Chapter II

REVIEW OF RELATED LITERATURE

The research scholar has made sincere efforts to locate and collect the literature relevant to the study. The related literature collected from different source have been presented in an abstract form in this chapter.

Lee et al., (2012) stated the contribution of left ventricular (LV) twist and recoil in augmenting stroke volume during exercise is poorly understood, and few data are available describing the impact of endurance exercise on LV twist and recoil in middle-aged individuals. Therefore, the effects of chronic endurance training on these LV indices at rest and during submaximal exercise were examined in healthy, middle-aged untrained (MU) men and age-matched healthy, middle-aged endurance-trained (MT) men and in healthy, young untrained (YU) men as a healthy model. LV twist increased from rest to exercise in YU subjects but not in MU subjects. LV twist also increased from supine rest to exercise in MT subjects. Time to peak untwisting velocity was significantly delayed in MU subjects during rest and exercise compared with both YU and MT subjects. No differences were detected in any of the timing indices of LV twist between YU and MT subjects. This response pattern may help explain the mechanism underlying the training-induced augmentation in stroke volume during exercise, particularly the importance of the timing of key LV events that contribute to enhanced diastolic performance seen after endurance training.

Tsao and coworkers (2012) investigated the effects of different exercise intensities on C-reactive protein (CRP), and whether changes in CRP levels correlated with blood lipid levels. Ten men exercised at 25%, 65%, and 85% of their maximum oxygen consumption rates. Participants' blood was analyzed for CRP and blood lipid levels before and after the exercise sessions. Although there was an intensity effect for post exercise high-density lipoprotein levels, there were no significant differences or correlations for post exercise CRP levels or between CRP and lipid levels across the three exercise intensities. In an acute aerobic bout
model with isoenergetic expenditures, CRP was not affected by the exercise intensity. Additionally, changes in blood lipid levels might not have been connected to CIRP levels for physically fit participants.

Robach et al., (2012) examined ‘live high-train low’ altitude training increases exercise performance. Haematological and skeletal muscle adaptations have both been proposed. To test the hypotheses that (i) LHTL improves maximal oxygen uptake and (ii) this improvement is related to hypoxia-induced increases in total haemoglobin mass and not to improved maximal oxidative capacity of skeletal muscle, we determined VO(2)max before LHTL and after LHTL, before and after the altitude-induced increases in Hb(mass) (measured by carbon-monoxide rebreathing) had been abolished by isovolumic haemodilution. We obtained skeletal muscle biopsies to quantify mitochondrial oxidative capacity and efficiency. Sixteen endurance-trained athletes were assigned to ≥16 h/day over 4 weeks to normoxia or normobaric hypoxia equivalent to 3000 m altitude. Four-week LHTL did not increase VO(2)max, irrespective of treatment. Hb(mass) was slightly increased (4.6%) in 5 (of 10) LHTL subjects but this was not accompanied by a concurrent increase in VO(2)max. In the subjects demonstrating an increase in Hb(mass), isovolumic haemodilution elicited a 5.8% decrease in VO(2)max. Cycling efficiency was altered neither with time nor by LHTL. Neither maximal capacity of oxidative phosphorylation nor mitochondrial efficiency was modified by time or LHTL. The present results suggest that LHTL has no positive effect on VO(2)max in endurance-trained athletes because (i) muscle maximal oxidative capacity is not improved following LHTL and (ii) erythrocyte volume expansion after LHTL, if any, is too small to alter O(2) transport.

Eastwood et al., (2012) reported that Haemoglobin mass determination using CO rebreathing may assist to detect illegal blood doping practices; however variations in Hbmass with periods of intensive training and detraining must be quantified. This study aimed to determine the effect of a 30-day period of detraining on Hbmass in ultra-endurance triathletes. 9 male recreational triathletes (29-44 years) participated in the study. Hbmass was assessed using CO rebreathing 30 days and 10 days before an ultra-endurance triathlon and after ~10, 20 and 30
days of detraining following the race. V˙O2max was assessed 10 days before the race and also after the 30-day detraining period, which consisted of an 87% reduction in training hours. After 30-days of detraining there was a 3.1% decrease in mean Hbmass from 868±99 to 840±94 g, (p=0.03), and a 4.7% decrease in mean V˙O2max from 4.83±0.29 to 4.61±0.41 L/min as well as a 2.8% increase of body mass from 75.1±6.4 to 77.1±6.1 kg and a 28% increase in skinfold total from 43.9±14.2 to 55.1±14.0 mm. Individual decreases in Hbmass following detraining would need to be considered if using Hbmass for anti-doping purposes.

Therese, E. et al., (2011) conducted a study to determine the effect of cycling, electrical stimulations, or both, on thigh muscle volume and stimulated muscle strength in children with spinal cord injury (SCI). Design: Randomized controlled trial. Setting: Children’s hospital specializing in pediatric SCI. participants: Children (N = 30; ages, 5 – 13 y) with chronic SCI. Interventions: Children were randomly assigned to 1 to 2 interventions: functional electrical stimulation cycling (FESC), passive cycling (PC), and noncycling, electrically stimulated exercise (ES), Each group exercised for 1 hour, 3 times per week for 6 months at home. Main outcome measures: Preintervention and postintervention, children underwent magnetic resonance imaging to assess muscle volume, and electrically stimulated isometric muscle strength testing with the use of a computerized dynamometer. Data were analyzed via analyses of covariance (ANCOVA) with baseline measures a covariates. Within-group changes were assessed via paired t tests, Results: All 30 children completed the training. Muscle volume data were complete for 24 children (8 FESC, 8 PC, 8 ES) and stimulated strength data for 27 children (9 per group). Per ANCOVA, there were differences between groups (P<.05) for quadriceps muscle volume and stimulated strength, with the ES group having greater changes in volume and the FESC group having greater changes in volume and strength. Within-group analyses showed increased quadriceps volume and strength for the FESC group and increased quadriceps volume for the ES group. Conclusions: Children receiving either electrically stimulated exercise experienced changes in muscle size, stimulated strength, or
both. These changes may decrease their risk of cardiovascular disease, insulin resistance, glucose intolerance, and type 2 diabetes.

Prakken et al., (2011) conducted a study to establish cardiac magnetic resonance imaging (MRI) reference values for atrial adaptation to training in endurance athletes in comparison with matched non-athletes. In addition, to study the relationship of atrial size to ventricular and annular size and valvular function. Cross-sectional study of 180 healthy individuals aged 18–39 years: 60 elite endurance athletes, 60 regular endurance athletes, and 60 age and gender matched non-athletes underwent cardiac MRI. Quantitative atrial dimensions and volumes, indexed for body surface area (BSA), were compared with ventricular and annular dimensions. Regurgitant fractions of all four valves and peak velocities of mitral and tricuspid valves were also assessed. BSA-corrected right and left atrial volumes and diameters were significantly larger for athletes compared with non-athletes. Ventricular, annular and atrial ratios remained constant for all groups, suggesting balanced adaptation to exercise training. E/A ratios remained statistically unchanged in all groups. Regurgitant fractions of the four cardiac valves were all mild and not significantly different in athletes compared with non-athletes.

Kim and Andy, Kerr (2010) examined the recruitment pattern of lower limb muscles during cycling is known to alter because of changes in workload and seat height. The effect of foot/pedal position is not well understood but may be useful in the prevention and management of injury. Seven healthy female subjects participated in a study. Three-foot position on the pedal were tested in a random order: neutral, back and fore. Each subject cycled for 5 minutes at a set cadence and resistance during which 30 seconds of electromyogram data were recorded for gastrocnemius (Gast.) and tibialis anterior (TA). An electrogoniometer was located across the knee to concurrently record pedal revolutions. To test the effect of position, an ANOVA and Tukey’s post-hoc were used for Gast. However, the data from the TA were not normally distributed; therefore, a Kruskal-Wallis was used for this muscle instead. No statistical significant relationship was found between foot position and TA activity. However, there was a significantly lower
level of activity in Gast. When the pedal was placed in the back foot position. Altering the position of the foot on a pedal changes the muscle activity of Gast. This is likely to be caused by the change in moment arm and may be exploited as a strategy to progress resistance during a training programme or as a method of protecting the muscle during a period of recovery.

Teske and coworkers (2010) conducted a study to explore the functional changes measured using tissue Doppler imaging (TDI) deformation analysis in athletes fulfilling LVH criteria participating in different endurance sports. Healthy controls and endurance athletes aged 18–40 years were prospectively enrolled and underwent both standard echocardiography as well as TDI. Longitudinal TDI-derived strain and strain rate (SR) were calculated in the septal and posterior wall in three segments. LVH was defined as a left ventricular mass (LVM) over 132 g/m\(^2\) in men and over 109 g/m\(^2\) in women. Echocardiographic LVH was observed in 33 athletes. LVM was significantly increased in both athlete groups. Diastolic parameters were not significantly different between groups. Athletes with LVH showed no significant difference in strain and SR values in any segment of the septal or posterior wall compared with controls or those without LVH. A weak but significant correlation was found for septal wall thickness and LVM in peak systolic strain. Nevertheless, strain and SR values were still within normal limits in all athletes.

Shaw (2010) reported that successful performance in aerobic distance running is dependant on the athlete's ability to cover a fixed distance in the shortest time possible. An effective distance runner's programme must include an exercise prescription specifically developed for the individual athlete. In this regard, a percentage of either measured or predicted maximum heart rate is commonly used to prescribe and measure exercise intensity. However, maximum heart rate in athletes may be greater during competition or training than during laboratory exercise testing. Therefore, it is essential to determine if endurance-trained runners train and compete at or above laboratory measures of ‘maximum’ heart rate. Research indicates that long distance runners attain higher maximal heart rates in a field or competition setting than in a laboratory setting and as such, distance event
Review of Related Literature

Runners' exercise intensities should not be based on laboratory assessment of maximum heart rate, but instead on maximum heart rate obtained either during training or during competition.

Haro and coworkers (2007) conducted a study to access the fat-oxidation rate in triathlon and different modalities of endurance cycling. 34 endurance athletes (15 male triathletes, 4 female triathletes, 11 road cyclists and 4 male mountain bikers) underwent a progressive cycloergometer test until exhaustion. Relative work intensity (VO$_{2\text{max}}$), minimal lactate concentration (La$_{-\text{min}}$), lactic threshold, individual lactic threshold (ILT), maximal fat-oxidation rate (Fat$_{\text{max}}$, Fat$_{\text{max}}$ zone) and minimal fat-oxidation rate (Fat$_{\text{min}}$) were determined in each of the groups. No significant differences were found for Fat$_{\text{max}}$, Fat$_{\text{min}}$ or for the Fat$_{\text{max}}$ zone expressed as fat oxidation rate (g/min). Intensities −20%, −10% and −5% Fat$_{\text{max}}$ were significantly lower for mountain bikers with respect to road cyclists and female triathletes, expressed as % VO$_{2\text{max}}$. Intensities 20%, 10% and 5% Fat$_{\text{max}}$ were significantly lower for mountain bikers with respect to male triathletes and female triathletes, and for male triathletes in comparison with female triathletes, expressed as % VO$_{2\text{max}}$. Lactic threshold and La$_{-\text{min}}$ did not show significant differences with respect to Fat$_{\text{max}}$. Lactic threshold was found at the same VO$_{2\text{max}}$ with respect to the higher part of the Fat$_{\text{max}}$ zone, and La$_{-\text{min}}$ at the same VO$_{2\text{max}}$ with respect to the lower part of the Fat$_{\text{max}}$ zone.

Nagashima et al., (2006) to estimate predictors of race time, by a subanalysis of an echocardiographic study performed on 291 Japanese participants in a 100 km ultramarathon. A total of 247 male participants in a 100 km ultramarathon (age 20–73 years) were examined by echocardiography. Correlations between age, body surface area, monthly running distance, or echocardiographic variables and the race time were examined. According to simple regression analysis, age, monthly running distance, left ventricular end diastolic diameter, and left ventricular end systolic diameter correlated significantly with the race time. When multiple regression analysis was performed, age, monthly running distance, and left ventricular end systolic diameter remained significant predictors of the race time.
Lucia (2005) reported that road cycling is a sport that requires performing in great variety of terrains (i.e. level vs. uphill roads) and competitive situations (i.e. individual cycling or drafting behind numerous cyclists). In turn, cycling performance in each of the competition terrains is partly determined by individual morphological characteristics (body mass, height, body surface and frontal areas, body mass index (BMI). Anthropometric variables might thus greatly differ depending on each PC specialty. TT or flat terrain specialists are usually taller and heavier (180 to 185 cm tall, weighing 70 to 75 Kg., BMI of \( \approx 22 \)) than those exceed in uphill climbing (175 to 180 cm tall, weighing 60 to 66 Kg, BMI of 19 – 20).

Vella and Robergs (2005) reported that traditionally, it has been accepted that, during incremental exercise, stroke volume plateaus at 40% of \( \text{VO}_2\text{max} \). However, recent research has documented that stroke volume progressively increases to \( \text{VO}_2\text{max} \) in both trained and untrained subjects. The stroke volume response to incremental exercise to \( \text{VO}_2\text{max} \) may be influenced by training status, age, and sex. For endurance trained subjects, the proposed mechanisms for the progressive increase in stroke volume to \( \text{VO}_2\text{max} \) are enhanced diastolic filling, enhanced contractility, larger blood volume, and decreased cardiac afterload. For untrained subjects, it has been proposed that continued increases in stroke volume may result from a naturally occurring high blood volume. However, additional research is needed to evaluate the importance of blood volume, or other mechanisms, that influence the stroke volume response to exercise in untrained subjects.

Savelberg et al., (2003) conducted a study evaluate the effect of body configuration on muscle recruitment and joint kinematics. Changing trunk angle affects the length of muscles that span the hip joint. It is hypothesized that this affects the recruitment of the muscles directly involved, and as a consequence of affected joint torque distributions, also influences the recruitment of more distal muscles and the kinematics of distal joints. It was found that changing the trunk from an upright position to approximately 20 deg forward or backward affected muscle activation patterns and kinematics in the entire lower limb. The knee joint
was the only joint not affected by manipulation of the lengths of hip joint muscles. Changes in trunk angle affected ankle and hip joint kinematics and the orientation of the thigh. A similar pattern has been demonstrated for muscle activity. Both the muscles that span the hip joint and those acting on the ankle joint were affected with respect to timing and amplitude of EMG. Moreover, it was found that the association between muscle activity and muscle length was adapted to manipulation of trunk angle. In all three conditions, most of the muscles that were considered displayed some eccentric activity. The ratio of eccentric to concentric activity changed with trunk angle. The present study showed that trunk angle influences muscle recruitment and (inter) muscular dynamics in the entire limb. As this will have consequences for the efficiency of cycling, body configuration should be a factor in bicycle design.

Garvican (2001) found that the delivery of oxygen during exercise is critically important for endurance athletes. Elite endurance athletes possess superior amount of haemoglobin versus untrained counter parts, which enables a high rate of oxygen delivery during exercise. The research in this thesis utilises the recently, optimized method for the measurement of Hb mass in elite endurance athletes, predominantly cyclists, with the aim of determining the importance of Hb mass for endurance performance.

The influence of training on Hb mass are somewhat limited. Despite the observation that training can be associated with small increases in HB mass of few percent, preliminary evidence suggests that very high levels of Hb mass observed in elite athletes is either due to prolonged cumulative effects of training or is genetically predetermined and hence, naturally selected.

Ganong (1997) studied the amount of blood ejected by each ventricle per stoke at rest of 70-90 ml. The end diastolic ventricular volume is about 130 ml. Thus about 50 ml of blood remains in each ventricle at the end of systole (end systolic ventricular volume) and ejection fraction, the percent of the end-diastolic ventricular volume that is ejected with each stroke is about 65%. The ejection fraction is a valuable index of ventricular function.
Wall movement and other aspects of cardiac function can be evaluated by echocardiography, a noninvasive technique that does not involve injections and insertions of a catheter. In echo cardiography, pulses of ultrasonic waves, commonly at a frequency of 2.25 MHz are emulated from a transducer that also functions as a receiver to detect waves reflected back from various parts of the heart. Reflections over wherever acoustic impedance changes, and a recording of the echoes displayed against time as an oscilloscope provides a record of the movements of the ventricular wall, septum and valve during the cardiac cycle.

Dibello et al., (1996) 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 transmitral 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 at 50% of maximal aerobic capacity, at peak of exercise and during recovery. Ejection fraction in athletes increased significantly at peak of exercise. Stroke volume and cardiac output 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 cardiovascular adjustments induced by training, which allowed higher peak working power, a greater cardiac output, and VO2 max when compared with an untrained control population.

Tummavuori and Rusko (1996) investigated the development of the athlete’s heart in 30 male cross country skiers during five 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 end diastolic diameter (EDD), mean wall thickness (MWT) and left ventricular mass (LVM) were calculated from resting echocardiograms recorded in left lateral position in the beginning of the study and after five years. The effects of
progressively increased training volume were demonstrated in maximal oxygen uptake and left ventricular mass detraining included minor changes in heart dimensions and LVM.

Bonetti et al., (1995) studied plasma levels of lipoprotein (a), total cholesterol, triglycerides, HDL, cholesterol, apoprotein A and aprotein 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 a 72 hours period. Subsequently the same parameters were evaluated for 8 long distance runners during marathon, with blood samples being taken before and after the race and then after one month of detraining. After the exercise, lipoprotein (a) in untrained subjects began to decrease significantly from the 24th hour on and remained lower than baseline levels up till the 72nd hour. After detraining, lipoprotein (a) in marathon runners increased significantly both with respect to basal values and especially to postrace values. In the two groups of subjects examined, no correlation was found between lipoprotein (a) and the anthropometrical data and metabolic parameters considered.

George et al., (1993) selected 10 varsity level endurance trained athletes, 10 resistance trained athletes and 10 non athletes. Left ventricular dimensions were measured by M-mlde 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. A close relationship between skeletal
and cardiac muscularity in resistance trained athletes of both genders also was supported.

Goodman, Liu and Mchaughlin (1993) examined the effect of 150 minutes of prolonged exercise (EX) on left ventricular (LV) performance. 15 competitive male cyclists 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 a 30 min. recovery. Exercise data for heart rate, L.V. ejection fraction (EF), end diastolic (EDV) end systolic (ESV) and stroke volume (SV) were taken. A trend for a slower rapid filling phase of diastole following exercise was observed. These data suggest there is no evidence of cardiac fatigue during prolonged effort.

Katsumur et al., (1993) 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 before the race, at the finish and following the day. Mean left ventricular end diastolic dimension (L.VDd) decreased after the race. But mean I.V end-systolic dimension (LVDs) was unchanged. Individually, however, the I.VDs 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 LVDs. 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 suggest that the reduction in myocardial contractility observed at the finish did not result mainly from myocardial injury.

Maston; Tran and Weltrman (1993) examined the effects of exercise training on lipid and lipoprotein levels. Exercise training can have favourable effects on the lipid profile in humans. However the magnitude and direction of the gender effect is not clear. In which 152 subjects were analysed. 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.

Sullivan et al., (1993) conducted a cross sectional study to determine if fitness was associated with lipoprotein (a) concentrations, cardiorespiratory 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, triglyceride (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.

Zmuda et al., (1993) compared lipid and lipoprotein concentrations, in 12 endurance trained and 13 sedentary women. Runners had non-significantly lower triglyceride and higher HDL-C, concentrations. Results suggest that increased lipoprotein lipase and enhanced plasma triglyceride clearance at least partly contribute to the elevated HDL-C levels of endurance trained women.

Kerbs (1992) examined the effects of bicycle training and marathon training on fasting blood chemistry values. The significant differences were observed between cyclists and marathon runners on the eighteen blood parameters studied. Significant differences were found for albumin, cholesterol, creatine, phosphokinase, globulin, hematocrit, lactate dehydrogenase, globulin, hematocrit, lactate dehydrogenase low density lipoprotein, total protein, red blood cells, and triglycerides, were observed between the two groups.

Farlane et al., (1991) 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 74.7 ± 1.43. Group II consisted of ten elite weight lifters with 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.

Gledhill; Cox and Jamnik (1991) examined left ventricular function during incremental work rates to maximum using simultaneous determinations of stroke volume, left ventricular ejection time (1. VET) and diastolic filling time. Seven endurance trained and seven untrained young adult males were studied on a cycle ergometer at matched heart rates of 90, 120, 140, 160, 180 and 190 bpm. Stroke volume of untrained subjects reached a plateau at 120 bpm, but the stroke volume of the trained subjects continued to increase to their maximum heart rate with no plateau. Throughout incremental work rates, I.VET was significantly longer and DT was significantly shorter in the trained subjects. During incremental work rate the stroke volume of endurance trained athletes increases progressively to maximum with no plateau. In addition, although trained athletes rely on enhancements in both ventricular filling and ventricular emptying to augment stroke volume, by far their major advantage over untrained subjects is in ventricular filling.

Barr et al., (1991) conducted a study to assess whether a previously described dose-response relationship between the amount of exercise and the magnitude of change in 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 season of training and competition in experienced male collegiate swimmers, who were divided into two groups matched for swimming skill. No changes in HDL cholesterol were observed during the season 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 of swimming exercise may not be related to the degree of changes in blood lipid and lipoproteins levels in healthy subjects with high activity levels.
Dirix; Knuttgen and Tittel (1991) reports that intensive sports competition affect the immune systems of athletes. Prolonged endurance exercise of high intensity exert an influence on the acute phase proteins and immunoglobulms. Due to the elevation of intravascular haemolysis, particularly in running exercise, the concentration of leucocytes, lymphocytes and monocytes are raised with out any detectable inflammation, the eosinophilic granulocytes however decrease. This is particularly true for marathon running. The T-lymphocyte show an intense reaction to heavy athletic training and release numerous cytotoxins.

While blood cells, neutrophil, lymphocyte and eosinophil are the factors present in the blood, which normally count as 5000-1000, 40-60, 20-45, and 2-7 respectively.

Coyle et al., (1991) evaluated the physiological and biomechanical responses of “elite-national class” and “good-state class” cyclists while they simulated a 40 km time-trial in the laboratory by cycling on an ergometer for 1 h at their highest power output. Actual road racing 40 km time-trial performance was highly correlated with average absolute power during the 1 h laboratory performance test in turn, 1 h power output was related to each cyclists’ VO2 at the blood lactate threshold. Group 1 was not different from group 2 regarding VO2 max or lean body weight. However, group 1 bicycled 40 km on the road 10% faster than group 2 Additionally, group 1 was able to generate 11% more power during the 1 h performance test than group 2 and they averaged 90 +/- 1% VO2 max compared with 86 +/- 2% VO2 max in group 2. The higher performance power output of group 1 was produced primarily by generating higher peak torques about the center of the crank by applying larger vertical forces to the crank arm during the cycling downstroke. Compared with group 2, group 1 also produced higher peak torques and vertical forces during the downstroke even when cycling at the same absolute work rate as group 2. Factors possibly contributing to the ability of group 1 to produce higher “downstroke power” are a greater percentage of Type 1 muscle fibers and a 23% greater muscle capillary density compared with group 2. We have also observed a strong relationship between years of endurance training and percent Type 1 muscle fibers. It appears that “elite-national
class” cyclists have the ability to generate higher “downstroke power”, possibly as a result of muscular adaptations stimulated by more years of endurance training.

Basset et al., (1990) conducted a study on 15 highly trained, pre-pubertal female gymnasts of same age, height and 15 girls 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 was stress, left ventricular internal wall to posterior wall thickness ration and percent of posterior wall thickness 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 of LVID and LVPW. The R/th ratio was significantly lower in gymnasts, suggesting in appropriate hypertrophy. Highly trained young gymnasts does not seem to be deleterious to their cardio vascular system.

Fox; Bowers and Foss (1989) reports that haemoglobin concentration does not usually change with training. If any thing it decrease slightly for example the normal haemoglobin concentration for male is 15 gms per 100 ml of blood on the average. In a group of highly trained endurance runners, the average haemoglobin concentration was only 14.3 gm/100 ml of blood.

Miller and Manfredi (1987) conducted a study to assess the relationship between physiological and anthropometrical variables and 15 km time trial (TT) cycling performance time. Twenty-two competitive cyclists average 59.7 ml. kg-1. min-1 for maximal oxygen consumption (VO2 max), 42.8 ml.kg-1, min-1 for anaerobic threshold (AT), and 23.5 min for the 15 km TT race. The relationship between VO2 max and cycling performance time was r is -0.68, while the correlation between AT and performance time was r is -0.93. Applying stepwise multiple regression analysis, the two-variable model of the AT and the body circumference ratio, thigh plus calf: arm plus chest, was found to correlate highly
with cycling performance time (r is 0.966). It was concluded that the successful cyclists are characterized by the ability to consume large amounts of oxygen prior to ventilatory changes associated with the anaerobic threshold as well as larger lower to upper body circumference ratio which may favourably decrease wind resistance while cycling.

Harries et al., (1986) 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 endurance sports, such as running, swimming and cycling, demand prolonged elevation of cardiac output.

Cardiac output is the volume of blood ejected by the left or right ventricle to the great arteries per minute.

Stroke volume is the volume of blood ejected from the left ventricle for 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.

Echocardiography, a non-invasive cardiac imaging involves the placing of a transducer, which emits ultrasound waves on the chest. The measurement of cavity size and the wall thickness of the left ventricle, the size of both atria, left ventricular end diastolic dimension, end-systolic dimension. Septal thickness ejection fraction with a normal range of 5 to 7 fractional shortening. Left ventricular mass is with a normal value of approximately 180 ± 50 g.

Morgan et al., (1986) found that serum high density lipoproteins cholesterol (HDL-C) levels and percent HDL-C were significantly higher in nine female endurance runners than in equal groups of female weight trainers and sedentary female controls. Weight trainers and controls showed no significant differences in HDL-C. No significant dose-response relationships were found for either runners
or weight trainers when daily training duration, weekly training frequency and weekly mileage were correlated with HDL-C. It was concluded that HDL-C levels in females are associated with specific training methods.

Perrault (1985) conducted a study on thirteen male marathon runners by using echocardiography to assess the left ventricular performance, prior to and immediately upon completion of a 42 kms race. Measurements of end-diastolic diameters were not significantly altered following the run. Significantly higher cardiac output calculated from M-mode echocardiographic 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 a marked reduction in systolic blood pressure. These result indicate that myocardiac performance was not impaired following marathon running.

Bale, Rowell, and Colley (1985) investigated to determine how female marathon runners of varying standards differed in body composition and physique and in their training regimes, and secondly to develop predictors of distance running performance from the anthropometric and training variables, 36 Female marathon runner, all participants in a national 10 mile (16 km) road racing championship, were divided into three groups according to their best time for the 26.2 mile race. They were assessed for body composition and somatotype using anthropometric techniques and completed a questionnaire about their current training for the marathon. No difference was found between the groups of distance runners when measured for height, bone widths and circumferences. The three groups were found to have similar body weights of approximately 53 kg, a value which is much lower than the average for sedentary women, but which compares favourably with those from previous studies of female long distance runners. While all the runners had a lower per cent fat, as measured from skinfold thicknesses, than sedentary women, the elite runners were seen to have significantly lower values than the other two groups. The difference in body fat
was particularly reflected in the triceps skinfold value. There was also a tendency for the elite runners to be more ectomorphic and less endomorphic than the others. The better runners were seen, on the whole, to have been running longer, and to have more strenuous regimes, both in terms of intensity of training and distance run per week. Multiple regression and discriminant function analyses indicated that the number of training sessions per week and the number of years training were the best predictors of competitive performance at both 10 mile and marathon distance. They also indicated that a female long distance runner with a slim physique high in ectomorphy has the greatest potential for success.

Wieling and co-workers (1981) studied nine freshmen and 14 senior Oars Men undergraduates during seven 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 and a greater left ventricular septum and posterior left ventricular wall than control subjects and freshmen. The two later groups did not differ from each other. During the training period there was a 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 month during the 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 with in moths.

Mathews and Fox (1981) stated that an indicator of cardio-respiratory endurance is the pulse rate. This is used extensively in numerous adult fitness programme. Research has shown that children have faster resting pulse rates than adults, although senior citizens usually have faster pulse rate than young athletes. Individuals with high level of cardio respiratory endurance have a lower resting pulse rate and return faster to the resting rate than physically fit individuals.
Michelli, and co-workers (1981) studied a comparison of exercise training intensity on lipoprotein cholesterol fractions. Forty nine men were studied to determine the effect of 12 weeks of bicycle ergometer training at 65%, 75%, 85% of heart rate maximum of lipoprotein cholesterol fractions.

All other 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.

Ikahemio and co-workers (1979) evaluated possible differences in cardiac effects of different types of running training. 22 competing male 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, percent 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 dilatation 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.

Guyton (1976) 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 enhance, 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.

According to Morehouse and Miller, (1976) the red blood cell counts is frequently increase in the early stage of exercise. During more prolonged exercise, fluid possess in to the blood, and the resulting dilution, of course, lowers the red blood cell count. Very strenuous exertion may also cause an increased rate of destruction of red blood cells due to compression of the capillaries of blood flow.
This is especially noticeable in person of sedentary habits who sporadically indulge in exercise.

Morganroth et al., (1975) studied echocardiograms of 56 active athletes. Mean left ventricular end-diastolic volume and mass were increased in athletes involved in isotomic 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 volumes but increased wall thickness and mass. Thus the athletes participating in isotomic exercise has increased left ventricular mass with cardiac changes similar to those in chromic volume overload.

Mann, et al (1969) has reported that regular exercise programmes causes decreases in both blood cholesterol and triglycerides levels. This change is particularly apparent in individuals who initially have very high blood 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).

Astrand et al., (1964) reported that cardiac volume has been subsequently found to correlate well with stroke volume, cardiac output, maximum oxygen uptake, total blood volume and total haemoglobin content.