CHAPTER II

REVIEW OF RELATED LITERATURE

The review of literature is instrumental in the selection of the topic, formulation of hypothesis and deductive reasoning leading to the problem. It helps to get a clear idea and supports the finding with regard to the problem under study.

The researcher came across several books, periodicals and journals and published thesis, while searching for relevant facts and finding that were related to this present study, such as those were given below or the better understanding and to justify the study.

The purpose of this review of selected literature was to relate studies pertaining to the topic under study and to organise the collected review into meaningful sub sections as listed below:

a) Studies relating to long jump performances

b) Studies relating to comparison of physical fitness variables.

2.1 STUDIES RELATING TO LONG JUMP PERFORMANCE

Keller M et al. (2014) documented that Drop jumps and their adaptations to training have been extensively investigated. However, the influence of augmented feedback (aF) on stretch-shortening cycle (SSC) was not scrutinized so far despite the well-known positive effects of aF on

motor performance and motor learning. The aim of the present study was therefore to investigate the effects of aF by evaluating immediate within-session effects and long-term adaptations. 34 participants were assigned to three groups that trained drop jumps with different relative frequencies of aF about their jump height: 100%, 50%, or 0%. A significant within-session effect of aF on jump height was observed before and also after the training period (pre: +4.6%; post: +2.6%). In the long-term (comparing pre- to post-measurement), the 100% group showed the greatest increase in jump height (+14%), followed by the 50% (+10%) and the 0% group (+6%). The importance of aF on drop jumps is therefore twofold: (i) to immediately increase jump performance and (ii) to improve long-term training efficacy. In contrast to the proposition of the guidance hypothesis, high frequency of aF seems to be beneficial when maximizing SSC-performance. As jump height cannot be quantified without objective technical measures it is recommended to include them into daily training.

Hébert-Losier K et al. (2014) investigated squat jump (SJ), countermovement jump (CMJ), standing long jump (SLJ), and hopping performed by 8 elite and 8 amateur male foot-orienteering athletes (29 ± 7 y, 183 ± 5 cm, 73 ± 7 kg) and possible correlations to road, path, and forest running and sprinting performance, as well as running economy, velocity at anaerobic threshold, and VO2peak from treadmill assessments. During SJs and CMJs, elites demonstrated superior relative peak forces, time-to-peak forces, and pre-stretch augmentation albeit lower SJ heights and peak powers.

Between-group differences were unclear for CMJ heights, hopping stiffness, and most SLJ parameters. Large pair-wise correlations were observed between relative peak and time-to-peak forces and sprinting velocities; time-to-peak forces and running velocities; and pre-stretch augmentation and forest running velocities. Pre-stretch augmentation and time-to-peak forces were moderately correlated to VO2peak. Correlations between running economy and jumping or hopping were small or trivial. Overall, our elites exhibited superior stretch-shortening cycle utilization and rapid generation of high relative maximal forces, especially vertically. These functional measures were more closely related to sprinting and/or running abilities, indicating benefits of lower-body training in orienteering.

Agar-Newman DJ and Klimstra M. (2014) explored the relationship between horizontal jumping tasks (standing longjump (SLJ) and standing triple jump (STJ)) and sprint speed (initial sprint speed (ISS) and maximum sprint speed (MSS)) in elite female rugby athletes.Data was collected from provincial, under 20 international fifteens players, in addition to senior sevens international level female rugby athletes (n=114). Bodyweight, standinglong jump, standing triple jump, 10m sprint speed (ISS), 30-40m sprint speed (MSS), initial sprint momentum and maximal sprint momentum were analysed.When categorized by horizontal jumping ability there was a significant difference in sprint speeds ($p<0.001$) between the Top 50% and Bottom 50% groups. Examining the relationship between horizontal jumping tasks and sprinting speed, revealed a stronger correlation in the slowest 50% of athletes

compared to the fastest 50%. A linear regression developed from STJ and body weight adequately predicted ISS ($r=0.645$, $p<0.001$) and MSS ($r=0.761$, $p<0.001$).In conclusion, horizontal jumping tasks can be used as a valuable performance test to identify differences of sprinting ability in elite female rugby players. However, the relationship between horizontal jumping tasks and sprinting speed appears to decrease in faster athletes. Further, STJ and body weight can be used to predict both ISS and MSS. Based on this data it is suggested that only STJ be collected when identifying potential sprinting talent in female rugby athletes and caution be used when generalizing results across varying levels of athletes.

Donti O et al. (2014) examined the effects of baseline flexibility and vertical jump ability on straight leg raise range of motion (ROM) and counter-movement jump performance (CMJ) following different volumes of stretching and potentiating exercises. ROM and CMJ were measured after two different warm-up protocols involving static stretching and potentiating exercises. Three groups of elite athletes (10 male, 14 female artistic gymnasts and 10 female rhythmic gymnasts) varying greatly in ROM and CMJ, performed two warm-up routines. One warm-up included short (15 s) static stretching followed by 5 tuck jumps, while the other included long static stretching (30 s) followed by 3x5 tuck jumps. ROM and CMJ were measured before, during and for 12 min after the two warm-up routines. Three-way ANOVA showed large differences between the three groups in baseline ROM and CMJ performance. A type of warm-up x time interaction was found for both ROM ($p = 0.031$) and CMJ ($p =$

0.016). However, all athletes, irrespective of group, responded in a similar fashion to the different warm-up protocols for both ROM and CMJ, as indicated from the lack of significant interactions for group (condition x group, time x group or condition x time x group). In the short warm-up protocol, ROM was not affected by stretching, while in the long warm-up protocol ROM increased by 5.9% ± 0.7% ($p = 0.001$) after stretching. Similarly, CMJ remained unchanged after the short warm-up protocol, but increased by 4.6 ± 0.9% ($p = 0.012$) 4 min after the long warm- up protocol, despite the increased ROM. It is concluded that the initial levels of flexibility and CMJ performance do not alter the responses of elite gymnasts to warm-up protocols differing in stretching and potentiating exercise volumes. Furthermore, 3 sets of 5 tuck jumps result in a relatively large increase in CMJ performance despite an increase in flexibility in these highly-trained athletes. Key PointsThe initial levels of flexibility and vertical jump ability have no effect on straight leg raise range of motion (ROM) and counter-movement jump performance (CMJ) of elite gymnasts following warm-up protocols differing in stretching and potentiating exercise volumesStretching of the main leg muscle groups for only 15 s has no effect on ROM of elite gymnastsIn these highly-trained athletes, one set of 5 tuck jumps during warm-up is not adequate to increase CMJ performance, while 3 sets of 5 tuck jumps result in a relatively large increase in CMJ performance (by 4.6% above baseline), despite a 5.9% increase in flexibility due to the 30 s stretching exercises.

Rebutini VZ et al. (2014) determined the effects of a plyometric long jump training program on torque around the lower limb joints and swimming jump start kinetic and kinematic. Ten swimmers performed three identical assessment sessions, measuring hip and knee muscle extensors during maximal voluntary isometric contraction and, kinetic and kinematics parameters during the swimming jump start, at three instants: INI (two weeks prior to the training program, control period), PRE (two weeks after INI measurements) and POST (24-48h after 9 weeks of training). There were no significant changes from INI to PRE measurements. However, the peak torque and rate of torque development increased significantly from PRE to POST measurements for both hip (47% and 108%) and knee (24% and 41%) joints. There were significant improvements to the horizontal force (7%), impulse (9%) and angle of resultant force (19%). In addition, there were significant improvements to the center of mass displacement (5%), horizontal takeoff velocity (16%), horizontal velocity at water entrance (22%), and peak angle velocity for the knee (15%) and hip joints (16%). Therefore, the plyometric long jumptraining protocol was effective to enhance torque around the lower limb joints and to control the resultant vector direction, in order to increase swimming jump start performance. These findings suggest that coaches should use long jump training instead of vertical jump one to improve swimming start performance.

Hébert-Losier K and Beaven CM. (2014) assessed the effect of interventions because their outcomes are reported valid indicators of

functional performance. In this study, we examined the reproducibility of performance parameters from 3 common jump tests obtained using the commercially available Kistler Measurement, Analysis and Reporting Software (MARS). On 2 separate days, 32 men performed 3 squat jumps (SJs), 3 countermovement jumps (CMJs), and 3 standing long jumps (LJs) on a Kistler force-plate. On both days, the performancemeasures from the best jump of each series were extracted using the MARS. Changes in the mean scores, intraclass correlation coefficients (ICCs), and coefficients of variations (CVs) were computed to quantify the between-day reproducibility of each parameter. Moreover, the reproducibility quantifiers specific to the 3 separate jumps were compared using nonparametric tests. Overall, an acceptable between-day reproducibility (mean ± SD, ICC, and CV) of SJ (0.88 ± 0.06 and 7.1 ± 3.8%), CMJ (0.84 ± 0.17 and 5.9 ± 4.1%), and LJ (0.80 ± 0.13 and 8.1 ± 4.1%) measures was found using the MARS, except for parameters directly relating to the rate of force development (i.e., time to maximal force) and change in momentum during countermovement (i.e., negative force impulse) where reproducibility was lower. A greater proportion of the performance measures from the standing LJs had low ICCs and/or high CVs values most likely owing to the complex nature of the LJ test. Practitioners and researchers can use most of the jump test parameters from the MARS with confidence to quantify changes in the functional ability of individuals over time, except for those relating to the rate of force development or change in momentum during countermovement phases of jumps.

Manimmanakorn N et al. (2014) analyzed the current evidence for the effectiveness of whole body vibration (WBV) on jump height. We included randomized controlled trials or matched design studies comparing the effect of WBV training on countermovement and squat jump (SJ) height, which were gathered from MEDLINE, Web of Knowledge, Sciencedirect, Proquest, Scopus, Google Scholar, and SPORTDiscus databases. The overall effect of WBV training (from the 15 studies included) compared with having no additional exercise on countermovement jumpheight yielded a positive standardized mean difference of 0.77 (95% confidence interval, 0.55-0.99). The effect of WBV training on SJ height was 0.68 (0.08-1.11). Vibration exercise consisting of a higher frequency (>30 Hz, 0.86, 0.62-1.10), higher amplitude (>3 mm, 0.84, 0.52-1.17), longer exposure duration (>10 minutes per session, 0.92, 0.48-1.36), longer training period (>12 weeks, 0.87, 0.56-1.19) and among nonathletes (0.96, 0.63-1.30) had greater benefit for jump height improvement than a lower frequency (≤ 30 Hz, 0.56, 0.13-0.99), lower amplitude (≤ 3 mm, 0.66, 0.35-0.98), shorter exposure duration (≤ 10 minutes per session, 0.68, 0.45-0.92), intermediate training period (4-12 weeks, 0.72, 0.35-1.09), shorter training period (<4 weeks, 0.58, -0.08 to -1.23) and in athletes (0.59, 0.31-0.88). The effect of WBV training compared with a standard cardiovascular-type exercise group from 4 studies was 0.63 (0.10-1.15). In conclusion, WBV training produces a moderate-to-large effect on jump height. Vibration training protocols with higher frequencies, higher amplitudes, longer exposures per session, and longer training periods are more likely to enhance muscle power.

Ribak G et al. (2013) explored the option to exploit this jumping mechanism for application to small mechanical devices having to extricate themselves from rough terrain. We combined experiments on a biomimetic jumping device with a physical-mathematical model of the jump to assess the effect of morphological variation on the jumping performance. We found that through morphological change of two non-dimensional (size independent) parameters, the propulsive force powering the jump can be directed at angles as small as 40°. However, in practice jumping at such angles is precluded by loss of traction with the ground during the push-off phase. This limitation to steepjump angles is inherent to the jumping mechanism which is based on rotation of body parts about a single hinge. Such a rotation dictates a curvilinear trajectory for the center of mass during takeoff so that the vertical and horizontal accelerations occur out of phase, implying loss of traction with the ground before substantial horizontal acceleration can be reached. Thus click-beetle inspired jumping is effective mainly for making steep-angle righting jumps.

Porter JM et al. (2013) investigated the effect of increasing the distance of an external focus of attention on standing long jump performance in a highly trained population. Using a counterbalanced, within-participant design, current collegiate male athletes (n = 38, age = 20.7 years, SD = 2.2 years) performed 2 standing longjumps following 4 different sets of verbal instructions. Subjects completed all 8 trials in 1 testing session, which lasted approximately 20 minutes. One set of instructions was designed to focus attention internally

toward the movements of the body (INT), a second set of instructions focused attention externally near the body (EXN), another set of instructions directed attention externally to a target farther from the body (EXF), and the last set of instructions served as a control condition (CON) and encouraged the athlete to use his "normal" focus while jumping. Results indicated that the EXN and EXF conditions elicited jump distances that were significantly greater than the INT and CON conditions. In addition, the participants jumped significantly farther in the EXF condition than the EXN condition. These findings suggest that increasing the distance of an external focus of attention relative to the body, immediately improved standing long jump performance in a highly trained population.

Hudgins B et al. (2013) determined if jumping performance would have some relationship to running performance in different distance events. This study involved 33 competitive track and field runners who participated in events ranging from 60 to 5,000 m (10 sprinters: height = 1.72 ± 10.26 m, mass = 67.80 ± 10.83 kg; 11 middle-distance runners: height = 1.77 ± 0.08 m, mass = 64.40 ± 8.02 kg; 12 long-distance runners: height = 1.73 ± 0.11 m, mass = 60.42 ± 10.36 kg). All subjects were competitive NCAA Division I athletes. Subjects were tested on a single occasion in a 3-jumptest (TSJP), which was the distance covered during 3 two-leg standing long jumps performed in immediate succession. Time in the 60, 100, 200, 800, 3,000, and 5,000 m was obtained from recent race performances. The mean TSJP for sprinters, middle-distance runners, and long-distance runners were 8.24 ± 1.32, 6.59 ± 1.23, and 5.61 ±

0.88 m, respectively. The mean 60, 100, 200, 800, 3,000, and 5,000 m performances were 7.28 ± 0.78, 11.25 ± 0.87, 23.47 ± 2.25, 127.17 ± 15.13, 562.09 ± 60.54, and 987.65 ± 117.19 seconds, respectively. Significant correlations ($p \leq 0.05$) were observed between TSJP and running performance for all distances (60 m: 0.97 seconds, 100 m: 1.00 seconds, 200 m: 0.97 seconds, 800 m: 0.83 seconds, 3,000 m: 0.72 seconds, and 5,000 m: 0.71 seconds). The strength of the correlations, in general, was strongest to weakest based on event distance from the shortest distance (60 m) to the longest distance (5,000 m). Thus, the contribution of muscle power, as possibly determined by TSJP, maybe most important in shorter distance races (60, 100, and 200 m). However, because of the significant correlations between TSJP and middle- andlong-distance running performance as well, the contribution of muscle power to these events (800, 3,000, and 5,000 m) should be considered as a component for training for both sprinters and middle- and long-distance runners.

Wu WF et al. (2012) evaluated peak force and jump performance between internal and external focus of attention strategies. Untrained subjects were assigned to both experimental conditions in which verbal instructions were provided to promote either an external or internal focus of attention. All subjects completed a total number of 5 standing long jumps. The results of the study demonstrated that the external focus of attention condition elicited significantly greaterjump distance (153.6 ± 38.6 cm) than the internal focus of attention condition (139.5 ± 46.7 cm). There

were no significant differences observed between conditions in peak force (1429.8 ± 289.1 N and 1453.7 ± 299.7 N, respectively). The results add to the growing body of literature describing the training and learning benefits of an external focus of attention. Practitioners should create standardized verbal instructions using an external focus of attention to maximize standing long jump performance.

Porter JM et al. (2012) investigated the effect of increasing the distance of an external focus of attention on standing long jump performance. Using a counterbalanced within-participant design, recreationally trained male subjects (n = 35) performed 2 standing long jumps following 3 different sets of verbal instructions (total of 6 jumps; each separated by 1 minute of seated rest). One set of instructions was designed to focus attention externally near the body (EXN); another set of instructions directed attention externally to a target farther from the body (EXF); the last set of instructions served as a control condition (CON) and did not encourage a specific focus of attention. The results indicated that the EXN and EXF conditions elicited jump distances that were significantly greater than the CON condition. In addition, the subjects in the EXF condition jumped significantly farther than those in the EXN condition. These findings suggest that increasing the distance of an external focus of attention, relative to the body, immediately improves standing long jump performance.

Chapman DW et al. (2012) quantified the impact of long haul travel on lower body muscle performance. Five elite Australian skeleton athletes (1 M, 4 F) undertook long haul flight from Australia to Canada (LH(travel)), while seven national team Canadian skeleton athletes (1 M, 6 F) acted as controls (NO(travel)). Lower body power assessments were performed once per day between 09:30 and 11:00 h local time for 11 days. Lower body power tests comprised of box drop jumps, squat jump (SJ) and countermovement jumps (CMJ). The LH(travel) significantly decreased peak and mean SJ velocity but not CMJ velocity in the days following long haul flight. CMJ height but not SJ height decreased significantly in the LH(travel) group. The peak velocity, mean velocity and jump power eccentric utilisation ratio for the LH(travel) group all significantly increased 48 h after long haul flight. Anecdotally athletes perceived themselves as 'jet-lagged' and this corresponded with disturbances observed in 'one-off' daily jumping ability between 09:30 and 11:00 h after eastward long haul travel from Australia to North America when compared to non-travel and baseline controls.

Moresi MP et al. (2011) evaluated the reliability of two long jump tasks and their ability to predict 10 m sprint performance in elite adolescent female athletes. Eight junior national-level female track and field athletes completed three standing (SLJ) and reactive long jumps (RLJ) on portable force plates, followed by three 10 m sprints. Intra-class correlation coefficients (ICC) and coefficients of variation (CV) were calculated to examine reliability. Linear regression results identified the best predictor of average and best 10 m sprint

time from thejump kinematic and kinetic measures. The ICCs and CVs indicated good reliability for the majority of kinetic measures however, better reliability was reported for the SLJ. The SLJ was a good predictor of best and average 10 m sprint time, with average horizontal power the best predictor of performance (best; R2 = 0.751, p = 0.003, Standard Error of Estimate (SEE)% = 2.2 average; R2 = 0.708, p = 0.005, SEE% = 2.5).

Porter JM et al. (2010) investigated if whole-body movements (e.g., standing long jump), without object manipulation, are influenced by an internal or external focus of attention. After participants (n = 120) completed a short warm-up, they were assigned to either an internal (INT) or external (EXT) focus of attention group. All participants completed 5 standing long jumps separated by a 2-minute seated rest. Before each jump, participants in the INT condition were read the following instructions: "When you are attempting to jump as far as possible, I want you to focus your attention on extending your knees as rapidly as possible." Participants in the EXT condition were read the following instructions: "When you are attempting to jump as far as possible, I want you to focus your attention on jumping as far past the start line as possible." An independent samples t-test revealed a significant difference (p = 0.003) in the average distance jumped between the EXT (187.37 +/- 42.66 cm) group and the INT group (177.33 +/- 40.97 cm). The results suggest that providing instructions that focus attention externally enhances standing long-jump performance compared with instructions that focus attention internally.

This finding is valuable for strength and conditioning professionals that use jumping tests to evaluate performance.

Pereira G et al. (2009) tested if the critical power model can be used to determine the critical rest interval (CRI) between vertical jumps. Ten males performed intermittent countermovement jumps on a force platform with different resting periods (4.1+/-0.3 s, 5.0+/-0.4 s, 5.9+/-0.6 s). Jump trials were interrupted when participants could no longer maintain 95% of their maximal jump height. After interruption, number of jumps, total exercise duration and total external work were computed. Time to exhaustion (s) and total external work (J) were used to solve the equation Work=a+b x time. The CRI (corresponding to the shortest resting interval that allowed jump height to be maintained for a long time without fatigue) was determined dividing the average external work needed to jump at a fixed height (J) by b parameter (J/s). In the final session, participants jumped at their calculated CRI. A high coefficient of determination (0.995+/-0.007) and the CRI (7.5+/-1.6 s) were obtained. In addition, the longer the resting period, the greater the number of jumps (44+/-13, 71+/-28, 105+/-30, 169+/-53 jumps; $p<0.0001$), time to exhaustion (179+/-50, 351+/-120, 610+/-141, 1,282+/-417s; $p<0.0001$) and total external work (28.0+/-8.3, 45.0+/-16.6, 67.6+/-17.8, 111.9+/-34.6kJ; $p<0.0001$). Therefore, the critical power model may be an alternative approach to determine the CRI during intermittent vertical jumps.

2.2 STUDIES RELATING TO COMPARISONS OF PHYSICAL FITNESS VARIABLES

Stodden DF et al. (2014) examined associations among motor skill competence (MSC) and health-related fitness (HRF) in youth. A convenient sample of 253 boys and 203 girls (aged 4-13 years) participated in the study. Associations among measures of MSC (throwing and kicking speed and standing long jump distance) and a composite measure of HRF (push-ups, curl-ups, grip strength and PACER test) across five age groups (4-5, 6-7, 8-9, 10-11 and 12-13 yrs.) were assessed using hierarchical regression modeling. When including all children, throwing and jumping were significantly associated with the composite HRF factor for both boys and girls (throw, $t = 5.33$; jump, $t = 4.49$) beyond the significant age effect ($t = 4.98$) with kicking approaching significance ($t = 1.73$, $p = .08$). Associations between throwing and kicking speed and HRF appeared to increase from early to middle to late childhood age ranges. Associations between jumping and HRF were variable across age groups. These results support the notion that the relationship between MSC and HRFperformance are dynamic and may change across childhood. These data suggest that the development of object control skills in childhood may be important for the development and maintenance of HRF across childhood and into adolescence.

Jones MT and, Lorenzo DC. (2013) assessed power, speed, and agility in athletic, preadolescent youth, and determine how agility related to muscular

strength and power. Boys (N.=53) and girls (N.=104) completed vertical jump (VJ), standing long jump (SLJ), seated medicine ball throw (SMBT), proagility shuttle run (PRO), partial curl-ups (CURL), and 20 yd sprint (20 SP). One-way analysis of variance for gender comparison and multiple regression analysis for determining association among tests were used. No gender differences (P>0.05) existed for VJ or PRO. However, boys performed better on SLJ (P=0.03; 162.61+24.64 vs.154.51+20.78 cm), 20 SP (P=0.001; 3.70+0.35 vs. 3.96+0.33 s), and CURL (P=0.02; 35.16+9.67 vs. 31.48+8.80) while girls scored higher on SMBT (P=0.001; 340.46+68.58 vs. 287.12+56.39 cm). Among girls, PRO was correlated (P<0.01) with SLJ (r=-0.70) and VJ (r=-0.67). In boys, correlations (P<0.01) existed between VJ and SLJ (r=0.73) and 20 SP and PRO (r=0.72). The current study supports previous research that found a correlation between SLJ and VJ. SLJ, VJ and SP were significant predictors of PRO, accounting for 55%, 46%, and 43% of the variation, respectively. The PRO agility test is easy to administer and requires lower body strength and power necessary for the quick changes in direction inherent to ground-based field sports. When designing a performance-related test battery for young athletes, PRO, SLJ, and VJ are effective measures and worthy of inclusion.

Smilios I et al. (2013) examined the changes in maximum strength, vertical jump performance, and the load-velocity and load-power relationship after a resistance training period using a heavy load and an individual load that maximizes mechanical power output with and without including body mass in

power calculations. Forty-three moderately trained men (age: 22.7 ± 2.5 years) were separated into 4 groups, 2 groups of maximum power, 1 where body mass was not included in the calculations of the load that maximizes mechanical power (Pmax - bw, n = 11) and another where body mass was included in the calculations (Pmax + bw, n = 9), a high load group (HL-90%, n = 12), and a control group (C, n = 11). The subjects performed 4-6 sets of jump squat and the repeated-jump exercises for 6 weeks. For the jump squat, the HL-90% group performed 3 repetitions at each set with a load of 90% of 1 repetition maximum (1RM), the Pmax - bw group 5 repetitions with loads 48-58% of 1RM and the Pmax + bw 8 repetitions with loads 20-37% of 1RM. For the repeated jump, all the groups performed 6 repetitions at each set. All training groups improved ($p < 0.05$) maximum strength in the semisquat exercise (HL-90%: 15.2 ± 7.1, Pmax - bw: 6.6 ± 4.7, Pmax + bw: 6.9 ± 7.1, and C: 0 ± 4.3%) and the HL-90% group presented higher values ($p < 0.05$) than the other groups did. All training groups improved similarly ($p < 0.05$) squat (HL-90%: 11.7 ± 7.9, Pmax - bw: 14.5 ± 11.8, Pmax + bw: 11.3 ± 7.9, and C: -2.2 ± 5.5%) and countermovement jump height (HL-90%: 8.6 ± 7.9, Pmax - bw: 10.9 ± 9.4, Pmax + bw: 8.8 ± 4.3, and C: 0.4 ± 6%). The HL-90% and the Pmax - bw group increased ($p < 0.05$) power output at loads of 20, 35, 50, 65, and 80% of 1RM and the Pmax + bw group at loads of 20 and 35% of 1RM. The inclusion or not of body mass to determine the load that maximizes mechanical power output affects the long-term adaptations differently in the load-power relationship. Thus, training load selection will depend on the required adaptations. However,

the use of heavy loads causes greater overall neuromuscular adaptations in moderately trained individuals.

Place N et al. (2013) assessed the effect of a novel self-administered proprioceptive neuromuscular facilitation (PNF) paradigm with short periods of stretching and contraction on quadriceps neuromuscular function, vertical jump performance, and articular range of motion (ROM). Twelve healthy men (age: 27.7 ± 7.3 years, height: 178.4 ± 10.4 cm, weight: 73.8 ± 16.9 kg) volunteered to participate in a PNF session and a control session separated by 2-7 days. The PNF stretching lasted 2 minutes and consisted of 4 sets of 5-second isometric hamstring contraction immediately followed by 5 seconds of passive static stretch of the quadriceps immediately followed by 5 seconds isometric quadriceps contraction for each leg. For the control session, the participants were asked to walk at a comfortable speed for 2 minutes. Active ROM of knee flexion, vertical jump performance, and quadriceps neuromuscular function were tested before, immediately after, and 15 minutes after the intervention. The PNF stretching procedure did not affect ROM, squat jump, and countermovement jump performances. Accordingly, we did not observe any change in maximal voluntary contraction force, voluntary activation level, M-wave and twitch contractile properties that could be attributed to PNF stretching. The present self-administered PNF stretching of the quadriceps with short (5-second) stretches is not recommended before sports where flexibility is mandatory for performance.

Tsolakis C and , Bogdanis GC. (2012) examined the effects of two different warm-up protocols on lower limb power and flexibility in high level athletes. Twenty international level fencers (10 males and 10 females) performed two warm-up protocols that included 5-min light jogging and either short (15s) or long (45s) static stretching exercises for each of the main leg muscle groups (quadriceps, hamstrings and triceps surae), followed by either 3 sets of 3 (short stretching treatment), or 3 sets of 5 tuck jumps (long stretching treatment), in a randomized crossover design with one week between treatments. Hip joint flexion was measured with a Lafayette goniometer before and after the 5-min warm-up, after stretching and 8 min after the tuck jumps, while counter movement jump (CMJ)performance was evaluated by an Ergojump contact platform, before and after the stretching treatment, as well as immediately after and 8 minutes after the tuck jumps. Three way ANOVA (condition, time, gender) revealed significant time ($p < 0.001$) and gender ($p < 0.001$) main effects for hip joint flexion, with no interaction between factors. Flexibility increased by 6. 8 ± 1.1% ($p < 0.01$) after warm-up and by another 5.8 ± 1.6% ($p < 0.01$) after stretching, while it remained increased 8 min after the tuck jumps. Women had greater ROM compared with men at all time points (125 ± 8° vs. 94 ± 4° $p<0.01$ at baseline), but the pattern of change in hip flexibility was not different between genders. CMJ performance was greater in men compared with women at all time points (38.2 ± 1.9 cm vs. 29.8 ± 1.2 cm $p < 0.01$ at baseline), but the percentage of change CMJ performancewas not different between genders. CMJ performance remained unchanged throughout

the short stretching protocol, while it decreased by 5.5 ± 0.9% ($p < 0.01$) after stretching in the long stretching protocol However, 8 min after the tuck jumps, CMJ performance was not different from the baseline value ($p = 0.075$). In conclusion, lower limb power may be decreased after long periods of stretching, but performance of explosive exercises may reverse this phenomenon.

Claudino JG et al. (2012) assessed the effect of training load regulation, using the CMJ at the beginning of the session, on the total plyometric training load and the vertical jump performance. 44 males were divided into 4 groups: No Regulation Group (nRG), Regulation Group (RG), Yoked Group (YG) and Control Group (CG). The nRG received 6 weeks of plyometric training, with no adjustment in training load. The RG underwent the same training; however, the training load was adjusted according to the CMJ performance at the beginning of each session. The adjustment made in RG was replicated for the volunteers from the corresponding quartile in the YG, with no consideration given to the YG participant's condition at the beginning of its session. At the end of the training, the CMJ and SJ performance of all of the participants was reassessed. The total training load was significantly lower ($p=0.036$; ES=0.82) in the RG and the YG (1905±37 jumps) compared to the nRG (1926±0 jumps). The enhancement in vertical jump performance was significant for the groups that underwent the training ($p<0.001$). Vertical jump performance, performed at the beginning of the session, as a tool to regulate the training load resulted in a decrease of the total training load, without decreasing the long-term effects on vertical jump performance.

Yuktasir B and Kaya F. (2009) investigated the long-term effects of two different stretching techniques on the range of motion (ROM) and on drop jump (DJ). DJ scores were assessed by means of a contact mat connected to a digital timer. ROM was measured by use of a goniometer. The training was carried out four times a week for 6 weeks on 10 subjects as passive static stretching (SS), and on 9 subjects as contract-relax PNF (CRPNF) stretching. The remaining nine subjects did not perform any exercises (control group). One-way Analysis of Variance (ANOVA) results indicated that the differences among groups on DJ were not statistically different ($F(2,27)=.41$, $p>.05$). ROM values were significantly higher for both stretching groups, while no change was observed for the control group. In conclusion, static and proprioceptive neuromuscular facilitation (PNF) stretching techniques improved the ROM, but neither of the stretching exercises had any statistically significant effect on the DJ scores.

Almuzaini KS and Fleck SJ. (2008) investigated whether modifying the standing long jump test would enhance its ability to be a better predictor of anaerobic performance compared to other common anaerobic power tests. Three modified box long jump (MBLJ) tests were performed using 1, 2, or 3 boxes. Subjects consisted of 38 healthy males (age, 21.7 +/- 1.7 years) who performed all the testing procedures. All 3 variations of the MBLJ test showed significant correlations ($p < 0.05$) with the vertical jump (VJ); standing long jump (SLJ); 50-, 100-, 200-, 400-m runs; long jump; triple jump; and shot put ability ($r = 0.362$-0.891). All 3 variations of the MBLJ test also showed significant

correlations with isokinetic peak torque knee extension and flexion, Wingate mean power (W), and Wingate mean power per kilogram (W/kg) (r = 0.357-0.504). Generally, correlations of the 3 MBLJ tests were stronger than correlations between VJ and SLJ ability to the same measure of power. Generally, the 3-box MBLJ tests showed stronger correlations with measures of power than the 1- and 2-box MBLJ tests. Multiple linear regression models indicated that the 3-box MBLJ test is a major predictor of the track and field performances compared to the other tests of anaerobic power. Along with other independent variables, the 3-box MBLJ test explained 55%, 44%, 51%, 61%, 52%, and 72% of the variance of 50-, 100-, 200-, and 400-m runs; long jump; and triple jump performance, respectively. In conclusion, due to the significant correlations between the MBLJ tests, especially the 3-box version, and other measures of power, these tests are appropriate for testing lower body power.

Chen et.al.(2006) reported that the 3 min step test is a widely used method to evaluate physical fitness, but whether this method is valid when performed at altitude is unknown. The purpose of this study was to examine the effect of altitude on the fitness score of the 3 min step test, and the role of ambient temperature in this effect. In study I, 11 healthy volunteers (aged 18.1 +/- 1.1 years) performed a 3 min step test at sea level and at altitude (1950 m). Plasma lactate and stress hormones, as indicators of metabolic stress, were measured before and after the test. To determine the role of ambient temperature, we performed study II at sea level with the same step test simulating the altitude temperature condition (24 degrees C at high altitude

versus 32 degrees C at sea level) with 23 subjects (aged 20.4 +/- 0.4 y). In study I, plasma lactate of the subjects was elevated during the step test at sea level and to a greater extent at high altitude. Plasma cortisol and testosterone levels were elevated only at high altitude. However, the heart rate (HR) recovery after the step test was faster at high altitude than at sea level, producing a better physical fitness index. Furthermore, in study II, we demonstrated that the subjects who performed the 3 min step test at 24 degrees C exhibited faster HR recovery than at 32 degrees C. The current study therefore suggests that environmental conditions leading to temperature variation have strong confounding effects on the fitness score of the 3 min step test.

van de Vliet et.al (2006) investigated the physical fitness profile of high-performance athletes with intellectual disability (ID) in comparison with able-bodied individuals. Participants were 231 male and 82 female athletes. All evaluations were done using the EUROFIT physical fitness test. RESULTS: In comparison with population data, both male and female athletes with ID score better for flexibility and upper body muscle endurance, but have similar or lower values for running speed, speed of limb movement, and strength measures. Compared with age-matched physical education students, male athletes with ID score better for running speed and flexibility, and worse for strength. Female athletes with ID score not different from able-bodied individuals for flexibility, running speed, and upper body muscle endurance, but worse for strength measures. Athletes with ID also have poorer cardio respiratory endurance capacity compared with sportive peers without ID.

Furthermore, male athletes have a more differentiated profile depending upon their sports discipline, compared with female athletes. CONCLUSION: It can be concluded that high-performance athletes with ID reach physical fitness levels that are equal to or lower than those of able-bodied sportive counterparts. Further research should investigate the importance of reduced muscle strength to be the limiting factor.

Milde et.al (2006) assessed the physical fitness of short-statured boys aged 7 - 20 years by applying fitness norms established for the Polish population in relation to calendar or growth age. MATERIAL AND METHODS: The results of EUROFIT fitness tests recorded in 3517 short-statured (below percentile 10 for body height) boys, aged 7-20 years, selected from a large (n=37 000) representative male cohort, were analysed. RESULTS: Individual results were confronted with the respective percentile norms related to calendar age (CA) or growth age (GA), since body height deficiency at given CA could have affected the results of fitness tests expected for that CA. The percentages of subjects below, the percentile 3 or above percentile 97 for given fitness test and CA or GA for the Polish population, were determined. No differences between the percentages computed for CA and GA were noted in case of the following tests: sit-and-reach (SAR) and bent-arm hang (BAH). Significant differences in percentages for both percentiles were found for the following tests: standing broad jump (SBJ), endurance shuttle run (ESR), handgrip (HGR) and plate tapping (PLT). In case of sit-ups (SUP) significant differences in percentages between CA and GA norms were found below the

percentile 3, and in case of shuttle run (SHR) and flamingo balance (FLB) -- above percentile 97. SUMMARY AND CONCLUSIONS: Fitness tests were classified into two categories according to the differences between the results related to norms for calendar or growth age: those independent of whether CA or GA norms were applied (SAR and BAH), and those susceptible to the kind of norm (SBJ, HGR, PLT, SHR, FLB and SUP). The results of tests from the latter category should thus be evaluated by confronting them with the norms established for the growth age, and not calendar age.

Armstrong and Welsman (2006) reviewed the reviews the habitual physical activity of children and adolescents from member countries of the European Union in relation to methods of assessing and interpreting physical activity. Data are available from all European Union countries except Luxembourg and the trends are very similar. European boys of all ages participate in more physical activity than European girls and the gender difference is more marked when vigorous activity is considered. The physical activity levels of both genders are higher during childhood and decline as young people move through their teen years. Physical activity patterns are sporadic and sustained periods of moderate or vigorous physical activity are seldom achieved by many European children and adolescents. Expert committees have produced guidelines for health-related physical activity for youth but they are evidence-informed rather than evidence-based and where there is evidence of a relationship between physical activity during youth and health status there is little evidence of a particular shape of that relationship. The number of children

who experience physical activity of the duration, frequency and intensity recommended by expert committees decreases with age but accurate estimates of how many girls and boys are inactive are clouded by methodological problems. If additional insights into the promotion of health through habitual physical activity during youth are to be made, methods of assessment need to be further refined and recommended guidelines re-visited in relation to the existing evidence base.

Liou and Chiang (2004) investigated levels of physical activity among children and examine their rates of compliance with various international recommendations. The sample was comprised 463 children (249 boys and 214 girls) , aged between nine and twelve from four cities in Taiwan. Three-day Physical Activity Logs (3-d PAL) were used as the instrument to measure physical activity in the previous seven days. The mean and percentile of average estimated energy expenditure (EE, kcal/kg/day), moderate-vigorous physical activity (MVPA, min/day) and vigorous physical activity (VPA, min/day) among boys and girls according to age group were reported. Four international physical activity recommendations were used, as the criteria with which were examined compliance rates. Results indicated no significant main effects of age or gender, and no interaction was found between EE and MVPA. VPA significantly increased between the aged nine and eleven. Girls aged 12 engaged less significantly VPA than boys. Over 90% of children met the Physical Activity Guidelines for Adolescents (PAGA) and the United States' Healthy People Objective No. 22.6; 80% met the United Kingdom Expert Consensus

Group guideline; and 70% met the Healthy People Objective No. 22.7. These results indicated that physical activity among the majority of children complied with the international recommendations. The only significant difference came in participation rates for vigorous physical activity among children of different ages and gender. Our results provide important information for health policy in the field of children' s physical activity. We would recommend the setting up of national objectives for the physical activity of children and the conducting of a national surveillance study with a more precise and consistent measurement of physical activity for children to offer a comparable data in the future is suggested.

Yi-Ching Huang and Malina (2002) studied on the relationship between physical activity and health-related physical fitness was evaluated in 282 Taiwanese adolescents 12-14 years of age. The subjects were randomly selected from the 7^{th}, 8^{th} and 9^{th} grades in two junior high schools in Taiwan. Physical activity was estimated as total daily energy expenditure and energy expenditure in moderate-to-vigorous physical activity from 24-hour activity records for three days, two week days and one weekend day. Health-related fitness was assessed as the one-mile run (cardiorespiratory endurance), timed sit-ups (abdominal strength and endurance), sit-and-reach (lower back flexibility), and subcutaneous fatness (sum of the triceps, subscapular, suprailiac, and medial calf skinfolds). Physical activity is significantly and positively correlated with one-mile run performance and the sit-and-reach, but not with sit-ups and subcutaneous fatness. Overall, the strength of the relationships between

estimated energy expenditure and specific fitness items in the total sample vary from low to moderate, with only 1% to 12% of the variance in fitness variables being explained by estimated energy expenditure. Comparisons of active versus inactive, and fit versus unfit adolescents provide additional insights. The more active (highest quartile) are also more fit in cardiorespiratory endurance and in the sit-and-reach than the less active (lowest quartile), and the more fit in the one-mile run (better time, lowest quartile) and the sit-and-reach (highest quartile) are more active than the less fit in each item, respectively.

Hong Yan et.al (1996). reported that there are 200 million Chinese adolescents and they represent a significant proportion of the world adolescent population. Their health, growth and nutritional status is of vital importance to China but also to the health of adolescents globally. Previous assessments of nutritional status of adolescents in China have been undertaken without using World Health Organization (WHO) recommended anthropometric methods or reference data. Using data from the National Survey on the Constitution and Health of Chinese Students in 1995 (NSCHCS-95), this study aimed to assess the current nutritional status of Shaanxi school students using WHO recommended methods of nutritional assessment. Data for 6284 (3142 females and 3142 males) Shaanxi school students aged 10–17 years was abstracted from the Shaanxi portion of the NSCHCS-95. This national cross-sectional survey gathered anthropometric measurements using standard methods, maturity indicators, and basic social and demographic data. The calculation of anthropometric indicators was based on the National Centre for Health

Statistics/WHO reference data and the prevalence of nutritional status indicators was estimated using standard WHO recommended cut-offs and methods of maturity adjustment. The median age of menarche and spermarche was delayed for Shaanxi rural female and male students in comparison with the reference data by 0.81 and 0.39 years, respectively. The prevalence of stunting and thinness in students in almost all ages was higher than in the reference population. For all age groups combined, the adjusted prevalence of stunting was 8.0% for urban students, and 11.0% for rural students. For students under 14 years of age, the adjusted prevalence of thinness was 18.3% for urban students, and 15.1% for rural students. The prevalence of 'at risk of overweight' and obesity among urban male students aged 10–11.99 (for overweight) and 10–12.99 years (for obesity) were similar to the reference population. Undernutrition (stunting and thinness) continues to be a public health problem in the Shaanxi school population and may be related to the less developed rural economy in the province. Young Shaanxi urban male students showed a tendency towards an excess prevalence of 'at risk of overweight' and obesity, which may be related to improved economic conditions in urban areas. It is necessary to develop national anthropometric reference data, cut-off points and median ages of attainment of WHO recommended maturational indicators for Chinese adolescents

MacDonncha and Rhoda Sohun (2006) compared the physical fitness levels of Iresh adolescents and reported that physical fitness data for males (n = 610) and females (n = 646) from Northern Ireland aged between 15 - 17 years

for the following variables: height (males = 1728 cm, females = 1616 cm); weight (males = 63 kg, females = 56 kg); sit-ups in 30s (males = 26 reps, females = 20 reps); sit and reach (males = 22 cm, females = 25 cm); grip strength (males = 42 kg, females = 28 kg); standing long jump (males = 192 cm, females = 148 cm) and body fat percentage (males = 13.5%, females = 23.8%). When a comparison was made between adolescents from Irealnd results demonstrated that large percentage differences exist between mean values for Irish adolescents and Northern Ireland adolescents for the following variables: sit-ups (30s); sit and reach flexibility and grip strength. The percentage body fat of Irish female adolescents was also greater than their Nothern Ireland counterparts. Healthy body fat values for males and females are 15% and 25% respectively.

Rode and Shephard (2005) made a study on physical characteristics, muscle strength, and predicted aerobic power were compared in two circumpolar populations aged 20-49 years at different stages in acculturation to a "modern" sedentary life-style: the Inuit of Igloolik (110 males, 80 females tested in 1989-90) and the nGanasan of Volochanka (29 males, 25 females tested in 1992-3). Both populations show short stature but normal body mass. Skinfold thicknesses (average of triceps, subscapular, and suprailiac) of the male Inuit (mean 10-11 mm, rising with age to 15 mm) are now much greater than in previous surveys, reflecting adoption of a mechanized, sedentary life-style. Recent estimates from Siberia suggest continuing substantial daily energy expenditures by the men but not the women of this region, and averaged values

for the three skinfolds in the nGanasan males (mean 7-8 mm) are still low. In women, both Inuit (mean skinfolds 15 mm, rising to 29 mm with age) and nGanasan (mean 19 mm, rising to 25 mm) are now relatively obese. Compared to the nGanasan, male Inuit have greater handgrip force (probably due to snowmobile operation), but poorer knee extension strength (probably because they now do little walking through snow). In contrast, older nGanasan women have less knee extension strength than the Inuit (probably because the latter still carry babies on their backs). The aerobic power of both Inuit and nGanasan (mean of 48, declining with age to 38-40ml/[kg.min] in males, mean of 38-45 declining with age to 33-37 ml/[kg.min] in females) still corresponds to that of a moderately active urban population.

Stafilidis S, and Arampatzis A.(2007) , study was to test the hypothesis that sprint performance (time over a given distance) would be affected by track compliance, with better performances on the more compliant surface. Ten sprinters participated in the study. The athletes performed maximal sprints (60 m) on three different track configurations (hard, 5500 kN m(-1); soft, 2200 kN m(-1); spring, 550 kN m(-1)). A 60-m single-lane running surface was constructed. Plywood boards (1.2 cm thick) were placed on a 60 x 0.6 m wooden chipboard frame serving as the base surface. All participants ran two times on each track configuration in a randomized order. The athletes' kinematics were recorded using the Vicon 624 system with 12 cameras operating at 250 Hz. Four Kistler force plates (1250 Hz) were used to record ground reaction forces. Sprint performance (time over 60 m) was unaffected by

the different track compliances (P= 0.57). In addition, there was no effect of track (P> 0.05) on the sprinting kinematics and kinetics of the ankle or knee joint. The hypothesis that sprint performance is affected by track compliance can be rejected because the sprinters recorded similar performances while sprinting over 60 m on all three track configurations. We conclude that: (1) the possible deformation of the track while sprinting is minor enough not to cause a specific adjustment in the leg mechanics affecting the effectiveness of the stretch-shortening cycle of the sprinters; and (2) the energy exchange between sprinters and tracks has only a marginal effect on sprint performance due to its small magnitude. More research on tracks with lower stiffness is required.

Falk B, et.al. (2004) reported that the processes of talent detection and early development are critical in any sport programme. However, not much is known about the appropriate strategies to be implemented during these processes, and little scientific inquiry has been conducted in this area. The aim of this study was to identify variables of swimming, ball handling and physical ability, as well as game intelligence, which could assist in the selection process of young water-polo players. Twenty-four players aged 14-15 years underwent a battery of tests three times during a 2-year period, before selection to the junior national team. The tests included: freestyle swim for 50, 100, 200 and 400 m, 100-m breast-stroke, 100-m 'butterfly' (with breast-stroke leg motion), 50-m dribbling, throwing at the goal, throw for distance in the water, vertical 'jump' from the water, and evaluation of game intelligence by two coaches. A comparison of those players eventually selected to the team and those not

selected demonstrated that, 2 years before selection, selected players were already superior on most of the swim tasks (with the exception of breast-stroke and 50-m freestyle), as well as dribbling and game intelligence. This superiority was maintained throughout the 2 years. Two-way tabulation revealed that, based on baseline scores, the prediction for 67% of the players was in agreement with the final selection to the junior national team. We recommend that fewer swim events be used in the process of selecting young water-polo players, and that greater emphasis should be placed on evaluation of game intelligence.

Stafilidis S, and Arampatzis A.(2007) , study was to test the hypothesis that sprint performance (time over a given distance) would be affected by track compliance, with better performances on the more compliant surface. Ten sprinters participated in the study. The athletes performed maximal sprints (60 m) on three different track configurations (hard, 5500 kN m(-1); soft, 2200 kN m(-1); spring, 550 kN m(-1)). A 60-m single-lane running surface was constructed. Plywood boards (1.2 cm thick) were placed on a 60 x 0.6 m wooden chipboard frame serving as the base surface. All participants ran two times on each track configuration in a randomized order. The athletes' kinematics were recorded using the Vicon 624 system with 12 cameras operating at 250 Hz. Four Kistler force plates (1250 Hz) were used to record ground reaction forces. Sprint performance (time over 60 m) was unaffected by the different track compliances ($P= 0.57$). In addition, there was no effect of track ($P> 0.05$) on the sprinting kinematics and kinetics of the ankle or knee joint. The hypothesis that sprint performance is affected by track compliance

can be rejected because the sprinters recorded similar performances while sprinting over 60 m on all three track configurations. We conclude that: (1) the possible deformation of the track while sprinting is minor enough not to cause a specific adjustment in the leg mechanics affecting the effectiveness of the stretch-shortening cycle of the sprinters; and (2) the energy exchange between sprinters and tracks has only a marginal effect on sprint performance due to its small magnitude. More research on tracks with lower stiffness is required.

Stafilidis S, and Arampatzis A. (2007) determined whether sprint performance is related to the mechanical (elongation - force relationship of the tendon and aponeurosis, muscle strength) and morphological (fascicle length, pennation angle, muscle thickness) properties of the quadriceps femoris and triceps surae muscle - tendon units. Two groups of sprinters (slow, n = 11; fast, n = 17) performed maximal isometric knee extension and plantar flexion contractions on a dynamometer at 11 different muscle - tendon unit lengths. Elongation of the tendon and aponeurosis of the gastrocnemius medialis and the vastus lateralis was measured using ultrasonography. We observed no significant differences in maximal joint moments at the ankle and knee joints or morphological properties of the gastrocnemius medialis and vastus lateralis between groups ($P > 0.05$). The fast group exhibited greater elongation of the vastus lateralis tendon and aponeurosis at a given tendon force, and greater maximal elongation of the vastus lateralis tendon and aponeurosis during maximum voluntary contraction ($P < 0.05$). Furthermore, maximal elongation of the vastus lateralis tendon and aponeurosis showed a significant correlation

with 100-m sprint times (r = -0.567, P = 0.003). For the elongation - force relationship at the gastrocnemius medialis tendon and aponeurosis, the two groups recorded similar values. It is suggested that the greater elongation of the vastus lateralis tendon and aponeurosis of the fast group benefits energy storage and return as well as the shortening velocity of the muscle - tendon unit.

Arampatzis A, et.al. (2007) , investigated whether the mechanical properties (i.e. force strain relationship) of the triceps surae tendon and aponeurosis relate to the performed sport activity in an intensity-dependent manner. This was done by comparing sprinters with endurance runners and subjects not active in sports. Sixty-six young male subjects (26+/-5 yr; 183+/-6 cm; 77.6+/-6.7 kg) participated in the study. Ten of these subjects were adults not active in sports, 28 were endurance runners and 28 sprinters. All subjects performed isometric maximal voluntary plantar flexion contractions (MVC) on a dynamometer. The distal aponeuroses of the gastrocnemius medialis (GM) was visualised by ultrasound during the MVC. The results showed that only the sprinters had higher normalised stiffness (relationship between tendon force and tendon strain) of the triceps surae tendon and aponeurosis and maximal calculated tendon forces than the endurance runners and the subjects not active in sports. Furthermore, including the data of all 66 examined participants tendon stiffness correlated significantly (r=0.817, P<0.001) with the maximal tendon force achieved during the MVC. It has been concluded that the mechanical properties of the triceps surae tendon and aponeurosis do not show a graded response to the intensity of the performed sport activity but rather remain at

control level in a wide range of applied strains and that strain amplitude and/or frequency should exceed a given threshold in order to trigger additional adaptation effects. The results further indicate that subjects with higher muscle strength possibly increase the margin of tolerated mechanical loading of the tendon due to the greater stiffness of their triceps surae tendon and aponeurosis.

Mero A, et.al. (2006) examined the effects of muscle-tendon length on joint moment and power during maximal sprint starts. Nine male sprinters performed maximal sprint starts from the blocks that were adjusted either to 40 degrees or 65 degrees to the horizontal. Ground reaction forces were recorded at 833 Hz using a force platform and kinematic data were recorded at 200 Hz with a film camera. Joint moments and powers were analysed using kinematic and kinetic data. Muscle - tendon lengths of the medial gastrocnemius, soleus, vastus medialis, rectus femoris and biceps femoris were calculated from the set position to the end of the first single leg contact. The results indicated that block velocity (the horizontal velocity of centre of mass at the end of the block phase) was greater ($P < 0.01$) in the 40 degrees than in the 65 degrees block angle condition (3.39 +/- 0.23 vs. 3.30 +/- 0.21 m . s(-1)). Similarly, the initial lengths of the gastrocnemius and soleus of the front leg in the block at the beginning of force production until half way through the block phase were longer ($P < 0.001$) in the 40 degrees than in the 65 degrees block angle condition. The initial length and the length in the middle of the block phase were also longer in the 40 degrees than in the 65 degrees block angle condition both for both the gastrocnemius ($P < 0.01$) and soleus ($P < 0.01$-0.05) of the rear leg. In contrast,

the initial lengths of the rectus femoris and vastus medialis of the front leg were longer ($P < 0.05$) in the 65 degrees than in the 40 degrees block angle condition. All differences gradually disappeared during the later block phase. The peak ankle joint moment ($P < 0.01$) and power ($P < 0.05$) during the block phase were greater in the 40 degrees than in the 65 degrees block angle condition for the rear leg. The peak ankle joint moment during the block phase was greater ($P < 0.05$) in the 40 degrees block angle for the front leg, whereas the peak knee joint moment of the rear leg was greater ($P < 0.01$) in the 65 degrees block angle condition. The results suggest that the longer initial muscle-tendon lengths of the gastrocnemius and soleus in the block phase at the beginning of force production contribute to the greater peak ankle joint moment and power and consequently the greater block velocity during the sprint start.

Delecluse C, et.al. (2003) examined the impact of short-term (7-day), high-dose (0.35 g.kg(-1).d(-1)) oral creatine monohydrate supplementation (CrS) on single sprint running performance (40 m, <6 seconds) and on intermittent sprint performance in highly trained sprinters. Nine subjects completed the double-blind cross-over design with 2 supplementation periods (placebo and creatine) and a 7-week wash-out period. A test protocol consisting of 40-m sprint runs was performed, and running velocity was continuously recorded over the total distance. The maximal sprint performance, the relative degree of fatigue at the end of intermittent sprint exercise (6 x 40 m, 30-second rest interval), as well as the degree of recovery (120-second passive rest) remained unchanged following CrS. There were no significant changes related

to CrS in absolute running velocity at any distance between start and finish (40 m). It was concluded that no ergogenic effect on single or repeated 40-m sprint times with varying rest periods was observed in highly trained athletes.

Korhonen MT,et.al. (2003) study was undertaken to investigate age-related differences in the velocity and selected stride parameters in male and female master sprinters and to determine which stride characteristics were related to the overall decline in the performance of the 100 m with age. The performances of 70 finalists (males 40-88 yr, females 35-87 yr) at the European Veterans Athletics Championships were recorded using two high-speed cameras (200 Hz) with a panning video technique and distance markers at 10-m intervals. Velocity, stride length (SL), stride rate (SR), ground contact time (CT), and flight time (FT) during the acceleration, peak velocity, and deceleration phases of the 100-m race were determined from the video records with the aid of the Peak Performance analysis system. There was a general decline in sprint performances with age, the decrease becoming more evident around 65-70 yr of age. The velocity during the different phases of the run declined on average from 5 to 6% per decade in males and from 5 to 7% per decade in females. Similarly, SL showed clear reductions with increasing age, whereas SR remained unchanged until the oldest age groups in both genders. Furthermore, the CT, which correlated with velocity, was significantly longer, and FT, which correlated with both velocity and SL, was shorter in older age groups. Our findings indicated that age-associated differences in velocity in elite master sprinters were similar in each phase of the 100-m run. The

deterioration of the overall performance with age was primarily related to reduction in SL and increase in CT.

2.3 SUMMARY OF RELATED LITERATURE

The investigator has reviewed several journals, research articles and presented the above related studies in two broad areas, namely, studies on long jump performance and studies on comparing physical fitness levels. The studies proved that long jump performance was estimated based on selected physical fitness variables, apart from the fact that long jump activities were also used to improve skills in selected sports activities such as sprinting, sports and games. Similarly the comparisons physical fitness variables have been reported among different groups of people such as sports men, sports women, children, and adolescents' etcetera. However, it was found that there was further scope for research in analyzing the physical fitness and performance among Indian male and female long jumpers. Hence, this research was undertaken.

Based on the experience the investigator gained, the investigator selected suitable methodology to be followed in this research, which is presented in Chapter III