2-handed overhead throwing velocity with different ball weights. Sixty-eight high-school students (16.5 ± 1.8 years, 57.8 ± 12 kg, 164 ± 9 cm), divided into 3 groups, participated in the study. The training programs were matched on total workload, which resulted in the velocity-training group performing 6 series of 14 reps per session with soccer balls, whereas the resistance-training group performed 3 series of 6 throws with a 3-kg medicine ball, and the combination-training group threw 9 times with a 3-kg medicine ball and 3 series of 14 reps with a soccer ball per session. Throwing velocity with a soccer ball, a
1- and 3-kg medicine ball was tested before and after a training period of 6 weeks with 2 sessions per week. In contrast, no group interaction was found with the different balls indicating that velocity, resistance, or a combination as a form of training increased the throwing velocity. Different types of training with the same total workload can increase the throwing velocity in a similar way, which shows that workload is of importance in designing training programs and comparing training with each other. Therefore, those that train high-school soccer players could implement any one of these 3 6-week programs to increase 2-handed overhead soccer throw-in velocity. This could allow the throw-in to be harder or potentially thrown farther if the right trajectory is used.

Ignjatovic, A. M., Markovic, Z. M., & Radovanovic, D. S. (2012) examined the effects of medicine ball training on the strength and power in young female handball athletes. Twenty-one young female handball players (age, 16.9 ± 1.2 years) were randomly assigned to experimental and control groups. Experimental group (n = 11) participated in a 12-week medicine ball training program incorporated into the regular training session, whereas controls (n = 10) participated only in the regular training. Performance in the medicine ball throws in standing and sitting positions, 1 repetition maximum (1RM) bench and shoulder press, and power test at 2 different loads (30 and 50% of 1RM) on bench and shoulder press were assessed at pre- and post training testing. These data suggest that 12-week medicine ball training, when incorporated into a regular training session, can provide greater sport-specific training improvements in the upper body for young female handball players.
Marques, M. C., et al (2012) investigated the effects of two different strength-training programs with the same workload (impulse) on throwing velocity in water polo. 30 water polo players were randomly divided in two groups based upon throwing performance with water polo ball. The medicine-ball training group performed 3 x 6 reps with a 3-kg medicine ball, while the combination training group completed 1 x 9 repetitions with the 3-kg medicine ball, followed by 3 x 14 repetitions with a water polo ball. Both groups trained eight weeks twice per week in addition to their regular water polo training. Throwing velocity was measured with a Doppler radar gun before and after the training period. Testing included throws with a water polo ball on land and in water, as well as with 1-kg and 3-kg medicine balls on land. These findings indicate that after training with the same workload (impulse), increases in throwing velocity in water polo are similar and suggesting workload may be a critical variable for training results.

Santos Eduardo, J. A. M., & Janeira Manuel, A. A. S. (2012) assessed the effects of a lower- and upper-body 10-week in-season resistance training program on explosive strength development in young basketball players. Twenty-five adolescent male athletes, aged 14–15 years old, were randomly assigned to an experimental group (EG; n = 15) and a control group (CG; n = 10). The subjects were assessed at baseline and after training for squat jump (SJ), countermovement jump (CMJ), Abalakov test, drop jump, and seated medicine ball throw (MBT). The results of this study show that a 10-week in-season resistance training program with moderate volume and intensity loads increased vertical jump and MBT performance in adolescent male basketball players.
Sporiš Goran., Harasin Drazen., Bok Daniel., Matika Dario., Vuleta Dinko. (2012) investigated the effects of special operations battalion (SOB) training program on soldiers' fitness parameters. The research was conducted on a sample of 25 members (mean ± SD: age 27.93 ± 5.12 years, height 178.64 ± 6.91 cm, body mass 81.42 ± 9.18 kg) of the Croatian Armed Forces for SOB, divided into control and experimental groups. Total duration of the SOB basic training was 62 days. The sample of variables consists of 12 tests for the assessment of fitness characteristics, 2 tests for functional capacity, and 18 morphological measures. Morphological parameters were measured according to the instructions of the International Biological Program. Fitness characteristics were measured with the following tests: 1-kg medicine ball throw from a seated position, standing broad jump (SBJ), relative sergeant test, 20-m sprint, the maximum thrust from the bench, push-ups in 2 minutes (PU2minutes), sit-ups in 2 minutes (SU2minutes), pull-ups (PU), thrust from the bench with 70% of body weight (BP70%), crawling and jumping, agility test 93639 with turn (A9-3-6-3-9), and sit and reach. Functional abilities were evaluated with 2 tests: 3,200 m running (SK3200) and 300 yards running (MBI3Y). Analyzing the results of t-test, differences of variables, it was evident that the difference after the SOB program occurred in 7 variables in the experimental group: SBJ, PU2minutes, SU2minutes, PU, BP70%, MBI3Y, and SK3200. Basic training for SOB during 8 weeks has produced significant burnout of the body for the participants who have completed their training. This led to a reduction in fitness performance manifested through the tested variables.

Van den Tillaar, R., & Marques, M. C. (2012) investigated the effect of a single and a double training workload with 3 kg medicine ball had upon the throwing speed in two hand overhead throwing movement. Secondly, what the effect of training with 3 kg medicine
balls had upon throwing speed with other ball weights. Forty high school students (age 15.9 ± 1.0 yr, mass 60.9 ± 9 kg, height 1.68 ± 0.08 m.) divided into three speed-matched groups, participated in the study. The first group was a control group and did not train any throwing program regimen, while the other two groups trained overhead throwing with a single (3 series of 6 throws with a 3 kg medicine ball) or double training workload (6 series of 6 throws with a 3 kg medicine ball) for six weeks. Throwing speed with a 0.35 kg, 0.45 kg, a 1 kg and 3 kg medicine ball was tested before and after a training period of six weeks with two sessions per week. The result indicates that training workload is of importance in these subjects for enhancement of ball throwing performance and in designing training programs. Furthermore, that throwing with high enough training volume of throws with a 3 kg medicine ball also can increase ball speed with lighter balls.

Cook, C. J., & Beaven, C. M. (2013) discussed testosterone may also contribute to improved volitional motivation and, when monitored longitudinally, may provide one proxy marker for readiness to perform. Twelve female netball players provided saliva samples prior to five standardized training sessions in which they completed a maximal-distance medicine ball throw, and then 3 sets of bench press and then back squat using a self-selected load perceived to equal a 3-repetition maximum load. Additional repetitions were encouraged when possible and total voluntary workload was calculated from the product of the load lifted and repetitions performed. It was concluded that, individual salivary testosterone, when viewed relatively over time, demonstrated strong relationships with self-selected workloads during an in-season training period in female netball players. As such, daily variations in testosterone may provide information regarding voluntary training motivation and readiness to perform in elite athletic populations. Psychological and
behavioral aspects of testosterone may have the potential to enhance training adaptation by complementing the known anabolic and permissive properties of testosterone.

**Genevois, C., Frican, B., Creveaux, T., Hautier, C., & Rogowski, I. (2013)** examined the effects of 2 training modalities on the tennis forehand drive performance. Forty-four tennis players were randomly assigned into 3 groups. During 6 weeks, the first group performed handled medicine ball (HMB) throws included in the regular tennis practice, the second group (overweight racket-OFR) played tennis forehand drives with an overweighed racket during the regular tennis practice, and the third group (regular tennis training-RTT) practiced only tennis training as usual. Before and after the 6-week program, velocity and accuracy of tennis crosscourt forehand drives were evaluated in the 3 groups. The findings of this study highlighted the efficiency of both training modalities to improve tennis forehand drive performance but also suggested that the HMB throws may be incorporated into the preseason program preferably, whereas the OWR forehand drives may be included in the on-season program.

**Lehman, G., Drinkwater, E. J., & Behm, D. G. (2013)** determined if bilateral or unilateral lower-body field testing correlates with throwing velocity. Baseball throwing velocity scores were correlated to the following tests: medicine ball (MB) scoop toss and squat throw, bilateral and unilateral vertical jumps, single and triple broad jumps, hop and stop in both directions, lateral to medial jumps, 10- and 60-yd sprints, and both left and right single-leg 10-yd hop for speed in 42 college baseball players. Overall, this study found that lateral to medial jumps were consistently correlated with high throwing velocity in each of the throwing techniques, in both left-handed and right-handed throwers. This is the first
study to correlate throwing velocity with a unilateral jump in the frontal plane, mimicking the action of the throwing stride.

**Summary of Literature**

The review of literature helped the investigator to spot out relevant topics and variables. Further the literature helped the investigator to frame the suitable hypothesis leading to the problems. The latest literature also helped the investigator to support her findings with regard to the problem. Further the literature collected in the study will also help the research scholar understanding in the similar areas.

The research studies were presented in two sections. The first section carries effect of theraband training. Here the reviews were collected from the year 1990 to till date. The second section carries effect of medicine ball training. Here, the reviews were collected from 2003 to till date. All the reviews were arranged in a chronological and alphabetical order.

All the research studies were presented in the section proves that there is a significant improvement on all selected variables due to theraband and medicine ball training. The strong evidence shown in the literature is that the positive association between the two training programmes and improvements of all selected parameters.

The review of literature helped the researcher from the methodological point of view too. It was learnt that most of the research studies cited in this chapter on content analysis and experimental design as the appropriate methods for finding out the lapses and remediation.