CHAPTER - II
REVIEW OF RELATED LITERATURE
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A study of relevant literature is an essential step to get a complete idea of what has been done with regard to the problem under study. Such a review brings about deep and clear perspective of the overall field. The literature in any field forms the foundation upon which all future work will be built.

The review of literature is instrumental in the selection of topic, formulation of hypotheses and deductive reasoning leading to the problem. It helps to get a clear idea and supports the findings with regard to the problem under study, Thirumalaisamy .R (1995)

2.1. STUDIES ON BENCH STEP TRAINING

Scharff Olson et.al (1996) investigated the acute cardio respiratory responses to the current 'popularized' style of bench step exercise had validated its use in improving aerobic physical fitness, particularly in women. However, no marked differences in relative measures of cardio respiratory demand have been reported between men and women. Instructor data and training investigations further substantiate the effectiveness of bench step exercise in promoting physical fitness, including upper body strength. However, the energy cost of bench step exercise can vary dramatically. Important factors include, the selected step height, exercise rate, imposed step man, routine format and use of hand-held weights. Hand-held weights may be more useful for men than woman. During training, bench step exercise has been reported to yield a high incidence of grade I injury complaints, particularly in the calf and shoulder region. However, nearly 90% of these complaints were attributable to acute muscle soreness. Few serious injuries have been associated with the activity. Biomechanical research has shown that the ground reaction forces (GRF) experienced during bench stepping are lower than running and directly related to the step height and type of maneuver. In addition, compared with
novices, instructors exhibit a modulation in the GRF pattern generated during landing. This suggests that a learning effect has occurred and that teachers yield a more consistent landing pattern. Finally, the activity may be effective in improving body composition, but a consideration of factors related to energy expenditure (e.g. exercise duration and dietary control) appear to be important in regimens prescribed for modifying body fat.

Kraemer et al. (2001) investigated the comprehensive physiological alterations that take place during the combination of bench-step aerobics (BSA) and resistance exercise training. Thirty-five healthy, active women were randomly assigned to one of four groups that either. a) Performed 25 min of BSA only (SA25); b) performed a combination of 25 min of BSA and a multiple-set upper and lower body resistance exercise program (SAR); c) performed 40 min of BSA only (SA40); or d) served as a control group, (C) only performing activities of daily living. Direct assessments for body composition, aerobic fitness, muscular strength, endurance, power, and cross-sectional area were performed 1 wk before and after 12 wk of training. All training groups significantly improved peak VO\(_2\) (3.7 to 5.3 mL O\(_2\) kg\(^{-1}\) min\(^{-1}\)), with the greatest improvement observed in the SAR group (P = 0.05). Significant reductions in pre exercise heart rates (8-9 bpm) and body fat percent (5-6%) were observed in all training groups after training. Significant reductions in resting diastolic blood pressure were observed for the SAR and SA40 groups (6.7 and 5.8 mm Hg, respectively). Muscular strength and endurance only improved significantly in the SAR group (21 and 11% respectively). All groups demonstrated increased lower body power (11-14%), but only the SAR group significantly improved upper body power (32%). Thigh muscle cross-sectional areas measured via magnetic resonance imaging (MRI) increased primarily for the SAR group. BSA is an exercise modality effective for improving physical fitness and body composition in healthy women. The addition of resistance exercise appears to enhance the total fitness profile by improving muscular performances, muscle morphology, and
cardiovascular fitness greater than from performing BSA alone. Therefore, the inclusion of both modalities to an exercise program is most effective for improving total body fitness and a woman's health profile.

Engels et.al (2002) studied the effect of bench step, group exercise with and without extremity loading on muscular fitness, body composition, and psychological affect. A prospective training study was carried out on general community fitness center comprising 44 healthy adult females (age: 21-51 yrs). 12 weeks of bench/ step exercise (3 sessions/week, 50 min/session, 60-90% HRmax). Subjects were randomly assigned to groups that trained with (WT, n=16) and without (NWT, n=16) 0.68 kg/ankle and 1.36 kg/hand weights while 12 subjects served as non-training controls (NTC). Pre- and post intervention muscular strength and endurance for knee and elbow flexion and extension, and for shoulder abduction and adduction were examined by isokinetic dynamometry. Body composition was assessed with hydrostatic weighing and psychological affect by questionnaire. Thirty-two subjects completed the study. ANOVA revealed that pre- to post intervention changes for body fat (2.6%), fat-free weight (+0.7 kg), fat weight (-1.9 kg), and knee flexion peak torque were significantly different in the bench/step exercise trained (WT+NWT) compared to the NTC study group. Specific comparisons of muscle strength and endurance change scores of WT+NWT relative to NTC, and of WT relative to NWT revealed no other significant differences between groups. Positive and negative affective states were similar among study groups before and after the intervention. Participation in bench step exercise improved body composition but was of limited or no value as a modality to change muscular fitness and psychological affect in healthy adult females. The use of ankle and hand weights failed to enhance training adaptations.

Williford et.al (1998) investigated was to evaluate injury rates and changes in VO2 peak in women associated with aerobic exercise (bench stepping and running). A pretest post-test repeated measures design was used
to evaluate changes in VO$_2$ peak after training for 10 weeks, 3 days per week, for 1 hour per session. Injury incidence was monitored by questionnaires throughout the training program. All testing and training took place at Auburn University Montgomery, Montgomery, USA. The subjects were women enrolled in university physical activity courses. The exercise groups consisted of 23 women who performed bench exercise and 15 who performed running jogging. Eleven subjects served as non-exercising controls. The 10-week exercise-training program served as the intervention. Subjects were both pre- and post-tested for VO$_2$peak by open circuit calorimetric. Body composition was estimated from a 7-site skin fold equation. A daily injury log was maintained to evaluate injury status. Repeated measures ANOVA found similar significant improvements in VO$_2$peak for both the bench and running groups with no change for the control group. An evaluation of the injuries graded II or higher found 0.29 injuries per 100 hrs for the bench group and 0.66 injuries per 100 hrs for the running group. When all complaints were considered (grade I to grade IV) the rates increased to 2.44 per 100 hrs for the running group and 6.09 per 100 hrs for the bench group. Aerobic bench exercise produced similar changes in VO$_2$ peak compared to running. The indicated that the primary injury complaints were grade I and related to delayed onset muscle soreness (DOMS). The bench group experienced a greater incidence of grade I complaints while the running group experienced a slightly greater incidence of more serious grade II or higher injuries.

Olson et.al (1991) investigated to measure cardiovascular and metabolic responses to 20 min continuous bouts of "choreographed" bench stepping exercise in healthy females. Four frequently used bench heights were employed in a crossover design 15.2 cm (6 inches, B-6), 20.3 cm (8 inches, B-8), 25.4 cm (10 inches, B-10), and 30.5 cm (12 inches, B-12). Oxygen uptake (VO$_2$) responses were significantly more pronounced in direct relationship to the bench height, B-12 greater than B-10 greater than B-8 greater than B-6 (P less than 0.05). Mean responses for VO$_2$ ranged from 28.4 ml.kg$^{-1}$.min$^{-1}$ for B-6 to
37.3 ml.kg⁻¹.min⁻¹ for B-12. Interestingly, no difference was revealed for heart rate and the respiratory exchange ratio between B-12 and B-10 despite a higher VO₂ for B-12 (B-12, B-10 greater than B-8 greater than B-6, P less than 0.05). The incorporation of 0.91 kg (2 lb) hand weights with exercise on the 20.3 cm bench elicited a modest but statistically significant increase in VO₂ compared with no hand weights. No significant increase in VO₂ was revealed for conditions that employed 0.45 kg (1 lb) hand weights. The demonstrate that aerobic bench stepping is an exercise modality that provides sufficient cardio respiratory demand for enhancing aerobic fitness and promoting weight loss in females.

Scharff Olson et al. (1997) determined the effects of two bench-step exercise speeds on vertical impact forces and to explore this variable between novices, and instructors. 12 women (mean age 24 yr.) randomly performed 8-min. protocols of the "basic" bench-stepping technique and a more advanced "travel" technique at 30 and 33 cycles /min.-1. Analysis showed that the faster exercise rate yielded significantly higher vertical impact forces on a reference (B-8) step height (20.3 cm). At 33 cycles.min.-1, the instructors, and novices' responses were both higher than those at 30 cycles.min.-1. The mean peak vertical impact force ranged from 1.54 times the body weight for the novice group at 30 cycles /min.-1 to 1.87 times the body weight for instructors at 33 cycles.min.-1. A comparison of the groups' force curves showed a distinctive pattern in the loading of the impact forces. Specifically, the instructors consistently produced a transitory decrement in force prior to attaining peak force. In addition, the novices exhibited no uniform increases in the production of vertical impact force across other step heights at the faster (33 cycles.min.-1) speed. Thus, experience with bench-step exercise may afford an ability to make uniform and force-absorbing adjustments in the resultant vertical impact forces at increased speeds.
Darby et al. (1995) studied the physiological responses to aerobic dance exercise of varied impact (high, low), step (less arm movement vs. more arm movement), and cadence (124 vs. 138 beats.min⁻¹) were investigated. Experienced, female aerobic dancers (N = 16) performed activities that combined the levels of impact and step for 3 trials of 8-min each. Dependent variables included heart rate, percentage of maximal heart rate, oxygen consumption, percentage of maximal oxygen consumption, and respiratory exchange ratio. Repeated measures analyses of variance indicated a significant Impact x Step interaction whereby oxygen consumption was greater for the high impact-less arm movement activity (jog), while the low impact-more arm movement activity (power jack) was greater for heart rate. The interaction of aerobic dance characteristics (e.g., impact, arm movement) that may alter physiological responses to aerobic dance exercise should be identified in future aerobic dance routines and studies.

Okura et al. (2003) analysed whether "low-intensity" exercise (walking) and "high-intensity" exercise (aerobic dance), when added to a weight loss diet, have different effects on coronary heart disease (CHD) risk factors and physical fitness. Ninety obese women were divided into diet only (DO), diet plus walking (DW), and diet plus aerobic dance (DA) groups. DXA was used to evaluate segmental body composition. Leg-extension strength and maximal oxygen uptake (VO₂max) were the indicators of physical fitness. Blood pressure, lipoproteins, and fasting glucose were used as indices for CHD risk factors. These items were measured before and after a 14-week intervention period. Whole-body plus all segmental fat masses was significantly reduced (p < 0.001). Reductions in whole-body and lower-limb fat- and bone-free masses were significantly less (p < 0.01) in the DA group (-1.5 and -0.1 kg, respectively) compared with the DO (-2.1 and -0.4 kg, respectively) and DW (-2.5 and -0.5 kg, respectively) groups. Improvements in leg-extension strength and VO₂max were significantly greater (p < 0.05) in the DA group compared with the DO group. The CHD risk factors clearly improved (p < 0.05) within
each group. Reductions in low-density lipoprotein-cholesterol and fasting glucose were significantly greater (p < 0.05) in the DA group compared with the DO and DW groups. Adding higher intensity aerobic dance to a weight-loss diet program may help maintain fat- and bone-free mass and may be more effective in improving CHD risk factors compared with low-intensity walking.

Sutherland et al. (1999) established the cardiovascular and metabolic demands of a university step aerobics session entitled 'Uni-Step' performed at three step heights, and to evaluate the use of heart rate and ratings of perceived exertion for the estimation of exercise intensity during this mode. Ten female participants in step aerobics (mean VO2max = 47.7, s = 6.8 ml.kg-1.min-1) performed a 40-min Uni-Step routine on steps of height 6, 8 and 10 inches (15.2, 20.3 and 25.4 cm). Oxygen uptake, heart rate and ratings of perceived exertion were recorded throughout each test. Maximum oxygen uptake (VO2max) and maximum heart rate were measured using a continuous treadmill protocol. The mean intensities were 45.6%, 51.6% and 56.2% VO2max for the 6-, 8- and 10-inch steps respectively. The mean percent heart rate reserves were 57.2%, 63.6% and 70.1% at these 3 heights respectively. Correlations indicated a weak relationship between percentage VO2max and ratings of perceived exertion for the 6- and 8-inch steps (r = 0.61 and 0.66 respectively) but a stronger one for the 10-inch step (r = 0.79). Uni-Step performed on the two highest steps was of a sufficient relative intensity to improve or maintain the cardiovascular fitness of participants in this study. The lowest step may be useful for participants of lower fitness. Heart rate were overestimated the metabolic cost of Uni-Step at all three step heights and therefore caution is advised if used to predict intensity. Low correlations between percentage VO2max and ratings of perceived exertion at the two lower step heights indicate that ratings of perceived exertion may have limited utility in prescribing training intensity.
Grier et al. (2002) determined the metabolic and cardiovascular responses of aerobic dance bench stepping (ADBS) at commonly used cadences and bench heights. 30 women (19-47 years of age) performed a graded maximal treadmill test and four 8-minute sub maximal ADBS routines. Subjects followed identical videotape sequences of basic ADBS movements at cadences of 125 and 130 beats, in (-1) at bench heights of 6 and 8 in. Physiological measurements were taken during each minute of each test. Mean values calculated from the last 3 minutes were used for data analysis. Although there were no physiological differences between ADBS at the two cadences, there were significant physiological differences between ADBS at the two bench heights. On average, a 2-in. increase in bench height, increased heart rate, VO\(_2\), and rating of perceived exertion by 10 beats. in(-1), 3.09 ml.kg(-1) min(-1), and 1.53, respectively. In, it appears that bench height is more of a factor than cadence in increasing metabolic cost of ADBS. From this study provide information about the energy cost of ADBS at the common bench heights and cadences used in this study and, therefore, may be used to help aerobic participants select the proper bench height and cadence combination to control body weight and develop cardio respiratory fitness safely and effectively.

Stanforth et al. (1993) studied to: (1) verify the aerobic requirement (AR) of bench stepping (BS); (2) determine the effect of leg length (LL), bench height (BH), stepping rate (SR), body weight (BW), and fat free mass (FFM) on the AR of BS; and (3) compare the HR and VO\(_2\) of BS with treadmill walking/running (TM). Twenty-eight females completed randomly assigned BS sessions with hands on hips at 30 and 32 steps cycles.min-1. Sessions consisted of four 5 min. bouts at BH of 15.2, 30.4, 25.4 and 30.5 cm. 4 x 2 repeated measures ANOVA determined that VO\(_2\) was significantly different between each BH and SR (p < 0.01) with no significant interaction between BH and SR (p > 0.05). A stepwise multiple regressions determined that BH, BW, SR, FFM, and LL significantly affected BS VO\(_2\) (p < 0.05) with BH and
BW accounting for 83% of the VO₂. A series of t-tests found no significant
difference (p > 0.05) between measured VO₂ and that predicted by the ACSM
equation (1) at 15.2, 20.3 and 25.4 cm. Measured VO₂ was significantly greater
than predicted at 30.5 cm (p < 0.01). A repeated measure ANCOVA
determined that the VO₂/HR slopes for BS and TM were not parallel
(p < 0.01). Point testing determined that the HR elicited by TM at a specific
VO₂ was significantly higher than the BS HR until 34 ml.kg⁻¹ x min⁻¹.

Hayakawa (2000) stated evaluated the effect of music on the mood of
women during exercise. 16 middle-aged women, aged 49.9 +/- 7.53 yr.,
performed 60-min. bench stepping exercise while listening to Japanese
traditional folk song, aerobic dance music, or non-music. The subjects reported
significantly less fatigue with aerobic dance music and Japanese traditional
folk song than with non-music. Aerobic dance music was associated with
significantly more vigor and less confusion than non-music.

Mosher et.al (2005) Exercise training can improve lipid and lipoprotein
concentrations and reduce the risk of heart disease. Little information is
available concerning aerobic dance training and lipoprotein concentration
changes in women. The purpose of this study was to compare the effects of two
different methods of step bench training on cardiorespiratory fitness, body
composition, and lipoprotein concentrations in college-aged females. Subjects
were assigned to one of three groups, a traditional continuous step (CS), an
interval step group (IS), or a non-exercise control group (C). The CS and the IS
groups participated in three 50-minute sessions for 12 weeks. The CS session
included a warm-up, 30-35 min of continuous bench stepping, 10-15 min of
calisthenic exercises, and a 5-min cool-down. The IS sessions included a 5-7-
min warm-up, 35-40 min of alternating intervals of bench stepping and non-
step aerobic dance, and a 5-7-min cool-down. Target heart rates were
maintained within 70 to 85% of maximal heart rate. Results showed increases
in HDL-C concentrations in the IS group (p<0.05). Decreases in percent body
fat were evident in both dance groups (p<0.05) and cardiovascular fitness increased in both groups (p<0.01). No changes were evident in the control group. In college-aged women, 12 weeks of IS or CS training improved cardiorespiratory fitness and body composition. In addition, IS training appears to have a greater effect on HDL-C concentrations than CS training.

2.2. STUDIES ON PHYSIOLOGICAL VARIABLES

STUDIES ON PLASMA GLUCOSE

Colberg (1996) stated that Utilization of glycogen but not plasma glucose is reduced in individuals with NIDDM during mild-intensity exercise. To test the hypothesis that substrate utilization during mild-intensity exercise differs in non-insulin-dependent diabetes mellitus (NIDDM) compared with nondiabetic subjects, seven lean healthy subjects (L), seven obese healthy subjects (O), and seven individuals with NIDDM were studied during 40 min of mild-intensity cycling (40% of peak O₂ uptake). Systemic utilization of plasma glucose (Glc Rd) was determined by using isotope dilution Gas exchange was measured to determine rates of carbohydrate (CHO) and lipid oxidation. During exercise, when CHO oxidation was greater than Glc Rd, the net oxidation of glycogen was calculated as the difference. CHO oxidation Glc Rd. During mild-intensity cycling, the respiratory exchange ratio was similar across groups (0.87 ± 0.02, 0.85 ± 0.02, and 0.86 ± 0.01 in L, O, and NIDDM subjects, respectively), and CHO oxidation accounted for one-half of total energy expenditure during exercise. Glc Rd increased during exercise and was greatest in subjects with NIDDM (3.0 ± 0.2, 2.9 ± 0.2, and 4.5 ± 0.4 ml kg⁻¹ min⁻¹ in L, O, and NIDDM subjects, respectively, P < 0.05), yet Glc Rd was less than CHO oxidation during exercise, indicating net oxidation of glycogen. Glycogen oxidation was greater in L and O than in NIDDM subjects (3.4 ± 1.0, 2.5 ± 0.9, and 1.7 ± 0.8 ml kg⁻¹ min⁻¹; P < 0.05). In summary, during mild-intensity exercise, NIDDM subjects have an increased Glc Rd and a decreased oxidation of muscle glycogen. Obesity; non-insulin-dependent diabetes mellitus; glucose uptake; muscle glycogen; gas exchange
Coggan et al. (1992) investigated the hypothesis that the rate of plasma glucose oxidation in the vastus lateralis muscle during exercise is inversely related to muscle respiratory capacity. Fourteen subjects of high and low lactate thresholds were infused with glucose during 90 minutes of exercise at 55% of VO2 peak. The high threshold group maintained higher pretest citrate synthase activity in the vastus lateralis muscle (4.59 ± 0.41 mmol·h⁻¹·kg protein⁻¹, the high lactate threshold, and 3.00 ± 0.48 mmol·h⁻¹·kg protein⁻¹, the low lactate threshold). Mean rates of glucose appearance, disappearance and oxidation were significantly lower in the low threshold group. The high threshold group was more metabolically fit which is related to the higher mitochondrial content as reflected by citrate synthase activity. This supports the concept that skeletal muscle respiratory capacity has a major role in determining the metabolic response to submaximal exercise. These data also indicate training in a reduction in plasma glucose turnover, due to decreased reliance of carbohydrate as a substrate and improved oxidative functioning of the muscle.

Coggan et al. (1995) investigated glucose kinetics during high-intensity exercise in endurance-trained and untrained humans. Eight trained and eight untrained cyclists were infused with glucose during 30 minutes of cycling at 80% of VO2max. Glucose appearance was the same for both groups (34.3 ± 3.6 vs. 36.0 ± 1.7 μmol·min⁻¹·kg⁻¹); however, the rate of glucose disappearance was 19% lower in trained subjects (27.0 ± 2.6 vs. 33.2 ± 1.5 μmol·min⁻¹·kg⁻¹; p<0.001). Also during exercise, plasma glucose concentration rose significantly in the trained subjects (5.15 ± 0.20 vs. 4.92 ± 0.24 mmol/l) but did not change for the untrained subjects. It was concluded that the rate of glucose utilization is lower in trained subjects even at higher relative and absolute intensities, and training reduces reliance on plasma glucose as an energy source during moderate intensities.
Coggan et al (1990) examined the effects of training on plasma glucose metabolism during exercise in man. Seven men (age 26 ± 1 yr) were studied before and after a strenuous 12 week exercise training program consisting of 3 days/week running and 3 days/week cycling. Testing consisted of maintained steady state cycling exercise for 120 minutes. Indicate training causes a decreased reliance on plasma glucose as an energy source during exercise performed at the same absolute intensity due to a lower rate of appearance, disappearance and clearance. After training, steady state plasma glucose turnover, over a period of the final 30 minutes of exercise, was significantly lower by an average of 29%. However, plasma glucose concentration was similar and slightly higher when compared pre and post (4.69 ± 0.13 mmol/l vs. 4.93 ± 0.14 mmol/l) although not significant.

Arkinstall and Bruce (2004) to date the of studies that have examined the effects of altering pre-exercise muscle glycogen content and exercise intensity on endogenous carbohydrate oxidation are equivocal. Differences in the training status of subjects between investigations may in part explain these inconsistent findings. Accordingly, we determined the relative effects of exercise intensity and carbohydrate availability on patterns of fuel utilization in the same subjects who performed a random order of four 60-min rides, two at 45% and two at 70% of peak O2 uptake (Vo2 peak), after exercise-diet intervention to manipulate muscle glycogen content. Pre exercise muscle glycogen content was 596 +/- 43 and 202 +/- 21 mmol/kg dry mass (P < 0.001) for high-glycogen (HG) and low-glycogen (LG) conditions respectively. Respiratory exchange ratio was higher for HG than LG during exercise at both 45% (0.85 +/- 0.01 vs. 0.74 +/- 0.01; P < 0.001) and 70% (0.90 +/- 0.01 vs. 0.79 +/- 0.01; P < 0.001) of Vo2 peak. The contribution of whole body muscle glycogen oxidation to energy expenditure differed between LG and HG for exercise at both 45% (5 +/- 2 vs. 45 +/- 5%; P < 0.001) and 70% (25 +/- 3 vs. 60 +/- 3%; P < 0.001) of VO2 peak. Yet, despite marked differences in preexercise muscle glycogen content and its subsequent utilization, rates of
plasma glucose disappearance were similar under all conditions. We conclude that in moderately trained individuals muscle glycogen availability (low vs. high) does not influence rates of plasma glucose disposal during either low- or moderate-intensity exercise.

Wilber et al. (1996) examined the effect of a 6-wk deep-water running program on the maintenance of cardiorespiratory performance (VO2max, ventilator threshold, running economy); metabolic measurements of blood glucose, blood lactate, and plasma norepinephrine; and body composition. Sixteen trained male runners (VO2max = 58.6 +/- 3.6 ml.kg-1.min-1) were assigned to one of two groups matched by VO2max, treadmill run (R) or water run (WR). Subjects participated in their respective training programs, which consisted of workouts of a) 30 min at 90-100% VO2max and b) 60 min at 70-75% VO2max alternated daily for 5 d.wk-1. Following 6 wk of workouts, no significant intra- or inter group differences were observed for treadmill VO2max for R (pre = 58.4 +/- 2.3, post = 60.1 +/- 3.6 ml.kg-1.min) and WR (pre = 58.7 +/- 4.7, post = 59.6 +/- 5.4 ml.kg-1.min-1). Similarly, ventilatory threshold was unaltered in R (pre = 47.5 +/- 1.8, post = 48.2 +/- 3.3 ml.kg-1.min-1) and WR (pre = 46.5 +/- 6.4, post = 47.4 +/- 6.7 ml.kg-1.min-1), nor were there any changes in running economy in R (pre = 48.4 +/- 2.3, post = 48.9 +/- 2.0 ml.kg-1.min-1 at 255 m.min-1) and WR (pre = 51.8 +/- 2.0, post = 48.9 +/- 2.2 ml.kg-1.min-1 at 255 m.min-1). No significant differences were observed within or between groups for maximal blood glucose, blood lactate, and plasma norepinephrine concentration as well as for body composition indices. It was concluded that deep-water running might serve as an effective training alternative to land based running for the maintenance of aerobic performance for up to 6 wk in trained endurance athletes.

Jurimae et al. (2004) stated Plasma leptin concentrations are reduced in the presence of a negative energy balance. The purpose of this study was to investigate the effects of a prolonged single endurance rowing training session
on plasma leptin concentrations in female rowers. Ten female college level single scull rowers participated in this study. Venous blood samples were obtained during the early follicular phase of the menstrual cycle immediately before and after on-water rowing lasting about 2 h (7518±293 s; distance covered 18.9±1.4 km; heart rate 150±7 beats. min (-1)). Blood lactate concentration did not change significantly during sculling training session (from 1.6±0.4 to 1.9±0.5 mmol. L (-1)) indicating that training was performed at moderate intensities. Leptin values were significantly reduced immediately after prolonged rowing by a mean 44% and no further changes occurred during the first 2 h of recovery. Insulin and glucose values were also decreased immediately after prolonged rowing. A further reduction in insulin was seen during the 2(nd) hour of recovery. No further changes occurred during the first 2 h of recovery in glucose concentration. Plasma leptin concentrations immediately after (r=-0.64), and 30 min (r=-0.66) and 2 h (r=-0.64) after an endurance rowing training session were related (p<0.05) to the distance covered. Our findings indicate that a prolonged low-intensity rowing training session in an energy deficit beyond the threshold that is necessary to reduce plasma leptin concentration without changing body fat mass in female rowers. It was suggested that plasma leptin could be regarded as a signal for metabolic reaction to endurance rowing training session and following recovery in female endurance athletes.

Angelopoulos et.al. (2002) determined the effects of short-term exercise on glucose tolerance and insulin response to a glucose load in centrally obese individuals. Design 75 g oral glucose tolerance tests (OGTT) were performed prior to participation and 24 hours after the last exercise session. Exercise bouts were 40 minutes in duration and consisted of treadmill walking and cycle ergometry at 70-80% of age-predicted maximum heart rate (APHR (max)). Eleven sedentary, centrally obese men [mean (SE) Mass, 119.1 (5.4) kg; BMI, 37.7 (1.8) kg/m (-2); waist-to-hip ratio (WHR), 0.97 (0.01); age 31.7 (2.4) years] were studied before and after 10 days of aerobic exercise training. No
significant change (p > 0.05) in body mass was noted following 10 days of exercise as compared with pre participation [119.1 (5.4) kg versus 118.9 (5.4) kg]. Fasting plasma glucose concentration was significantly lower (p < 0.05) following 10 days of exercise as compared with pre exercise [5.58 (0.15) mmol/L versus 5.27 (0.12) mmol/L]. No significant change (p > 0.05) in fasting plasma insulin concentration, however, was observed following 10 days of exercise training as compared with pre exercise [276.2 (33.7) pmol/L versus 225.3 (35.9) pmol/L]. Plasma insulin concentrations at 60 minutes and 120 minutes were significantly decreased (p < 0.05) when comparing the pre exercise to the post exercise OGTT [60: 1264.2 (88.3) pmol/L versus 1103.5 (81.1) pmol/L; 120, 1066.9 (110.5) pmol/L versus 764.1 (106.2) pmol/L]. Plasma glucose concentration at 120 minutes was also significantly reduced (p < 0.05) after 10 days of exercise as compared with pre exercise [6.09 (0.24) mmol/L versus 5.39 (0.22) mmol/L]. Area under the glucose curve was significantly (p < 0.05) reduced after 10 days of exercise as compared with pre participation [944.6 (44.4) mmol/L/120 min versus 884.4 (43.2) mmol/L/120 min]. Area under the insulin curve was also significantly decreased (p < 0.05) following 10 days of exercise training as compared with pre exercise [126,890 (9014.0) pmol/L/120 min versus 109,445 (7,888.9) pmol/L/120 min]. These data suggest that short-term exercise may improve glucose tolerance and insulin response to a glucose load in centrally obese men.

Friedlander et.al (1998) examined the effects of exercise intensity and training [12 wk, 5 days/wk, 1 h, 75% peak oxygen consumption (VO2 peak)] on lipolysis and plasma free fatty acid (FFA) flux in women (n = 8; 24.3 +/- 1.6 yr). Two pre training trials (45 and 65% of VO2 peak) and two post training trials [same absolute workload (65% of old VO2 peak; ABT) and same relative workload (65% of new VO2 peak; RLT)] were performed using infusions of [1,1,2,3,3-2H]glycerol and [1-13C] palmitate. Pre training rates of FFA appearance (Ra), disappearance (Rd), and oxidation (Rox p) were similar between the 65% (6.8 +/- 0.6, 6.2 +/- 0.7, 3.1 +/- 0.3 micromol. kg^-1. min^-1,
respectively) and the 45% of VO₂ peak trials. At ABT and RLT training increased FFA Ra to 8.4 +/- 1.0 and 9.7 +/- 1.1 micromol. kg⁻¹. min⁻¹, Rd to 8.3 +/- 1.0 and 9.5 +/- 1.1 micromol. kg⁻¹. min⁻¹, and Rox p to 4.8 +/- 0.4 and 6.7 +/- 0.7 micromol. kg⁻¹. min⁻¹, respectively (P ≤ 0.05). Total FFA oxidation from respiratory exchange ratio was also elevated after training at ABT and RLT, with all of the increase attributed to plasma FFA sources. Pertaining glycerol Ra was higher during exercise at 65 than 45% of VO₂ peak (6.9 +/- 0.9 vs. 4.7 +/- 0.6 micromol. kg⁻¹. min⁻¹) but was not changed by training. In young women 1) plasma FFA kinetics and oxidation are not linearly related to exercise intensity before training. 2) Training increases FFA Ra, Rd, and Rox p whether measured at given absolute or relative exercise intensities. 3) Whole body lipolysis (glycerol Ra) during exercise is not significantly impacted by training. In addition 4) training-induced increases in plasma FFA oxidation are the main contributor to elevated total FFA oxidation during exercise exertion after training.

STUDIES ON PLASMA CREATINE

Rotenberg et al (1988) kinetically measured total lactate dehydrogenase (LD, EC 1.1.1.27), total creatine kinase (CK, EC 2.7.3.2), and aspartate aminotransferase (AST, EC 2.6.1.1.) in 16 elite college basketball players, before the competition season and not in close temporal relation to near-maximal exercise, and in 17 healthy non-athlete controls. LD isoenzymes were determined by both electrophoretic and immuno precipitation. CK-MB isoenzyme was measured electrophoretically. We found significantly higher mean LD-1 values and LD-1/LD-2 ratios in the players than the controls: 31.6 (SD 3.7) percentage vs 25.8 (SD 3.2) percentage (P less than 0.005) and 1.1 (SD 0.13) vs 0.87 (SD 0.16) (P less than 0.001), respectively. A "flipped" LD pattern (LD-1 greater than LD-2) was found in half the players and in six of the eight black athletes, but in only two of the control group and in none of the black controls. Mean CK activity in serum exceeded normal values in the serum of the athletes and was higher in comparison with the control group [274
Mean CK was significantly higher in the eight athletes with the flipped LD pattern than in those with LD-1 less than LD-2 [322 (SD 163) vs. 180 (SD 98) U/L; P = 0.05], and in comparison with CK in the two controls with flipped LD pattern. We saw no significant difference in mean CK between the nine players with normal immunochemical LD-1/LD ratios and the seven players with above-normal ratios. CK-MB was not detected in either athletes or controls. None of the players had any clinical or electrocardiography evidence for myocardial ischemia or infarction. Evidently, the flipped LD pattern usually found in patients with acute myocardial infarction and reported in some athletes after extreme exercise such as ultra-marathon running may also be found in athletes who are in their "basal fitness shape" but who are not involved in competitive physical activity.

Pilis et al. (1988) examined that eight untrained men performed 15-s and 60-s high-intensity exercise on a bicycle ergometer. Activities of the creatine kinase (CK) and lactate dehydrogenase (LDH) were measured in blood 3 min and 2, 6, and 24 h after cessation of exercise. The indicate that anaerobic exercise induces a transient increase in plasma LDH activity and a more prolonged elevation in plasma CK activity. A negative correlation was found between CK activity measured before and 3 min after exercise and mean power, and total external work performed in both test types. A similar correlation was ascertained between pre- and post-exercise CK activity and maximal power output measured in the 60-s test. After the 15-s exercise test, only post-exercise plasma CK activity was negatively correlated with the maximal power output.

Rumley et al. (1985) examined that Serum total creatine kinase (CK) and the lactate dehydrogenase (LDH) isoenzymes were studied in 38 sedentary middle-aged men (aged 35-50 yrs) during a 30 week marathon training programme. Basal CK activity rose by 33% after 15 weeks but a significant rise (27%) in LDH activity took 30 weeks to occur. Post-exercise (maximum
test on a bicycle ergometer) CK and LDH activities were higher than pre-exercise levels but the increment in enzyme activity following exercise did not change. LDH1 and LDH2 isoenzyme activity increased by 2.5% and 4% of total LDH respectively while LDH3 and LDH5 decreased by 3.9% and 2.4% respectively over 30 weeks. Post marathon total CK did not correlate with finishing time at 30 mins or 30 hrs post race. The range of CK MB isoenzyme activities at 30 mins post race were 1.8-9.8% of total CK with 11 subjects having a value above 6%. The training programme appears not to have affected muscle CK and LDH release during exercise but isoenzyme distribution changes reflect the adaptations known to occur in muscle during endurance training.

Wolf et.al (1987) analysed that the skeletal muscle is rich in creatine kinase (CK), lactate dehydrogenase (LD), and other enzymes. Many reports describe changes in serum CK and LD following exercise. In our study, 11 male international-class medium-distance runners were followed over a 10-month period prior to the 1984 US Olympic Trials. Cardio respiratory fitness, evaluated through repetitive treadmill testing, was unchanged in our athletes. Total CK increased significantly during the course of training, and the CK-MB activity was higher than that of sedentary individuals; CK-MB never rose to more than 3% of the total CK. Total LD also rose following acute exercise; however, the proportions of the five isoenzymes were unaltered. There was no change in the LD-1/LD-2 ratio from normal. The origin of the increased serum enzymes was believed to be primarily skeletal muscle. A decrease of serum haptoglobin following acute stress was attributed to intravascular hemolysis and binding of hemoglobin. As expected, serum lactate was dramatically increased immediately post exercise.

Schocke et.al (2004) Studies performed incremental or progressive muscle exercises have observed that a decrease in pH is accompanied with acceleration in phosphocreatine (PCr) hydrolysis. The purpose of this study
was to investigate the relationship between PCr breakdown and pH during isotonic, exhaustive, incremental plantar flexion exercises. We included eight healthy, male volunteers into this study. Using a 1.5 Tesla MR scanner and a self-built exercise bench, we performed serial free induction decay (FID) (31) P MRS Measurements with a time resolution of 1 min at rest, isotonic calf muscle exercise, and recovery. The exercise protocol consisted of 5-min intervals with 4.5, 6, 7.5, and 9 W workload followed by 9-min recovery. Changes in PCr and inorganic phosphate (Pi) were determined as percent changes in comparison to the baseline. In addition, pH values were calculated. This study obtained significant decreases in PCr corresponding to the gradual increases in workload. In each workload level that was succeeded by all volunteers, PCr hydrolysis passed into a steady state. After an early biphasic response, we detected a significant decrease in pH from the first to the second minute of the 6-W workload level followed by a further continuous decrease in pH up to the second minute of the recovery phase. The decrease in pH was not accompanied by acceleration in PCr hydrolysis. In, this study shows that PCr hydrolysis during incremental plantar flexion exercises passes into a steady state at different workload levels. The observed decrease in pH does not result in acceleration of PCr hydrolysis.

Ricci et.al (1991) examined twenty patients with renal failure and severe anemia (hemoglobin range 6.6-8.7 g/dl) on thrice-weekly maintenance hemodialysis were treated with recombinant human erythropoietin. After three months of intravenous therapy the hemoglobin increase averaged 2 g/dl, and was steadily maintained even after two months of subcutaneous (sc) therapy. The significant increase of macrocyte counts, determined by an automated red blood cell counter after both steps of therapy, suggested the release of young red cells (large cells) into blood circulation. This assumption may be supported by the significant increase of the red cell creatine contents. 2,3-diphosphoglycerate (2,3-DPG) levels of the erythrocytes did not significantly change after rHuEPO administration.
Bangsbo (1993) studied compared biochemical and 31P-nuclear magnetic resonance (NMR) determinations of energy metabolites during isometric contractions of the human calf muscle at various exercise intensities. Seven male subjects performed one-legged isometric contractions at a workload of 28, 64, and 90% of maximal voluntary contraction force (28-, 64-, and 90%-CON, respectively) for 3 min, 40 s, and 40 s, respectively, in a magnet and in an exact model of the magnet with an arrangement for rapid muscle biopsy sampling from the gastrocnemius. The decrease in phosphocreatine (CrP) determined by NMR was 20, 33, and 71% for 28%-CON, 64%-CON, and 90%-CON, respectively. These decreases were the same as those determined biochemical (25, 34, and 61%, respectively). Muscle CrP 1 min after 90%-CON was also found to be similar between NMR and biochemical determinations (88 and 74% of resting value, respectively). Although no significant change in muscle ATP was found by NMR, a decrease of 29% was observed biochemical at 90%-CON. The ratio between muscle CrP and ATP was the same between NMR and biochemical determinations except for 90%-CON (1.98 and 0.78, respectively). The increase in muscle ADP determined by NMR was two-, five-, and eightfold higher than that found biochemical for 28%-CON, 64%-CON, and 90%-CON, respectively.

STUDIES ON PLASMA INORGANIC PHOSPHATE

Yoshida and Watari (1994) investigated the splitting of the inorganic phosphate (Pi) peak during exercise and recovery, a time-resolved 31 phosphorus nuclear magnetic resonance spectroscopy (31P-MRS) technique was used. Seven healthy young sedentary male subjects performed knee flexion exercise in the prone position inside a 2.1-T magnet, with the surface coil for 31P-MRS being placed on the biceps femoris muscle. After a 1-min warm-up without loading, 0.41 W increased the exercise intensity at 15-s intervals until exhaustion, followed by a 5-min recovery period. The 31P-MRS were recorded every 5 s during the rest-exercise-recovery sequence. Computer-
aided contour analysis and pixel imaging of the Pi and phosphocreatine peaks were performed. Five of the seven subjects showed two distinct Pi peaks during exercise, suggesting two different pH distributions in exercising muscle (high pH and low pH region). In these five subjects, the high-pH increased rapidly just after the onset of exercise, while the low-pH peak increased gradually approximately 60 s after the onset of exercise. During recovery, the disappearance of the high-pH peak was more rapid than that of the low-pH peak. These findings suggest that our method 31P-MRS provides a simple approach for studying the kinetics of the Pi peak and intramuscular pH during exercise and recovery.

Yoshida (2002) investigated time-resolved 31-phosphorus nuclear magnetic resonance spectroscopy (31P-MRS) of the biceps femoris muscles was performed during exercise and recovery in six healthy sedentary male subjects (maximal oxygen uptake; 46.6 +/- 1.7 (SEM) ml.kg-1.min-1), 5 male sprinters (56.2 +/- 2.5), and 5 male long-distance runners (73.6 +/- 2.2). Each performed 4 min of knee flexion exercises at absolute values of 1.63 W and 4.90 W, followed by 5 min of recovery in a prone position in a 2.1 T superconducting magnet with a 67 cm bore. 31P-MRS spectra were recorded every 12.8 s during the rest-exercise-recovery sequence. Computer-aided contour analysis and pixel imaging of phosphocreatine peaks (PCr) and inorganic phosphate (Pi) were performed. The workloads in the present study were selected as mild exercise (1.63 W) and heavy exercise (4.90 W), corresponding to 18-23% and 54-70% of maximal exercise intensity. Long-distance runners showed a significantly smaller decrement in PCr and less acidification at a given exercise intensity compared to those shown by sedentary subjects. The transient responses of PCr and Pi during recovery were characterized by first-order kinetics. After exercise, the recovery rates of PCr and Pi were significantly faster in long-distance runners than in sedentary subjects (P < 0.05). Since it is postulated that PCr resynthesis is controlled by aerobic metabolism and mitochondrial creatinekinase, it is suggested that the
faster PCr and Pi recovery rates and decreased acidification seen in long-distance runners during and after exercise might be attributed to their greater capacity for aerobic metabolism.

Yoshida and Watari (1997) assessed muscle metabolism and inorganic phosphate (P(i)) peak splitting during exercise, 31-phosphorus nuclear magnetic resonance spectroscopy was performed during ramp incremental and submaximal step exercise with and without circulatory occlusion. Seven healthy men performed calf flexion in a superconducting magnet. There was no P(i) splitting during ramp incremental exercise with the circulation present and phosphocreatine (PCr) decreased linearly by 0.07 (SEM 0.01) mmol.l-1.s-1, while exercise with the circulation occluded caused the P(i) peak to split into a high and a low pH peak. The rate of PCr decrease during exercise with the circulation occluded was 0.15 (SEM 0.03) mmol.l-1.s-1 which with the efficiency of the adenosine 5'-triphosphate (ATP) hydrolysis reaction corresponded well to the mechanical energy. Both with and without occlusion of the circulation PCr decreased with some time lag which may reflect the consumption of residual oxygen. In submaximal step exercise PCr decreased exponentially at the onset of exercise with the circulation open whereas it decreased linearly by 0.15 mmol.l-1.s-1 when the circulation was occluded. After exercise, occlusion of the circulation was maintained for 1 min more and there was no PCr resynthesis. It is suggested that ATP synthesis was limited by the availability of oxygen.

Yoshida and Watari (1993) assessed the rates of change in muscle metabolites such as phosphocreatine (PCr) and inorganic phosphate (Pi) during repeated exercise sessions with rest periods, 31-phosphorus nuclear magnetic resonance spectroscopy was used for continuous and noninvasive measurements. Five long-distance runners and six healthy male subjects as controls performed a 2-min femoral flexion exercise at 20 kg.m.min-1 in a 2.1 T superconducting magnet with a 67-cm bore; they repeated this exercise four
times with a 2-min rest period. At the beginning of exercise, PCr decreased exponentially; at the end, it increased. During exercise and in the early phase of the recovery in every exercise session, the PCr values were significantly higher in the long-distance runners than in the control subjects (P < 0.05). The Pi increases and decreases involved with exercise also revealed exponential changes. The Pi values did not significantly differ during exercise; however, Pi recovery was faster in the long-distance runners than in the control subjects (P < 0.05). The Pi, PCr ratio during exercise increased linearly with exercise; and Pi, PCr during recovery was smaller in the long-distance runners than in the control subjects (P < 0.05). In, the long-distance runners revealed faster PCr and Pi kinetics after exercise and a smaller Pi, PCr during exercise than did the control subjects. It is suggested that these were attributable to a greater oxidative capacity of muscles in the long-distance runners.

Sullivan et al. (1994) compared evaluation of skeletal muscle metabolism (vastus lateralis) evaluated by 31P-magnetic resonance spectroscopy (MRS) and biochemical analysis. During identical isometric knee extensor exercise protocols to fatigue in eight men, biopsy samples were taken at rest, peak exercise, and 32 s postexercise and 31P-MRS data were collected continuously for phosphocreatine (PCr), pH, ATP, and P(i) at 8- or 32-s intervals. There was no difference in ATP or pH measurements between the two techniques at rest, during peak exercise, or in recovery. Corresponding measurements of pH by the two techniques were closely related (r = 0.88, P < 0.01), and pH measured by 31P-MRS was closely related to muscle lactate accumulation (r = -0.84, P < 0.001). The level of PCr at peak exercise, expressed as a percentage of the baseline value, was not different between the two techniques (42 +/- 15 vs. 46 +/- 15%). The indicate that, in skeletal muscle in normal subjects, 1) measurements of pH and PCr at rest and during exercise do not differ between the 31P-MRS and biopsy techniques and 2) muscle pH measured by 31P-MRS is closely related to lactate accumulation in
men. Our data suggest that direct comparison of studies of exercise metabolism using these two techniques is warranted.

Yoshida et.al (1996) examined Six male long-distance runners performed knee flexion exercises in a 2.1 T superconducting magnet. 31P MRS was used to investigate the splitting pattern of the inorganic phosphate (Pi) peak during active and passive recovery. During exercise splitting of the Pi peak into two was observed (high and low pH) and after exercise the manner in which the Pi peak disappeared was different in passive and active recoveries. During passive recovery, in which exercise was not performed at all, the high-pH Pi peak disappeared more rapidly than the low-pH Pi peak. The low-pH Pi peak remained at a similar acidified chemical shift as during exercise, and then gradually disappeared during passive recovery. Conversely, during active recovery in which unloaded exercise was followed, the high-pH Pi peak was reduced, but remained, whereas the low-pH Pi peak returned very quickly to the pre-exercise level and then disappeared. The recovery rate of the low pH during active recovery (0.095 +/- 0.019 pH units/min) was significantly faster than that during passive recovery (0.014 +/- 0.019 pH units/min) (p < 0.01). The slow disappearance of the low pH Pi peak during passive recovery can be explained by the halting of glycogenolysis and an insufficient oxygen supply to resting glycolytic fibers, whereas the quick disappearance observed with active recovery would have been due to elevated sufficient oxygen supply and efficient removal of lactate because of the maintained blood flow. Oxy-myoglobin and hemoglobin was also measured with near infrared spectroscopy.

Kreider et.al. (1990) examined Seven male competitive runners (VO2max 73.9 +/- 6.3 ml.kg-1.min-1) participated in a two-session, placebo, double-blind study to determine the effects of phosphate loading on oxygen uptake, ventilator anaerobic threshold, and 5-mile run performance. Subjects ingested 1000 mg of tri-basic sodium phosphate or a placebo four times daily
for 6 d. A maximal running stress test or a 5-mile performance run was performed randomly on either the 3rd or the 6th d. Test sessions were separated by a 2-wk washout period and repeated with alternating phosphate and placebo regimens. Venous blood samples were collected prior to and following each max and run session. Revealed that placebo resting serum phosphate levels were mildly elevated and that phosphate loading significantly increased resting and post-exercise serum phosphate values. Resting and post-exercise 2,3-diphosphoglycerate values were decreased while hemoglobin values were elevated with phosphate ingestion. Phosphate loading significantly increased maximal oxygen uptake from 4.77 +/- 0.29 to 5.18 +/- 0.25 l.min-1 and ventilatory anaerobic threshold from 3.74 +/- 0.28 to 4.18 +/- 0.14 l.min-1. Five-mile run times were no significantly different between placebo and phosphate sessions. However, mean performance run oxygen uptake was significantly lower (3.87 +/- 0.3 to 3.80 +/- 0.3 l.min-1) with phosphate ingestion. Data demonstrate that maximal and run performances were influenced by elevations in serum phosphate eliciting an increased maximal oxygen uptake, ventilator anaerobic threshold, and variable effects on 5-mile run performance. These adaptations occurred without observable increases in red cell 2,3-diphosphoglycerate.

Remes (1979) observed statistically significant 10% increase (p less than 0.005) in mean red cell 2,3-diphosphoglycerate (2,3-DPG) concentration, concomitantly with a mean 16% increase (p less than 0.001) in the predicted maximal oxygen uptake (VO2max) was observed in 29 recruits, who were studied during 6 months of physical training in military service. The increase in 2,3-DPG was higher, the lower the initial 2,3-DPG and VO2max levels. The mean initial 2,3-DPG level was higher in the subjects with a higher initial VO2max. A strenuous but highly aerobic 21-km marching exercise elicited a mean 9% increase (p less than 0.005) in red cell 2,3-DPG concentration. A significantly greater response of 2,3-DPG to marching exercise was observed in subjects with a lower pre-test VO2max than in those with a higher pre-test
VO₂max. During another more competitive march 2, 3-DPG remained almost unchanged and was associated with a tendency towards a negative correlation with the accompanying lactate response (r = -0.60, p less than 0.05). Red cell 2, 3-DPG response to a standardized exercise is considered a suitable indicator for evaluating the effect of training on an individual.

Agrafiotis et.al. (1982) examined whole blood oxygen affinity, erythrocyte pH and organic phosphates were studied in five anaemic untransfused patients with end stage renal disease undergoing continuous ambulatory peritoneal dialysis. Decreased whole blood oxygen affinity with increased adenosine triphosphate and normal 2.3 diphosphoglycerate (DPG) values were observed. Normal and stable serum phosphate and permanent mild metabolic acidosis may be important factors contributing to maintain DPG levels within the normal range despite anemia. Continuous dialysis avoids cyclic fluctuation of blood oxygen affinity as described during and after dialysis sessions in patients on maintenance haemodialysis.

III. STUDIES ON HEMATOLOGICAL VARIABLES

STUDIES ON HEMOGLOBIN

Carlone et.al. (1982) studied the behavior of the oxyhemoglobin curve was studied in ten patients with respiratory alkalosis (arterial [H+] less than 37 nM, pCO2 less than 32 mmHg and HCO-3 less than 22.0 mEq/L) and ten patients with metabolic alkalosis ([H+] less than 34 nM, pCO2 greater than 37 mmHg and HCO-3 greater than 28.0 mEq/L) to determine. Whether different alkalotic states similarly affect the red blood cell [H+] and 2,3-diphosphoglycerate interaction and thus the oxygen affinity of hemoglobin. The findings were statistically indistinguishable in respiratory alkalosis and metabolic alkalosis. a) low plasma [H+], normal red blood cell [H+], and high transmembrane [H+] gradient; b) elevated red blood cell 2, 3-diphosphoglycerate inversely proportional to low arterial plasma [H+]; c) decrease in oxygen affinity of hemoglobin when normalized for plasma [H+].
but less decreased when normalized for red blood cell [H+] Other factors capable of affecting the oxygen affinity of hemoglobin were mean corpuscular hemoglobin concentration red blood cell adenosine triphosphate carboxyhemoglobin and methemoglobin were not significantly different between groups.

Fallon (2004) determined the clinical and performance related utility of hematological and iron-related screening in elite athletes. White blood cell count red blood cell count hemoglobin hematocrit mean cell volume mean cell hemoglobin concentration platelet count percent hypochromic red cells serum iron ferritin transferrin and percent transferrin saturation. Eight female athletes (4.6%) had clinically relevant abnormal 6 with an obvious explanation on clinical history and examination and 1 who was diagnosed with hemochromatosis following genetic testing. Eighty-nine (51.1%) female athletes had abnormal that were not associated with obvious clinical signs or symptoms. Twenty-seven female athletes had a serum ferritin less than 30 mg/mL and were placed on iron supplementation. In male athletes 5 cases had screening abnormalities that were associated with illness or other factors identified during the clinical consultations. No clinically significant abnormalities in males were generally minor reductions in hemoglobin and/or hematocrit or minor alterations in red cell parameters. Five male athletes had a serum ferritin less than 30 ng/mL and were placed on iron supplementation. Screening for hematological and iron-related abnormalities in male athletes has a very low yield. Due to the critical nature of the effects of anemia and low serum ferritin on some aspects of performance it is reasonable to perform a full blood count and a serum ferritin on male athletes entering an elite training program. Further testing should be performed on clinical grounds. In females the yield is greater. Again it is reasonable to perform a full blood count and a serum ferritin on female athletes entering an elite training program. In view of their greater risk of iron depletion and to assess the effect of increased training inherent in elite programs this could be repeated at 6-month intervals or an
isolated measurement of serum ferritin could be performed. Further testing should be performed on clinical grounds.

Spodaryk (1993) obtained more information on the effects of long-lasting endurance and strength training on the constituents of the blood, several hematological and iron-related parameters were measured at rest in 39 male athletes from the Polish team who participated in the Olympics in Seoul in 1988. The athletes were divided into two groups, endurance-trained subjects (group E, cyclists, canoeists and rowers; n = 22) and strength-trained subjects (group S, wrestlers and judo; n = 17). The control group was composed of untrained male subjects (n = 48). Blood samples were taken from an antecubital vein with the subject at rest for determinations of hemoglobin concentration ([Hb]), packed cell volume (PCV), erythrocyte (RBC) and reticulocyte count, plasma free hemoglobin concentration, haptoglobin concentration, serum iron, transferrin concentration and ferritin concentrations ([Ferr]); red blood cells were used for estimation of glutamato-oxalate transaminase (GOT) activity and free erythrocyte protoporphyrin concentration ([FEP]). The mean [Hb], PVC, RBC measured in the E athletes were significantly lower than in the control group but were comparable to those obtained in the S athletes. There were no significantly differences in the hematological indices mean corpuscular volume (MCV), mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration) between the groups of athletes and the control group. A significant increase in reticulocytosis and GOT activity was observed in the endurance-trained athletes. No impairment of erythropoiesis was observed as indicated by several sensitive markers of hemoglobin formation (FEP, MCV and inspection of blood smears) in the athletes.

Casoni et al. (1983) examined the hemoglobin concentration of runners has been reported to be often below normal (1). In the present investigation the hemoglobin and iron concentrations and the haematocrit have been determined
in 45 marathon runners examined before and after the 1982 Italian Marathon Championship and in 79 runners examined before and after the 1982 Firenze-Faenza race (107 km). The obtained suggest that the training programs followed by the marathon runners (up to 260 km per week in the months preceding the race) are accompanied by a significant decrease of the hemoglobin and iron levels and of the hematocrit. Similar have been observed in the participants to the Firenze-Faenza race. Nevertheless, in these ultra marathoners the decreases of the hemoglobin and iron concentration and of the hematocrit are less marked, possibly because their training programs are less intense than those of the marathon runner. The findings obtained are in favour of the hypothesis that the degree of "sport anemia" might be related to the amount of training of the athletes.

Suett et al. (1996) In 10 female and eight male Danish elite middle- and long-distance runners, hematological status, including blood volume, was examined. Hemoglobin, hematocrit and serum (s)-ferritin concentrations were all within the normal range. In both men and women, blood volume, plasma volume and erythrocyte volume were increased in relation to various reference values. However, the runners had a low body weight due to a reduced fat level, 9.5% (7.3-15.1%) fat for the women, 5.9% (5.0-8.8%) fat (median and ranges) for the men, measured by dual-energy X-ray absorptiometry (DEXA) scanning. When the runners' body weights were 'normalized' to a reference population (25% fat for women, 15% fat for men), only plasma volume remained increased in relation to body weight for the women, whereas all the volumes remained increased for the men. This confirms that endurance training induces a true increased plasma volume. The lower erythrocyte volume in the women compared with the men could be a consequence of the generally poorer iron status in the women, indicating that a combination of hemolysis, menstruation and low caloric (iron) intake makes it difficult for trained women to obtain optimal effects on erythrocyte volume equal to those obtained by trained men.
Furthermore, the study emphasizes the importance of considering body composition when comparing well-trained athletes with a reference population.

Weight et al. (1991) stated that Exercise-induced hemolysis has been implicated in the sub-optimal iron status of endurance-trained athletes. Accordingly, erythrocyte survival studies using 51Cr were performed on male and female distance runners (n = 20) and sedentary control subjects (n = 10) in order to determine whether the rate of erythrocyte destruction was altered because of repetitive exercise training. 2. The chromium half-disappearance time of the male (25.4 +/- 3.6 days, mean +/- SD) but not the female (28.3 +/- 4.6 days) athletes was significantly lower than that of the male (33.1 +/- 4.5 days) and female (32.3 +/- 2.6 days) control subjects (P less than 0.01). The mean erythrocyte lifespan of the male and female distance runners (67.2 +/- 22.2 and 72.4 +/- 26.0 days, respectively) was significantly shorter than that of the non-exercising male and female subjects (113.4 +/- 31.0 and 114.1 +/- 29.0 days, respectively) (P less than 0.01). 3. There was no correlation between the mean erythrocyte lifespan and the hemoglobin concentration, serum ferritin levels, body mass, weekly training distance, number of years running or daily protein intake. The mean cell volume and reticulocyte count measured in the same athletes before and after completing a standard 42 km marathon race were within the normal range, whereas the plasma hemoglobin levels were elevated (77.0 +/- 50.5 mg/l) and the serum haptoglobin levels were decreased (0.89 +/- 0.4 g/l) at rest, with a further significant decrease after running (0.69 +/- 0.4 g/l) in the latter measurement (P less than 0.05). It is concluded that the demonstrated increase in erythrocyte turnover may be sufficient to precipitate an iron deficiency in endurance athletes when dietary intake or absorption does not meet the accelerated erythropoietic demands.

Bodary (1999) investigated further the influence of exercise on erythropoietin. We observed the effects of high intensity running on plasma erythropoietin concentration in competitive distance runners. A repeated
measures design was used to compare the responses of intermittent high intensity (HIGH) exercise to continuous moderate intensity (MOD) exercise and rest (REST). The HIGH treatment consisted of 60 min of exercise alternating 5 min of running at ~90% of O2max with 5 min of brisk walking. The MOD treatment consisted of a continuous 60-min run on the treadmill at 60% of O2max. Blood samples were collected immediately before the exercise (PRE), immediately following the exercise (POST), and 4 (heart rate (4HR), 12 (12HR), 24 (24HR), and 48 (48HR)) following the exercise. The variables examined included plasma erythropoietin concentration (EPO), hemoglobin (Hb) concentration ([Hb]), hematocrit (Hct), red blood cell count (RBC), and mean corpuscular volume (MCV). ANOVA revealed the expected treatment-by-time interaction for Hct and [Hb] suggesting a hemodilution at 24 and 48 h post exercise for the MOD and HIGH treatments. However, no significant treatment-by-time interactions were observed for [EPO], RBC, or MCV. These indicate that intermittent high intensity exercise does not have a significant effect on [EPO] in trained distance runners.

**STUDIES ON RED BLOOD CELLS**

Wu et.al. (2004) analyzed the detailed changes in hematology and biochemistry tests parameters before and after a long-distance race in ultra marathon runners. Blood samples of 11 participants were obtained for standard analysis before, immediately after, two days after and nine days after the 2002 International Ultra-marathon 24 h Race and the International Association of Ultra runners (IAU) Asia 24 h Championship. Total bilirubin (BIL-T), direct bilirubin (BIL-D), alkaline phosphatase (ALP), aspartate aminotransferase (AST), alanine aminotransferase (ALT) and lactate dehydrogenase (LDH) increased statistically significantly (P<0.05) the race. Significant declines (P<0.05) in red blood cell (RBC), hemoglobin (Hb) and hematocrit (Hct) were detected two days and nine days d after the race. 2 d after the race, total protein (TP), concentration of albumin and globulin decreased significantly. While BIL, BIL-D and ALP recovered to their original levels. High-density
lipoprotein cholesterol (HDL-C) remained unchanged immediately after the race, but it was significantly decreased on the second and ninth days after the race. Ultra-marathon running is associated with a wide range of significant changes in hematological parameters, several of which are injury related. To provide appropriate health care and intervention, the man who receives athletes on high frequent training program high intensity training programs must monitor their liver and gallbladder function.

Casoni et.al. (1985) determined Red blood cell indices, serum iron, and serum ferritin concentration were determined in 45 marathon runners, 56 ultra marathon runners, and 32 healthy sedentary controls. A significant reduction of hemoglobin concentration, hematocrit, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration, mean corpuscular volume, serum iron, and serum ferritin were found in marathon runners compared to control subjects. The same variables were also reduced, but to a lesser extent, in the less trained ultra marathon runners. The decreased hemoglobin concentration demonstrated in the runners examined is related to both a reduced mean corpuscular hemoglobin concentration and a reduced hematocrit and may depend on a reduction of the body iron stores.

Hunding et.al (1981) found systemic iron deficiency was found in 63 (56%) of 113 joggers and competition runners (33 women and 80 men). Thirteen women and ten men had latent anemia. A majority of the women was fertile with iron loss from menstruation; the men were runners training long distances. The average transferrin iron-binding capacity was 80 mu mol/l serum in the women and 77 (iron-binding groups) in the men. The haptoglobin and iron concentrations in serum were remarkably low (most often below 10 and 20 mu mol/l, respectively). Three of the long-distance runners ran 25 km daily. They returned with so much free hemoglobin in their plasma that an accompanying iron loss (integrated over months), if not balanced by diet, would lead to iron deficiency and anemia. Oral iron therapy (200 mg ferrous
sulphate per day) normalized the hemoglobin concentration and improved the transferrin saturation fraction in 61 persons. The competition runners reported personal records.

Brodthagen et.al (1985) stated the 20 male elite long distance runners were compared to a control group of blood donors to determine the effect of training on red blood cells. The acute effects of exercise on red cells were investigated in 11 of the runners following a race of 15-30 km. The runners had elevated resting values of red cell 2,3-DPG (P less than 0.05) and mean cell volume (P less than 0.01); blood Hb and ATP were not different from concentrations in the control group. An increased proportion of young erythrocytes in runners may explain the red cell status of the athletes. No statistically significant changes in red cell 2,3-DPG, ATP, mean cell volume or blood Hb were found post exercise.

Ricci et.al (1991) examined twenty patients with renal failure and severe anemia (hemoglobin range 6.6-8.7 g/dl) on thrice-weekly maintenance hemodialysis were treated with recombinant human erythropoietin (rHuEPO). After three months of intravenous (iv) therapy the hemoglobin increase averaged 2 g/dl, and was steadily maintained even after two months of subcutaneous (sc) therapy. The significant increase of macrocyte counts, determined by an automated red blood cell counter after both steps of therapy, suggested the release of young red cells (large cells) into blood circulation. This assumption may be supported by the significant increase of the red cell creatine contents. 2,3-diphosphoglycerate (2,3-DPG) levels of the erythrocytes did not significantly change after rHuEPO administration.

Hespel et.al (1988) examined the erythrocyte 2,3-diphosphoglycerate concentration (2,3-DPG) and the activity of red cell hexokinase, pyruvate kinase, glucose-6 phosphate dehydrogenase and glutathione reductase were studied in 27 normal volunteers before and after 2 and 4 months of physical endurance training. The 4 months of training increased maximal oxygen uptake
and physical working capacity (PWC130) by 16% (p less than 0.001) and 29% (p less than 0.001) respectively. Resting heart rate was decreased (p less than 0.001) by 11 beats.min-1. With 2 months of training the erythrocyte 2,3-DPG concentration increased by 9% (p less than 0.001); with 4 months training the increase was only 4% (p less than 0.05). The training-induced increase in red cell 2,3-DPG was not accompanied by enhanced activity of erythrocyte hexokinase, pyruvate kinase, glucose-6 phosphate dehydrogenase or glutathione reductase. It is concluded that the rise in red cell 2,3-DPG induced by physical endurance training is not due to activation of red cell glycolytic enzymes or the enzymes involved in the pentose-phosphate cycle.

Brodthagen et.al (1985) 20 male elite long distance runners were compared to a control group of blood donors to determine the effect of training on red blood cells. The acute effects of exercise on red cells were investigated in 11 of the runners following a race of 15-30 km. The runners had elevated resting values of red cell 2,3-DPG (P less than 0.05) and mean cell volume (P less than 0.01); blood Hb and ATP were not different from concentrations in the control group. An increased proportion of young erythrocytes in runners may explain the red cell status of the athletes. No statistically significant changes in red cell 2,3-DPG, ATP, mean cell volume or blood Hb were found post exercise.

Cade et.al (1984) revealed that increased concentration of red blood cell 2,3-diphosphoglycerate (RBC 2,3-DPG) shifts the hemoglobin-oxygen dissociation curve to the right, thus theoretically allowing better oxygenation of tissues. To determine whether such a shift is physiologically significant, we investigated the effects of oral phosphate loading on several parameters including plasma phosphate concentration, RBC 2,3-DPG, hematocrit and hemoglobin concentration, maximal oxygen uptake (VO2max), and degree of lactic acidemia in 10 well-trained distance runners. After control determinations were made, either a phosphate load or a placebo was given for
3 d before the athlete was restudied. A placebo and two phosphate-loading studies were performed at weekly intervals, followed by 2 wk of rest and another post-intervention control study. Blood samples for control values were drawn before and after a standard warm-up period, after treadmill exercise at a 10% grade, and at the completion of the VO\textsubscript{2} determination. After oral phosphate loading there was a significant increase in serum phosphate and RBC 2,3-DPG. Maximal oxygen uptake was significantly increased and correlated with the rise in RBC 2,3-DPG (r = 0.81). The increase in blood lactate after exercise on the 10% grade was attenuated during sessions, which followed phosphate loading.

2.4. STUDIES ON BIOCHEMICAL VARIABLES

STUDIES ON URINE CREATINE

Elio De Palo (2003) examine physical exercise-related changes in urinary excretion of protein/peptide hormones and to correlate modifications with the general increase in post-exercise proteinuria, urine C-peptide, insulin and insulin-like growth factor-I (IGF-I) and their plasma concentrations were measured. Plasma and urinary C-peptide, insulin and IGF-I before (Bex) and at the end (Eex) of physical exercise (a 2.5-hour competition, 102 km) were analysed in 20 young cyclists. At Eex compared with Bex, concentration of urinary C-peptide decreased slightly but significantly (21.3±2.7 vs. 13.5±1.7 nmol/l), but urinary insulin and urinary IGF-I concentrations significantly increased at Eex (92.5±4.2 vs. 131.4±15.7 pmol/l and 10.0±2.1 vs. 33.6±3.8 pmol/l, respectively). Plasma insulin and plasma C-peptide significantly decreased, whereas plasma IGF-I was unchanged. Urinary concentrations of total proteins and creatinine significantly increased. Both Eex urinary C-peptide/urinary protein and urinary C-peptide/urinary creatinine ratios were significantly reduced. The correlation between C-peptide and insulin in plasma was confirmed at Bex as well as Eex, but in urine only at Bex. An increased renal tubular reabsorption of C-peptide at the end of exercise might be
suggested, but the expected values considering creatinine excretion were almost three times less. The Eex urinary insulin concentration was higher than expected, considering the circulation levels, but lower when compared with the expected concentration considering creatinine excretion. Physical exercise proteinuria, related to an increased protein filtration and a saturation of the mechanisms responsible for the reabsorption, does not appear similar for all peptide hormones.

Thomas Remer (2000) established anthropometry-based reference values for 24-h urinary creatinine excretion in healthy white children aged 3–18 y. Anthropometric variables and 24-h urinary creatinine excretion rates were determined cross-sectionally (225 boys and 229 girls). Age and sex dependency of 24-h creatinine excretion (crude and related to individual anthropometric variables) were assessed to derive appropriate creatinine reference values. The applicability of these creatinine reference values for estimation of daily excretion of certain analyses was assessed in 40 additional children. Sex-specific, body-weight-related creatinine reference values were derived for the following age groups 3, 4–5, 6–8, 9–13, and 14–18 y. The 5th percentile exceeded 0.1 mmol·kg\(^{-1}\)·d\(^{-1}\) in all age groups >3 y. The use of these creatinine reference values for estimating average 24-h excretion rates of certain analytes (determined as the ratio of analyte to creatinine in spot urine samples) yielded reasonable estimates of mean 24-h urinary excretion rates actually analyzed (spot and 24-h urine samples from the same children). Ideal 24-h creatinine excretion values for height were also derived for a potential determination of the creatinine height index.

Thomas Remer (1998) saw a strong age dependency was seen for absolute daily creatinine excretion from age 3 y onward. When urinary creatinine output was adjusted for anthropometric characteristics by relating creatinine excretion to body surface area, to body weight, or to fat-free mass, a significant age dependency in creatinine excretion was seen for all
adjustment variables. Because age dependency was reduced to a larger degree by relating creatinine to body weight \( (r = 0.45) \) than to fat-free mass \( (r = 0.49) \) or body surface area \( (r = 0.73) \), we calculated the individual ratios of creatinine to body weight to control for body-composition changes during growth. ANCOVA showed that sex \( (F = 12.1, P < 0.001) \) and the covariate age \( (F = 119.6, P < 0.0001) \) significantly improved the proportion of explained variation in urinary creatinine output related to body weight. By using two-way ANOVA, an adequate control of the influence of age on the ratio of creatinine to body weight could be achieved by establishing the following 5 age groups 3, 4–5, 6–8, 9–13, and 14–18 y. Within these age groups, no significant increase was found for the ratio of creatinine to body weight from the respective youngest to the respective oldest age \( (F \) values of two-way ANOVA for age ranged between 0.13 and 0.64), whereas the sex difference remained largely stable \( (F \) values 2.4–3.3). The corresponding sex-specific reference values for body weight–related 24-h urinary creatinine excretion during growth. From 3 to 14–18 y of age, the ratio of mean creatinine to body weight increased by 50% in boys and 43% in girls.

Thomas Remer et.al (2005) established anthropometry-based reference values for 24-h urinary creatinine excretion in healthy white children aged 3–18 y. Urinary creatinine reference values that take anthropometric data into account, which is mandatory during growth, are not available for healthy white children. Anthropometric variables and 24-h urinary creatinine excretion rates were determined cross-sectional (225 boys and 229 girls). Age and sex dependency of 24-h creatinine excretion (crude and related to individual anthropometric variables) were assessed to derive appropriate creatinine reference values. The applicability of these creatinine reference values for estimation of daily excretion of certain analyses was assessed in 40 additional children. Sex-specific, body weight related creatinine reference values were derived for the following age groups 3, 4–5, 6–8, 9–13, and 14–18 y. The fifth percentile exceeded 0.1 mmol·kg⁻¹·d⁻¹ in all age groups >3 y. The use of these
creatine reference values for estimating average 24-h excretion rates of certain analyses (determined as the ratio of analyze to creatinine in spot urine samples) yielded reasonable estimates of mean 24-h urinary excretion rates actually analyzed (spot and 24-h urine samples from the same children).

Irving et al. (1986) stated daily blood and 24-hour urine samples from 6 runners were studied for 2 days before and for 5 days after a 42.2 km. marathon footrace run in cool environmental conditions. Although the race caused muscle damage as shown by the increased post-race serum creatinekinase activity and C-reactive protein levels, renal function measured by urine flow rates, creatinine clearance and protein excretion was normal during the race. Sodium and fractional sodium excretion decreased during the race despite a maintained osmolar clearance, and remained low for the next 48 hours, whereas osmolar clearance decreased sharply for the remainder of the race day but it was significantly elevated on days 2 to 4 after the race. Creatinine clearance was increased significantly 24 hours after the race, and reached its peak 3 days after the race, while urine flow rates were elevated from days 2 to 5 after the race. Urea excretion was significantly decreased 3 to 5 days after the race, while creatinine excretion was increased significantly on day 3 after the race. Glomerular proteinuria occurred 24 hours after the race with no associated reduction in tubular re-absorption of the low molecular weight protein beta-2-microglobulin. This study shows previously unrecognized substantial delayed effects of prolonged exercise on renal function. The nature of these changes may reflect catabolic followed by anabolic processes in muscle as well as changes consequent on excess sodium retention and related fluid compartment shifts.

Noakes et al. (1982) examined number of blood biochemical parameters, including the activities of the plasma enzymes creatine kinase (CK), aspartate aminotransferase (ASAT), lactate dehydrogenase and alkaline phosphatase, were measured in 23 athletes before, and immediately after a 56-km running
race. Of the 23 athletes, 18 had previously completed standard 42-km marathon or longer (up to 90-km) ultra-marathon races, whereas not one of the other five athletes had previously run in a long-distance race. After the race, plasma CK and ASAT activities had both risen at least 280% more in the novice runners despite their much slower mean running speed (9.8 +/- 0.4 vs. 13.8 +/- 0.3 km/h). There were no other inter-group differences in the absolute levels of the other measured biochemical parameters, although the rise in plasma calcium during the race was significantly greater in the experienced marathon runners. Either this study shows that higher levels of training, or previous ultra-marathon racing experience, or both, is associated with lower immediate post-exercise levels of plasma enzyme activity. This is compatible with the finding that physical training reduces post-exercise plasma enzyme levels.

**STUDIES ON URINE INORGANIC PHOSPHATE**

Eric et.al (2005) investigated that the renal function was investigated in adult rainbow trout following acute and prolonged exposure to waterborne Ni in moderately hard Lake Ontario water (~140 mg L^-1 as CaCO₃). Fish were exposed for 36 days to a sub lethal concentration of 442 μg Ni L^-1, followed by 96 h of exposure to 12,850 μg Ni L^-1 (approximately 33% of the 96 h LC₅₀). Prolonged exposure markedly affected only the renal handling of Ni, with no substantial effect on the plasma concentration, urinary excretion rate (UER) or clearance ratio (CR) of Na⁺, Cl⁻, K⁺, Ca²⁺, Mg²⁺, inorganic phosphate (Pᵢ), glucose, lactate, total ammonia (Tₐₙₙ), protein and free amino acids (FAA). Glomerular filtration rate (GFR) was reduced by 75% over 96 h of acute Ni challenge in both fish previously exposed to Ni and naïve fish, with no significant change in urine flow rate (UFR), suggesting a substantial reduction in water reabsorption to maintain urine flow and water balance. Renal Mg²⁺ handling was specifically impaired by acute Ni challenge, leading to a significantly increased UER₉₉ and significantly decreased plasma [Mg²⁺] only in naïve fish. Previously exposed fish were well protected against
Ni-induced Mg2+ antagonism, indicating true acclimation to Ni. Only in naïve, acutely challenged fish was there an increased UER of titratable acidity (TA-HCO3), net acidic equivalents, P, Tamm and K+. Again, all of these parameters were well conserved in previously exposed fish during acute Ni exposure, strongly suggesting that prolonged, and sub lethal exposure protected against acute Ni-induced respiratory toxicity.

Shiro Sakurai et al (2001) has shown that recently a huge amount of fluoride in coal has been released into indoor environments by the combustion of coal and fluoride pollution seem to be increasing in some rural areas in China. Combustion of coal and coal bricks is the primary source of gaseous and aerosol fluoride and these forms of fluoride can easily enter exposed food products and the human respiratory tract. Major human fluoride exposure was caused by consumption of fluoride-contaminated food, such as corn, chilies and potatoes. For each diagnostic syndrome of dental fluorosis, a log-normal distribution was observed on the logarithm of urinary fluoride concentration in students in China. Urinary fluoride content was found to be a primary health indicator of the prevalence of dental fluorosis in the community. In the fluorosis areas, osteosclerosis in skeletal fluorosis patients was observed with a high prevalence. A biochemical marker of bone resorption, urinary deoxypyridinoline content was much higher in residents in China than in residents in Japan. It was suggested that bone resorption was stimulated largely in residents in China and fluoride may stimulate both bone resorption and bone formation. Renal function especially glomerular filtration rate was very sensitive to fluoride exposure. Inorganic phosphate concentrations in urine were significantly lower in the residents in fluorosis areas in China than in non-fluorosis area in China and Japan. Since airborne fluoride from the combustion of coal pollutes extensively both the living environment and food, it is necessary to reduce fluoride pollution caused by coal burning.
Heaton and Hodgkinson (1963) concluded that the effect of exercise, urine flow and food intake on the renal excretion of calcium, magnesium, water, sodium, potassium, phosphate and creatinine was observed in normal adults. In fasting subjects, the rate of calcium and magnesium excretion was greater during the night than during the day, irrespective of whether the subjects were at rest or active during the day. When the subjects were receiving normal meals, the excretion rate of calcium and magnesium was usually greater during the day than during the night. A rapid rise in the excretion of calcium and magnesium occurred after a meal, the average rate of excretion increasing two to four times in the first 3 h and then decreasing during the next 12–15 h. No significant effect on the excretion of sodium, potassium, creatinine or phosphate was observed. The excretion of calcium and magnesium was reduced during moderate exercise but the excretion of sodium, potassium, creatinine, and inorganic phosphate was unaffected. No correlation was found between urine flow and the excretion of calcium or magnesium during water diuresis but there was a significant correlation between urine flow and the excretion of sodium and potassium.

Benjamin Buemann et al. (2000) examined the D-tagatose, which is a stereoisomer of D-fructose, is phosphorylated to D-tagatose-1-phosphate by fructokinase in the liver. Because of a slow degradation rate of D-tagatose-1-phosphate, this substance may accumulate, and ingested D-tagatose may therefore cause a longer lasting reduction in inorganic phosphate (P_i) and adenosine triphosphate (ATP) levels in the liver compared with D-fructose. Similar to what is seen in patients with hereditary fructose intolerance; this may increase purine nucleotide degradation and thereby increase uric acid production. The effect of 30 g D-tagatose or D-fructose administered orally on ketohexose-1-phosphates, ATP, and P_i levels in the liver was studied by 31P-magnetic resonance spectroscopy (PMRS) in 5 young male volunteers. Blood and urine were collected to detect a possible increased uric acid production. A peak at 5.2 ppm assigned as D-tagatose-1-phosphate equivalent to about 1
mmol/L was found in the spectrum within 30 minutes after D-tagatose was administered in all subjects. Concomitantly, ATP was reduced by about 12% (P < .05). Both effects had vanished after 150 minutes. Serum uric acid concentration was increased by 17% 50 minutes after D-tagatose (P < .05) and did not reach baseline level when the experiment was terminated 230 minutes after the load. Although renal fractional extraction of uric acid decreased by approximately 12%, this could not explain the acute hyperuricemic effect of D-tagatose. No changes in 31PMRS spectra or serum uric acid concentration were found after D-fructose. These results suggest that a moderate intake of D-tagatose may affect liver metabolism by phosphate trapping despite the fact that the sugar may only be incompletely absorbed in the gut.

2.5. SUMMARY OF THE LITERATURES

The abstract of research literature pertinent to the present study, reviewed by the researcher and listed in this chapter are summarized as under.

As many as 65 (Sixty-five) review of research endeavors relevant to the present study have been accommodated in this chapter. They have been categorized into the various components of the study and presented in the order of priority.

The research review relevant to the selected dependent variables of the study has been categorized, 13 (Thirteen) represents studies on Bench step training, 25 (Twenty-Five) represents studies on Physiological variables, 17 (Seventeen) represents studies on Hematological variables and 10 (Ten) represent studies on Biochemical variables.