CHAPTER – II

REVIEW OF THE RELATED LITERATURE

A literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Its ultimate goal is to bring the reader up to date with current literature on a topic and forms the basis for another goal, such as future research that may be needed in the area. The present reviews are based upon the available literature in respect to the study under investigation and therefore confined to the studies to which the investigator has accessed. All the relevant literature thus obtained by the researcher has been presented in this chapter to furnish necessary background material to evaluate the significance of the study. The research scholar has made every possible effort to go thorough the literatures related to the problem wherever available. The scholar has gleaned through almost every source like research quarterly, journals of various kinds, periodicals, encyclopedias, relevant books and e-resources to pick up related material.

2.1 REVIEWS ON AEROBIC AND ANAEROBIC TRAINING

Salvadori, et al. (2014) demonstrated that aerobic exercise plays an important role in weight loss programs for obesity by increasing 24 h metabolic rate. While aerobic exercise can result in health and fitness benefits in obese subjects, also independently of weight loss, not completely clear are the effects of bouts of hard exercise on metabolic outcomes. The aim of this study was to test the hypothesis that short-term aerobic activity with anaerobic bouts might result in a greater improvement in the management of obesity than aerobic activity alone. We studied 16 obese subjects (eight men) during a progressive cycloergometric test up to exhaustion, before and after 4 weeks of two different training schedules (6 days/week). Insulin and glycaemia, non-esterified fatty acids (NEFA) and lactic acid were sampled. Group A (eight subjects, four men) performed an aerobic cycle workout; Group B (eight subjects, four men) performed a 25 min aerobic workout followed by 5 min ofanaerobic workout. All the subjects maintained their individual eating habits. The post-training test showed a decrease in AUCs NEFA in Group A ($p < 0.05$) and an increase in Group B ($p < 0.05$), together with an increase in lactic acid in Group A and a decrease in Group B ($p < 0.01$). β-cell function (HOMA2-B) revealed a reduction only in Group A ($p < 0.05$). Group B achieved a greatest reduction in body fat mass than Group A ($p < 0.05$). Aerobic plus anaerobic training seem to produce a greater response in lipid metabolism and not significant modifications in glucose indexes; then, in training prescription for obesity, we might suggest at starting weight loss program aerobic with short bouts of anaerobic training to reduce fat mass and subsequently a prolonged aerobic training alone to ameliorate the metabolic profile.

Sayyed, et al. (2013) examined the effects of light and moderate aerobic intensity on body composition and serum lipid profile in obese/overweight women living in Isfahan. Forty-five middle-aged obese/overweight volunteer women (25-40 years, and body mass index (BMI) ≥25 to 30 kg/m^2) were randomly assigned into three groups: 1. Light aerobics [45-50% heart rate reserve maximum (HRR_{max})], 2. Moderate aerobics (70-75% HRR_{max}), 3. No exercise training (control). Training program lasted for 10 weeks and included three sessions of 60 minutes aerobics per week. The intensity of aerobics was controlled by monitoring heart rate. Body composition was measured using skin fold thickness method. Serum lipid was measured. Both light and moderate aerobics significantly improved weight ($P < 0.000$), fat percent ($P < 0.045$), BMI ($P < 0.000$), fat weight ($P < 0/031$), lean body weight ($P < 0.02$), waist-to-hip ratio (WHR) ($P < 0.000$), High-density lipoprotein (HDL) ($P < 0.000$). Our findings showed that both light and moderate aerobics improved body composition and serum lipid profile in obese/overweight women. Our findings support the application of aerobics for obese/overweight women. Initially, they can start with light programs and proceed to more intense programs.

Aziz (2012) determined if aerobic and anaerobic training-induced adaptations were compromised as a result of Ramadan fasting. Methods: Twenty adolescent males of the Muslim and non-Muslim faith were divided into fasting (FAS, n = 10) and non-fasting or control (CON, n = 10) groups, respectively. High-intensity interval cycle exercise training was conducted three times per week for seven weeks, with Ramadan fasting falling during training weeks 3 to 6 for the FAS group. Results: Both groups significantly improved their peak oxygen uptake (VO2peak; FAS 2.77 ± 0.33 to 3.08 ± 0.22 and CON 2.61 ± 0.22 to 2.89 ± 0.21 L/min) and maximal anaerobic performance (total work during four Wingate bouts; FAS 53.4 ± 5.2 to 57.7 ± 4.8 and CON 47.4 ± 4.5 to 52.0 ± 4.5 kJ) (all $p < 0.05$). There were no significant differences in the magnitude of improvements made between groups, either for aerobic (FAS 0.31 ± 0.28 vs. CON 0.28 ± 0.12 L/min) or anaerobic (FAS 4.3 ± 3.3 vs. CON 4.6 ± 3.4 kJ) performance (all $p > 0.05$). Indices of training intensity (mean heart rate and mean blood lactate) and mean daily energy and fluid intake were not significantly different between groups throughout the study period. Conclusions: Aerobic and anaerobic adaptations to seven weeks of training were not compromised by four weeks of intermittent Ramadan fasting, possibly because the overall training intensity and nutrient intake were maintained throughout the Ramadan period.

Shalaby (2012) revealed the role of aerobic and anaerobic training programs on CD34+ Stem Cells and chosen physiological variables. Twenty healthy male athletes aged 18–24 years were recruited for this study. Healthy low active males and BMI matched participants (n=10) aged 20–22 years were recruited as controls. Aerobic and anaerobic training programs for 12 weeks were conducted. VO2max pulse observation was carried out using the Astrand Rhyming protocol. RBCs, WBCs, HB and hematocrit were estimated using a coulter counter, lactate by the Accusport apparatus, CD34+ stem cells by flow cytometry. VO2max was increased significantly in case of the aerobic training program compared to anaerobic one (62±2.2 ml/kg/min vs. 54±2.1 ml/kg/min). Haemotological values increased significantly in the anaerobic program when compared to the aerobic one, RBCs (5.3±0.3 and 4.9±0.2 mln/ul), WBCs (6.6±0.5 and 6.1±0.4 thous/ul), HB (15.4±0.4 and 14.2±0.5 g/de), Hematocrit (4.6±1.2 and 4.4±1.1 %), CD34+ stem cells count increased significantly in case of the anaerobic program compared to the aerobic (251.6±21.64 and 130±14.61) and sedentary one (172±24.10). These findings suggest that anaerobic training programs provoke better adaptation to exercise and stem cell counts may differ between trained and sedentary subjects. Circulating immature cells are likely to be involved in angiogenesis and repair process, both mechanisms being associated with strenuous exercise. Knowledge of the physiological effects of training on stem cells might be of potential clinical use.

Agnieszka, et al. (2010) assessed the anaerobic threshold in obese and normal weight women and to analyse the effect of weight-reduction therapy on the determined thresholds. Patients and methods: 42 obese women without concomitant disease (age 30.5 ± 6.9y; BMI 33.6 ± 3.7 $kg \cdot m^{-2}$) and 19 healthy normal weight women (age 27.6 ± 7.0y; BMI 21.2 ± 1.9 $kg \cdot m^{-2}$) performed cycle ergometer incremental ramp exercise test up to exhaustion. The test was repeated in 19 obese women after 12.3 ± 4.2% weight loss. The lactate threshold (LT) and the ventilatory threshold (VT) were determined. Obese women had higher lactate (expressed as oxygen consumption) and ventilator threshold than normal weight women. The lactate threshold was higher than ventilatory one both in obese and normal weight women (1.11 ± 0.21 vs 0.88 ± 0.18 $L \cdot min^{-1}$, $p < 0.001$; 0.94 ± 0.15 vs 0.79 ± 0.23 $L \cdot min^{-1}$, $p < 0.01$, respectively). After weight reduction therapy neither the lactate nor the ventilatory threshold changed significantly. The results concluded that; 1. The higher lactate threshold noted in obese women may be related to the increased fat acid usage in metabolism. 2. Both in obese and normal weight women lactate threshold appears at higher oxygen consumption than ventilatory threshold. 3. The obtained weight reduction, without weight normalisation was insufficient to cause significant changes of lactate and ventilatory thresholds in obese women.

Whyte, et al. (2010) investigated the effects of very high intensity sprint interval training (SIT) on metabolic and vascular risk factors in overweight/obese sedentary men. Ten men (age, 32.1 ± 8.7 years; body mass index, 31.0 ± 3.7 kg m(-2)) participated. After baseline metabolic, anthropometric, and fitness measurements, participants completed a 2-week SIT intervention, comprising 6 sessions of 4 to 6 repeats of 30-second Wingate anaerobic sprints on an electromagnetically braked cycle ergometer, with 4.5-minute recovery between each repetition. Metabolic, anthropometric, and fitness assessments were repeated post-intervention. Both maximal oxygen uptake (2.98 ± 0.15 vs 3.23 ± 0.14 L min(-1), P = .013) and mean Wingate power (579 ± 24 vs 600 ± 19 W, P = .040) significantly increased after 2 weeks of SIT. Insulin sensitivity index (5.35 ± 0.72 vs 4.34 ± 0.72, P = .027) and resting fat oxidation rate in the fasted state (0.13 ± 0.01 vs 0.11 ± 0.01 g min(-1), P = .019) were significantly higher and systolic blood pressure (121 ± 3 vs 127 ± 3 mm Hg, P = .020) and resting carbohydrate oxidation in the fasted state (0.03 ± 0.01 vs 0.08 ± 0.02 g min(-1), P = .037) were significantly lower 24 hours post-intervention compared with baseline, but these changes were no longer significant 72 hours post-intervention. Significant decreases in waist (98.9 ± 3.1 vs 101.3 ± 2.7 cm, P = .004) and hip (109.8 ± 2.2 vs 110.9 ± 2.2 cm, P = .017) circumferences compared with baseline were also observed after the intervention. Thus, 2 weeks of SIT substantially improved a number of metabolic and vascular risk factors in overweight/obese sedentary men, highlighting the potential for this to provide an alternative exercise model for the improvement of vascular and metabolic health in this population.

Tjønna, et al. (2009) compared the effects of a multidisciplinary approach (MTG) and aerobic interval training (AIT) on cardiovascular risk factors in overweight adolescents. A total of 62 overweight and obese adolescents from Trøndelag County in Norway, referred to medical treatment at St Olav's Hospital, Trondheim, Norway, were invited to participate. Of these, 54 adolescents (age, 14.0 +/- 0.3 years) were randomized to either AIT (4 x 4 min intervals at 90% of maximal heart rate, each interval separated by 3 min at 70%, twice a week for 3 months) or to MTG (exercise, dietary and psychological advice, twice a month for 12 months). Follow-up testing occurred at 3 and 12 months. VO(2max) (maximal oxygen uptake) increased more after AIT compared with MTG, both at 3 months (11 compared with 0%; P<0.01) and 12 months (12 compared with -1%; P<0.01). AIT enhanced endothelial function compared with MTG at both 3 months (absolute change, 5.1 compared with 3.9%; P<0.01) and 12 months (absolute change, 6.3 compared with 1.0%; P<0.01). AIT was favourable compared with MTG in reducing BMI (body mass index), percentage of fat, MAP (mean arterial blood pressure) and increasing peak oxygen pulse. In addition, AIT induced a more favourable regulation of blood glucose and insulin compared with MTG. In conclusion, the novel findings of the present proof-of-concept study was that 3 months of twice weekly high-intensity exercise sessions reduced several known cardiovascular risk factors in obese adolescents more than that observed after a multitreatment strategy, which was initiated as hospital treatment. Follow-up at 12 months confirmed that AIT improved or maintained these risk factors to a better degree than MTG.

Perry, et al. (2008) investigated skeletal muscle and whole-body metabolic adaptations that occurred following 6 weeks of HIIT (~1 h of 10 x 4 min intervals at ~90% of peak oxygen consumption (VO2 peak), separated by 2 min rest, 3 d.week-1). A VO2 peak test, a test to exhaustion (TE) at 90% of pre-training VO2 peak, and a 1 h cycle at 60% of pre-training VO2 peak were performed pre- and post-HIIT. Muscle biopsies were sampled during the TE at rest, after 5 min, and at exhaustion. Training power output increased by 21%, and VO2 peak increased by 9% following HIIT. Muscle adaptations at rest included the following: (i) increased cytochrome c oxidase IV content (18%) and maximal activities of the mitochondrial enzymes citrate synthase (26%), beta-hydroxyacyl-CoA dehydrogenase (29%), aspartate-amino transferase (26%), and pyruvate dehydrogenase (PDH; 21%); (ii) increased FAT/CD36, FABPpm, GLUT 4, and MCT 1 and 4 transport proteins (14%-30%); and (iii) increased glycogen content (59%). Major adaptations during exercise included the following: (i) reduced glycogenolysis, lactate accumulation, and substrate phosphorylation (0-5 min of TE); (ii) unchanged PDH activation (carbohydrate oxidation; 0-5 min of TE); (iii) ~2-fold greater time during the TE; and (iv) increased fat oxidation at 60% of pre-training VO2 peak. This study demonstrated that 18 h of repeated high-intensity exercise sessions over 6 weeks (3 d.week-1) is a powerful method to increase whole-body and skeletal muscle capacities to oxidize fat and carbohydrate in previously untrained individuals.

Trapp, et al. (2008) determined the effects of a 15-week high-intensity intermittent exercise (HIIE) program on subcutaneous and trunk fat and insulin resistance of young women. Subjects were randomly assigned to one of the three groups: HIIE (n=15), steady-state exercise (SSE; n=15) or control (CONT; n=15). HIIE and SSE groups underwent a 15-week exercise intervention. Forty-five women with a mean BMI of 23.2+/-2.0 kg m(-2) and age of 20.2+/-2.0 years. Both exercise groups demonstrated a significant improvement ($P<0.05$) in cardiovascular fitness. However, only the HIIE group had a significant reduction in total body mass (TBM), fat mass (FM), trunk fat and fasting plasma insulin levels. There was significant fat loss ($P<0.05$) in legs compared to arms in the HIIE group only. Lean compared to overweight women lost less fat after HIIE. Decreases in leptin concentrations were negatively correlated with increases in VO(2peak) ($r=-0.57$, $P<0.05$) and positively correlated with decreases in TBM ($r=0.47$; $P<0.0001$). There was no significant change in adiponectin levels after training. HIIE three times per week for 15 weeks compared to the same frequency of SSE exercise was associated with significant reductions in total body fat, subcutaneous leg and trunk fat, and insulin resistance in young women.

Wisloff, et al. (2007) compared the training programs with moderate versus high exercise intensity with regard to variables associated with cardiovascular function and prognosis in patients with postinfarction heart failure. Twenty-seven patients with stable postinfarction heart failure who were undergoing optimal medical treatment, including beta-blockers and angiotensin-converting enzyme inhibitors (aged 75.5+/-11.1 years; left ventricular [LV] ejection fraction 29%; VO2peak 13 mL x kg(-1) x min(-1)) were randomized to either moderate continuous training (70% of highest measured heart rate, ie, peak heart rate) or aerobic interval training (95% of peak heart rate) 3 times per week for 12 weeks or to a control group that received standard advice regarding physical activity. VO2peak increased more with aerobic interval training than moderate continuous training (46% versus 14%, $P<0.001$) and was associated with reverse LV remodeling. LV end-diastolic and end-systolic volumes declined with aerobic interval training only, by 18% and 25%, respectively; LV ejection fraction increased 35%, and pro-brain natriuretic peptide decreased 40%. Improvement in brachial artery flow-mediated dilation (endothelial function) was greater with aerobic interval training, and mitochondrial function in lateral vastus muscle increased with aerobic interval training only. The MacNew global score for quality of life in cardiovascular disease increased in both exercise groups. No changes occurred in the control group. Exercise intensity was an important factor for reversing LV remodeling and improving aerobic capacity, endothelial function, and quality of life in patients with postinfarction heart failure. These findings may have important implications for exercise training in rehabilitation programs and future studies.

Helgerud, et al. (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 V O2max 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.

Talanian, et al. (2007) examined the effects of seven high-intensity aerobic interval training (HIIT) sessions over 2 wk on skeletal muscle fuel content, mitochondrial enzyme activities, fatty acid transport proteins, peak O(2) consumption (Vo(2 peak)), and whole body metabolic, hormonal, and cardiovascular responses to exercise. Eight women (22.1 +/- 0.2 yr old, 65.0 +/- 2.2 kg body wt, 2.36 +/- 0.24 l/min Vo(2 peak)) performed a Vo(2 peak) test and a 60-min cycling trial at approximately 60% Vo(2 peak) before and after training. Each session consisted of ten 4-min bouts at approximately 90% Vo(2 peak) with 2 min of rest between intervals. Training increased Vo(2 peak) by 13%. After HIIT, plasma epinephrine and heart rate were lower during the final 30 min of the 60-min cycling trial at approximately 60% pretraining Vo(2 peak). Exercise whole body fat oxidation increased by 36% (from 15.0 +/- 2.4 to 20.4 +/- 2.5 g) after HIIT. Resting muscle glycogen and triacylglycerol contents were unaffected by HIIT, but net glycogen use was reduced during the posttraining

60-min cycling trial. HIIT significantly increased muscle mitochondrial beta-hydroxyacyl-CoA dehydrogenase (15.44 +/- 1.57 and 20.35 +/- 1.40 mmol.min(-1).kg wet mass(-1) before and after training, respectively) and citrate synthase (24.45 +/- 1.89 and 29.31 +/- 1.64 mmol.min(-1).kg wet mass(-1) before and after training, respectively) maximal activities by 32% and 20%, while cytoplasmic hormone-sensitive lipase protein content was not significantly increased. Total muscle plasma membrane fatty acid-binding protein content increased significantly (25%), whereas fatty acid translocase/CD36 content was unaffected after HIIT. In summary, seven sessions of HIIT over 2 wk induced marked increases in whole body and skeletal muscle capacity for fatty acid oxidation during exercise in moderately active women.

Trapp, et al. (2007) metabolic response to two different forms of high-intensity intermittent cycle exercise was investigated in young women. Subjects (8 trained and 8 untrained) performed two bouts of high-intensity intermittent exercise: short sprint (SS) (8-s sprint, 12-s recovery) and long sprint (LS) (24-s sprint, 36-s recovery) for 20 min on two separate occasions. Both workload and oxygen uptake were greater in the trained subjects but were not significantly different for SS and LS. Plasma glycerol concentrations significantly increased during exercise. Lactate concentrations rose over the 20 min and were higher for the trained women. Catecholamine concentration was also higher postexercise compared with preexercise for both groups. Both SS and LS produced similar metabolic response although both lactate and catecholamines were higher after the 24-s sprint. In conclusion, these results show that high-intensity intermittent exercise resulted in significant elevations in catecholamines that appear to be related to increased venous glycerol concentrations. The trained compared with the untrained women tended to show an earlier increase in plasma glycerol concentrations during high-intensity exercise.

Ayse, et al. (2006) compared the effects of aerobic and resistance exercise on weight, muscle strength, cardiovascular fitness, blood pressure and mood in obese women who were not on an energy-restricted diet. **Design**: Randomized, prospective, controlled trial. **Setting**: Department of Physical Medicine and Rehabilitation, University Hospital. **Subjects**: Sixty obese women were assigned to one of three groups: aerobic exercise (n=20), resistance exercise (n=20) and control group (n=20). **Interventions**: The aerobic exercise group performed both walking and leg cycle exercise with increasing duration and frequency. The resistance exercise group performed progressive weight-resistance exercises for the upper and lower body. **Main outcome measures**: Before and after a 12-week period, all subjects were evaluated by anthropometric measurement, rating of mood, cardiorespiratory capacity and maximum strength of trained muscles. **Results**: After a 12-week training period, subjects in the resistance group showed significant improvement in one-repetition maximum test of hip abductors (7.95±3.58 kg), quadriceps (14±7.18 kg), biceps (3.37± 2.84 kg) and pectorals (8.75±5.09 kg) compared with those in the control group (P<0.001). VO_2 max increased (0.51±0.40) and Beck Depression Scale scores decreased (-5.40±4.27) in the aerobic exercise group compared with the control group, significantly (P<0.001). Only in hip abductor muscle strength was there a significant increase in the resistance exercise group compared with the aerobic exercise group (P <0.05). **Conclusion**: Both aerobic exercise and resistance exercise resulted in improved performance and exercise capacity in obese women. While aerobic exercise appeared to be beneficial with regard to improving depressive symptoms and maximum oxygen consumption, resistance exercise was beneficial in increasing muscle strength.

Bloomer, et al. (2005) compared oxidative modification of blood proteins, lipids, DNA,and glutathione in the 24 hours following aerobic and anaerobic exercise using similar muscle groups. Ten cross-trained men (24.3 6 3.8 years, [mean 6 *SEM*]) performed in random order 30 minutes of continuous cycling at 70% of V˙ O2max and intermittent dumbbell squatting at 70% of 1 repetition maximum (1RM), eparated by 1–2 weeks, in a crossover design. Blood samples taken before, and immediately, 1, 6, and 24 hours postexercise were analyzed for plasma protein carbonyls (PC), plasma malondialdehyde (MDA), and whole-blood total (TGSH), oxidized (GSSG), nd reduced (GSH) glutathione. Blood samples taken before and 24 hours postexercise were analyzed for serum 8-hydroxy-29- deoxyguanosine (8-OHdG). PC values were greater at 6 and 24 hours postexercise compared with pre-exercise for squatting, with greater PC values at 24 hours postexercise for squatting compared with cycling (0.634 6 0.053 vs. 0.359 6 0.018 nM·mg protein21). There was no significant interaction or main effects for MDA or 8-OHdG. GSSG experienced a shortlived increase and GSH a ransient decrease immediately following both exercise modes. These data suggest that 30 minutes of aerobic and anaerobic exercise performed by young, crosstrained men (a) can increase certain biomarkers of oxidative stress in blood, (b) differentially affect oxidative stress biomarkers, and (c) result in a different magnitude of oxidation based on the macromolecule studied. While protein and glutathione oxidation was increased following acute exercise as performed in this study, future research may investigate methods of reducing macromolecule oxidation, possibly through the use of antioxidant therapy.

George, et al. (2005) examined the effect of aerobic exercise training on insulin sensitivity in overweight and obese girls. Nineteen overweight and obese girls (mean ± SD: age, 13.1 ± 1.8 years; body mass index, 26.8 ± 3.9 kg/m^2) volunteered for this study. Body composition (dual-energy x-ray absorptiometry), insulin sensitivity (oral glucose tolerance test and homeostasis model assessment estimate of insulin resistance; n = 15), adiponectin, C-reactive protein (CRP), interleukin (IL) 6, insulin-like growth factor-1, soluble intercellular adhesion molecule-1 and soluble vascular cell adhesion molecule-1 serum levels, and blood lipids and lipoproteins were assessed before and after 12 weeks of aerobic training. Cardiorespiratory fitness increased by 18.8% ($P < .05$) as a result of training. The area under the insulin concentration curve (insulin area under the curve) decreased by 23.3% (12 781.7 ± 7454.2 vs 9799.0 ± 4918.6 μU·min/mL before and after intervention, respectively; $P = .03$). Insulin sensitivity was improved without changes in body weight (preintervention, 67.9 ± 14.5 kg; postintervention, 68.3 ± 14.0 kg) or percent body fat (preintervention, 41.4% ± 4.8%; postintervention, 40.7% ± 5.2%). The lower limb fat-free mass increased by 6.2% ($P < .01$) as a result of training, and changes in lower limb fat-free mass were correlated with changes in the insulin area under the curve ($r = -.68$; $P < .01$). Serum adiponectin, IL-6, and CRP concentrations did not change (preintervention vs postintervention: adiponectin, 9.57 ± 3.01 vs 9.08 ±

2.32μg/mL; IL-6, 1.67 ± 1.29 vs 1.65 ± 1.25 pg/mL, CRP, 3.21 ± 2.48 vs 2.73 ± 1.88 mg/L) whereas insulin-like growth factor-1 was lower after training (preintervention, 453.8 ± 159.3 ng/mL; postintervention, 403.2 ± 155.1 ng/mL; $P < .05$). In conclusion, 12 weeks of aerobic training improved insulin sensitivity in overweight and obese girls without change in body weight, percent body fat, and circulating concentrations of adiponectin, IL-6, CRP, and other inflammatory markers. These findings suggest that increased physical activity may ameliorate the metabolic abnormalities associated with obesity in children with a mechanism other than the parameters cited earlier.

Okura, et al. (2005) tested the effects on abdominal fat reduction of adding aerobic exercise training to a diet program and obesity phenotype in response to weight loss. A prospective clinical trial with a 14 week weight loss intervention design. In total, 209 overweight and obese women were assigned to four subgroups depending on type of treatment and the subject's obesity phenotype: diet alone (DA) with intra-abdominal fat (IF) obesity (> or =mean IF area), diet plus exercise (DE) with IF obesity, DA with abdominal subcutaneous fat (ASF) obesity (<mean IF area) and DE with ASF obesity. Abdominal fat areas were evaluated by CT scans, with values adjusted for selected variables. Values were adjusted for age, menopausal status and change in body weight and total fat mass. The IF reductions were significantly (P<0.0001) greater in subjects with IF obesity phenotype (-45.1 cm2) compared to the ASF obesity phenotype (-22.2 cm2). The ASF reductions were significantly (P<0.001) greater for subjects with ASF obesity (-74.5 cm2) compared to IF obesity (-55.5 cm2). For IF obesity, the IF reduction was significantly (P<0.01) greater in the DE group (-49.3 cm2) than in the DA group (-37.8 cm2). These results suggest that for individuals with IF obesity, the efficacy on reducing IF of adding aerobic exercise training to a diet-alone weight-reduction program is more prominent (-49.3 cm2/-37.8 cm2=1.3 times) compared with DA. Moreover, abdominal fat reduction was found to be modified by obesity phenotype in response to weight loss.

Dao, et al. (2004) investigated if a multidisciplinary weight loss programme in adolescents suffering severe obesity allows an improvement of anaerobic and aerobic aptitudes. In all, 55 adolescents (33 girls and 22 boys) suffering from severe obesity were enrolled in an interdisciplinary weight reduction programme lasting 6–12 months. Progressive submaximal physical activity was performed and national dietary allowances for adolescents with low levels of physical activity were provided. Total and regional body composition and anaerobic aptitudes (handgrip strength (HGS), vertical jump height (VJH)) and aerobic aptitudes (maximal aerobic power (MAP), maximal oxygen uptake (VO_{2max})) were measured before and after weight loss. The mean reduction of body mass index (BMI) was similar in girls (21.4±5.9%) and boys (23.7±6.4%). Fat mass (FM) steepest drop was observed in the trunk (-63.2±10.1% in boys and -51.5±11.4% in girls). The total lean mass (LM) did not vary in both sexes. Right HGS and VJH increased in both sexes (P<0.05), whereas left HGS increased only in boys. MAP and VO_{2max} per kg BW increased (P< 0.0001) in both sexes (2.3±0.3 *vs* 1.7±0.3 W/kg and 32.8±4.5 *vs* 26.7±4.1 ml/min/kg in girls and 2.8 ± 1.9 *vs* 1.9 ± 0.4 W/kg and 39.1 ± 6.3 *vs* 27.9 ± 5.1 ml/min/kg in boys, respectively), whereas MAP and VO_{2max} in absolute value and per kg LM increased only in boys (*P*=0.04). Total LM was the strongest determinant of HGS, VJH, MAP and VO_{2max} in both sexes (*P*<0.005). Multidisciplinary weight reduction programme including moderate dietary restriction in combination with regular physical training induced an improvement of anaerobic and aerobic aptitudes, a marked reduction of obesity and a preservation of LM in severely obese adolescents.

Lafortuna, et al.(2004) investigated the effect of gender, age and level of obesity on body composition and anaerobic power output, and to test the hypothesis that variation in body composition affects muscle power output in obesity, a cohort of 377 subjects (112 males and 265 females, aged 18-75 yr) with different levels of obesity [class IIII, body mass index (BMI) range: 30.6-60.3 kg m(-2)] was cross-sectionally investigated. Body composition was assessed with bioelectric impedance analysis (BIA), in standardized conditions and using obesity-specific prediction formulas. Lower limb anaerobic power output (W) was measured with a modification of the Margaria stair climbing test. In males, a similar increase in fat-free mass (FFM) and fat mass (FM) was observed as a function of BMI, while in females, FM increased more than FFM. In both genders, FFM significantly decreased as a function of age (p<0.001), but was higher in men of all ages. Similar patterns of variation were observed in W. A differently significant correlation between BMI and W was observed between men and women, and it was found by multivariate analysis of variance (MANOVA) that W was affected negatively by age (p<0.001) and positively by BMI (p<0.001) in males, while in females only age had a significant effect (p<0.001) but not BMI. A positive correlation (p<0.001) was detected between

FFM and W, in both genders. W per unit body mass, the actual muscle power for rapid external work, was higher in men than in women of all groups, and decreased with age in both genders, but only in older women decreased significantly ($p<0.01$) depending on BMI. It is concluded that the gender-dependent pattern of variation in body composition may be an important determinant of the different motor limitations observed in men and women. Older women (> or =50 yr) with extreme obesity (class III) suffered from the most serious motor dysfunction within this obese cohort. This result may have important clinical relevance in the care of obesity.

Mourot, et al. (2004) compared between constant and interval training exercises. Heart rate variability (HRV) was assessed during the short- (within 1 h) and long- (within 48 h) term recovery following a single bout of either constant (CST) or interval training (SWEET) exercise performed at the same total physical work [9.4 (0.3) kJ kg(-1)]. R-R intervals, systolic (SAP) and diastolic (DAP) arterial pressures were recorded in supine and upright positions before and 1, 24 and 48 h after the termination of the exercises in ten male subjects [mean (SEM), age 24.6 (0.6) years, height 177.2 (1.1) cm and body mass 68.5 (0.9) kg]. The parameters were also recorded in the supine position during the first 20 min following the end of the exercise. Spectral analysis parameters of HRV [total (TP), low- (LF), and high- (HF) frequency power, and LF/TP, HF/TP and LF/HF ratios] were determined over 5 min during each phase. Except for higher HF values in both supine and upright positions during the first hour following CST compared with SWEET, cardiovascular and HRV analysis responses were of the same magnitude after their termination. R-R intervals, TP, and HF/TP were significantly decreased while LF/TP and LF/HF were significantly increased during the early recovery, when compared with control values. This could be a response to the significant decrease in SAP and DAP at this time. Twenty-four and 48 h after the end of the exercise, HRV parameters were at the same levels as before exercises in the supine posture, but a persistent tachycardia continued to be observed in the upright posture, together with reduced TP values, showing that cardiovascular functions were still disturbed. The short-term HRV recovery seemed dependent on the type of exercise, contrary to the long-term recovery.

Rognmo, et al. (2004) assessed the effects of high intensity aerobic interval exercise compared to moderate intensity exercise, representing the same total training load, for increasing VO2peak in stable CAD-patients. Twenty-one stable CAD-patients were randomized to supervised treadmill walking at either high intensity (80-90% of VO2peak) or moderate intensity (50-60% of VO2peak) three times a week for 10 weeks. After training VO2peak increased by 17.9% (P=0.012) in the high intensity group and 7.9% (P=0.038) in the moderate intensity group. The training-induced adaptation was significantly higher in the high intensity group (P=0.011). High intensity aerobic interval exercise is superior to moderate exercise for increasing VO2peak in stable CAD-patients. As VO2peak seems to reflect a continuum between health and cardiovascular disease and death, the present data may be useful in designing effective training programmes for improved health in the future.

Kraemer, et al. (2004) determined the effects of high intensity endurance training (ET) and resistance training (RT) alone and in combination on various military tasks. Thirty-five male soldiers were randomly assigned to one of four training groups: total body resistance training plus endurance training (RT + ET), upper body resistance training plus endurance training (UB + ET), RT only, and ET only. Training was performed 4 days per week for 12 weeks. Testing occurred before and after the 12-week training regimen. All groups significantly improved push-up performance, whereas only the RT + ET group did not improve sit-up performance. The groups that included ET significantly decreased 2-mile run time, however, only RT + ET and UB + ET showed improved loaded 2-mile run time. Leg power increased for groups that included lower body strengthening exercises (RT and RT + ET). Army Physical Fitness Test performance, loaded running, and leg power responded positively to training, however, it appears there is a high degree of specificity when concurrent training regimens are implemented.

Tomlin & Wenger. (2001) the relationship between aerobic fitness and recovery from high intensity intermittent exercise. A strong relationship between aerobic fitness and the aerobic response to repeated bouts of high intensity exercise 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 submaximal 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.

Linda, et al. (2000) evaluated the effects of various modes of training on the time-course of changes in lipoprotein-lipid profiles in the blood, cardiovascular fitness, and body composition after 16 weeks of training and 6 weeks of detraining in young women. A group of 48 sedentary but healthy women [mean age 20.4 (SD 1) years] were matched and randomly placed into a control group (CG, *n*=12), an aerobic training group (ATG, *n*=12), a resistance training group (RTG, *n*=12), or a cross-training group that combined both aerobic and resistance training (XTG, *n*=12). The ATG, RTG and XTG trained for 16 weeks and were monitored for changes in blood concentrations of lipoprotein-lipids, cardiovascular fitness, body composition, and dietary composition throughout a 16 week period of training and 6 weeks of detraining. The ATG significantly reduced blood concentrations of triglycerides (TRI) ($P < 0.05$) and significantly increased blood concentrations of high-density lipoprotein-cholesterol (HDL-C) after 16 weeks of training. The correlation between percentage fat and HDL-C was 0.63 ($P < 0.05$), which explained 40% of the variation in HDL-C, while the correlation between maximal oxygen uptake ($\dot{V}O_{2max}$) and HDL-C was 0.48 ($P < 0.05$), which explained 23% of the variation in HDL-C. The ATG increased $\dot{V}O_{2max}$ by 25% ($P < 0.001$) and decreased percentage body fat by 13% ($P < 0.05$) after 16 weeks. Each of the alterations in the ATG had disappeared after the 6 week detraining period. The concentration of total cholesterol (TC), TRI, HDL-C and low density lipoprotein-cholesterol in the blood did not change during the study in RTG, XTG and CG. The RTG increased upper and lower body strength by 29% ($P < 0.001$) and 38%, respectively. The 6 week detraining strength values obtained in RTG were significantly greater than those obtained at baseline. The XTG increased upper and lower body strength by 19% ($P < 0.01$) and 25% ($P < 0.001$), respectively. The 6 week detraining strength values obtained in XTG were significantly greater than those obtained at baseline. The RTG, XTG and CG did not demonstrate any significant changes in either $\dot{V}O_{2max}$, or body composition during the training and detraining periods. The results of this study suggest that aerobic-type exercise improves lipoprotein-lipid profiles, cardiorespiratory fitness and body composition in healthy, young women, while resistance training significantly improved upper and lower body strength only.

Ross, et al. (1999) examined short and long term changes in weight, body composition, and cardiovascular risk profiles produced by diet combined with either structured aerobic exercise or moderate-intensity lifestyle activity. Sixteen-week randomized controlled trial with 1-year follow-up, conducted from August 1995 to December 1996. Forty obese women (mean body mass index [weight in kilograms divided by the square of height in meters], 32.9 kg/m^2; mean weight, 89.2 kg) with a mean age of 42.9 years (range, 21-60 years) seen in a university-based weight management program. Structured aerobic exercise or moderate lifestyle activity; low-fat diet of about 1200 kcal/d. Changes in body weight, body composition, cardiovascular risk profiles, and physical fitness at 16 weeks and at 1 year. Mean (SD) weight losses during the 16-week treatment program were 8.3 (3.8) kg for the aerobic group and 7.9 (4.2) kg for the lifestyle group (within groups, P<.001; between groups, P = .08). The aerobic group lost significantly less fat-free mass (0.5 [1.3] kg) than the lifestyle group (1.4 [1.3] kg; P = .03). During the 1-year follow-up, the aerobic group regained 1.6 [5.5] kg, while the lifestyle group regained 0.08 (4.6) kg. At week 16, serum triglyceride levels and total cholesterol levels were reduced significantly (P<.001) from baseline (16.3% and 10.1% reductions, respectively) but did not differ significantly between groups and were not different from baseline or between groups at week 68. A program of diet plus lifestyle activity may offer similar health benefits and be a suitable alternative to diet plus structured aerobic activity for obese women.

Chacon-Mikahil (1998) investigated the effects of aerobic training on the efferent autonomic control of heart rate (HR) during dynamic exercise in middle-aged men, eight of whom underwent exercise training (T) while the other seven continued their sedentary (S) life style. The training was conducted over 10 months (three 1-h sessions/week on a field track at 70-85% of the peak HR). The contribution of sympathetic and parasympathetic exercise tachycardia was determined in terms of differences in the time constant effects on the HR response obtained using a discontinuous protocol (4-min tests at 25, 50, 100 and 125 watts on a cycle ergometer), and a continuous protocol (25 watts/min until exhaustion) allowed the quantification of the parameters (anaerobic threshold, VO_2 AT; peak O_2 uptake, VO_2 peak; power peak) that reflect oxygen transport. The results obtained for the S and the T groups were: 1) a smaller resting HR in T (66 beats/min) when compared to S (84 beats/min); 2) during exercise, a small increase in the fast tachycardia (□0-10 s) related to vagal withdrawal (P<0.05, only at 25 watts) was observed in T at all powers; at middle and higher powers a significant decrease (P<0.05 at 50, 100 and 125 watts) in the slow tachycardia (□1-4 min) related to a sympathetic-dependent mechanism was observed in T; 3) the VO_2 AT (S = 1.06 and T = 1.33 l/min) and VO_2 peak (S = 1.97 and T = 2.47 l/min) were higher in T (P<0.05). These results demonstrate that aerobic training can induce significant physiological adaptations in middle-aged men, mainly expressed as a decrease in the sympathetic effects on heart rate associated with an increase in oxygen transport during dynamic exercise.

Geliebter, et al. (1997) moderate obese subjects (aged 19-48 y) 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 counseling. Subjects in the two exercise groups, designed to be isoenergetic, 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.

Tabata, et al. (1996) consisted of 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.

Douglas, et al. (1996) Contrasting effects of resistance and aerobic training on body composition and metabolism after diet-induced weight loss. This study examined whether exercise training facilitates maintenance of body weight at reduced levels following weight loss by attenuating weight loss-induced reductions in resting metabolism and fat oxidation. The effects of 12 weeks (three times per week) of either aerobic or weight training exercise on body weight, body composition, and energy metabolism during rest and following a meal in 18 older (mean ± SE, 61 ± 1 years; range, 56 to 70) subjects who had recently lost a mean of 9 ± 1 kg were studied. During the exercise training period, the aerobic training group (five women, four men) had a significant (*P* < .05) reduction in body weight (−2.5 ± 0.6 kg) as compared with the weight training group (five women, four men) (0.4 ± 0.9 kg). Eight of nine aerobic training subjects lost additional weight, while six of nine weight training subjects gained weight. Neither type of training reversed the depressions in resting metabolism or fat oxidation rates (ie, resting or postprandial) that had occurred as a consequence of the prior weight loss. Thus, alterations in resting metabolism or fat oxidation (resting or postprandial) do not appear to be the mechanism(s) by which exercise training facilitates maintenance of diet-induced weight loss.

Tremblay, et al. (1994) the impact of two different modes of training on body fatness and skeletal muscle metabolism was investigated in young adults who were subjected to either a 20-week endurance-training (ET) program (eight men and nine women) or a 15-week high-intensity intermittent-training (HIIT) program (five men and five women). The mean estimated total energy cost of the ET program was 120.4 MJ, whereas the corresponding value for the HIIT program was 57.9 MJ. Despite its lower energy cost, the HIIT program induced a more pronounced reduction in subcutaneous adiposity compared with the ET program. When corrected for the energy cost of training, the decrease in the sum of six subcutaneous skinfolds induced by the HIIT program was ninefold greater than by the ET program. Muscle biopsies obtained in the vastus lateralis before and after training showed that both training programs increased similarly the level of the citric acid cycle enzymatic marker. On the other hand, the activity of muscle glycolytic enzymes was increased by the HIIT program, whereas a decrease was observed following the ET program. The enhancing effect of training on muscle 3-hydroxyacyl coenzyme A dehydrogenase (HADH) enzyme activity, a marker of the activity of beta-oxidation, was significantly greater after the HIIT program. In conclusion, these results reinforce the notion that for a given level of energy expenditure, vigorous exercise favors negative energy and lipid balance to a greater extent than exercise of low to moderate intensity. Moreover, the metabolic adaptations taking place in the skeletal muscle in response to the HIIT program appear to favor the process of lipid oxidation.

2.2 SUMMARY

The review of literature helped the investigator to spot out relevant topics and variables. Further the literature helped the investigator to frame the suitable hypothesis leading to the problems. The latest literature also helped the investigator to support her finding with regard to the problem. Further the literature collected in the study also helped the research scholar to summarize her study. The researcher has presented the reviews in the related subjects by depending upon the highly authentic sources. Each review has been written in details in related to my subjects. Finally the researcher puts to an end to this chapter after giving all relevant details to each reviews of this chapter.

The reviews on aerobic and anaerobic training (30) were presented. All the research studies presented in the section proved that the aerobic and anaerobic training contribute significantly for better development of dependent variables. The research studies reviewed were collected from journals available in the websites and some university libraries. Based on the experience gained through review of the studies, the investigator formulated suitable methodology to be followed in this research, which is presented in Chapter III.