CHAPTER-II

REVIEW OF RELATED LITERATURE

Reviews of related literature allow the researcher to acquaint with current knowledge in the field of research. Many researchers in various fields established its great need for proper guidance and healthy conclusions. A review of old literature concerning any problem in a particular area is of great help, the investigator gets an idea of work that has already been completed in a particular area or field help in clear understanding of the area of investigation, methods were used to collect the required information, statistical techniques used, findings and recommendation made in different studies. The researcher has gone through a number of studies which have been conducted on related areas. For this purpose the research scholar has gleaned through the relevant literature available in the various libraries at: Indira Gandhi Institute of Physical Education and Sport Sciences, Delhi; Central References Library, University of Delhi; websites; Online Journals and Articles.

The literature which was found directly and indirectly related to the present study is briefly described in this chapter which may be helpful in understanding and bringing out meaningful outcome for this study.

Schmidt (2001), conducted a study to determine if three 10 minutes bouts of exercise per day (3×10) and two 15 minutes bouts per day (2×15) were as effective as one 30 minutes bout per day (1×30) for improving VO2 max and weight loss. Over weight, female college students (body mass index ≥28 kg/m²) were recruited and assessed at baseline and post-treatment for aerobic fitness, weight, skin fold thickness and circumference measures. Following measurement of resting energy expenditure, subjects were asked to follow a self-monitored calorie restricted diet (80% of free) for the twelve week duration of the study and were assigned to one of four treatment groups: 1) a non exercising control group (control, n= 8); 2) a 30 minutes continuous exercise group (1×30, n=12); 3) a 30 minute accumulated exercise group (2×15, n=10); and 4) a second 30 minutes accumulated exercise group (3×10, n=8). The
exercising subjects participated in aerobic exercise training at 75% of heart rate three to five days per week with all exercise monitored. VO2 max increased significantly while weight, body mass index, sum of skin folds and sum of circumferences decreased significantly from baseline to post-treatment in the 1×30,2×15 and the 3×10 groups, but not in the control group. A tertiary finding was that exercise participation did not differ among the exercising groups with regard to the average number of days per week.

Saša and Radmila (2006), conducted a study including 59 women aged 22 to 25, 29 of which made up the experimental group, and 30 the control group. The effects of a recreational aerobic exercise model on the indicators of functional abilities were studied. The experimental model of the recreational aerobic exercise model was realized three times a week, over a period of three months, and the duration of each individual exercise was 60 minutes. The duration of the aerobic part was 35 minutes. The functional abilities were evaluated by means of the following parameters: (1) resting heart rate (the number of heart beats per minute); (2) systolic blood pressure (mmHg); (3) diastolic blood pressure (mmHg); (4) absolute oxygen uptake (l/min); (5) relative oxygen uptake (ml/kg/min). The basic descriptive statistic parameters were calculated for all of the results, and the difference between the initial and final measuring was determined by a canonical-discriminate analysis. The multivariate analysis of covariance (MANCOVA) and the univariate analysis of covariance (ANCOVA) were used to determine the achieved effects of the exercise. A statistically significant difference was found to exist between the initial and final measuring in regards to the applied variables for the evaluation of functional abilities of the subjects belonging to the experimental group, while there were no statistically significant differences found in the case of the subjects belonging to the control group. The results from the final measuring also indicated that the realized recreational aerobic exercise model had a positive effect on the functional abilities of the female subjects belonging to the experimental group (p= .00). This research supports the existing conclusions about the positive effects of recreational aerobic exercise, on the condition that it is realized with the appropriate intensity, length and duration.
Cox (1988), conducted a study on thirty-two female students who participated in a single session experiment during which they carried out two 8-min trial of high intensity exercise and two 8-min trials of low intensity exercise. One high-and one low-exercise trial were accompanied by music; the other two trials were accompanied by metronome. Mood was assessed with a modification of the profile of mood states before and immediately after each trial. The purpose of the experiment was disguised to reduce the influence of subject expectation on mood responses. Participants were divided into fit and unfit groups based on heart rate response during high-exercise trials. Over all, high intensity exercise led to increase in tension/anxiety and fatigue, whereas positive mood change (vigor and exhilaration) were seen following low intensity exercise only. No group differences in mood response were observed. Explanations of these results are considered in light of other literature concerning the acute effects of exercise on mood.

Whelton (2002), determined the effect of aerobic exercise on blood pressure. For this purpose 54 randomized controlled trials (2419 participants) whose intervention and controlled group differed only in aerobic exercise. In a random-effects model, data from each trial we pooled and weighted by the inverse of the total variance. Aerobics exercise was associated with a significant reduction in mean systolic and diastolic blood pressure. A reduction in blood pressure was associated with a aerobic exercise in hypertensive participants and normotensive participants and in overweight participants. Aerobic exercise reduces blood pressure in both hypertensive persons. An increase in aerobic physical activity should be considered an important component of lifestyle modification for prevention and treatment of high blood pressure.

Hawley (2001), conducted a study to investigate the effects of interval exercise on VO2max. Training was performed on a stationary cycle ergometer for three days each week. The program began with four intervals lasting 30 s, separated by a 4-min rest period. By Week 7 the number of intervals had increased to 10, while the rest intervals were gradually reduced to 2.5 min. VO2max increased by 9%, demonstrating that significant gains in VO2max could be achieved from exercise of a relatively short duration. In the first week of the program, each training session lasted 14 min. By Week 7, the length of each training session had increased to 30 minutes. A
team from Japan’s National Institute of Fitness and Sport found that a high-intensity intermittent training program achieved bigger gains in VO2max than a program of steady cycling (Tabata et al., 1997). Active male subjects were assigned to one of two groups, each training 5 days per week for 6 weeks. One group followed a training program involving 60 min of moderate intensity exercise (70% VO2max), for a total of 5 hours per week. The VO2max in this group improved by an average of 9%. Training sessions of the other group consisted of eight all-out work bouts, each lasting 20 s, with 10 s of rest. This group cycled for a total of only 20 min per week, yet their VO2max improved by 15%. In addition to its effect on VO2max, high-intensity intermittent training can improve athletic performance. Lindsay et al. (1996) reported that 4 weeks of interval training can improve 40-km time trial performance of competitive cyclists. The cyclists replaced approximately 15% of moderate intensity endurance training with high-intensity intermittent training, completing six interval sessions during the course of the study. Each interval session consisted of six to eight 5-min work bouts at 80% of peak power, separated by 60 s of recovery. The authors found significant improvements in 40-km time trial performance (54.4 ± 3.2 vs 56.4 ± 3.6 min) and time to fatigue at 150% of peak power (72.5 ± 7.6 vs 60.5 ± 9.3 s).

Rahimi (1996), conducted a study to determine the effect of 12 weeks of high intensity versus moderate intensity weight training of equal work output on body composition in overweight men (BMI = 25-29.9 kg/m2). Twenty sedentary men (age: 27 ± 0.5 year; Body weight: 84 ± 1.43 kg; BMI: 28.23 ± 1.11 kg/m) were randomized in two equal groups (n = 10): 1) moderate intensity exercise (MI; 5sets*6reps [60% (1RM-1repetition maximum)]; and 2) high intensity exercise (HI; 5sets*6reps [85% 1RM]). The weight training program was performed 3d.w. Relative body fat (% BF) was assessed by a skin-fold caliper. Significant differences between and within the groups were analyzed using a two-way split-plot analysis of variance (ANOVA). Statistical significance was accepted at p<0.05. The two-way ANOVA showed statistically significant differences between HI and MI groups, therefore, the Scheffe Post-Hoc Test showed that there was a significant decrease (p<0.05) in the relative body fat (BF) (D = 27%), percent of body fat (%BF) (22%), BMI (D = 9.34%), and body weight (BW) (D = 6.51%) in the HI group during the course of the study than in
the MI group. Also, comparison of means between the pre/post test showed statistically significant decreases in 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.

**Quinn et al, (2006),** determined whether a 12-week intermittent (INT; 2 x 15 min.d(-1)) exercise program yielded similar improvements in cardiovascular health and fitness, compared with a traditional 12-week, 30-minute continuous (CON; 1 x 30 min.d(-1)) exercise program. A second purpose was to determine the effects of switching exercise programs and continuing training for an additional 12 weeks. Twenty women and 17 men, (age 48.8 +/- 9.0 years) were divided randomly into 2 groups: INT (n = 20) and CON (n = 17). Aerobic exercise was performed 4 d.wk(-1) for 12 weeks. Subjects then crossed over to the opposite training program for an additional 12 weeks of training. Subjects exercised incrementally for weeks 1-4 and training was conducted at 70-80% heart rate reserve for weeks 5-24. Both groups showed comparable exercise adherence, completing 96.6 +/- 12.2% (CON) and 96.3% +/- 17.7% (INT) of the prescribed exercise time. The INT walked at a lower percentage of Vo(2)max, maximum heart rate, systolic blood pressure, and diastolic blood pressure (p < 0.05). Maximal oxygen consumption increased by 4.5% in CON and by 8.7% in INT. Following the second 12 weeks, Vo(2)max increased by 3.6 and 7.7% in CON and INT, respectively. Treadmill test time increased by 41 seconds in CON (p < 0.05) and 71 seconds in INT (p < 0.05) after 12 weeks of training. High-density lipoproteins significantly increased in the INT group following the first 12 weeks of training. This study suggests that an INT exercise program, which is incremental in nature, provides comparable, and in some cases greater, health and fitness benefits than those expected following traditional CON exercise training.

**DeBusk et al, (2004),** evaluated the “threshold” duration of exercise required to produce training effects, 18 healthy men aged 51 ± 6 years completing 30 minutes of
exercise training/day were compared with 18 men aged 52 ± 6 years completing three 10-minute bouts of exercise/day, each separated by at least 4 hours. Exercise training intensity was moderate (65 to 75% of peak treadmill heart rate). During the 8-week study period VO$_2$ max increased significantly in both groups from 33.3 ± 3.2 to 37.9 ± 3.5 ml/kg/min in men performing long exercise bouts and from 32.1 ± 4.6 to 34.5 ± 4.5 ml/kg/min in men performing short exercise bouts (p < 0.05 within and between groups). Adherence to unsupervised exercise training performed at home and at work by men in long and short bouts was high; total duration of training completed was 96 and 93% of the prescribed amount and total number of sessions completed was 92 and 93% of that prescribed, respectively. In both groups exercise heart rate measured by a portable microprocessor was within or above the prescribed range for >85% of the prescribed duration. Thus, multiple short bouts of moderate-intensity exercise training significantly increase peak oxygen uptake. For many individuals short bouts of exercise training may fit better into a busy schedule than a single long bout.

Murtagh et al. (2005), examined the effect of instructing sedentary individuals to undertake 20 min of brisk walking, in two different patterns, 3 days per week, on fitness and other cardiovascular disease (CVD) risk factors. Forty-eight subjects (31 women) mean (±SD) age 45.7 ± 9.4 year were randomly assigned to either one 20-min walk (single bout), two 10-min walks (accumulated bouts) 3 days week$^{-1}$ for 12-week, or no training (control). Oxygen consumption (VO$_2$), heart rate (HR), and ratings of perceived exertion (RPE) were measured during a 4-stage treadmill test at pre- and post-intervention. Body composition, resting blood pressure and fasting lipoproteins were also assessed. Thirty-two subjects completed the study. There was a significant difference between single-bout and accumulated-bout walkers in the reduction of HR at stages 2 and 3 of the treadmill test from pre- to post-intervention (P < 0.05). There were no differences between groups for changes in VO$_2$ or RPE from pre- to post-intervention. There were also no changes in body mass, adiposity, blood pressure, waist and hip circumferences, or lipid/lipoproteins. Brisk walking for 20 min on 3 days of the week fails to alter cardiovascular disease risk factors in previously sedentary adults.
Osei-Tutu & Campagna (2005), compared the ACSM-CDC physical activity accumulation recommendation to the traditional recommendation, for impact on mood and physiological markers of fitness. Randomized controlled trial with sedentary male (n = 21) and female (n = 19) subjects assigned to walk either long bouts (LB; 30 min/day), short bouts (SB; 3 × 10 min/day), or a non exercise control (CTL) group for 8 weeks. Pre- and post-measures were collected for VO$_{2\text{max}}$ and percent body fat. Pre-, mid-, and post-measures were collected for the Profile of Mood States (POMS). VO$_{2\text{max}}$. Increased in the SB group (+7.2%) and LB (+6.7%; $P \leq 0.05$). Percent body fat decreased in the LB group (−6.7%; $P \leq 0.05$). Total mood disturbance (TMD) decreased in the LB and SB groups ($P \leq 0.05$); only the LB group showed reductions compared to the CTL group ($P \leq 0.05$). Tension–anxiety and vigor–activity were altered in the LB group compared to the other two groups ($P \leq 0.05$). Reductions in percent body fat correlated with TMD ($r = 0.38; P \leq 0.05$) and Tension–anxiety reduction ($r = 0.40; P \leq 0.05$).LB and SB walking produced similar and significant improvements in VO$_{2\text{max}}$. LB walking was more effective at reducing percent body fat, tension–anxiety and total mood disturbance, and increasing vigor compared to the control group.

Upadhyay (2010), compared the effect of VO$_{2\text{max}}$, a measure of endurance capacity, on school-going males. Twenty-two school-going non-athlete males between 14 and 17 years of age with no history of systemic illness were randomly divided into HIT group (n=12) and slow continuous training (SCT) group (n=10). The HIT group was imparted thrice weekly training of six bouts of 2-min high-intensity run alternated with 2-min rest while SCT group was made to run five times every week for 60 min of slow continuous run (75% of HR$_{\text{max}}$ for age). Both groups were trained for 6 weeks. Pre- and post-training VO$_{2\text{max}}$ were recorded for each group by bleep test. Pre-training mean VO$_{2\text{max}}$ was 40.3 ml/kg/min. Subsequent to training, HIT group showed mean improvement in VO$_{2\text{max}}$ by 4.5 ml/kg/min (11.7%) while SCT group showed mean improvement in VO$_{2\text{max}}$ by 2.2 ml/kg/min (6.0%). High intensity interval training is an effective endurance training tool in non-athletic school going male population and provides better improvement in VO$_{2\text{max}}$ than SCT.
Hamer & Taylor (2005), performed a systematic review of randomized controlled trials (RCTs) that examined the effect of acute aerobic exercise on blood pressure (BP) responses (the change from baseline to stress) to psychosocial laboratory tasks. Fifteen RCTs met inclusion criteria of which ten demonstrated significantly reductions in post-exercise stress related BP responses compared with control (mean effect sizes for systolic and diastolic BP, 0.38 and 0.40). Studies involving greater exercise doses tended to show larger effects, with the minimum dose to show a significantly effect being 30 min at 50% V’O2max. No other moderators emerged from the examination of participant characteristics, research designs and stressor characteristics. In conclusion, an acute bout of aerobic exercise appears to have a significantly impact on the BP response to a psychosocial stressor.

Norris et al., (1992), determined whether participating in physical activity affects psychological well-being in an adolescent population. 147 adolescents completed self-reports of exercise and psychological stress and well-being. Analysis revealed that those who reported greater physical activity also reported less stress and lower levels of depression. Adolescents who experienced a higher incidence of life events also demonstrated a strong association between stress and anxiety/depression/hostility. To investigate the effects of exercise training on psychological well-being, adolescents were assigned to either high or moderate intensity aerobic training, flexibility training or a control group. The training groups met twice per week for 25-30 min. Aerobic fitness levels, heart rate, blood pressure and self-report of stress and well-being were measured prior to and following 10 weeks of training. Post-training fitness measures confirmed the effectiveness of the high intensity aerobic exercise and between groups differences for physiological and some psychological measures were found. Subjects undergoing high intensity exercise reported significantly less stress than subjects in the remaining three groups. The relationship between stress and anxiety/depression/hostility for the high intensity group was considerably weakened at the end of the training period. For the remaining subjects, however, this relationship was, if anything, strengthened. This experiment provides evidence to suggest that in an adolescent population, high intensity aerobic exercise has positive effects on well-being.
Norris et al., (1990), determined whether fitness alters psychological and physiological indices of well-being. Male police officers were assigned to either an aerobic or anaerobic training condition or to a no treatment control group. The training groups met three times per week in 45 min sessions aimed at improving either cardiovascular endurance or muscle strength. Aerobic fitness level, heart rate, blood pressure and self-report of stress and well-being were measured prior to and following 10 weeks of training. Post-training fitness measures confirmed the effectiveness of training and between group differences for physiological and self-report measures was found. Subjects undergoing aerobic training evinced larger changes on the self-report measures of well-being and stress than the anaerobic trainers and both groups showed significant improvement when compared to controls. This experiment provides support for the hypothesis that exercise, and in particular aerobic exercise, has positive effects of well-being. It is suggested that future research might usefully explore the particular contribution of different aspects of the training situation to these effects.

Kim & Lee (2009), looked at the correlation between waist circumference and cardio-respiratory fitness levels, discovering that children with higher fitness levels had smaller waist circumferences, lowering their risk for several diseases. The effects of aerobic exercise without a caloric restriction was also studied, in hopes to discover if benefits did exist, even if BMI was still elevated. In the time frame of sixteen weeks, aerobic exercise alone proved to be very effective, significantly reducing total visceral, abdominal, and subcutaneous fat. The results show that 30 to 60 minutes per day of regular exercise for at least three days per week would generate significant total fat reductions in men and women without a caloric restriction.

Shaw (2009), determined the effect of resistance training on anthropometric measures of total, central and abdominal adiposity. Twenty-five healthy, sedentary males not on an energy-restricted diet were assigned to a non-exercising control group (CON) (n = 12) or a resistance training group (RES) (n = 13) to determine the effect of 16 weeks of resistance training on anthropometric measures of total, centrally located and abdominal adiposity. Resistance training was prescribed three times weekly using eight exercises for three sets of 15 repetitions at 60% of one-repetition maximum.
Resistance training decreased three of the six anthropometric measures of total adiposity and increased body mass and body mass index (BMI). Resistance training had no impact on the measures of centrally located and abdominal adiposity. Body mass and BMI should be used with caution in risk calculations and measures of total adiposity in individuals engaging in resistance training due to this mode of training increasing lean mass (and thus body mass and BMI). Resistance training reduced total adiposity but did not provide an effective stimulus to lower centrally located and abdominal adiposity.

**Helgerud (2007),** compared the effects of aerobic endurance training at different intensities and with different methods matched for total work and frequency. Responses in maximal oxygen uptake (VO2max), stroke volume of the heart (SV), blood volume, lactate threshold (LT), and running economy (CR) were examined. Forty healthy, nonsmoking, moderately trained male subjects were randomly assigned to one of four groups: 1) long slow distance (70% maximal heart rate; HRmax); 2) lactate threshold (85% HRmax); 3) 15/15 interval running (15 s of running at 90-95% HRmax followed by 15 s of active resting at 70% HRmax); and 4) 4 x 4 min of interval running (4 min of running at 90-95% HRmax followed by 3 min of active resting at 70% HRmax). All four training protocols resulted in similar total oxygen consumption and were performed 3 d.wk for 8 wk. High-intensity aerobic interval training resulted in significantly increased VO2max compared with long slow distance and lactate-threshold training intensities (P<0.01). The percentage increases for the 15/15 and 4 x 4 min groups were 5.5 and 7.2%, respectively, reflecting increases in VO2max from 60.5 to 64.4 mL x kg(-1) x min(-1) and 55.5 to 60.4 mL x kg(-1) x min(-1). SV increased significantly by approximately 10% after interval training (P<0.05). High-aerobic intensity endurance interval training is significantly more effective than performing the same total work at either lactate threshold or at 70% HRmax, in improving VO2max. The changes in VO2max correspond with changes in SV, indicating a close link between the two groups.

**Tabata et.al., (1996),** studied two training experiments using a mechanically braked cycle ergometer. First, the effect of 6 wk of moderate-intensity endurance training (intensity: 70% of maximal oxygen uptake (VO2max), 60 min.d-1, 5 d.wk-1) on the
anaerobic capacity (the maximal accumulated oxygen deficit) and VO2max was evaluated. After the training, the anaerobic capacity did not increase significantly (P > 0.10), while VO2max increased from 53 +/- 5 ml.kg-1.min-1 to 58 +/- 3 ml.kg-1.min-1 (P < 0.01) (mean +/- SD). Second, to quantify the effect of high-intensity intermittent training on energy release, seven subjects performed an intermittent training exercise 5 d.wk-1 for 6 wk. The exhaustive intermittent training consisted of seven to eight sets of 20-s exercise at an intensity of about 170% of VO2max with a 10-s rest between each bout. After the training period, VO2max increased by 7 ml.kg-1.min-1, while the anaerobic capacity increased by 28%. In conclusion, this study showed that moderate-intensity aerobic training that improves the maximal aerobic power does not change anaerobic capacity and that adequate high-intensity intermittent training may improve both anaerobic and aerobic energy supplying systems significantly, probably through imposing intensive stimuli on both systems.

Tanisho (2009), examined the effects of 2 different training regimens, continuous (CT) and interval (IT), on endurance capacity in maximal intermittent exercise. Eighteen lacrosse players were divided into CT (n = 6), IT (n = 6), and non-training (n = 6) groups. Both training groups trained for 3 days per week for 15 weeks using bicycle ergometer. Continuous training performed continuous aerobic training for 20-25 minutes, and IT performed high-intensity pedaling comprising 10 sets of 10-second maximal pedaling with 20-second recovery periods. Maximal anaerobic power, maximal oxygen uptake (VO2max), and intermittent power output were measured before and after the training period. The intermittent exercise test consisted of a set of ten 10-second maximal sprints with 40-second intervals. Maximal anaerobic power significantly increased in IT (p <= 0.05), whereas VO2max increased in both training groups (p <= 0.05). In the intermittent exercise test, the average of the total mean power output (1-10 sets) increased in both training groups (p <= 0.05); however, the mean power output in the last stage (8-10 sets) and fatigability improved only in IT. Consequently, continuous aerobic training reduced lactate production and increased the mean power output, but there was little effect on high-power endurance capacity in maximal intermittent exercise. In contrast, although lactate production did not decrease, IT improved fatigability and mean power output.
in the last stage. These results indicated that the endurance capacities for maximal intermittent and continuous exercises were not identical. Ball game players should therefore improve their endurance capacity with high-intensity intermittent exercise, and it is insufficient to assess their capacity with only VO2max or continuous exercise tests.

Ziemann (2011), investigated the aerobic and anaerobic benefits of high-intensity interval training performed at a work-to-rest ratio of 1:2 because little performance enhancement data exist based on this ratio. Recreationally active male volunteers (21 years, 184 cm, 81.5 kg) were randomly assigned to a training (interval training [IT] n = 10) or control group (n = 11). Baseline assessments were repeated after the last training session. Each participant underwent basic anthropometric assessment and performed a VO2max test on an electronically braked cycle ergometer and a 30-second Wingate test. Venous samples were acquired at the ante cubital vein and subsequently processed for lactate (LA); samples were obtained at rest, and 5 and 15-minute post-Wingate test. The interval training used a cycling power output equivalent to 80% of VO2max (80% p VO2max) applied for 6 to 90-second bouts (each followed by 180-second rest) per session, 3 sessions per week, for 6 weeks. The control group maintained their normal routine for the 6-week period. Group × time repeated-measures analyses of variance revealed that IT improved VO2max (5.5 ml · kg(-1) · min), anaerobic threshold (3.8 ml · kg(-1) · min), work output (12.5 J · kg(-1)), glycolytic work (11.5 J · kg(-1)), mean power (0.3 W · kg), peak power (0.4 W · kg(-1)), and max power (0.4 W · kg(-1)); p < 0.05. Post-testing LA was lower on average for IT at the 5-minute mark but significantly so at the 15-minute mark. Twenty-seven minutes of cycling at 80% p VO2max applied with a work-to-rest ratio of 1:2 and spread over 3 sessions per week for 6 weeks provided sufficient stimulus to significantly improve markers of anaerobic and aerobic performance in recreationally active college-aged men. Inclusion of such a protocol into a training program may rapidly restore or improve a client’s or athlete’s maximal functional capacity.

Gormley (2008), determined whether various intensities of aerobic training differentially affect aerobic capacity as well as resting HR and resting blood pressure (BP). Sixty-one healthy young adult subjects were matched for sex and
VO 2, 11.0 and were randomly assigned to a moderate- (50% VO2 reserve (V02R), vigorous (75% VO2R), near-maximal-intensity (95% VO2R), or a non exercising control group. Intensity during exercise was controlled by having the subjects maintain target HR based on HR reserve. Exercise volume (and thus energy expenditure) was controlled across the three training groups by varying duration and frequency. Fifty-five subjects completed a 6-wk training protocol on a stationary bicycle ergometer and pre- and post testing. During the final 4 wk, the moderate-intensity group exercised for 60 min, 4 d'wk-1 the vigorous-intensity group exercised for 40 min, 4 dwk-1 and the near-maximal-intensity group exercised 3 d-wk-1 performing 5 min at 75% V02R followed by five intervals of 5 min at 95% VO2 R and 5 min at 50% VO2 R. VO2.- significantly increased in all exercising groups by 7.2, 4.8, and 3.4 mL/min1-kg-1 in the near-maximal-, the vigorous-, and the moderate-intensity groups, respectively. Percent increases in the near-maximal- (20.6%), the vigorous- (14.3%), and the moderate-intensity (10.0%) groups were all significantly different from each other (P < 0.05). There were no significant changes in resting HR and BP in any group. Conclusion: When volume of exercise is controlled, higher intensities of exercise are more effective for improving VO2,- than lower intensities of exercise in healthy, young adults.

**Chaitra (2011)**, explored the effect of aerobics on pulmonary function in general population. He evaluated the effect of aerobic exercise training on Peak Expiratory Flow Rate (PEFR) in healthy volunteers. Eighty apparently healthy medical students of either sex, aged 17-20 years were recruited for the study. Randomization into experimental and control groups (40 each), was carried out with a table of random numbers. Experimental group participated in a 16 weeks aerobic exercise plan (five 20 minute sessions of jogging in a week), while control group had no plan of exercise during that period of time. PEFR was recorded by computerized spirometer, before the commencement of training and at the end of 4 months in both the groups. Student’s paired ‘t’ test (2 tail) was applied to compare the pre and post training values of both the groups. Statistics were tested at the p<0.05 level of significance and data were reported as mean ± standard deviation. Results At baseline, PEFR (L/min)
values of experimental and control group were 437.8±64 (mean ± S.D.) and 429.7±53 respectively. After 4 months of aerobics training, the PEFR values in experimental and control groups were 512.9±62 (P=0.007), and 431.5±59 (P=0.491) respectively. There was 17% improvement in PEFR in experimental group after the training. It was concluded that aerobic exercise training leads to improvement in pulmonary function in healthy subjects; and thus provides further support for the aerobic exercise being an important component of pulmonary rehabilitation. The health care community should better recognize aerobics as a complement to conventional medical care; thus lead to better and improved treatments of COPD.

Bass (2002), ascertained the effect of weight-training versus aerobic dance on psychological stress in college students. 45 students participated in a weight-training course, 35 students participated in aerobic dance classes, and 34 students served as a control group. The Survey of Recent Life Experiences was used to appraise stressfulness of current experiences before and after exercise intervention. On immediate retest after 8 wk. of weight-training perceived stress was significantly reduced when compared with an 8-wk. aerobic dance program, but there were no significant differences between the control group and the weight-training group or the aerobic dance group. These results suggest that a regular routine of low intensity exercise such as weight-training may reduce perceived stress on an immediate test

Edwards (2005), compared psychological well-being and physical self-perception of persons who regularly engage in various forms of physical activity, exercise and sport with a control group of non-exercisers. Different physical activities selected included health club exercises (mainly resistance training), hockey (a team sport), and running (mainly aerobic exercise). Main findings were that persons engaging in regular physical activity perceived themselves as having more autonomy, personal growth, environmental mastery, purpose in life, positive relations with others, self-acceptance, sport competence and conditioning than non-exercisers. Regular exercisers also attached more importance to sport, conditioning, & attractiveness and strength than non-exercisers. Hockey players perceived themselves as having more positive relations with others and sport competence than either health club members
or runners. The relevance of these findings and further implications for health and sport psychological research and interventions were discussed.

**Rendi (2008),** reported on a Hungarian study of 76 male and 4 female regular participants (mean age: 35) in fitness activities and the psychological benefits of aerobic exercise. Half the sample exercised on a stationary bicycle and half on a treadmill in their normal environment and at self-selected workloads. All participants completed the Exercise-Induced Feeling Inventory based on a series of Likert scales before and after 20 minutes of exercise and all wore a heart rate monitor. Distance travelled and weight-corrected calories burned were read directly from the equipment displays. The exercise intensity and heart rate, perceived intensity and estimates of burned calories were higher in runners than cyclists. However, there were no differences in self-reports of enjoyment of the exercise sessions and in the psychological improvements from pre- to post-exercise between the two groups. The authors conclude that significant psychological improvements occur after a 20-minute bout of exercise and, in line with previous research, that these changes are independent of the workload or exercise intensity.

**Scully (1998),** offered a critical examination of evidence relating to the relationship between physical exercise and psychological benefits. The review examines existing literature on exercise and mental health in relation to changes in anxiety, depression, mood, self-esteem, and stress reactivity, premenstrual syndrome and body image. The general conclusion is that a range of exercise regimens may be able to play a therapeutic role in relation to a number of psychological disorders. The authors argue that enthusiasm for the positive effects of exercise on psychological well-being must be tempered with an acknowledgement of potential danger, such as exercise addiction and body image. Existing research suggests that different forms of physical exercise may be palliative in relation to particular conditions and different psychological conditions respond differently to differing exercise regimens. With regard to depression the authors conclude that it seems safe to accept that physical exercise regimens will have a positive influence, with the most powerful effects noted among clinical populations. Limited evidence would suggest that aerobic exercise is most effective, including activities such as walking, jogging, cycling, light circuit training
and weight training and that regimens which extend over several months appear to yield the most positive results. With regard to anxiety the literature unequivocally supports the positive effects of exercise, with short bursts of exercise appearing to be sufficient. In addition, the nature of the exercise does not appear to be crucial, with the most positive effects being among those who adhere to programmes for several months. In respect of stress responsively the role that exercise plays is described as preventive rather than corrective and there are unanswered questions about the relationship between stress and physiological and psychological symptoms. Nevertheless, it would appear that aerobic exercise (of sufficient intensity to elevate the heart rate significantly above resting pulse rate for over 21 minutes) may significantly enhance stress responsively, especially in relation to stress related to lifestyle or work. In respect of mood states both aerobic and anaerobic exercise can be associated with an elevation of mood state, particularly for clinical samples, although it is likely that more than one underlying mechanism may be implicated. With regard to self-esteem the more specific sub domains of perceived sport competence, physical condition, attractive body and strength may be associated differentially with behaviour in various sports. However, the literature gives little guidance as to which forms of exercise may be beneficial to which types of self-esteem.

With regard to premenstrual syndrome (PMS) the evidence points to the benefits of exercise, with less strenuous forms of non-competitive exercise most effective. The type of exercise, its duration and length still await clarification. It is very difficult to establish precise guidelines with regard to the intensity and duration of exercise, partly because of methodological difficulties inconsistencies across studies. Overall three main factors are considered when explaining why more definitive conclusions cannot yet be reached. Firstly, the research base remains thin and primary data are not extensive. Secondly, it is not yet clear how psychological and physiological processes and functions interact in the determination of outcomes. Thirdly, the primary mechanisms that underlie the relation between exercise and psychological well-being remain poorly understood.

**Knapen (2005)**, assessed the effects of aerobic exercise on various psychological dimensions, including well-being. The first objective of this study was to compare the
changes in physical self-concept, global self-esteem, depression and anxiety after participation in one of two 16-week psychomotor therapy programs for non psychotic psychiatric inpatients. The second objective was to study the relationship between changes in these variables. One hundred and ninety-nine inpatients were randomly assigned to either a personalized psychomotor fitness program, consisting of aerobic exercise and weight training, or a general program of psychomotor therapy, consisting of different forms of physical exercises and relaxation training. Physical self-concept was evaluated using the Dutch version of the Physical Self-Perception Profile at baseline, after 8 weeks, and after completion of the 16-week interventions. At the same time points, additional variables of global self-esteem, depression and anxiety were assessed by means of the Rosenberg Self-Esteem Inventory, the Beck Depression Inventory and the Trait Anxiety Inventory, respectively. After 16 weeks, both groups showed significant improvements in all outcome measures (p values ranged from 0.01 to < 0.0001), with no between-group differences. In both groups, the improvement in physical self-concept was correlated with increased global self-esteem and decreased depression and anxiety levels (p < 0.01). The results suggest that both psychomotor therapy programs are equally effective in enhancing physical self-concept. The relationship between improvements in physical self-concept and enhancements in global self-esteem, depression and anxiety supports the potential role of the physical self-concept in the recovery process of depressed and anxious psychiatric inpatients.

Akdur (2007), conducted a study to determine the effects of three different exercise regimens on physical and physiological fitness parameters in 60 sedentary obese female subjects without hypertension, diabetes and cardiovascular disease. The study groups whose interventions were diet and step aerobic exercise (trice weekly, 1 hour periods for 10 weeks) (n=20), diet and walking exercise (trice weekly, 1 hour periods for 10 weeks)(n=20), and diet only. The case were followed up for changes in the body weight, body mass index, body fat percentage, circumferences measurements, measures of flexibility, total cholesterol and other biomechanical parameters before and after the interventions and the results showed that body weight, body mass index and total cholesterol changed significantly at the end in of the study in step aerobic
exercise and walking exercise groups. Circumference measurement and Low density lipoprotein (LDL) cholesterol were decreased without reaching statistical significance. Flexibility parameters increased in all groups including the controls without reaching statistical significance.

Mayer (2001), conducted a study to compare the effects of intermittent and continuous aerobic exercise among the elderly. Factors studied included fitness, weight loss, body composition and thyroid status. The CT grouped exercised at their target heart rate (THR) for the prescribed time while the IT group alternated between aerobic exercise (until they reached 5 bpm above their THR) and active rest (until their heart rate fell to 5 bpm below their THR). Active rest refers to slow continuous movement (rating of perceived exertion 1 to 10 on the Borg Scale) using the same muscle groups involved in the preceding aerobic activity. THR for both exercise groups were initially set at 40 % of the VO2.submax, heart rate reserve (HRR). Training intensity increased 5% each week to a maximum of 85% VO2.sub max, heart rate reserve (HRR). Significant reductions occurred in both body fat percentage and weight for the IT group (-1.56 percent and -2.42 kg), but not for the CT group (-0.11 percent and -0.88 kg) or control group (+0.93 percent and +1.58 kg kg). The IT and CT groups significantly improved their mean cardio respiratory function as measured by VO2 max (+3.28 ml/kg/min and +2.99 ml/kg/min), respectively, compared to the control group (+0.22 ml/kg/min). The findings in this study confirm the observations of research using intermittent training techniques.

Murphy et al., (2002), conducted a study on the effects of different patterns of regular brisk walking on fitness, risk factors for cardiovascular disease, and psychological well-being in previously sedentary adults. Twenty-one subjects (14 women, 7 men), aged 44.5 +/- 6.1 yr (mean +/- SD) were randomly assigned to two different, 6-wk programs of brisk walking in a cross-over design, with an interval of 2 wk. One program comprised one 30-min walk per day, 5 days per week (-1) (long bout) and the other three 10-min walks per day, also 5 day/week (-1) (short bouts). All walking was at 70-80% of predicted maximal heart rate. Maximal oxygen uptake [VO2max], body composition, resting arterial blood pressure, fasting plasma lipoprotein variables, and psychological parameters were assessed before and after
each program. Overall, subjects completed 88.2 +/- 1.1% and 91.3 +/- 4.1% of prescribed total walking time in the short- and long-bout programs, respectively. Both programs increased plasma concentrations of high-density lipoprotein cholesterol, and decreased concentrations of triglycerol and total cholesterol (all < 0.05). There were no changes in body mass, but the sum of four skin folds, waist circumference, and hip circumference were decreased after both walking programs (all P<0.05). Predicted VO2max increased with both programs (P<0.05), but this increase was greater with the program based on short bouts (P<0.05). Both walking patterns resulted in similar decreases in tension/anxiety (P<0.05). These findings suggest that three short bouts (10 min) of brisk walking accumulated throughout the day are at least as effective as one continuous bout of equal total duration in reducing cardiovascular risk and improving aspects of mood in previously sedentary individuals.

Campbell et al., (2010), compared the effects of 12 weeks of caloric restriction and interval exercise (INT) and caloric restriction and continuous aerobic exercise (CON) on physiological outcomes in an obese population. Forty-four individuals (BMI > 30 kg·m⁻²) were randomized into the INT or CON group. Participant withdrawal resulted in 12 and 14 participants in the INT and CON groups, respectively. All participants were on a strict monitored diet. Exercise involved two 15-min bouts of walking performed on five days per week. Interval exercise consisted of a 2:1 min ratio of low-intensity (40-45% VO₂peak) and high- intensity (70-75% VO₂peak) exercise, while the CON group exercised between 50-55% VO₂peak. Exercise duration and average intensity (%VO₂peak) were similar between groups. There were no significant differences (p > 0.05) between the two groups for any variable assessed apart from very low density lipoprotein (VLDL-C), which significantly decreased over time in the INT group only (p < 0.05, d = 1.03). Caloric restriction and interval exercise compared to caloric restriction and continuous aerobic exercise resulted in similar outcome measures apart from VLDL-C levels, which significantly improved in the INT group only.

Zafeiridis et al., (2010), conducted a study to compare the physiological responses to heavy continuous (HC), short-intermittent (SI), and long-intermittent (LI) treadmill exercise protocols in non-endurance adolescent males. Nine adolescents
(14 ± 0.6 years) performed a maximal incremental treadmill test followed, on separate days, by a SI [30 s at 110% of maximal aerobic velocity (MAV) with 30 s recovery at 50%], a LI (3 min at 95% of MAV with 3 min recovery at 35%), and a HC (at 83% of MAV) aerobic exercise protocol. VO₂ and HR were measured continuously, and blood samples were obtained prior to and after the protocols. The duration of exercise and the distance covered were longer (p < 0.05) in HC and LI versus SI. All participants reached 80 and 85% of VO₂peak irrespective of the protocol, while more participants reached 90 and 95% of VO₂peak in the intermittent protocols (9 and 6, respectively) versus HC (5 and 3, respectively). The time spent above 80 and 85% of VO₂peak was higher in HC and LI versus SI; the time above 90% was higher only in LI versus SI, and the time above 95% was higher in LI versus HC and SI. The total VO₂ consumed was greater in HC and LI versus SI. Lactate was higher after LI versus HC. In conclusion, when matched for exhaustion level, LI is more effective in stimulating the aerobic system compared to both HC and SI, while HC aerobic exercise appears equally effective to SI. Nevertheless, adolescents have to exercise for a longer time in HC and LI to achieve these effects.

Donnelly et al., (2000), conducted a study to compare the effects of 18 months of continuous vs intermittent exercise on aerobic capacity, body weight and composition, and metabolic fitness in previously sedentary, moderately obese females. Randomized, prospective, long-term cohort study. Subjects performed continuous exercise at 60 to 75% of maximum aerobic capacity, 3 days per week, 30 min per session, or exercised intermittently using brisk walking for two, 15 min sessions, 5 days per week. Aerobic capacity, body weight, body composition, and metabolic fitness (blood pressure, lipids, glucose and insulin. Significant improvements for aerobic capacity of 8% and 6% were shown for the continuous and intermittent exercise groups, respectively. Weight loss for the continuous exercise group was significant at 2.1% from baseline weight and the intermittent group was essentially unchanged. The continuous group showed a significant decrease in percentage of body fat and fat weight while the intermittent group did not. HDL cholesterol and insulin were significantly improved for both groups. In previously sedentary, moderately obese females, continuous or intermittent exercise performed long-term
may be effective for preventing weight gain and for improving some measures of metabolic fitness.

**Eddy et al., (1977)**, conducted a study on fourteen subjects (6 male, 8 female) participated in a training program upon a bicycle ergometer for 7 weeks. **Group CT** followed a continuous training regimen 4 days per week at 70% \( \dot{V}O_2 \) max. Group IT trained by an interval method at 100% \( \dot{V}O_2 \) max. The duration of each training session was assigned so that each subject would complete 10,000 kpm of work per session during the first week. Each subsequent week, the work load was increased 3000 kpm. Pre-training tests included \( \dot{V}O_2 \) max, standard 7 min tests at 80% \( \dot{V}O_2 \) and 90% \( \dot{V}O_2 \), an endurance test at 90%, and an intense anaerobic work bout at 2400 kpm. Variables assessed were \( \dot{V}O_2 \), HR, and blood lactic acid concentrations. The mean increase in \( \dot{V}O_2 \) max was 5.1 ml/kg min (15%) for both groups with a corresponding increase in maximal lactate of 20 mg-%. The response to the post-training tests was nearly identical for both groups: sub maximal heart rate at the same absolute work load declined 17 beats/min (CT) and 15 beats/min (IT), sub maximal lactate levels declined significantly, endurance ride duration increased 26 min.

Continuous and interval training at 70% and 100% \( \dot{V}O_2 \) max respectively produce identical changes in heart rate response, blood lactic acid concentration and \( \dot{V}O_2 \) max when the total work load is equated per training session.

**Mike and Halabi (2005)**, conducted a study to examine the effects of different work-rest durations during 40 min intermittent treadmill exercise and subsequent running performance. Eight males (mean ± s: age 24.3 ± 2.0 years, body mass 79.4 ± 7.0 kg, height 1.77 ± 0.05 m) undertook intermittent exercise involving repeated sprints at 120% of the speed at which maximal oxygen uptake (\( v \cdot \dot{V}O_{2\text{max}} \)) was attained with passive recovery between each one. The work-rest ratio was constant at 1:1.5 with trials involving short (6:9 s), medium (12:18 s) or long (24:36 s) work-rest durations. Each trial was followed by a performance run to volitional exhaustion at 150% \( v \cdot \dot{V}O_{2\text{max}} \). After 40 min, mean exercise intensity was greater during the long (68.4 ± 9.3%) than the short work-rest trial (54.9 ± 8.1% \( \dot{V} \).
Blood lactate concentration at 10 min was higher in the long and medium than in the short work-rest trial (6.1 ± 0.8, 5.2 ± 0.9, 4.5 ± 1.3 mmol·l⁻¹, respectively; *P* < 0.05). The respiratory exchange ratio was consistently higher during the long than during the medium and short work-rest trials (*P* < 0.05). Plasma glucose concentration was higher in the long and medium than in the short work-rest trial after 40 min of exercise (5.6 ± 0.1, 6.6 ± 0.2 and 5.3 ± 0.5 mmol·l⁻¹, respectively; *P* < 0.05). No differences were observed between trials for performance time (72.7 ± 14.9, 63.2 ± 13.2, 57.6 ± 13.5 s for the short, medium and long work-rest trial, respectively; *P* = 0.17), although a relationship between performance time and 40 min plasma glucose was observed (*P* < 0.05). The results show that 40 min of intermittent exercise involving long and medium work-rest durations elicits greater physiological strain and carbohydrate utilization than the same amount of intermittent exercise undertaken with a short work-rest duration.

Macfarlane et al. (2006), conducted a study to examine whether accumulating short intermittent bouts of light-to-moderate physical activity (LMPA) can elicit significant improvements in the fitness of sedentary adults, compared to one longer continuous bout. Fifty sedentary 35- to 60-year-old adults in Hong Kong were randomly appointed to one of two gender-balanced intervention programs: Exercise Prescription Model (EPM) of 30-minute continuous activity, 3–4 days per week, or a Lifestyle group (LIFE) of 6-minute activity, 5 times per day, 4–5 days per week. Aerobic fitness (VO₂max), mass, body composition, blood pressure, waist-to-hip ratio, and body mass index (BMI) were assessed at baseline (December 1995) and after 8 weeks. Nearly half of bouts by the LIFE group were ≤ 6 min, while 85% of the EPM bouts were ≥ 30 min, with no differences in additional energy expenditure between groups (EPM: 163.0 ± 89.6 MET h vs LIFE: 148.2 ± 71.6 MET h). Both groups significantly improved their VO₂max, 7.4% (ES = 0.36) and 5.3% (ES = 0.24) for the EPM and Lifestyle groups respectively (*F*(1,43) = 34.0, *p* < 0.0001). Accumulating multiple short bouts of LMPA, of which ~ 50% were ≤ 6 min, can provide significant improvements in the fitness of sedentary adults that is not dissimilar as one continuous bout of similar total duration.
Klooster et al., (2002), conducted a study to determine whether positive physiological changes occurred following either a 12-week intermittent (2 × 15-minute) self-selected exercise program, versus a 12-week, 30-minute continuous self-selected exercise program. Subjects (20 women, 17 men; age = 48.8 ± 9.0 yrs) were randomly divided into two groups of either two, 15-minute bouts of exercise per day (INT, n = 22) or one, 30-minute bout of exercise per day (CON, n = 15). Aerobic exercise was performed four days per week for 12 weeks. Subjects exercised at 50-60% of heart rate reserve (HRR) for weeks 1-2, 60-70% HRR for weeks 3-4, and 70-80% HRR for weeks 5-12. All subjects were familiar with treadmill walking. Sub maximal (Speed 1: 80.4 m per min (3.0 mph) and Speed 2: 101.8 m per min (3.8 mph)) and maximal oxygen uptake (VO_{2max}) were measured on a treadmill prior to and following the 12-week training period. Skin fold measurement was taken to determine body composition. Groups were not different in any of the variables at baseline. A repeated-measures analysis of variance (ANOVA) was used to detect differences within and between training regimens. A p-value of < 0.05 was used to determine statistical significance. Following the 12-week training period, the INT group improved their exercise economy (percent of VO_{2max} lower HR, and percent of HR_{max}) at both speeds (p < 0.05). Exercise blood pressures (SBP/DBP) were lower for both groups at both speeds. Maximal oxygen consumption increased by 3.2% in CON and by 7.8% (p < 0.05) in INT. Maximal treadmill test time significantly (p < 0.05) increased in both groups (CON=+41 s; INT=+71 s). There were no changes in body composition, weight, or circumference measurements, over time or between groups. Our findings show that subjects in both the INT and CON exercise groups had similar changes toward improving cardiovascular fitness, walking economy, maximal oxygen consumption, and treadmill test time. The INT exercise, however, appears to provide more significant, positive physiological improvements in study sample.

Bryner et al., (1999), conducted a study to examine the utilization of very-low-calorie diets (VLCD) for weight loss results in loss of lean body weight (LBW) and a decrease in resting metabolic rate (RMR). The addition of aerobic exercise does not prevent this. The purpose of this study was to examine the effect of intensive, high
volume resistance training combined with a VLCD on these parameters. Twenty subjects (17 women, three men), mean age 38 years, were randomly assigned to either standard treatment control plus diet (C+D), n=10, or resistance exercise plus diet (R+D), n=10. Both groups consumed 800 kcal/day liquid formula diets for 12 weeks. The C+D group exercised 1 hour four times/week by walking, biking or stair climbing. The R+D group performed resistance training 3 days/week at 10 stations increasing from two sets of 8 to 15 repetitions to four sets of 8 to 15 repetitions by 12 weeks. Groups were similar at baseline with respect to weight, body composition, aerobic capacity, and resting metabolic rate. Maximum oxygen consumption (Max \( \text{VO}_2 \)) increased significantly (p<0.05) but equally in both groups. Body weight decreased significantly more (p<0.01) in C+D than R+D. The C+D group lost a significant (p<0.05) amount of LBW (51 to 47 kg). No decrease in LBW was observed in R+D. In addition, R+D had an increase (p<0.05) in RMR \( \text{O}_2 \) ml/kg/min (2.6 to 3.1). The 24 hour RMR decreased (p<0.05) in the C+D group. The addition of an intensive, high volume resistance training program resulted in preservation of LBW and RMR during weight loss with a VLCD.

Geliebter et al., (2000), study on a randomized controlled intervention trial, moderately obese subjects (aged 19-48 y) who were assigned to one of three groups: diet plus strength training, diet plus aerobic training, or diet only. Sixty-five subjects (25 men and 40 women) completed the study. They received a formula diet with an energy content of 70% of RMR or 5150 +/- 1070 kJ/d (x +/- SD) during the 8-wk intervention. They were seen weekly for individual nutritional counselling. Subjects in the two exercise groups, designed to be energetic, trained three times per week under supervision. Those in the strength-training group performed progressive weight-resistance exercises for the upper and lower body. Those in the aerobic group performed alternate leg and arm cycling. After 8 wk, the mean amount of weight lost, 9.0 kg, did not differ significantly among groups. The strength-training group, however, lost significantly less FFM (P < 0.05) than the aerobic and diet-only groups. The strength-training group also showed significant increases (P < 0.05) in anthropometrically measured flexed arm muscle mass and grip strength. Mean RMR declined significantly, without differing among groups. Peak oxygen consumption
increased the most for the aerobic group (P = 0.03). In conclusion, strength training significantly reduced the loss of FFM during dieting but did not prevent the decline in RMR.

_Gharbi et al., (2008)_ assessed the effects of continuous and intermittent exercise training on lactate kinetic parameters and maximal aerobic speed (MAS) using field tests. Twenty-four male sport students were equally divided into continuous (CT) and intermittent (IT) physically trained groups. Another six participants acted as non-trained controls (CG). The trained participants practiced 6-days per week for 6 weeks. Before and after training, all participants completed an incremental exercise test to assess their MAS, and a 30-second supra maximal exercise followed by 30 minutes of active recovery to determine the individual blood lactate recovery curve. It was found that exercise training has significantly increased MAS (p < 0.001), the lactate exchange and removal abilities as well as the lactate concentrations at the beginning of the recovery ([La]- (0)); for both CT and IT groups; this was accompanied by a significant reduction of the time to lactate-peak. Nevertheless, the improvement in MAS was significantly higher (p < 0.001) post-intermittent (15.1 % ± 2.4) than post-continuous (10.3 % ± 3.2) training. The lactate-exchange and removal abilities were also significantly higher for IT than for CT-group (P<0.05). Moreover, IT-group showed a significantly shorter half-time of the blood lactate (t-½-[La]) than CT-group (7.2 ± 0.5 min vs 7.7 ± 0.3 min, respectively) (p < 0.05). However, no significant differences were observed in peak blood lactate concentration ([La]peak), time to reach [La]peak (t-[La]peak), and [La]- (0) between the two physically-trained groups. We conclude that both continuous and intermittent training exercises were equally effective in improving t-[La]peak and [La]peak, although intermittent training was more beneficial in elevating MAS and in raising the lactate exchange (γ1) and removal (γ2) indexes.

_Cornelissen et al., (2009)_ investigated the effects of endurance training intensity (1) on systolic blood pressure (SBP) and heart rate (HR) at rest before exercise, and during and after a maximal exercise test; and (2) on measures of HR variability at rest before exercise and during recovery from the exercise test, in at least 55-year-old healthy sedentary men and women. A randomized crossover study comprising three
10-week periods was performed. In the first and third period, participants exercised at lower or higher intensity (33% or 66% of HR reserve) in random order, with a sedentary period in between. Training programmes were identical except for intensity, and were performed under supervision thrice for 1 h per week. The results show that in the three conditions, that is, at rest before exercise, during exercise and during recovery, they found endurance training at lower and higher intensity to reduce SBP significantly ($P<0.05$) and to a similar extent. Further, SBP during recovery was, on average, not lower than at rest before exercise, and chronic endurance training did not affect the response of SBP after an acute bout of exercise. The effect of training on HR at rest, during exercise and recovery was more pronounced ($P<0.05$) with higher intensity. Finally, endurance training had no significant effect on sympathovagal balance. In conclusion, in participants at higher age, both training programmes exert similar effects on SBP at rest, during exercise and during post-exercise recovery, whereas the effects on HR are more pronounced after higher intensity training.

Thompson et al. (2004), examined the relationship between objectively determined physical activity (pedometer counted steps per day) and body composition variables in middle-aged women. Height, weight, body fat percentage (%BF), waist circumference, and hip circumference were measured on eighty women (50.3 +/- 6.8 yr). For 7 d after testing, each subject wore a pedometer throughout the day while following her normal daily routine. Each morning the pedometer was reset to zero, and each evening the subject recorded the steps accumulated during the day. Pearson product moment correlations were used to examine the relationship between average steps per day and body composition variables. Subjects were placed in groups to reflect different levels of physical activity: inactive (<6000 steps x d), somewhat active (6000-9999 steps x d), and regularly active (> or = 10,000 steps x d). ANOVA was utilized to determine whether body composition variables varied across activity groups. Significance was set at $P < 0.05$ for all tests. A significant correlation was found between average steps per day and %BF (-0.713, $P < 0.0001$); body mass index (BMI) (-0.417, $P < 0.0001$); waist circumference (-0.616; $P < 0.0001$); hip circumference (-0.278; $P = 0.013$); and waist-to-hip ratio (-0.652; $P < 0.0001$).
was a significant difference in body composition variables among activity groups, with higher values found in the less active groups. This is the first study to specifically examine the relationship between steps per day and body composition in middle-aged women. Although the cross-sectional nature of this study does not allow causal relationships to be determined, women who walked more had lower %BF. Additionally, the average BMI of women who accumulated 10,000+ steps x d was in the normal range.

Hassmen et al., (2000), explored the association between physical exercise frequency and a number of measures of psychological well-being in a large population-based sample. A total of 3403 participants (1856 women and 1547 men) of the Finnish cardiovascular risk factor survey, ranging in age between 25 and 64, completed questionnaires. Besides answering questions concerning their exercise habits and perceived health and fitness, the participants also completed the Beck Depression Inventory, the State-Trait Anger Scale, the Cynical Distrust Scale, and the Sense of Coherence inventory. The results of this cross-sectional study suggest that individuals who exercised at least two to three times a week experienced significantly less depression, anger, cynical distrust, and stress than those exercising less frequently or not at all. Furthermore, regular exercisers perceived their health and fitness to be better than less frequent exercisers did. Finally, those who exercised at least twice a week reported higher levels of sense of coherence and a stronger feeling of social integration than their less frequently exercising counterparts. The results indicate a consistent association between enhanced psychological well-being, as measured using a variety of psychological inventories, and regular physical exercise.

Belle (1983), conducted a study to determine the effects of aerobic dance on physical work capacity, cardiovascular function and body composition of middle aged women. Maximal oxygen uptake, heart rate during sub-maximal treadmill walking, resting heart rate, blood pressure and body composition assessed using hydrostatic weighing and skin fold and circumferences measures were determined before and after all 10 week aerobic dance conditioning program in 28 women (18 experimental group and 10 control group) age 25 to 44 years. During the 10 weeks treatment period the experimental subjects participated in 45 minutes of aerobic dance that utilized 70-85
% of the HRR, 3 days/week, whereas the control group continued their normal physical activity pattern. Vo2 max increased significantly (P<0.05) in the experimental group by 0.142(1/min.16%) or 1.8 ml/kg min.(5%), where as the control group decreased significantly (p<.05) by 0.117/min.(60%) and 2.5 ml/kg min.(7.7%). Time on the modified Balke treadmill test increased significantly by 2.1 min. in the experimental group, and did not change in the control group.

Frost and Mc Kelvie (2001), conducted a study on one hundred and twenty seven male and female elementary school, high school, and university students who were classified as high or low exercisers completed questionnaires that measured global self-esteem, body satisfaction, and body build. For all participants combined, high exercisers reported greater self-esteem than low exercisers, showing that the positive relationship between exercise activity and self-esteem is robust across sex and age. High exercising male participants had a bigger body build than low exercising male participants, and they also reported greater satisfaction with specific aspects of their bodies (body-catharsis).

McAuley (1997), conducted a study at University of Illinois on exercise and self-esteem in middle-aged adults participating in a twenty week structured exercise program who demonstrated support for the theoretical relationships among the components of self-esteem. The purpose of this study was to determine the relation between general self-concept and the specific subareas of self-concept, specifically how the changes in efficacy and aerobic capacity as well as engaging in an exercise program impacted self-worth. This research tested the extent to which self-esteem changed over time with exercise participation and within the hierarchical structure of self-esteem as postulated by Sonstroem and Morgan (1989). The results demonstrated that improved levels of physical self-efficacy and fitness were more directly related to physical self-esteem than perceptions occurring in the subareas. The authors conclude that the findings are consistent with the Sonstroem and Morgan model indicating that self-efficacy predicts physical competence which then impacts self-esteem.

Hazell et al., (2010), assessed whether 10-s sprint interval training (SIT) bouts with 2 or 4 min recovery periods can improve aerobic and anaerobic performance. Subjects
(n = 48) were assigned to one of four groups [exercise time (s); recovery time (min)]:
(1) 30:4, (2) 10:4, (3) 10:2 or (4) control (no training). Training was cycling 3 week (-1) for 2 weeks (starting with 4 bouts session (-1), increasing 1 bout every 2 sessions, 6 total). Pre- and post-training measures included: VO2max, 5-km time trial (TT), and a
30-s Wingate test. All groups were similar pre-training and the control group did not change over time. The 10-s groups trained at a higher intensity demonstrated by greater (P < 0.05) reproducibility of peak (10:4 = 96%; 10:2 = 95% vs. 30:4 = 89%), average (10:4 = 84%; 10:2 = 82% vs. 30:4 = 58%), and minimum power (10:4 = 73%; 10:2 = 69%; vs. 30:4 = 40%) within each session while the 30:4 group performed ~2X
(P < 0.05) the total work session(-1) (83-124 kJ, 4-6 bouts) versus 10:4(38-58 kJ);
10:2 (39-59 kJ). Training increased TT performance (P < 0.05) in the 30:4 (5.2%),
10:4 (3.5%), and 10:2 (3.0%) groups. VO2max increased in the 30:4 (9.3%) and 10:4
(9.2%), but not the 10:2 groups. Wingate peak power kg (-1) increased (P < 0.05) in
the 30:4 (9.5%), 10:4 (8.5%), and 10:2 (4.2%). Average Wingate power kg (-1)
increased (P < 0.05) in the 30:4 (12.1%) and 10:4 (6.5%) groups. These data indicate
that 10-s (with either 2 or 4 min recovery) and 30-s SIT bouts are effective for
increasing anaerobic and aerobic performance.

Borel & Benoit (2010), examined the aim of this article is to determine
correspondences between three levels of continuous and intermittent exercise (CE and
IE, respectively) in terms of steady-state oxygen uptake (VO(2SS)) and heart rate
(HR) in children. Fourteen healthy children performed seven exercises on a treadmill:
one graded test for the determination of maximal aerobic speed (MAS), three CE at
60, 70 and 80% of MAS (CE60, CE70 and CE80) and three IE (alternating 15 s of
exercise intercepted with 15 s of passive recovery) at 90, 100 and 110% of MAS
(IE90, IE100 and IE110). Mean VO(2SS) and mean HR were determined for both
continuous and intermittent exercises. For comparison, three associations were
designed: CE60 versus IE90, CE70 versus IE100 and CE80 versus IE110. No
VO(2SS) difference was observed for CE60 versus IE90 and CE70 versus IE100
whereas a significant difference (P < 0.01) was found for CE80 versus IE110 (1.36
+- 0.45 vs. 1.19 +- 0.38 L min(-1), respectively). Significant linear regressions were
found for the three CE versus IE associations for VO(2SS) (0.60 < r (2) < 0.99, P <
0.05). For the three associations, mean HR presented no significant difference. Only one significant relation was found for CE80 versus IE110 association (r(2) = 0.49, P < 0.05). Correspondences between CE and IE intensities are possible in terms of VO(2SS) whatever the level of exercise; even if for high intensities, VO(2SS) was higher during CE. These results demonstrated that it is possible to diversify the exercise modality while conserving exercise individualization.

Guiraud et al., (2010), conducted a study to examine the High intensity interval training has been shown to be more effective than moderate intensity continuous training for improving maximal oxygen uptake (VO(2max)) in patients with coronary heart disease (CHD). However, no evidence supports the prescription of one specific protocol of high intensity interval exercise (HIIE) in this population. The purpose of this study was to compare the acute cardiopulmonary responses with four different single bouts of HIIE in order to identify the most optimal one in CHD patients. Nineteen stable CHD patients (17 males, 2 females, 65 +/- 8 years) performed four different bouts of HIIE, all with exercise phases at 100% of maximal aerobic power (MAP), but which varied in interval duration (15 s for mode A and B and 60 s for mode C and D) and type of recovery (0% of MAP for modes A and C and 50% of MAP for modes B and D). A passive recovery phase resulted in a longer time to exhaustion compared to an active recovery phase, irrespective of the duration of the exercise and recovery periods (15 or 60 s, p < 0.05). Time to exhaustion also tended to be higher with mode A relative to mode C (p = 0.06). Despite differences in time to exhaustion between modes, time spent at a high percentage of VO(2max) was similar between HIIE modes except for less time spent above 90 and 95% of VO(2max) for mode C when compared with modes B and D. When considering perceived exertion, patient comfort and time spent above 80% of VO(2max), mode A appeared to be the optimal HIIE session for these coronary patients.

Cornelissen et al., (2010), investigated the effects of endurance training intensity (1) on systolic blood pressure (SBP) and heart rate (HR) at rest before exercise, and during and after a maximal exercise test; and (2) on measures of HR variability at rest before exercise and during recovery from the exercise test, in at least 55-year-old healthy sedentary men and women. A randomized crossover study comprising three
10-week periods was performed. In the first and third period, participants exercised at lower or higher intensity (33% or 66% of HR reserve) in random order, with a sedentary period in between. Training programmes were identical except for intensity, and were performed under Supervision thrice for 1 h per week. The results show that in the three conditions, that is, at rest before exercise, during exercise and during recovery, we found endurance training at lower and higher intensity to reduce SBP significantly (P<0.05) and to a similar extent. Further, SBP during recovery was, on average, not lower than at rest before exercise, and chronic endurance training did not affect the response of SBP after an acute bout of exercise. The effect of training on HR at rest, during exercise and recovery was more pronounced (P<0.05) with higher intensity. Finally, endurance training had no significant effect on sympathovagal balance. In conclusion, in participants at higher age, both training programmes exert similar effects on SBP at rest, during exercise and during post-exercise recovery, whereas the effects on HR are more pronounced after higher intensity training.

*Thevenet et al., (2007)*, compared during a 30s intermittent exercise (IE), the effects of exercise intensity on time spent above 90% VO2max (t90VO2max) and time spent above 95% VO2max(t95VO2max) in young endurance trained athletes. It was hypothesized that during a 30sIE, an increase in exercise intensity would allow an increase in t90VO2max and t95VO2max due to a decrease in time to achieve 90% or 95% of VO2max. Nine endurance-trained male adolescents took part in three field tests. After determination of their VO2max and maximal aerobic velocity (MAV), they performed, until exhaustion, two intermittent exercise sessions alternating 30s at 100% of MAV (IE(100)) or 110% of MAV (IE(110)) and 30s at 50% of MAV. Mean time to exhaustion (t (lim)) values obtained during IE(100) were significantly longer than during IE(110) (p < 0.01). Moreover, no significant difference was found in t90VO2max or t95VO2max expressed in absolute or relative (%t (lim)) values between IE(100) and IE(110). In conclusion, an increase of 10% of exercise intensity during a 30s intermittent exercise model (with active recovery), does not seem to be the most efficient exercise to solicit oxygen uptake to its highest level in young endurance-trained athletes.
Rozenek et al., (2007), conducted a study that has indicated that short-duration, high-intensity work intervals performed at velocities associated with maximal oxygen uptake (VO2max) combined with active recovery intervals may be effective in eliciting improvements in endurance performance. This study was designed to characterize selected physiological responses to short-duration (< or = 60 seconds) interval work performed at velocities corresponding to 100% of vVO2max. Twelve men participated in 3 randomized trials consisting of treadmill running using work (W)/recovery (R) intervals of 15 seconds W/15 seconds R (15/15); 30 seconds W/15 seconds R (30/15); and 60 seconds W/15 seconds R (60/15). Work intervals were performed at 100% of vVO2max, whereas R intervals were performed at 50% of vVO2max. A fourth trial consisting of continuous work (C) at 100% of vVO2max was also performed. All subjects completed the 15/15 and 30/15 trials; however, only 5 of the 12 completed the 60/15 trial. The percentage of VO2max (mean +/- SD) during 15/15 (71.6 +/- 4.2%) was significantly lower (p < or = 0.05) than the percentages during 30/15 (84.6 +/- 4.0%), 60/15 (89.2 +/- 4.2%), or C (87.9 +/- 5.0%). Similar results were found for heart rate and perceived exertion. Blood lactate concentrations following exercise were significantly lower (p < or = 0.05) in 15/15 (7.3 +/- 2.4 mmol x L(-1)) than in the other trials. No significant differences (p 0.05) existed among 30/15 (11.5 +/- 1.8 mmol x L(-1)), 60/15 (12.5 +/- 1.8 mmol x L(-1)) or C (12.1 +/- 1.8 mmol x L(-1)). High intensity, short-duration 2:1 W/R intervals appear to produce responses that may benefit both aerobic and anaerobic energy system development. A 4:1 W/R ratio may be an upper limit for individuals in the initial phases of interval training.

Boutcher (2011), conducted a study to examine the effect of regular aerobic exercise on body fat is negligible; however, other forms of exercise may have a greater impact on body composition. For example, emerging research examining high-intensity intermittent exercise (HIIE) indicates that it may be more effective at reducing subcutaneous and abdominal body fat than other types of exercise. The mechanisms underlying the fat reduction induced by HIIE, however, are undetermined. Regular HIIE has been shown to significantly increase both aerobic and anaerobic fitness. HIIE also significantly lowers insulin resistance and results in a number of skeletal
muscle adaptations that result in enhanced skeletal muscle fat oxidation and improved glucose tolerance. This review summarizes the results of HIIE studies on fat loss, fitness, insulin resistance, and skeletal muscle. Possible mechanisms underlying HIIE-induced fat loss and implications for the use of HIIE in the treatment and prevention of obesity are also discussed.

Tomlin & Wenger (2001), examined a strong relationship between aerobic fitness and the aerobic response to repeated bouts of high intensity exercise that has been established, suggesting that aerobic fitness is important in determining the magnitude of the oxidative response. The elevation of exercise oxygen consumption (VO2) is at least partially responsible for the larger fast component of excess post-exercise oxygen consumption (EPOC) seen in endurance-trained athletes following intense intermittent exercise. Replenishment of phosphocreatine (PCr) has been linked to both fast EPOC and power recovery in repeated efforts. Although 31P magnetic resonance spectroscopy studies appear to support a relationship between endurance training and PCr recovery following both sub maximal work and repeated bouts of moderate intensity exercise, PCr resynthesis following single bouts of high intensity effort does not always correlate well with maximal oxygen consumption (VO2max). It appears that intense exercise involving larger muscle mass displays a stronger relationship between VO2max and PCr resynthesis than does intense exercise utilising small muscle mass. A strong relationship between power recovery and endurance fitness, as measured by the percentage VO2max corresponding to a blood lactate concentration of 4 mmol/L, has been demonstrated. The results from most studies examining power recovery and VO2max seem to suggest that endurance training and/or a higher VO2max results in superior power recovery across repeated bouts of high intensity intermittent exercise. Some studies have supported an association between aerobic fitness and lactate removal following high intensity exercise, whereas others have failed to confirm an association. Unfortunately, all studies have relied on measurements of blood lactate to reflect muscle lactate clearance, and different mathematical methods have been used for assessing blood lactate clearance, which may compromise conclusions on lactate removal. In summary, the literature suggests that aerobic fitness enhances recovery from high intensity intermittent exercise.
through increased aerobic response, improved lactate removal and enhanced PCr regeneration.

**Jeneifer & Arnold (2005)**, conducted a study to determine the effect of exercise intensity on excess post exercise oxygen consumption (EPOC) that was determined in 18 to 30 year old apparently healthy individuals. Subjects participated in 3 different exercise sessions; aerobic exercise, interval exercise (IE) and high intensity interval exercise (HIIE), on separate days. EPOC was measured one hour after each exercise while subjects were in supine position. ANOVA with repeated measurements was used to assess differences. The mean values (± SEM) for EPOC of aerobic exercise, IE and HIIE were 2.106 (± 0.219), 2.846 (± 0.309) and 4.969 (± 0.522) l·hour -1. There was no significant difference (p < 0.05) between mean EPOC of aerobic exercise and IE, however, a significant difference (p < 0.05) was found in mean EPOC of HIIE when it was compared with both aerobic exercise and IE. These data suggest that exercise intensity has a significant effect on EPOC.

**Alpert & Bené (1990)**, investigated the effects of aerobic exercise on 24 3–5 yr olds. 30 min of aerobic exercises were provided daily for 8 wks for 12 Ss, while the remaining 12 Ss engaged in free play on the school playground. Ss were given pre- and posttests on a sub-maximal exercise test on a pediatric bicycle (baseline and 3 workloads), an agility test, a health knowledge test, a self-esteem scale, and an observational measure of their gross-motor activity. Despite comparability on pretests, the aerobic exercise group showed significant decreases in heart rate at all 3 workloads as well as increases in agility and self-esteem following the exercise program.

**Rockefeller & Burke (1979)**, determined: (1) the energy cost and (2) the psychophysiological effects of an aerobic dance programme in young women. Twenty-one college-age women participated 40 minutes a day, three days a week, for a 10-week training period. Each work session included a five-minute warm-up period, a 30-minute stimulus period (including walk-runs) and a five-minute cool-down period. During the last four weeks of the training period, the following parameters were monitored in six of the subjects during two consecutive sessions: perceived exertion
(RPE) utilizing the Borg 6-20 scale, Mean = 13.19; heart rate (HR) monitored at regular intervals during the training session, Mean = 166.37; and estimated caloric expenditure based on measured oxygen consumption ($\dot{V}O_2$) utilizing a Kofranyi-Michaelis respirometer, Mean = 289.32. Multivariate analysis of variance (MANOVA) computed between pre and post tests for the six dependent variables revealed a significant approximate F-ratio of 5.72 (p < .05). Univariate t-test analysis of mean changes revealed significant pre-post test differences for $\dot{V}O_2$ max expressed in ml/kg min$^{-1}$, maximal pulmonary ventilation, maximal working capacity on the bicycle ergometer, sub maximal HR and sub maximal RPE. Body weight was not significantly altered. It was concluded that the aerobic dance training programme employed was of sufficient intensity to elicit significant physiological and psychophysiological alterations in college-age women.

Tanisho and Hirakawa (2000), examined the effects of 2 different training regimens, continuous (CT) and interval (IT), on endurance capacity in maximal intermittent exercise. Eighteen lacrosse players were divided into CT (n = 6), IT (n = 6), and non training (n = 6) groups. Both training groups trained for 3 days per week for 15 weeks using bicycle ergometer. Continuous training performed continuous aerobic training for 20-25 minutes, and IT performed high-intensity pedaling comprising 10 sets of 10-second maximal pedaling with 20-second recovery periods. Maximal anaerobic power, maximal oxygen uptake (VO2max), and intermittent power output were measured before and after the training period. The intermittent exercise test consisted of a set of ten 10-second maximal sprints with 40-second intervals. Maximal anaerobic power significantly increased in IT (p <or= 0.05), whereas (VO2max) increased in both training groups (p <or= 0.05). In the intermittent exercise test, the average of the total mean power output (1-10 sets) increased in both training groups (p <or= 0.05); however, the mean power output in the last stage (8-10 sets) and fatigability improved only in IT. Consequently, continuous aerobic training reduced lactate production and increased the mean power output, but there was little effect on high-power endurance capacity in maximal intermittent exercise. In contrast, although lactate production did not decrease, IT improved fatigability and mean power output in the last stage. These results indicated
that the endurance capacities for maximal intermittent and continuous exercises were not identical. Ball game players should therefore improve their endurance capacity with high-intensity intermittent exercise, and it is insufficient to assess their capacity with only (VO2max) or continuous exercise tests.

**Whelton and Chin (2002),** conducted a study was included if they were randomized controlled trials (RCTs) comparing interventions that included aerobic exercise (treatment group) with interventions without aerobic exercise (control group), that lasted ≥2 weeks, reported changes in blood pressure (systolic, diastolic, or both) from baseline to follow up with the corresponding or data variances to estimate them, and participants were ≥18 years of age. All frequencies, intensities, and types of aerobic exercise were considered. Three reviewers independently extracted data on sample size, participant characteristics, study design, details of the intervention, study duration, and outcomes. Outcomes included changes in blood pressure (systolic, diastolic, or both) from baseline to follow-up. 54 RCTs (2419 participants) met the selection criteria. Data from the RCTs were pooled in a random-effects model, with each study weighted by the reciprocal of the total variance for blood pressure change. Both overall and subgroup analysis showed that reduction in systolic and diastolic blood pressure was greater in the treatment group than in the control group. In adults, aerobic exercise is effective for lowering systolic and diastolic blood pressure.

**Sirithienthad & Prawee (2006),** compared the effects of three bouts of exercise, resistance (RE), continuous aerobic (CA), and intermittent aerobic (IA), matched for energy expenditure (kcal) and rate of oxygen consumption (VO2), on 12h post exercise metabolic rate and basal metabolic rate (BMR). Ten healthy men (age: 22 ± 2 yrs, height: 173.8 ± 11.6 cm, weight: 77.1 ± 16.4 kg, VO2max: 34.5 ± 6.1 ml/kg/min) were recruited to participate in this study. 12h post exercise and BMR were measured on four sessions over a four week period: control, RE, CA, and IA. For each session, subjects performed exercise at 9.00 am and returned to the laboratory at 9.00 pm to have their 12 h post exercise metabolic rate measured and to stay overnight in the laboratory, to have their BMR measured the following morning. For RE session, subjects performed one circuit of five exercises vertical butterflies, squats, toe raises, lateral pull downs, and triceps press downs at approximately 50-60% of their maximal
lifts. Each set was performed until failure, and followed by 60s of rest. The circuit was repeated for a total of 45 min of exercise. VO2 was measured continuously and used for calculating the total amount of energy expenditure (216 ± 19 kcal) and average rate of VO2 (12.5 ± 1.8 ml/kg/min). For CA, subjects cycled at a work load that produced the same average rate of VO2 at each subject’s average rate of VO2 during the RE. For IA, subjects cycled at high intensity interval between 90%-100% of VO2max for 30 seconds and a low intensity interval at 20-30% of VO2max. For the low intensity interval, subjects cycled until the average rate of VO2 in that interval matched the average rate of VO2 during the RE. For both CA and IA, subjects cycled until spending the same amount of kcal measured during RE (exercise duration; CA: 43.2 ± 2.3; IA: 43.5 ± 1.8min). For 12h post exercise metabolic rate, RE caused greater increases in metabolic rate compared to the control (14.6%), CA (9.3%) and IA (4.4%). IA also had significantly higher metabolic rate compared to the control (9.8%) and CA (4.7%). BMR was significantly higher after RE compared to the control (15.6%), CA (12.1%), and IA (12.1%). These results suggest that RE has greater effects on BMR compared to CA and IA, indicating the importance of further research to examine a possible role for RE in controlling body weight.

Cramer et al., (1990), examined the relationship between moderate exercise training (five 45 min sessions/week, brisk walking at 62 β ± 2% VO2max for 15 weeks), psychological well-being and mood state that was investigated in a group of 35 sedentary, mildly obese women. A 2 (exercise (EX) (N = 18), and non exercise (NEX) (N = 17) groups) × 3 (baseline, 6-week, 15-week testing sessions) factorial design was used with data analyzed using repeated measures ANOVA. Four psychological tests were administered: Daily Hassles Scale (DHS), General Well-being (GWB), Spielberger State Anxiety Inventory (S-Anxiety), and Profile of Mood States (POMS). The EX and NEX groups had significantly different patterns of change over time for GWB total scores \[F(2,66) = 5.72, p = 0.005\] and the GWB subscales ‘energy level’ and ‘freedom from health concern or worry’ . Scores for the EX group were elevated at both 6 and 15 weeks. General well-being total scores and subscale ‘energy level’ scores were significantly correlated with improvement in sub-maximal cardio-respiratory fitness \(r = -0.41, p = 0.014; r = -0.40, p = 0.017, \text{ respectively}\).
Exercise training also had a significant effect on frequency but not intensity of DHS scores, and S-Anxiety, with a significant decrease seen in the EX group at 6 weeks but not 15 weeks. Profile of Mood States scores was not significantly related to exercise training. These data support the results of other studies that have reported improvement in general psychological well-being with exercise training.

**Watts & Boquet (1999),** investigated the effects of aerobic exercise on peoples' general well-being and level of anxiety. A group of 54 and a group of 53 sedentary people participated in this study. An activity questionnaire identified exercisers and sedentary participants. The exercise group completed 60 min of an aerobic activity and the sedentary group completed a 60-min lecture control class. Following the groups' activity, all participants completed a demographic and activity questionnaire, the state portion of the Spielberger's State–Trait Anxiety Inventory (Spielberger, 1983), and the General Well-Being Schedule (National Center for Health Statistics, 1973. A 1-way multivariate analysis of variance revealed that the groups differed significantly. The exercise group reported higher feelings of general well-being. The present findings support the capacity of aerobic exercise to positively enhance global quality of life.

**Rowland (1990),** conducted a study on the accuracy of physical working capacity in estimating aerobic fitness in children. For this study 35 children- 18 boys and 17 girls of age 10 and 9 respectively underwent maximal cycle testing. The workload, the heart rate of 17 bpm has been utilized. The measures were closely correlated in absolute terms but the relationship was weak when both were expressed per kg body weight. When VO2 max calculated from regression equation of VO2 max versus PWC, the mean error from measured VO2 max was 3.4ml/kg/min, for girls and 2.8ml/kg/min for boys. The finding indicated that although mean predictability of VO2 mean from PWC was good, the variability was wide with 10-15% error. PWC provides a crude estimate of VO2 max and should not be used to predicate individual’s maximal aerobic power.

**Kalliokoski, & Nuutila (2001),** in their study showed good correlation between regional blood flow (BF) and oxygen uptake (VO2) 30 minutes after exhaustive
exercise. The question that remains open is whether there is similar good correlation between BF and VO2 also during exercise. They re-analyzed the previous data from a study in which BF and VO2 was measured in different quadriceps femoris muscles in seven healthy endurance-trained and seven healthy untrained men at rest and during low-intensity intermittent static knee-extension exercise. When the mean values of each muscle were considered, there was good correlation between BF and VO2 during exercise in both groups ($r^2 0.82$ in untrained and $0.97$ in trained). However, when calculated individually the correlations were poorer and the mean correlation coefficient ($r^2$) was significantly higher in the trained men ($0.71\pm0.07$ vs $0.40\pm0.11$, $p=0.03$). These results suggest that there is large individual variation in matching blood flow to oxygen uptake in human skeletal muscles during exercise, ranging from very poor to excellent. Furthermore, this matching seems to be better in the endurance trained than in untrained men.

**Usitalo (2000),** conducted a study on heart rate in endurance athletes ($M=2$, $F=3$) after three different forms of training: Long slow distance work (2–4 hours at < 65% Vo2 max); an intense interval run (5c, km>90% Vo2 max) and a control (30, 60 minutes, 65 % Vo2 max). Heart rate variability was measured during five minutes of standing and 48 hours after each form of exercise. The forms of exercise did not change blood lactate levels, heart rates or heart rate variability. Recovery of heart rates was complete within 24 hours of exercise and long slow distance work caused the greatest response in heart rate variables. Heart rate responses differ markedly between individuals. However, heart rates recover from endurance exercise within 24 hours, but long slow distance work has the greatest effect on compare heart rate recovery response patterns when forms of endurance exercise differ.

**Kelley (2001),** examined the effects of walking on resting systolic and diastolic blood pressure in adults. A total of 24 primary outcomes from 16 studies and 650 subjects (410 exercise, 240 control) met the criteria for inclusion: (1) randomized and nonrandomized controlled trials, (2) walking as the only intervention, (3) subjects apparently sedentary, (4) adult humans ≥18 years of age, (5) English-language studies published between January 1966 and December 1998, (6) resting blood pressure assessed, (7) training studies ≥4 weeks. Using a random effects model, statistically
significant decreases of approximately 2% were found for both resting systolic and diastolic blood pressure (systolic, $\overline{x} \pm \text{SEM} = -3 \pm 1 \text{ mm Hg}$, 95% confidence interval: $-5$ to $-2 \text{ mm Hg}$; diastolic, $\overline{x} \pm \text{SEM} = -2 \pm 1 \text{ mm Hg}$, 95% confidence interval: $-3$ to $-1 \text{ mm Hg}$). Walking exercise programs reduce resting blood pressure in adults.

**Lai & Hsieh (2004)**, evaluated the effects of group aerobic exercise program over a 3-week period on psycho-physiological parameters among the midlife and elderly people. A repeated measure quasi-experimental design was employed. The study took place in a hospital's OPD. Purposive sampling was used, 30 participants aged 50 years or over were selected. The average age was 61.79 (SD = 8.24). Participants received a 20 minutes group aerobic exercise 3 times a week for 3 consecutive weeks. Participants were evaluated for psycho-physiological parameters including flexibility, cardio-respiratory fitness, balance, depression, and life satisfaction. While controlling for pretreatment scores and baseline scores on self-rated health status, age, exercise habit, hypotheses were tested using repeated measures of ANCOVA. Findings were that subjects had significantly better life satisfaction over the three posttests, ($F = 11.69, p < .01$), but other parameters were not significant. The findings provide evidence for health caregivers to use aerobic exercise as an empirical-based intervention for life satisfaction in older adults. (Tzu Chi Nursing Journal, 2004; 3:2, 50-58.)

**Bartholomew (2005)**, determined if a single bout of moderate-intensity aerobic exercise would improve mood and well-being in 40 (15 male, 25 female) individuals who were receiving treatment for major depressive disorder (MDD). All participants were randomly assigned to exercise at 60–70% of age-predicted maximal heart rate for 30 min or to a 30-min period of quiet rest. Participants completed the Profile of Mood States (POMS) and Subjective Exercise Experiences Scale (SEES) as indicators of mood 5 min before, and 5, 30, and 60 min following their experimental condition. Both groups reported similar reductions in measures of psychological distress, depression, confusion, fatigue, tension, and anger. Only the exercise group, however, reported a significant increase in positive well-being and vigor scores. It was concluded that although 30 min of either moderate-intensity treadmill exercise or
quiet rest is sufficient to improve the mood and well-being of patients with MDD, exercise appears to have a greater effect on the positively balanced states measured.

Asan (2005), determined EPOC in 18 to 30 year old apparently healthy individuals. Subjects participated in 3 different exercise sessions; aerobic exercise, interval exercise (IE) and high intensity interval exercise (HIIE), on separate days. EPOC was measured one hour after each exercise while subjects were in supine position. ANOVA with repeated measurements was used to assess differences. The mean values (± SEM) for EPOC of aerobic exercise, IE and HIIE were 2.106 (± 0.219), 2.846 (± 0.309) and 4.969 (± 0.522) l·hour⁻¹. There was no significant difference (p < 0.05) between mean EPOC of aerobic exercise and IE, however, a significant difference (p < 0.05) was found in mean EPOC of HIIE when it was compared with both aerobic exercise and IE. These data suggest that exercise intensity has a significant effect on EPOC.

Roth (1989), examined the acute emotional and psycho-physiological effects of a single bout of aerobic exercise. Forty active and 40 inactive college students were randomly assigned to an aerobic exercise or a waiting-period control condition. Self-report measures of mood and cardiovascular response measures to challenging cognitive tasks were collected before and after the 20-min exercise/control period to examine any exercise-induced changes. The results indicated that mood was significantly altered by the exercise activity, with reductions in tension and anxiety specifically evident. Exercise was not found to have any effects on cardiovascular reactivity. A test of aerobic fitness confirmed fitness differences between active and inactive participants, but no mood or reactivity effects related to activity status were obtained. These results suggest that both active and inactive individuals experience acute reductions in anxiety following single bouts of exercise, even in the absence of changes in cardiovascular reactivity. Implications for the continued investigation of the acute effects of exercise are discussed.

Holmes (1988), study on students who reported experiencing a high number of stressful life events were randomly assigned to: (a) an aerobic training condition, (b) a relaxation training condition, or (c) a no treatment control condition. Immediately
before and after the 11 week training/control period, subjects' aerobic fitness and cardiovascular responses to acute psychological stress were assessed. Results indicated that: (1) subjects in the aerobic training condition showed significantly greater improvements in aerobic fitness than subjects in the other conditions, and (2) the subjects in the aerobic training condition showed significantly greater reductions in heart rate during all phases of the stress than subjects in the other conditions. Post-training differences between aerobic and control conditions during the moderate psychological stress were as great as 17 bpm. These results provide evidence for the utility of aerobic training for reducing cardiovascular activity during psychological stress, and they are consistent with earlier findings linking fitness to less illness following stress, reductions in depression and enhanced recovery in cardiac patients

**Marra et al., (2005),** determined the effect of 14 weeks of high intensity versus moderate intensity aerobic exercise of equal work output on body composition in overweight men (BMI = 25-29.9 kg/m2). Sixteen sedentary military men (18 - 33 yrs) were randomized in two equal groups (n=8): 1) moderate intensity exercise (MI; 60 - 70% of their maximum heart rate; HRmax), and 2) high intensity exercise (HI; 75 - 90% HRmax). The aerobic exercise (jogging/running) training program was performed three days/wk. Relative body fat (% BF) was assessed by dual energy x-ray absorptiometry (DXA) (Lunar DPX - IQ). Significant differences between and within the groups were analyzed using a two-way split-plot analysis of variance (SPANOVA). Statistical significance was accepted at p<0.05. After the 14 wks of the aerobic exercise program the mean %BF of the HI significantly (p<0.05) decreased to 22.49 % (Δ=4.91%). The decrease in mean %BF (Δ=1.4 %) in the MI was not significant (p>0.05). It is concluded that 14 wks of HI aerobic exercise may be more effective in improving body composition than MI aerobic exercise in overweight young military men with physical characteristics similar to the present study.

**Fox (2000),** provides an overview of the literature on the impact of exercise on self-esteem. It examines the complex nature of self-esteem and the self-system and the role of the physical self within this. It explores the potential for exercise in the promotion of self-esteem and the various mechanisms through which this might be achieved. It reviews current research evidence on the effect of exercise on self-esteem
and summarizes the general conclusions to be drawn from cross-sectional research, intervention research (concentrating on 36 randomized controlled studies). It examines findings for various age groups and explores the characteristics of effective exercise, frequency, intensity and duration and outlines possible mechanisms underpinning the positive relationships between exercise and self-esteem (although these are not well understood). Mechanisms may include: an undetermined psycho-physiological mechanism; improvements in fitness or weight loss; autonomy and personal control; sense of belonging and significance. The general implications for practice are:

1. Greatest improvements in self-perception/self-esteem are likely to occur in those groups who have the most to gain physically from exercise participation, such as the middle-aged, the elderly and the overweight and obese.

2. Greatest improvements are likely to occur in those who are initially low in self-esteem, physical self-worth and body image, including women in general, those with mild depression, physically disabled children and adults, overweight and obese adults and, perhaps, offenders.

3. There is greatest support for the effectiveness of cardiovascular exercise and weight training programmes.

4. A focus on moderately demanding exercise, with sessions of about 60 minutes.

5. Programmes should last at least 12 weeks with some form of contact continuing for 6 months or more.

6. Adherence factors cannot be separated from those that promote self-esteem. Conditions that affect the attractiveness of the exercise programme, such as the qualities of the leader or the exercise setting, may be crucial to changes in self-esteem.