CHAPTER - II

REVIEW OF RELATED LITERATURE

A study of relevant literature is an essential step to get a full picture by what has been done with regard to the problem under study. Such review brings about a deep and clear perspective of the overall field.

Familiarity with the literature related to any problem helps the scholar to discover what is already known, what others have attempted to find out, what methods of approach have been promising or disappointing and what problems remain to be solved. The review would enable the investigator to have a profound insight. Clear perspective and a better understanding of a chosen problem and various factors are connected with the study.

“The Literature in any field forms the foundations upon which all future work will be built”. The researcher has attempted in this chapter to locate the literature related to this study. The relevant studies taken from World Wide Web site and other sources, which the research scholar has come across, are cited below,

2.1 STUDIES ON RESISTANCE TRAINING

Kwon *et al.* (2010) Twenty-eight overweight women with type 2 diabetes were randomly assigned to a resistance training group (RG, n = 13) or a control group (CG, n = 15). RG performed resistance training using elastic bands, of which strength was equal to 40 to 50% of one repetition maximum (1RM), for three days per week. Each exercise consisted of three sets for 60 minutes. We assessed abdominal fat using computed tomography, muscle mass using dual-energy X-ray absorptiometry, and muscle strength using Keiser's chest and leg press. Insulin sensitivity was measured using the insulin tolerance test, and aerobic capacity was expressed as oxygen uptake at the anaerobic threshold (AT-VO(2)) before and after the 12-week exercise program. The age of participants was 56.4 +/- 7.1 years, duration of diabetes was 5.9 +/- 5.5 years, and BMI was 27.4 +/- 2.5 kg/m(2), without significant differences between two groups. During intervention, a greater increase in muscle mass and greater decreases in both total fat mass and abdominal fat were observed in RG compared to those of CG (P = 0.015, P = 0.011, P = 0.010, respectively). Increase in 1RM of upper and lower extremities was observed in the RG (P = 0.004, P = 0.040, respectively), without changes in AT-VO(2) and insulin resistance in either group. In conclusion, the low intensity resistance training was effective in increasing muscle mass and strength and reducing total fat mass without change of insulin sensitivity in type 2 diabetic patients.

George and Kristi (2000) to examine the effects of progressive resistance exercise on resting systolic and diastolic blood pressure in adult humans. Studies were retrieved via (1) computerized literature searches, (2) cross-referencing from original and review articles, and (3) review of the reference list by 2 experts on exercise and blood pressure. Inclusion criteria were as follows: (1) trials that included a randomized non exercise control group; (2) progressive resistance exercise as the only intervention; (3) adult humans; (4) journal articles, dissertations, and masters theses published in the English-language literature; (5) studies published and indexed between January 1966 and December 1998; (6) resting systolic and/or diastolic blood pressure assessed; and (7) training studies lasting a minimum of 4 weeks. Across all designs and categories, fixed-effects modeling yielded decreases of 2% and 4% for resting systolic and diastolic blood pressure, respectively (mean ±SD systolic, -3±3 mm Hg; 95% bootstrap CI, -4 to -1 mm Hg; mean ±SD diastolic, -3±2 mm Hg; 95% bootstrap CI, -4 to -1 mm Hg). It was concluded that progressive resistance exercise is efficacious for reducing resting systolic and diastolic blood pressure in adults. However, a need exists for additional studies that limit enrollment to hypertensive subjects as well as analysis of data with an intention-to-treat approach before the effectiveness of progressive resistance exercise as a non pharmacological intervention can be determined.

George (1997) to examine the effects of dynamic resistance exercise, i.e., weight training, on resting systolic and diastolic blood pressure in adults. A total of nine studies consisting of 259 subjects (144 exercises, 115 control) and 18 groups (9 exercise, 9 control) were included in this analysis. With the use of the bootstrap technique (10,000 samples), significant treatment effect (Δ_3) reductions were found across all designs and categories for both systolic and diastolic blood pressure [systolic, mean ± SD = −4.55 ± 1.75 mmHg, 95% confidence interval (CI) = −1.56 to −8.56; diastolic, mean ± SD −3.79 + 1.12 mmHg, 95% confidence interval CI = −1.89 to −6.33]. Changes corresponded with relative decreases of 3and 4% in resting systolic and diastolic blood pressure, respectively. In conclusion, meta-analytic review of included studies suggests that dynamic resistance exercise reduces resting systolic and diastolic blood pressure in adults. However, it is premature to form strong conclusions regarding the effects of dynamic resistance exercise on resting blood pressure. A need exists for additional, well-designed studies on this topic before a recommendation can be made regarding the efficacy of dynamic resistance exercise as a non pharmacological therapy for reducing resting blood pressure in adults, especially in hypertensive adults

Sarsan *et al.* (2006) Sixty obese women were assigned to one of three groups: aerobic exercise (n = 20), resistance exercise (n = 20) and control group (n = 20). The aerobic exercise group performed both walking and leg cycle exercise with increasing duration and frequency. The resistance exercise group performed progressive weight-resistance exercises for the upper and lower body. Before and after a 12-week period, all subjects were evaluated by anthropometric measurement, rating of mood, cardio respiratory capacity and maximum strength of trained muscles. After a 12-week training period, subjects in the resistance group showed significant improvement in one-repetition maximum test of hip abductors (7.95+/-3.58 kg), quadriceps (14+/-7.18 kg), biceps (3.37+/- 2.84 kg) and pectorals (8.75+/-5.09 kg) compared with those in the control group ($P < 0.001$). VO2 max increased (0.51+/-0.40) and Beck Depression Scale scores decreased (-5.40+/-4.27) in the aerobic exercise group compared with the control group, significantly ($P < 0.001$). Only in hip abductor muscle strength was there a significant increase in the resistance exercise group compared with the aerobic exercise group ($P < 0.05$). Both aerobic exercise and resistance exercise resulted in improved performance and exercise capacity in obese women. While aerobic exercise appeared to be beneficial with regard to improving depressive symptoms and maximum oxygen consumption, resistance exercise was beneficial in increasing muscle strength.

Jankowska *et al.* (2008) Ten patients with stable ischaemic CHF in NYHA class III (9 men, age: 70 ± 6 years [mean ± SD], left ventricular ejection fraction: 30 ± 5%, peak oxygen consumption [peak VO_2]: 12.4 ± 3.0 mL/min/kg) underwent the rehabilitation programme which consisted of a 12-week training phase (progressive resistance exercises restricted to the quadriceps muscles) followed by a 12-week detraining phase.All subjects completed a training phase of the programme with no adverse events. Resistance training markedly increased quadriceps strength (right leg: 260 ± 34 vs. 352 ± 28 N, left leg: 264 ± 38 vs. 342 ± 30 N, both $p < 0.01$ — all comparisons: baseline vs. after training), but did not affect lean tissue mass of lower extremities (both $p > 0.2$). It was accompanied by an improvement in clinical status (all NYHA III vs. all NYHA II, $p < 0.01$), quality of life (Minnesota questionnaire: 44 ± 15 vs. 33 ± 18 points, $p < 0.05$), exercise capacity assessed using a distance during 6-minute walk test (6MWT: 362 ± 83 vs. 455 ± 71 m, $p < 0.01$), but not peak VO_2 ($p > 0.2$). Plasma NT-proBNP remained unchanged during the training. At the end of detraining phase, only a partial improvement in quadriceps strength ($p < 0.05$), a 6MWT distance ($p < 0.05$) and NYHA class ($p = 0.07$ vs. baseline) persisted. Applied resistance quadriceps training is safe in patients with CHF. It increases muscle strength, improves clinical status, exercise capacity, and quality of life. Applied resistance quadriceps training is safe in patients with CHF. It increases muscle strength, improves clinical status, exercise capacity, and quality of life.

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

Gilmar *et al.* (2009) to compare the influence of two and five-minute rest intervals on the number of repetitions per set, per exercise and total repetitions in resistance training sessions. Fourteen trained men (23.0 ± 2. 2 yrs; 74.9 ± 4.1 kg; 1.75 ± 0.03 m) completed three sets per exercise, with 10RM load in four training sessions. Two sessions involved lower body exercises (leg press, leg extension and leg curl), with two-minute (SEQA) and with five-minute interval (SEQB). The other two sessions involved upper body exercises (bench press, pec-deck and triceps pulley), with two (SEQC) and five-minute intervals (SEQD). For two-minute, five of six exercises presented reductions in the second set, compared with the first set, and for the third set compared with the first and second sets. For five-minute, three of the six exercises presented reductions in the third set, compared with the first sets, and two of the six for the third set, compared with the second sets. The total number of repetitions in SEQA (66.7 ± 4.9) was significantly smaller than in SEQB (80.9 ± 6.9). Similarly, the total repetitions was significantly lower in SEQC (71.1 ± 4.7) compared with SEQD (83.7 ± 6.1). The results indicate that the training session performance is reduced by shorter intervals, being the initial exercises less affected during the progression of the sets.

Anthony and David (2002) to determine 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·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·s -1 and hip extension torque at 1.05 and 4.74 rad·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.

Hulmi *et al.* (2010) Regardless of age or gender, resistance training or provision of adequate amounts of dietary protein (PRO) or essential amino acids (EAA) can increase muscle protein synthesis (MPS) in healthy adults. Combined PRO or EAA ingestion proximal to resistance training, however, can augment the post-exercise MPS response and has been shown to elicit a greater anabolic effect than exercise plus carbohydrate. Unfortunately, chronic/adaptive response data comparing the effects of different protein sources is limited. A growing body of evidence does, however, suggest that dairy PRO, and whey in particular may: 1) stimulate the greatest rise in MPS, 2) result in greater muscle cross-sectional area when combined with chronic resistance training, and 3) at least in younger individuals, enhance exercise recovery. Therefore, this review will focus on whey protein supplementation and its effects on skeletal muscle mass when combined with heavy resistance training.

Robbins ***et al.*** **(2010)** to investigate the acute effects of performing traditional set (TS) vs. complex set (CS) agonist-antagonist training over 3 consecutive sets, on bench press throw (BPT) throw height (TH), peak velocity (PV), peak power (PP), bench pull volume load (VL), and electromyographic (EMG) activity. Eighteen trained men performed 2 testing protocols: TS comprising 3 sets of Bpull followed by 3 sets of BPT performed in approximately 20 minutes or CS comprising 3 sets of both Bpull and BPT performed in an alternating manner in approximately 10 minutes. Throw height, PV, PP, and EMG activity were not different within, or between, the 2 conditions. Bench pull VL decreased significantly from set 1 to sets 2 and 3, under both conditions. Decreases from set 1 to set 2 were 14.55 +/- 26.11 and 9.07 +/- 13.89% and from set 1 to set 3 were 16.87 +/- 29.90 and 14.17 +/- 18.37% under CS and TS, respectively. There was no difference in VL per set, or session, between the conditions. Although there was no augmentation of the power measures, CS was determined to have approximately twice the efficiency (ouput/time) as compared to TS.

Efficiency calculations for VL, TH, PV, and PP are 103.47 kg.min, 26.25 cm.min, 1.98 m.s.min, 890.39 W.min under CS and 54.71 kg.min, 13.02 cm.min, 0.99 m.s.min, 459.28 W.min under TS. Comparison of EMG activity between the protocols suggests the level of neuromuscular fatigue did not differ under the 2 conditions. Complex set training would appear to be an effective method of exercise with respect to efficiency and the maintenance of TH, PV, PP, and VL.

Sparkes and Behm (2010) to determine differences in physiological and performance measures after stable and unstable resistance training. Eighteen subjects (10 men and 8 women) resistance trained 3 days/week under either stable or unstable conditions for 8 weeks. Pre and post training measures included chest press isometric force and electromyography activity of the triceps brachii and pectorals major under stable and unstable conditions and 1-legged throwing distance, balance, countermovement jump (CMJ) and drop jump (DJ) heights. There were no significant training group effects found with any measure. However, there was a tendency ($p = 0.06$) for the unstable training group to improve the stable to unstable chest press force ratio to a greater degree (24.8%) than the stable group (10.8%). There were significant overall pre to post training improvements in maximum voluntary isometric contraction (MVIC) force (13.3%: $p < 0.0001$), unstable/stable force (18.2%: $p = 0.0005$), bench press (11%: $p < 0.0001$), squat (14.9%: $p < 0.0001$), CMJs (11.2%: $p = 0.002$), and DJs (3.3%: $p = 0.001$), wobble board contacts (12.4%: $p = 0.03$), and wobble board on-off ratios (62%: $p = 0.005$). There was a significant ($p < 0.0001$) 42.2% greater MVIC force and 43.2 and 33.2% greater triceps ($p = 0.003$) and pectoral ($p = 0.005$) neuromuscular efficiency with stable vs. unstable isometric chest press. It appears that instability resistance training, which reportedly uses lower forces, can increase strength and balance in previously untrained young individuals similar to training with more stable machines employing heavier loads.

Hartman *et al.* (2010) to compare the effects of fatigue of the plantar flexors on peak torque and voluntary activation in untrained (UT) and resistance-trained (RT) men. Six men with no previous resistance training experience and 8 men with similar histories of chronic resistance training (9.8 +/- 5.9 years, 3.8 +/- 0.7 days/week) volunteered for this study. Subjects performed isometric maximal voluntary contractions (MVCs) before and immediately after unilateral dynamic isotonic contractions performed at 40% of MVC until volitional exhaustion. Voluntary activation of the plantar flexors was assessed using the interpolated twitch method (ITT) and central activation ratio (CAR). Surface electromyographic (EMG) amplitude of the soleus and medial gastrocnemius (MG) was measured during the MVC. There were significant reductions in MVC torque in both UT and RT groups after the fatiguing exercise (-10.7 +/- 6.8%, $p < 0.02$; -9.1 +/- 8.7%, $p < 0.02$, respectively), with no difference in the number of repetitions performed between groups. The UT and RT men experienced a significant decrease in ITT after the fatiguing exercise bout (-14.2 +/- 11.8%, $p = 0.03$; -7.8 +/- 9.3%, $p = 0.045$, respectively). The UT group experienced a significant decrease in CAR (99.5 +/- 0.8% to 91.4 +/- 6.4%, $p = 0.025$) with no change ($p > 0.05$) in the RT group. There was also a fatigue-induced decrease in normalized EMG amplitude for the soleus and MG muscles in both groups ($p < 0.05$). However, no differences were determined between groups for ITT, CAR, or EMG. Despite similar reductions in MVC torque postexercise, the UT men had a significant decrease in CAR and experienced nearly twice the decline in ITT than the RT men. These results indicate that the neural adaptations associated with chronic resistance training may lead to less susceptibility to central fatigue as measured by ITT and CAR.

Tamse *et al.* (2010) to examine the effects of a moderate intensity resistance training program on Special Olympic athletes (SOAs) and similarly aged typically developed volunteers (TDs) who also served as coaches. Fifteen SOAs and 17 TDs participated (age range 19-24 years). The intervention consisted of resistance training: 1 set, 8-12 reps, over 10-12 sessions, on Med-X weight equipment. Exercises tested were seated row (SR), leg curl (LC), leg extension (LE), chest press (CP), and the abdominal crunch (AC). The weight lifted, and the amount of repetitions performed at the beginning and end of training, were used to determine the predicted 1 repetition max (1RM). A 2-way (2:group x 2:time) analysis of variance was computed for each exercise. Time main effects were detected, which indicated that predicted 1RM increased significantly for all participants. Specifically, these were the SR ($F(1,30) = 99.238$, $p < 0.001$); the LC ($F(1,30) = 91.578$, $p < 0.001$); the LE ($F(1,30) = 83.253$, $p < 0.001$); the CP ($F(1,30) = 53.675$, $p < 0.001$); and the AC ($F(1,30) = 57.759$, $p < 0.001$). The predicted 1RM values increased between 25 and 50% across the exercises tested. There were no group main effects or interactions. Thus, with minimal training time, both similar and significant strength gains can be accomplished by both SOAs and TDs, respectively. Supervised moderate intensity resistance training is recommended for the populations tested and may result in vocational and athletic performance gains.

Campos *et al.* (2002) to investigate the "strength-endurance continuum". Subjects were divided into four groups: a low repetition group (Low Rep, n = 9) performing 3-5 repetitions maximum (RM) for four sets of each exercise with 3 min rest between sets and exercises, an intermediate repetition group (Int Rep, n = 11) performing 9-11 RM for three sets with 2 min rest, a high repetition group (High Rep, n = 7) performing 20-28 RM for two sets with 1 min rest, and a non-exercising control group (Con, n = 5). Three exercises (leg press, squat, and knee extension) were performed 2 days/week for the first 4 weeks and 3 days/week for the final 4 weeks. Maximal strength [one repetition maximum, 1RM), local muscular endurance (maximal number of repetitions performed with 60% of 1RM), and various cardio respiratory parameters (e.g., maximum oxygen consumption, pulmonary ventilation, maximal aerobic power, time to exhaustion) were assessed at the beginning and end of the study. In addition, pre- and post-training muscle biopsy samples were analyzed for fiber-type composition, cross-sectional area, myosin heavy chain (MHC) content, and capillarization. Maximal strength improved significantly more for the Low Rep group compared to the other training groups, and the maximal number of repetitions at 60% 1RM improved the most for the High Rep group. In addition, maximal aerobic power and time to exhaustion significantly increased at the end of the study for only the High Rep group. All three major fiber types (types I, IIA, and IIB) hypertrophied for the Low Rep and Int Rep groups, whereas no significant increases were demonstrated for either the High Rep or Con groups. However, the percentage of type IIB fibers decreased, with a concomitant increase in IIAB fibers for all three resistance-trained groups. These fiber-type conversions were supported by a significant decrease in MHCIIb accompanied by a significant increase in MHCIIa. No significant changes in fiber-type composition were found in the control samples. Although all three training regimens resulted in similar fiber-type transformations (IIB to IIA), the low to intermediate repetition resistance-training programs induced a greater hypertrophic effect compared to the high repetition regimen. The High Rep group, however, appeared better adapted for submaximal, prolonged contractions, with significant increases after training in aerobic power and time to exhaustion. Thus, low and intermediate RM training appears to induce similar muscular adaptations, at least after short-term training in previously untrained subjects. Overall, however, these data demonstrate that both physical performance and the associated physiological adaptations are linked to the intensity and number of repetitions performed, and thus lend support to the "strength-endurance continuum".

Elliott *et al.* (2002) Eight weeks of resistance training produced significant increases in knee extension ($F_{1,13}$ = 12.60; p<0.01), bench press ($F_{1,13}$ = 13.79; p<0.01), leg press ($F_{1,13}$ = 15.65; p<0.01), and lat pull-down ($F_{1,13}$ = 16.60; p<0.005) 10RM strength tests. Although 10RM strength decreased after eight weeks of detraining, the results remained significantly elevated from baseline measures. Eight weeks of training did not result in any significant alterations in blood lipid profiles, body composition, or dynamic isokinetic leg strength. There were no significant differences in any of the variables investigated over the 16 week period in the control group. These data suggest that a short, low intensity resistance training programme produces substantial improvements in muscle strength. Training of this intensity and duration was not sufficient to produce significant alterations in blood lipid concentrations.

Faigenbaum *et al.* (1999) In twice-weekly sessions of resistance training for 8 weeks, children performed 1 set of 6 to 8 repetitions with a heavy load (*n* = 15) or 1 set of 13 to 15 repetition**s** with a moderate load (*n* = 16) on child-size exercise machines. Children in the control group (*n* = 12) did not resistance train**.** One repetition maximum (RM) strength and muscular endurance (repetitions performed posttraining with the pretraining 1-RM load) were determined on the leg extension and chest press exercises. One RM leg extension strength significantly increased in both exercise groups compared with that in the control subjects. Increases of 31.0% and 40.9%, respectively, for the low repetition-heavy load and high repetition-moderate load groups were observed. Leg extension muscular endurance significantly increased in both exercise groups compared with that in the control subjects, although gains resulting from high repetition-moderate load training (13.1 ± 6.2 repetitions) were significantly greater than those resulting from low repetition-heavy load training (8.7 ± 2.9 repetitions). On the chest press exercise, only the high repetition-moderate load exercise group made gains in 1-RM strength (16.3%) and muscular endurance (5.2 ± 3.6 repetitions) that were significantly greater than gains in the control subjects. These findings support the concept that muscular strength and muscular endurance can be improved during the childhood years and favor the prescription of higher repetition-moderate load resistance training programs during the initial adaptation period.

Keitaro *et al.* (2002) to examined whether resistance and stretching training programmes altered the viscoelastic properties of human tendon structures *in vivo*. Eight subjects completed 8 weeks (4 days per week) of resistance training which consisted of unilateral plantar flexion at 70 % of one repetition maximum with 10 repetitions per set (5 sets per day). They performed resistance training (RT) on one side and resistance training and static stretching training (RST; 10 min per day, 7 days per week) on the other side. Before and after training, the elongation of the tendon structures in the medial gastrocnemius muscle was directly measured using ultrasonography, while the subjects performed ramp isometric plantar flexion up to the voluntary maximum, followed by a ramp relaxation. The relationship between estimated muscle force (F_m) and tendon elongation (L) was fitted to a linear regression, the slope of which was defined as stiffness. The hysteresis was calculated as the ratio of the area within the F_m-L loop to the area beneath the load portion of the curve. The stiffness increased significantly by 18.8 ± 10.4 % for RT and 15.3 ± 9.3 % for RST. There was no significant difference in the relative increase of stiffness between RT and RST. The hysteresis, on the other hand, decreased 17 ± 20 % for RST, but was unchanged for RT. These results suggested that the resistance training increased the stiffness of tendon structures as well as muscle strength and size, and the stretching training affected the viscosity of tendon structures but not the elasticity.

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

Faigenbaum *et al.* (2007) to evaluate 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.

Takahashi *et al.* (2008) carried out resistance training five or six times a week, another six women were assigned to exercise group (b) that carried out resistance training three or four times a week, and the remaining ten comprised, the control group (non exercise group). The exercise groups carried out resistance training for both the upper and lower parts of the body using ankle and wrist weights for 8 weeks. Blood samples were obtained at the onset of the study (before the start of any activity in the exercise groups) and at the conclusion of the training (8 weeks later) in order to determine NKCA. A physical fitness test and a muscle strength test were conducted on the subjects to assess the strength of the upper and lower parts of the body, muscular endurance, and flexibility. The mean NKCA at the conclusion of the training showed a significant increase in exercise group (b), even though there was no significant difference in NKCA in the non exercise group or in exercise group (a) between before and after the training. An improvement in physical fitness and muscle strength was observed in exercise group (a) and exercise group (b). This study showed that resistance training improved physical fitness, muscle strength, and NKCA in young female subjects. Regarding the effects of exercise frequency on NKCA, this study suggests that exercise carried out three of four times a week might be associated with an increase in NKCA.

Cyarto *et al.* (2008) One hundred sixty-seven retirement village residents aged 65 to 96 years. Nine resistance training exercises, using graded exercise bands and body weight, two balance exercises, and 10 stretches. Home-based participants were given an exercise booklet, 8 hours of instruction, and telephone support. Instructors supervised the group-based resistance training and walking programs. Each group exercised twice weekly for 20 weeks. Functional performance (strength, aerobic endurance, flexibility, and agility/ dynamic balance) was assessed using the Senior Fitness Test. Intervention effects were evaluated using mixed-model, repeated measures analysis of variance. Significant between-group differences were observed only for the lower-body flexibility test. Group resistance training participants improved, but home resistance training and walking participants did not. However, strength, lower-body flexibility, and agility/dynamic balance improved in the group-based resistance training participants, and strength and upper-body flexibility improved in the home-based participants. No improvements were observed in the walking group. Findings support the implementation of both home- and group-based resistance training programs in retirement villages. Encouraging residents to adopt and maintain a resistance training program remains a research priority.

Bird *et al.* (2009) explored the balance benefits to untrained older adults of participating in community-based resistance and flexibility programs. In a blinded randomized crossover trial, 32 older adults (M = 66.9 yr) participated in a resistance-exercise program and a flexibility -exercise program for 16 weeks each. Sway velocity and mediolateral sway range were recorded. Timed up-and-go, 10 times sit-to-stand, and step test were also assessed, and lower limb strength was measured. Significant improvements in sway velocity, as well as timed up-and-go, 10 times sit- to-stand, and step test, were seen with both interventions, with no significant differences between the 2 groups. Resistance training resulted in significant increases in strength that were not evident in the flexibility intervention. Balance performance was significantly improved after both resistance training and standing flexibility training; however, further investigation is required to determine the mechanisms responsible for the improvement.

Molacek *et al.* (2010) to determine the effects of acute low- and high-volume static and proprioceptive neuromuscular facilitation (PNF) stretching on 1-repetition maximum (1RM) bench press. Fifteen healthy male National Collegiate Athletic Association Division II football players (age: 19.9 +/- 1.1 years; weight: 98.89 +/- 13.39 kg; height: 184.2 +/- 5.7 cm; body composition: 14.6 +/- 7.4%; and 1RM bench press: 129.7 +/- 3.3 kg) volunteered to participate in the study. Subjects completed 5 different stretching protocols integrated with a 1RM dynamic warm-up routine followed by 1RM testing in randomly assigned order. The protocols included (a) non stretching (NS), (b) low-volume PNF stretching (LVPNFS), (c) high-volume PNF stretching (HVPNFS), (d) low-volume static stretching (LVSS), and (d) high-volume static stretching (HVSS). Two and 5 sets of stretching were completed for the low- and high-volume protocols, respectively. The stretching protocols targeted triceps and chest/shoulder muscle groups using 2 separate exercises. There were no significant differences in 1RM bench press performance ($p > 0.05$) among any of the stretching protocols NS (129.7 +/- 3.3 kg), LVPNFS (128.9 +/- 3.8 kg), HVPNFS (128.3 +/- 3.7 kg), LVSS (129.7 +/- 3.7 kg), and HVSS (128.2 +/- 3.7 kg). We conclude that low- and high-volume PNF and static stretching have no significant acute effect on 1RM bench press in resistance-trained collegiate football players. This suggests that resistance-trained athletes can include either (a) a dynamic warm-up with no stretching or (b) a dynamic warm-up in concert with low- or high-volume static or PNF flexibility exercises before maximal upper body isotonic resistance-training lifts, if adequate rest is allowed before performance.

2.2 STUDIES RELATED TO ASANAS

Cowen and Adams (2007) to investigate differences in heart rate during the physical practice of yoga postures, breathing exercises, and relaxation. Sixteen participants were led through three different styles of yoga asana practice. Polar S610 heart rate monitors were used to measure one minute average heart rates throughout each session. Repeated measures analysis of variance indicated that there was a significant difference ($P<0.05$) in heart rate between astanga yoga (M=95, SD=12.84) and the other two styles, but not between the hatha (M=80, SD=9.32) and gentle (M=74, SD=7.41) yoga styles. These results indicate that there may be different fitness benefits for different styles of yoga practice.

Clay *et al.* (2005) to determine the metabolic and heart rate (HR) responses of hatha yoga, 26 women (19-40 years old) performed a 30-minute hatha yoga routine of supine lying, sitting, and standing asanas (i.e., postures). Subjects followed identical videotaped sequences of hatha yoga asanas. Mean physiological responses were compared to the physiological responses of resting in a chair and walking on a treadmill at 93.86 m.min(-1) [3.5 miles per hour (mph)]. During the 30-minute hatha yoga routine, mean absolute oxygen consumption (Vo(2)), relative Vo(2), percentage maximal oxygen consumption (%Vo(2)R), metabolic equivalents (METs), energy expenditure, HR, and percentage maximal heart rate (%MHR) were 0.45 L.min(-1), 7.59 ml.kg(-1).min(-1), 14.50%, 2.17 METs, 2.23 kcal.min(-1), 105.29 b.min(-1), and 56.89%, respectively. When compared to resting in a chair, hatha yoga required 114% greater O(2) (L.min(-1)), 111% greater O(2)(ml.kg(-1).min(-1)), 4,294% greater %Vo(2)R, 111% greater METs, 108% greater kcal.min(-1), 24% greater HR, and 24% greater %MHR. When compared to walking at 93.86 m.min (-1), hatha yoga required 54% lower O(2)(L.min(-1)), 53% lower O(2)(ml.kg(-1).min(-1)), 68% lower %Vo(2)R, 53% lower METs, 53% lower kcal.min(-1), 21% lower HR, and 21% lower %MHR. The hatha yoga routine in this study required 14.50% Vo(2)R, which can be considered a very light intensity and significantly lighter than 44.8% Vo(2)R for walking at 93.86 m.min(-1) (3.5 mph). The intensity of hatha yoga may be too low to provide a training stimulus for improving cardiovascular fitness. Although previous research suggests that hatha yoga is an acceptable form of physical activity for enhancing muscular fitness and flexibility, these data demonstrate that hatha yoga may have little, if any, cardiovascular benefit.

Hagins *et al.* (2007) to observational study, 20 intermediate-to-advanced level yoga practitioners, age 31.4 +/- 8.3 years, performed an exercise routine inside a human respiratory chamber (indirect calorimeter) while wearing heart rate monitors. The exercise routine consisted of 30 minutes of sitting, 56 minutes of beginner-level hatha yoga administered by video, and 10 minutes of treadmill walking at 3.2 and 4.8 kph each. Measures were mean oxygen consumption (VO2), heart rate (HR), percentage predicted maximal heart rate (%MHR), metabolic equivalents (METs), and energy expenditure (kcal). Seven subjects repeated the protocol so that measurement reliability could be established. Mean values across the entire yoga session for VO2, HR, %MHR, METs, and energy/min were 0.6 L/kg/min; 93.2 beats/min; 49.4%; 2.5; and 3.2 kcal/min; respectively. Results of the ICCs (2,1) for mean values across the entire yoga session for kcal, METs, and %MHR were 0.979 and 0.973, and 0.865, respectively. Metabolic costs of yoga averaged across the entire session represent low levels of physical activity, are similar to walking on a treadmill at 3.2 kph, and do not meet recommendations for levels of physical activity for improving or maintaining health or cardiovascular fitness. Yoga practice incorporating sun salutation postures exceeding the minimum bout of 10 minutes may contribute some portion of sufficiently intense physical activity to improve cardio-respiratory fitness in unfit or sedentary individuals. The measurement of energy expenditure across yoga sessions is highly reliable.

Jauregui *et al*. (2007) 12 female aged from 39 to 60 years old (mean 51.3 + 6.8) participated in a yoga and dancing program for 4 hours/week in 2 sessions for 1 year. The following variables were evaluated before and after the program: BMI, Body fat by BIA; physical fitness using the AHHPERD test and the battery from the Senior Fitness Test Manual (Rickli&Jones, 2001); Bone health (BMD and BMC) was evaluated by DEXA.The women lost weight during the program (mean: 900 gr). All the patients improved flexibility and strength of upper and low extremities. The practice of yoga promotes slow movements that can lead to improvement of strength. Improved joint mobility and strength can be explained by the isotonic contractions, followed by the isometric contractions that take place while realizing the asanas (Bryant and col, 2002, 1994, ACSM, 2004). These results may be affected by the pre-existence of chronic diseases in the individual patients such as obesity, osteoporosis, sarcopenia and hormonal status. In this study, improvements on the strength and muscle resistance of pre and post menopausal women can be associated with activities such as yoga and dancing. Reducing the risk of injury.

Blank *et al.* (2001) to conducted as a preliminary study of the cardiovascular and metabolic responses to yoga asanas practiced by healthy subjects. Practitioners (5 females and 1 male; ages 21-42 yr.; practice experience 4-18 mo.) were monitored for continuous heart rate (HR) and whole body metabolic (breath by breath open circuitry gas analysis) responses to 60 min of asana practice. Baseline values were determined after 5 min virasana (HR = 80 ± 3.8 bpm, oxygen cost = 3.2 ± 0.2 ml/kg/min, mean ± SEM). Compared with baseline values, HR significantly increased during asana flows ($P < 0.05$) and was sustained between 60-70% age-predicted HRmax (median values) for approximately 30 min concurrent with a significantly increased oxygen cost (range: 11.7 - 23.4 ml/kg/min).

Breath holding, which is undesirable, frequently occurs during practice by beginners. Breath holding during inversions elicited the highest HR response. In one subject, breath holding while sustaining a hand stand elicited HR exceeding age-predicted HRmax. Following 5 min of rest (savasana), HR and metabolic indices did not differ from baseline. The results indicated that power yoga practice provides a moderate cardiopulmonary exercise stimulus for beginning yoga practitioners who maintain appropriate breathing patterns during asanas.

Arciero *et al.* (2009) Thirty-three, healthy women (43.2± 4.6 yrs) were randomly assigned to 10-wks of Pulse Yoga (PY; n=8), functional resistance training (FCT; n=9), or wait-list control (C; n=8). Experimental groups (PY, FCT) participated in three 60-75 min exercise sessions/wk, whereas controls maintained their pre-existing level of physical activity (<60min physical activity/wk). All subjects followed an energy-balanced healthy eating plan throughout the 10-wks. Outcome assessments performed at baseline and after the 10-wk intervention included total and regional body composition analysis (DXA), blood lipid profile, Profile of Mood States (POMS), and aerobic fitness. Twenty-five of the 33 women recruited and randomized were included in the analysis (three drop-outs, five non-compliant). Total %body fat and abdominal %body fat declined significantly ($P<0.05$) in PY (-5.9%; -6.4%) and FCT (-5.8%; 8.8%) but remained unchanged in C. Total cholesterol levels decreased significantly ($P<0.05$) in all three groups PY (12.5%), FCT (11.5%) and C (11.5%), whereas triglyceride levels decreased significantly in PY (32%) and C (23%) and remained unchanged in FCT. Tension decreased in FCT (7.5 vs. 4, $P<0.05$) and vigor increased in PY (15 vs. 20.5, $P<0.05$) following the intervention. Estimated VO_{2peak} increased significantly ($P<0.05$) in both treatment groups following the training (PY; 30 vs. 35 ml/kg/min, 16.6%: FCT; 31 vs. 36 ml/kg/min, 16.8%). Both yoga and functional resistance exercise training elicit favorable changes in total and regional body fat distribution and aerobic fitness which coincides with enhanced psychological mood state. These findings support the use of yoga and functional resistance exercise for improved body composition, cardiovascular and psychological health in middle aged women.

Chin-Lung *et al.* (2005) to investigate the effects of 24-weeks Aerobic-Resistance training and Yoga-Resistance training on lumbar bone mineral density (BMD) and aerobic fitness (AF) in Postmenopausal Women (PMW). 19 of none regular exercise PMW who didn't receive hormone replacement therapy as the subjects. Their mean age, weight, height and body mass index (BMI) were 51.47+/- 4.25 yrs, 57.55+/- 5.86 kg, 1.55+/- 0.04 m, and 24.12+/- 2.53, respectively. Subjects were divided into 2 experimental groups (EX1 and EX2) and control group (CON). EX1 and EX2 subjects both received 3 times a week, 1hr each time training for 24 weeks and CON received no training. Each session, EX1 included 30 minutes bench-stepping aerobics (intensity about 70-80% Maximal Heart Rate) and 30 minutes resistance exercise; while EX2 subjects received 30 minutes Yoga exercise (intensity about 50-60% Maximal Heart Rate) and 30 minutes resistance exercise. The average attending rates of the experimental groups were 97.90 %. The lumbar BMD (scanned by DEXA, QMD-4500, Hologic) and the 6-minute walk test were measured prior, 12 and 24 weeks of the training program. The collected data were analyzed with two ways ANCOVA. Compared with CON, the experimental groups had higher ($p < .05$) BMD at 24 week, and higher ($p<.05$) aerobic fitness at 12 and 24 weeks of training program. However, both BMD and aerobic fitness were no significant difference between 2 experimental groups. The 24-week aerobic-resistance training and yoga-resistance training both can maintain the BMD and improve the aerobic fitness of PMW.

Sinha *et al.* (2004) to observe critically the energy cost and different cardio respiratory changes during the practice of SN. Twenty-one male volunteers from the Indian Army practiced selected Yogic exercises for six days in a week for three months duration. The Yogic practice schedule consisted of Hatha Yogic Asanas (28 min), Pranayama (10.5 min) and Meditation (5 min). In the Yogic practice schedule 1st they practiced Kapal Bhathi (breathing maneuvers) for 2 min then Yogamudra (yogic postural exercise) for 2 min, after that they took rest until oxygen consumption and heart rate (HR) came to resting value. Subsequently subjects performed SN for 3 min 40 seconds on an average. After three months of training at the beginning of the fourth month subjects performed entire Yogic practice schedule in the laboratory as they practiced during their training session and experiments were carried out. Their pulmonary ventilation, carbon dioxide output, Oxygen consumption, HR and other cardio respiratory parameters were measured during the actual practice of SN. Oxygen consumption was highest in the eighth posture (1.22+/-0.073 1 min(-1)) and lowest in the first posture (0.35+/-0.02 1 min(-1)). Total energy cost throughout the practice of SN was 13.91 kcal and at an average of 3.79 kcal/min. During its practice highest HR was 101+/-13.5 b.p.m. As an aerobic exercise SN seemed to be ideal as it involves both static stretching and slow dynamic component of exercise with optimal stress on the cardiorespiratory system.

Tran *et al.* (2001) Ten healthy, untrained volunteers (nine females and one male), ranging in age from 18-27 years, were studied to determine the effects of hatha yoga practice on the health-related aspects of physical fitness, including muscular strength and endurance, flexibility, cardiorespiratory fitness, body composition, and pulmonary function. Subjects were required to attend a minimum of two yoga classes per week for a total of 8 weeks. Each yoga session consisted of 10 minutes of pranayamas (breath-control exercises), 15 minutes of dynamic warm-up exercises, 50 minutes of asanas (yoga postures), and 10 minutes of supine relaxation in savasana (corpse pose). The subjects were evaluated before and after the 8-week training program. Isokinetic muscular strength for elbow extension, elbow flexion, and knee extension increased by 31%, 19%, and 28% ($p<0.05$), respectively, whereas isometric muscular endurance for knee flexion increased 57% ($p<0.01$). Ankle flexibility, shoulder elevation, trunk extension, and trunk flexion increased by 13% ($p<0.01$), 155% ($p<0.001$), 188% ($p<0.001$), and 14% ($p<0.05$), respectively. Absolute and relative maximal oxygen uptake increased by 7% and 6%, respectively ($p<0.01$). These findings indicate that regular hatha yoga practice can elicit improvements in the health-related aspects of physical fitness.

Schell *et al.* (1994) Hatha-Yoga has become increasingly popular in western countries as a method for coping with stress. However, little is known about the physiological and psychological effects of yoga practice. We measured heart rate, blood pressure, the hormones cortisol, prolactin and growth hormone and certain psychological parameters in a yoga practicing group and a control group of young female volunteers reading in a comfortable position during the experimental period. There were no substantial differences between the groups concerning endocrine parameters and blood pressure. The course of heart rate was significantly different, the yoga group had a decrease during the yoga practice. Significant differences between both groups were found in psychological parameters. In the personality inventory the yoga group showed markedly higher scores in life satisfaction and lower scores in excitability, aggressiveness, openness, emotionality and somatic complaints. Significant differences could also be observed concerning coping with stress and the mood at the end of the experiment. The yoga group had significant higher scores in high spirits and extravertedness.

Ray *et al.* (2001) to observe any beneficial effect of yogic practices during training period on the young trainees. 54 trainees of 20-25 years age group were divided randomly in two groups i.e. yoga and control group. Yoga group (23 males and 5 females) was administered yogic practices for the first five months of the course while control group (21 males and 5 females) did not perform yogic exercises during this period. From the 6th to 10th month of training both the groups performed the yogic practices. Physiological parameters like heart rate, blood pressure, oral temperature, skin temperature in resting condition, responses to maximal and submaximal exercise, body flexibility were recorded. Psychological parameters like personality, learning, arithmetic and psychomotor ability, mental well being were also recorded. Various parameters were taken before and during the 5th and 10th month of training period. Initially there was relatively higher sympathetic activity in both the groups due to the new work/training environment but gradually it subsided. Later on at the 5th and 10th month, yoga group had relatively lower sympathetic activity than the control group. There was improvement in performance at sub maximal level of exercise and in anaerobic threshold in the yoga group. Shoulder, hip, trunk and neck flexibility improved in the yoga group. There was improvement in various psychological parameters like reduction in anxiety and depression and a better mental function after yogic practices.

Chen *et al.* (2008) Convenience samples of 204 subjects were recruited from eight senior activity centres and 176 subjects completed the study. Subjects were randomly assigned into three groups based on the centres: (1) Experiment I: complete silver yoga with stretching and meditation, (2) Experiment II: shortened silver yoga without the guided-imagery meditation and (3) Wait-list control. The interventions were conducted three times per week for 24 weeks. Physical fitness indicators included body compositions, cardiovascular-respiratory functions, physical functions and the range of motion. At the end of the 24-week period, the physical fitness of subjects in Experiments I and II had significantly improved whether or not guided-imagery meditation was used and all had better physical fitness than subjects in the control group (all $p < 0.05$). The physical fitness of older adults in both the 70-minute complete silver yoga group and the 55-minute shortened silver yoga group had significantly improved after the interventions. It was recommended that the silver yoga programme be shortened by eliminating the guided-imagery meditation. The shortened silver yoga exercise programme is recommended to be incorporated as an activity programme in community-settings to promote the physical fitness of older adults.

Colleen *et al.* (2004) to administered a DOMS-inducing bench-stepping exercise. Muscle soreness was assessed at baseline, 24, 48, 72, 96, and 120 hours after bench-stepping using a Visual Analog Scale (VAS). Groups were also compared on body awareness (BA), flexibility using the sit-and-reach test (SR), and perceived exertion (RPE). Statistical significance was accepted at p </= 0.05. A 2 x 2 mixed factorial ANOVA with repeated measures at 24 and 48 hours revealed a significant (p < 0.05) group main effect with VAS scores greater for CON than YT. Paired t-tests revealed that in YT, VAS scores were higher before yoga class than after yoga class at 24 hours (21.4 [+/- 6.9] mm vs. 11.1 [+/- 4.1] mm; p = 0.02). The SR was greater in YT than in CON (65.0 [+/- 7.9] cm vs. 33.3 [+/- 7.0] cm; p < 0.01); however, no differences were found between yoga and control in BA (94.0 [+/- 4.4] units vs. 83.8 [+/- 3.7] units; p = 0.21) or in RPE at 5-minute intervals (2.9 [+/- 0.3], 5.3 [+/- 0.8], 5.8 [+/- 0.9], and 5.2 [+/- 0.8] vs. 2.5 [+/- 0.3], 4.0 [+/- 0.5], 4.2 [+/- 0.3], and 4.9 [+/- 0.4]. Yoga training and a single bout of yoga appear to attenuate peak muscle soreness in women following a bout of eccentric exercise. These findings have significant implications for coaches, athletes, and the exercising public who may want to implement yoga training as a preseason regimen or supplemental activity to lessen the symptoms associated with muscle soreness.

Ramos-Jimenez *et al.* (2010) In this prospective quasiexperimental design, four middle-aged and nine older CHY practicing females (yoginis) were enrolled into an 11-week IHY program consisting of 5 sessions/week for 90 min (55 sessions). The program adherence, asana performance, and work intensity were assessed along the intervention. Anthropometric [body mass index (BMI), % body fat and ∑ skin folds], cardiovascular fitness [maximal expired air volume (VE max), maximal O 2 consumption (VO 2max), maximal heart rate (HR max), systolic (BPs) and diastolic blood pressure (BPd)], biochemical [glucose, triacylglycerols (TAG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C)], and dietary parameters were evaluated before and after IHY. Daily caloric intake (~1,916 kcal/day), program adherence (~85%), and exercising skills (asana performance) were similar in both middle-aged and older women. The IHY program did not modify any anthropometric measurements. However, it increased VO 2max and VE max and HDL-C while TAG and LDL-C remained stable in both middle-aged and older groups ($P < 0.01$). The proposed IHY program improves different cardiovascular risk factors (namely VO 2max and HDL-C) in middle-aged and older women.

Madanmohan *et al.* (2008) to designed to test whether yoga training of six weeks duration modulates sweating response to dynamic exercise and improves respiratory pressures, handgrip strength and handgrip endurance. Out of 46 healthy subjects (30 males and 16 females, aged 17–20 yr), 23 motivated subjects (15 male and 8 female) were given yoga training and the remaining 23 subjects served as controls. Weight loss following Harvard step test (an index of sweat loss), maximum inspiratory pressure, maximum expiratory pressure, 40 mm endurance, handgrip strength and handgrip endurance were determined before and after the six week study period. In the yoga group, weight loss in response to Harvard step test was 64±30 g after yoga training as compared to 161±133 g before the training and the difference was significant (n = 15 male subjects, P<0.0001). In contrast, weight loss following step test was not significantly different in the control group at the end of the study period. Yoga training produced a marked increase in respiratory pressures and endurance in 40 mm Hg test in both male and female subjects (*P*<0.05 for all comparisons). In conclusion, the present study demonstrates attenuation of the sweating response to step test by yoga training. Further, yoga training for a short period of six weeks can produce significant improvements in respiratory muscle strength and endurance.

Madanmohan *et al.* (2005) planned to undertake a comparative study of the effect of short term (three weeks) training in avitri (slow breathing) and bhastrika (fast breathing) pranayam on respiratory pressures and endurance, reaction time, blood pressure, heart rate, rate-pressure product and double product. Thirty student volunteers were divided into two groups of fifteen each. Group I was given training in savitri Pranayama that involves slow, rhythmic, and deep breathing. Group II was given training in bhastrika Pranayama, which is bellows-type rapid and deep breathing. Parameters were measured before and after three week training period. Savitri Pranayama produced a significant increase in respiratory pressures and respiratory endurance. In both the groups, there was an appreciable but statistically insignificant shortening of reaction time. Heart rate, rate pressure product and double product decreased in savitri pranayam group but increased significantly in bhastrika group. It is concluded that different types of Pranayama produce different physiological responses in normal young volunteers.

Raghurj *et al.* (1998) to determined the effect of two selected yogic breathing techniques on heart rate variability twelve male volunteers (age range, 21 to 33 years) were assessed before and after each practice on separate days. The electrocardiogram (lead 1) was digitized on-line and offline. Analysis was done. The results showed a significant increase in low frequency (LF) power and LF/HF ratio while high frequency (HF) power was significantly lower following kapalabhati. There were no significant changes following nadisuddhi. The results suggest that kapalabhati modifies the autonomic status by increasing sympathetic activity with reduced vagal activity.

The study also suggests that HRV is a more useful psycho physiological measure than heart rate alone.

Rajakumar, (2010) to analyzed the impact of yogic practices and physical exercises on selected physiological variables among the intercollegiate soccer players. 60 male intercollegiate soccer players from the various colleges; Chennai were selected at random. Their age ranged between 17 to 22. The selected subjects were divided into three equal groups of 20 each, namely yogic practice group (Group A), physical exercises group (Group B) and control group (Group C). The experimental groups have underwent 12 weeks of training namely; yogic practices and physical exercises respectively, whereas the control group (Group C) maintained their daily routine activities and no special training was given. The subjects of the three groups were tested using standardized tests and procedures on selected physiological variables before and after the training period to find out the training efforts in the following test items: Resting pulse rate through stethoscope, Breath holding time through digital stop watch, Peak flow rate through Wright's peak flow meter. The collected data were analyzed statistically through Analysis of Co-variance (ANACOVA) and Schiff's post - hoc test to find out the pre and post training performances, compare the significant difference between the adjusted final means and the better group. The yogic practice group showed significant improvement due to 12 weeks training on resting pulse rate, breath holding time and peak flow rate compared to the physical exercise and control group. In the overall training effects in terms of improved number of physiological variables and their magnitude of improvement through training, yogic practice group is found to be the better group when compared to the other two groups.

Bhutkar *et al.* (2008) tested that the efficacy of regular practice of ‘suriyanamaskar’ in improving the cardio-respiratory fitness. The present study was conducted on 78 subjects, (48 males and 30 females). It was observed that 6 months of suryanamaskar practice decreases resting pulse rate and blood pressure. At the same time it increases cardio-respiratory efficiency and respiratory capacity as evaluated by bicycle Ergometry and various lung functions tests, in both male and female subjects. From this study we conclude that suryanamaskar practice can be advocated to improve cardio-respiratory efficiency for patients as well as healthy individuals.

Bera and Rajapurkar (1993) conducted a study on Body composition, cardiovascular endurance and anaerobic power of yogic practitioner forty male high school students, age 12-15 yrs, participated for a study of yoga in relation to body composition, cardiovascular endurance and anaerobic power. The Ss were placed into two subsets viz., yoga group and control group. Body composition, cardiovascular endurance anaerobic power was measured using standard method. The duration of experiment was one year. The result of ANCOVA revealed that a significant improvement in ideal body weight, body density, cardiovascular endurance and anaerobic power was observed as a result of yoga training. This study could not show significant change in body fat (midaxillary), skeletal diameters and most of the body circumferences. It was evident that some of the fat-folds (tricep, subscapular, suprailiac, umbilical, thigh and calf) and body circumferences (waist, umbilical and hip) were reduced significantly.

Chanavirut *et al.* (2006) tested the hypothesis that short-term Yoga exercise increased chest wall expansion and lung volumes in young healthy Thais. Fifty-eight healthy young volunteers (20.1±0.6 years of age) were randomly allocated into Yoga training (n=29) and control (n=29). Five positions of Hatha Yoga (Uttita Kummersana, Ardha Matsyendrasana, Vrikshasana, Yoga Mudra, and Ushtrasana) were assigned because of their dominant effects on chest wall function. The Yoga practice was 20 min/session and 3 sessions/week for 6 weeks. The matching control subjects were designed and stayed free without Yoga exercise in a similar period. Before and after training lung expansion was measured by a standard tape at three levels: upper (sternal angle), middle (rib 5), and lower (rib 8). Lung volumes (tidal volume, FEV1, FEV25-75%, and FVC) were measured by a standard spirometer. Compared to pre-training, Yoga exercise significantly increased ($p<0.05$) chest wall expansion in all levels (upper 3.2±0.1 versus 4.4±0.1 cm, middle 5.0±0.1 versus 5.9±0.1 cm, lower 5.9±0.2 versus 6.8±0.1 cm), FEV1 (2.5±0.1 versus 2.8±0.1 L), FEV25-75% (4.1±0.2 versus 4.8±0.2 L/sec), and FVC (2.5±0.1 versus 2.8±0.1 L). The upper chest wall expansion improved better than the other two levels. Resting tidal volume was not altered by Yoga (0.53±0.03 versus 0.55±0.03 L). In contrast, the control subjects did not show any change in all measured parameters through the study. The present data suggest that short-term Yoga exercise improves respiratory breathing capacity by increasing chest wall expansion and forced expiratory lung volumes.

Mark *et al.* (2007) to determined the effects of Hatha yoga practice on the health-related aspects of physical fitness, including muscular strength and endurance, flexibility, cardio respiratory fitness, body composition, and pulmonary function. Subjects were required to attend a minimum of two yoga classes per week for a total of 8 weeks. Each yoga session consisted of 10 minutes of pranayamas (breath-control exercises), 15 minutes of dynamic warm-up exercises, 50 minutes of asanas (yoga postures), and 10 minutes of supine relaxation in savasana (corpse pose). The subjects were evaluated before and after the 8-week training program. Isokinetic muscular strength for elbow extension, elbow flexion, and knee extension increased by 31%, 19%, and 28% ($p<0.05$), respectively, whereas isometric muscular endurance for knee flexion increased 57% ($p<0.01$). Ankle flexibility, shoulder elevation, trunk extension, and trunk flexion increased by 13% ($p<0.01$), 155% ($p<0.001$), 188% ($p<0.001$), and 14% ($p<0.05$), respectively. Absolute and relative maximal oxygen uptake increased by 7% and 6%, respectively ($p<0.01$). These findings indicate that regular hatha yoga practice can elicit improvements in the health-related aspects of physical fitness.

Madanmohan *et al.* (1992) investigated that the effect of yoga training on visual and auditory reaction times (RTs), maximum expiratory pressure (MEP), maximum inspiratory pressure (MIP), 40 mmHg test, breath holding time after expiration (BHTexp), breath holding time after inspiration (BHTinsp), and hand grip strength (HGS). Twenty seven student volunteers were given yoga training for 12 weeks. Our results show that yoga practice for 12 weeks results in significant reduction in visual and auditory RTs and significant increase in respiratory pressures, breath holding times and HGS.

Dhungel *et al.* (2008) conducted a study on the effect of alternate nostril breathing exercise on cardio respiratory functions, Pranayama (breathing exercise), one of the yogic techniques can produce different physiological responses in healthy individuals. The responses of Alternate Nostril Breathing (ANB) the Nadisuddhi Pranayama on some cardio-respiratory functions were investigated in healthy young adults. The subjects performed ANB exercise (15 minutes everyday in the morning) for four weeks. Cardio-respiratory parameters were recorded before and after 4-weeks training period. A significant increment in Peak expiratory flow rate (PEFR L/min) and Pulse pressure (PP) was noted. Although Systolic blood pressure (SBP) was decreased insignificantly, the decreases in pulse rate (PR), respiratory rate (RR), diastolic blood pressure (DBP) were significant. Results indicate that regular practice of ANB (Nadisuddhi) increases parasympathetic activity.

Madanmohan *et al.* (2004) reports the effects of yoga training on cardiovascular response to exercise and the time course of recovery after the exercise. Cardiovascular response to exercise was determined by Harvard step test using a platform of 45 cm height. The subjects were asked to step up and down the platform at a rate of 30/min for a total duration of 5 min or until fatigue, whichever was earlier. Heart rate (HR) and blood pressure response to exercise were measured in supine position before exercise and at 1, 2, 3, 4, 5, 7 and 10 minutes after the exercise. Rate-pressure product [RPP = (HR × SP)/100] and double product, which are indices of work done by the heart were also calculated. Exercise produced a significant increase in HR, systolic pressure, RPP & D_OP and a significant decrease in diastolic pressure. After two months of yoga training, exercise induced changes in these parameters were significantly reduced. It is concluded that after yoga training a given level of exercise leads to a milder cardiovascular response, suggesting better exercise tolerance.

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

12 weeks of HI weight training may be more effective in improving body composition than MI weight training in overweight young men with physical characteristics similar to the ones found in the present study.

Subbalakshmi *et al.* (2005) to determined effect of ‘Nadi-Shoshanna Pranayama’ on some selected parameters of cardiovascular, pulmonary, and higher functions of brain thai (a yogic technique in which breath is actively blasted out in ‘whooshes’ following a deep inspiration) has any effect on central neural processing by studying its effect on RT. 22 healthy schoolboys who were practicing yoga for the past three months were recruited for the present study. VRT and ART were recorded before and after nine rounds of mukh bhastrika. Mukh bhastrika produced a significant ($P<0.01$) decrease in VRT as well as ART. A decrease in RT indicates an improved sensory-motor performance and enhanced processing ability of central nervous system. This may be due to greater arousal, faster rate of information processing, improved concentration and/ or an ability to ignore extraneous stimuli. This is of applied value in situations requiring faster reactivity such as sports, machine operation, race driving and specialized surgery. It may also be of value to train mentally retarded children and older sports persons who have prolonged RT.

2.3 STUDIES RELATED TO MASSAGE

McKechnie (2007) to determine if three minutes of Petrissage and tapotement forms of massage would influence plantar flexors’ flexibility, and muscle power. Nineteen participants were randomly subjected to three conditions (control and two massages) before performing two power tests. Prior to the intervention, subjects completed ankle joint flexibility assessments. The conditions were; (1) control, where subjects lay prone and had a therapist’s hands resting, (2) vigorous petrissage, and (3) tapotement applied at a rate of 4Hz; all on the triceps surae. Following completion of the intervention, subjects immediately completed a post-ankle joint flexibility test, followed by a drop-jump and concentric calf raise. The power measures were; concentric peak force, rate of force development, and drop-jump height / contact time. The data showed a significant increase ($p < 0.05$) in ankle joint angle on the right leg and a corresponding tendency on the left. No significant change was seen with the power measures. Results suggest that massage can increase plantar flexors' flexibility without a change in power and thus may be an alternative to static stretching during an athletic warm-up

Farr *et al.* (2002) to investigated the effects of a therapeutic massage on delayed onset muscle soreness and muscle function following downhill walking. Eight male subjects performed a 40-min downhill treadmill walk loaded with 10% of their body mass. A qualified masseur performed a 30-min therapeutic massage to one limb 2 hours post-walk. Muscle soreness, tenderness, isometric strength, isokinetic strength, and single leg vertical jump height were measured on two occasions before, and 1, 24, 72 and 120 hours post-walk for both limbs. Subjects showed significant ($p<0.004$) increases in soreness and tenderness for the non-massaged limb 24 hours post-walk with a significant ($p<0.001$) difference between the two limbs. A significant reduction in isometric strength was recorded for both limbs compared to baseline 1 hour post-walk. Isokinetic strength at 60°/sec and vertical jump height were significantly lower for the massaged limb at 1 and 24 hours post-walk. No significant differences were evident in the remaining testing variables. These results suggest that therapeutic massage may attenuate soreness and tenderness associated with delayed onset muscle soreness. However it may not be beneficial in the treatment of strength and functional declines.

Rinder and Sutherland (1995) Thirteen males and 7 females completed their maximum number of leg extensions against a half maximum load. In a randomized, crossover study they were exercised to fatigue using an ergonometer, ski-squats and leg extensions followed either by a 6 min massage or rest after which they again completed their maximum number of leg extensions against half maximum load. The process was repeated a few days later with the alternative condition (rest or massage). The results showed that massage after exercise fatigue significantly improved quadriceps performance compared to rest (p=0.001). The data was further analyzed in relation to age and gender.

Manuel *et al.* (2008) to study included 62 healthy active individuals. After baseline measurements, the subjects performed standardized warm-up exercises followed by three 30-second Wingate tests. After completing the exercise protocol, the subjects were randomly assigned to a massage (myofascial release) or placebo (sham treatment with disconnected ultrasound and magneto therapy equipment) group for a 40-minute recovery period. Holter recording and BP measurements were taken after exercise protocol and after the intervention. After the exercise protocol, both groups showed a significant decrease in normal-to-normal interval, HRV index, diastolic BP ($P > .001$), and low-frequency domain values ($P = .006$). After the recovery period, HRV index ($P = .42$) and high-frequency (HF) ($P = .94$) values were similar to baseline levels in the massage group, whereas the HRV index tended ($P = .05$) to be lower and the HF was significantly ($P < .01$) lower vs baseline values in the placebo group, which also showed a tendency ($P = .06$) for HF to be lower than after the exercise. Likewise, diastolic BP returned to baseline levels in the massage group ($P = .45$) but remained lower in the placebo group ($P = .02$). Myofascial release massage favors the recovery of HRV and diastolic BP after high-intensity exercise (3 Wingate tests) to pre exercise levels.

Ramiz Arabaci (2008) to examine the acute effects of pre-performance lower limb massage after warm-up on explosive and high-speed motor capacities and flexibility. Twenty-four physically active healthy Caucasian male subjects volunteered to participate in this study. All subjects were from a Physical Education and Sport Department in a large university in Turkey. The study had a counterbalanced crossover design. Each of the subjects applied the following intervention protocols in a randomized order; (a) massage, (b) stretching, and (c) rest. Before (pre) and after (post) each of the interventions, the 10 meter acceleration (AS), flying start 20 meter sprint (FS), 30 meter sprint from standing position (TS), leg reaction time (LR), vertical jump (VJ) and sit & reach (SR) tests were performed. signed rank test was used to compare before and after test values within the three interventions (massage, stretching and rest). The data showed a significant worsening, after massage and stretching interventions, in the VJ, LR (only in stretching intervention), AS and TS tests ($p < 0.05$), and significant improvement in the SR test ($p < 0.05$). In contrast, the rest intervention led only to a significant decrement in TS performance ($p < 0.05$). In conclusion, the present findings suggest that performing 10 minute posterior and 5 minute anterior lower limb Swedish massage has an adverse effect on vertical jump, speed, and reaction time, and a positive effect on sit and reach test results.

Dawson *et al.* (2004) to evaluate the potential for repeated massage therapy interventions to influence recovery of quadriceps and hamstring muscle soreness, recovery of quadriceps and hamstring muscle strength and reduction of upper leg muscle swelling over a two week recovery period following an actual road running race. Twelve adult recreational runners (8 male, 4 female) completed a half marathon (21.1 km) road race. On days 1,4, 8, and 11 post-race, subjects received 30 minutes of standardized massage therapy performed by a registered massage therapist on a randomly assigned massage treatment leg, while the other (control) leg received no massage treatment. Two days prior to the race (baseline) and preceding the treatments on post-race days 1, 4, 8, and 11 the following measures were conducted on each of the massage and control legs: strength of quadriceps and hamstring muscles, leg swelling, and soreness perception. At day 1, post-race quadriceps peak torque was significantly reduced ($p < 0.05$), and soreness and leg circumference significantly elevated ($p < 0.05$) relative to pre-race values with no difference between legs. This suggested that exercise-induced muscle disruption did occur. Comparing the rate of return to baseline measures between the massaged and control legs, revealed no significant differences ($p > 0.05$). All measures had returned to baseline at day 11. Massage did not affect the recovery of muscles in terms of physiological measures of strength, swelling, or soreness. However, questionnaires revealed that 7 of the 12 participants perceived that the massaged leg felt better upon recovery.

Ogai *et al.* (2008) Subjects were 11 healthy female students actively engaged in sports. Exercise bouts of ergometer cycling at loads determined individually (0.075 kp x body weight (kg)) for 5 s repeated eight times at intervals of 20 s had to be performed twice on an experimental day with 35 min intermittent bed rest. Each subject was investigated on two occasions with a minimum interval of 1 week, once without (control, CO) and once with 10 min petrissage (massage, MA) of the exercising lower leg during the bed rest phase. Effects of exercise bouts on blood lactate, muscle stiffness and perceived lower limb fatigue and their recovery before and after the second exercise bout were determined. For the first exercise bouts total power did not differ between MA and CO. Courses of blood lactate did not differ between MA and CO. However, recovery from measured muscle stiffness ($p<0.05$) and perceived lower limb fatigue ($p<0.05$) were more pronounced and total power during the second exercise bout was enhanced ($p<0.01$) in MA as compared with CO subjects. Petrissage improved cycle ergometer pedalling performance independent of blood lactate but in correlation with improved recovery from muscle stiffness and perceived lower limb fatigue.

Kokkonen, and Allred (2002) to assigned muscle group three times a week for a total of 10 weeks. The other leg was used as a control. Participants were massaged by using a deep tissue massage treatment and received about 350-400 strokes on the hamstring muscles during each treatment session. Pre and post-test of flexibility was measured by a goniometry at the knee joint. Pre and post-tests of strength (1RM) in the hamstring curl exercise were also performed on both legs. A paired T-test was used for statistical analysis. The MASSAGE leg demonstrated higher strength and flexibility gains than the NO-MASSAGE leg.

Pocklington, *et al*. (2002) to determine the effect of massage on metabolism. It was hypothesized that there would be no significant difference in metabolism between the resting state and either during or post massage. The subjects were female, ages 25 to 50 with regular menses. The protocol involved a ten minute resting period, followed by an hour massage and concluded with a fifteen minute recovery period. VO2 (ml/kg/min) and RER were measured continuously during the resting and recovery periods and at various pre-set points during the massage. A full body massage was administered in the standardized order of: back; posterior legs; head; neck and shoulders; arms; abdomen; anterior legs; and feet. The data was statistically analyzed using descriptive statistics, analysis of variance (ANOVA), analysis of covariance (ANCOVA), pair wise comparisons, and effect size. The results showed a statistically significant increase in metabolism from the resting state (X = 2.93ml/kg/min) to the recovery phase (X = 3.81ml/kg/min) measured by the level of oxygen consumption, (ANOVA p = .004, ANCOVA p = .011). Pair wise comparisons indicated significant differences between sections. The post/recovery phase had significantly higher levels of oxygen consumption than all other sections. The abdomen was significantly lower than all other sections apart from the foot. Pairwise comparisons for RER indicated significantly lower figures for the back than all other sections apart from the posterior leg, and significantly higher figures were obtained for the abdomen than all other sections apart from the foot. It was concluded that massage significantly increases metabolism from the resting level and this increase is maintained for at least 15 minutes after the completion of the massage.

Gupta and Guru (1989) Regarding the beneficial effects of exercise, Susruta has mentioned the vyayama makes the body stout and strong, helps the symmetrical growth of the limbs and muscles, improves the complexion and digestive fire (power), prevent lazyness and makes the body light and glossy, firm and compact. It gives the power of ending fatigue and weariness and the variations of temperature (cold and heat) thirst etc… and ultimately leads to health existence. According to Ayurveda, physical and massages are very closely related with each other. No hard and fast lines could be drawn between these two branches. If we wished to develop the men who are too delicate to undertake any kind of physical exercise. We can do the same for him by suitable massage. A lean man can be made healthy and rebuilt and a stout man lean by massage as well as physical exercise. So great is inter-relationship between these two the Ayurveda considered them as in inseparable. After completion of exercise one should have his whole body well massaged or shampooed (without causing harm) until it gives a pleasing and comfortable sensation in the limbs. Massage which is positive treatment of vyayama forms preliminary measure of abhyanga as it consists of lubrication, rubbing and bath and form an important method in preventive and curative of many diseases. Massage is generally divided into three main divisions viz. (a) Dhehamardhanam or Athletic massage for development of strength and formation of the body.(b) Samvahanam or Medical massage this is include pressing of limbs comfortably in a soothing position. When the subject is retired to bed.(c) Keshamardhanam or Shampooing of the hair. Apart from these three several other process of dexterous manipulation in massage which are said to be useful in the treatment of various diseases or being practiced in India from time immemorial.

Best *et al.* (2008) Study inclusion criteria required that subjects (1) were humans, (2) performed strenuous exercise, (3) received massage, and (4) were assessed for muscle recovery and performance. Ultimately, 27 studies met inclusion criteria. Eligible studies were reviewed, and data were extracted by the senior author (TMB). The main outcomes extracted were type and timing of massage and outcome measures studied. Data from 17 case series revealed inconsistent results. Most studies evaluating post-exercise function suggest that massage is not effective, whereas studies that also evaluated the symptoms of DOMS did show some benefit. Data from 10 randomized controlled trials (RCTs) do, however, provide moderate evidence for the efficacy of massage therapy. The search identified no trend between type and timing of massage and any specific outcome measures investigated. Case series provide little support for the use of massage to aid muscle recovery or performance after intense exercise. In contrast, RCTs provide moderate data supporting its use to facilitate recovery from repetitive muscular contractions. Further investigation using standardized protocols measuring similar outcome variables is necessary to more conclusively determine the efficacy of sport massage and the optimal strategy for its implementation to enhance recovery following intense exercise.

Bakowski P *et al.* (2008) Delayed onset muscle soreness (DOMS) is the pain or discomfort often felt 12 to 24 hours after exercising and subsides generally within 4 to 6 days. Once thought to be caused by lactic acid buildup, a more recent theory is that it is caused by inflammatory process or tiny tears in the muscle fibers caused by eccentric contraction, or unaccustomed training levels. Exercises that involve many eccentric contractions will result in the most severe DOMS. Fourteen healthy men with no history of upper arm injury and no experience in resistance training were recruited. The mean age, height, and mass of the subjects were 22.8 +/- 1.2 years, 178.3 +/- 10.3 cm, and 75.0 +/- 14.2 kg, respectively. Subjects performed 8 sets of concentric and eccentric actions of the elbow flexors with each arm according to Stay protocol. One arm received 10 minutes of massage 30 minutes after exercise, the contralateral arm received no treatment. Measurements were taken at 9 assessment times: pre-exercise and post exercise at 10 min, 6, 12, 24, 36, 48, 72 and 96 hours. Dependent variables were range of motion, perceived soreness and upper arm circumference. There was noticed difference in perceived soreness across time between groups. The analysis indicated that massage resulted in a 10% to 20% decrease in the severity of soreness, but the differences were not significant. Difference in range of motion and arm circumference was not observed. Massage administered 30 minutes after exercises could have a beneficial influence on DOMS but without influence on muscle swelling and range of motion.

Caruso and Coday (2008) to compared different forms of very short rest periods administered between resistance exercises sets of individual workouts on subsequent performance. With a within-subjects design methodology, subjects (n = 30) performed three workouts that were identical in terms of the exercises (45 degrees leg press, prone leg curl, seated shoulder press, standing barbell curl), number of sets, and the resistance employed. For each workout, subjects received one of the following treatments between sets: 1 minute of rest as they stood upright, 30 seconds of rest as they stood upright, or 30 seconds of concurrent massage and body part elevation (MBPE), which entailed Petrissage of the exercised limbs in a raised and supported position in an attempt to abate fatigue and enhance recovery from the previous set. Subjects were instructed to perform as many repetitions as possible for each set. For each exercise, two dependent variables were calculated: a total work/elapsed time ratio and the cumulative number of repetitions performed. For each exercise, one-way repeated-measures analysis of variance and Tukey's post hoc test revealed the following total work/elapsed time results: 1 minute rest <30 seconds' rest, 30 seconds' MBPE. For each exercise, cumulative repetition results were as follows: 1 minute rest >30 seconds' rest, 30 seconds' MBPE. Results imply that rest period duration exerts more influence on resistance exercise performance than MBPE. Those who seek improved resistance exercise performance should pay particular attention to rest period durations.