CHAPTER - II

REVIEW OF RELATED LITERATURE

2.1 NEED OF RELATED LITERATURE

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

The relevant literature pertaining to the present study has been abstracted in this chapter to provide the background material to evaluate the significance of this study as well as to interpret its findings.

Related literature plays a crucial part in the planning of the study. It contributes to the scholarship of the investigator and it provides a background for the development of the present reader up to date.

The literature in any field forms the foundation upon which all future work will be built.
Sagiv, et al., stated that this study used the metabolic charts and echocardiography to examine the influence of two different types of load carriage during 30 min of treadmill walking on left ventricular function, hemodynamics, and cardiovascular responses. Fifteen elderly (age 66.1 +/- 3.5 years) aerobically well-trained male subjects (VO(2 peak) 44.2 +/- 5.0 ml x kg(-1) x min(-1)) volunteered in this study. The subjects walked on a treadmill (at a speed of 4.5 km x h(-1)), carrying a load of 20 kg during one session and a load of 30 kg during a second session. Following the 30-min exercise in each session, significant (p < 0.05) differences were noted between the 20-kg and the 30-kg work loads with regard to cardiac output (6.8 +/- 0.5 and 7.8 +/- 0.4 l.min(-1)), heart rate (114.0 +/- 11.0 and 126.0 +/- 10.0 beats.min(-1)), diastolic blood pressure (79.4 +/- 5.0 and 84.3 +/- 5.0 mm Hg), mean arterial blood pressure (104.0 +/- 4.0 and 109.2 +/- 3.0 mm Hg), and left ventricular contractility ratio (3.3 +/- 0.4 and 3.6 +/- 0.3). No significant differences were noted between the work loads with regard to systolic blood pressure, cardiac output, left ventricular volumes, and ejection fraction. This study suggests that in the highly trained elderly, the influence of the autoregulation mechanism dominates during combined dynamic and isometric exercises, thus the opposing force to the left ventricular ejection is reduced which in turn does not change left ventricular global function.
Journeay, et al., stated that the hypothesis that reduced cardiac filling, as a result of lower body negative pressure (LBNP) and postexercise hypotension (PEH), would attenuate the reflex changes to heart rate (HR), skin blood flow (SkBF), and mean arterial pressure (MAP) normally induced by facial immersion was tested. The purpose of this study was to investigate the cardiovascular control mechanisms associated with apneic facial immersion during different cardiovascular challenges. Six subjects randomly performed 30-s apneic facial immersions in 6.0 +/- 1.2 degrees C water under the following conditions: 1) -20 mmHg LBNP, 2) +40 mmHg lower body positive pressure (LBPP), 3) during a period of PEH, and 4) normal resting (control). Measurements included SkBF at one acral (distal phalanx of the thumb) and one nonacral region of skin (ventral forearm), HR, and MAP. Facial immersion reduced HR and SkBF at both sites and increased MAP under all conditions (P < 0.05). Reduced cardiac filling during LBNP and PEH significantly attenuated the absolute HR nadir observed during the control immersion (P < 0.05). The LBPP condition did not result in a lower HR nadir than control but did result in a nadir significantly lower than that of the LBNP and PEH conditions (P < 0.05). No differences were observed in either SkBF or MAP between conditions; however, the magnitude of SkBF reduction was greater at the acral site than at the nonacral site for all conditions (P < 0.05). These results suggest that the cardiac
parasympathetic response during facial immersion can be attenuated when cardiac filling is compromised.

**Jaraba Caballero**, et.al., stated that Male children aged 6 and 7 years were selected from a public school (PS) and from a soccer sports school (SS). They underwent anthropometrical measurement. Those boys who were further than one standard deviation from the 50th percentile were excluded from the study. A total of 74 boys were selected with 41 being from the PS and 33 from the SS. Three different physical competitive activities were performed by the children. Hemodynamic measurements [heart rate (HR), systolic, mean and diastolic blood pressure (SBP, MBP and DBP)] and respiratory measurements [respiratory rate (RR), arterial oxygen saturation (SatO2), peak expiratory flow (PEF), forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and the FEV1/FVC relationship] were taken before and after the physical activity. Overall we found a significantly higher physical performance in the SS group (p < 0.001). The HR before and after exercise was significantly lower in the SS group. The comparison between constants before and after physical activity in each group showed a significant increase in HR, SBP, MBP and DBP in the PS group, but there was no difference between the SBP before and after physical activity in the SS group. The SS group had a significantly lower RR and better SatO2 in the basal measurement. The relationship between constants before and after physical activity showed a rise in the PEF in the PS group and a
decrease in the SatO2 in the SS group. We recommend controlled physical competitive activity in children because of its benefits on cardiorespiratory function and the absence of adverse effects.

Loudina and Franke, stated that Endurance-trained males may be more prone to orthostatic hypotension than untrained subjects and this is reflected in differences in their cardiovascular responses to lower body negative pressure (LBNP). It is uncertain if the type of endurance training used affects these responses. Endurance-trained runners will differ from endurance-trained swimmers in their cardiovascular responses to LBNP. Male intercollegiate cross country runners (XC, n = 9), sprinters (SP, n = 7) and swimmers (SW, n = 12) underwent exposures to -10, -20 and -40 mm Hg LBNP. Forearm blood flow, heart rate (HR) and blood pressure were measured throughout. Maximal oxygen consumption (VO2max) was determined separately via combined arm-and-leg cycle ergometry. The XC were more fit than the SW and SP (VO2max = 64.5 +/- 3.5 vs. 51.7 +/- 1.9, 49.5 +/- 2.4 ml.kg-1.min-1; x +/- SEM; p < 0.05). Resting mean arterial pressure (MAP, 93 +/- 3 mm Hg) and forearm vascular resistance (FVR; 26.2 +/- 6.0 units) did not differ significantly between groups although HR was 17 +/- 3 b.min-1 higher (p < 0.05) in SW vs. SP and XC. Neither the pulse pressure, MAP, HR, nor FVR responses to the LBNP exposures differed significantly between the 3 groups. Compared to rest, pulse pressure was reduced (p < 0.05) 14% at -40 mm Hg. Similarly, HR was increased (p < 0.05) 10% at -40 mm Hg. FVR increased (p < 0.05) with
each increase in LBNP becoming 91% greater at -40 mm Hg vs. rest. These data suggest that the cardiovascular responses to LBNP up to -40 mm Hg do not differ in chronically exercising males training with different modalities.

Torok, et.al., stated that the purpose of this study was to examine the cardiovascular responses of sprinters and distance runners to isometric (IE) and dynamic exercise (DE). Normotensive males were selected and grouped according to prior running performance: sprinter (N = 6) or distance runner (N = 6). Each subject completed an incremental DE (cycle ergometry) test (6-min stages) at 20%, 40%, and 60% of VO2peak, and 3 min of isometric handgrip at 30% of MVC. Blood pressure (BP), heart rate (HR), cardiac output (Q), oxygen uptake, and blood lactate were measured, while mean arterial blood pressure (MABP), cardiac index (CI), and systemic vascular resistance (SVR) were calculated during each stage of DE. BP and HR were measured during each minute of IE. Muscle biopsies of the vastus lateralis revealed a significant difference in capillary density (capillaries per mm2 and capillaries per fiber) between the sprinters and distance runners (323 +/- 23 vs 409 +/- 27 and 2.2 +/- 0.2 vs 3.2 +/- 0.3, P < 0.05) and for the percentage of Type I fibers (46.4 +/- 4% vs 64.8 +/- 7%, P < 0.05). The IE challenge elicited a greater BP response at minute 3 in the sprinters, which was associated with a greater HR response. During DE, there were no significant differences in BP or HR between the groups. However, at 60% of VO2peak, the distance runners
had a significantly higher cardiac index and a lower systemic vascular resistance than the sprinters (P < 0.05).

Blackburn stated that a dinghy sailing race protocol was developed from video analysis of elite Laser class sailors competing in fairly windy (> 12 knots) national level races. A dinghy sailing ergometer was constructed for use with a 90 min protocol. Subjects watched a video of a Laser dinghy skipper sailing (on-water) according to the protocol while themselves hiking (leaning out) from the ergometer and simulating their normal on-water movements in tandem with the video. This simulation was used to examine physiological responses to dinghy sailing and factors correlated with hiking performance in 10 of Australia's top 30 Laser dinghy sailors. Simulated dinghy sailing elicited a large blood pressure response but a low rate of aerobic and anaerobic metabolism. During the 20 min upwind legs, the mean (+/- S.E.M.) systolic and diastolic blood pressures were 172 +/- 18 and 100 +/- 14 mmHg respectively, and mean arterial blood pressure (MABP) was 123 +/- 14 mmHg. Oxygen uptake during the simulated upwind legs was 1.12 +/- 0.22 1 min^-1. Both blood pressure and VO2 were significantly lower during the 12 min reaching legs. The mean of the blood lactate concentrations measured 1 min following each of the upwind legs was 2.32 +/- 0.81 mM. Isometric knee extension strength (at 130 degrees) and the length to which subjects set the hiking strap on the ergometer were moderately related to upwind hiking performance (knee
extension strength and upwind hiking strap tension, \( r=0.62 \); hiking strap length and upwind righting moment, \( r = 0.66 \); both \( P < 0.05 \).

D'Este, et.al., stated that a dose of 10 mg of enalapril was administered once a day to regularly trained hypertensive athletes (mean age 39 +/- 8.9 range 29-51) in order to evaluate the effect of the drug on ambulatory blood pressure and on blood pressure and physical performance during stress testing. This investigation was a randomized, double blind, cross-over versus placebo trial. At first, subjects whose blood pressure met the entry criteria (casual diastolic blood pressure greater than or equal to 95 mmHg), were subjected to 24-hour ambulatory blood pressure monitoring and maximal upright bicycle stress testing including measurement of O2 uptake. Then they were randomly assigned to treatment with placebo or enalapril. After one month they repeated stress testing and then they were crossed over. Stress testing was repeated in all subjects after two months. The 24-hour ambulatory blood pressure monitoring was repeated in all subjects during enalapril treatment only, by a non-blind investigator. Ambulatory blood pressure decreased significantly during enalapril and no changes in heart rate were observed during the monitoring. The results of bicycle stress testing, both in basal and during the placebo test were comparable as regards blood pressure response, maximal workload, effort duration, maximal heart rate and VO2 max. With enalapril systolic and diastolic blood pressure decreased significantly during stress testing both versus basal test and placebo test.
at each workload considered including maximal workload. No changes were observed during enalapril as regards maximal workload, effort duration, maximal heart rate and VO2 max. Our results suggest that enalapril could be effective in treating hypertensive athletes because it reduces blood pressure during physical effort without affecting physical performance. We conclude that enalapril could be considered a first-choice drug in hypertensive athletes doing aerobic sports.

Kelly, et al., stated that the purpose of this study was to examine the effects of walking on resting systolic and diastolic blood pressure in adults. A total of 24 primary outcomes from 16 studies and 650 subjects (410 exercise, 240 control) met the criteria for inclusion: (1) randomized and nonrandomized controlled trials, (2) walking as the only intervention, (3) subjects apparently sedentary, (4) adult humans ≥ 18 years of age, (5) English-language studies published between January 1966 and December 1998, (6) resting blood pressure assessed, (7) training studies > or =4 weeks. Using a random effects model, statistically significant decreases of approximately 2% were found for both resting systolic and diastolic blood pressure (systolic, mean +/- SEM = -3 +/- 1 mm Hg, 95% confidence interval: -5 to -2 mm Hg; diastolic, mean +/- SEM = -2 +/- 1 mm Hg, 95% confidence interval: -3 to -1 mm Hg) Walking exercise programs reduce resting blood pressure in adults.
Kelley stated that the purpose of this study was to examine the effects of dynamic resistance exercise, i.e., weight training, on resting systolic and diastolic blood pressure in adults. A total of nine studies consisting of 259 subjects (144 exercise, 115 control) and 18 groups (9 exercise, 9 control) were included in this analysis. With the use of the bootstrap technique (10,000 samples), significant treatment effect (delta 3) reductions were found across all designs and categories for both systolic and diastolic blood pressure [systolic, mean +/- SD = -4.55 +/- 1.75 mmHg, 95% confidence interval (CI) = -1.56 to -8.56; diastolic, mean +/- SD = -3.79 + 1.12 mmHg, 95% confidence interval CI = -1.89 to -6.33]. Delta 3 changes corresponded with relative decreases of approximately 3 and 4% in resting systolic and diastolic blood pressure, respectively. In conclusion, meta-analytic review of included studies suggests that dynamic resistance exercise reduces resting systolic and diastolic blood pressure in adults. However, it is premature to form strong conclusions regarding the effects of dynamic resistance exercise on resting blood pressure. A need exists for additional, well-designed studies on this topic before a recommendation can be made regarding the efficacy of dynamic resistance exercise as a nonpharmacological therapy for reducing resting blood pressure in adults, especially in hypertensive adults.

Fogarty, et.al., stated that We have undertaken a laboratory-based examination of the cardiovascular and thermal impact of wearing thermal
(heat) protective clothing during fatiguing exercise in the heat. Seven males completed semi-recumbent, intermittent cycling (39.6 degrees C, 45% relative humidity) wearing either protective clothing or shorts (control). Mean core and skin temperatures, cardiac frequency (f(c)), stroke volume (Q), cardiac output (Q), arterial pressure, forearm blood flow (Q(f)), plasma volume change, and sweat rates were measured. In the clothed trials, subjects experienced significantly shorter times to fatigue (52.5 vs. 58.9 min), at lower peak work rates (204.3 vs. 277.4 W), and with higher core (37.9 degrees vs. 37.5 degrees C) and mean skin temperatures (37.3 degrees vs. 36.9 degrees C). There was a significant interaction between time and clothing on f(c), such that, over time, the clothing effect became more powerful. Clothing had a significant main affect on Q, but not Q, indicating the higher Q was chronotropically driven. Despite a greater sweat loss when clothed (923.0 vs. 547.1 g.m(-2) x h(-1); P<0.05), Q(f) and plasma volume change remained equivalent. Protective clothing reduced exercise tolerance, but did not affect overall cardiovascular function, at the point of volitional fatigue. It was concluded that, during moderately heavy, semi-recumbent exercise under hot, dry conditions, the strain on the unclothed body was already high, such that the additional stress imparted by the clothing ensemble represented a negligible, further impact upon cardiovascular stability.
Franke, et al., stated that this study tested the hypotheses that trained swimmers would have greater orthostatic tolerance than runners and, if present, it would be due to differences in their autonomic and hemodynamic responses to graded central hypovolemia. Twenty intercollegiate male athletes [11 runners and 9 swimmers; \(\dot{V}O_{2\text{max}}\) = 70.0 (1.6) vs 69.5 (2.6) ml.kg\(^{-1}\).min\(^{-1}\), respectively] underwent graded lower body negative pressure (LBNP) to presyncope. The swimmers were heavier [80.5 (1.9) vs 70.3 (1.9) kg, \(P<0.05\)], with larger resting cardiac [4.44 (0.29) vs 3.68 (0.18) l.min\(^{-1}\).m\(^{-2}\)] and total peripheral conductance [0.056 (0.04) vs 0.044 (0.02) units.m\(^{-2}\)] indices. Neither spontaneous cardiac baroreflex sensitivity (sequence method) nor heart rate variability (spectral analysis) differed significantly between groups at rest. LBNP tolerance did not differ between groups, with an index value of 51 (2) kPa.min for the runners and 54 (4) kPa.min for the swimmers [383 (16) vs 402 (32) mmHg.min], although the swimmers had larger declines in pulse pressure and tended \((P=0.078)\) to have larger declines in total peripheral conductance index in the last completed stage of LBNP. These responses did not differ between groups in the last 2 min of LBNP. Neither the heart rate, mean arterial pressure nor forearm vascular conductance responses differed between groups throughout. Changes in heart rate variability indices did not differ significantly between groups, with similar declines in the high frequency component and increases in the low frequency/high frequency ratio. These data suggest that swim training
does not lead to greater orthostatic tolerance than run training, and responses to maximal LBNP do not differ between swimmers and runners. Moreover, neither heart rate nor the autonomic modulation of the heart rate response to LBNP are affected by training modality.

Banz, et.al., stated that individuals exhibiting "the metabolic syndrome" have multiple coronary artery disease risk factors, including insulin resistance, hyperlipidemia, hypertension, and android obesity. We performed a randomized trial to compare the effects of aerobic and resistance training regimens on coronary risk factors. Twenty-six volunteers who exhibited android obesity and at least one other risk factor for coronary artery disease were randomized to aerobic or resistance training groups. Body mass index, waist-to-hip ratio, glucose, insulin, body composition, 24-hr urinary albumin, fibrinogen, blood pressure, and lipid profile were measured at baseline and after 10 weeks of exercise training. Both groups showed a significant reduction in waist-to-hip ratio and the resistance training group also showed a reduction in total body fat. There was no significant change in mean arterial blood pressure in either group. Fasting plasma glucose, insulin, total cholesterol, low-density lipoprotein (LDL) cholesterol, and triglycerides were unchanged in both groups. High-density lipoprotein (HDL) cholesterol increased (13%) with aerobic training only. Plasma fibrinogen was increased (28% and 34%, P < 0.02) in both groups and both groups showed a significant decrease (34% and 28%, P < 0.03) in microalbuminuria after their respective training regimen. In
conclusion, resistance training was effective in improving body composition of middle-aged obese sedentary males. Only aerobic training was effective in raising HDL cholesterol. More studies are warranted to assess the effects of exercise on plasma fibrinogen and microalbuminuria.

Carter, et al., stated that the effects of resistance training on arterial blood pressure and muscle sympathetic nerve activity (MSNA) at rest have not been established. Although endurance training is commonly recommended to lower arterial blood pressure, it is not known whether similar adaptations occur with resistance training. Therefore, we tested the hypothesis that whole body resistance training reduces arterial blood pressure at rest, with concomitant reductions in MSNA. Twelve young [21 +/- 0.3 (SE) yr] subjects underwent a program of whole body resistance training 3 days/wk for 8 wk. Resting arterial blood pressure (n = 12; automated sphygmonanometer) and MSNA (n = 8; peroneal nerve microneurography) were measured during a 5-min period of supine rest before and after exercise training. Thirteen additional young (21 +/- 0.8 yr) subjects served as controls. Resistance training significantly increased one-repetition maximum values in all trained muscle groups (P < 0.001), and it significantly decreased systolic (130 +/- 3 to 121 +/- 2 mmHg; P = 0.01), diastolic (69 +/- 3 to 61 +/- 2 mmHg; P = 0.04), and mean (89 +/- 2 to 81 +/- 2 mmHg; P = 0.01) arterial blood pressures at rest. Resistance training did not affect MSNA or heart rate. Arterial blood pressures and MSNA were unchanged, but heart rate increased after 8 wk.
of relative inactivity for subjects in the control group (61 +/- 2 to 67 +/- 3 beats/min; \(P = 0.01\)). These results indicate that whole body resistance exercise training might decrease the risk for development of cardiovascular disease by lowering arterial blood pressure but that reductions of pressure are not coupled to resistance exercise-induced decreases of sympathetic tone.

Panton, et al., stated that the purpose of the present study was to determine whether resistance training alters the cardiovascular responses to submaximal lower body negative pressure (LBNP) in the elderly. Twenty-one subjects were randomized into a control (C: \(n=10; 70 +/- 3\) years, mean +/- SD) or a resistance training (TR: \(n=11; 67 +/- 7\) years) group. Subjects in the TR underwent 12 weeks of training consisting of three sets of 8-12 contractions at approximately 60-80% of their initial maximal one repetition, three times per week, on 10 different machines. Before (Pre) and after (Post) training, all subjects underwent exposures of LBNP of -10, -20 and -40 Torr and muscle biopsy sampling at the vastus lateralis. TR increased (\(P< 0.05\)) knee extension (Pre=379 +/- 140 N, Post=534 +/- 182 N) and chest press (Pre=349 +/- 137 N, Post=480 +/- 192 N) strength. Neither body weight nor percentage body fat were altered (\(P >0.05\)) by training. Resistance training increased (\(P< 0.05\)) cross-sectional area in both Type I (4203 +/- 1196 to 5248 +/- 1728 microm\(^2\)) and Type II (3375 +/- 1027 to 4286 +/- 1892 microm\(^2\)) muscle fibres. Forearm blood flow, forearm vascular conductance, mean arterial
pressure, and heart-rate responses to LBNP were not altered by the training. These data suggest that the cardiovascular responses of elderly to LBNP are unaffected by 12 weeks of whole-body resistance training despite increases in muscle strength and size.

Rolsch, et.al., stated that Resistive exercise elicits a pressor response that results in a dramatic increase in blood pressure (BP) during the exercise. However, it is not known if the BP elevation persists after resistive exercise. This study examined the effects of an acute resistive exercise session on 24-h ambulatory BP in sedentary (5 men, 6 women), resistance-trained (6 men, 6 women), and endurance-trained (4 men, 6 women) young subjects (age 22 +/- 3.2 yr) with normal BP. Two 24-h ambulatory BP recordings were made on each subject, one after two sets of resistive exercise on 12 weight machines and one after 48 h without prior exercise. Systolic, diastolic, and mean arterial BP and heart rate (HR) were not different in the hours after and for up to 24 h after the single resistive exercise session compared with the control day. There also was no difference in the ambulatory BP or HR response after the single session of resistive exercise based on the training status of the subjects. Thus, the elevated BP that occurs during resistive exercise does not persist in the 24 h after acute resistive exercise in sedentary, resistance-trained, or endurance-trained, young, normotensive men and women.
Bertovic, et.al., stated that Aerobic exercise training increases arterial compliance and reduces systolic blood pressure, but the effects of muscular strength training on arterial mechanical properties are unknown. We compared blood pressure, whole body arterial compliance, aortic impedance, aortic stiffness (measured by beta-index and carotid pulse pressure divided by normalized systolic expansion \([Ep]\)), pulse wave velocity, and left ventricular parameters in 19 muscular strength-trained athletes (mean+/-SD age, 26+/-4 years) and 19 sedentary controls (26+/-5 years). Subjects were healthy, non-steroid-using, nonsmoking males, and athletes had been engaged in a strength-training program with no aerobic component for a minimum of 12 months. There was no difference in maximum oxygen consumption between groups, but handgrip strength (mean+/-SEM, 44+/-2 versus 56+/-2 kg; \(P<0.01\)) and left ventricular mass (168+/-8 versus 190+/-8 g; \(P<0.05\)) were greater in athletes. Arterial stiffness was higher in athletes, as evidenced by lower whole body arterial compliance (0.40+/-0.04 versus 0.54+/-0.04 arbitrary compliance units; \(P=0.01\)), higher aortic characteristic impedance (1.55+/-0.13 versus 1.18+/-0.08 mm Hg. s. cm\(^{-1}\); \(P<0.05\)), beta-index (4.6+/-0.2 versus 3.8+/-0.4; \(P<0.05\)), and In Ep (10.86+/-0.06 versus 10.60+/-0.08; \(P<0.01\)). Femoral-dorsalis pedis pulse wave velocity was also higher in the athletes, but carotid-femoral pulse wave velocity was not different. Furthermore, both carotid (56+/-3 versus 44+/-2 mm Hg; \(P<0.001\)) and brachial (60+/-3 versus 50+/-2 mm Hg; \(P<0.01\)) pulse pressures were higher in the
athletes, but mean arterial pressure and resting heart rate did not differ between groups. These data indicate that both the proximal aorta and the leg arteries are stiffer in strength-trained individuals and contribute to a higher cardiac afterload.

REVIEWS RELATED TO INTERVAL TRAINING

Nilsson, et.al., stated that the purpose of this study was to investigate the effect of upper body 20-s or 180-s interval training, using a double poling ergometer, on upper body power output and selected physiological and biomechanical parameters in cross-country skiers. Twenty (12 male, 8 female) well-trained cross-country skiers took part. Two intervention groups, a 20-s interval training group (IT20; n=6) and a 180-s interval training group (IT180; n=7), underwent training three times a week for 6 weeks on a double poling ergometer. A third group served as a control (CON; n=7) and followed the same training program as the IT20 and IT180 groups without the double poling ergometer interval training. The IT20 and IT180 groups significantly (P<0.05) increased both peak and mean power in a 30-s test and mean power in a 6-min test after double poling training. There was a significant improvement in work efficiency in both IT20 and IT180 (P<0.05) and, in IT180, a significant reduction (P<0.05) in blood lactate concentration at given sub-maximal workloads. VO(2peak) increased significantly during double poling in IT180 ( P<0.05) only. VO(2max) did not change significantly in either group. There were no
significant changes in any of the test variables in CON. In conclusion, this study shows that 6 weeks of 20-s or 180-s double poling interval training, three times a week, significantly increases power output in both 30-s and 6-min tests, as well as in selected physiological and biomechanical parameters in well-trained cross-country skiers.

Dupont, et al., stated that the effects of in-season, high-intensity interval training on professional male soccer players' running performances were investigated. Twenty-two subjects participated in 2 consecutive training periods of 10 weeks. The first period was considered a control period and was compared with a period where 2 high-intensity interval training exercises were included in the usual training program. Intermittent runs consisted of 12-15 runs lasting 15 seconds at 120% of maximal aerobic speed alternated with 15 seconds of rest. Sprint repetitions consisted of 12-15 all-out 40-m runs alternated with 30 seconds of rest. Results from the high-intensity interval training have shown that maximal aerobic speed was improved (+8.1 +/- 3.1%; p < 0.001) and that the time of the 40-m sprint was decreased (-3.5 +/- 1.5%; p < 0.001), whereas no change in either parameters were observed during the control period. This study shows that improvements in physical qualities can be made during the in-season period.

Creer, et al., stated that the purpose of this study was to investigate the effects of short-term, high-intensity sprint training on the root mean
squared (RMS) and median frequency (MF) derived from surface electromyography (EMG), as well as peak power, mean power, total work, and plasma lactate levels in trained cyclists when performed concurrently with endurance training. Seventeen trained cyclists were randomly assigned to a sprint training (S) group (n = 10, age 25 +/- 2.0 y) or a control (C) group (n = 7, age 25 +/- 0.5 y). Sprint training was performed bi-weekly for four weeks, comprising a total of 28 min over the training period. EMG measurements were taken before and after training during a series of four 30-s sprints separated by four minutes of active recovery. Plasma lactate, peak power, mean power, and total work were measured during each sprint bout. Following sprint training a significant increase occurred in the RMS of the vastus lateralis with a decrease in MF of the same muscle. Values for the vastus medialis did not change. Pre training exercising plasma lactate values were higher (p < 0.05) in C compared to S, but did not change with training. Exercising plasma lactate values increased (p < 0.05) from pre to post training in S, but were not different from C post training. Total work output increased from pre to post in S (p = 0.06). Peak power, mean power, and V.O (2)max increased (p < 0.05) pre to post training in S and C, indicating C was not a true control. In conclusion, these data suggest that four weeks of high-intensity sprint training combined with endurance training in a trained cycling population increased motor unit activation, exercising plasma lactate levels, and total
work output with a relatively low volume of sprint exercise compared to endurance training alone.

Laffite, et.al., stated that the aim of this study was to examine (i) the effects of a severe interval training period on oxygen pulse kinetics (O2-p, the ratio between VO2 and heart rate), and (ii) to study the consequences of these effects on the variation of performance (time to exhaustion) during severe runs. Seven athletes were tested before and after an eight-weeks period of a specific intermittent training at v Delta 50, i.e., the intermediate velocity between the lactate threshold (vLT) and the velocity associated with VO2max (vVO2max ). During the test sessions, athletes performed an incremental test and an all-out test at the pretraining v Delta 50. After the training period they also completed an additional all-out test at the posttraining v Delta 50 (v Delta 50bis). Results showed that after training there was i) an increase in the O2-p maximal value during the incremental test (22.7 +/- 1.5 mlO2.b-1 vs. 20.6 +/- 1.5 mlO2.b-1; p < 0.04), ii) a decrease in the time to reach the O2-p steady state (TRO2-p ) at the same absolute v Delta 50 (33 +/- 7 s vs. 60 +/- 27 s; p < 0.04) and iii) an increase in the O2-p steady state duration (TSSO2-p) at the same absolute v Delta 50 (552 +/- 201 s vs. 407 +/- 106 s; p <0.04). However, there was no relationship between the improvement of these two O2-p kinetics parameters (TRO2-p and TSS O2-p) and those of the performance. This study found that after an individualised interval-training program conducted at the same absolute velocity, the O2-p kinetics
reached a steady state quicker and for a longer duration than before training. This is however not related with the improvement of performance.

**Herrmann, et.al., stated that** Since homocysteine (Hcy) is a risk factor for cardiovascular and other diseases, it is important to know how exercise can modify it. Previous studies have suggested that endurance training influences Hcy. However, little is known about the effect of training intensity on Hcy. We investigated Hcy, vitamin B12, vitamin B6, folate and methylmalonic acid (MMA) before and after 3 weeks of volume-oriented training (VOL) (30 km/week) and high-intensity interval training (HIT) (20 km/week) in 20 young swimmers (16 +/- 2 years). Afterward, the athletes completed 5 days of recovery training. The training induced a Hcy increase in HIT and VOL (6.47 +/- 0.95 micromol/l vs. 7.44 +/- 1.17 micromol/l and 7.33 +/- 1.92 micromol/l vs. 8.28 +/- 1.42 micromol/l, respectively) that persisted during the recovery period (8.02 +/- 1.69 micromol/l and 8.00 +/- 1.81 micromol/l, respectively). Vitamin B12 was unchanged after the training (539 +/- 166 ng/l vs. 556 +/- 192 ng/l and 480 +/- 144 ng/l vs. 491 +/- 124 ng/l, respectively) but decreased during the recovery period (459 +/- 134 ng/l and 451 +/- 116 ng/l, respectively). Folate showed an increase during the training (9.07 +/- 2.01 microg/l vs. 11.71 +/- 4.08 microg/l and 10.34 +/- 2.32 microg/l vs. 11.13 +/- 4.64 microg/l, respectively), which was reversible by the end of the recovery training (8.57 +/- 1.98 microg/l and 9.60 +/- 2.38 microg/l, respectively). Vitamin B6 and MMA did not change. For none of the measured
parameters were there significant differences between HIT and VOL. Three weeks of strenuous swimming caused a prolonged Hcy increase, which was accompanied by changes in vitamin B12 and folate. The magnitude of these effects was not influenced by the training intensity.

Buyukyazi, et.al., stated that the Effects of two different eight-week aerobic training programs consisting of continuous (CR) or extensive interval running (IR) on serum growth (GH) and cortisol hormones in 33 male basketball players aged 15-16 were assessed. The CR group ran 4.8 km and the IR group ran 4 x 1.2 km, using equal work-to-rest ratio, three times per week. Aerobic power scores of all subjects and anaerobic power marks of the training subjects increased (p<0.01). Upon exertion, though serum GH levels increased in both exercise groups (p<0.01) prior to and following training; cortisol levels increased only in the IR group prior to training, and in both exercise groups following training (p<0.05). Following the eight week period, resting cortisol levels rose in the training (p<0.05) and control (p<0.01) groups. To conclude, an 8-week training program consisting of continuous or extensive interval running has been effective on acute GH and cortisol secretion in 15-16 year-old male athletes.

Wilkinson JG, et.al., stated that the purpose of this study was to examine the effects of a 6 week high-intensity interval training (HIT) program, followed by 2 weeks recovery, on iron status in cyclists. Eleven
male collegiate cyclists (21.8 +/- 0.8 yr, 71.4 +/- 2.2 kg, and 8.6 +/- 0.9 %
body fat) participated in a 6 week cycle training program that consisted of
5 days of high intensity interval and endurance training per week.
Hematocrit (Hct), hemoglobin (Hb), red blood cell (RBC) count, serum iron,
serum ferritin, and total iron binding capacity (TIBC) were analyzed from
venous blood samples taken at baseline (B), and each week following
interval training (T1-T6) and recovery (R1-R2). Dietary intakes including
iron were monitored weekly. The dependent variables were analyzed by
repeated measures ANOVA (p < 0.05). RBC count, Hb and Hct were
significantly decreased compared to baseline at T3. Serum iron did not
change significantly. Serum ferritin decreased significantly from 55.9 +/-
9.7 at B to 42.2 +/- 8.0 ng x ml -1 at T5 and remained depressed at T6, R1
and R2. TIBC was significantly increased above baseline at T3, T4, T6, R1
and R2. These results suggest that 6 weeks of high-intensity interval
training can reduce iron stores. It is possible that this reduction in iron
stores over time could adversely affect aerobic cycling performance.

Collins, et.al., stated that the aims of this study were to determine if
there are significant kinematic changes in running pattern after intense
interval workouts, whether duration of recovery affects running kinematics,
and whether changes in running economy are related to changes in
running kinematics. Seven highly trained male endurance runners
(VO2max = 72.3+/-3.3 ml x kg(-1) x min(-1); mean +/- s) performed three
interval running workouts of 10 x 400 m at a speed of 5.94 +/- 0.19 m x s(-1) (356 +/- 11.2 m x min(-1)) with a minimum of 4 days recovery between runs. Recovery of 60, 120 or 180 s between each 400 m repetition was assigned at random. Before and after each workout, running economy and several kinematic variables were measured at speeds of 3.33 and 4.47 m x s(-1) (200 and 268 m x min(-1)). Speed was found to have a significant effect on shank angle, knee velocity and stride length (P < 0.05). Correlations between changes pre- and post-test for VO2 (ml x kg(-1) x min(-1)) and several kinematic variables were not significant (P > 0.05) at both speeds. In general, duration of recovery was not found to adversely affect running economy or the kinematic variables assessed, possibly because of intra-individual adaptations to fatigue.

Stepto, et.al., stated that We have investigated the effect of varying the intensity of interval training on 40-km time-trial performance in 20 male endurance cyclists (peak oxygen uptake 4.8 +/- 0.6 L x min(-1), mean +/- SD). Cyclists performed a 25-kJ sprint test, an incremental test to determine peak aerobic power (PP) and a simulated 40-km time-trial on a Kingcycle ergometer. They were then randomly assigned to one of five types of interval-training session: 12x30 s at 175% PP, 12x60 s at 100% PP, 12x2 min at 90% PP, 8x4 min at 85% PP, or 4x8 min at 80% PP. Cyclists completed 6 sessions over 3 wk, in addition to their usual aerobic base training. All laboratory tests were then repeated. Performances in the time trial were highly reliable when controlled for training effects.
The percent improvement in the time trial was modeled as a polynomial function of the rank order of the intensity of the training intervals, a procedure validated by simulation. The cubic trend was strong and statistically significant (overall correlation = 0.70, P = 0.005) and predicted greatest enhancement for the intervals performed at 85% PP (2.8%, 95% CI = 4.3-1.3%) and at 175% PP (2.4%, 95% CI = 4.0-0.7%). Intervals performed at 100% PP and 80% PP did not produce statistically significant enhancements of performance. Quadratic and linear trends were weak or insubstantial. Interval training with work bouts close to race-pace enhance 1-h endurance performance; work bouts at much higher intensity also appear to improve performance, possibly by a different mechanism.

Billat, et.al., stated that Between inefficient training and overtraining, an appropriate training stimulus (in terms of intensity and duration) has to be determined in accordance with individual capacities. Interval training at the minimal velocity associated with VO2max (vVO2max) allows an athlete to run for as long as possible at VO2max. Nevertheless, we don’t know the influence of a defined increase in training volume at vVO2max on aerobic performance, noradrenaline, and heart rate. Eight subjects performed 4 wk of normal training (NT) with one session per week at vVO2max, i.e., five repetitions run at 50% of the time limit at vVO2max, with recovery of the same duration at 60% vVO2max. They then performed 4 wk of overload training (OT) with three interval
training sessions at vVO2max. Normal training significantly improved their velocity associated with VO2max (20.5+/−0.7 vs 21.1+/−0.8 km x h(−1), P = 0.02). As a result of improved running economy (50.6+/−3.5 vs 47.5+/−2.4 mL x min(−1) x kg(−1), P = 0.02), VO2max was not significantly different (71.6+/−4.8 vs 72.7+/−4.8 mL x min(−1) x kg(−1)). Time to exhaustion at vVO2max was not significantly different (301+/−56 vs 283+/−41 s) as was performance (i.e., distance limit run at vVO2max: 2052.2+/−331 vs 1986.2+/−252.9 m). Heart rate at 14 km x h(−1) decreased significantly after NT (162+/−16 vs 155+/−18 bpm, P < 0.01). Lactate threshold remained the same after normal training (84.1+/−4.8% vVO2max). Overload training changed neither the performance nor the factors concerning performance. However, the submaximal heart rate measured at 14 km x h(−1) decreased after overload training (155+/−18 vs 150+/−15 bpm). The maximal heart rate was not significantly different after NT and OT (199+/−9.5, 198+/−11, 194+/−10.4, P = 0.1). Resting plasma norepinephrine (venous blood sample measured by high pressure liquid chromatography), was unchanged (2.6 vs 2.4 nm x L(−1), P = 0.8). However, plasma norepinephrine measured at the end of the vVO2max test increased significantly (11.1 vs 26.0 nm x L(−1), P = 0.002). Performance and aerobic factors associated with the performance were not altered by the 4 wk of intensive training at vVO2max despite the increase of plasma noradrenaline..
Franch, et al., stated that to compare the effects of three types of intensive run training on running economy (RE) during exhaustive running and to establish possible relationships with changes in ventilatory function and/or muscle fiber type distribution. Thirty-six male recreational runners were divided into three groups and assigned to either exhaustive distance training (DT), long-interval training (LIT), or short-interval training (SIT) three times 20-30 minxwk(-1) for 6 wk. VO2 max and RE were measured during treadmill running before and after training. Muscle fiber type distribution of the vastus lateralis muscle was established from biopsy material. VO2 max (Lxmin(-1)) increased by 5.9% (P < 0.0001), 6.0% (P < 0.0001), and 3.6% (P < 0.01) in DT, LIT, and SIT, respectively, and running speed at VO2 max by 9% (P < 0.0001), 10% (P < 0.0001), and 4% (P < 0.05), respectively. Time-to-exhaustion at 87% of pretraining VO2 max (mean 3.83 mxs(-1)) increased by 94% in DT (P < 0.0001), 67% in LIT (P < 0.0001). Running economy improved by 3.1% in DT (P < 0.05), 3.0% in LIT (P < 0.01), and 0.9% SIT (NS): pulmonary ventilation (VE) was on average 11 Lxmin(-1) lower following training (P < 0.0001). The individual decrements in VE correlated with improvements in RE (r = 0.77; P < 0.0001) and may account for 25-70% of the decrease in aerobic demand. Muscle fiber composition, and respiratory exchange ratio, stride length, and stride frequency during running were unaltered with training. Recreational runners can improve RE and aerobic run performance by exchanging parts of their conventional aerobic
distance training with intensive distance or long-interval running, whereas short-interval running is less efficient. The improvement in RE may relate to reduced ventilatory demands. Muscle fiber type distribution was unaltered with training and showed no associations with RE.

MacDougall, et.al., stated that the purpose was to examine the effects of sprint interval training on muscle glycolytic and oxidative enzyme activity and exercise performance. Twelve healthy men (22 +/- 2 yr of age) underwent intense interval training on a cycle ergometer for 7 wk. Training consisted of 30-s maximum sprint efforts (Wingate protocol) interspersed by 2-4 min of recovery, performed three times per week. The program began with four intervals with 4 min of recovery per session in week 1 and progressed to 10 intervals with 2.5 min of recovery per session by week 7. Peak power output and total work over repeated maximal 30-s efforts and maximal oxygen consumption (VO2 max) were measured before and after the training program. Needle biopsies were taken from vastus lateralis of nine subjects before and after the program and assayed for the maximal activity of hexokinase, total glycogen phosphorylase, phosphofructokinase, lactate dehydrogenase, citrate synthase, succinate dehydrogenase, malate dehydrogenase, and 3-hydroxyacyl-CoA dehydrogenase. The training program resulted in significant increases in peak power output, total work over 30 s, and VO2 max. Maximal enzyme activity of hexokinase, phosphofructokinase, citrate synthase, succinate dehydrogenase, and malate dehydrogenase was also significantly
(P < 0.05) higher after training. It was concluded that relatively brief but intense sprint training can result in an increase in both glycolytic and oxidative enzyme activity, maximum short-term power output, and VO2 max.

Westgarth-Taylor, stated that this study examined the effects of sustained high-intensity interval training (HIT) on the athletic performances and fuel utilisation of eight male endurance-trained cyclists. Before HIT, each subject undertook three baseline peak power output Wpeak tests and two simulated 40-km time-trial cycling performance (TT40) tests, of which the variabilities were 1.5 (1.3)% and 1.0 (0.5)%, respectively [mean (SD)]. Over 6 weeks, the cyclists then replaced 15 (2)% of their 300 (66) km.week-1 endurance training with 12 HIT sessions, each consisting of six to nine 5-min rides at 80% of Wpeak, separated by a 1-min recovery. HIT increased Wpeak from 404 (40) to 424 (53) W (P < 0.01) and improved TT40 speeds from 42.0 (3.6) to 43.0 (4.2) km.h-1 (P < 0.05). Faster TT40 performances were due to increases in both the absolute work rates from 291 (43) to 327 (51) W (P < 0.05) and the relative work rates from 72.6 (5.3)% of pre-HIT Wpeak to 78.1 (2.8)% of post-HIT Wpeak (P < 0.05). HIT decreased carbohydrate (CHO) oxidation, plasma lactate concentration and ventilation when the cyclists rode at the same absolute work rates of 60, 70 and 80% of pre-HIT Wpeak (P < 0.05), but not when they exercised at the same relative (% post-HIT Wpeak) work rates. Thus, the ability of the cyclists to sustain higher percentages of Wpeak in TT40
performances after HIT was not due to lower rates of CHO oxidation. Higher relative work rates in the TT40 rides following HIT increased the estimated rates of CHO oxidation from approximately 4.3 to approximately 5.1 g.min⁻¹.

Subudhi, et.al., stated that To quantify physiological and performance effects of increased F₁O₂ during interval training sessions. 10 members of the US National Long Track Speedskating Team (5 males, 5 females) participated in two randomized, blinded, and placebo controlled trials at an elevation of 1375m. All athletes performed a maximal exercise test on a Velotron cycle ergometer to determine ventilatory threshold (VT: systematic rise in VE/VO₂) and maximal Watts (Wmax) prior to training. Subsequently, male and female athletes performed 4 × 5km and 4 × 3km cycling intervals, respectively, on two occasions, one week apart. Athletes were coached to complete all intervals at an RPE of 9 (10 point scale), using a work to rest ratio of 2:1. Oxygen (F₁O₂ = 21% or F₁O₂ = 60%) was administered during the last two sets each day Hemoglobin saturation was significantly augmented by supplemental O₂ (21% O₂ = 92 ± 2% vs. 60% O₂ = 98 ± 3%, p<0.01). Blood lactate was not affected during the 5km intervals (21% O₂ = 5.6 ± 2.4 vs. 60% O₂ = 5.7 ± 2.0 mmol/L), but was lower during the 3km intervals while breathing 60% O₂ (21% O₂ = 9.1 ± 2.2mmol/L vs. 60% O₂ = 7.4 ± 2.1 mmol/L, p<0.05) No effect on heart rate was detected. Supplemental O₂ improved 5km interval performance by 5.6% (552 ± 15 vs. 521 ± 8 sec, p < 0.01) and 3km performance by 1.8%
Average power output was 15% and 5% greater during the 5km and 3km intervals, respectively, while breathing 60% O2 (p<0.05). 5km intervals were performed at a power output corresponding to 100% VT (67 ± 5% Wmax) while breathing 21% O2 and 114% VT (77 ± 5% Wmax) while breathing 60% O2. 3km intervals were performed at power outputs corresponding to 112% VT (74 ± 2% Wmax) with 21% O2 and 117% VT (78 ± 2% Wmax) with 60% O2. Administration of 60% O2 increased hemoglobin saturation, average power output and, subsequently, interval training performance. Future studies should investigate the hyperoxic dose/intensity/response relationship needed to improve normoxic performance.

REVIEWS RELATED TO HEMOGLOBIN CONCENTRATION

Schumacher and Ashenden stated that there is a long history of science seeking to develop artificial substitutes for body parts damaged by disease or trauma. While defective teeth and limbs are commonly replaced by imitations without major loss of functionality, the development of a substitute for red blood cells has proved elusive. There is a permanent shortage of donor blood in western societies. Nevertheless, despite whole blood transfusions carrying measurable risks due to immunogenicity and the transmission of blood-borne infectious diseases, red blood cells are still relatively inexpensive, well tolerated and widely available. Researchers seeking to develop products that are able to meet and
perhaps exceed these criteria have responded to this difficult challenge by adopting many different approaches. Work has focussed on two classes of substances: modified haemoglobin solutions and perfluorocarbon emulsions. Other approaches include the creation of artificial red cells, where haemoglobin and supporting enzyme systems are encapsulated into liposomes. Haemoglobin is ideally suited to oxygen transport when encased by the red cell membrane; however, once removed, it rapidly dissociates into dimers and is cleared by the kidney. Therefore, it must be stabilised before it can be safely re-infused into humans. Modifications concomitantly alter the vascular half-life, oxygen affinity and hypertensive characteristics of raw haemoglobin, which can be sourced from outdated blood stores, genetically-engineered Escherichia coli or even bovine herds. In contrast, perfluorocarbons are entirely synthetic molecules that are capable of dissolving oxygen but biologically inert. Since they dissolve rather than bind oxygen, their capacity to serve as a blood substitute is determined principally by the oxygen pressure gradients in the lung and at the target tissue. Blood substitutes have important potential areas of clinical application including red cell replacement during surgery, emergency resuscitation of traumatic blood loss, oxygen therapeutic applications in radiography (oxygenation of tumour cells is beneficial to the effect of certain chemotherapeutic agents), other medical applications such as organ preservation, and finally to meet the requirements of patients who cannot receive donor blood because of religious beliefs.
Given the elite athlete's historical propensity to experiment with novel doping strategies, it is likely that the burgeoning field of artificial oxygen carriers has already attracted their attention. Scientific data concerning the performance benefits associated with blood substitutes are virtually nonexistent; however, international sporting federations have been commendably proactive in adding this category to their banned substance lists. The current situation is vulnerable to exploitation by immoral athletes since there is still no accepted methodology to test for the presence of artificial oxygen carriers.

Connes, et al., stated that we tested the hypothesis that prolonged administration of moderate doses of recombinant human erythropoietin (r-HuEPO) accelerates the initial rate of rise in pulmonary O2 uptake (VO2) in response to submaximal exercise and increases the maximal rate of O2 uptake (VO2(max)). Sixteen endurance-trained athletes were divided into two groups: r-HuEPO- (n=9) or placebo-treated (n=7). r-HuEPO or placebo (saline) injections were given s.c. 3 times a week for 4 weeks. Exercise testing, before and after the 4 weeks, comprised incremental maximal tests and several transitions from rest to 10-min cycling exercise at 65% VO2(max). VO2 was measured breath-by-breath during all tests. In the r-HuEPO group, resting haemoglobin concentration (+9.6%) and haematocrit (+8.3%), as well as VO2(max) (+7.0%) and power output (+7.2%) increased significantly (P<0.05) after the 4 weeks, whereas no change was observed in the control group. The time constant
of the primary VO2 response was significantly faster (+18%) after the 4 weeks r-HuEPO treatment than before (mean+/−SD; 29.3+/−4.5 vs. 35.7+/−7.4 s, respectively, P<0.05) but was unaffected in the placebo group (34.5+/−7.3 vs. 33.4+/−7.9 s). Collectively, our findings suggest that r-HuEPO contributes both to an acceleration of the dynamic response of VO2 to submaximal exercise and to an increase in maximal exercise capacity.

Ashenden, et.al., stated that ON- and OFF-model scores derived from blood parameters sensitive to erythropoiesis have been shown to be a useful tool to identify athletes who are currently injecting erythropoietin to enhance performance or those who have recently stopped doing so. We investigated changes in blood parameters and model scores during and after exposure to terrestrial and simulated altitudes. We retrospectively evaluated changes in hematologic data collected from 19 elite cyclists who lived and trained 2690 m above sea level for 26-31 days, from six elite Kenyan runners who lived 2100 m above sea level but descended to compete at sea level competitions, and from 39 well-trained subjects who resided at sea level but slept at a simulated altitude of 2650-3000 m for 20-23 days of either consecutive or intermittent nightly exposure. Upon ascent to a terrestrial altitude, ON- and OFF-model scores increased immediately, mainly because of an increase in hemoglobin concentration. Scores had not returned fully to baseline three weeks after return to sea level, because of the persistence of the raised hemoglobin concentration.
for the ON and OFF scores and a fall in reticulocyte percentage for OFF scores. Effects were smaller or negligible for simulated altitude. For Kenyan runners, ON- and OFF-model scores decreased within seven days of descent to sea level. Our results reinforce the notion that caution should be exercised when interpreting blood results from athletes who have recently been exposed to either terrestrial or simulated altitude, and appropriate allowance should be made for the effect of altitude on blood model scores.

Schmidt, et.al., stated that to determine whether total hemoglobin (tHb) mass and total blood volume (BV) are influenced by training, by chronic altitude exposure, and possibly by the combination of both conditions. Four groups (N = 12, each) either from locations at sea level or at moderate altitude (2600 m) were investigated: 1) sea-level control group (UT-0 m), 2) altitude control group (UT-2600 m), 3) professional cyclists from sea level (C-0 m), and 4) professional cyclists from altitude (C-2600 m). All subjects from altitude were born at about 2600 m and lived all their lives (except during competitions at lower levels) at this altitude. tHb and BV were determined by the CO-rebreathing method. VO2max (mL x kg(-1) x min(-1)) was significantly higher in UT-0 m (45.3 +/- 3.2) than in UT-2600 m (39.6 +/- 4.0) but did not differ between C-0 m (68.2 +/- 2.7) and C-2600 m (69.9 +/- 4.4). tHb (g x kg(-1)) was affected by training (UT-0 m: 11.0 +/- 1.1, C-0 m: 15.4 +/- 1.3) and by altitude (UT-2600 m: 13.4 +/- 0.9) and showed both effects in C-2600 m (17.1 +/- 1.4). Because red cell
volume showed a behavior similar to tHb and because plasma volume was not affected by altitude but by training, BV (mL x kg(-1)) was increased in C-0 m (UT-0 m: 78.3 +/- 7.9; C-0 m: 107.0 +/- 6.2) and in UT-2600 m (88.2 +/- 4.8), showing highest values in the C-2600 m group (116.5 +/- 11.4). In endurance athletes who are native to moderate altitude, tHb and BV were synergistically influenced by training and by altitude exposure, which is probably one important reason for their high performance.

Ekblom, et.al., stated that the Doping through increasing [Hb] increases physical performance in sport. Therefore, no cross-country skiers with [Hb] values above 160 and 175 g/l for women and men, respectively, may start in competitions. Even plasma expanders have been used, possibly for lowering a high [Hb] but this procedure may not increase physical performance. There are methods available for detecting the use of erythropoietin but not reinfusion of erythrocytes to increase [Hb]. To make it more difficult to increase [Hb] by different unethical methods we suggest that the [Hb] in endurance athletes is determined both during the training and the competition season to establish individual [Hb] mean values and range. Since endurance training at altitude does not increase [Hb] after return to sea level, an occasional increased [Hb] is suspicious. In such a case complementary doping tests may be used.

Schumacher, et.al., stated that Maximal oxygen uptake is the major performance limiting factor in endurance sports. Sophisticated
training methods have been developed to increase this variable. On the other hand, attempts have been made to improve maximal oxygen uptake by artificial means: blood doping and the misuse of recombinant human erythropoietin have beneficial effects on aerobic exercise capacity. Both methods have been banned by international sporting federations. A new class of substances might represent the next step of fraudulent improvement of the maximal oxygen uptake: artificial oxygen carriers, such as solutions based on recombinant, bovine or human hemoglobin and perfluorocarbon-emulsions have been shown to improve oxygen delivery to the muscle. Hemoglobin-based solutions improve aerobic exercise capacity in animal and human testing. Both substances have potentially lethal side effects including renal toxicity, increased systemic and pulmonary blood pressure and impairment of the immune system. Hemoglobin-based carriers can be detected in drug testing with routine laboratory tests based on the detection of free hemoglobin. Perfluorocarbon is not metabolized by the body and exhaled through the lung and can be measured with chromatography. No screening for these substances in drug tests has been performed so far. International sporting federations should be aware of this new, emerging doping threat.

Schoffstall, et.al., stated that Dehydration, a common practice among competitive athletes in sports including weight classes, has uncertain effects on strength. This study examined the effects of passive dehydration (D, approximately 2 hours in a sauna) followed by rehydration
(R, approximately 2 hours of rest with water ad libitum) on bench press one-repetition maximum (1RM). Ten weight-trained males (x +/- SE; age = 25 +/- 1 years; mass = 85.5 +/- 5.2 kg; height = 173.5 +/- 1.7 cm; body fat = 17.8 +/- 2.2%; 1RM = 118 +/- 8 kg) completed 2 testing sessions (E1/E2 and D/R) consisting of, respectively, 2 euhydration 1RM measurements separated by 2 hours of rest; and D 1RM followed by R 1RM. Testing sessions were administered in counterbalanced order and separated by 1 week. D resulted in increases (p < 0.005) in body temperature, urine specific gravity, hematocrit, and hemoglobin (calculated 8% decrease in plasma volume) as well as decreased body mass (p < 0.005). 1RM was decreased following D (111.4 +/- 7.2 kg) compared to both E1 (118 +/- 7.6 kg, p = 0.0015) and R (117.3 +/- 7.8 kg, p = 0.0023), with no significant difference between E1 and R. A significant association (r = -0.67, p < 0.05) was observed between percent lean body mass (%LBM) and the change in 1RM following D. In conclusion, passive dehydration resulting in approximately 1.5% loss of body mass adversely affects bench press 1RM performance. The adverse affects of dehydration seem to be overcome by a 2-hour rest period and water consumption.

Heinicke, et.al., stated that the study was to determine whether athletes from different disciplines are characterized by different blood volumes and secondly to what extent the blood volume can possibly limit endurance performance.
We investigated 94 male elite athletes subdivided into the following 6 groups: downhill skiing (DHS), swimming (S), running (R), triathlon (TA), cycling junior (CJ) and cycling professional (CP). Two groups of untrained subjects (UT) and leisure sportsmen (LS) served as controls. Total hemoglobin (tHb) and blood volume (BV) were measured by the CO-rebreathing method. In comparison to UT (mean +/- SD: tHb 11.0 +/- 1.1 g/kg, BV 78.3 +/- 7.9 ml/kg) tHb and BV were about 35 - 40 % higher in the endurance groups R, TA, CJ, and CP (e. g. in CP: tHb 15.3 +/- 1.3 g/kg, BV 107.1 +/- 7.0 ml/kg). Within the endurance groups we found no significant differences. The anaerobic discipline DHS was characterized by very low BV (87.6 +/- 3.1 ml/kg). S had an intermediate position (BV 97.4 +/- 6.1 ml/kg), probably because of the immersion effects during training in the water. VO(2)max was significantly related to tHb and BV not only in the whole group but also in all endurance disciplines. The reasons for the different BVs are an increased adaptation to training stimuli and probably also individual predisposing genetic factors.

Ekblom stated that Reinfusion of whole blood or packed red blood cells (RBCs) increasing the haemoglobin concentration ([Hb]) above the individual's normal values increases VO2max and enhances physical performance. During submaximal exercise heart rate and blood lactate concentration ([Hla]) are reduced, while arterial blood pressure remains
unchanged despite increased haematocrit (Hct). There is no method available for detecting this type of blood 'doping'. Seven weeks of injection with recombinant human erythropoietin (rhEPO) (20-40 IU per kg body weight) increased [Hb] and Hct, maximal oxygen uptake (VO2max) and physical performance were increased. The change in VO2max per gram change in [Hb] is the same after reinfusion of blood and after rhEPO injections. During submaximal exercise arterial blood pressure is increased, which despite a reduced heart rate, puts greater stress on the circulation even in trained athletes. An electrophoretic method is available to detect the use of rhEPO but it is costly and slow and therefore it can not be used in sport. Indirect markers of increased erythropoiesis may be used.

Richalet, et.al., stated that the Exposure to high altitude induces physiological or pathological modifications that are not always clearly attributable to a specific environmental factor: hypoxia, cold, stress, inadequate food. The principal goal of hypobaric chamber studies is to determine the specific effect of hypoxia. Eight male volunteers ("altinauts"), aged 23 to 37 were selected. They were first preacclimatized in the Observatoire Vallot (4,350 m) before entering the chamber. The chamber was progressively decompressed down to 253 mmHg barometric pressure, with a recovery period of 3 days at 5,000 m in the middle of the decompression period. They spent a total of 31 days in the chamber. Eighteen protocols were organized by 14 European teams, exploring the limiting factors of physical and psychological performance, and the
pathophysiology of acute mountain sickness (AMS). All subjects reached 8,000 m and 7 of them reached the simulated altitude of 8,848 m. Three altiumauts complained of transient neurological symptoms which resolved rapidly with reoxygenation. Body weight decreased by 5.4 kg through a negative caloric balance. Only four days after the return to sea-level, subjects had recovered 3.4 kg, i.e. 63% of the total loss. At 8,848 m (n = 5), PaO2 was 30.6 +/- 1.4 mmHg, PCO2 11.9 +/- 1.4 mmHg, pH 7.58 +/- 0.02 (arterialized capillary blood). Hemoglobin concentration increased from 14.8 +/- 1.4 to 18.4 +/- 1.5 g/dl at 8,000 m and recovered within 4 days at sea-level. AMS score increased rapidly at 6,000 m and was maximal at 7,000 m, especially for sleep. AMS was related to alteration in color vision and elevation of body temperature. VO2MAX decreased by 59% at 7,000 m. The purpose of this paper is to give a general description of the study and the time course of the main clinical and physiological parameters. The altiumauts reached the "summit" (for some of them three consecutive times) in better physiological conditions than it would have been possible in the mountains, probably because acclimatization and other environmental factors such as cold and nutrition were controlled.

Bongbele, et.al., stated that the purpose of the present investigation was to examine the effects of the malaria parasite on the oxygen capacity of blood. 15 males basket-ball players (mean +/- SE: age: 17-30 +/- 1.44 years; weight = 63.20 +/- 6.55 kg; height: 177.99 +/- 0.10 cm) were volunteered to take part in this study. Nine subjects were
infected by the malaria parasite, but seemed healthy. Six other subjects were really healthy. The oxygen capacity of blood was decreased in the infected group when compared with the noninfected group (15.86 +/- 1.59 ml vs 17.64 +/- 0.62 ml) (p < 0.05). The comparison of all other hematologic data showed them all reduced in the infected group: total number of erythrocytes = 4.90 +/- 0.50 x 10(9)/ml vs 5.03 +/- 0.33 x 10(9)/ml (p < 0.05), mean cellular volume (CMV): 71.75 +/- 6.37 fl vs 77.67 +/- 5.74 fl (p < 0.01), hemoglobin concentration ([Hb]): 11.84 +/- 1.19 g/100 ml vs 13.16 +/- 0.46 g/100 ml (p < 0.05), hematocrit: 35.22 +/- 2.86% vs 38.93 +/- 1.18% (p < 0.05). The chronic anemia induced by the malaria might theoretically limit the oxygen capacity of blood, which constitutes an important factor for the aerobic performance.

Boning, et.al., stated that the aim of the study was to investigate blood alterations caused by altitude acclimatization which last more than few days after return and might play a role for exercise performance at sea level. Measurements were performed in 12 mountaineers before, during and either 7/8 or 11/12 days after a Himalaya expedition (26-29 days at 4900 to 7600 m altitude). [Erythropoietin] rose only temporarily at altitude (max. +11 +/- 1 [SE] mu/ml serum). After return hemoglobin mass (initially 881 +/- 44 g, CO-Hb method) was increased by 14% (p < 0.01); aspartate aminotransferase activity in erythrocytes (initially 682 +/- 25 U/l) was augmented (day 7: +964 +/- 152 U/l, day 11: +533 +/- 107 U/l) indicating reduced mean cell age. Calculated blood volume (+14%) was influenced
by red cell formation at altitude but also by plasma expansion at sea level. The half saturation pressure for Hb-O2 (pH 7.4, 37 degrees C) as well as the 2.3-diphosphoglycerate concentration were already initially high (32.1 +/- 0.5 mmHg, 20.5 +/- 0.7 mumol/g Hb) and showed only a nonsignificant tendency to increase after return. Also Hill’s n was consistently high in the mountaineers, whereas the Bohr coefficients were slightly increased only after descent. Probably the preparatory physical training, partly in the Alps, and the stay in the Himalaya influenced O2-affinity for a prolonged time. The adaptations might reduce the loss of physical performance capacity at altitude and be part of altitude training effects.

Karamizrak, et.al., stated that to evaluate the relation between iron status and physical working capacity, and to assess the effect of oral iron treatment on these variables, in athletes with borderline iron status.

METHODS--Blood haemoglobin (Hb), packed cell volume (PCV), red blood cell count (RBC), serum iron, total iron binding capacity (TIBC), and ferritin determinations were compared in 71 male and 18 female athletes participating in various sports and in matched male (n = 11) and female (n = 8) controls. The first aim was to assess the relations between these variables and performance in a physical work capacity test (PWC170). Oral iron treatment (175-350 mg ferrous fumarate daily) was provided for three weeks to six male and five female athletes with borderline Hb concentrations, to determine the effects of such treatment on both iron status and performance. Among females, handball players had the lowest
serum ferritin concentrations (P < 0.05), the highest TIBC values, and lowest PWC170 scores (P < 0.01); runners had the highest ferritin concentrations and PWC170 scores (P < 0.01). There were significant correlations (P < 0.01) between PWC170 and PCV, serum ferritin, and transferrin saturation of female athletes. Hb, serum iron, serum ferritin, and transferrin saturation increased with iron treatment in both males (P < 0.01) and females (P < 0.05). Serum ferritin determination may prove a valuable addition to the screening of athletes and may indicate the need for iron treatment, even though a causal effect on improvement of work capacity may not be present.

Telford, et.al., stated that this study investigated the relationships between resting whole blood viscosity (WBV), haemoglobin concentration (HGB), haematocrit (HCT), and performance in 25 highly-trained national squad rowers (11 women and 14 men). The WBV and HGB were measured at rest prior to a 2500 m simulated race on a Concept rowing ergometer when performance (P) was measured by average velocity. A group of 12 rowers were measured on just one occasion, another 11 were measured twice with an intervening 5 weeks of continued training and 2 were measured three times, the third test after another 4 weeks. Regression analyses making simultaneous use of both intra- and interindividual data indicated a significant inverse relationship between P and WBV (at both high and low shear rates), a relationship which was strengthened after statistically controlling for the effects of HGB, this effect
being slightly more significant than HCT. A significant positive regression also emerged between P and HGB, but only after statistically controlling for the influence of WBV at high shear rate. Overall, stronger relationships were demonstrated in the male rowers compared with the female. These data, in the light of previous evidence that fitter people tend to have lower WBV, would indicate that blood rheology unrelated to HGB (or HCT) is related to performance in relatively homogeneous and already highly-trained athletes.

Schumacher, et.al., stated that Alterations of the red blood cell system and iron metabolism can influence physical performance. On the other hand, exercise can influence hematological variables. The purpose of this epidemiological study was to investigate the characteristics of the red blood cell system and the iron metabolism in athletes of different sporting disciplines and at different levels of performance. We studied 851 male subjects (747 athletes, 104 untrained controls). Hemoglobin (Hb), hematocrit (Hct), red blood cell count (RBC), iron, transferrin, ferritin (Fer), and haptoglobin were analyzed in standardized blood samples, obtained after 2 d of rest, considering levels of performance (internationally, nationally, locally competitive, and leisure time), distinctive sporting category (endurance- (END), strength- (POW), and mixed-trained (MIX)), and, within endurance athletes, distinctive disciplines (cycling (CYC) and running (RUN)). No difference was found between athletes and controls in Hb and Hct. Reduced Hb, Hct, and RBC levels were observed in END
compared with POW and MIX. These findings can mainly be attributed to exercise-induced plasma volume expansion, and only to a lesser degree and in selected athlete populations to hemolysis, as low haptoglobin is only observed in RUN, not in CYC, suggesting that not exercise itself but the "traumatic" movement of running might trigger the destruction of red blood cells. Physical activity of increasing duration and workloads (leisure time compared with competitive athletes) leads to decreased Fer levels in athletes, disregarding their discipline, but more pronounced in RUN. Physical training itself has no significant effect on selected hematological variables in athletes compared with untrained controls. The specific type and duration of exercise is of major importance in the adaptations of the blood cell system and the iron metabolism.

Ashenden, et.al., stated that the aim of this study was to monitor the haematological response of female athletes with moderately low ferritin values to an iron injection. We measured the total haemoglobin mass of 11 female basketballers with a range of ferritin values who lived and trained together for the duration of the study (age 18+/-1, range 16-19 yrs), [Hb] 12.4+/-1.3, 11.5-16.1 g x dL; ferritin 35.6+/-15.6, 9-58 microg x L). A total dose of 2.5 mL Ferrum H was administered to six squad members who were matched with the remaining five controls based on ferritin measures obtained three weeks earlier. Venous blood samples were drawn weekly to obtain full blood counts, reticulocyte parameters as well as iron profiles. There was no change detected in any of the haematological parameters.
measured in the treatment group compared to controls. A repeated measures ANOVA (treatment x time) demonstrated that neither total haemoglobin mass (P = 0.91) nor [Hb] (P = 0.79) altered significantly between groups, whilst the mean haemoglobin content of reticulocytes also showed no response (P = 0.17). Because a positive haematological response is definitive evidence of impaired red cell production, our results indicate that none of the athletes were iron deficient at the time of the injection. This suggests that low ferritin values in trained female athletes are not always associated with impaired red cell production.

REVIEW: RELATED TO RUN & WALK

Mondillo, et al., stated that to analyze the effects of short-term therapy with simvastatin on walking performance in hypercholesterolemic patients with peripheral vascular disease. Eighty-six patients with peripheral arterial disease (Fontaine stage II), intermittent claudication, and total cholesterol levels >220 mg/dL were enrolled in a randomized, placebo-controlled, double-blind study. Forty-three patients were assigned to simvastatin (40 mg/d); the remaining 43 patients were assigned to placebo treatment. All patients underwent an exercise test and clinical examination, and completed a self-assessment questionnaire at 0, 3, and 6 months. Pain-free and total walking distance, resting and postexercise ankle-brachial indexes, and questionnaire scores were determined at each follow-up. At 6 months, the mean pain-free walking distance had increased 90 meters (95% confidence interval [CI]: 64 to 116 meters;
P <0.005) more in the simvastatin group than in the placebo group. Similar results were seen for the total walking distance (mean between-group difference in the change, 126 meters; 95% CI: 101 to 151 meters; P <0.001), and for the ankle-brachial index at rest (mean, 0.09; 95% CI: 0.06 to 0.12; P <0.01) and after exercise (mean, 0.19; 95% CI: 0.14 to 0.24; P <0.005). There was also a greater improvement in claudication symptoms among patients treated with simvastatin. The effects on walking performance, ankle-brachial indexes, and questionnaire scores had also been significant at 3 months. High-dose short-term therapy with simvastatin may improve walking performance, ankle-brachial pressure indexes, and symptoms of claudication in hypercholesterolemic patients with peripheral vascular disease.

McDermott, et.al., stated that among individuals with lower-extremity peripheral arterial disease (PAD), specific leg symptoms and the ankle brachial index (ABI) are cross-sectionally related to the degree of functional impairment. However, relations between these clinical characteristics and objectively measured functional decline are unknown. To define whether PAD, ABI, and specific leg symptoms predict functional decline at 2-year follow-up. Prospective cohort study among 676 consecutively identified individuals (aged > or =55 years) with and without PAD (n = 417 and n = 259, respectively), with baseline functional assessments occurring between October 1, 1998, and January 31, 2000, and follow-up assessments scheduled 1 and 2 years thereafter. PAD was
defined as ABI less than 0.90, and participants with PAD were categorized at baseline into 1 of 5 mutually exclusive symptom groups. Mean annual changes in 6-minute walk performance and in usual-paced and fast-paced 4-m walking velocity, adjusted for age, sex, race, prior-year functioning, comorbid diseases, body mass index, pack-years of cigarette smoking, and patterns of missing data. Lower baseline ABI values were associated with greater mean (95% confidence interval) annual decline in 6-minute walk performance (-73.0 [-142 to -4.2] ft for ABI <0.50 vs -58.8 [-83.5 to -34.0] ft for ABI 0.50 to <0.90 vs -12.6 [-40.3 to 15.1] ft for ABI 0.90-1.50, P = .02). Compared with participants without PAD, PAD participants with leg pain on exertion and rest at baseline had greater mean annual decline in 6-minute walk performance (-111 [-173 to -50.0] ft vs -8.67 [-36.9 to 19.5] ft, P = .004), usual-pace 4-meter walking velocity (-0.06 [-0.09 to -0.02] m/sec vs -0.01 [-0.03 to 0.003] m/sec, P = .02), and fastest-pace 4-meter walking velocity (-0.07 [-0.11 to -0.03] m/sec vs -0.02 [-0.04 to -0.006] m/sec, P = .046). Compared with participants without PAD, asymptomatic PAD was associated with greater mean annual decline in 6-minute walk performance (-76.8 [-135 to -18.6] ft vs -8.67 [-36.9 to 19.5] ft, P = .04) and an increased odds ratio for becoming unable to walk for 6 minutes continuously (3.63; 95% confidence interval, 1.58-8.36; P = .002). Baseline ABI and the nature of leg symptoms predict the degree of functional decline at 2-year follow-up. Previously reported lack of worsening in claudication symptoms over time in patients with PAD may be more
related to declining functional performance to than lack of disease progression.

**Garrod, et al.,** stated that the study was undertaken to compare the performance of a pulsed dose oxygen delivery system with continuous flow oxygen or air during a maximal walking test. Fourteen patients with chronic obstructive pulmonary disease (COPD) and arterial oxygen desaturation on exercise (mean (SD) forced expiratory volume in one second (FEV1) 0.83 (0.28)1, arterial oxygen pressure (PaO2) 8.38 (1.24) kPa, arterial carbon dioxide pressure (PaCO2) 5.95 (0.86) kPa) were randomised to perform a walking test using air administered via a cylinder or continuous flow oxygen at 2 l/min or by a PDOD system. There was no significant difference in the mean arterial oxygen saturation (SaO2) using the PDOD system or with continuous flow oxygen (p = 0.33). Patients showed greatest desaturation whilst walking with the air cylinder (SaO2 79.2 (8.59)%) which was significantly different from the desaturation with both continuous flow oxygen (87.6 (5.85)%, p = 0.001) and PDOD (85.6 (7.36)%, p = 0.004). There was no significant difference between the distance walked using oxygen delivered at 2 l/min by continuous flow or via the PDOD (p = 0.72; CI 0.34 to 1.08). The mean (SD) distance walked on continuous flow oxygen (203.6 (106.1) m) and PDOD (207.9 (109.8) m) was significantly greater than the distance walked with the air cylinder (188.6 (110.02) m); (1.12 fold increase in distance, CI 1.01 to 1.23, p =
0.02, and 1.14 fold increase in distance, CI 1.01 to 1.28, p = 0.03, respectively). These findings suggest that the pulsed dose oxygen conserving device was as effective as continuous flow oxygen in maintaining arterial oxygen saturation and that the use of this device was associated with similar improvements in exercise tolerance to patients taking continuous flow oxygen therapy.

Arfvidsson, et al., stated that the unselected patients (n = 183) with subjective symptoms of intermittent claudication were examined clinically and by various circulatory tests (calf blood-flow, ankle, toe pressures). The aims of the present study were to evaluate to what extent the central or peripheral circulation is limiting in unselected patients with subjective symptoms of intermittent claudication, to determine the co-variation between the maximum walking capacity and traditional haemodynamical measures mentioned above and to evaluate to what extent a traditional bicycle ergometer exercise test and treadmill walking test give similar information regarding maximum performance. Eighty-five per cent of all patients were or had been smokers and 16% were diabetics. The mean ankle/brachial blood pressure index was 0.58 +/- 0.02 and the average post-ischemic maximum calf bloodflow was 13.3 +/- 0.6 ml/min/100 ml tissue. Leg arterial insufficiency was the limiting factor of walking capacity in 90% of all patients at 87 +/- 2 W corresponding to a walking distance of 282 +/- 13 m, while leg exhaustion was the limiting factor in 80% of the patients during test on the bicycle ergometer at maximum 84 +/- 2W. The
mean maximum walking capacity for all patients was 86 +/- 3W and the mean maximum capacity on the bicycle ergometer was 87 +/- 2W. The ankle/brachial index showed only a weak correlation (r = 0.30, p < 0.002) to walking capacity. Our results demonstrate that the maximum walking capacity on a treadmill agrees with mean values of maximum exercise capacity on a bicycle ergometer.

Kim, et al., stated that to compare the effect of functional electric stimulation (FES) with that of a hinged ankle-foot orthosis (AFO) for assisting foot clearance, gait speed, and endurance and to determine whether there is added benefit in using FES in conjunction with the hinged AFO in persons with incomplete spinal cord injury (SCI). Within-subject comparison of walking under 4 conditions: AFO, FES, AFO and FES, and no orthosis. A plastic hinged AFO was used for all AFO conditions. Nineteen subjects with incomplete self-selected gait speed, 6-minute walk distance, and foot clearance values were compared between conditions. Gait speed increased with FES (P <.05) and with the AFO (P =.06). Six-minute walk distance also increased with the AFO (P <.05). No difference was found between the 2 forms of orthoses in either gait speed or endurance. The greatest increase in gait speed and endurance from the no-orthosis condition occurred with the combined AFO and FES condition. Foot clearance improved with FES but not with AFO. Subjects whose gait speed increased with FES had weaker hip flexors, knee flexors, and ankle dorsiflexors than those who did not
benefit from FES. Both FES and the hinged AFO promote walking and FES is only superior to the AFO in increasing foot-clearance values. The hinged AFO and FES together may offer advantages over either device alone.

Branthwaite, et.al., stated that the purpose of this study was to establish the effect of simple non moulded flat based insoles on three-dimensional foot motion during normal walking. Excessive foot pronation is considered a major contributing factor to lower limb injuries. Moulded foot orthoses have been shown to decrease maximum foot eversion. Simple insoles are widely used in clinical practice as an alternative to moulded orthoses. However, there has been little research into the kinematic effects of simple insoles. All subjects had an inverted rearfoot and forefoot position when the subtalar joint was placed in neutral, which was assessed by a weight bearing goniometer. Rotations of the whole foot about three orthogonal axes relative to the shank were estimated using a five camera motion analysis system. Biplanar insoles significantly (P < 0.05) reduced maximum eversion by an average of 3.1 degrees when compared to the no insole condition. The cobra insole reduced maximum eversion by an average of 2.1 degrees when compared to the no insole condition. This difference approached statistical significance (P = 0.058). Biplanar and cobra insoles had no significant effect on maximum dorsiflexion, abduction or rate of eversion, when compared to the no insole condition. These
results provide some limited support for the use of simple insoles to control for excessive foot pronation during walking.

Eich, et.al., stated that to evaluate the immediate and long-term effects of aerobic treadmill plus Bobath walking training in subacute stroke survivors compared with Bobath walking training alone. Randomized controlled trial. Fifty patients, first-time supratentorial stroke, stroke interval less than six weeks, Barthel Index (0-100) from 50 to 80, able to walk a minimum distance of 12 m with either intermittent help or stand-by while walking, cardiovascular stable, minimum 50 W in the bicycle ergometry, randomly allocated to two groups, A and B. Group A 30 min of treadmill training, harness secured and minimally supported according to patients' needs, and 30 min of physiotherapy, every workday for six weeks, speed and inclination of the treadmill were adjusted to achieve a heart rate of HR: (Hrmax-HRrest)*0.6+HRrest; in group B 60 min of daily physiotherapy for six weeks. Primary outcome variables were the absolute improvement of walking velocity (m/s) and capacity (m), secondary were gross motor function including walking ability (score out of 13) and walking quality (score out of 41), blindly assessed before and after the intervention, and at follow-up three months later. Patients tolerated the aerobic training well with no side-effects, significantly greater improvement of walking velocity and capacity both at study end (p =0.001 versus p =0.002) and at follow-up (p <0.001 versus p <0.001) in the experimental group. Between weeks
0 and 6, the experimental group improved walking speed and capacity by a mean of 0.31 m/s and 91 m, the control group by a mean of 0.16 m/s and 56 m. Between weeks 0 and 18, the experimental group improved walking speed and capacity by a mean of 0.36 m/s and 111 m, the control group by a mean of 0.15 m/s and 57 m. Gross motor function and walking quality did not differ at any time. Aerobic treadmill plus Bobath walking training in moderately affected stroke patients was better than Bobath walking training alone with respect to the improvement of walking velocity and capacity. The treatment approach is recommended in patients meeting the inclusion criteria. A multicentre trial should follow to strengthen the evidence.

Fogelholm, et al., stated that Maintenance of weight loss is a core problem in the treatment of obesity. Physical activity may improve maintenance and metabolic risk factors associated with obesity. (1) A walking training program of moderate intensity, started after weight reduction by a very-low-energy diet, improves maintenance of weight loss and obesity-related metabolic disorders; and (2) the effect of the training program is related to the prescribed amount of physical activity, ie, a higher amount (energy expenditure) leads to more favorable results. The participants were premenopausal women with a mean body mass index of 34.0 kg/m². Eighty-two participants were randomized to this study; 74 participated in the follow-up assessment. A 12-week weight reduction by mostly a very-low-energy diet was followed by a 40-week maintenance
program randomized in 3 groups: a control group with no increase in habitual exercise and with counseling on diet and relapse prevention; a walk-1 group, with a walking program targeted to expend 4.2 MJ/wk and diet counseling; and a walk-2 group, with a walking program of 8.4 MJ/wk and diet counseling. Random permuted blocks within strata were used, with weight loss (in 3 classes) as the stratifying factor. After the intervention, the subjects were followed up for 2 years. Primary outcomes were body weight, fat mass, and waist circumference at the 2-year follow-up. Secondary outcomes were the levels of serum lipoproteins and lipids, plasma glucose, insulin, and blood pressure. The mean weight loss after weight reduction was 13.1 kg. The main outcome variables remained stable during the maintenance program, but increased during the follow-up period. Compared with the end of weight reduction, weight regain at the 2-year follow-up was 3.5 kg less (95% confidence interval, 0.2-6.8) and waist circumference regain 3.8 cm less (95% confidence interval, 0.3-7.3) in the walk-1 group vs controls. The secondary outcomes showed a partial relapse during the maintenance program, and a further regain during the follow-up period. Inclusion of a walking program of moderate training regimen into a weight maintenance program improved maintenance of losses in weight and waist circumference.

Beneke and Meyer stated that the effect of a 3-week exercise programme on performance and economy of walking was analysed in 16 male patients with chronic heart failure [mean age 51.8 (SD 6.9) years,
height 174.9 (SD 6.3) cm, body mass 75.3 (SD 11.5) kg, ejection fraction 20.8 (SD 5.0)%]. They were submitted to a cardiopulmonary exercise test on a cycle ergometer and a 6-min walking test on a treadmill before and after the period of exercise training. The training programme consisted of interval cycle (five times a week for 15 min), and treadmill ergometer training (three times a week for 10 min) at approximately 70% cycling peak oxygen uptake (VO2peak) and supplementary exercises (three times a week for 20 min). Compared to the pre values cycling VO2peak [11.9 (SD 2.9) vs 14.0 (SD 2.3) ml. kg-1.min-1], maximal self paced walking speed [0.68 (SD 0.33) vs 1.16 (SD 0.30) m.s-1], and net walking power [2.16 (SD 0.89) vs 2.73 (SD 0.91) W.kg-1] had increased (P < 0.01) while net energy cost [3.31 (SD 0.66) vs 2.33 (SD 0.38) J.kg-1. m-1] had decreased (P < 0.001) after the training period. Approximately 42% of the increase of walking speed resulted from a higher walking power output, whereas approximately 58% corresponded to a positive effect on walking economy. The improvement in walking economy was a function of an increase in walking velocity itself and a result of a more efficient walking technique. These results would indicate that in patients with marked exercise intolerance, adequate exercise training programmes could contribute to favourable metabolic changes with positive effects on the economy of motion.

Winningham stated that having the energy to maintain functional independence and social roles is an important component of quality of life.
in cancer patients. Unnecessary bedrest and prolonged sedentarism can contribute significantly to the development of fatigue and may result in rapid and potentially irreversible losses in energy and functioning. Walking is an important self-care activity that can counter some of the debilitating effects of disease, treatment, and inactivity. Research on exercise for ambulatory cancer patients has been limited to moderate intensity, interval, supervised exercise programs on cycle ergometers. However, lower intensity walking can be used as a self-care intervention for individuals or groups. Cancer patients often ask questions about what kind, frequency, duration, and intensity of exercise they should perform. By teaching self-care techniques, such as keeping a walking diary and pulse monitoring to regulate activity, nurses can help patients develop safe activity practices. I also present guidelines and precautions related to safe exercising by ambulatory patients during and after treatment for cancer.

Zwierska, et.al., stated that to compare treadmill and shuttle walk tests for assessing functional capacity in patients with intermittent claudication, with respect to test-retest reliability, cardiovascular responses, and patient preferences. Patients with stable intermittent claudication (N = 55, ages 52-85 yr, median age 68 yr) were recruited from the Sheffield Vascular Institute at the Northern General Hospital, Sheffield, UK. Each patient performed an incremental shuttle walk test, a constant-pace shuttle walk test, and a standardized treadmill test (3.2 km[h]-1, 12% gradient), each on three occasions. The incremental shuttle
walk began at 3 km·h⁻¹ and increased by 0.5 km·h⁻¹ every minute, whereas the constant-pace shuttle walk was performed at the fixed pace of 4 km·h⁻¹. Claudication distance (CD), maximum walking distance (MWD), heart rate (HR), and blood pressure were assessed in each testing session. The patients also completed a test preference questionnaire. CD and MWD for both shuttle walks were greater than the corresponding walking distances achieved in the treadmill test (P < 0.001). Average coefficients of variation for repeated incremental shuttle walk, constant-pace shuttle walk, and treadmill tests were 15.9%, 21.1%, and 18.7%, respectively, for MWD, corresponding to average intraclass correlation coefficients of 0.87, 0.82, and 0.87. Treadmill walking evoked greater increases in HR and blood pressure (P < 0.001), and fewer patients expressed a preference for it (24 vs 43% for shuttle walking). These findings indicated that shuttle walk testing exhibits similar test-retest reliability as treadmill testing, but that it evoked a lower level of cardiovascular stress and is preferred to treadmill testing by a large proportion of patients.

Saunders, et al., stated that to establish the typical error (TE) associated with equipment, testing, and biological variation of a running economy (RE) test in 11 elite male distance runners (O₂max 70.3 +/- 7.3 mL·min⁻¹·kg⁻¹), and measure the between-athlete variation of 70 highly trained runners (O₂max 69.7 +/- 6.0 mL·min⁻¹·kg⁻¹).
to determine the magnitude of the smallest worthwhile change (SWC) required for RE. Runners performed three 4-min bouts of submaximal treadmill running at speeds of 14, 16, and 18 km[h-1] (0% grade), on two separate occasions within a 7-d period to determine reliability and once over a 3-yr period to measure the SWC. During all RE tests O2 consumption ([V with dot above]O2), ventilation ([V with dot above]E), respiratory exchange ratio (RER), heart rate (HR), stride rate (SR), and concentration of blood lactate (Lac) were determined. The TE for the pooled data of three running speeds (14, 16, and 18 km[h-1]) was 2.4% for [V with dot above]O2, 7.3% for [V with dot above]E, 27% for Lac, and ranged between 1 and 4% for RER, HR, and SR. The results demonstrate that although the magnitude of the TE for a submaximal treadmill running protocol of three 4-min work efforts is small (2.4-7.3%) for measures associated with cardiorespiratory parameters, it is three- to fourfold higher for Lac. Given the small TE associated with RE, and a SWC of similar magnitude for this cohort of distance runners, the RE test is useful in detecting changes attributable to training interventions. Changes in RE greater than ~2.4% in this cohort of elite distance runners are likely to be "real" and "worthwhile," and not simply related to testing error and typical variation.

Utter Alan, et.al., stated that concurrent and construct validity of the OMNI-Walk/Run Scale of Perceived Exertion was examined using
young adult women and men (18-36 yr). Concurrent validity was established by correlating OMNI-Walk/Run Scale ratings of perceived exertion (RPE-OMNI) with oxygen uptake (\[\text{O}_2\]), relative maximal oxygen uptake (\%\[\text{O}_2\text{max}\]), ventilation (\[\text{E}\]), respiratory rate (RR), respiratory exchange ratio (RER), and heart rate (HR) to a graded exercise test on a treadmill. Construct validity was established by correlating RPE-OMNI with RPE from the Borg (6-20) Scale (RPE-BORG). Measurements were made every min throughout the test. The range of exercise responses across the incremental walking/running test for the female and male groups were: \[\text{O}_2 = 0.99-3.9 \text{ L.min}^{-1}, \text{HR} = 98-190 \text{ beats.min}^{-1} \text{ and RPE-OMNI = 1.3-9.4.}

Correlation/regression analyses indicated that RPE-OMNI distributed as a positive linear function for all criterion measures; \( r = 0.67 \text{ to } 0.88 \text{ (P < 0.05). \ RPE-OMNI was positively and linearly related to the RPE-BORG; } r = 0.96 \text{ (P < 0.01) for both the female and male groups. Concurrent and construct evidence supports use of the OMNI-Walk/Run Scale by adult women and men to estimate RPE during graded exercise test on a treadmill.}

**Walker,** et.al., stated that the purpose of this study was to develop and cross-validate generalized models for estimating relative steady-state caloric expenditure (kcal/kg/min) in children and adolescents during submaximal walking and running. Subjects were 101 boys and 79 girls,
ages 9-18 years. Each subject performed a submaximal treadmill exercise test at randomly selected walking and running speeds from 2-8 mph. Caloric expenditure was estimated from steady-state oxygen uptake and respiratory exchange ratio through open-circuit spirometry. The sample was randomly divided into a derivation sample and cross-validation sample, each with 90 subjects. Multiple regression revealed that the relationship between caloric expenditure and running speed was linear (p<.05), but for walking speed was curvilinear (p<.05). The restricted model is: Caloric cost (kcal/kg/min) = 0.004 + (0.033xSpeed) - (0.058xWalk = 1, Run = 0) + (0.002xSpeed2 x Walk = 1, Run = 0), R = .93, SEE = 0.021 kcal/kg/min. Age accounted for additional variation in caloric expenditure (p<.05). The full model is: Caloric cost (kcal/kg/min) = 0.038 + (0.033xSpeed) - (0.054xWalk = 1, Run = 0) + (0.002xSpeed2 x Walk = 1, Run = 0), - (0.003xAge), R = .94, SEE = 0.020 kcal/kg/min. Cross validation revealed very little shrinkage in either the restricted model (R = .91, Error = 0.025 kcal/kg/min) or the full model (R = .92, Error = 0.023 kcal/kg/min). These data demonstrate that the relative caloric cost of exercise can be accurately estimated from submaximal steady-state walking and running speed in youth. Estimation of caloric expenditure during exercise in children and adolescents may provide a means for balancing caloric input with output and preventing undue weight gain.

REVIEWS RELATED TO BLOOD LACTIC ACID: 

100
Billat, et.al., stated that the maximal lactate steady state (MLSS) is defined as the highest blood lactate concentration (MLSSc) and work load (MLSSw) that can be maintained over time without a continual blood lactate accumulation. A close relationship between endurance sport performance and MLSSw has been reported and the average velocity over a marathon is just below MLSSw. This work rate delineates the low- to high-intensity exercises at which carbohydrates contribute more than 50% of the total energy need and at which the fuel mix switches (crosses over) from predominantly fat to predominantly carbohydrate. The rate of metabolic adenosine triphosphate (ATP) turnover increases as a direct function of metabolic power output and the blood lactate at MLSS represents the highest point in the equilibrium between lactate appearance and disappearance both being equal to the lactate turnover. However, MLSSc has been reported to demonstrate a great variability between individuals (from 2-8 mmol/L) in capillary blood and not to be related to MLSSw. The fate of enhanced lactate clearance in trained individuals has been attributed primarily to oxidation in active muscle and gluconeogenesis in liver. The transport of lactate into and out of the cells is facilitated by monocarboxylate transporters (MCTs) which are transmembrane proteins and which are significantly improved by training. Endurance training increases the expression of MCT1 with intervariable effects on MCT4. The relationship between the concentration of the two MCTs and the performance parameters (i.e. the maximal distance run in
lactate exchange and removal indirectly estimated with velocity constants of the individual blood lactate recovery has been reported to be related to time to exhaustion at maximal oxygen uptake.

Coyle, stated that performance in endurance events is typically evaluated by the power or velocity that can be maintained for durations of 30 min. to four hours. The two main by-products of intense and prolonged oxidative metabolism that can limit performance are the accumulation of hydrogen ion (i.e. lactic acidosis) and heat (i.e. hyperthermia). A model for endurance performance is presented that revolves around identification of the lactate threshold velocity which is presented as a function of numerous morphological components as well as gross mechanical efficiency. When cycling at 80 RPM, gross mechanical efficiency is positively related to Type I muscle fiber composition, which has great potential to improve endurance performance. Endurance performance can also be influenced by altering the availability of oxygen and blood glucose during exercise. The latter need forms the basis for ingesting carbohydrate at 30-60 grams per hour during exercise. In laboratory simulations of performance, athletes fatigue due to hyperthermia when esophageal is approximately 40 degrees C, in association with near maximal heart rate and perceived exertion. It is likely that the central nervous system is involved in the aetiology of fatigue from hyperthermia. Dehydration during exercise promotes hyperthermia by reducing skin blood flow, sweating rate and
thus heat dissipation. The combination of dehydration and hyperthermia during exercise causes large reductions in cardiac output and blood flow to the exercising musculature, and thus has a large potential to impair endurance performance. Endurance performance is optimized when training is aimed specifically at developing individual components of the model presented and nutritional supplementation prevents hypoglycemia and attenuates dehydration and hyperthermia. Indeed, the challenge at the transition to a new millennium is to synergistically integrate these physiological factors in training and competition.

Billat, stated that time over a distance, i.e. speed, is the reference for performance for all events whose rules are based on locomotion in different mechanical constraints. A certain power output has to be maintained during a distance or over time. The energy requirements and metabolic support for optimal performance are functions of the length of the race and the intensity at which it is completed. However, despite the complexity of the regulation of lactate metabolism, blood lactate measurements can be used by coaches for prediction of exercise performance. The anaerobic threshold, commonly defined as the exercise intensity, speed or fraction of maximal oxygen uptake (VO2max) at a fixed blood lactate level or at a maximal lactate steady-state (MLSS), has been accepted as a measure of the endurance. The blood lactate threshold, expressed as a fraction of the velocity associated with VO2max, depends on the relationship between velocity and oxygen uptake (VO2). The
measurement of the post-competition blood lactate in short events (lasting 1 to 2 minutes) has been found to be related to the performance in events (400 to 800m in running). Blood lactate levels can be used to assist with determining training exercise intensity. However, to interpret the training effect on the blood lactate profile, the athlete's nutritional state and exercise protocol have also to be controlled. Moreover, improvement of fractional utilisation of VO2max at the MLSS has to be considered among all discriminating factors of the performance, such as the velocity associated with VO2max.

Magkos, et.al., stated that preparations containing caffeine and ephedrine have become increasingly popular among sportspersons in recent years as a means to enhance athletic performance. This is due to a slowly accumulating body of evidence suggesting that combination of the two drugs may be more efficacious than each one alone. Caffeine is a compound with documented ergogenicity in various exercise modalities, while ephedrine and related alkaloids have not been shown, as yet, to result in any significant performance improvements. Caffeine-ephedrine mixtures, however, have been reported in several instances to confer a greater ergogenic benefit than either drug by itself. Although data are limited and heterogeneous in nature to allow for reaching consensus, the increase in performance is a rather uniform finding as it has been observed during submaximal steady-state aerobic exercise, short- and long-distance running, maximal and supramaximal anaerobic cycling, as
well as weight lifting. From the metabolic point of view, combined ingestion of caffeine and ephedrine has been observed to increase blood glucose and lactate concentrations during exercise, whereas qualitatively similar effects on lipid fuels (free fatty acids and glycerol) are less pronounced. In parallel, epinephrine and dopamine concentrations are significantly increased, whereas the effects on norepinephrine are less clear. With respect to pulmonary gas exchange during short-term intense exercise, no physiologically significant effects have been reported following ingestion of caffeine, ephedrine or their combination. Yet, during longer and/or more demanding efforts, some sporadic enhancements have indeed been shown. On the other hand, a relatively consistent cardiovascular manifestation of the latter preparation is an increase in heart rate, in addition to that caused by exercise alone. Finally, evidence to date strongly suggests that caffeine and ephedrine combined are quite effective in decreasing the rating of perceived exertion and this seems to be independent of the type of activity being performed. In general, our knowledge and understanding of the physiological, metabolic and performance-enhancing effects of caffeine-ephedrine mixtures are still in their infancy. Research in this field is probably hampered by sound ethical concerns that preclude administration of potentially hazardous substances to human volunteers. In contrast, while it is certainly true that caffeine and especially ephedrine have been associated with several acute adverse effects on health, athletes do not seem to be concerned with these, as
long as they perceive that their performance will improve. In light of the fact that caffeine and ephedra alkaloids, but not ephedrine itself, have been removed from the list of banned substances, their use in sports can be expected to rise considerably in the foreseeable future. Caffeine-ephedra mixtures may thus become one of most popular ergogenic aids in the years to come and while they may indeed prove to be one of the most effective ones, and probably one of the few legal ones, whether they also turn out to be one of the most dangerous ones awaits to be witnessed.

**Falk.** et al, stated that to examine the effect of ambient heat on the decrease in blood lactate concentration ([L]bl during passive and during active recovery. ten trained men performed six 1-min bouts of exercise at 100% VO2 peak on a cycle ergometer, with 1-min rest between the bouts. each subject exercised twice in thermo neutral (22 degrees c, 40% RH, TN) and twice in hot (35 degrees c, 30%RH, TN) conditions. exercise was followed by either 40min of passive recovery.(sitting)or by 20 min of active recovery (cycling at 35%Vo2 peak) and 20 min passive recovery, named thereafter, active recovery. Capillary blood lactate was measured before, 1 min after and every 5 min during recovery. Heart rate (HR), rectal and skin temperature (Tre, Tsk) were monitored continuously. Vo2 was measured prior to exercise, during the last exercise bout, the first 10 min of recovery, and periodically thereafter post exercise [LA] bl was similar in all treatments. (13.5 +/-1.8,13.0+/-1.3,14.8+/-4.1,13.3+/-2.6mmol/l-1for TN-active, TN-passive, H-active and H-passive, respectively). [LA]bl was
significantly lower during active compared to passive recovery in both, TN and H conditions. Environmental heart did not independently affect [LA]bl during passive or active recovery-exercise resulted in an elevation in Tre in all treatments, with a significantly higher Tre during active recovery in H compared to the other sessions. Likewise, no differences in HR and in VO2 were observed between H and TN conditions during active nor during passive recovery.

Billat. et al, conducted a study to estimate the characteristic exercise intensity (WCL) which produces the maximal steady state of blood lactate concentration (MLSS) from submaximal intensities of 20 min carried out on the same day and separated by 40 min. Ten fit male adults (maximal oxygen uptake (Vo2 max) 62 (SDT) ml .min .kg –1) exercised for two 30-min periods on a cycle ergometer at 67% (test1.1) and 82% of VO2 max (test 1.2) separated by 40 min. They exercised 4 days later for 30 min at 82% of VO2 max without prior exercise (test 2). Blood lactate was collected for determination of lactic acid concentration every 5 min and heart rate and O2 uptake (VO2) were measured every 30 sec. There were no significant differences at the 5th, 10th, 15th, 20th, or 30th min between VO2, lactic acidemia, and heart rate during tests 1.2 and 2. Moreover, we compared the exercise intensities (WCL) which produced the MLSS obtained during tests 1.1 and 1.2 or during tests 1.1 and 2 calculated from differential values of lactic acid blood concentration ([la]-[b]) between the 30th and the 5th min or between the 20th and the 5th min.
There was no significant difference between the different valued of WCL[68(SD9), 71(SD7, 73) (SD6), 71(SD11)% of VO2 max] (ANOVA test, p<0.05) four subjects ran for 60 min at their WCL determined from periods performed on the same day (test 1.1 and 1.2) and the difference between the {la-} b at 5 min and at 20 min (delta ({la-}b) was computed.

Kamber found that the measurement of lactate is a major aid for controlling the capacity of an athlete and for establishing individual training schedules. The results are affected by different factors like the site of blood sampling or the distribution of lactate in the blood. The aim of the study was to investigate under constant conditions the results of four different commercially available methods for measuring lactate in blood. All methods were first tested with pure standards of lactate and with different reference sera. Both the accuracy and the reproducibility of the results were good. One method (Lange) showed good accuracy at room temperature but the values were too low at higher temperatures. The enzymatic methods was then chosen as reference method for investigations with blood samples. The first methods (ESAT) showed excellent correspondence, the results of the second (Lange) were 5-10% too low and the third methods (YSI) showed results too low and were also susceptible to trouble.

Rotstein et.al., stated that this study evaluated the aerobic capacity and anaerobic threshold of national level Israeli wheel chair basketball...
players. Subjects were tested working on a wheel chair rolling on a motor driven treadmill and on an arm cycle ergometer. Metabolic and cardiopulmonary parameters were measured during graded maximal exercise tests. Blood lactic acid (LA) concentration was measured in the intervals between loads during the test on the wheel chair. Heart rate (HR) and % heart rate reserve (%HRR) corresponding to the anaerobic threshold (4mm blood LA) were evaluated while working on the wheel chair rolling on a motor driven treadmill while working on the wheelchair the following peak exercise values were obtained. VO2 =24.7ml.kg/min, VE=92.091/min HR=181.5 b/min and R=1.22 values corresponding to the anaerobic threshold were found to be, HR=139b/min and % HRR=57.02 Low correlations were obtained between peak exercise VO2 and VE measured while working on the wheel chair and those measured with arm cycle ergometer (r=0.57 p=0.137 and r=0.4 p=0.233 respectively). As athletes, subjects in the present study may be classified as having a low aerobic capacity and anaerobic threshold. It is also concluded that the ergometer type may have an important influence on test results.

Weltman et.al., examined the lactate threshold (LT) for exercise prescription. Twenty four Sedentary eumenorrheic women (age=31.3+/−40 yrs, wt=66.2+/−76kg, ht=166.4+/−5.8cm) were assessed at baseline {during days 1-3 of the menstrual cycle (MC)} and every 4 MC thereafter (for 1 year) for VO2 and velocity (V) at LT, at fixed blood lactate concentrations (FBLC) of 2.0, 2.5 and 4.0 mm, and at peak subjects were assigned to
control (c,n=7), at LT (LT, trained 6 days/week at the velocity associated with LT, n=9) or above LT (>LT, trained 3 days/week at=LT velocity, n=8) group exercise prescriptions were adjusted after each assessment and each group progressed similarly in weekly mileage. A groups time ANOVA indicated that the control group did not change. Both training groups showed similarly increases in VO2 and V at LT, FBLC, and peak from baseline to MC 4(p<0.05). At MC 8 and 12 only the >LT group confined to increase VO2 and V (p<0.05). This is shown below for VO2 2.5mm. The present results indicate that at the onset of training, at or above the results in similar improvements in VO2 and V at LT, FBLC and peak. However, for continued improvement some training must be above LT. We conclude that the LT may be a critical intensity for exercise prescription Supported in part by NIH grant HD 20465.

Nummcta, et.al., had conducted a study to investigate whether the sprint training induced changes in the different components of anaerobic performance capacity can (MARP) test-male sprint runners(n=34) performed the MARP test before and after the 10 to 12 week training during the pre competitive season in the MARP test the sprinters ran Nx20s on a treadmill and the speed was increased by 0.38m 5-1 for each consecutive run until exhaustion blood lactate concentrations were determined during the 100s recovery between the runs. The maximum speed the speed at 3 mm and 10mm blood lactate levels and the peak blood lactate concentration were determined. In addition, 12 subjects ran a
maximal 30m speed test before and after the training period to determine their maximum running speed on a track. Training data were analysed from the training records. During the training period VO2 max increased. The correlation analysis revealed that the high volume of lactic speed endurance training influence negatively VO2 max and blood lactate concentration. On the other hand, the volume of interval training at low intensity (aerobic) correlated positively with the change of VO2 max. The volume of speed training was found to be advantageous for the change in VO2 max. It was concluded that the results of the MARP Test reflect the sprint training induced changes in the anaerobic performance capacity.

Gaesser, et al., had conducted a study to test the hypothesis that adaptations to high intensity exercise could be achieved following very low intensity training. 11 subjects (5 males, 6 females, 21 ± 1, 64.2 ± 3 kg, 171.5 ± 3 cm) exercised on cycle ergometer 4 days/week for 5 weeks 60 minutes/session at an intensity of 36.4 ± 1.7 VO2 peak 96 ± 1.2 percent max HR = 42.7 ± 2.0 percent heart rate reserve) pre and post training responses to incremental and high intensity constant load exercise (10 min at a power dictating 85 percent VO2 peak) were compared with those of an age and gender-matched control group to values for all post tests were not different from pre tests. VO2 peak was exchanges following training. The trained group demonstrated significant reductions during the post test constant-load exercise about for VE, VO2 HR, VCO2 and blood lactate. They conclude that 5 weeks (twenty-60 minutes sessions) of training at 36
percent VO2 peak results in significant adaptations in the cardiorespiratory and blood lactate responses to high intensity constant load exercise. They interpret this as evidence that very low intensity training improves tolerance for high intensity exercise since VO2 peak was not increased this parameter may not be a useful index to document adaptation, to this type of training. Thus very low intensity exercise training may improve capacity for high intensity exercise without a measured increase in peak aerobic power.

Taylor and Bronks analysed the changes in electro myographic (EMG) activity of the vastus lateralis, biceps femoris and gastronemius muscles during incremental treadmill running. The changes in EMG were related to the lactate and ventilatory threshold. Ten trained subjects participated in the study. Minute ventilation, Oxygen consumption, carbon dioxide expired and the fraction of oxygen in the expired gas were recorded continuously. Venous blood samples were collected at each exercise intensity and analysed for lactate concentration. The EMG were recorded at the end of each exercise intensity using surface electrodes. The EMG were quantified through integration (EMG) and by calculating the mean power frequency (MPF). The EMG measurements were characterized by a breakpoint in the vastus lateralis and for gastrocnemius muscles in eight of the subjects tested. However, the results indicated that blood lactate concentrations had already began to increase in a nonlinear fashion before the EMG breakpoint had been surpassed consequently, the
occurrence of the lactate threshold cannot be attributed slowly to the change in motor unit recruitment or rate coding patterns demonstrated by the EMG breakpoint the ventilatory threshold was shown to be a far more reliable and convenient noninvasive predictor of the lactate threshold in comparison with EMG techniques. Un conclusion the EMG measurements used in this study (EMG and MPF) were not considered to be viable noninvasive determinants of the aerobic-anaerobic transition phase in treadmill running.

REVIEWS RELATED TO BLOOD GLUCOSE

Walberg-Rankin, stated that reduction of body stores of carbohydrate and blood glucose is related to the perception of fatigue and the inability to maintain high-quality performance. This has been clearly shown with aerobic, endurance events of moderate intensity of over 90 min duration. Carbohydrate intake may also have relevance for athletes involved in short, high-intensity events, especially if body weight control is an issue. Prevention of carbohydrate depletion begins with a high-carbohydrate training diet of about 60-70% carbohydrate. If possible, carbohydrate beverages should be consumed during the event at the rate of 30-70 g/hr to reduce the chance of body carbohydrate depletion. Finally, replacement of body carbohydrate stores can be achieved most rapidly if
40-60 g of carbohydrate is consumed as soon as possible after the exercise and at repeating 1-hr intervals for at least 5 hr after the event.

Herman stated that past exercise research of caffeine has primarily focused on its potential ergogenic effects to improve the endurance of elite athletes. Consequently, most study designs included relatively high sub maximal exercise intensities (60-80% VO2 max). The purpose of this study was to examine the influence of caffeine on metabolism during prolonged exercise at low and moderate aerobic intensities. Six non-smoking, aerobically trained males (VO2 max: 58.0 ml/kg/min, SD +/- 6.0) with a low habitual caffeine intake (<100mg/day) each completed a total of four 90 min treadmill walking tests (two at 30% and 55% VO2 max respectively) with and without prior caffeine intake. The order of tests was randomized and followed a counter balanced format caffeine (5mg/kg body weight) and placebo solutions were given orally 60 min prior to exercise in a single blind fusion. Blood concentrations of FFA, glycerol, glucose, and lactic acid were determined spectrophotometrically, VO2, VE, and RER were measured using open circuit spirometry. Pre/post exercise FFA, glycerol, glucose and lactic acid concentrations were not significantly different between caffeine and placebo trials (>0.05) post exercise FFA and glycerol levels were higher after the 55% VO2 max exercise trials when compared to the 30% VO2 max tests. Gaseous exchange indicated that caffeine had no effect on exercise VO2 and RER Values (p > 0.05), but significantly increased VE(p < 0.01). In conclusion, the present findings
on energy substrate responses and gaseous exchange offer no evidence in support of a significant effect of 5 mg/kg caffeine on substrate mobilization and/or a change in utilization during prolonged exercise at low and moderate aerobic intensities in aerobically trained males.

Oshida et al., stated that physical training has been shown to improve glucose tolerance and insulin action. In the present study insulin action was determined. Using the euglycemic clamp technique in six trained male athletes compared with six untrained controls matched by age. Sex. And weight at 14, 38, and 86 hours and at 6 days after cessation of exercise. The rate of insulin-mediated glucose uptake (glucose disposal) was 9.40±0.46mg.kg-1.min-1 (mean +/-SEM) for the athletes at 14h after the last exercise bout, compared with 6.80±0.86mg.kg-1.min-1 obtained for the untrained controls (P less than 0.01). Glucose disposal was gradually decreased to 7.78±0.87mg.kg-1.min-1 at 38h, 6.82±0.49 mg.kg-1.min-1 at 86h and to 7.11±1.00 mg.kg-1.min-1 at 6 days after cessation of physical training at 38h, 86h and 6 days of detraining. Glucose disposal exhibited by training athletes did not differ significantly from untrained controls. These results suggest that physical training increases insulin action, and that this effect could be reversed to the control levels within 38h after detraining.

Smutok determined whether training can induce favourable alterations in glucose regulation, 37 untrained male with high risk profiles
for CHD (age =50+/- 10 yrs,M+SD) were studied before and after completion of 20 weeks of either a circuit weight training programme (N=14), a treadmill walk /jog programme (N=13) or no exercise group was used to control for methodological variation. Plasma concentrations of glucose and insulin were means after a 12-14 hour fast and during a standard oral glucose tolerance test (OGTT) before and appropriate 19 hours training MANOVA was used prior to univariate and planned comparisons were made to determine the effects of each training modality and whether training-induced changes between strength and aerobic exercise training difference. In contrast to aerobic exercise training, strength training had no significant effect on VO2 max or body composition. However, strength training produced significant reductions in total plasma glucose area (mg dl-1.120 min-1) under the OGTT (20879 +/- 6092 vs 18806 +/- 6043, p<0.05) and in plasma glucose levels (mg dl-1) at 60 min (170 +/- 75 vs 150 +/- 74, p<0.05) after glucose ingestion strength training also lowered the total plasma insulin area (u ml-1.120 min-1) under the OGTT curve (8648 +/- 3428 vs 6842 +/- 1910, p<0.05) and plasma insulin levels (u ml-1) during fasting (15 +/- 11 vs 12 +/- 7, p<0.01) and 120 min (91 +/- 47 vs 57 +/- 29, p<0.01) after glucose ingestion. There were no significant in OGTT results between strength and aerobic exercise training and no changes were observed in the no exercise group. The results indicated that strength training may improve glucose tolerance and increase insulin sensitivity to the same extent as aerobic exercise training
in M at risk for CHD, independently of changes in aerobic capacity or body composition. These findings suggest that strength training may reduce risk for CHD by improving glucose regulation.

Swain, stated that the concentration of glucose is tightly regulated in the blood by a complicated set of physiological variables. To provide students with a means to more readily understand these complex mechanisms, the control of the water level in a beaver pond is presented as an analogy. A beaver must maintain a constant water level in the pond for the proper functioning of the lodge, just as blood glucose is maintained for, among other reasons, brain function. The beaver controls the water level by changing outflow over the dam and inflow from stream beds. Water flow over the dam is analogous to glucose leaving the blood for tissues, which is controlled by insulin. Inflow of water from streams is analogous to glucose absorption from the gastrointestinal tract and glucose release from the liver, the latter being controlled by glucagon and other counterregulatory hormones. The analogy is extended by considering the effects of exercise in normal and diabetic individuals on blood glucose levels.

Ribeiro, et al., stated that this study aimed to analyse the validity of glucose minimum speed (GMS) for lactate minimum speed (LMS) assessment during running and their relationship to endurance performance. Eight male trained runners (28.7 +/- 9.0 years) volunteered
to take part in this study and underwent an official 10-km road race and a track lactate minimum test (LMT) (0.5-km sprint plus 6 x 800 m from 87 to 98% of maximal 3-km speed). Lactate and glucose minimum speeds were considered those related to the minimum blood lactate and glucose concentrations respectively attained during the graded phase of LMT. Significant correlations (p<0.05) were found between LMS and GMS (r=0.72) and LMS and 10-km performance (r=0.83), but not between GMS and 10-km performance (r=0.49). No significant differences (p>0.05) were found between LMS (4.75 +/- 0.08 m/s), GMS (4.73 +/- 0.07 m/s) and 10-km mean speed (4.79 +/- 0.17 m/s). In conclusion, we found GMS to be a good predictor of LMS during track LMT, LMS being well related to endurance running performance.

Schwellnus, et.al., stated that to determine whether acute exercise associated muscle cramping (EAMC) in distance runners is related to changes in serum electrolyte concentrations and hydration status. A cohort of 72 runners participating in an ultra-distance road race was followed up for the development of EAMC. All subjects were weighed before and immediately after the race. Blood samples were taken before the race, immediately after the race, and 60 minutes after the race. Blood samples were analysed for glucose, protein, sodium, potassium, calcium, and magnesium concentrations, as well as serum osmolality, haemoglobin, and packed cell volume. Runners who suffered from acute EAMC during the race formed the cramp group (cramp, n = 21), while
runners with no history of EAMC during the race formed the control group (control, n = 22). There were no significant differences between the two groups for pre-race or post-race body weight, percent change in body weight, blood volume, plasma volume, or red cell volume. The immediate post-race serum sodium concentration was significantly lower (p = 0.004) in the cramp group (mean (SD), 139.8 (3.1) mmol/l) than in the control group (142.3 (2.1) mmol/l). The immediate post-race serum magnesium concentration was significantly higher (p = 0.03) in the cramp group (0.73 (0.06) mmol/l) than in the control group (0.67 (0.08) mmol/l). There are no clinically significant alterations in serum electrolyte concentrations and there is no alteration in hydration status in runners with EAMC participating in an ultra-distance race. Serum electrolyte concentrations and hydration status are not associated with exercise associated muscle cramping (EAMC) in distance runners.

Shin, et al., stated that WooKiEum (WKE) has been used for the purpose of the development of increased immune-system strength in Korea. In the present study, we examined the anti-immobility effect of WKE on the forced swimming test (FST), and then measured blood biochemical parameters related to fatigue: glucose (Glc), blood urea nitrogen (BUN), lactic dehydrogenase (LDH), creatinine, and total protein (TP). WKE (0.1, 1 g/kg) was administered orally to mice for 7 d. After 2 d, the immobility time was decreased in the WKE-administered group. After 7 d, the immobility time was significantly decreased in the WKE-
administered group (64.6+/−9.0 s for 0.1 g/kg) in comparison with the control group (101.3+/−32.7 s). In addition, amount of Glucose in the blood serum was increased, whereas the contents of BUN, LDH and TP decreased in the WKE-administered group. Next, we investigated the effect of WKE on the production of cytokines in a human T-cell line, MOLT-4 cells and mouse peritoneal macrophages. WKE (1 mg/ml) significantly increased interferon (IFN)-gamma and TNF-alpha production compared with the media control (about 2.2-fold for IFN-gamma, about 1.7-fold for TNF-alpha, p<0.05) after 24 h. WKE increased the protein expression of IFN-gamma in MOLT-4 cells. These results suggest that WKE may be useful in immune function improvement.

Dear Gde, et.al., stated that insulin-requiring diabetes mellitus (IRDM) is commonly described as an absolute contraindication to scuba diving. A 1993 Divers Alert Network survey, however, identified many active IRDM divers. We report on the plasma glucose response to recreational diving in IRDM divers. Plasma glucose values were collected before and after diving in IRDM and healthy control divers. Time/depth profiles of 555 dives in IRDM divers were recorded. IRDM divers had been diving for a mean of almost nine years and had diabetes for a mean of over 15 years. No symptoms or complications related to hypoglycemia were reported (or observed). Post-dive plasma glucose fell below 70 mg x dL(-1) in 7% (37/555) of the IRDM group dives compared to 1% (6/504) of the controls (p<0.05). Moderate levels of hyperglycemia were also noted in
23 divers with IRDM on 84 occasions. While large plasma glucose swings from pre-dive to post-dive were noted, our observations indicate that plasma glucose levels, in moderately-controlled IRDM, can be managed to avoid hypoglycemia during routine recreational dives under ordinary environmental conditions and low risk decompression profiles.

Petibois, et.al., stated that for determining exercise-induced changes in plasma molecular species, we investigated the feasibility of using two-dimensional correlation spectra (2D-COS) on 21 series of plasma samples obtained from progressive exercise tests. Intensities of 2D synchronous and asynchronous correlation peaks were compared to concentration evolutions of glucose, lactate, triglycerides (TG), glycerol, fatty acyl moieties, amino acids, proteins, and albumin [determined from plasma Fourier transform infrared (FTIR) spectra] and to performance and training levels of athletes. Synchronous 2D-COS allowed us to determine the linear relationship between protein and fatty acid concentration evolutions as exercise intensity increased (nu1-nu2; 2959 vs 1656 and 1543 cm(-1)). Asynchronous 2D-COS allowed differentiation of fibrinolysis level in subjects during intense exercise, as well as parameters of fatty acid metabolism specifically related either to performance or to training levels. Furthermore, unexpected correlated evolutions of molecular species were highlighted by this method, showing that 2D spectrometry may also be used for experimental investigations on human physiology.
This study has demonstrated that 2D-COS may be used for the treatment of complex biological samples, such as plasma.

Baldi, et al., stated that the purpose of this investigation was to determine whether moderate intensity resistance training (RT) improves glycaemic control in obese, type 2 diabetic men. Eighteen subjects were randomly assigned to a 10-week RT program, or a non-training control group (C). Glycosylated haemoglobin (HbA1c), fasting glucose and insulin, glucose and insulin 120 minutes (2h) after a 75 g oral glucose load, body composition and muscular strength and endurance were measured before and after the 10-week experimental period. In the RT group fasting glucose and insulin decreased with training (p < 0.05) and decreases in HbA1c approached significance (p = 0.057). 2-h glucose and insulin did not change in either group. Fat free mass (FFM) increased by 3.5 % after RT but was unchanged in the controls. Fat mass (FM) increased 6.9 % in C but was unchanged in RT. Percent body fat was unchanged in both groups. Muscular strength and endurance increased by 25 to 52 % in the RT group but was unchanged in controls. Changes in fasting glucose and HbA1c were inversely related to changes in FFM. These results suggest that RT is an effective form of exercise training which modestly improves glycaemic control and lowers fasting insulin levels in obese type 2 diabetics. Resistance training improves glycaemic control in obese type 2 diabetic men.
Manetta, et.al., stated that the goal of this study was to characterize the respective effects of aging and endurance training on serum insulin-like growth factor I (IGF-I), as well as IGF-binding proteins (IGFBP)-1 and -3 in relationship with glucose disposal. Thirty-two subjects (16 middle-aged men: 8 cyclists and 8 sedentary men; and 16 young men: 8 cyclists and 8 sedentary men) were compared in this study. Insulin sensitivity (SI) and glucose effectiveness (Sg) were assessed by the minimal model. Endurance training increased SI, Sg, and IGFBP-1 and -3 in both age groups (P<.05), but the older group showed a greater increase in SI and IGFBP-1 than the younger group (P<.05). IGF-I was increased only in the middle-aged trained men (P<.05). An effect of aging was found in the sedentary subjects, who presented lower IGF-I and SI (P<.05) when older. This effect disappeared with training since IGF-I and SI were nearly identical in young and middle-aged trained subjects. SI was correlated with IGFBP-1 (P<.01). These data suggest that (1) endurance training increases SI, Sg, and IGFBP-1 and -3 in men and, for SI and IGFBP-1, this increase becomes more pronounced with age; (2) endurance training may attenuate the aged-related decline in SI and IGF-I; and (3) IGFBP-1 may protect against the risk of hypoglycemia by counteracting the hypoglycemic effect of IGF-I in such situations of high SI.

Slawta, et.al., stated that Physical activity is strongly recommended as a principal component of coronary heart disease (CHD) risk factor management aimed at favorably lowering abdominal fat accumulation,
lowering levels of triglyceride (TG), raising levels of high-density lipoprotein-cholesterol (HDL-C), and improving insulin sensitivity. Although physical activity practices are reported to be low in women with multiple sclerosis (MS), some women with MS remain physically active despite their disability. Thus, the primary aim of the study was to determine whether abdominal fat accumulation and levels of TG, HDL-C, and glucose differ between active and inactive women with MS. The study sample consisted of 123 women with MS, aged 23-72 yr. Venous blood was collected for measurement of lipids, lipoprotein-cholesterol, and glucose. Skin-fold thicknesses and girth circumferences were obtained for estimation of total and abdominal body fat. Leisure-time physical activity (LTPA) during the last 12 months was assessed by the physical activity questionnaire used in the Postmenopausal Estrogens/Progestins Intervention (PEPI) Study. Eating habits were assessed by the Block Food Frequency Questionnaire. LTPA was significantly associated with lower waist circumference (P = 0.0001), lower TG levels (P = 0.0005), and lower glucose levels (0.002). After adjusting for several covariates, women participating in low- to moderate-intensity LTPA had significantly lower waist circumferences, TG levels, and glucose levels relative to inactive women. Low- to moderate-intensity LTPA was significantly associated with less abdominal fat accumulation, lower levels of TG, and lower levels of glucose in the present sample of women with MS. These findings
suggest that exercise levels attainable by women with MS may improve CHD risk and contribute to important health-related benefits.

**Ohkuwa, et.al.,** stated that this study was designed to examine the effect of exposure to two levels of light intensity (bright; 5000 lux, dim; 50 lux) prior to supramaximal cycle exercise on performance and metabolic alterations. The exercise was performed after bright and dim light exposure for 90 minutes. Ten male long-distance runners volunteered to take part in the study. They performed 45-sec supramaximal exercise using a cycle ergometer in a 500-lux. Mean power output was measured during the exercise. Lactate and ammonia in the blood and epinephrine and norepinephrine concentrations in plasma were measured at rest immediately after bright and dim light exposures and after the exercise. Bright and dim light exposure prior to exercise did not significantly affect the power output during the exercise. Blood glucose concentration immediately after exercise and plasma epinephrine during the resting period were significantly lower after bright light exposure compared with dim light exposure ($p < 0.05$). No significant difference was found in blood lactate, ammonia, or plasma norepinephrine levels after exercise following bright and dim light exposures. This study demonstrated that bright light stimulation prior to supramaximal exercise decreases glucose and epinephrine levels, but is not related to physical performance.
Olive, et al., stated that this study investigated the effect of different exercise bouts on plasma leptin response. Trained men (n = 9) performed a short duration, maximal intensity (MAX) bout and a 60-min endurance run at approximately 70% of maximal oxygen consumption (END). Blood was collected before, immediately after, 24 h after (24 h Post), and 48 h after exercise (48 h Post) for measurement of plasma leptin, insulin, and glucose. VO(2)max and percent body fat were 57.8 +/- 2.1 mL x kg(-1) x min(-1) and 10.8 +/- 1.5% (mean +/- SEM), respectively. Energy expenditure was 197.5 +/- 11.8 and 882.7 +/- 14.4 kcal for MAX and END, respectively. Plasma leptin levels did not differ between time points for the MAX run. Leptin was significantly lower 48 h Post (2.2 +/- 0.3 ng/mL) versus before, immediately after, and 24 h Post exercise (3.1 +/- 0.3, 3.0 +/- 0.3, and 2.5 +/- 0.4 ng/mL, respectively) for END. Leptin tended to be lower at 24 h Post than before or immediately after exercise (P = 0.10). Plasma insulin was lower 24 h Post- versus pre exercise for the END, but was not correlated to changes in leptin levels. Plasma glucose levels did not change significantly during the endurance test. We found a delayed decrease in leptin at 48 h after an extended exercise session (900 kcal). Furthermore, this effect did not appear to be related to changes in insulin or glucose levels. Findings from this study address the effects of exercise on leptin, aiding in the evaluation of the impact of exercise and energy expenditure on plasma leptin concentrations in the prevention and treatment of obesity.
MaClaren, et.al., stated that this investigation evaluated the effectiveness of supplementing eight elite rugby league referees with a 6% maltodextrin (Md) solution whilst undertaking a simulated rugby league game. The simulation was based on motion analysis of six rugby league matches. Subjects undertook two trials of repetitive 20-m shuttle activity on an indoor track. During one trial 200 ml of Md was ingested at eight time points and in the other trial a similarly tasting placebo (PI) was administered. A single-blind, counterbalanced design was employed. The simulation involved subjects performing four, 10-min blocks of shuttle activity before a 10-min break was instigated. Three further 10-min blocks of shuttle activity were also performed before a performance test to volitional exhaustion involving 20-m shuttles at paces varying between 55 and 95% of a pre-determined VO2max was undertaken. Timed 15-m sprints took place during each of the 10-min blocks. The rating of perceived exertion (RPE), and blood glucose and lactate concentrations were also determined throughout. The mean number of shuttles to exhaustion was significantly greater with Md ingestion than with PI ingestion (57 +/- 19 vs. 43 +/- 15; p < 0.05), while the mean 15-m sprint times were significantly shorter for the Md than the PI condition (2.40 +/- 0.09 s vs. 2.51 +/- 0.14 s; p < 0.01). The mean RPE was 5.2% lower during Md than PI ingestion, the values being significantly different (Md: 12.07 +/- 0.32; PI: 12.73 +/- 0.28; p < 0.01). Maltodextrin ingestion significantly elevated blood glucose levels compared with placebo (F(1,7)
= 18.07: p < 0.01), although no significant differences were apparent for blood lactate levels (F(1,7) = 4.39; p > 0.05). These results highlight the beneficial effects of maltodextrin ingestion on work-rates of rugby league referees in a simulation of a game's activity. The improvement may be related to higher circulating concentrations of blood glucose.

Zonderland, et.al., stated that Regular physical activity may prevent or postpone type 2 diabetes, and is thought to be related to an increase of insulin sensitivity. We studied whether physically active, glucose-tolerant first-degree relatives of type 2 diabetes patients differ in glucose tolerance (oral glucose tolerance test [OGTT]) and insulin secretion (hyperglycemic glucose clamp) from less active first-degree relatives. A group of 37 relatives was split into 2 subgroups according to the sex-specific median of the sports index, assessed by a questionnaire, as the cutoff point. Blood glucose levels during the OGTT were lower in the highly active subgroup versus the less active counterparts (multivariate ANOVA [MANOVA], P = .011), but the plasma insulin levels were similar. First-phase secretion was not different in the highly active group versus the less active group, but second-phase secretion (average plasma insulin in the third hour) was significantly lower (P = .016). As expected, the insulin sensitivity index (ISI) was higher in the highly active subgroup (P= .011). Subdivision into subgroups with high or low maximal O2 consumption (VO2max) resulted in similar differences, but these were not significant. In a group of 21 controls, the results resembled the values in
the relatives but were less often statistically significant. In conclusion, regular physical activity not only is associated with increased insulin sensitivity but also down regulates the pancreatic beta cell. This down regulation may provide an extra mechanism by which physical activity diminishes the development of type 2 diabetes.

2.2 The Summary of Related literature

The summary of related literature presented an overview of independent variables such as Run and walk and Interval training and dependent variables such as Haemoglobin concentration, Mean Arterial pressure, Blood glucose and Blood Lactic acid concentration.

The researcher has collected 89 reviews of related Literatures relevant to this research.

The researcher has collected 14 reviews on Run & walk program in which 9 authors conducted Run & walk tests on patients of men and women with peripheral arterial disease, cancer and chronic heart failure patients, 2 authors conducted tests on foot orthosis and foot motion, 3 authors conducted tests on distance runners, young adult men, women, children, and adolescence. Out of 14 studies on Run & walk 12 studies were significant and 2 were insignificant.

14 Reviews were collected on Interval training in which 4 authors conducted test on cyclists, 5 authors conducted tests on endurance
runners and athletes, 5 authors conducted tests on soccer players, cross country skiers, speed skaters, swimmers, and basketball players. Out of 14 studies on Interval training 10 studies were significant and 4 were insignificant.

The researcher has collected 16 reviews on Haemoglobin in which 8 authors conducted tests on endurance and elite athletes, 2 authors conducted tests on cyclists, 2 authors conducted tests on Basketball players and 4 authors conducted tests on skiers, weight lifters, mountaineers and rowers. Out of 16 reviews on Haemoglobin concentration 11 studies were significant and 5 were insignificant.

16 reviews were collected on Mean arterial pressure in which 5 authors conducted tests on aerobic and resistant training, 5 authors conducted tests on cardio vascular response to endurance runners, sprinters and swimmers, 6 authors conducted tests on Tread mill walking, sailors, stress testing, weight lifting, and anthropometrics responses. Out of 16 reviews on Mean Arterial pressure 12 studies were significant and 4 were insignificant.

17 studies stated about Blood glucose in which 11 authors conducted tests on physical training and aerobic endurance training, 6 authors conducted tests on weight training, wookieum, diving, cycling and
shuttle run. Out of 17 reviews on Blood glucose studies were significant and 2 were insignificant.

The researcher has collected 12 reviews on Blood Lactic acid concentration in which 7 authors conducted tests on speed and endurance training, 3 authors conducted tests on cycle ergometer and 2 authors conducted tests on Treadmill running. Out of 12 studies on Blood Lactic Acid concentration 9 studies were significant and 3 were insignificant.