CHAPTER-2

REVIEW OF RELATED LITERATURE

A review of the related literature to the present study that the research scholar could gather in order to provide the background material to evaluate the significance of this study as well as to interpret its findings is presented in this chapter.

Metternich \(^1\) determined the effect of aerobic training on the plasma lipids and lipoproteins, functional capacity and body composition of sedentary women. All participants were given a pre test (T1), intermediate test (T2) and post test (T3) on the following variables (1) Blood test - measured high density lipoprotein cholesterol (HDL-C), low density lipoprotein

\(^1\) Karen Amanda Metternich "The Effect Of Aerobic Training On The Plasma Lipids And Lipoproteins, Functional Capacity And Body Composition Of Sedentary Adult Women" Dissertation Abstracts International 43 (December 1982) : 1876-A
cholesterol (LDL – C), triglycerides, total cholesterol (HDL-C), triglycerides, total cholesterol, and the HDL-C / total cholesterol ratio (2) Body composition – Percent body fat, (3) Body weight (4) Functional capacity. The result of fourteen weeks of aerobic training on a sedentary adult women are significantly increased functional capacity and significantly decreased body fat. LDL-C, triglycerides, total cholesterol ratio were unchanged in this particular study.

Jocobsen et al. 2 studied the effect of physical fitness and body lipid levels of 12 weeks of simulated cross country skiing of 12 sedentary women aged 20 – 40 years and compared with 10 matched women assigned to a control group. Training sessions were held four times a week, progressing from 20 to 40 minutes / sessions.

Kantor et al. conducted a study on acute increase in lipid protein lipase following prolonged exercise. To investigate the acute effects of prolonged exercise on lipoprotein metabolism. Data were collected by ten well trained men (aged 20-37 yrs) one day before and one day after a 42 km. Foot race. LDL-C decreased by ten percent and total HDL-C levels increased by nine percent after the race. Triglyceride levels decreased by thirty-nine percent.

Campaign examined six men with familial


hypoalphalipoprotein (FHA) with bottom dicelie high density lipoprotein cholesterol. Subjects took part in a 12 week endurance training on HDL-C, apolipoprotein (AI), peak oxygen consumption (PVO₂), lean body mass (LBM) body 3 weight (Wt.) post heparin hepatic triglycerides (HL) and lipoprotein lipase (LPL) levels. Training increase PVO₂, LBM, or with change in HL or LPL. In FHA, with major gene depression of HDL-C and consequent high CHD risk, physical training increases HDL-C and thus may diminish CHD risk by mechanism to be elucidated.

Thorland and Gilliam ⁵ conducted a study on fifty five pre-adolescent males to determine if differences existed in the serum levels of total triglycerides, total cholesterol, HDL-C, or HDL-C / total cholesterol ratio between groups with contrasting levels of body fatness and physical activity habits.

⁵ Thorland and Gilliam, Medicine and Science in Sports and Exercise.
statistical comparisons between these groups indicated an absence of body fatness effects on any of the serum lipids.

The results indicated that greater exposure to activities classified as moderate to very highly intense was consistent with lower total triglycerides and higher HDL-C / total cholesterol ratio in these 8 to 11 years old males.

Wilmore et al. 6 conducted a study on body composition changes with a 10 week programme on jogging. The following conclusion was drawn that the change in body composition induced by training are as follows 1) a decrease in total body fat and 2) no change or slight increase in lean body weight and

3) a small decrease of total body weight. For the most part, these changes particularly that of fat loss are more pronounced for obese men and women than for the already lean individual.

Michielle et al.\textsuperscript{7} made a comparison of exercise training intensities on lipoproteins cholesterol fractions. Forty nine men with a mean age of 44 + 8 years studied to determine the effect of 12 week of bicycle ergometer training at 65%, 75%, and 85% of HR Max on lipoprotein cholesterol fractions in fasting venous plasma samples. Lipid values (total cholesterol, HDL-C, LDL-C, VLDL-C, and TG) showed no significant changes related to training. While exercise intensity caused a training effect it did not significantly effect lipid levels in the blood.

Panny et al.\(^8\) have pointed out that the role of exercise (especially running) in raising the level of HDL-C has received considerable attention over the past few years and is presently being researched in various laboratories throughout the world. Epidomologic research indicates that a vigorous exercise programme may bring about an increased level of HDL-C in young and middle-aged men, while at the same time, exercise appears to bring about if any decrease in total serum cholesterol levels.

Schurrer\(^9\) conducted a study on intensity of training and serum lipid levels. Thirty-one college women participated in a five days per week, 12-week training programme. Subjects were


randomly assigned to three groups, above ( ) the onset of blood lactate accumulation (OBLA) (N=12) (trained at two work loads OBLA) below ( ) OBLA (trained at the workload associated with OBLA) (N=11) and control (C) (N=8) training work loads were equated so that each subject expended.

Roger et al. 10 determined the effect of long term exercise training on exercise capacity and plasma lipids in patients with Ischemic disease. Nine male patients with coronary heart disease were studied after one year participation in a vigorous cardiac rehabilitation program and then again after six years of training. It was concluded that training can maintain a large initial increase on VO2 max while also improving serum HDL-C cholesterol and the TC/HDL ratio in patients with Ischmic heart disease.

Allison and Iammarino\textsuperscript{11} examined the effect of short term triglycerides. Nine sedentary men and 10 joggers were studied for five consecutive days. Results indicated that regular aerobic exercise as little as 4 km per day will lower TC. However, the effect of exercise on HDL-C is more complex: 8 km of jogging may decrease HDL-C on the short term but chronic training seems to ultimately lead to higher levels.

Moody et al.\textsuperscript{12} investigated the effect of a jogging programme on the body composition of normal and obese high school girls. The change in body composition resulting from physical training are 1) a sizable decrease in body fat, 2) a small decrease in lean body weight and 3) a small decrease in total body weight.


McNaughton and Davies 13 examined the effect of a 16 week training and detraining on high density lipoprotein levels and aerobic conditioning programme on serum lipids, lipoproteins and coronary risk factors. Nineteen people of varying ages undertook the 16 week conditioning programme in the form of aerobic dance. The exercise was at seventy seen in any of the blood measured variables. It was concluded that the 16 week of aerobic dance is not of sufficient duration to elicit percent of their maximum heart rate. The result of the programme indicated that fitness parameters increased for the group due largely to the increased bought about by the male group. Female showed no increase in any of the fitness parameters over the 16 weeks. No statistically significant effect were any change in serum lipids and lipoproteins.

Linder determined the effect of physical conditioning on lipoprotein profiles of white male adolescents. The experiment group participated in a 8 week of progressive aerobic exercise while the control group participated in their normal activities. Even though the exercise was strenuous enough to increase the physical condition group's physical working capacity significantly, as compared to the control group, there was no corresponding effect of this group's serum lipoprotein levels not their physical measurement.

Schriwer, Gunnewing and Assmann found that ten weeks


of aerobic exercise, consisting of thirty minutes of running three times per week decreased triglycerides level significantly but had no such an effect on total cholesterol or low density lipoproteins (LDLs).

Robert and Wallace \(^{16}\) determined whether 12 months of dynamic exercise conditioning modifies concentrations of plasma lipids and lipoproteins in 22 previously sedentary men and women. Subjects were divided by sex and adherence to a program of walking, jogging or swimming for three days per week, at 69 to 80 percent of heart rate reserve. High adhering women (HAW) decreased concentration of total cholesterol and LDL-C. There were no changes in concentrations of HDL-C and VDL-C in high adhering men (HAM) and high adhering women (HAW). Concentration of triglycerides (TG) were lower in

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HAM compared to low adhering men post conditioning. The findings demonstrated that dynamic exercise of this magnitude of this study increases VO2 max and favorably modifies TC, TG and LDL-C but not HDL-C and VLDL-C.

Sady et al. 17 studied the comparative effects of exercise training on serum lipids and lipoproteins of pre pubescent boys and adult men. Training involved walking / jogging / running 3 days per week at a distance which the changes in HDL/Cholesterol ratio among the groups. Dietary intake and body weight did not change.

Morgan et al. 18 conducted a study on HDL-C concentration in weight-trained endurance trained and sedentary females. Serum high density lipoproteins cholesterol (HDL-C) levels and percent HDL-C were significantly higher in nine female endurance runners that in equal trainers and controls showed no significant differences in HDL-C and percent HDL-C. It was concluded that HDL-C levels in female are associated with specific training methods.

Savage 19 examined exercise training effect on serum lipids of prepubescent boys and adult men. Training involved walking/jogging/running 3 days per week at a distance which


progressed from 2.4 km per day in the first week and 4.8 km per day from the fifth week. Fasting blood samples, collected on two days during both pre and post training, were assessed for triglycerides, total cholesterol and high density lipoprotein cholesterol. Maximum aerobic power was determined from a treadmill test. It was concluded that boys and men did not differ in the changes in serum lipids and lipoproteins and cardio-respiratory fitness from 10 week of aerobic training.

Albert conducted the study to determine the effect of a 12 week quantitative aerobic training programme (Jogging) on the fasting serum concentration of cholesterol (C) and triglycerides (TC) in the high density lipoprotein (HDL) low density lipoprotein (LDL) and very low density lipoprotein (VLDL) classes in middle aged men after 3, 6, 9, and 12 weeks. Significant changes were

observed in the concentration of total serum (LDL-C, HDL-TG, LDL-TG and the ratio of HDL-C/LDL-C). The jogging however had significantly lower level of total serum TG (130.0 Vs 177.5 mg.%), VLDL−TG (83.6 Vs 128 mg%) and VLDL-C (21.4 Vs 34.2 mg%) than the TRL. The analysis of covariance indicated that these changes in the lipoprotein fraction were independent of diet and alterations in weight and adipose tissue.

Cohen 21 examined the effect of varying intensities of aerobic training upon the plasma lipid profiles on 49 sedentary male, 30–63 years. The analysis of co-variance ‘F’ test showed that there was no significant difference in lipid levels among the groups as a result of conditioning. Significant intra group increases in HDL level were seen following training at .85% and

75% of maximum heart rate, and significant intra group decrease in LDL level and LDL/HDL risk ratio were seen following training at 75% of maximum heart rate.

There were no significance with group difference in body composition, dietary habits or alcoholic consumption following training. Bonetti et al. 22 studied plasma levels of lipoprotein (a), total cholesterol, triglycerides, HDL, cholesterol, apoprotein A and apoprotein B were assessed in 10 healthy untrained volunteers subjected to a bicycle ergometric exercise equal to 50% of individual VO₂ max, followed by increasing loads until muscular exhaustion. Blood samples were taken before the exercise, immediately afterwards and then at 12 hourly intervals for 72 hours period. Subsequently the same parameters were evaluated for a 8 hour long distance runners during marathon, with blood samples being taken before and

after the race and then after one Arlene month of detraining. After the exercise, lipoprotein (a) in untrained subjects began to decrease significantly from the 24\textsuperscript{th} hour on and remained lower than baseline levels up till the 72\textsuperscript{nd} hour. After detraining, lipoprotein (a) in marathon runners increased significantly both with respect to basal values and especially to post race values. In the two groups of subjects examined, no correlation was found between lipoprotein (a) and the anthropometrical data and metabolic parameters considered.

Barr \textit{et al.} \textsuperscript{23} conducted a study to assess whether a previously described dose-response relationship between the amount of exercise and the magnitude of change in the blood lipid and lipoprotein levels is observed with large volume of exercise in young, healthy individuals. Blood Lipid and lipoprotein levels were monitored during 25 week session of

\textsuperscript{23} Barr \textit{et al.} \textit{Medicine And Science In Sports And Exercise} p 795
training and competition in experienced male collegiate swimmers, who were divided into two groups matched for swimming skills. No changes in HDL cholesterol were observed during the session in either the increased training or the regular training groups. Total and LDL cholesterol levels were lower at 20 wk than at the start of the study, but final levels did not differ from initial levels. Thus the volume in blood lipid and lipoprotein levels in healthy subjects with high activity levels.

Mangold and Bezegh \(^{24}\) described that most of the lipids present in blood and many other tissues are bound to protein, the various plasma lipoprotein are well characterized. Very low density proteins (VLDL) low density lipoprotein (LDL) and high density

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lipoprotein (HDL). Among these VLDL are rich triglycerides while LDL are rich in cholesterol. Analysis of triglycerides and total cholesterol are of special interest as they complement the results of lipoprotein electrophores and aids in the diagnosis of the higher lipoproteinerias. The concentration of triglycerides as well as total cholesterol in plasma depend upon the age and sex of the subjects. The mean values for normal males of plasma triglycerides and total plasma triglycerides and total plasma cholesterol in age group of 0-19 years 60 mg/dl and 172 mg/dl and in age group 20-29 are 73 mg/dl and 183 mg/dl respectively.

Higashi Y, Sasaki S, et al. The effects of long-term aerobic exercise on endothelial function in patients with essential hypertension remain unclear. To determine whether endothelial

25. Higashi Y and Sasaki N “Daily Aerobic Exercise Improves Reactive Hyperemia In patients with essential hypertension”. First Department of Internal Medicine, Hiroshima University School of Medicine, Japan

Yhigashi@mca.med.hiroshima-u.ac.jp 1999 Jan : 33 (1 pt 2) : 591-7
function relating to forearm hemodynamics in these patients differs from normotensive subjects and whether endothelial function can be modified by continued physical exercise.

We randomized patients with essential hypertension into a group that engaged in 30 minutes of brisk walking 5 to 7 times weekly for 12 weeks (n=20) or group that underwent no activity modifications (control group =7). Forearm blood flow measured using stain-gauge plethysmography during reactive hyperemia to test for endothelium – dependent vasodilatation and after sublingual nitroglycerin administration to test endothelium – independent vasodilatation. Forearm blood flow in hypertensive patients during reactive hyperemia was significantly less than in normotensive subjects (n=17). Increases in forearm blood flow after nitroglycerine were similar between hypertensive and normotensive subjects. Exercise lowered mean blood pressure from 115.7+/ - 5.3 to 110.2+/ -5.1 mm Hg. (P<0.01) and forearm vascular resistance from 25.6+/ - 3.2 to 23.2+/ - 2.8 mm Hg / ml
per minute per 100 ml tissue (P<0.01); no change occurred in controls. Vassal forearm blood flow, body weight and heart rate did not differ with exercise. After 12 weeks of exercise maximal forearm blood flow, response during reactive hyperemia increased significantly from 38.4 +/- 4.6 to 47.1 +/- 4.9 ml/min/100 ml tissue (P<0.05): This increase was not seen in controls. Changes in forearm blood flow after subjects -lingual nitroglycerine administration were similar before and after 12 weeks of exercise.

Inter - arterial infusion of the nitric oxide synthases inhibitor NG-monomethyl -L-argenine abolished the enhancement of reactive hyperemia induced by 12 weeks of exercise. These findings suggest that through increased release of nitric oxide, continued physical exercise alleviates impairment of reactive hyperemia in patients with essential hyper tension.

Poirier P, Cattelliar C et al. The study was designed to

examine the impact of exercise training on the plasma lipid profile in non-insulin dependent diabetes mellitus (NIDDM) and, more particularly, to determine the relationship between changes in body fat, mass and changes in the lipid profile. 11 men with NIDDM exercised for 1 hour thrice per week on an ergocycle over a 6 month period at 60% maximal oxygen uptake (VO2 max). Diet and hypoglycemic agents were kept constant throughout this period. VO2 max, body composition, fasting plasma glucose and insulin levels, glycosylated hemoglobin and the lipoprotein profile were determined at baseline. In the middle (3 months) and at the end (6 months) of the training programme. When the subjects were considered as a group, the only significant effect of training was on VO2 max, which increased from 32.3 +/- 1.2 ml/kg/min at baseline to 38.0 +/- 1.7 ml/kg/min at 6 months (P < 0.001). When the data were analyzed on an individual basis, significant associations were observed between changes in body fat mass and changes in low density lipoprotein (LDL) cholesterol / high density lipoprotein (HDL) cholesterol ratio (R = 0.62, P = 0.04) or triglycerides (TG) levels (R = 0.64, P = 0.03). This data indicate that
fat loss, not training per se, favorably alters the lipid profile of subjects with NIDDM who participate in an aerobic physical conditioning programme.

Superko\textsuperscript{27} reports that the role of lipoprotein manipulation in the of atherosclerosis is well established improvement in lipoprotein cholesterol concentrations and subclass distribution through exercise training is prior to pharmacological intervention. As with other\textsuperscript{27}, HDL therapeutic dose must be stipulated to the patient. The dose of exercise training require beneficial lipoprotein changes is unclear. This is further complicated by the potential effect of exercise training and lipoprotein subclass distribution, enzymes, apportions, and transfer proteins and by the changes in diet and body composition that often accompany exercise training. These changes may be responsible for all part of the lipoprotein change attributed to exercise.

27. R. Superko "Exercise Training, Serum Lipid And Lipoprotein Particles: Is there a change Threshold?" \textit{Medicine And Science In Sports And Exercise} Vol. 23 (1991): 677
Hardman et al. To consider how physical activity interacts with diet to modify lipoprotein metabolism and comment on implications for human health. An overview of lipoprotein metabolism is followed by a summary of the main effects of physical activity on lipoprotein metabolism. Interactions with dietary practice Maston Tran and Weltrmarr examined the effects of exercise training on lipid and lipoprotein levels. Exercise training can have favourable effects on the lipid profile in and the disposition of dietary lipid are reviewed, with comment on links with body fatness. Literature is reviewed in relation to the risk of artherosclerotic disease. Although some data are presented on

28. Hardman A E et al, "Interaction of physical activity and diet :implications for lipoprotein metabolism. "Human muscle metabolism research group,Department of Physical Education ,Sports science and "recreation management, Loughborough University ,Leicestershire. e.hardman@lboro.ac.uk

athletic groups, evidence relating to individuals with normal physical activity habits is mainly discussed humans. However the magnitude and direction of the gender effect is not clear. In which 152 subjects were analyzed. Data were divided into two groups by gender. Results show that exercise training appears to have a similar effect on the lipid profile for both men and women. Concluded that exercise training may be useful in decreasing risk in both men and women for coronary artery disease due to high HDL cholesterol levels.

Lehmann R, Vokac A\textsuperscript{30} et al. Non insulin-dependent diabetes mellitus (NIDDM) is associated with an increased cardiovascular risk.

\textsuperscript{30}Lehman R, Vokac A et al. "Loss Of Abdominal Fat And Improvement Of The Cardiovascular Risk Profile By Regular Moderate Exercise Training In Patients With NIDDM. Department of Internal medicine, University Hospital Zurich, Switzerland. Diabetologia 1995 Nov; 38 (11): 1313–9."
Glycemic control alone is often insufficient to control diabetic dyslipidaemia and other cardiovascular risk factors associated with NIDDM. The present trial was designed to evaluate the effects of physical activity as an adjunct to standard diabetes therapy on the lipid profile, blood pressure, glycaemic control, weight and body fat. 16 well-controlled (HbA1c 7.5%) patients with NIDDM participated in a regular aerobic exercise training programme at 50-70% maximal effort over 3 months. 13 age and sex-matched patients with NIDDM served as a control group. The 3-month intervention with an increase in physical activity from 92 (mean +/- SD) +/- 79 to 246 +/- 112 min per week (p<0.001) by means of a structured activity programme resulted in significant improvement of plasma lipid with a 20% decrease in triglycerides (p<0.001), unchanged total cholesterol and increases in high-density lipoprotein and high-density lipoprotein -3 subfraction of 23% (p<0.001) and 16% (p<0.001), respectively from Systolic and diastolic blood pressure decreased significantly from 138 +/- 16 to 130 +/- 17 mm Hg (p<0.05) and 88 +/- 10 to 80 +/- 10 mm Hg (p<0.001), respectively Resting heart rate decreased from 81 +/- 13 to 74 +/- 14
beats per minute (p<0.01), waist hip circumference ratio decreased from 0.96 +/- 0.11 to 0.92 +/- 0.10 (p<0.001) and body fat decreased from 35.3 +/- 7.2 to 33.0 +/- 8.0% (p<0.001). These effects occurred independently of changes in body weight and Glycemic control, which did not change during the study. This study shows that improvement in physical fitness by introducing regular exercise as part of the treatment programme in patients with NIDDM results in a significant amelioration of their cardiovascular risk profile.

Yeater R, Reed C\textsuperscript{31} et al. To determine whether there is a difference in cardiac size and function as well as body composition, aerobic capacity, and blood lipids between resistance trained athletes who use anabolic steroids and those who do not, and to compare them to university cross country athletes. Four groups of men were evaluated

\textsuperscript{31}Yeater R, Reed C et al. "Resistance Trained Athletes Using Or Not Using Anabolic Steroids Compared To Runners; Effects On Cardiorespiratory Variables, Body Composition And Plasma Lipid." Department of Medicine, West Virginia university, Morgantown 26506-6116 USA. BR J Sports Med. 1996 Mar;30 (1):11-4
recreational lifters, n= 11, lifting < 10 h.week⁻¹; heavy lifters n= 16, lifting > 10 h. week⁻¹; steroid users, n=8, same as heavy lifters and used steroids; runners, n=8, university track members. Echocardiograms, body composition (hydrostatic weighing), maximum oxygen consumption (VO₂) and lipids were studied. As expected, VO₂ (ml.kg⁻¹.m⁻¹), was greatest in the runners, with no difference among the lifting groups.

High density lipoprotein cholesterol in the steroid user group was lower than in heavy lifters or runners. Left ventricular internal diastolic dimension was similar among the groups. The left ventricular mass index of the steroid user group was significantly greater than recreational lifters, at 161 v 103. There was no difference among heavy lifters (127), runners (124) and steroid users. There was no compromise in diastolic function in an group. There was no difference among groups in resting or exercise blood pressure. Resistance training in the absence of steroid use
result in the same positive effects on cardiac dimensions, diastolic function, and blood lipids as aerobic training.

Harries et al. 32 reported the cardiac response to exercise is complex and ill understood, but involves the interaction of a number of changes, including heart rate, myocardial contractility, and the pre and after load condition of the heart. All forms of exercise increase cardiac output, and in particular sport, such as running, swimming, and cycling demand prolonged elevation of cardiac output.

Cardiac output is the volume of blood ejected by the left ventricle to the great arteries per minute. Stroke volume is the volume of blood ejected from the left ventricle of each heart beat. This depended upon the end diastolic volume and ejection fraction. The ejection fraction is simply a percentage measurement of the difference between the end-systolic and end-diastolic left ventricular volume.

Sullivan et al.\textsuperscript{33} conducted a cross sectional study to determine if fitness was associated with lipoprotein (a) concentrations. Cardio respiratory fitness, percent body fat, body fat distribution, lipoprotein profile and LDL particle size were determined in 100 healthy men. LP (a) was not significantly correlated with age, treadmill time, total cholesterol (TC), high density lipoprotein (HDL), LDL, Triglycerides (TG), glucose, TC/HDL, LDL particle diameter, percentage body fat. It was found that LP(a) was unrelated to cardiorespiratory fitness and body composition factors known to influence risk of CHD.

Barlow, Kampert and Blarr\textsuperscript{34} conducted a study to identify environmental correlates of non responsiveness of high 33. M.

\textsuperscript{33} Sullivan et al. "Relationship Between Cardio Respiratory Fitness and Plasma Lipoprotein (a) in Men" \textit{Medicine And Science In Sports And Exercise} Vol. 25 (1993) : S. 204.

\textsuperscript{34} C E Barlow , J B Kampert and S N Blair , "Correlates Of High Density Lipoprotein (HDL-C) Responders And Non Responders To Exercise Training" \textit{Medicine And Science In Sports And Exercise} Vol. 28, 1996, S 72
density lipoprotein (HDL–C) to high levels of exercise training examined HDL-C levels in 806 women and 4,011 men (age range 20–80 years) who reported regular walking or running for at least one year and at least 10 miles/week. HDL–C non responders in women were compared with responders (R) in women, on several characteristics associated with HDL-C concentration treadmill tune (TRT) number of years exercised (YE) and total cholesterol (TC) were higher in women R. Body mass index (BMI) and triglycerides (TG) were lower in women R, TRT, MW, YE, TC were higher in men R. Muscles per mile, BMI, TG, and glucose were lower in men R. These results suggest that non responsiveness of HDL-C to exercise training is unrelated to known correlates of HDL-C. It is presumed that non responsiveness is under genetic control.

Le Mura Von Duvillavd and William 35 examined Blood

lipids, Cardiorespiratory fitness and dietary quantity in a group of 160 Sicilian pre adolescent children. Cardiorespiratory fitness was assessed by a maximal graded treadmill test. Blood sample were collected after an overnight fast. The concentration of total cholesterol (TC) high density lipoprotein cholesterol (HDL-C) and triglycerides was determined from plasma using dry chemistry analyzer. The children were divided into two groups a lower fit group and a higher fit group. An analysis of variance revealed that the higher fit group had a lower percent of body fat. There were no difference between groups for TC, HDL-C, and triglycerides.

Fagard RH\textsuperscript{36} et al. There is overwhelming evidence,

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particularly from echocardiography, that the heart of competitive athletes may differ from that of non-athletes, matched for age, gender, and body size. A larger left ventricular mass has been shown in athletes performing predominantly dynamic aerobic and anaerobic sports, in athletes engaged in static training and in players of ball sports. Enlargement of the left ventricular internal diameter was most pronounced and reached about 10% in athletes performing predominantly dynamic sports; mainly strength training athletes had a lesser increase of the internal dimension which was limited to 2.5%. Also the left ventricular wall thickness was proportionate to slightly increased (predominantly eccentric hypertrophy). In strength athletes, the disproportionate increase of wall thickness averaged about 12% (predominantly concentric hypertrophy). In sports with high dynamic and high static demands requiring prolonged training, such as cycling, the increases of absolute relative wall thickness reached 29% and 19% and were more pronounced than in runners (mixed hypertrophy). A plausible interpretation of these results is that the
development of so-called eccentric or concentric left ventricular hypertrophy according to the type of sports cannot be regarded as an absolute or dichotomous concept because training regimes and sports activities are not exclusively dynamic or static and because the load on the heart is not purely of the volume or the pressure type. Most studies agree that left ventricular systolic and diastolic function is normal in the athlete at rest. Whereas diastolic function seems to be enhanced in the exercising endurance athlete. The consistency of the results of studies on athletes in the competitive and the resting season, of training of sedentary subjects, and of spinal cord-injured patients suggests that variations in physical activity can alter left ventricular structure; genetic factors do not seem to be involved in the size of the left ventricular internal diameter but have taken into account to interpret wall thickness.
Libonati JR et al. There are several important links between aerobic exercise performance and the diastolic phase of the cardiac cycle. During acute exercise, diastolic function must be augmented in order for left ventricular filling to match increased left ventricular output, i.e., cardiac output. This challenges the myocardium because the shortened duration of diastole during exercise may compromise left ventricular filling, thereby limiting stroke volume. Additionally, ventricular filling must be accomplished at relatively low filling pressures, otherwise pulmonary vascular congestion may occur. Left ventricular diastolic function may be impaired in the elderly and/or in individuals with ischemic coronary syndromes. Regular aerobic exercise training appears to enhance left ventricular diastolic function and may benefit.

patients with clinically relevant "diastolic dysfunction". The purpose of this paper is to discuss the relative importance between diastole and exercise and to review some of the involved putative mechanism.

Guyton \(^{38}\) reported chronic heavy exercise over a period of many weeks or months leads to hypertrophy of the cardiac muscle and also the enlargement of the ventricular chambers. As a result the overall strength of the heart becomes greatly enhanced; and the effectiveness of the heart as a pump increases. Cardiac hyper effectiveness on the cardiac function, can increase pumping by the heart more than 100 percent.

Basset \(^{39}\) et al. conducted a study on 15 highly trained pre-pubertal female gymnasts of same age, height and 15 girls

38. Guyton, Text of Book Medical Physiology. 161

39. S. Basset et al "Cardiac Dimensions Of Highly Trained Pre Pubescent Female Gymnasts " Medicine And Science In Sports And Exercise" Vol. 22 1990
who were not involved in any competitive sports. Standard M-mode echocardiography was used to evaluate left ventricular internal dimensions. Posterior wall thickness and ventricular septal thickness during diastole and blood pressure was also recorded. Left ventricular shortening fraction. Left ventricular internal peak systolic wall stress, left ventricular internal wall to posterior wall thickness ratio and percent of posterior were calculated. No significant difference between age, height and weight were noted between the two groups. LVS in gymnasts was significantly thicker than in controls. With the controls having a higher wall stress. Although no significant difference was found between the two groups for LVID and LVPW. The T/Th ratio was significantly lower in gymnasts suggesting in appropriate hypertrophy. Highly trained young gymnasts does not seem to be delirious to their cardio-vascular system.

Mann, et al.\textsuperscript{40} Has reported that regular exercise

\textsuperscript{40}Mann et al. "Ex to prevent Coronary Heart Disease "American Journal of Medicine; 46 (1969); 12-27.
programs causes decreases in blood Cholesterol and triglycerides levels. This change is particularly apparent in individuals who initially have very high levels prior to training. Of recent interest are the specific kinds of cholesterol found in the blood, referred to as high density lipoproteins (HDL), low density lipoproteins (LDL) and very low density lipoproteins (VLDL).

Morganroth et al. 41 studied echocardiograms of 56 active athletes. Mean left ventricular end-diastolic volume and mass were increased in athletes involved in isotonic exercise, such as swimming and running compared with controls. Wall thickness was normal. Athletes involved in isometric exercise, such as wrestling and shot putting had normal mean left ventricular end-diastolic volume but 40.G. increased wall thickness and mass. Thus the athletes participating in isotonic exercise has increased left

ventricular mass with cardiac changes similar —— in chronic volume overload.

Tummavuori and Rusko \(^{42}\) investigated the development of the athlete’s heart in 30 male cross country skiers during 5 years. During this period 18 skiers increased their training volume 2-3 years after the beginning of the study. A control group consisted of 11 physically active non-athletes. MANOVA showed group difference and interaction in maximum oxygen uptake. Left ventricular and diastolic diameter (EDD) mean wall thickness (MWT) and left ventricular mass (LVM) were calculated from resting echocardiograms recorded in left lateral positioning the beginning of the study and after 5 years. The effect of progressively increased training volume were demonstrated in maximal oxygen.

\(^{42}\)M. Tummavuori and H Rusko “Training And Detraining Effects On The Athletes Heart During 5 Years Echocardiographic Study,” *Medicine And Science In Sports And Exercise* Vol. 28 (1996) : S 68
Weiling and co-worker \textsuperscript{43} studied 9 freshmen and 14 senior Oars Men undergraduates during 7 months of training and compared them with 17 age and sex matched sedentary control subjects in order to assess the influence of heavy physical exercise on cardiac dimension and maximal oxygen uptake. Standard M-Mode Echocardiographic techniques were used. At the start of the season senior oarsmen had a greater left ventricular septum and posterior left ventricular wall than controlled subjects and freshmen. The two later groups did not differ from each other. During the training period there was slight and gradual increase in left ventricular end-diastolic dimension and inter ventricular septum and posterior wall thickness in freshmen. In seniors only left ventricular end diastolic dimension increased significantly. Maximum oxygen uptake showed a distinct increase between fourth and seventh

\textsuperscript{43} Weiling et al. "Echocardiographic Dimension And Maximal Oxygen Uptake In Oarsmen During Training" British heart journal. 46 :

(August 1981) : 190–195
month during period of intensive training. There was no relation between echo-cardiographic variables and maximal oxygen uptake. A combination of heavy dynamic and static exercise can thus lead to significant changes in both left ventricular wall thickness and chamber size within months.

Lamont\textsuperscript{44} reported that one month endurance swimming (five hours a week) on eleven women's swimming team participants aged 18–32 years resulted in a significant improvement in left ventricular end diastolic diameter, left ventricular posterior wall thickness, and left ventricular mass and no significant difference was found in left ventricular end systolic diameter and inter ventricular septum thickness.

\textsuperscript{44} S. L. Lamont, "Effects Of Training On Echocardiographic Dimensions And Systolic Time Intervals In Women Swimmers." Journal of medicine and physical fitness.. 20 : 4 (1980) : 397 – 404
Pokan R, Hofmann P et al. The purpose of this investigation was to study myocardial function at rest, during three phases of energy supply, and during recovery. Radionuclide angiography was performed during the aerobic phase (phase -I, rest – first lactate increase), the aerobic-anaerobic transition phase (phase -II, first lactate increase –second lactate increase).

The anaerobic phase (phase –III, second lactate increase-maximal work performance (P max) and during recovery thirty eight male patients (59 +/- d after myocardial infarction) were compared with 19 healthy control subjects and 21 sport students of comparable age. Left ventricular ejection fraction (LVEF) increased from rest to phase I and from phase I to phase II in sports students and control subjects. During phase III LVEF did not change significantly in sports students, but it decreased

45. Pokan R, Hofmann P et al. "Left Ventricular Function In Response To The Transition From Aerobic To Anaerobic Metabolism." Department Of
significantly in control subjects. This is in contrast to the patients who showed an increase of LVEF from resting values (47 +/- 3%) to phase I (50 +/- 1%), no change during phase II (51 +/- 2%), and a decrease to resting values (45 +/- 2) during phase III. All subjects showed an increase in stroke volume (SV) during phase I and II, reaching a maximum at phase II. This was evidenced by an improvement of the systolic function with a constant left ventricular and end-diastolic the end of exercise performance volume (EDV) in control subjects and sports students. In contrast, an improved SV in patients was achieved through an increase in the left ventricular end-systolic volume (ESV). Maximal LVEF values were measured during the first 90 s of recovery in all subjects. Values during recovery are not representative of load dependent myocardial function. This increase in LVEF does not cause an increase in cardiac output but is consequence of changes in the EDV and ESV, which decrease again immediately after.
Convertino VA, Bloomfield SA. Reduction of exercise capacity with confinement to bed rest is well recognized. Underlying physiological mechanisms include dramatic reductions in maximal stroke volume, cardiac output, and oxygen uptake. However, bed rest by itself does not appear to contribute to cardiac dysfunction. Increased muscle fatigue is associated with reduced muscle blood flow, red cell volume, capillarization and oxidative enzymes. Loss of muscle mass and bone density may be reflected by reduced muscle strength and higher risk for injury to bones and joints. The resultant deconditioning caused by bed rest can be independent of the primary diseases and physically debilitating in patients who attempt to reambulate to normal active living and working. A challenge to clinicians and health care specialists has been the

46. Convertino VA, Bloomfield SA "An Overview Of The Issues: Physiological Effects Of Bed Rest And Restricted Physical Activity."
identification of appropriate and effective methods to restore physical capacity of patients during or after restricted physical activity associated with prolonged bed rest. The examination of physiological responses to bed rest deconditioning and exercise training in healthy subjects has provided significant information to develop effective rehabilitation treatments. The successful application of acute exercise to enhance orthostatic stability, daily endurance exercise to maintain aerobic capacity, or specific resistance exercise to maintain musculoskeletal integrity rather than the use of surgical, pharmacological, and other medical treatments for clinical conditions has been enhanced by investigation and understanding of underlying mechanisms that distinguish physical reconditioning from the disease. This symposium presents an overview of cardiovascular and musculoskeletal reconditioning associated with reduced training regimes that have proven successful in Amelia or reversing these adverse effects.
Niranjan V, McBrayer et al. We studied cardiopulmonary function during exercise in young subjects with long-standing insulin-dependent diabetes mellitus (IDDM) who have no clinical cardiopulmonary disease to determine the relationships of aerobic capacity, gas exchange, ventilatory power requirement, and cardiac output to chronic Glycemic control. Eighteen subjects with IDDM and 14 normal control subjects received twice daily insulin injections and had chronically elevated levels of glycosylated hemoglobin (hyperglycemic group); 9 other diabetic subjects received insulin via continuous infusion pumps and maintained chronic near-normal levels of glycosylated hemoglobin (normoglycemic group). At the end of at least 7 years of regular follow up, aerobic capacity was determined by cycle ergometry. Lung volume, diffusing capacity, and cardiac output during exercise were measured by a rebreathing technique.

47. Niranjan V, McBrayer DG, et al. "Glycemic Control and Cardiopulmonary Function In Patients With Insulin-Dependent Diabetes Mellitus." Department of Medicine, University Of Texas Southwester Medical Medical Center, Dallas Of Medicine 75235-9034
Ventilatory power measured by the esophageal balloon technique. Maximal work load and oxygen uptake were markedly impaired in chronically hyperglycemic diabetic patients associated with significant restrictions of lung volume, lung diffusing capacity and stroke index during exercise. Membrane diffusing capacity was significantly reduced at a given cardiac index. The normoglycemic patients consistently showed less impairment than the hyperglycemic patients. Physiologically significant cardiopulmonary dysfunction develops in asymptotic patients with long standing IDDM. Chronic maintenance of near-normoglycemia is associated with improved cardiopulmonary function.

MacFarlane et al. 48 studied two clearly defined groups of elite athletes, by M-mode and Doppler echocardiography with a group of inactive individuals as controls. Group I comprised ten elite endurance athletes with maximal oxygen consumption of

48. MacFarlane et al., Sports Medicine, 45
74.7 + 1.43. Group II consisted of ten elite VO2 max 45.3 + -
2.00. Group III comprised ten inactive individuals with VO2 max
44.5 +- 2.13. Left ventricular end diastolic dimension was
significantly higher in group I and II than in group III.
Percentage fractional shortening was used as an index of systolic
function and no significant difference was found between groups.
These data show that both modes of intense training produce
left ventricular hypertrophy. Diastolic function was not impaired in
the athletes and may be augmented in the endurance athletes.

Morales et al. 49 conducted a study to assess gender
differences in cardiovascular adaptations in equally trained
populations of distance runners. Six men and women of the

49. M Morales et al. "Left Ventricular Mass In Men And And Women
Distance Runners "Medicine And Science In Sports And Exercise Vol. 23
(1991) : S 158
same age were selected who habitually run 35–60 miles per week were evaluated by echo-cardiography to measure left ventricular mass. There was no significant difference in the amount of miles per week run between the two groups.

Treadmill exercise tests with direct measurements of oxygen consumption were performed to further assess training status. There was not a significant difference in maximum heart rate. The data indicate that there is no significant gender difference with respect to LVM in an equally trained population of individuals when indexed for body surface area (BSA) or LBM. The lack of difference in LVM between men and women with comparable training would suggest that gender does not play a role in LVM adaptation to training.

The cardiac dimensions of adults were determined by M-mode echocardiography and were analyzed in relation to the
Somatotype components by Song et al. The sample included 398 healthy sedentary subjects. Somatotype was determined by the Heart Carter anthropometric technique. Left ventricular internal dimension at end-diastolic (LV Idd) Left ventricular end diastolic volume (LVEDV), posterior wall thickness at end diastole (PWTD) thickness of intraventricular septum, at end diastole, and left ventricular mass were obtained (LVM) More cardiac dimensions were associated with Somatotype components in females than in males. It is concluded that ENDO and MESO are generally positively and ECTO negatively correlated with heart dimensions in adult both sexes.

George et al. varsity level endurance trained athletes, 10 50.


T.M.K resistance trained athletes and 10 non-athletes. Left ventricular dimensions were measured by M-mode and two-dimensional echocardiography. For endurance trained athletes, absolute left ventricular and diastolic volume and valves normalized for lean body mass were significantly greater than in non-athletes. An inter study comparison of female Vs male endurance trained athletes from the same population also revealed significantly lower values for M-mode left ventricular mass expressed per kg m of lean body mass in the former. Absolute and normalized wall thickness were not significantly greater in resistance trained athletes compared to the other two groups. Wall thickness indexed for lean body mass was similar for the three groups. It appears that both female resistance and endurance trained athletes exhibit a lesser degree of enlargement of left ventricular wall thickness and mass than male athletes close relationship between skeletal and cardiac musculature in resistance trained athletes of both genders also was supported.
Dibello et al. conducted a study to evaluate left ventricular function during exercise in 10 male elite runners and in 10 sedentary males. End diastolic (EDV) and systolic volume (ESV) left ventricular ejection fraction (EF), early peak transmitted flow velocity, time velocity integral of mitral inflow, mitral cross sectional area, mitral stroke volume and cardiac output were measured by echo-Doppler, arterial blood pressure by sphygmomanometer and heart rate by ECG. The parameters were measured under basal conditions 50% of maximal aerobic capacity, at peak of exercise and during recovery. Ejection fraction in athletes increased significantly in athletes at peak of exercise. Left ventricular diastolic function was superior in athletes versus controls in fact higher peak E in athletes enhanced early diastolic ventricular filling. The athletes showed complex cardio vascular adjustments induced by training, which

allowed higher peak working power, a greater cardiac output and VO2 max when compared with untrained control population.

Bert et al \(^{53}\) compared patients with severe left ventricular dysfunction (SLDV) responds to an exercise stimulus to patients with mild left ventricular dysfunction over an 8 week period. Thirty-nine cardiac patients were divided into two groups and administered heart function test. Results suggest that the rate of improvement for a group of mild left ventricular dysfunction is similar to SLDV after a long term conditioning stimulus.

Siconolfi, Charles, and Moore \(^{54}\) reported that interval

\(^{53}\)T.Berk et al, “Rate of effect Change in Severe Left Ventricular Dysfunction” “Medicine & Science In sports And Exercise” Vol:25 (1993): 55

exercise (IE) during space flight maintained VO2 peak and the heart rate response to standing upon landing while continuous exercise maintained only VO2 peak and no exercise during flight maintained neither parameter. In this study, reported changes left ventricular end diastolic and systolic dimensions, shortening fraction and stroke volume in the same astronauts. Ventricular dimensions and stroke volume were determined before and after landing with echo cardiographic and pulsed Doppler method. The results suggest that changes in left ventricular dimensions observed with speae flight and little effect on cardiac function as described by shortening fraction and stroke volume. In flight exercise did not consistently modify these results.

Goodmann, Liu and Mehaughlin 55 examined the effect of 150 minutes of prolonged exercise on left ventricular (LV)

performance. 15 competitive male cyclist were selected and upright bicycle exercise was performed at 70 - 72 % of vo2 max. measures of L. V. Performance were made using equilibrium radionuclide angiography at rest after 30, 60, 90 and 150 min of exercise and after 30 min recovery. Exercise data for heart rate, LV Performance were made using equilibrium radionuclide angiography at rest, after 30, 60, 90 and 150 min of exercise and after a 30 min recovery data for heart rate, LV ejection fraction (EF) end diastolic (EDV) end systolic (ESV) and stroke volume (SV) were taken. A trend for a slower rapid filling phase of diastolic following exercise was observed. These data suggest there is no evidence of cardiac fatigue during prolonged effort.

Kastuimur 56 et al investigated the changes in cardiac

function echographically 21 Japanese men who completed 3.9 km swim, 180.2 km bike, 42.2 km run were tested two days after the race, at the finish and following the day. Mean left ventricular end diastolic dimension (LVLD) decreased after the race. But mean LV end-diastolic dimension (LVD) was unchanged individually, however the LVD’s were not consistently increased or decreased. Left ventricular ejection fraction (EF) was reduced at the finish, and returned to the pre race level on the following day. The wall stress was unchanged. The reduction in EF was not correlated with the changes in LVDD but LVDD. Further more it is not correlated with the changes in WS. Accordingly the reduction in EF might resulted from the reduction in myocardial contractility itself. Result suggested that the reduction in myocardial contractility observed at the finish did not result mainly from myocardial injury.
Komick, Saleedo and Puhl \textsuperscript{57} compared left ventricular mass in 565 patients aged 20 – 79 years without evidence of coronary artery disease or history of hypertension. All patients underwent echocardiography and arterial blood pressure determination LVM was indexed to body surface are and expressed as left ventricular indexed LVMI. Other variables of interest included left arterial size posterior and septal wall thickness, fractional shortening, relative wall thickness and wall stress. A significant relationship was observed between LVM and BSA. Concluded with the indices of LV chamber dimensions, thickness and systolic function were normal across age ranges

Perrault \textsuperscript{58} conducted a study on thirteen male marathon


\textsuperscript{58} Perrault, "Assessment of cardiac performance before and after marathon running", Medicine And Science In Sports And Exercise, Vol. 17, 1985, P203
runners by using echocardiography to assess the left ventricular performance, prior to an immediate upon competition of a 42 Kms race. Measurements of end-diastolic diameters where not significantly altered following the run. Significantly higher cardiac output calculated from M-mode echocardiography dimensions was observed following the run due to a marked increase in the heart rate, stroke volume remaining unchanged. Computations of left ventricular performance indices showed no changes in either stroke dimensions, fractional shortening pre-ejection period, ejection time index, mean velocity of the circumferential fiber shortening. Alternatively peak systolic wall stress was significantly reduced due to mark reduction in systolic blood pressure. These result indicate that myocardial performance was not impaired following marathon running.

Ikahemio and Co-workers 59 evaluated possible differences

in cardiac effects of different types of running training, 22 competing mall runners, 10 sprinters and 12 endurance runners were studied with echocardiography. The left ventricular end-diastolic volume was equally greater than normal in both groups of athletes. But in endurance runners person changes of the minor axis diameter in systole was greater than in sprinters or control subjects. Values for left ventricular wall thickness and mass were greater than the normal in both groups of athletes but were higher in endurance runners than in sprinters. Endurance training causes left ventricular dilation equal to that of sprinter training, greater wall hypertrophy and improved systolic emptying of the left ventricle and it also dilates the left atrium perhaps because of decreased left ventricular compliance.

Allen and co-workers 60 reported that and echo-

cardiographic evaluation of 77 members of championship, childhood swim team showed dimensional variations from normal in most athletes. Cardiac walls were thicker than the 95th percentile of normal right ventricular posterior walls exceed. Children who participate extensively in athletic training programs such as swimming may have echocardiograms which are quantitatively different from those of non athletic youngsters.