CHAPTER II
REVIEW OF RELATED LITERATURE

The review of related literature is a crucial aspect of planning a study, the object of which is to justify the rationale behind a study. It provides an overview of historical perspective, development, deviations and new departures of research in that area and also guides to identify the methods appropriate to the present problem under investigation. The review of related literature is instrumental in the selection of topic, formulation of hypothesis and detective reasoning leading to the problem. It helps to get a clear idea and supports the findings with regard to the problem under study.

2.1 STUDIES ON TREADMILL TRAINING

Sung-Gyung Kim · Young Uk Ryu · Hyun Dong Je · Ji Hoon Jeong · Hye ong-Dong Kim (2015) conducted a study on Backward walking treadmill therapy can improve walking ability in children with spastic cerebral palsy: The development of efficient and independent walking is an important therapeutic goal for many children with cerebral palsy (CP). Consequently, there has been growing interest in determining the effects of treadmill training programs for these children. A systematic review of the literature was conducted to evaluate the effectiveness of treadmill training for children with CP. Relevant trials were identified by searching electronic databases and by citation tracking. Of 125 papers initially identified, five met the criteria for review. Results showed that treadmill training is safe and feasible for children with CP across a wide range of ages and functional abilities. Children with more severely affected walking ability significantly increased their walking speed (d = 1.48, 95% CI: 0.49-2.40) and gross motor performance (d = 1.5, 95% CI: 0.50-2.50) after training. However, the results also suggested that treadmill speed and length of
training sessions might need to be set to specifically match desired intervention goals such as increasing walking speed or endurance. The review suggests that treadmill training is safe and feasible for children with CP and indicates that there may be some positive benefits in walking speed over short distances and in general gross motor skills. The provision of PBWS may be particularly beneficial for children with more severe walking disability (GMFCS III and IV). Further research is necessary before it can be concluded that treadmill training is beneficial for children with CP.

Lin Wang1, Youlian Hong2, Jing Xian Li3(2014), conducted a study on Muscular Activity of Lower Extremity Muscles Running on Treadmill Compared with Different Over ground Surfaces. The objective of this study is to compare the muscular activity of lower extremity muscles while running on treadmill and on over ground surfaces. A total of 13 experienced heel-to-toe runners participated in the study. Electromyographic (EMG) data of four lower extremity muscles, including rectus femoris, tibialis anterior, biceps femoris, and gastronomies, were collected using the Noraxon EMG system while running on a treadmill and on over ground surfaces at a running speed of 3.8 m/s. The obtained data were then analyzed. In this study, throughout the stance phase, the EMG values in the rectus femoris (P<0.01) and the biceps femoris (P<0.05) were higher while running on over ground surfaces than those on a treadmill. The EMG values in the rectus femoris (P<0.05) and the biceps femoris (P<0.05) were also higher on concrete than those on grass in the stance phase. Results showed that the muscle activity was significantly different in treadmill running than in over ground running. The difference in muscle activity while running on different over ground surfaces was also found in this study. Kinematic adjustment of the lower extremity may explain the EMG difference while running on different surfaces.
I-Hsuan Chen, PhD Yea-Ru Yang, PhD Rai-Chi Chan, MD Ray-Yau Wang, (2013) conducted a study on PhD- Turning-Based Treadmill Training Improves Turning Performance and Gait Symmetry After Stroke. Turning is a challenging task for stroke patients. Programs that effectively target turning, however, have not been established. This study examined the effects of a novel turning-based treadmill training on turning performance, gait symmetry, balance, and muscle strength in patients with chronic stroke. Thirty participants were randomly assigned to the experimental group that received 30 minutes of turning-based treadmill training or to the control group that received 30 minutes of regular treadmill training, followed by a 10-minute general exercise program for 12 sessions over 4 weeks. Primary outcomes (over ground turning speed and temporal–spatial characteristics of straight walking) and secondary outcomes (balance and muscle strength) were assessed at baseline, after training, and at 1-month follow-up. Fifteen participants per group were 54.2 ± 9.6 years old, post stroke 2.6 ± 1.9 years, and walked over ground at 0.59 ± 0.28 m/s. Sixteen had an ischemic and 14 a hemorrhagic stroke. There were significant interaction effects between groups and time on turning speed regardless of turning direction, straight-walking performance (speed and temporal symmetry), strength of hip muscles and ankle dorsiflexors, and balance control (Berg Balance Scale, weight shifting in the forward direction and vestibular function). Compared with the control group, the experimental group showed greater improvements in these measures following training. These improvements persisted at the 1-month follow-up evaluation. Turning-based treadmill training may be a feasible and effective strategy to improve turning ability, gait symmetry, muscle strength, and balance control for individuals with chronic stroke.
Sen-Wei Tsai · Hsiao-Ling Chen · Yi-Chun Chang · Chuan-Mu Chen (2013)-conducted a study on Molecular Mechanisms of Treadmill Therapy on Neuromuscular Atrophy Induced via Botulinum Toxin A. Botulinum toxin A (BoNT-A) is a bacterial zinc-dependent end peptidase that acts specifically on neuromuscular junctions. BoNT-A blocks the release of acetylcholine, thereby decreasing the ability of a spastic muscle to generate forceful contraction, which results in a temporal local weakness and the atrophy of targeted muscles. BoNT-A-induced temporal muscle weakness has been used to manage skeletal muscle spasticity, such as post stroke spasticity, cerebral palsy, and cervical dystonia. However, the combined effect of treadmill exercise and BoNT-A treatment is not well understood. We previously demonstrated that for rats, following BoNT-A injection in the gastronomies muscle, treadmill running improved the recovery of the sciatic functional index (SFI), muscle contraction strength, and compound muscle action potential (CMAP) amplitude and area. Treadmill training had no influence on gastronomies mass that received BoNT-A injection, but it improved the maximal contraction force of the gastronomies, and upregulation of GAP-43, IGF-1, Myo-D, Myf-5, myogenin, and acetylcholine receptor (AChR) subunits α and β was found following treadmill training. Taken together, these results suggest that the up regulation of genes associated with neurite and AChR regeneration following treadmill training may contribute to enhanced gastronomies strength recovery.

Bas Kluitenberg², Steef W Bredeweg¹, Sjouke Zijlstra¹, Wiebren Zijlstra²³ and Ida Buist¹ (2012) conducted a study on comparison of vertical ground reaction forces during over ground and treadmill running. One major drawback in measuring ground-reaction forces during running is that it is time consuming to get representative ground-reaction force (GRF) values with a traditional force platform.
An instrumented force measuring treadmill can overcome the shortcomings inherent to over ground testing. The purpose of the current study was to determine the validity of an instrumented force measuring treadmill for measuring vertical ground-reaction force parameters during running. Vertical ground-reaction forces of experienced runners (12 male, 12 female) were obtained during over ground and treadmill running at slow, preferred and fast self-selected running speeds. For each runner, 7 mean vertical ground-reaction force parameters of the right leg were calculated based on five successful over ground steps and 30 seconds of treadmill running data. Intraclass correlations (ICC, 3, 1) and ratio limits of agreement (RLOA) were used for further analysis. Qualitatively, the over ground and treadmill ground-reaction force curves for heel strike runners and non-heel strike runners were very similar. Quantitatively, the time-related parameters and active peak showed excellent agreement (ICCs between 0.76 and 0.95, RLOA between 5.7% and 15.5%). Impact peak showed modest agreement (ICCs between 0.71 and 0.76, RLOA between 19.9% and 28.8%). The maximal and average loading-rate showed modest to excellent ICCs (between 0.70 and 0.89), but RLOA were higher (between 34.3% and 45.4%). The results of this study demonstrated that the treadmill is a moderate to highly valid tool for the assessment of vertical ground-reaction forces during running for runners who showed a consistent landing strategy during over ground and treadmill running. The high stride-to-stride variance during both over ground and treadmill running demonstrates the importance of measuring sufficient steps for representative ground-reaction force values. Therefore, an instrumented treadmill seems to be suitable for measuring representative vertical ground-reaction forces during running.

Fabiana A. Machado (2012) conducted a study on Incremental test design, running speed and endurance performance in runners. Peak running speed
obtained during an incremental treadmill test (V\text{peak}) is a good predictor of endurance run performance. However, the best-designed protocol for V\text{peak} determination and the best V\text{peak} definition remain unknown. Therefore, this study examined the influence of stage duration and V\text{peak} definition on the relationship between V\text{peak} and endurance run performance. Twenty-seven male, recreational, endurance-trained runners (10-km running pace: 10–17 km h^{-1}) performed, in counterbalanced order, three continuous incremental treadmill tests of different stage durations (1-, 2-, or 3-min) to determine V\text{peak}, and two 5-km and two 10-km time trials on a 400-m track to obtain their 5-km and 10-km run performances. V\text{peak} was defined as either (a) the highest speed that could be maintained for a complete minute (V_{\text{peak-60}s}), (b) the speed of the last complete stage (V_{\text{peak-c}}), or (c) the speed of the last complete stage added to the multiplication of the speed increment by the completed fraction of the incomplete stage (V_{\text{peak-p}}). The V_{\text{peak}} determined during the 3-min stage duration protocol was the most highly correlated with both the 5-km (r=0.95) and 10-km (r=0.92) running performances and these relationships were minimally influenced by the V_{\text{peak}} definition. However, independent of the stage duration, the V_{\text{peak-p}} provided the highest correlation with both running performances. Incremental treadmill tests comprising 3-min stage duration is preferred to 1-min and 2-min stage duration protocols in order to determine V_{\text{peak}} to accurately predict 5-km and 10-km running performances. Further, V_{\text{peak-p}} should be used as standard for the determination of V_{\text{peak}}.

Pamela W. Duncan, P.T., Katherine J. Sullivan, P.T., (2011) conducted a study on Body-Weight-Supported Treadmill Rehabilitation after Stroke. Loco motor training, including the use of body-weight support in treadmill stepping, is a physical therapy intervention used to improve recovery of the ability to walk after
stroke. The effectiveness and appropriate timing of this intervention have not been established. We stratified 408 participants who had had a stroke 2 months earlier according to the extent of walking impairment — moderate (able to walk 0.4 to <0.8 m per second) or severe (able to walk <0.4 m per second) — and randomly assigned them to one of three training groups. One group received training on a treadmill with the use of body-weight support 2 months after the stroke had occurred (early locomotors training), the second group received this training 6 months after the stroke had occurred (late loco motor training), and the third group participated in an exercise program at home managed by a physical therapist 2 months after the stroke (home-exercise program). Each intervention included 36 sessions of 90 minutes each for 12 to 16 weeks. The primary outcome was the proportion of participants in each group who had an improvement in functional walking ability 1 year after the stroke. At 1 year, 52.0% of all participants had increased functional walking ability. No significant differences in improvement were found between early locomotors training and home exercise (adjusted odds ratio for the primary outcome, 0.83; 95% confidence interval [CI], 0.50 to 1.39) or between late loco motor training and home exercise (adjusted odds ratio, 1.19; 95% CI, 0.72 to 1.99). All groups had similar improvements in walking speed, motor recovery, balance, functional status, and quality of life. Neither the delay in initiating the late loco motor training nor the severity of the initial impairment affected the outcome at 1 year. Ten related serious adverse events were reported (occurring in 2.2% of participants undergoing early loco motor training, 3.5% of those undergoing late loco motor training, and 1.6% of those engaging in home exercise). As compared with the home-exercise group, each of the groups receiving loco motor training had a higher frequency of dizziness or faintness during treatment (P=0.008). Among patients with severe walking impairment, multiple falls
were more common in the group receiving early loco motor training than in the other two groups (P=0.02). Loco motor training, including the use of body-weight support in stepping on a treadmill, was not shown to be superior to progressive exercise at home.

DeJong AT¹, Bonzheim K, Franklin BA, Saltarelli W. (2009) conducted a study on Cardio respiratory responses to maximal arm and leg exercise in national-class marathon runners. Marathon runners (MR) are among the most aerobically fit athletes in the world. Although aerobic capacity (VO₂ (2) max) during arm exercise generally varies between 64% and 80% of leg VO₂ (2) max (mean 70%) in healthy men, few data are available regarding the comparative arm fitness of MR. To clarify the relationship between arm and leg fitness in MR, we studied 10 national-class MR (mean + or - standard deviation age 30 + or - 4 years) whose best marathon times averaged < 2 hours and 40 minutes. Each MR underwent lower and upper body maximal exercise evaluations with measurement of cardio respiratory variables using indirect calorimetry during treadmill testing (standard Bruce protocol) and arm-crank ergometry, respectively. Our subjects achieved VO₂ (2) max levels equalling 75.8 + or - 7.1 mL/kg/min (5.2 + or - 0.6 L/min) during treadmill testing, which was significantly higher than the level of cardio respiratory fitness achieved during maximal arm exercise (45.4 + or - 12.4 mL/kg/min [3.1 + or - 0.9 L/min]; P < 0.01). In addition, maximal heart rate (183.2 + or - 8.2 vs 163.7 + or - 10 bpm) and systolic blood pressure (201.8 + or - 10.1 vs 186.6 + or - 12.1 mm Hg) were significantly higher (P < 0.01 and P < 0.05, respectively) during maximal leg versus arm exercise. Relative arm fitness (arm VO₂ (2) max/leg VO₂ (2) max) was extremely variable (41%-76%), averaging 60% + or - 13%. Although MR are able to achieve significantly higher VO₂(2)max values during treadmill testing than those observed in the general
population, their relative arm fitness appears to be slightly reduced. These findings add to and strongly support the specificity of measurement and training concept.

Diane L. Damiano, PT, PhD and Stacey L. DeJong, PT, MS (2008) conducted a study on A Systematic Review of the Effectiveness of Treadmill Training and Body Weight Support in Paediatric Rehabilitation. Given the extensive literature on body weight supported treadmill training (BWSTT) in adult rehabilitation, a systematic review was undertaken to explore the strength, quality and conclusiveness of the scientific evidence supporting the use of treadmill training and body weight support in those with paediatric motor disabilities. A secondary goal was to ascertain whether sufficient protocol guidelines for BWSTT are as yet available to guide paediatric physical therapy practice. The database search included MEDLINE, EMBASE, CINAHL Plus (Cumulative Index to Nursing and Allied Health Literature), PEDro (Physiotherapy Evidence Database), Cochrane Library databases, and ERIC (Education Resources Information Centre) from January 1, 1980 until May 31, 2008 for all articles that included treadmill training and body weight support alone or in combination for individuals under 21 years of age, with or at risk for having a motor disability. We identified 277 unique articles from which 29 met all inclusion criteria. Efficacy of treadmill training in accelerating walking development in Down syndrome has been well-demonstrated. Evidence supporting the efficacy or effectiveness of BWSTT in paediatric practice for improving gait impairments and level of activity and participation in those with cerebral palsy, spinal cord injuries, and other central nervous system disorders remains insufficient even though many studies noted positive, yet small, effects. Increased use of randomized designs, studies with treadmill training only groups, and dosage studies are needed before practice guidelines can be formulated. Neural changes in response to training warrant greater
exploration, especially given the capacity for change in developing nervous systems. Large scale controlled trials are critically needed to support the use of BWSTT in specific pediatric patient sub-groups and to define optimal protocol parameters. The state of the evidence for body weight supported treadmill training in paediatric rehabilitation varies across populations. Efficacy of this training compared to controls has been demonstrated in infants with Down syndrome. While some individual results can be compelling, evidence in paediatric SCI is very limited in the number of studies and the strength and quality of the evidence, so no general conclusion can yet be made regarding efficacy or effectiveness in this population. Despite the increased number of studies in CP and other central motor disorders, the strength of the evidence is generally weak with no randomized clinical trial performed to date to address the efficacy of this intervention. Optimal protocol development is still in its infancy for all three populations.

Antoinette Domingo Gregory S Sawicki Daniel P Ferris (2007) conducted a study on Kinematics and muscle activity of individuals with incomplete spinal cord injury during treadmill stepping with and without manual Treadmill training with bodyweight support and manual assistance improves walking ability of patients with neurological injury. The purpose of this study was to determine how manual assistance changes muscle activation and kinematic patterns during treadmill training in individuals with incomplete spinal cord injury. We tested six volunteers with incomplete spinal cord injury and six volunteers with intact nervous systems. Subjects with spinal cord injury walked on a treadmill at six speeds (0.18–1.07 m/s) with body weight support with and without manual assistance. Healthy subjects walked at the same speeds only with body weight support. We measured electromyographic (EMG) and kinematics in the lower extremities and calculated EMG root mean square (RMS)
amplitudes and joint excursions. We performed cross-correlation analyses to compare EMG and kinematic profiles. Normalized muscle activation amplitudes and profiles in subjects with spinal cord injury were similar for stepping with and without manual assistance (ANOVA, p > 0.05). Muscle activation amplitudes increased with increasing speed (ANOVA, p < 0.05). When comparing spinal cord injury subject EMG data to control subject EMG data, neither the condition with manual assistance nor the condition without manual assistance showed a greater similarity to the control subject data, except for vastus lateralis. The shape and timing of EMG patterns in subjects with spinal cord injury became less similar to controls at faster speeds, especially when walking without manual assistance (ANOVA, p < 0.05). There were no consistent changes in kinematic profiles across spinal cord injury subjects when they were given manual assistance. Knee joint excursion was ~5 degrees greater with manual assistance during swing (ANOVA, p < 0.05). Hip and ankle joint excursions were both ~3 degrees lower with manual assistance during stance (ANOVA, p < 0.05). Providing manual assistance does not lower EMG amplitudes or alter muscle activation profiles in relatively higher functioning spinal cord injury subjects. One advantage of manual assistance is that it allows spinal cord injury subjects to walk at faster speeds than they could without assistance. Concerns that manual assistance will promote passivity in subjects are unsupported by our findings. We predicted that EMG activity and joint kinematics would change with manual assistance. The overall result, however, is that EMG amplitudes change little with manual assistance for relatively higher functioning spinal cord injury subjects. There were small but significant differences in joint range of motion with manual assistance. Providing manual assistance is not a detrimental part of body weight supported treadmill training and it allows subjects with spinal cord injury walk at faster speeds than they
could without assistance. In addition, manual assistance helps to keep the muscle activation patterns more similar to control data when walking at higher speeds.

Aziz AR¹, Mukherjee S, Chia MY, Teh KC(2007) conducted a study on Relationship between measured maximal oxygen uptake and aerobic endurance performance with running repeated sprint ability in young elite soccer players. The aim of the study was to determine the relationships between maximal oxygen uptake (VO(2max)) in a maximal treadmill run and the aerobic endurance performance in the 20-m multistage shuttle run (MST) test, with the performance indices obtained in the running repeated sprint ability (rRSA) test, in elite youth soccer players. Thirty-seven adolescent male outfield players performed on separate days and in random order the treadmill run test and the MST, to obtain their measured VO(2max) and aerobic endurance performance (via the number of completed shuttles in the MST), respectively. Players also completed the rRSA test of 6x20-m all-out sprints, interspersed with 20 s of active recovery. There was a significant moderate correlation between measured VO(2max) (in L . min(-1) and mL . kg(-1) . min(-1)) and MST results (r=0.43 and 0.54, P<0.05, respectively). There was no significant correlation between measured VO(2max) and aerobic endurance performance with any of the performance indices in the rRSA test (all P>0.05).The moderate association between the measured VO(2max) and MST suggests that both tests were plausibly measuring different aspects of a player's aerobic fitness. The lack of association between measured VO (2max) and aerobic endurance performance in the MST with performance in the rRSA suggests that aerobic fitness per se is poorly associated with performance in the rRSA in elite youth soccer players.

Scoon GS¹, Hopkins WG, Mayhew S, Cotter JD(2007) conducted a study on, effect of post-exercise sauna bathing on the endurance performance of competitive
male runners. The physiological adaptations to sauna bathing could enhance endurance performance. We have therefore performed a cross-over study in which six male distance runners completed 3 wk of post-training sauna bathing and 3 wk of control training, with a 3 wk washout. During the sauna period, subjects sat in a humid sauna at 89.9+/2.0 degrees C (mean+/standard deviation) immediately post-exercise for 31+/5 min on 12.7+/2.1 occasions. The performance test was a approximately 15 min treadmill run to exhaustion at the runner's current best speed over 5 km. The test was performed on the 1st and 2nd day following completion of the sauna and control periods, and the times were averaged. Plasma, red-cell and total blood volume were measured via Evans blue dye dilution immediately prior to the first run to exhaustion for each period. Relative to control, sauna bathing increased run time to exhaustion by 32% (90% confidence limits 21-43%), which is equivalent to an enhancement of approximately 1.9% (1.3-2.4%) in an endurance time trial. Plasma and red-cell volumes increased by 7.1% (5.6-8.7%) and 3.5% (-0.8% to 8.1%) respectively, after sauna relative to control. Change in performance had high correlations with change in plasma volume (0.96, 0.76-0.99) and total blood volume (0.94, 0.66-0.99), but the correlation with change in red cell volume was unclear (0.48, -0.40 to 0.90). We conclude that 3 wk of post-exercise sauna bathing produced a worthwhile enhancement of endurance running performance, probably by increasing blood volume

Nummela A, Hämäläinen I, Rusko H (2007) conducted a study on, comparison of maximal anaerobic running tests on a treadmill and track. To develop a track version of the maximal anaerobic running test, 10 sprint runners and 12 distance runners performed the test on a treadmill and on a track. The treadmill test consisted of incremental 20-s runs with a 100-s recovery between the runs. On the track, 20-s
runs were replaced by 150-m runs. To determine the blood lactate versus running velocity curve, fingertip blood samples were taken for analysis of blood lactate concentration at rest and after each run. For both the treadmill and track protocols, maximal running velocity (v max), the velocities associated with blood lactate concentrations of 10 mmol x l-1 (v10 mM) and 5 mmol x l(-1) (v5 mM), and the peak blood lactate concentration were determined. The results of both protocols were compared with the seasonal best 400-m runs for the sprint runners and seasonal best 1000-m time-trials for the distance runners. Maximal running velocity was significantly higher on the track (7.57 +/- 0.79 m x s(-1)) than on the treadmill (7.13 +/- 0.75 m x s(-1)), and sprint runners had significantly higher vmax, v10 mM, and peak blood lactate concentration than distance runners (P < 0.05). The Pearson product--moment correlation coefficients between the variables for the track and treadmill protocols were 0.96 (v max), 0.82 (v10 mM), 0.70 (v5 mM), and 0.78 (peak blood lactate concentration) (P < 0.05). In sprint runners, the velocity of the seasonal best 400-m run correlated positively with vmax in the treadmill (r = 0.90, P < 0.001) and track protocols (r = 0.92, P < 0.001). In distance runners, a positive correlation was observed between the velocity of the 1000-m time-trial and vmax in the treadmill (r = 0.70, P < 0.01) and track protocols (r = 0.63, P < 0.05). It is apparent that the results from the track protocol are related to, and in agreement with, the results of the treadmill protocol. In conclusion, the track version of the maximal anaerobic running test is a valid means of measuring different determinants of sprint running performance.

Papadopoulos C¹, Doyle JA, LaBudde BD (2006) conducted a study on Relationship between running velocity of 2 distances and various lactate parameters. The purpose of this study was to determine the relationship between various lactate-
threshold (LT) definitions and the average running velocity during a 10-km and a 21.1-km time trial (TT). Thirteen well-trained runners completed an incremental maximal exercise test, a 10-km TT, and a 21.1-km TT on a motorized treadmill. Blood samples were collected through a venous catheter placed in an antecubital vein. Pearson's correlation coefficients were used to determine the relationship between the running velocity at the different LT definitions and the average running velocity during each TT. A dependent t test was used to determine statistical differences for the mean lactate response between the 2 running distances. The LT(Dmax), the point on the regression curve that yielded the maximal perpendicular distance to the straight line formed by the 2 endpoints, was the LT definition with the highest correlation for both 10-km (r = .844) and 21.1-km TTs (r = .783). The velocity at the LT (Dmax) was not, however, the velocity closest to the performance velocity for either distance. The mean running velocity at each LT was significantly different and tended to overestimate the mean TT performance velocities. The mean lactate concentration during the 10-km TT (3.52 + or - 1.58 mmol) was significantly higher than during the 21.1-km TT (1.86 + or - 0.90 mmol). These results indicate that a single LT point cannot be reliably associated with different running distances. Furthermore, these data suggest that a different methodology for estimating the LT that considers individual responses might be required for different running distances.

Stojiljković S1, Mazić S, Nesić D, Velkovski S, Mitrović D(2005) conducted a study on [Running velocity at the ventilatory threshold and at VO2max before and after the eight-week cardiovascular endurance training. The purpose of this research was to compare changes in running velocity at ventilatory threshold with the velocity at VO2max, before and after the eight-week exercise program. 32 male subjects (age: 22.3 +/- 2.5 years, height: 179.8 +/- 7.6 cm, body mass: 76.8 +/- 9.0 kg) performed a
progressive test for ventilatory threshold (VT) measurement and VO2max on treadmill. After 8 weeks of endurance training (3 times per week, 30 to 70 min, in different zones in respect to the ventilatory threshold) the performed the same test. Running velocity at ventilatory threshold increased significantly (p = 0.0001), between initial and final measurements (10.88 +/- 2.09, 12.94 +/- 1.90 km/h, respectively); as well as at VO2max (14.63 +/- 1.86, 16.44 +/- 1.59 km/h, respectively). At the initial test, velocity at ventilatory threshold was 74.11 % of VO2max. At the final test, velocity at ventilatory threshold was 78.43% of VO2max. Running velocity at ventilatory threshold has significantly increased at final test (p = 0.001).Running velocity at ventilatory threshold has significantly increased after eight weeks of endurance training (p = 0.001), when expressed in absolute values and percentage of velocity at VO2max.Comparison between the initial and final test demonstrated a significant increase of observed variables, under experimental conditions: at final test running velocity has increased at ventilatory threshold, in respect to absolute values and expressed as percentage at VO2max.

Thelen DG¹, Chumanov ES, Hoerth DM, Best TM, Swanson SC, Li L, Young M, Heiderscheit BC. (2005) conducted a study on Hamstring muscle kinematics during treadmill sprinting. The objective of this study was to characterize hamstring muscle kinematics during sprinting, so as to provide scientific data to better understand injury mechanisms and differences in injury rates between muscles. We conducted three-dimensional motion analyses of 14 athletes performing treadmill sprinting at speeds ranging from 80 to 100% of maximum. Scaled musculoskeletal models were used to estimate hamstring muscle-tendon lengths throughout the sprinting gait cycle for each speed. We tested the hypothesis that the biceps femoris (BF) long head would be stretched a greater amount, relative to its length in an
upright posture, than the semitendinosus (ST) and semimembranosus (SM). We also tested the hypothesis that increasing from sub maximal to maximal sprinting speed would both increase the magnitude and delay the occurrence of peak muscle-tendon length in the gait cycle. Maximum hamstring lengths occurred during the late swing phase of sprinting and were an average of 7.4% (SM), 8.1% (ST), and 9.5% (BF) greater than the respective muscle-tendon lengths in an upright configuration. Peak lengths were significantly larger in the BF than the ST and SM (P < 0.01), occurred significantly later in the gait cycle at the maximal speed (P < 0.01), but did not increase significantly with speed. Differences in the hip extension and knee flexion moment arms between the biarticular hamstrings account for the inter muscle variations in the peak lengths that were estimated. Conclude that inter muscle differences in hamstring moment arms about the hip and knee may be a factor contributing to the greater propensity for hamstring strain injuries to occur in the BF muscle.

Egaña M¹, Donne B (2004) conducted a study on. Physiological changes following a 12 week gym based stair-climbing, elliptical trainer and treadmill running program in females. Despite the growing popularity in recent years of the elliptical trainer aerobic exercise modality the physiological changes induced following a training program using elliptical trainers remains unknown. The present study investigated the metabolic and cardio respiratory improvements following a 12-week aerobic training program using elliptical trainer, treadmill or stair-climbing modalities. Twenty-two moderately active females (28.6 +/- 5.3 y, 1.65 +/- 0.05 m) were randomly assigned to treadmill running (n=7), elliptical trainer (n=8) or stair-climber (n=7) groups and trained 3 days x week(-1) initially at 70-80% of maximum heart rate (HRmax) for 30 min, progressing to 80-90% HRmax for 40 min. Subjects
performed incremental exercise to volitional exhaustion using an electronically loaded cycle ergometer before and upon completion of the program. In addition, subjects performed sub-maximal fixed load tests at 0, 4, 8 and 12 weeks, using ergometers specific to their exercise group. No significant inter-group differences were recorded for pre-training VO2max or VEmax. Significant (p<0.05) post-training increases in cycling VO2max and VEmax were observed for treadmill (mean +/- SEM, 40.7 +/- 2.2 vs 43.4 +/- 2.6 ml x kg(-1) x min(-1) and 82.9 +/- 5.1 vs 90.2 +/- 6.41 x min(-1)), elliptical trainer (36.9 +/- 2.5 vs 39.6 +/- 2.4 ml x kg(-1) x min(-1) and 86.8 +/- 2.3 vs 92.5 +/- 4.11 x min(-1)) and stair-climber (37.4 +/- 2.9 vs 39.2 +/- 3.1 ml x kg(-1) x min(-1) and 95.9 +/- 5.8 vs 97.4 +/- 5.81 x min(-1)) modalities, however, the increases were not significantly different between groups. For all groups, sub-maximal HR significantly decreased from week 0 to 4, and from week 4 to 8. In moderately active females similar physiological improvements were observed using stair-climber, elliptical trainer and treadmill running when training volume and intensity were equivalent.

Kivi DM, Maraj BK, Gervais P.A (2002) conducted a study on kinematic analysis of high-speed treadmill sprinting over a range of velocities. The purpose of this study was to measure changes in stride characteristics and lower-extremity kinematics of the hip and knee as a function of increasing treadmill velocity, at velocities ranging from sub maximal to near maximal. Six power/speed athletes experienced at sprinting on a treadmill performed trials at 70%, 80%, 90%, and 95% of their previous individual maximum velocity, with video data collected in the sagittal view at 60 Hz. Significant differences were seen in stride frequency (70%, 80%, P < 0.01; 90%, P < 0.05), stance time (70%, 80%, P < 0.01; 90%, P < 0.05) flight time (70%, P < 0.01; 80%, P < 0.05), hip flexion angle (70%, P < 0.01), hip
flexion angular velocity (70%, P < 0.01), hip extension angular velocity (70%, 80%, P < 0.01), knee flexion angular velocity (70%, 80%, P < 0.01), and knee extension angular velocity (70%, P < 0.01), as compared with the near maximum (95%) velocity. Coefficient of variation (CV) values showed that the positional variables at the hip and knee were more variable at faster test conditions, indicating that kinematic changes occur as a function of increased treadmill velocity. The results indicated that at slower velocities, there were differences in the stride characteristics and lower-extremity kinematics while sprinting on a treadmill. As the velocity approached near maximum mechanical breakdown was seen, suggesting that velocities greater than 90% should be used selectively during treadmill training.

Sullivan KJ\(^1\), Knowlton BJ, Dobkin BH. (2002) conducted a study on Step training with body weight support: effect of treadmill speed and practice paradigms on poststroke locomotor recovery. To investigate the effect of practice paradigms that varied treadmill speed during step training with body weight support in subjects with chronic hemiparesis after stroke. Randomized, repeated-measures pilot study with 1- and 3-month follow-ups. Twenty-four individuals with hemiparetic gait deficits whose walking speeds were at least 50% below normal. Participants were stratified by locomotor severity based on initial walking velocity and randomly assigned to treadmill training at slow (0.5mph), fast (2.0mph), or variable (0.5, 1.0, 1.5, 2.0mph) speeds. Participants received 20 minutes of training per session for 12 sessions over 4 weeks. Self-selected over ground walking velocity (SSV) was assessed at the onset, middle, and end of training, and 1 and 3 months later. SSV improved in all groups compared with baseline (P<.001). All groups increased SSV in the 1-month follow-up (P<.01) and maintained these gains at the 3-month follow-up (P=.77). The greatest improvement in SSV across training occurred with fast training speeds compared with
the slow and variable groups combined (P=.04). Effect size (ES) was large between fast compared with slow (ES=.75) and variable groups (ES=.73). Training at speeds comparable with normal walking velocity was more effective in improving SSV than training at speeds at or below the patient's typical over ground walking velocity.

Margareta Öhrström Jan Hedenbro and Mats Ekelun (2001) conducted a study on Energy expenditure during treadmill walking before and after vertical banded gastroplasty: a one-year follow-up study in 11 obese women. To find out whether weight reduction induced by vertical banded gastroplasty (VBG) alters the energy expenditure in severely obese women during treadmill walking. A prospective one year follow-up study, patients being their own controls. University hospital, Sweden. A consecutive series of 11 women who had VBG. Indirect calorimetric, body mass index (BMI), preset and comfortable walking speeds, heart rate, perceived exertion, and quality of life. 11 patients were evaluated. Mean BMI (kg/m²) decreased from 41 (range 36–46) before to 32 (range 25–37) 12 months postoperatively. The energy expenditure decreased significantly both at comfortable and preset walking speeds. The comfortable walking speed increased from 2.7 km.h⁻¹ (range 1.3–3.4) before operation to 3.8 (range 2.0–4.2) one year postoperatively (p= 0.003). All bodily variables in the SF-36 questionnaire showed improvement from 6 months onwards. Weight reduction in women reduces the energy expenditure during walking both at comfortable and preset speeds. The comfortable walking speed is increased. The improvements are reflected in the patients' own assessment.

Nicholson RM¹, Sleivert GG (2001) conducted Indices of lactate threshold and their relationship with 10-km running velocity. The object of this study was to determine the relationship of three measures of running velocity at lactate threshold (LT) with 10-km running velocity. The methods used to determine LT velocity (m.s(-
1) during sub maximal treadmill running were: 1) LT(1), the velocity preceding two consecutive increases in blood lactate > or = 1 mmol.L(-1); 2) LT(D), the velocity associated with the maximum perpendicular distance between the nonlinear regression line and the straight line formed by the two end data points of the blood lactate profile; and 3) LT(4), the velocity corresponding to a blood lactate concentration of 4 mmol.L(-1). Thirty competitive and recreational runners (11 female and 19 male) undertook two 10-km time trials (7 d apart), three treadmill familiarization sessions over the following 21 d, and then completed an incremental sub maximal treadmill run. From blood lactate samples taken during the sub maximal run, mean LT velocity (+/- SD) at LT(1) (3.76 +/- 0.57), LT(D) (3.79 +/- 0.58), and LT(4) (4.11 +/- 0.64) was determined. Pearson product moment correlation analysis revealed a strong relationship between all mean LT speeds and mean 10-km running velocity (3.77 +/- 0.57), with the strongest relationship observed for LT(D) (r = 0.86, P < 0.001). Correlations by gender between LT(D) and 10-km velocity were r = 0.84 (female) and r = 0.78 (male). Male subjects had significantly higher LT velocities than female subjects using all methods (P < 0.001), and velocity at LT(4) was significantly faster than 10-km velocity and velocity at LT(1) and LT(D) (P < 0.001). Of the methods measured, LT(D) appears to be the most sensitive and valid measure of LT velocity and may be of benefit in monitoring the training program of 10-km distance runners.

Aziz AR¹, Chia M, Teh KC. (2000) conducted a study on the relationship between maximal oxygen uptake and repeated sprint performance indices in field hockey and soccer players. The purpose of this study was to examine the relationship between maximal oxygen uptake and repeated sprint performance in field hockey and soccer players. A descriptive study on the aerobic-anaerobic
performance of intermittent team game players. The study was conducted at the Sports Medicine and Research Centre. Forty male national team game players (22.6+/−4.2 years; 1.73+/−0.07 m and 63.7+/−6.2 kg) were involved in the study. All subjects completed a treadmill run test to exhaustion to determine maximal oxygen uptake and 8x40 m sprints either on the field or running track to determine repeated sprint ability performance. Body mass-normalised maximal oxygen uptake of 58.0+/−4.9 ml x kg(-1) x min(-1) of the group is comparable to values reported in the literature for team game players. No significant correlations were established between the fastest 40 m sprint time and maximal oxygen uptake (r=-0.21 and -0.08, p>0.05). Moderate correlations were established between maximal oxygen uptake and total time for the eight sprints (r=-0.346 and -0.323; p<0.05).Maximal oxygen uptake was not correlated with the fastest 40 m sprint time but was moderately correlated with total sprint time. Since the shared variance between maximal oxygen uptake and total sprint time was only 12%, improving aerobic fitness further will only be expected to contribute marginally to improving repeated sprint performance of the team game players. It remains possible that a high level of aerobic fitness enhances other aspects of match play in games like soccer and hockey.

Rodger Kram, Timothy M. Griffin, J. Maxwell Donelan, Young Hui Chang (1998) conducted a study on Force treadmill for measuring vertical and horizontal ground reaction forces. We constructed a force treadmill to measure the vertical, horizontal and lateral components of the ground-reaction forces (Fz, Fy, Fx, respectively) and the ground-reaction force moments (Mz, My, Mx), respectively exerted by walking and running humans. The chassis of a custom-built, lightweight (90 kg), mechanically stiff treadmill was supported along its length by a large commercial force platform. The natural frequencies of vibration were >178 Hz for
$F_z$ and $>87$ Hz for $F_y$, i.e., well above the signal content of these ground-reaction forces. Mechanical tests and comparisons with data obtained from a force platform runway indicated that the force treadmill recorded $F_z$, $F_y$, $M_x$, and $M_y$ ground-reaction forces and moments accurately. Although the lowest natural frequency of vibration was 88 Hz for $F_x$, the signal-to-noise ratios for $F_x$ and $M_z$ were unacceptable. This device greatly decreases the time and laboratory space required for locomotion experiments and clinical evaluations. Our goal was to construct an improved force treadmill (FTM) for measuring the forces and moments exerted on the ground by walking and running humans. Previous force-measuring treadmill devices have been shown to reduce substantially data-collection time for locomotion experiments, to allow for feedback to subjects and/or patients, and to enable experiments to be conducted that are not otherwise possible. However, previous designs could satisfactorily measure only the vertical force component. We sought to build a FTM that can record all three components of the ground-reaction force: vertical ($F_z$), horizontal ($F_y$), and lateral ($F_x$), as well as the moments ($M_z$, $M_y$, and $M_x$). These measurements are necessary for measuring the mechanical work performed on the centre of mass, for determining the point of force application, and for calculating joint moments. Various combinations of force platforms or force transducers with treadmills have been constructed in the past, but each of the designs had limitations. Several laboratories have mounted a force platform inside a or built a treadmill around a ground-mounted force platform. These devices could record the vertical ground-reaction force and the moments around the lateral and anterior-posterior axes with excellent fidelity, but they could not measure $F_y$, $F_x$, or $M_z$. Other investigators have mounted a treadmill on top of multiple force sensors. Although these designs could measure $F_y$ in addition to $F_z$, $M_x$, and $M_y$, they have done so with unsatisfactory
fidelity. Frequency-response characteristics and signal-to-noise ratios were beyond limits normally considered acceptable. For example, the natural frequencies of Fd for all these designs have all been <45 Hz. These previous attempts were hampered by three factors: large treadmill mass, inadequate overall stiffness and vibrations induced by the motor or rollers. We have developed a FTM that is a hybrid of these two basic designs.

Melanson EL, Freedson PS, Jungbluth S(1996) Nov conducted a study on Changes in VO2max and maximal treadmill time after 9 wk of running or in-line skate training. This study tested the hypothesis that running and in-line skating training elicit similar improvements in cardio respiratory fitness. Changes in maximal oxygen consumption (VO2max) and maximal treadmill endurance time were compared in runners (N = 16), in-line skaters (N = 19), and controls who did no systematic training (N = 7). Training volumes were similar for runners and skaters (3 d.wk-1, 10-40 min/session, 80-90% of exercise specific maximal heart rate) and included both continuous and interval workouts. Pre- and post-training VO2max and maximal treadmill time were measured in all subjects using a running protocol and in skaters using an in-line skating protocol. The groups did not differ in pre-training running VO2max or maximal treadmill time. After 9 wk, significant increases in running VO2max and maximal treadmill time were observed in runners (mean +/- SE, 9.3 +/- 1.3%, 14.9 +/- 2.5%) and skaters (6.6 +/- 1.0%, 9.1 +/- 3.4%), but not controls. Skaters also significantly increased their skating VO2max and maximal treadmill time (8.6 +/- 1.8%, 7.9 +/- 2.9%). The magnitude of these increases was not different between the two training groups. In conclusion, in moderately active college-aged students, similar improvements in VO2max are achieved
with running and in-line skating programs that are equivalent in training volume and intensity.

Pitsiladis YP\textsuperscript{1}, Duignan C, Maughan RJ. (1996) conducted a study on .Effects of alterations in dietary carbohydrate intake on running performance during a 10 km treadmill time trial. To examine the influence of a seven day diet manipulation on performance during a 10 km treadmill time trial in trained runners. Six trained runners ran two 10 km time trials on a treadmill set at a constant 4\% gradient, each after a 7 d period of dietary manipulation. The two experimental diets were a low carbohydrate (CHO) diet (40\% CHO by total energy) to be consumed for 7 d, and a high CHO diet containing 55\% CHO for the first 4 d followed by 70\% CHO for the remaining 3 d. Blood samples were obtained before and immediately after each run. Expired gases were collected and heart rate monitored. Performance time following the high CHO [48.6(SD 2.7) min] and low CHO [48.6(2.3) min] diets was not different (P = 0.72), nor were there any differences in running speed between conditions. No significant differences were found between conditions in any of the metabolites measured (blood lactate, glucose, glycerol, and plasma free fatty acids). The rate of CHO oxidation was greater on the high CHO diet compared to the low CHO diet (P < 0.05). Heart rate was not different between conditions. The results of this study indicate that moderate changes in the composition of the diet do not affect 10 km running performance in trained subjects.

Wallick ME\textsuperscript{1}, Porcari JP, Wallick SB, Berg KM, Brice GA, Arimond GR(1995) conducted a study on Physiological responses to in-line skating compared to treadmill running. The physiologic responses to in-line skating were compared to those during treadmill running in 16 active males (18-37 yr). Each subject performed a VO2max test during in-line skating and treadmill running using speed-incremented,
discontinuous protocols. Protocols were designed so that each subject completed 4-6 stages. Stages were 3 min in duration and separated by a 5-min rest period. It was found that absolute VO2max (4.19 vs 4.44 l.min-1, P = 0.045), relative VO2max (56.8 vs 59.9 ml.kg-1.min-1, P = 0.054), and HRmax (189 vs 194 b.min-1, P < 0.05) were lower for in-line skating compared to treadmill running. Regression analyses were used to determine the sub maximal relationship between modalities. There were no significant (P > 0.05) differences in the slope and y-intercept of the HR/VO2 relationship, indicating a similar metabolic load at a given heart rate for both modes of exercise. Skating between 17.7-20.9 km.h-1 corresponded to 60-75\% of VO2max or 75-90\% of HRmax, which are common training intensities and within the guidelines recommended by the ACSM. Across the speeds investigated, caloric expenditure was 9.5-19.0 kcal.min-1. These results indicate that in-line skating elicits physiological responses comparable to treadmill running and thus would be another exercise alternative for improving aerobic capacity or maintaining body weight.

Frangolias DD\(^1\), Rhodes EC (1995) conducted a study on .Maximal and ventilatory threshold responses to treadmill and water immersion running. This study compared the metabolic responses of 13 endurance runners, familiar with non weight-bearing water immersion (WI) running, at ventilatory threshold (Tvent) and maximal effort (VO2max) for both treadmill and WI running performance. Oxygen consumption (VO2), ventilation (VE), heart-rate (HR), VE/VO2, respiratory exchange ratio (RER), perceived exertion (RPE), and stride frequency (SF) were measured at Tvent and VO2max. Paired t-tests revealed higher VO2max (59.7 vs 54.6 ml.kg.-1min-1), HRmax (190 vs 175 bpm), RERmax (1.20 vs 1.10), VO2 at Tvent (46.3 vs 42.8 ml.kg.-1min-1), HR at Tvent (165 vs 152 bpm) for treadmill versus WI running,
respectively. Treadmill and WI VE\textsubscript{max} (109.0 vs 105.8 l.min\(^{-1}\)), RPE\textsubscript{max} (20), VE at Tvent (66.4 vs 65.7 l.min\(^{-1}\)), RER at Tvent (0.99 vs 0.98), RPE at Tvent (13 vs 12) were similar, as were blood lactate [BLa] values obtained at 30 s (10.4 vs 9.8 mmol.l\(^{-1}\)) and 5 min (9.7 vs 9.2 mmol.l\(^{-1}\)) post-test. SF values over time were higher on the treadmill. The lower WI VO\textsubscript{2max} with similar peak [BLa] and lower SF values suggests that the active musculature and muscle recruitment patterns differ in WI running due to the high viscosity friction of water, and the non weight-bearing nature of WI running.

Léger L, Mercier D.(1984) conducted a study on Gross energy cost of horizontal treadmill and track running. The gross energy cost of treadmill and track running is re-investigated from data published in the literature. An average equation, weighted for the number of subjects in each study, was found: VO\textsubscript{2} (ml/kg/min) = 2.209 + 3.163 speed (km/h) for 130 subjects (trained and untrained males and females) and 10 treadmill studies. On the track, wind resistance as predicted by Pugh (1970) was added to the treadmill cost of running and yielded the following equation for adults of average weight and height: VO\textsubscript{2} = 2.209 + 3.163 speed + 0.000525542 speed. Between 8 and 25 km/h, the following linear equation: VO\textsubscript{2} = 3.5 speed (or met = km/h) was very close to the cubic equation. This linear equation for track running is, however different from the treadmill linear equation, particularly for speeds over 15 km/h. This equation is also slightly different from the one published by Pugh (1970) for track running from 7 trained subjects only.

**2.2 STUDIES ON CYCLE ERGO METER**

Lee, Vivian Ye Jee (2013) conducted a study on effect of carbohydrate ingestion during 'spin' classes on health and fitness parameters, quality of life and mood in recreational exercisers. The primary aim of this study was to examine the
effect of regular carbohydrate ingestion during exercise in a 10-week intervention on health and fitness parameters, mood and quality of life in recreational exercisers. A secondary aim was to examine the effect of 10-weeks of cycling exercise (spin classes) on health and fitness parameters, as well as quality of life. Methods: Twelve recreational exercisers that attended regular spin classes volunteered to participate in this study. These participants in the Exercise cohort (EXE) were randomly allocated to either Carbohydrate (7.5% carbohydrate solutions; 5 mL/kg of body mass per exercise session; n = 6; CHO) or Placebo (0% carbohydrate, taste- and volume-matched solutions; n = 6; PLA) groups. They each underwent 2 x 45-minute spin classes per week, over a 10-week intervention period. Before each class, participants were given their allocated drinks to consume during the exercise class. Various heart rate parameters, as well as perceptual measures of exertion, pleasure-displeasure and activation (arousal) were assessed after each exercise session. Five non-exercisers were recruited for the Control group (age and gender-matched; CON); they continued their normal daily activities throughout the 10 weeks. All participants (n = 17) were required to attend pre- and post intervention testing sessions where anthropometry, fat composition (BodPod), physiological measures (resting heart rate, resting blood pressure and oxygen saturation rate), cardio respiratory fitness (cycling test; O2max), quality of life (questionnaire), and various metabolic markers (via collection of blood samples) were assessed. Results: There were no changes from pre- to post-intervention in the measures of body mass, fat composition, waist-to-hip ratio, body mass index (BMI), resting heart rate and systolic blood pressure, oxygen saturation rate, O2max, metabolic markers (triglyceride, total cholesterol, low density lipoprotein and high density lipoprotein) and quality of life measures between CHO and PLA groups (all p > 0.05). However, a significant decrease in the resting diastolic
pressure in the CHO group was observed post-intervention (p = 0.02). Throughout the 10-week intervention, mean heart rate, proportion of time spent in different heart rate zones, perceived working resistance, and perceptual ratings of exertion and pleasure-displeasure did not change between CHO or PLA groups (all p > 0.05). However, the level of activation throughout the intervention increased in CHO participants, while it decreased in the PLA group (p = 0.03). Furthermore, a higher proportion of participants within the CHO group were in the ‘high-activation, pleasurable’ quadrant (circumflex model of affect) throughout the intervention. The 2-hour fasted glucose (p < 0.01) and high density lipoprotein (p = 0.04) levels also significantly decreased in the CHO group, while it increased in the PLA group. There were no differences in any health and fitness parameters between EXE and CON groups following the 10-week intervention (all p > 0.05) except for a decrease in waist-to-hip ratio of the EXE cohort, and an increase in the CON group (p = 0.02). Lower BMI (p = 0.03) and resting heart rate (p < 0.01), and higher cardio respiratory fitness (p < 0.01) and ‘work’ subscale of quality of life (p = 0.03) were seen at baseline in the EXE cohort.

Conclusion: Carbohydrate ingestion during regular exercise over a 10-week period did not have any physiological benefits in recreational exercisers. However carbohydrate ingestion appeared to enhance ‘feel-good’ state of recreational exercisers throughout the intervention period. The 10 weeks of regular exercise did not incur any additional benefits relative to no exercise. Nevertheless, the exercisers showed better physiological and cardiovascular fitness relative to non-exercisers.

Keywords: Feeling Scale, Felt Arousal Scale, circumflex model.

Roxana Brasil¹ / Ana Barreto¹ / Leandro Nogueira¹ / Edil Santos¹ / Jefferson Novaes¹ / Victor Reis¹ (2011) conducted a study Comparison of Physiological and Perceptual Responses Between Continuous and Intermittent Cycling. The present
study tested the hypothesis that the exercise protocol (continuous vs. intermittent) would affect the physiological response and the perception of effort during aquatic cycling. Each protocol was divided on four stages. Heart rate, arterial blood pressure, blood lactate concentration, central and peripheral rate of perceived exertion were collected in both protocols in aquatic cycling in 10 women (values are mean ± SD): age=32.8 ± 4.8 years; height=1.62 ± 0.05 cm; body mass=61.60 ± 5.19 kg; estimated body fat=27.13 ± 4.92%. Protocols were compared through two way ANOVA with Scheffé’s post-hoc test and the test of Mann-Whitney for rate of perceived exertion with α=0.05. No systematic and consistent differences in heart rate, arterial blood pressure, and double product and blood lactate concentration were found between protocols. On the other hand, central rate of perceived exertion was significantly higher at stage four during continuous protocol compared with intermittent protocol (p=0.01), while the peripheral rate of perceived exertion presented higher values at stages three (p=0.02) and four (p=0.00) in the continuous protocol when compared to the results found in intermittent protocol. These findings suggest that although the aquatic cycling induces similar physiologic demands in both protocols, the rate of perceived exertion may vary according to the continuous vs. intermittent nature of the exercise.

Simões RA, Gonelli PRG, Celante GS, Sindorf MAG, Souza TMF, Montebelo MIL, Borin JP, Cesar MC. (2011) conducted a study on Comparison of Acute Cardio respiratory Responses in Women Engaged in Local Muscle Endurance .High Load Strength Training is study examined the acute cardio respiratory responses of strength training protocols in trained women. Twenty-two subjects performed cardio respiratory, IRM tests, and two sessions of strength training with distinct load intensities. The strength protocols were local muscle endurance (LME, 3 sets of 15 to
20 RM repetitions at 50% of 1 RM and a 1 min rest interval between sets) and high load strength training (HLT, 3 sets of 3 to 5 RM repetitions, load of 90% of 1 RM and a 3 min rest interval between sets). At rest, there were no significant differences between the LME and HLT protocols for all variables. During the workout sessions, the LME protocol resulted in significantly (P<0.01) higher VO2, VCO2, VE, O2 pulse, HR, VE/VO2, and VE/VCO2 responses as well as total volume of training vs. the HLT protocol. Although the LME protocol resulted in a higher cardio respiratory overload versus the HLT protocol, it was too low to improve the cardio respiratory fitness of young trained women.

Kara L. Sieberta, Sharon K. DeMuthb, Loretta M. Knutsone & Eileen G. Fowlerld(2010) conducted a study on Stationary Cycling and Children with Cerebral Palsy: These case reports describe a stationary cycling intervention and outcomes for two child participants (P1 and P2) with spastic diplegic cerebral palsy. Each child completed a 12-week, 30-session cycling intervention consisting of strengthening and cardio respiratory fitness phases. P1 exhibited higher training intensities, particularly during the cardio respiratory phase. Average training heart rates were 59% and 35% of maximum heart rate for P1 and P2, respectively. Lower extremity peak knee flexor and extensor moments, gross motor function (Gross Motor Function Measure (GMFM-66)), preferred walking speed (thirty-second walk test), and walking endurance (600-yard walk-run test) were measured pre- and post intervention. Changes in outcome measurements corresponded with differences in exercise intensity. Greater gains in peak knee extensor moments, GMFM-66 scores (+4.2 versus +0.9), 600-yard walk-run test (−29% versus 0%) occurred for P1 versus P2, respectively. Preferred walking speeds did not increase substantially for P1 and decreased for P2.
Michael C Rumpf1, Amanda J Salacinski2, Pamela A Macfarlane2 and Marilyn A Looney2 (2009) conducted a study on Effect of Supra maximal Spinning® on Running Performance of Male Collegiate Soccer Players. Change of direction, first-step-quickness, acceleration, and sprinting are general components of athletes’ performances in many sports. Sport specific training of those abilities is necessary to ensure competency and success of players. However, nonspecific training forms such as resistance training and cycling are also used in the training process with different purposes. As a result, the purpose of this study was to investigate the influence of a non-specific training form (supra maximal Spinning®) on (soccer specific) running performance in Division I collegiate male soccer players. Performance variables were determined via a 23.65-meter sprint and a change of direction test. The fifteen soccer players of the team were randomly selected into a training (N=8) or a control group (N=7). The training consisted of 10 training session over a period of 14 days and was in addition to the regular daily team practice. Each training consisted of a 5-minute warm-up phase, 10 sets of 15-seconds maximum Spinning®, with no resistance intersperse with 30 seconds of active recovery and a 5-minute cool-down phase. An ANCOVA revealed significant between group differences on the adjusted post-test scores for 0-10 m acceleration (p=0.015) and 23.65-m sprint time (p=0.012). The treatment group was 0.05 seconds faster during the acceleration phase and 0.08 seconds faster in the 23.65-m sprint compared to the control group. The findings suggest that supra maximal Spinning® may be a promising way to improve acceleration of collegiate soccer players.

Carey DG1, Tofte C, Pliego GJ, Raymond RL. (2009) conducted a study on Transferability of running and cycling training zones in tri athletes: implications for steady-state exercise. The primary objective of this study was to determine whether
physiological measurements obtained from one mode of testing and training could be applied to another mode, as in prescribing heart rate (HR) zone training from cycling to running. Secondary objectives were 1) to assess the validity of applying data from incremental testing to steady-state exercise, and 2) to compare breakpoint in respiratory rate (RR) with the conventional method of anaerobic threshold (AT) breakpoint, the ventilatory equivalent for oxygen VE/VO2). Sixteen experienced tri athletes performed VO2max testing on a cycle ergometer (CE) and treadmill (TM). In addition, a 30-minute time trial (TT) was performed on a CE. No significant differences were observed between modes of testing for VO2max (CE = 68.4 +/- 11.1 mlxkgxmin, TM = 69.0 +/- 13.2 mlxkgxmin), maximum HR (CE = 177.1 +/- 6.1 bpm, TM = 178.1 +/- 7.4 bpm), or AT (CE AT HR = 153.9 +/- 10.5 bpm, TM AT HR = 157.0 +/- 9.5 bpm). Although the mean difference in AT HR was small (3.1 bpm), a small correlation coefficient (0.321) between the AT for the 2 testing modes resulted in a large total error (TE = 12.1 bpm), indicating limited practical application of training zones between modes of testing. Mean TT HR and mean TT RR were significantly greater than mean AT HR (159.4 +/- 8.9 vs. 153.9 +/- 10.5 bpm) and mean AT RR (37.8 +/- 6.0 vs. 32.4 +/- 3.2 breaths per minute) because of significant "drift" in these 2 variables over time, whereas TT watts and AT watts were not significantly different (249.1 +/- 47.8 vs. 240.6 +/- 71.1 W). Finally, a significant difference and large TE (9.0 bpm) bet weenVE/VO2 AT HR and the RR AT HR (153.9 +/- 10.5 and 158.4 +/- 10.0 bpm) may preclude the practical use of the RR breakpoint. From the results of this study, it is recommended that the tri athlete perform sport-specific testing to assess training zones for cycling and running. In addition, because both HR and RR "drift" upward with steady-state exercise, AT RR and AT HR determined by incremental testing underestimate steady-state HR and RR.
For this reason, monitoring wattage during steady-state exercise may be more appropriate than monitoring HR and RR.

Cesar Mde C, Borin JP, Gonelli PR, Simões RA, de Souza TM, Montebelo MI. J. (2009) conducted a study on the effect of local muscle endurance training on cardio respiratory capacity in young women. The purpose of this study was to investigate the effect of local muscle endurance training on maximal oxygen uptake and ventilatory threshold in young women. Nineteen untrained women, ranging in age from 18 to 26 years, were included in the study and assigned to two groups: the control group (n = 10), and the resistance training group (n = 9). The following variables were obtained at baseline and after 12 weeks: body mass; maximal oxygen uptake, maximal heart rate, maximal oxygen pulse, oxygen uptake at the ventilatory threshold, heart rate at the ventilatory threshold, and oxygen pulse at the ventilatory threshold assessed by cardiopulmonary exercise testing on treadmill; 1-repetition maximum (RM) tests in bench press, latissimus pull down, military press, lying barbell extension, standing barbell curls, leg press, knee extension, and hamstring curl. The training group underwent resistance strength training. Loading during training followed the concept of maximum repetitions. Each session was defined as the performance of three sets of 15RM with a 60-second rest between sets and exercises. No significant changes were observed in the control group before and after 12 weeks (p > 0.05). All 1RM tests increased after training (p < or = 0.01) in the training group, but no significant change was observed in body mass (p > 0.05). Cardiopulmonary variables showed no significant differences before and after resistance training (p > 0.05). These findings indicate that the local muscle endurance training realized produces no improvement in cardio respiratory capacity in young women.
Walker TB¹, Zupan MF, McGregor JN, Cantwell AR, Norris TD. (2009) conducted a study on performance of intermittent intense exercise enhanced by use of a commercial palm cooling device. The purpose of this study was to determine if using the Core Control Rapid Thermal Exchange (RTX), a commercial palm cooling device, during active rest periods of multiple set training is an effective means to increase performance. Ten volunteers (5 men, 5 women) completed a VO2max test on a motorized treadmill and 3 interval running tests on a human powered treadmill. This treadmill allowed the subjects to quickly reach their running speed while allowing for measurement of distance, speed, and force. During the interval running tests the subjects completed eight 30-second intervals at a hard/fast pace followed by a 90-second walking or light jogging recovery period. During the recovery period, the subjects placed their left hand on 1 of 3 media: the RTX held at 15 degrees C (R), a 15 degrees C standard refrigerant gel pack (P), or nothing at all (C). Although there were differences in core temperature (Tc), subjective heat stress ratings, distance, and power generated between intervals, there were no significant differences (p < 0.05) found between treatments for any of these variables, nor was the interaction effect of interval*treatment found to be significant. Mean distance completed per trial was 717.1 m +/- 124.4 m (R), 724.8 m +/- 130.3 m (P), and 728.6 m +/- 110.6 m (C). Change in Tc from baseline to end-test averaged 1.41 degrees C +/- 0.37 degrees C (R), 1.41 degrees C +/- 0.39 degrees C (P), and 1.41 degrees C +/- 0.59 degrees C (C). There were no significant differences (p < 0.05) in Tc, heart rate (HR), or VO2 between intervals or treatments. We conclude that the RTX, in its current iteration, is ineffective at improving performance and/or mitigating thermal stress during high-intensity intermittent exercise.
Millet GP\(^1\), Vleck VE, Bentley DJ(2009) conducted a study on Physiological differences between cycling and running: lessons from tri athletes. The purpose of this review was to provide a synopsis of the literature concerning the physiological differences between cycling and running. By comparing physiological variables such as maximal oxygen consumption (\(\text{VO}_{2\text{max}}\)), anaerobic threshold (AT), heart rate, economy or delta efficiency measured in cycling and running in tri athletes, runners or cyclists, this review aims to identify the effects of exercise modality on the underlying mechanisms (ventilatory responses, blood flow, muscle oxidative capacity, peripheral innervations and neuromuscular fatigue) of adaptation. The majority of studies indicate that runners achieve a higher \(\text{VO}_{2\text{max}}\) on treadmill whereas cyclists can achieve a \(\text{VO}_{2\text{max}}\) value in cycle ergometry similar to that in treadmill running. Hence, \(\text{VO}_{2\text{max}}\) is specific to the exercise modality. In addition, the muscles adapt specifically to a given exercise task over a period of time, resulting in an improvement in sub maximal physiological variables such as the ventilatory threshold, in some cases without a change in \(\text{VO}_{2\text{max}}\). However, this effect is probably larger in cycling than in running. At the same time, skill influencing motor unit recruitment patterns is an important influence on the anaerobic threshold in cycling. Furthermore, it is likely that there is more physiological training transfer from running to cycling than vice versa. In tri athletes, there is generally no difference in \(\text{VO}_{2\text{max}}\) measured in cycle ergometry and treadmill running. The data concerning the anaerobic threshold in cycling and running in tri athletes are conflicting. This is likely to be due to a combination of actual training load and prior training history in each discipline. The mechanisms surrounding the differences in the AT together with \(\text{VO}_{2\text{max}}\) in cycling and running are not largely understood but are probably due to the relative adaptation of cardiac output influencing \(\text{VO}_{2\text{max}}\)
and also the recruitment of muscle mass in combination with the oxidative capacity of this mass influencing the AT. Several other physiological differences between cycling and running are addressed: heart rate is different between the two activities both for maximal and sub maximal intensities. The delta efficiency is higher in running. Ventilation is more impaired in cycling than in running. It has also been shown that pedalling cadence affects the metabolic responses during cycling but also during a subsequent running bout. However, the optimal cadence is still debated. Central fatigue and decrease in maximal strength are more important after prolonged exercise in running than in cycling.

Max J Kurz and Nicholas Stergiou\(^2\)(2007) conducted a study on Do horizontal propulsive forces influence the nonlinear structure of locomotion. Several investigations have suggested that changes in the nonlinear gait dynamics are related to the neural control of locomotion. However, no investigations have provided insight on how neural control of the locomotive pattern may be directly reflected in changes in the nonlinear gait dynamics. Our simulations with a passive dynamic walking model predicted that toe-off impulses that assist the forward motion of the centre of mass influence the nonlinear gait dynamics. Here we tested this prediction in humans as they walked on the treadmill while the forward progression of the centre of mass was assisted by a custom built mechanical horizontal actuator. Nineteen participants walked for two minutes on a motorized treadmill as a horizontal actuator assisted the forward translation of the centre of mass during the stance phase. All subjects walked at a self-select speed that had a medium-high velocity. The actuator provided assistive forces equal to 0, 3, 6 and 9 percent of the participant's body weight. The largest Lyapunov exponent, which measures the nonlinear structure, was calculated for the hip, knee and ankle joint time series. A repeated measures one-way analysis of
variance with a t-test post hoc was used to determine significant differences in the nonlinear gait dynamics. The magnitude of the largest Lyapunov exponent systematically increased as the percent assistance provided by the mechanical actuator was increased. These results support our model's prediction that control of the forward progression of the centre of mass influences the nonlinear gait dynamics. The inability to control the forward progression of the centre of mass during the stance phase may be the reason the nonlinear gait dynamics are altered in pathological populations. However, these conclusions need to be further explored at a range of walking speeds. Horizontal propulsive forces that are applied during the stance phase influence the nonlinear structure of human locomotion. The experimental results presented here infer that the changes in the nonlinear structure may be related to the proper utilization the hip and ankle joint musculature to control the forward progression of the centre of mass. Future investigation should determine if the results presented here can be extended to individuals with altered nonlinear gait patterns (i.e., elderly, Parkinson's disease). The initial step toward making this connection should be directed towards determining if the results presented here are consistent for different walking speeds. This scientific information will provide further insight on which neuro mechanical components that are responsible for changes in the nonlinear structure of gait, and may lead to a better understanding of why the nonlinear gait pattern is altered in pathological populations.

M. A. Cariaa*, F. Tangianua, A. Concup, A. Crisafullib & O. Mamelia (2007) conducted a study on Quantification of spinning® bike performance during a standard 50-minute class. Spinning is a type of indoor fitness activity performed on stationary bikes by participants who pedal together to the rhythm of music and the motivating words of an instructor. Despite worldwide popularity of this type of
recreational activity, to date there have been few, mainly non-scientific, studies of the impact of spinning on metabolic, respiratory, and cardiovascular functions. The main aim of this study was to evaluate a number of metabolic and cardiovascular variables during a standard 50-min class performed by Spinning® instructors of both sexes: six males (age 30 $\pm$ 4.8 years, body mass index 24 $\pm$ 2.5 kg $\cdot$ m$^{-2}$; mean $\pm$ s) and six females (age 34 $\pm$ 6.3 years, body mass index 21 $\pm$ 1.9 kg $\cdot$ m$^{-2}$). The mean power output, heart rate, and oxygen uptake during the performance were 120 $\pm$ 4 W, 136 $\pm$ 13 beats $\cdot$ min$^{-1}$, and 32.8 $\pm$ 5.4 ml $\cdot$ kg$^{-1}$ $\cdot$ min$^{-1}$ respectively for males, and 73 $\pm$ 43 W, 143 $\pm$ 25 beats $\cdot$ min$^{-1}$, and 30 $\pm$ 9.9 ml $\cdot$ kg$^{-1}$ $\cdot$ min$^{-1}$ respectively for females. Analysis of individual performances showed that they were compatible with physical exercise that ranged from moderate-to-heavy to very heavy, the latter conditions prevailing. The results show that this type of fitness activity has a high impact on cardiovascular function and suggest that it is not suitable for unfit or sedentary individuals, especially the middle aged or elderly, who are willing to begin a recreational physical activity programme.

Baldari C$^1$, Di Luigi L, Silva SG, Gallotta MC, Emerenziani GP, Pesce C, Guidetti L (2007) conducted a study on Relationship between optimal lactate removal power output and Olympic triathlon performance. To investigate the relationships between race performance and parameters at the optimal power output for lactate removal, 10 male tri athletes were examined. Exercise intensities for lactate removal were defined by calculating 50% of difference (DeltaT) between running velocity (V(r)) at individual anaerobic threshold (IAT) and at individual ventilatory threshold (IVT), then choosing 3 V(r): at IVT plus 50% DeltaT (IVT(+50%DeltaT)), at IVT, and at IVT minus 50% DeltaT (IVT(-50%DeltaT)). After a 6-minute treadmill run at 75% of difference between IAT and V(\textendash)O2max, all tri athletes performed a
30-minute active recovery run at IVT(+50%DeltaT), IVT, and IVT(-50%DeltaT). Capillary blood lactate was determined at 1, 3, 6, 9, 12, 15, 20, 25, and 30 minutes of recovery. The IVT(-50%DeltaT) recovery was the most efficient V(r) for lactate removal. Running velocities at IVT and IVT(-50%DeltaT) were highly (p < 0.01) related to cycle, run, and overall race time. V(-)O2max values at IAT, IVT(+50%DeltaT), and IVT were less (p < 0.05) related to split and overall race time. The variable most related to overall race time, as determined by stepwise multiple linear regression analysis, was the V(r) at IVT(-50%DeltaT) (r = 0.87, p = 0.001). The R(2) value of 0.76 indicated that V(r) at IVT(-50%DeltaT) could account for 76% of the variance in triathlon race time. This study shows that the race performances of triathletes are highly related to the V(r) at which the most efficient lactate removal (IVT(-50%DeltaT)) occurs. These findings suggest that the assessment of V(r) at IVT and IAT (from which V(r) at IVT(-50%DeltaT) are calculated) may be a useful method for monitoring training-induced adaptations and performance improvements in athletes who participate in Olympic triathlons.

Faude O¹, Meyer T, Rosenberger F, Fries M, Huber G, Kindermann W (2007) conducted a study on Physiological characteristics of badminton match play. The present study aimed at examining the physiological characteristics and metabolic demands of badminton single match play. Twelve internationally ranked badminton players (eight women and four men) performed an incremental treadmill test [VO2peak = 50.3 +/- 4.1 ml min(-1) kg(-1) (women) and 61.8 +/- 5.9 ml min(-1) kg(-1) (men), respectively]. On a separate day, they played a simulated badminton match of two 15 min with simultaneous gas exchange (breath-by-breath) and heart rate measurements. Additionally, blood lactate concentrations were determined before, after 15 min and at the end of the match. Furthermore, the duration of rallies
and rests in between, the score as well as the number of shots per rally were recorded. A total of 630 rallies was analysed. Mean rally and rest duration were 5.5 +/- 4.4 s and 11.4 +/- 6.0 s, respectively, with an average 5.1 +/- 3.9 shots played per rally. Mean oxygen uptake (VO(2)), heart rate (HR), and blood lactate concentrations during badminton matches were 39.6 +/- 5.7 ml min(-1) kg(-1) (73.3% VO(2peak)), 169 +/- 9 min(-1) (89.0% HR(peak)) and 1.9 +/- 0.7 mmol l(-1), respectively. For a single subject 95% confidence intervals for VO (2) and HR during match play were on average 45.7-100.9% VO (2peak) and 78.3-99.8% HR (peak). High average intensity of badminton match play and considerable variability of several physiological variables demonstrate the importance of anaerobic alactic acid and aerobic energy production in competitive badminton. A well-developed aerobic endurance capacity seems necessary for fast recovery between rallies or intensive training workouts.

Legaz Arrese A¹, Munguía Izquierdo D, Serveto Galindo JR. (2006) conducted a study on physiological measures associated with marathon running performance in high-level male and female homogeneous groups. The study tested the hypothesis that physiological measurements can predict marathon running performance in a top-level homogeneous group of males and females. Ten male, performance: 2:12:04, coefficient of variation (CV) =2.33%, and 8 female marathon runners, performance: 2:34:53, CV=4.54%, performed an increment test on the treadmill (starting speed, 8 km.h-1; increments, 2 km.h-1; increment duration, 3 min to exhaustion). The heart rate (HR), VO2 and the lactate concentrations were measured at the end of each exercise level. During the recovery time, HR and lactate were measured. Furthermore, echocardiographic, anthropometric and hematologic measurements were made. The results of a stepwise multiple regression analysis using
marathon time as the dependent variable yielded R²=0.983 for the male group and R²=0.984 for the female group. The model for the male group used the independent variables lactate value at 10 km.h⁻¹, left ventricular telediastolic diameter (LVD) and lactate value at 22 km.h⁻¹. The model for the female group used the independent variables subscapular skinfold, serum ferritin and sum of six skinfolds. Our study demonstrates that in males and females, physiological parameters can explain the variance in marathon time among elite homogeneous groups.

Mika P¹, Spodaryk K, Cencora A, Mika A (2006). conducted a study on. Red blood cell deformability in patients with claudication after pain-free treadmill training. To assess the effect of pain-free treadmill training on red blood cell deformability and walking distance in patients with claudication. Randomized-controlled trial of exercise training. Patients were recruited from the primary care, vascular outpatient clinic. A total of 60 patients with peripheral arterial occlusive disease (stage II according to Leriche-Fontaine) were randomized into the treadmill program or a control group. Fifty-five patients completed the study (27 in the exercising group and 28 in the control group). Patients in the exercising group were walking on the treadmill 3 times a week for 3 months. Each session consisted of 1 hour repetitive walking [performed to 85% of the pain-free walking time (PFWT)] was supervised by a qualified physiotherapist. Changes in erythrocyte deformability and treadmill walking performance (PFWT, maximal walking time) were assessed in both groups before the study and after 3 months. After 3 months of treadmill training, red blood cell deformability in the exercising group significantly increased (P<0.01). No significant changes were seen in the erythrocyte deformability in the control group. PFWT was prolonged by 102% from 191+/−34 to 386+/−60 seconds (P<0.01), and maximal walking time increased by 49% from 438+/−62 to 656+/−79 seconds.
(P<0.01) in the exercising group, whereas these changes were insignificant in the control group. A significant improvement of walking ability over 3 months of pain-free treadmill training is associated with a significant increase in red cell deformability in patients with claudication.

Girard O\(^1\), Chevalier R, Leveque F, Micallef JP, Millet GP(2006) conducted a study on. Specific incremental field test for aerobic fitness in tennis. To compare metabolic and cardio respiratory responses between subjects undergoing incremental treadmill (non-specific) and tennis field based (sport specific) tests. Nine junior competitive tennis players randomly performed two incremental protocols to exhaustion: a treadmill test (TT) and a tennis specific fitness test (FT). The FT consisted of repeated displacements replicating the game of tennis at increasing speed on a court. In both tests, ventilatory variables and heart rate (HR) were determined at the ventilatory threshold (VT), respiratory compensation point (RCP), and maximal loads (max). Blood lactate concentration was determined at the point of volitional fatigue. Percentage (mean (SD)) maximal HR (83.6 (5.1) v 83.0 (2.8) and 92.1 (2.1) v 92.3 (2.1)%), respectively) and percentage maximal oxygen uptake (VO2max) (69.4 (8.1) v 73.5 (6.1) and 84.4 (6.5) v 85.5 (8.7)%, respectively) at the VT and RCP were not different between the FT and TT subjects, whereas VO2max was higher in the FT than in the TT (63.8 (3.0) v 58.9 (5.3) ml/min/kg; p<0.05). Blood lactate concentration (10.7 (3.0) v 10.6 (4.3) mmol/l) did not differ between the TT and FT. Although cardio respiratory variables were not different at sub maximal intensities between the two tests, VO2max values derived from laboratory measurements were underestimated. Using field testing in addition to treadmill testing provides a better measurement of a player's individual fitness level and may be routinely used to accurately prescribe appropriate aerobic exercise training.
Papadopoulos C\(^1\), Doyle JA, LaBude BD (2006) conducted a study on. Relationship between running velocity of 2 distances and various lactate parameters. The purpose of this study was to determine the relationship between various lactate-threshold (LT) definitions and the average running velocity during a 10-km and a 21.1-km time trial (TT). Thirteen well-trained runners completed an incremental maximal exercise test, a 10-km TT, and a 21.1-km TT on a motorized treadmill. Blood samples were collected through a venous catheter placed in an antecubital vein. Pearson’s correlation coefficients were used to determine the relationship between the running velocity at the different LT definitions and the average running velocity during each TT. A dependent t test was used to determine statistical differences for the mean lactate response between the 2 running distances. The LT(Dmax), the point on the regression curve that yielded the maximal perpendicular distance to the straight line formed by the 2 endpoints, was the LT definition with the highest correlation for both 10-km \((r = .844)\) and 21.1-km TTs \((r = .783)\). The velocity at the LT(Dmax) was not, however, the velocity closest to the performance velocity for either distance. The mean running velocity at each LT was significantly different and tended to overestimate the mean TT performance velocities. The mean lactate concentration during the 10-km TT \((3.52 + or - 1.58 \text{ mmol})\) was significantly higher than during the 21.1-km TT \((1.86 + or - 0.90 \text{ mmol})\).

These results indicate that a single LT point cannot be reliably associated with different running distances. Furthermore, these data suggest that a different methodology for estimating the LT that considers individual responses might be required for different running distances.

Modlin, (2006) conducted a study on Kim studied on The effect of handle bar height on low back pain in cyclists during spinning. A study was conducted to
determine the optimum position of the handlebar on the Johnny G. Spinning® bicycle to reduce low back pain in cyclists participating in a Spinning® class. A three period open label cross over design, involving thirty six subjects was conducted. Each subject participated in three Spinning® classes with a different handlebar height at each session. The saddle angle, saddle post height and fore/aft position of the saddle remained fixed to eliminate variability. The cyclists’ pain perception was measured via the Visual Analogue Scale, Lickert Scale and the McGill Pain Questionnaire. The results were analysed with respect to the change in the mean and standard deviation of the Visual Analogue Scale, the Lickert scale and the McGill Pain Questionnaire. The significance of the study was set at the 0.05 level. A zero value was recorded with respect to pain experienced by the cyclists during a Spinning® class on the VAS, Lickert scale and on the McGill Pain scale, when the handlebars were placed in the high handlebar height position on the Spinning® bicycle; this is the most important outcome of the study conducted. In conclusion, there is a statistically meaningful difference (p<0.001) between the mean values of pain recorded by participants of the low handlebar height compared to the normal handlebar height, with the normal handlebar height being the better position. The standard deviation remains relatively constant. No pain was recorded on the VAS, Lickert scale and on the McGill Pain scale when the handlebars were placed in the high handlebar height position on the Spinning® bicycle. The results of the study indicate that the high handlebar height position is the best position for participants in a Spinning® class.

Saunders, M. J., E. M. Evans, S. A. Arngrimsson, J. D. Allison, And K. J. Cureton(2003) conducted a study on Endurance Training Reduces End-Exercise V’O2 and Muscle Use during Sub maximal Cycling. End-exercise V’O2 during heavy, constant-load exercise is reduced after endurance training, due to an attenuated V’O2
slow component. Purpose/Methods: To determine whether the training-induced reduction in end-exercise V’ O2 was associated with reduced muscle use, we measured V’ O2 and T2 changes in magnetic resonance images in the final minute of two 15-min constant-load cycle rides, one above lactate threshold and the other below lactate threshold. These measures were repeated after a 4-wk period in eight subjects who trained on a cycle ergometer and seven controls. Results: There were no changes in end-exercise V’ O2 or active muscle after training in either group during low-intensity cycling, in which noV’ O2 slow component was present. During high-intensity cycling, in which there was a slow component before training, the training group experienced a significant reduction (P _ 0.05) in end-exerciseV’ O2 (2625 _ 673; 2567 _ 605 mL-min_1) and the T2 of the vastus lateralis (35.6 _ 1.4; 34.5 _ 0.9 ms). Conclusion: These results support the hypothesis that reduction in end-exercise V’ O2 (and the V’ O2 slow component) after training is due to reduced muscle use during heavy, constant load cycling Betros CL,3 McKeever KH, Kearns CF, Malinowski K.(2002) Effects of ageing and training on maximal heart rate and VO2max. The purpose of this study was to test the hypotheses that ageing would result in a decline in maximal heart rate (HRmax) and maximal aerobic capacity (VO2max) and, secondarily, that those effects would be reversible with training. Eighteen, healthy, unfit Standard bred mares representing 3 age groups: young (Y = mean +/- s.e. 6.8 +/- 0.4 years, n = 6); middle-aged (MA = 15.2 +/- 0.4 years, n = 6); and old (O = 27.0 +/- 0.2 years, n = 6) were used. HRmax, VO2max and oxygen pulse at VO2max (OPmax) and the velocities producing HRmax (VHRmax) and VO2max (VVO2max) were measured during pre training and post-training incremental exercise tests (GXT). During training, mares exercised 3 days/week (Weeks 1-8) and 4 days/week (Weeks 9-12) at a sub maximal intensity (approximately 60% HRmax).
for approximately 30 min/day. There were no differences (P>0.05) between Y and MA, before (218 +/- 2 vs. 213 +/- 3 beats/min; 116 +/- 3 vs. 109 +/- 3 ml/kg bwt/min; 0.55 +/- 0.01 vs. 0.52 +/- 0.02 ml/kg/beat; 9.0 +/- 0.3 vs. 9.3 +/- 0.2 ms; 8.8 +/- 0.2 vs. 8.8 +/- 0.2 m/s) or after training (224 +/- 2 vs. 218 +/- 2 beats/min; 131 +/- 3 vs. 120 +/- 2 ml/kg bwt/min; 0.58 +/- 0.01 vs. 0.55 +/- 0.01 ml/kg/beat; 10.5 +/- 0.2 vs. 9.5 +/- 0.1 ms; 10.6 +/- 0.2 vs. 9.5 +/- 0.1 m/s) for HRmax, VO2max, OPmax, VHRmax or VVO2max, respectively. Old horses had lower HRmax, VO2max and OPmax and reached them at lower velocities compared to Y and MA (P<0.05), both before (193 +/- 3 beats/min; 83.2 +/- 2.0 ml/kg bwt/min; 0.43 +/- 0.01 ml/kg/beat; 7.8 +/- 0.1 m/s; 7.2 +/- 0.1 m/s) and after training (198 +/- 2 beats/min; 95 +/- 2 ml/kg bwt/min; 0.48 +/- 0.01 ml/kg/beat; 8.2 +/- 0.2 m/s; 8.0 +/- 0.2 m/s). Training did not alter HRmax in any age group (P>0.05) but did cause increases in VO2max, OPmax and VVO2max for all groups (P<0.05). Interestingly, training increased VHRmax only in Y (P<0.05). These data demonstrate that there is a reduction in HRmax, VO2max, OPmax, VHRmax and VVO2max in old horses, and that training can partially reverse some effects of ageing.

O'Toole ML,1 Douglas PS, Hiller WD. (1998) conducted a study on Use of heart rate monitors by endurance athletes: lessons from tri athletes. Heart rate monitors are commonly used but little is documented about their use. We have reviewed the available literature and supplemented it with data regarding heart rate responses of a large number of highly trained athletes during cycle ergometer and treadmill exercise tests as well as during and following prolonged exercise. The main findings pertinent to the use of heart rate monitors are 1) estimated maximal heart rates are too variable to be of use to precisely guide training pace during cycling or running, 2) during prolonged (> 6 h) cycling or running, a highly trained athlete may
expect to exercise at an average intensity close 80% HRmax, but should also expect intensity to decline by 6-7% during the cycle ride or run, and 3) sub maximal exercise heart rates following prolonged exercise are not useful for judging completeness of recovery. This information holds the following implications for athletes wishing to optimize use of their heart rate monitors in training and racing: 1) formal maximal exercise tests should be performed to determine true HRmax in each exercise mode, 2) athletes should expect their heart rates to decrease over the course of a long race, and 3) athletes should not assume they completely recovered from a strenuous workout if sub maximal exercise heart rates are unchanged. Much remains to be clarified about the heart rate responses of ultra endurance athletes, particularly in relation to performance and the attainment of individual maximal potential.

Branch JD 3rd\(^1\), Pate RR, Bourque SP, Convertino VA, Durstine JL, Ward DS(1997) conducted a study on. Effects of exercise mode on hematologic adaptations to endurance training in adult females. The subjects were 26 healthy, sedentary adult females with the following characteristics: maximal oxygen consumption (VO2max) = 32.0 +/- 7.2 ml.kg\(^{-1}\).min\(^{-1}\); age = 32 +/- 5 yr; body mass index (BMI) = 23.2 +/- 3.4 kg.m\(^{-2}\) who were randomly assigned to control (CON; N = 8); treadmill training (TM; N = 8); or cycle ergometer training (CY; N = 10) to test the hypothesis that hematologic adaptations to endurance exercise training are specific to mode of exercise. Training, conducted 3-5 (3.4 +/- 0.06) d.week\(^{-1}\) at 80% of mode specific VO2max for 12 weeks, was supervised and progressive, with estimated exercise energy expenditure equated across training groups. Plasma volume (PV, T-1824 dilution); calculated total blood (THb) and red cell volumes (RCV); calculated total hemoglobin (THb) and other hematologic variables were measured at baseline and weeks 2, 4, 8 and 12 of training. Across 12 weeks of training, PV was decreased (95%
of baseline) in the TM group but increased (106% of baseline) in the CY group (p = 0.06). Similar trends were observed for RCV (p = 0.15) and TBV (p = 0.08). These results are in contrast to reported changes in PV, TBV and RCV in males following training. Hemodilution was observed in both training groups, reflected by decreases (p < 0.05) in hematocrit (Hct), hemoglobin (Hb) and RC count. Mean corpuscular Hb (MCH) and Hb content (MCHC) increased (p < 0.05) with training. These changes, as well as trend toward increased (p = 0.08) mean corpuscular volume (MCV), suggested the probable presence of a RC population with a lower mean age and decreased oxyhemoglobin affinity. The possibility of Type II error cannot be discounted in these trends, which suggest that PV, TBV and RCV may be affected by mode of endurance exercise in females.

2.3 STUDIES ON COMBINED TRAINING

Bralier CJ, Blank SE(1995). Conducted a study on Versa Climbing elicits higher VO2max than does treadmill running or rowing ergometry. Collegiate varsity oarswomen and coxswain (N = 11) completed maximal aerobic exercise tests on a treadmill, a rowing ergometer, and a simulated climbing machine. Successful completion of each test was evidenced by a plateau in oxygen consumption in response to increasing work rates. VO2max (l.min-1), and minute ventilation (VE, l.min-1) at VO2max were significantly greater (P < 0.05) during simulated climbing compared to treadmill running and rowing ergometry. Maximal heart rate (beats.min-1) was significantly greater (P < 0.05) during climbing and running than during rowing. Findings indicate that progressive, incremental, whole-body climbing exercise elicits significantly greater VO2max values for collegiate oarswomen and coxswain than does graded treadmill running or progressive rowing ergometry.
Martinez ML1, Ibañez Santos J, Grijalba A, Santesteban MD, Gorostiaga EM (1993) Conducted a study on Physiological comparison of roller skating, treadmill running and ergometer cycling. This study was undertaken to determine the metabolic and cardio respiratory differences between treadmill running, ergometer cycling and roller skating in top level roller skaters. The subjects performed 3 discontinuous graded tests until exhaustion. The protocol was established so that heart rate kinetics during exercise was similar in all the tests. Maximal oxygen uptake (VO2max), maximal heart rate and exercise time to exhaustion were higher during running (p < 0.05) than during cycling. Blood lactate during sub maximal and maximal running exercise was significantly lower (p < 0.05) than during cycling or roller skating. There were no differences between cycling and roller skating in any of the variables studied. These results seem to suggest that, compared with running; VO2max during cycling is limited more by local muscle fatigue than by cardiac factors. The similar response found during roller skating and cycling supports the concept that cycloergometer testing is a valid simple laboratory test for testing physical fitness in top level roller skaters.

Medelli J1, Maingourd Y, Bouferrache B, Bach V, Freville M, Libert JP. (1993) conducted a study on Maximal oxygen uptake and aerobic-anaerobic transition on treadmill and bicycle in tri athletes. The maximal aerobic capacity and the aerobic-anaerobic transition were analyzed on 14 tri athletes performing an incremental work load on a bicycle ergometer and on horizontal or inclined treadmills. To compare the cardio respiratory responses between cycling and running, the subjects were divided into 2 groups of 7 with similar aerobic capacity determined from cycle runs. The first group ran on horizontal treadmill while the second group performed similar exercise on inclined treadmill at constant grade (1.5%). Heart rate was recorded by
electrocardiogram. Oxygen uptake (VO2), CO2 production (VCO2), respiratory frequency, and pulmonary ventilation were monitored at 30 s intervals through a Rudolph valve connected to a calibrated Oxycon V. Tidal volume; respiratory exchange ratio, equivalent O2 and CO2 were calculated from on-line computer. Aerobic and anaerobic thresholds were determined by a non-invasive method from pulmonary ventilation curves. The results showed that maximum oxygen uptake (VO2max) did not differ between the 2 types of ergometers. Pulmonary ventilation, heart rate and VO2 recorded at aerobic and anaerobic thresholds depended on the mode of exercise and reached the highest values on inclined treadmill. The amount of muscle mass, the type and the distribution of active motor units involved in each exercise test might be at the origin of these differences. This indicates that, when assessing a training program from anaerobic threshold values, it is necessary to take into consideration the type of ergometer used and the protocol performed.

Fernhall B1, Kohrt W(1990) conducted a study on The effect of training specificity on maximal and sub maximal physiological responses to treadmill and cycle ergometry. The purpose of this study was to investigate the effect of training specificity during maximal and sub maximal treadmill (TM) and bicycle ergometer (BE) exercise. A group of trained runners (RG, no. 7) and trained bikers (BG, no. 7) underwent graded exercise testing on both TM and BE, utilizing the same testing protocol within each exercise mode for both groups. Data for VO2 HR and BP were collected during each 3 min stage. Group by trial ANOVAs followed by Tukey’s post hoc analysis, showed no group difference in VO2max, HRmax or BPmax during TM exercise. However, during each of the first four sub maximal 3 min stages, VO2 and HR were significantly less (p less than .05) in RG vs BC, with no significant difference in BP. During BE exercise, VO2max was significantly less for both groups
compared with TM (RG-59.6 vs 50.1 ml.kg-1.min-1 BS-59.4 vs 55.1 ml.kg-1.min-1) (p less than .05), with BG exhibiting the greater BEmax (p less than .05). RG also had a reduced HRmax during BE exercise (p less than .05). Both groups showed greater BPmax during BE vs TM exercise (p less than .05). Although sub maximal VO2 was slightly less during BE for each stage in RG than BG, these differences were not significant as measured either by ml.kg-1.min-1 or l.min-1. Both sub maximal HR and BP mirrored the VO2 response, with no significant differences between RG and BG. These data agree with previous studies, showing a greater effect of training specificity during maximal BE than during maximal TM exercise. However, during sub maximal exercise, training specificity appear to have a greater effect during TM than BE exercise. Surfaces managed by a physical therapist.

2.4 SUMMARY OF LITERATURES

The review of related literature helped the researcher to identify the suitable problem and parameters and also the reviews focus on the current recent trends on the chosen problem. The main reading of this review, the research scholar must understand the research cap in-between the earlier studies and his study. Further the scholar how to overcome the cap between the earlier studies and his study. As far as this problem were concerned totally Fifty three reviews were presented in three category ,i.e. studies on treadmill(n-28), studies on cycle ergometer (n-21) and studies on combined training(n-4).All the review were represented in the current year (2015) to the very beginning studies (1984) .