CHAPTER II

REVIEWS OF RELATED LITERATURE

2.1 REVIEWS ON PHYSICAL VARIABLES

A study of relevant literature is vital step to get a full picture of what has been done with regard to the problem under study. Such a review provides the investigator to familiar with the past work and the work that is to be done. It gives new ideas, theories and comparative materials for the researcher. The related literature collected pertaining to the study has been described in this chapter.

The Purpose (**D.Maniazhagu, 2014**) of the present study was to find out the effects of circuit training and circuit weight training on Speed. To achieve this purpose, thirty men kabaddi players from Alagappa University College of physical education, karaikudi, were randomly selected as subjects. The age of the subjects ranged between 21 to 28 years. The selected subjects were divided into three groups of ten subjects each. The experimental group – 1(n=10 CT) underwent circuit training, the experimental group – 2 (n = 10 CWT) underwent circuit weight training and control group-3 (n= 10, CG) did not participate in any special training programme apart from their regular activities. The data was collected at prior to and after the training programme of nine weeks. Speed was chosen as a criterion variable. The analysis of co variance (ANCOVA) was used to analyze the data. The results of the study showed that the Speed was significantly improved due to the circuit and circuit weight training.

The purpose of the study (**Dr.S.Dhanaraj, 2014**) was to find out the effects of circuit training on selected physical fitness variables among twenty women hockey players from Alagappa University College of Physical Education, karaikudi were selected randomly as subjects. The age of the students ranged from 18 to 24 years. The selected subjects were divided into two groups. Group A underwent circuit training and group B acted as control group. The experimental group was subjected to the training for three days in a week for a period of 8 weeks circuit training programme. The dependent variables namely speed and agility was measured by 50 yards run and shuttle run test. The Data were collected from each subject before and after the training period and statistically analyzed by using dependent 't' test and analysis of covariance (ANCOVA). It was found that there was a significant improvement in speed and agility due to the effects of circuit training programme.

Supervised periodized (**Taipale RS, et.al., 2014**) mixed maximal and explosive strength training added to endurance training in recreational endurance runners was examined during an 8-week intervention preceded by an 8-week preparatory strength training period. Thirty-four subjects (21-45 years) were divided into experimental groups: men (M, n = 9), women (W, n = 9), and control groups: men (MC, n = 7), women (WC, n = 9). The experimental groups performed mixed maximal and explosive exercises, whereas control subjects performed circuit training with body weight. Endurance training included running at an intensity below lactate threshold. Strength, power, endurance performance characteristics, and hormones were monitored throughout the study. Significance was set at $p \leq 0.05$. Increases were observed in both experimental groups that were more systematic than in the control groups in explosive strength (12 and 13% in men and women, respectively), muscle activation, maximal strength (6 and 13%), and peak running speed (14.9 ± 1.2 to 15.6 ± 1.2 and 12.9 ± 0.9 to 13.5 ± 0.8 km Ł h). The control groups showed significant improvements in maximal and explosive strength, but Speak increased only in MC. Submaximal running characteristics (blood lactate and heart rate) improved in all groups. Serum hormones fluctuated significantly in men (testosterone) and in women (thyroid stimulating hormone) but returned to baseline by the end of the study. Mixed strength training combined with endurance training may be more effective than circuit training in recreational endurance runners to benefit overall fitness that may be important for other adaptive processes and larger training loads associated with, e.g., marathon training.

This study (**Johnstone JA and Ford PA, 2010**)aims to provide a physiologic profile of professional cricketers and note positional differences at the start of the 2007/08 competitive season. Fifteen participants (9 bowlers, 6 batsmen) aged 25.0 ± 5.0 years (mean ± SD) took part in this study. Participants (bowlers and batsmen) completed a series of field-based fitness assessments: body composition (sum of 7 skinfolds, 72.5 ± 16.5 and 65.5 ± 19.3 mm, respectively), flexibility (sit and reach 8.1 ± 10.3 and 6.0 ± 6.2 cm, respectively), predicted maximal oxygen uptake (multistage shuttle run, 54.1 ± 2.8 and 56.1 ± 4.5 ml-1·kg-1·min-1, respectively), upper- (medicine ball throw, 7.7 ± 0.6 and 7.0 ± 0.1 m, respectively) and lower-body strength (countermovement jump, 45.7 ± 5.8 and 43.9 ± 4.1 cm, respectively), speed (sprint 17.7 m, 2.76 ± 0.6 and 2.77 ± 0.1 s, respectively), and explosive power (repeated jump, 31.0 ± 2.0 and 34.1 ± 4.8 cm, respectively). The data provided the physical fitness profile for each player, which, compared with normative data, identified that this cohort of professional cricketers had some superior fitness parameters compared with the general population, and where applicable, were comparable with other professional athletes. In addition, after effect size calculations, the results showed that some physical fitness differences existed between playing positions. Cricket professionals possess a superior level of physical fitness and strength, and conditioning coaches should seek to progress these physical parameters and further identify position-specific physical requirements to progress the modern game.

Although the physiological demands (**Petersen CJ, et.al.,2011**)of cricket match play are emerging, the demands of contemporary training practices have not been reported. The aim of this study was to quantify the physiological demands of selected cricket training activities and compare these to known match demands. Twenty-eight different training activities were monitored in national academy level cricketers (n = 42) using global positioning system units during a 14-week residential training programme. The training activities were classified into 3 categories: conditioning sessions (n = 8), skill sessions (n = 9), and game simulations (n = 11). Conditioning sessions were further classified into high- (n = 4) and low- (n = 4) intensity drills. Time-motion measures included movement patterns (walk, jog, run, stride, and sprint distances), total distance covered, number of sprints, number of high-intensity efforts, maximum speed, and recovery time between high-intensity efforts. Inferential statistics were used to quantify magnitudes of difference between various training drills. Movement patterns were then compared to recently published game data (Twenty20, One-Day, and Multiday games) from the same sample group of cricketers. Conditioning drills were twice as long in duration as skill drills and twice as intense as both the skill and game simulation drills. Exercising heart rates were 9-26% and lactate levels up to 3.5 times higher in conditioning compared to other training drills. Conditioning drills matched or exceeded (up to 10 $b \cdot min^{-1}$; 5%) peak game heart rates. Conversely, skill and simulation drills replicated mean game heart rates for some, but not all positions. In conclusion, training replicates or exceeds cricket match demands in conditioning-type drills but not in simulation or skill-based drills. Modification of skill and simulation training drill practices will ensure closer replication of match and training demands.

To investigate(**Hides JA, et.al., 2008**) using ultrasound imaging, the cross-sectional area (CSA) of the lumbar multitudes muscle at 4 vertebral levels (L2, L3, L4, L5) in elite cricketers with and without low back pain (LBP) and (2) to document the effect of a staged stabilization training programme on multitudes muscle CSA.

Despite high fitness levels and often intensive strength training programmes, athletes still suffer LBP. The incidence of LBP among Australian cricketers is 8% and as high as 14% among fast bowlers. Previous researchers have found that the multifidus muscle contributes to segmental stability of the lumbopelvic region; however, the CSA of this muscle has not been previously assessed in elite cricketers.

CSAs of the multifidus muscles were assessed at rest on the left and right sides for 4 vertebral levels at the start and completion of a 13-week cricket training camp. Participants who reported current or previous LBP were placed in a rehabilitation group. The stabilization program involved voluntary contraction of the multifidus, transversusabdominis, and pelvic floor muscles, with real-time feedback from rehabilitative ultrasound imaging (RUSI), progressed from non-weight-bearing to weight-bearing positions and movement training. Pain scores (using a visual analogue scale) were also collected from those with LBP.

The CSAs of the multitudes muscles at the L5 vertebral level increased for the 7 cricketers with LBP who received the stabilization training, compared with the 14 cricketers without LBP who did not receive rehabilitation (P = .004). In addition, the amount of muscle asymmetry among those with LBP significantly decreased (P = .029) and became comparable to cricketers without LBP. These effects were not evident for the L2, L3, and L4 vertebral levels. There was also a 50% decrease in the mean reported pain level among the cricketers with LBP.

Multitudes muscle atrophy can exist in highly active, elite athletes with LBP. Specific retraining resulted in an improvement in multitudes muscle CSA and this was concomitant with a decrease in pain.

The relationship between (**Phillips E, et.al.,2012**)performance variability and accuracy in cricket fast bowlers of different skill levels under three different task conditions was investigated. Bowlers of different skill levels were examined to observe if they could adapt movement patterns to maintain performance accuracy on a bowling skills test.

8 national, 12 emerging and 12 junior pace bowlers completed an adapted version of the Cricket Australia bowling skills test, in which they performed 30 trials involving short (n=10), good (n=10), and full (n=10) length deliveries.

Bowling accuracy was recorded by digitising ball position relative to the centre of a target. Performance measures were mean radial error (accuracy), variable error (consistency), centroid error (bias), bowling score and ball speed. Radial error changes across the duration of the skills test were used to record accuracy adjustment in subsequent deliveries.

Elite fast bowlers performed better in speed, accuracy, and test scores than developing athletes. Bowlers who were less variable were also more accurate across all delivery lengths. National and emerging bowlers were able to adapt subsequent performance trials within the same bowling session for short length deliveries.

Accuracy and adaptive variability were key components of elite performance in fast bowling which improved with skill level. In this study, only national elite bowlers showed requisite levels of adaptive variability to bowl a range of lengths to different pitch locations.

This study (**Hakkinen K, et.al., 2013**) compared the effects of mixed maximal strength and explosive strength training with maximal strength training and explosive strength training combined with endurance training over an 8-week training intervention. Male subjects (age 21-45 years) were divided into three strength training groups, maximal (MAX, n = 11), explosive (EXP, 10) and mixed maximal and explosive (MIX, 9), and a circuit training control group, (CON, 7). Strength training one to two times a week was performed concurrently with endurance training three to four times a week. Significant increases in maximal dynamic strength (1RM), countermovement jump (CMJ), maximal muscle activation during 1RM in MAX and during CMJ in EXP, peak running speed (S (peak)) and running speed at respiratory compensation threshold (RCT(speed)) were observed in MAX, EXP and MIX. Maximal isometric strength and muscle activation, rate of force development (RFD), maximal oxygen uptake [Formula: see text] and running economy (RE) at 10 and 12 km hr(-1) did not change significantly. No significant changes were observed in CON in maximal isometric strength, RFD, CMJ or muscle activation, and a significant decrease in 1RM was observed in the final 4 weeks of training. RE in CON did not change significantly, but significant increases were observed in S (peak), RCT(speed) and Low volume MAX, EXP and MIX strength training combined with higher volume endurance training over an 8-week intervention produced significant gains in strength, power and endurance performance measures of S (peak) and RCT(speed), but no significant changes were observed between groups.

The purpose (**Anek A,et.al., 2011**) of this research is to develop a circuit box jumping exercise program and to examine the effects of the circuit box jumping exercise program on bone formation, bone resorption, health related to physical fitness and balance of the premenopausal females. The samples consisted of 57 female volunteers from Chulalongkorn University, aged between 35-45. The subjects were divided into two groups: 28 females in the experimental group and 29 females in the control group by the simple random sampling method. The experimental group participated in the circuit box jumping exercise program while wearing heart rate monitors. The exercise speed was determined by the rhythm of the music. The experimental group completed two circuits of jumping at 6 stations with 10 jumps per station three times per week, for a period of twelve weeks. Each jumping box at Station 1 and 4 was 10 cm. high; the boxes at Station 2 and 5 were

15 cm. high; and at Station 3 and 6, the boxes were 20 cm. in height. The intensity is 60%-80% of a maximum heart rate. The control group did not participate in the circuit box jumping exercise program. The collected data before and after the experiment were the results of the physiology test, the biochemical bone markers, the health related physical fitness and the balance ability. The collected data were compared and analyzed by the mean and standard deviation. The differences of the tests are statistically significant at the .05 level. The results of the present study are as follows; 1. After the 12-week experiment training, the findings indicated that the mean scores on bone resorption (beta-Crosslaps) of the experimental group and the control group were significantly different at 0.05 level. In addition, the findings showed that the percentage changes on bone resorption (beta-Crosslaps) variance of the experiment group reduced by -25.6528%, while that of the control group reduced by -0.5933%. Bone formation (PINP/beta-Crosslaps) in the circuit box jumping subjects was significantly higher after the training intervention ($p < 0.05$). 2. The general physiological data in the circuit box jumping subjects after the training intervention was significantly lower in weight, resting heart rate and systolic blood pressure ($p < 0.05$). 3. The health-related to physical fitness in the circuit box jumping subjects after the training intervention was significantly lower in waist/hip ratio, body fat and fat in percent while skeleton muscle mass, leg strength, flexibility and VO2max were significantly higher after the training intervention ($p < 0.05$). 4. The balance in the circuit box jumping subjects after the training intervention was significantly better after the training intervention ($p < 0.05$). The circuit box jumping training has the positive effects on slowing down the bone resorption and consequently the bone formation increased. It can be concluded that the circuit box

jumping training reduces some risks of osteoporosis in the premenopausal women. Additionally, it promotes the better health-related to physical fitness and balance.

To examine (**Nash MS,et.al., 2007**) the effects of circuit resistance exercise (CRT) training on muscle strength, endurance, anaerobic power, and shoulder pain in middle-aged men with paraplegia.

Seven men (age range, 39-58y) with motor-complete paraplegia from T5 to T12 and confirmed shoulder pain occurring during daily activities.

Subjects underwent a 4-month CRT program using alternating resistance maneuvers and high-speed, low-resistance arm exercise. One-repetition maximal force was measured before training and monthly thereafter. Pretraining and posttraining peak oxygen uptake (Vo(2)peak) was measured by graded arm testing. Anaerobic power was measured before and after training using a 30-second Wingate Anaerobic Test. Shoulder pain was self-evaluated by an index validated for people with spinal cord injury (Wheelchair Users Shoulder Pain Index [WUSPI]).

Strength increases ranging from 38.6% to 59.7% were observed for all maneuvers (P range, .005-.008). Vo(2)peak increased after training by 10.4% (P=.01), and peak and average anaerobic power increased by 6% (P=.001) and 8.6% (P=.005), respectively. WUSPI scores +/- standard deviation were lowered from 31.9+/-24.8 to 5.7+/-5.9 (P=.008), with 3 of 7 subjects reporting complete resolution of shoulder pain.

CRT improves muscle strength, endurance, and anaerobic power of middle-aged men with paraplegia while significantly reducing their shoulder pain.

This study tested (**Jacobs PL andRusinowskiJW, 2001**). the safety and the effects of circuit resistance training (CRT) on peak upper extremitycardiorespiratory endurance and muscle strength in chronic survivors of paraplegia due to spinal cord injury.

Ten men with chronic neurologically complete paraplegia at the T5-L1 levels participated in the study. Subjects completed 12 wk of CRT, using a series of alternating isoinertial resistance exercises on a multi-station gym and high-speed, low-resistance arm ergometry. Peak arm ergometry tests, upper extremity isoinertial strength testing, and testing of upper extremity isokinetic strength were all performed before and after training.

None of the subjects suffered injury from exercise training. Significant increases were observed in peak oxygen consumption (29.7%, $P < 0.01$), time to fatigue ($P < 0.01$), and peak power output during arm testing ($P < 0.05$). Significant increases in isoinertial strength for the training maneuvers ranged from 11.9% to 30% ($Ps < 0.01$). Significant increases in isokinetic strength were experienced for shoulder joint internal rotation, extension, abduction, adduction, and horizontal adduction ($Ps < 0.05$).

Chronic survivors of paraplegia safely improve their upper extremity cardiorespiratory endurance and muscle strength when undergoing a short-term circuit resistance training program. Gains in fitness and strength exceeded those usually reported after either arm endurance exercise conditioning or strength training in this subject population.

The purpose (**S. Mohanasundaram and G. Vasanthi, 2013**)of this study is to determine the effect of S.A.Q training and tempo training on agility and resting pulse rate among junior cricket players. Forty five subjects were selected from the Stansford International Higher Secondary School, Puducherry and their age ranged from 14 to 17 years. The subjects were equally divided into three groups with fifteen subjects in each group. The group I was treated with S.A.Q training group, Group II was treated with tempo training group and Group III was treated with control group. Training was given for a period of 12 weeks. The results of pre-test and post-test were statistically analyzed by using analysis of co-variance. The result when compared between the two experimental groups revealed that resting pulse rate had no significant improvement due to S.A.Q training and tempo training when compared to the control group. But agility had significant improvement due to S.A.Q training and tempo training when compared to the control group. The result revealed that it was found that S.A.Q training group had significant effect on agility.

The aim of the study (**MoazzamHussain Khan and Kamran Ali, 2013**)was to compare the effects of Plyometrics on Grass Versus Clay Surface on Jumping, Sprinting and Agility in Collegiate Cricketers. Pre testpost test same subject group Experimental design.After random allocation, 24 players' completed 4 weeks of plyometric training, 12 players on clay surface and 12 players on grass surface. Before and after training, vertical jump, 40 yard sprint time and agility were measured.Independent t- test was used for data analysis. No significant difference was found between the clay surface and grass surface groups and both the groups showed similar improvements in all the three variables viz vertical jump, agility and sprint time.Both the surfaces can be used to improve the athletes' performances.

The purpose (**Ferrauti A, et.al., 2010**) of this study was to investigate the effects of a concurrent strength and endurance training program on running performance and running economy of middle-aged runners during their marathon preparation. Twenty-two (8 women and 14 men) recreational runners (mean ± SD: age 40.0 ± 11.7 years; body mass index 22.6 ± 2.1 kg•m^{-2}) were separated into 2 groups (n = 11; combined endurance running and strength training program [ES]: 9 men, 2 women and endurance running [E]: 7 men, and 4 women). Both completed an 8-week intervention period that consisted of either endurance training (E: 276 ± 108 minute running per week) or a combined endurance and strength training program (ES: 240 ± 121-minute running plus 2 strength training sessions per week [120 minutes]). Strength training was focused on trunk (strength endurance program) and leg muscles (high-intensity program). Before and after the intervention, subjects completed an incremental treadmill run and maximal isometric strength tests. The initial values for VO2peak (ES: 52.0 ± 6.1 vs. E: 51.1 ± 7.5 ml•kg^{-1}•min^{-1}) and anaerobic threshold (ES: 3.5 ± 0.4 vs. E: 3.4 ± 0.5 m•s^{-1}) were identical in both groups. A significant time × intervention effect was found for maximal isometric force of knee extension (ES: from 4.6 ± 1.4 to 6.2 ± 1.0 N•kg^{-1}, $p < 0.01$), whereas no changes in body mass occurred. No significant differences between the groups and no significant interaction (time × intervention) were found for VO2 (absolute and relative to VO2peak) at defined marathon running velocities (2.4 and 2.8 m•s^{-1}) and submaximal blood lactate thresholds (2.0, 3.0, and 4.0 mmol•L^{-1}). Stride length and stride frequency also remained unchanged. The results suggest no benefits of an 8-week concurrent strength training for running economy and coordination of recreational marathon runners despite a clear improvement in leg strength, maybe because of an insufficient sample size or a short intervention period.

The purpose (**Jakobsen MD, et.al., 2012**) of the present study was to evaluate the effect of contrasting training modalities on mechanical muscle performance and neuromuscular activity during maximal SSC (stretch-shortening cycle) countermovement jumps (CMJ). Bilateral countermovement jumping, surface electromyography (EMG) and muscle fiber size (CSA) were studied in untrained individuals (n=49, 21-45 yrs) pre and post 12 weeks of progressive heavy-resistance strength training (ST, n=8), recreational soccer training (SOC, n=15), high-intensity interval running (INT, n=7), continuous running (RUN, n=9) or continuation of an inactive life-style (CON, n=10). ST displayed shortened CMJ take-off time ($p<.05$) and increased ($p<.05$) maximal CMJ jump height, peak down- and upward velocity of center of mass (COM), rate of vertical force development (RFD: $\Delta F(Z)/\Delta t$), peak power production, rate of power development (RPD), mean plantar flexor EMG and peak hamstring rate of EMG rise (RER). Peak quadriceps EMG rate of rise increased in SOC ($p<.05$). Moreover, ST and SOC demonstrated increased quadriceps muscle fiber CSA and lean leg mass. Positive relationships ($r>.70$) were observed following ST between training-induced changes in CMJ SSC muscle performance, neuromuscular activity and muscle fiber CSA, respectively. ST induced a more rapid CMJ take-off phase and elevated muscle power production, indicating a more explosive-type SSC muscle performance. No effects were detected in CMJ performance after continuous running, high-intensity interval running and recreational soccer, despite an increased muscle fiber CSA and quadriceps muscle activity in SOC. Enhanced neuromuscular activity in the hip extensors (hamstrings) and plantar flexors, and increased myofiber fiber size were responsible for the enhanced CMJ SSC muscle performance with ST.

The aim of this study (**Pyne DB1,et.al., 2006**). was to characterize relationships between anthropometric and isoinertial strength characteristics and bowling speed in junior and senior cricket fast bowlers. Subjects were first-class senior (n = 24; mean +/- SD age = 23.9 +/- 4.8 years, height = 187.4 +/- 4.8 cm, mass = 87.8 +/- 8.4 kg) and junior representative (n = 48; mean +/- SD age = 14.8 +/- 1.3 years, height = 175.7 +/- 9.8 cm, mass = 65.8 +/- 12.9 kg) male fast bowlers. A full anthropometric profile, upper- and lower-body isoinertial strength tests, and peak bowling speed (Vpeak) were assessed on the same day. The senior bowlers had a substantially faster Vpeak (126.7 km.h(-1)) than the juniors (99.6 km.h(-1)), a larger estimated muscle mass (seniors 40.0 +/- 3.9 kg, juniors 28.3 +/- 5.6 kg), and a greater bench press throw and deltoid throw (all $p < 0.01$). The best multiple predictors of Vpeak for the junior bowlers were the static jump, bench throw, body mass, percentage muscle mass, and height (multiple-correlation r = 0.86). For the senior bowlers, static jump and arm length correlated positively with Vpeak (multiple-correlation r = 0.74). The 1-legged countermovement jump was negatively correlated with Vpeak in both groups. We conclude that differences in Vpeak between junior and senior bowlers relate primarily to body mass and upper-body strength. However, lower body strength is a more important contributor to Vpeak in senior bowlers.

The purpose (**Taşkin H, 2009**) of this study was to determine the effect of circuit training directed toward motion and action velocity over the sprint-agility and anaerobic endurance. A total of 32 healthy male physical education students with a mean age of 23.92 +/- 1.51 years were randomly allocated into a circuit training group (CTG; n = 16) and control group (CG; n = 16). A circuit training consisting of 8 stations was applied to the subjects 3 days a week for 10 weeks. Circuit training program was executed with 75% of maximal motion numbers in each station. The FIFA Medical Assessment and Research Centre (F-MARC) test battery, which was designed by FIFA, was used for measuring sprint-agility and anaerobic endurance. Pre- and posttraining testing of participants included assessments of sprint-agility and anaerobic endurance. Following training, there was a significant ($p < 0.05$) difference in sprint-agility between pre- and posttesting for the CTG (pretest = 14.76 +/- 0.48 seconds, posttest = 14.47 +/- 0.43 seconds). Also, there was a significant ($p < 0.05$) difference in anaerobic endurance between pre- and posttesting for the CG (pretest = 31.53 +/- 0.48 seconds, posttest = 30.73 +/- 0.50 seconds). In conclusion, circuit training, which is designed to be performed 3 days a week during 10 weeks of training, improves sprint-agility and anaerobic endurance.

The present (**Jullien H, et.al., 2008**) study assessed the effects of specific leg strength training (as part of a broader exercise program) on running speed and agility in young professional soccer players. Twenty-six male players (ages 17 to 19 years) were divided into 3 groups. The reference group (Re) performed individual technical work only, the coordination group (Co) performed a circuit designed to promote agility, coordination, and balance control (together with some technical work) and the Squat group (Sq) underwent 3 series of 3 squat repetitions (at 90% of the individual maximum value) and a sprint, before competition of the agility circuit and some technical work. These specific training programs were performed 5 times a week for 3 weeks. Before the experimental session and at the end of each week, all players were assessed using 4 types of tests, (agility, a shuttle test with changes of direction, and 2 sprints over 10 and 7.32 meters, respectively), with completion time being the only performance parameter recorded. Our results indicate that in the short sprints or shuttle sprint with changes in direction, lower limb strengthening did not improve performance. Performance improved in all 3 groups in the agility test but more so in the reference and coordination groups. It appears that soccer-specific training composed of exercise circuits specifically adapted to the different types of effort actually used in match play can enhance agility and coordination.

This study (**AlemuMinisha,et.al., 2014**)attempted to explore effects of circuit training program on selected physical fitness variables of female students. Purposive sampling technique was used to select 24 novice female students aged 15 to 16 years from grade 9 students. The main objective of the study was to investigate the effect of circuit training program on selected physical fitness variables of Wahel PrimaryandSecondarySchoolfemalestudentsinDireDawaAdministrativeRegion.All subjects under this study took part in experimental design pre- and post test without control group from April to June in 2013, 3 days per week for 3 months and 40 minutes per session. The physical fitness variables selected for the study were: cardio respiratory endurance (1.6 km run in minutes), muscular endurance (sit-ups reps/60 seconds), muscular strength (modified push- ups reps/30 seconds), power (standing long jump in meter) and agility (4x10 m shuttle run in seconds). Data were analyzed by using SPSS paired samples t- test with pair wise comparison of means at 95% confidence interval by using pre, during and post tests. The results indicated that there were significantly improvements in performance on selected physical fitness variables due to the effects of circuit training with active rest ($p < 0.05$). This study confirmed that circuit training with active rest was significant to improve the physical fitness variables. The mean difference (MD) between pre and post tests for: 1.6 km runwas -1.33 in minute and second; for 30 seconds, push-ups was +5.00 in number; for 60 seconds,sit ups was +6.58 in number; for standing long jump was +0.26 in meter and for 4x10 shuttle run was -1.35 in minute and seconds. The main finding of the study was novice female students have discovered positive outcomes towards physical fitness variables. The study also illustrates that health and fitness level of participants can be improved as a result of circuit training program.

Motor fitness (**Gaur Santosh Kumar and Nigam Deepali, 2011**).is gauged by performance and this performance is based on a composite of many factors. The most commonly motor fitness factors are Speed, Muscular Strength, Muscular Endurance, Muscular Power, Circulatory Respiratory Endurance, Flexibility and Agility. The purpose of the study was calculating the motor fitness components of inter-university cricket and football players. The subjects for this study were cricket and football interuniversity players of Dr. Ram ManoharLohiyaAwadh University, Faizabad, Uttar Pradesh. Seven tests were administered to assess the motor fitness level i.e. 50 yards run (Speed), Pull-ups (Muscular Strength), Bent knee sit-ups (Muscular Endurance), Standing broad jump (Muscular Power), 600 yards run/walk (Circulatory Respiratory Endurance), Sit and Reach test (Flexibility) and Shuttle run (Agility). The data was statistically analyzed using the 't' test. It was found that there was significant difference between cricket and football players in 50 yards run, bent knee sit-ups, 600 yards run walk, sit and reach test and shuttle run test. There was no significant difference between cricket and football players in pull-ups and standing broad jump test performance. The football players was superior than cricketer in 50 yards run, bent knee sit-ups, 600 yards run walk sit and reach test. The cricket players were better than footballer in shuttle run test. Motor fitness, Speed, Muscular Strength, Muscular Endurance, Muscular Power, Circulatory Respiratory Endurance, Flexibility and Agility.

Despite its long (**Noakes TD and Durandt JJ, 2000**).history and global appeal, relatively little is known about the physiological and other requirements of cricket. It has been suggested that the physiological demands of cricket are relatively mild, except in fast bowlers during prolonged bowling spells in warm conditions. However, the physiological demands of cricket may be underestimated because of the intermittent nature of the activity and the generally inadequate understanding of the physiological demands of intermittent activity. Here, we review published studies of the physiology of cricket. We propose that no current model used to analyse the nature of exercise fatigue (i.e. the cardiovascular-anaerobic model, the energy supply-energy depletion model, the muscle power-muscle recruitment model) can adequately explain the fatigue experienced during cricket. A study of players in the South African national cricket team competing in the 1999 Cricket World Cup revealed that, in a variety of measures of explosive ('anaerobic') power and aerobic endurance capacity, they were as 'fit' as South African national rugby players competing in the 1999 Rugby World Cup. Yet, outwardly, the physiological demands of rugby would seem to be far greater than those of cricket. This poses the question: 'Why are these international cricketers so fit if the physiological demands of cricket are apparently so mild?' One possibility is that this specific group of athletes are unusually proficient in a variety of sports; many achieved high standards of performance in other sports, including rugby, before choosing to specialize in cricket. Hence their apparently high fitness may simply reflect a superior genetic physical endowment, necessary to achieve success in modern international sports, including cricket. Alternatively, it could be hypothesized that superior power and endurance fitness may be required to cope with the repeated eccentric muscle contractions required in turning and in bowling and which may account for fatigue and risk of injury in cricket. If this is the case, the fitness of cricketers may be increased and their risk of injury reduced by more specific eccentric exercise training programmes.

The purpose (**Mikkola J, et.al., 2011**) of this study was to assess the effects of heavy resistance, explosive resistance, and muscle endurance training on neuromuscular, endurance, and high-intensity running performance in recreational endurance runners. Twenty-seven male runners were divided into one of three groups: heavy resistance, explosive resistance or muscle endurance training. After 6 weeks of preparatory training, the groups underwent an 8-week resistance training programme as a supplement to endurance training. Before and after the 8-week training period, maximal strength (one-repetition maximum), electromyographic activity of the leg extensors, countermovement jump height, maximal speed in the maximal anaerobic running test, maximal endurance performance, maximal oxygen uptake ([V•]O($_2$max)), and running economy were assessed. Maximal strength improved in the heavy ($P = 0.034$, effect size $ES = 0.38$) and explosive resistance training groups ($P = 0.003$, $ES = 0.67$) with increases in leg muscle activation (heavy: $P = 0.032$, $ES = 0.38$; explosive: $P = 0.002$, $ES = 0.77$). Only the heavy resistance training group improved maximal running speed in the maximal anaerobic running test ($P = 0.012$, $ES = 0.52$) and jump height ($P = 0.006$, $ES = 0.59$).

Maximal endurance running performance was improved in all groups (heavy: P = 0.005, ES = 0.56; explosive: P = 0.034, ES = 0.39; muscle endurance: P = 0.001, ES = 0.94), with small though not statistically significant improvements in [VO($_2$max) (heavy: ES = 0.08; explosive: ES = 0.29; muscle endurance: ES = 0.65) and running economy (ES in all groups < 0.08). All three modes of strength training used concurrently with endurance training were effective in improving treadmill running endurance performance. However, both heavy and explosive strength training were beneficial in improving neuromuscular characteristics, and heavy resistance training in particular contributed to improvements in high-intensity running characteristics. Thus, endurance runners should include heavy resistance training in their training programmes to enhance endurance performance, such as improving sprinting ability at the end of a race.

This study (**Kraemer WJ,et.al., 2010)** examined effects of periodized maximal versus explosive strength training and reduced strength training, combined with endurance training, on neuromuscular and endurance performance in recreational endurance runners. Subjects first completed 6 weeks of preparatory strength training. Then, groups of maximal strength (MAX, n=11), explosive strength (EXP, n=10) and circuit training (C, n=7) completed an 8-week strength training intervention, followed by 14 weeks of reduced strength training. Maximal strength (1RM) and muscle activation (EMG) of leg extensors, countermovement jump (CMJ), maximal oxygen uptake (VO(2MAX)), velocity at VO(2MAX) (vVO(2MAX)) running economy (RE) and basal serum hormones were measured. 1RM and CMJ improved ($p<0.05$) in all groups accompanied by increased EMG in MAX and EXP ($p<0.05$) during strength training. Minor changes occurred in

VO(2MAX), but vVO(2MAX) improved in all groups ($p<0.05$) and RE in EXP ($p<0.05$). During reduced strength training 1RM and EMG decreased in MAX ($p<0.05$) while vVO(2MAX) in MAX and EXP ($p<0.05$) and RE in MAX ($p<0.01$) improved. Serum testosterone and cortisol remained unaltered. Maximal or explosive strength training performed concurrently with endurance training was more effective in improving strength and neuromuscular performance and in enhancing vVO (2MAX) and RE in recreational endurance runners than concurrent circuit and endurance training.

The effects (**Kaikkonen H,et.al., 2000)** of a 12-week low resistance circuit weight training (CWT) on cardiovascular and muscular fitness were studied in 90 healthy sedentary adults. The subjects were randomized into three equally fit groups: CWT, Endurance (END) and Control (CON) according to their maximal aerobic power (VO2max). Both training groups exercised for 12 weeks, 3 days a week in sessions of 40 min, with a heart rate (HR) level of 70-80% HRmax. The CWT group trained with air resistance machines. Heart rate was controlled by setting the speed of movement. The END group walked, jogged, cross-country skied or cycled. The net differences (between pre- and posttraining changes) between the CWT and CON groups was statistically significant for VO2max (2.45 ml x min(-1) x kg(-1), 95% CI 1.1; 3.8), for abdominal muscles (3.7 reps, CI 0.3; 7.1), for push-ups (1.1 reps, CI 0.2; 2.1), and for kneeling (2.25 reps, CI 0.01; 4.5). The net difference (between pre- and posttraining changes) in the END and CON groups was statistically significant for VO2max (2.75 ml(-1) x min(-1) x kg(-1), 95% CI 0.9; 4.6), and kneeling (3.0 reps, CI 0.7; 5.3). Low resistance CWT with moderately hard HR level has effects comparable to an equal amount of endurance training on the cardiovascular fitness of sedentary adults. The CWT model was benefical also on muscular fitness. Based on the results, this type of exercise can be recommended for beginners because of its multilevel effects.

The aim of this study (**Houghton, LA, et.al.,2013**). was to determine whether intermittent shuttle running times (during a prolonged, simulated cricket batting innings) and Achilles tendon properties were affected by 8 weeks of plyometric training (PLYO, n = 7) or normal preseason (control [CON], n = 8). Turn (5-0-5-m agility) and 5-m sprint times were assessed using timing gates. Achilles tendon properties were determined using dynamometry, ultrasonography, and musculoskeletal geometry. Countermovement and squat jump heights were also assessed before and after training. Mean 5-0-5-m turn time did not significantly change in PLYO or CON (pre vs. post: 2.25 ± 0.08 vs. 2.22 ± 0.07 and 2.26 ± 0.06 vs. 2.25 ± 0.08 seconds, respectively). Mean 5-m sprint time did not significantly change in PLYO or CON (pre vs. post: 0.85 ± 0.02 vs. 0.84 ± 0.02 and 0.85 ± 0.03 vs. 0.85 ± 0.02 seconds, respectively). However, inferences from the smallest worthwhile change suggested that PLYO had a 51–72% chance of positive effects but only 6–15% chance of detrimental effects on shuttle running times. Jump heights only increased in PLYO (9.1–11.0%, $p < 0.050$). Achilles tendon mechanical properties (force, stiffness, elastic energy, strain, modulus) did not change in PLYO or CON. However, Achilles tendon cross-sectional area increased in PLYO (pre vs. post: 70 ± 7 vs. 79 ± 8 mm2, $p < 0.01$) but not CON (77 ± 4 vs. 77 ± 5 mm2, $p > 0.050$). In conclusion, plyometric training had possible benefits on intermittent shuttle running times and improved jump performance. Also, plyometric training increased tendon cross-sectional area, but further investigation is required to determine whether this translates to decreased injury risk

This study (**Vickery W1, et.al.,2013**)investigated the physiological responses and movement demands associated with modified versions of small-sided games for cricket training, termed 'Battlezone'. Eleven (22.2 ± 3.6 years; 1.80 ± 0.06 m; 81.7 ± 11.4 kg) male, cricket players volunteered to perform each of four modified 8-over scenarios of Battlezone. Modifications to Battlezone included reducing the field size, removal of a fielder, a combination of these modifications and additional rule changes. Heart rate, blood lactate concentration, rating of perceived exertion (RPE) and the movement patterns of participants were measured during each scenario. The total distances covered per 8-over bout ranged from 626 ± 335 m for wicketkeepers to 1795 ± 457 m for medium-fast bowlers; although similar distances ($P > 0.05$) were covered within positions between the four different scenarios. Between scenarios, the greatest mean speed, heart rate and blood lactate responses occurred when the rules were changed, resulting in increased movement patterns ($P < 0.05$), most notably for batsmen and wicketkeepers. In contrast, altering the playing field size or player number did not significantly influence ($P > 0.05$) these responses. These results suggest that the physical demands of cricket-specific training can be increased via rule variations including hit-and-run activities, more so than field size or player number.

Physical demands (**Petersen CJ1, et.al.,2011**). of cricket presumably vary by both game format and performance level. Differences in player movement patterns between 2 game formats (1 day and multiday) and 2 levels of elite performance (state and international) were quantified with global positioning system technology. Five movement categories were established, and 15 movement pattern variables were reported. Data from state (n = 42, 200 files) and international (n = 12, 63 files) cricketers were scaled to hourly values to compare movement demands. Cricketers generally covered similar distances in both formats, except for state 1-day fielders who covered moderately greater distance (~0.7 $km \cdot h^{-1}$ more; 21 ± 8%; mean ± 90% confidence interval) than state multiday (first-class) fielders. State 1-day cricketers also covered small to moderately greater distances (running 41 ± 13%; striding 38 ± 16%; sprinting 39 ± 36%) in the faster movement patterns and consequently had moderately less recovery time (13-67%) between high-intensity efforts as first-class cricketers. Comparisons of movements between performance levels revealed similar total distances between state and international cricketers. However, Test fielders covered moderately greater (29-48%) distances at the higher-intensity movement patterns (running, striding, and sprinting) than first-class fielders. In summary, although movement patterns were broadly similar between formats and levels, it appears that one day cricket (compared with multiday games) and test matches (compared with state-level competition) require more higher-intensity running. Conditioning coaches should train state and international 1-day cricket players similarly, but should account for the higher physical demands of international multiday cricket.

A characteristic (**LockieRG1, et.al.,2013**). of cricket sprints, which may require specific assessment, is that players carry a bat when running between the wickets. This study analyzed the relationships between general and specific cricket speed tests, which included 30-m sprint (0- to 5-, 0- to 10-, 0- to 30-m intervals; general); 505 change-of-direction speed test with left and right foot turns (general);

17.68-m sprint without and with (WB) a cricket bat (0- to 5-, 0- to 17.68-m intervals; specific); and run-a-three (specific). Seventeen male cricketers (age = 24.4 ± 5.0 years; height = 1.84 ± 0.06 m; mass = 86.9 ± 13.9 kg) completed the tests, which were correlated ($p < 0.05$) to determine if they assessed different physical qualities. The subjects were also split into faster and slower groups based on the 17.68-m WB sprint time. A 1-way analysis of variance ascertained between-group differences in the tests ($p < 0.05$). The 17.68-m WB sprint correlated with the 0- to 10- and 0- to 30-m sprint intervals ($r = 0.63$-0.78) but not with the 0- to 5-m interval. The run-a-three correlated with the 505 and 17.68-m WB sprint ($r = 0.62$-0.90) but not with the 0- to 5-m interval. Poor relationships between the 0- to 5-m interval and cricket-specific tests may be because of the bat inclusion, as the sprints with a bat began with the subject ahead of the start line, and bat placed behind it. Furthermore, although the 17.68-m WB sprint and run-a-three differentiated faster and slower subjects, the 0- to 5-m sprint interval, and left foot 505, did not. The results indicated the necessity for cricket-specific speed testing. The 17.68-m WB sprint and run-a-three are potentially valuable tests for assessing cricket-specific speed. A bat should be incorporated when testing the running.

The aims of this study (**Portus MR1, et.al., 2000**).were to determine the influence of an 8-over spell on cricket fast bowling technique and performance (speed and accuracy), and to establish the relationship of selected physical capacities with technique and performance during an 8-over spell. Fourteen first-grade fast bowlers with a mean age of 23 years participated in the study. Physical capacities assessed were abdominal strength, trunk stability, selected girth and skinfold measures. During the delivery stride, bowlers were filmed from an overhead and lateral perspective (50 Hz) to obtain two-dimensional data for transverse plane shoulder alignment and sagittal plane knee joint angle respectively. Ball speed was measured by a radar gun and accuracy by the impact point of each delivery on a zoned scoring target at the batter's stumps. Shoulder counter-rotation did not change significantly between overs 2 and 8 for all bowlers, but was significantly related to a more front-on shoulder orientation at back foot impact. When the front-on fast bowlers (n = 5) were isolated for analysis, shoulder counter-rotation increased significantly between overs 2 and 8. Ball speed remained constant while accuracy showed some non-significant variation during the spell. Shoulder counter-rotation was significantly related to accuracy scores during the second half of the 8-over spell. Chest girth and composition and body composition were significantly related to ball release speed at various times during the spell.

Fast bowling (**Wormgoor S1, et.al.,2010**).is fundamental to all forms of cricket. The purpose of this study was to identify parameters that contribute to high ball release speeds in cricket fast bowlers. We assessed anthropometric dimensions, concentric and eccentric isokinetic strength of selected knee and shoulder muscle groups, and specific aspects of technique from a single delivery in 28 high-performance fast bowlers (age 22.0 +/- 3.0 years, ball release speed 34.0 +/- 1.3 m s(-1)). Six 50-Hz cameras and the Ariel Performance Analysis System software were used to analyse the fast and accurate deliveries. Using Pearson's correlation, parameters that showed significant associations with ball release speed were identified. The findings suggest that greater front leg knee extension at ball release (r=0.52), shoulder alignment in the transverse plane rotated further away from the batsman at front foot strike (r=0.47), greater ankle height during the delivery stride (r=0.44), and greater shoulder extension strength (r=0.39) contribute significantly to higher ball release speeds. Predictor variables failed to allow their incorporation into a multivariate model, which is known to exist in less accomplished bowlers, suggesting that factors that determine ball release speed found in other groups may not apply to high-performance fast bowlers.

Studies investigating (**Loram LC1, et.al.,2005**).determinants of ball release speed have examined the technique and anthropometry of fast bowlers with little work being done on muscular strength. The aim of our study was to determine whether knee biomechanics during bowling and strength of the shoulder and knee could predict ball release speed.

Twelve cricketers, aged 16.6+/-0.7) years, from schools in Johannesburg, South Africa, volunteered for the study. Subjects were fast-medium bowlers (mean ball release speed of 29.2+/-1.8 m.s(-1)) and had been bowling for at least 5 years. Three accurate deliveries were filmed on an outdoor cricket pitch, in the sagittal plane with a high-speed digital camera recording at 250 frames per second. The mean ball release speed, knee angle at ball release and knee angle at front foot strike were determined using simple two-dimensional kinematics. On a separate day, peak concentric isokinetic muscle torque was measured for both knees and the dominant shoulder.

Ball release speed was positively correlated to a straight knee at front foot strike (r=0.72, P=0.009) and at ball release (r=0.71, P=0.011). No significant correlation was found between ball release speed and any of the peak torque values (knee extension peak torque, r=-0.11, knee flexion peak torque, r=-0.08, shoulder internal rotation peak torque, r=0.21 and shoulder external rotation, r=0.29, P>0.05). A multiple regression model using knee angle at front foot strike and at ball release, and the angle at which peak torque is generated during shoulder internal and external rotation, predicted ball release speed (adjusted r2=0.85, P<0.002).

We have confirmed that the angle of the front knee at the beginning and end of a delivery is an important correlate of ball release speed in schoolboy fast-medium bowlers. In addition we have also demonstrated that a multiple regression model based on knee kinematics and shoulder peak torque angles can be used to predict ball release speed.

We compared (**Petersen CJ1, et.al., 2010**) the movement patterns of cricketers in different playing positions across three formats of cricket (Twenty20, One Day, multi-day matches). Cricket Australia Centre of Excellence cricketers (n = 42) from five positions (batting, fast bowling, spin bowling, wicketkeeping, and fielding) had their movement patterns (walk, jog, run, stride, and sprint) quantified by global positioning system (GPS) technology over two seasons. Marked differences in movement patterns were evident between positions and game formats, with fast bowlers undertaking the greatest workload of any position in cricket. Fast bowlers sprinted twice as often, covered over three times the distance sprinting, with much smaller work-to-recovery ratios than other positions. Fast bowlers during multi-day matches covered 22.6 +/- 4.0 km (mean +/- s) total distance in a day (1.4 +/- 0.9 km in sprinting). In comparison, wicketkeepers rarely sprinted, despite still covering a daily total distance of 16.6 +/- 2.1 km. Overall, One Day and Twenty20 cricket required approximately 50 to 100% more sprinting per hour than multi-day matches. However, multi-day cricket's longer duration resulted in 16-

130% more sprinting per day. In summary, the shorter formats (Twenty20 and One Day) are more intensive per unit of time, but multi-day cricket has a greater overall physical load.

The aim of this study (**Taliep MS1, et.al.,2010**). was to determine if upper body muscle strength (as measured by the 1 repetition maximum bench press) was associated with cricket batting performance. Cricket batting performance was defined by the maximum hitting distance during a batting task and batting average and strike rate during 1-Day and Twenty/20 (T/20) matches. Eighteen, provincial level, elite cricket batsmen participated in the study. Upper body muscle strength was found to be positively correlated with maximum hitting distance ($p = 0.0052$). There were no significant correlations between upper body strength, batting average, and strike rate for both the 1-Day and T/20 matches. The results of this study have implications for coaches choosing a particular batting line-up. Batsmen who have stronger upper bodies could be favored to bat when a match situation requires them to hit powerful strokes resulting in boundaries. However, coaches cannot use upper body strength as a predictor of overall batting performance in 1-Day or T/20 matches.

This pilot study (**Stuelcken MC1 and Sinclair PJ 2009**). aimed to determine the magnitude of ground reaction forces experienced by female cricket fast bowlers at front foot contact in the delivery stride of the bowling action. The peak vertical force, peak horizontal braking force and vertical loading rate were assessed in 15 elite Australian female fast bowlers. A sequential averaging procedure indicated that a mean of twelve trials (+/-2.8) were required to achieve performance stability across these ground reaction force variables and this demonstrated the importance of analyzing a sufficient number of trials to obtain representative data. The mean peak vertical ground reaction force was 3.49kN (+/-0.81) and the mean peak horizontal braking force was 2.13kN (+/-0.52). Statistical analyses revealed that differences in body mass explained only 2.3% of the variance in peak vertical force and 2.0% of the variance in peak horizontal braking force so normalization using body mass a covariate is not recommended when reporting front foot ground reaction forces in elite female fast bowlers. The mean time to the peak vertical force was 0.033s (+/-0.009) and the vertical loading rate was 121.31kNs(-1) (+/-73.78). Further work is required to determine the best ways to minimise and attenuate front foot ground reaction forces.

This study (**Vickery W1, et.al.,2014**). compared physiological, physical and technical demands of Battlezone, traditional cricket training and one-day matches. Data were initially collected from 11 amateur, male cricket players (age: 22.2 ± 3.3 year, height: 1.82 ± 0.06 m body mass: 80.4 ± 9.8 kg) during four Battlezone and four traditional cricket training sessions encompassing different playing positions. Heart rate, blood lactate concentration, rating of perceived exertion and movement patterns of players were measured. Retrospective video analysis was performed to code for technical outcomes. Similar data were collected from 42 amateur, male cricket players (23.5 ± 4.7 year, 1.81 ± 0.07 m, 81.4 ± 11.4 kg) during one-day matches. Significant differences were found between Battlezone, traditional cricket training and one-day matches within each playing position. Specifically, Battlezone invoked the greatest physiological and physical demands from batsmen in comparison to traditional cricket training and one-day matches. However, the greatest technical demand for batsmen was observed during traditional cricket training. In regards to the other playing positions, a greater physiological, physical and technical demand was observed during Battlezone and traditional training than during one-day matches. These results suggest that the use of Battlezone and traditional cricket training provides players with a suitable training stimulus for replicating the physiological, physical and technical demands of one-day cricket

2.2 REVIEWS ON PERFORMANCE VARIABLES

In thestudy, (**Stretch RA, et.al.,2000**)the researcher evaluate the scientific research into the morphology and physiology of cricket batsmen. We consider all aspects of the motor control of this skill, in the context of research into dynamic interceptive actions, the biomechanics (kinematics and kinetics) of the various phases of batting strokes and injuries to batsmen. Some attention is also devoted to batting equipment and to psychological factors in batting. Because of the lack of published scientific research into women's cricket, this review focuses on the men's game and covers research on batsmen of various playing standards. For the future, we see as a high priority research into injury mechanisms, rather than simple injury statistics, and the role of cricket equipment design in injury prevention. A second priority is for multi- or inter-disciplinary research, linking the biomechanics of batting to the underlying motor control of the movements and the effect of environmental information. Biomechanical studies of the variability of the batsman's movements are needed, and these should be related to the compensatory variability proposal of ecological psychology. Clearly, there is also a need for scientific research into batting in women's cricket, which has been inadequately researched to date.

Throwing speed and accuracy (**Freeston J and Rooney K, 2014**) are both critical to sports performance but cannot be optimized simultaneously. This speed-accuracy trade-off (SATO) is evident across a number of throwing groups but remains poorly understood. The goal was to describe the SATO in baseball and cricket players and determine the speed that optimizes accuracy. 20 grade-level baseball and cricket players performed 10 throws at 80% and 100% of maximal throwing speed (MTS) toward a cricket stump. Baseball players then performed a further 10 throws at 70%, 80%, 90%, and 100% of MTS toward a circular target. Baseball players threw faster with greater accuracy than cricket players at both speeds. Both groups demonstrated a significant SATO as vertical error increased with increases in speed; the trade-off was worse for cricketers than baseball players. Accuracy was optimized at 70% of MTS for baseballers. Throwing athletes should decrease speed when accuracy is critical. Cricket players could adopt baseball-training practices to improve throwing performance.

Cricket fielding (**Robert GL, et.al.,2014**) often involves maximal acceleration to retrieve the ball. There has been no analysis of acceleration specific to cricketers, or for players who field primarily in the infield (closer to the pitch) or outfield (closer to the boundary). This study analyzed the first two steps of a 10-m sprint in experienced cricketers. Eighteen males (age = 24.06 ± 4.87 years; height = 1.81 ± 0.06 m; mass = 79.67 ± 10.37 kg) were defined as primarily infielders (n = 10) or outfielders (n = 8). Timing lights recorded 0-5 and 0-10 m time. Motion capture measured first and second step kinematics, including: step length; step frequency; contact time; shoulder motion; lead and rear arm elbow angle; drive leg hip and knee extension, and ankle plantar flexion; swing leg hip and knee flexion, and ankle dorsi flexion. A one-way analysis of variance ($p < 0.05$) determined between-group differences. Data was pooled for a Pearson's correlation analysis ($p < 0.05$) to analyze kinematic relationships. There were no differences in sprint times, and few variables differentiated infielders and outfielders. Left shoulder range of motion related to second step length ($r = 0.471$). First step hip flexion correlated with both step lengths ($r = 0.570$-0.598), and frequencies ($r = -0.504$--0.606). First step knee flexion related to both step lengths ($r = 0.528$-0.682), and first step frequency ($r = -0.669$). First step ankle plantar flexion correlated with second step length ($r = -0.692$) and frequency ($r = 0.726$). Greater joint motion ranges related to longer steps. Cricketers display similar sprint kinematics regardless of fielding position, likely because players may field in the infield or outfield depending on match situation. Due to relationships with shoulder and leg motion, and the importance and trainability of step length, cricketers should target this variable to enhance acceleration. Key PointsRegardless of whether cricketers field predominantly in the infield or outfield, they will produce relatively similar sprint acceleration kinematics. This is likely due to the fact that cricketers will often field in both areas of the cricket ground, depending on the requirements of the match.Due to the complexity of sprint acceleration, there were relatively few significant correlations between technique variables. However, step length had positive relationships with shoulder range of motion, swing leg hip and knee flexion, and drive leg ankle plantar flexion.As previous research has established the importance of step length to acceleration, as well as the trainability of this kinematic variable, training specifically to improve step length could lead to enhanced sprint acceleration in cricketers.

This study investigated (**McNamara DJ, et.al.,2013**)key fatigue and workload variables of cricket fast bowlers and nonfast bowlers during a 7-wk physical-preparation period and 10-d intensified competition period.

Twenty-six elite junior cricketers (mean ± SD age 17.7 ± 1.1 y) were classified as fast bowlers (n = 9) or nonfast bowlers (n = 17). Individual workloads were measured via global positioning system technology, and neuromuscular function (countermovement jump [relative power and flight time]), endocrine (salivary testosterone and cortisol concentrations), and perceptual well-being (soreness, mood, stress, sleep quality, and fatigue) markers were recorded.

Fast bowlers performed greater competition total distance (median [interquartile range] 7049 [3962] m vs 5062 [3694] m), including greater distances at low and high speeds, and more accelerations (40 [32] vs 19 [21]) and had a higher player load (912 [481] arbitrary units vs 697 [424] arbitrary units) than nonfast bowlers. Cortisol concentrations were higher in the physical-preparation (mean ± 90% confidence intervals, % likelihood; d = -0.88 ± 0.39, 100%) and competition phases (d = -0.39 ± 0.30, 85%), and testosterone concentrations, lower (d = 0.56 ± 0.29, 98%), in the competition phase in fast bowlers. Perceptual well-being was poorer in nonfast bowlers during competition only (d = 0.36 ± 0.22, 88%). Differences in neuromuscular function between groups were unclear during physical preparation and competition.

These findings demonstrate differences in the physical demands of cricket fast bowlers and nonfast bowlers and suggest that these external workloads differentially affect the neuromuscular, endocrine, and perceptual fatigue responses of these players.

Modern-day cricket (**Webster J and Roberts J, 2011**)has experienced a shift towards limited over games, where the emphasis is on scoring runs at a rapid rate. Although the use of protective equipment in cricket is mandatory, players perceive that leg guards, in particular, can restrict their motion. The aim of this study was to determine the influence of cricket leg guards on running performance. Initial testing revealed that wearing pads significantly increased the total time taken to complete three runs by up to 0.5 as compared with running without pads ($P < 0.05$). In addition, we found that the degree of impedance was dependent on pad design and could not be solely attributed to additional weight. To assess possible causes of reduced running performance, a biomechanical analysis was performed, investigating running kinematics, stride parameters, and ground reaction forces. The results revealed that the widest pad had the greatest effect on running kinematics, increasing hip abduction and decreasing hip extension, resulting in a shortened stride length (by 0.10 m) and increased stride width (by 0.12 m) compared with running without pads. Wearing pads also significantly increased peak braking force (by up to 0.3 times body weight [BW]), braking impulse (by up to 0.012 BW · s(-1)), peak mediolateral force (by up to 0.17 BW), and mediolateral impulse (by up to 0.016 BW · s(-1)) compared with running without pads, which resulted in reduced force applied in the direction of locomotion. The consequence of this reduction in running performance is an increased risk of being run-out or a reduction in the number of runs that could be scored from a particular shot.

The aim of this (**Loock N, et.al., 2006**). study was to compare a batsman's running and turning speed during three runs while wearing either traditional batting pads or one of two models of newly designed cricket batting pads. Fifteen cricketers participated. The running and turning speeds were measured on three different days with players using the three pairs of batting pads for each trial in random order. The weights of the pads were 1.85 kg, 1.70 kg and 1.30 kg for P1, P2 and P3 respectively. Each player had to run three runs (3 x 17.68m), with the times recorded at the completion of each run, as well as the time to cover the distance from 5 m before and after the turn at the end of the first run. The fastest time from two trials for each pair of pads was retained for analysis. An analysis of variance (ANOVA) with repeated measures was used to determine the differences between the mean times of the three trials. The results showed no significant differences between the types of batting pads and the time to complete the run-three-runs test (P1 = 10.67 +/- 0.48 s; P2 = 10.67 +/- 0.43; P3 = 10.69 +/- 0.44 s), the turning time (P1 = 2.34 +/- 0.18 s; P2 = 2.32 +/- 0.18 s; P3 = 2.35 +/- 0.19 s) and to complete the third run (P1 = 3.49 +/- 0.44 s; P2 = 3.53 +/- 0.34 s; P3 = 3.51 +/- 0.36 s). Of the 45 trials of three runs used for analysis, P1 recorded the fastest time on 16 trials (36%), P2 on 19 trials (42%) and P3 on 10 trials (22%). The results showed no significant differences in the running or turning speeds, although there may be some practical relevance to using the newly designed cricket batting pads.

High ground (**Worthington P,et.al.,2013**). reaction forces during the front foot contact phase of the bowling action are believed to be a major contributor to the high prevalence of lumbar stress fractures in fast bowlers. This study aimed to investigate the influence of front leg technique on peak ground reaction forces during the delivery stride. Three-dimensional kinematic data and ground reaction forces during the front foot contact phase were captured for 20 elite male fast bowlers. Eight kinematic parameters were determined for each performance, describing run-up speed and front leg technique, in addition to peak force and time to peak force in the vertical and horizontal directions. There were substantial variations between bowlers in both peak forces (vertical 6.7 ± 1.4 body weights; horizontal (braking) 4.5 ± 0.8 body weights) and times to peak force (vertical 0.03 ± 0.01 s; horizontal 0.03 ± 0.01 s). These differences were found to be linked to the orientation of the front leg at the instant of front foot contact. In particular, a larger plant angle and a heel strike technique were associated with lower peak forces and longer times to peak force during the front foot contact phase, which may help reduce the likelihood of lower back injuries.

Batting performance (**LemmerHH, 2011**) measures containing strike rate adjustments take into account the important fact that if two batsmen had scored the same number of runs in a match, the one with the better strike rate had performed best. But match conditions can influence the batting and bowling performances of cricket players. On a good pitch a batsman can get a good score at a high strike rate, but if the pitch was bad, a similar good score is normally accompanied by a much lower strike rate. The main objective of this study is to propose a method that can be used to make batsmen's scores comparable despite the fact that playing conditions might have been very different. The number of runs scored by a batsman is adjusted by comparing his strike rate with the overall strike rate of all the players in the specific match. These adjusted runs are then used in the most appropriate formula to calculate the average of the batsman. The method is illustrated by using the results of the Indian Premier League 2009 Twenty20 Series played during May and June 2009. The main conclusion is that the traditional average is not the most appropriate measure to compare batsmen's performances after conclusion of a short series. It is unfair to compare the score of a batsman obtained on a good pitch under ideal batting conditions with that of a batsman who had to battle under severe conditions.By comparing a batsman's strike rate with the overall strike rate of the players in the specific match, his score can be adjusted to get a better figure for his true performance.The results demonstrate clearly that the use of adjusted scores lead to rankings that differ from those based on the traditional measures.

This study sought (**Chin A, et.al.,2009**) to identify kinematic differences in finger-spin bowling actions required to generate variations in ball speed and spin between different playing groups. A 12-camera Vicon system recorded the off-spin bowling actions of six elite and 13 high-performance spin bowlers, and the "doosra" actions of four elite and two high-performance players. Forearm abduction and fixed elbow flexion in the bowling arm were higher for the elite players compared with the high-performance players. The elite bowlers when compared with the high-performance players delivered the off-break at a statistically significant higher velocity (75.1 and 67.1 km/hr respectively) and with a higher level of spin (26.7 and 22.2 rev/s respectively). Large effect sizes were seen between ball rotation, pelvic and shoulder alignment rotations in the transverse plane. Elbow extension was larger for elite bowlers over the period upper arm horizontal to ball release. Compared to the off-break, larger ranges of shoulder horizontal rotation, elbow and wrist extension were evident for the "doosra". Furthermore, the "doosra" was bowled with a significantly longer stride length and lower ball release height. Although not significantly different, moderate to high effect size differences were recorded for pelvis rotation, elbow extension and elbow rotation ranges of motion.

The link between (**Weissensteiner J,et.al.,2008**) the anticipation skills of cricket batsmen and their practice histories was examined. Skilled and lesser skilled batsmen of U15, U20, and adult age completed a temporal occlusion task, in which they were required to use prerelease kinematic information to predict the type and length of delivery being bowled, and a structured interview, in which their accumulated hours of experience in organized and unorganized sporting activities were estimated. Skilled adult and U20 players showed an ability to use prerelease kinematic information to anticipate ball type that was not evident among any other group, and skilled players of all ages were distinguishable in terms of their accumulated hours of cricket-specific experience. Hours of cricket-specific practice, however, explained only a modest percentage of the variance in anticipatory skill. Discussion focuses upon future refinements to the measurement of anticipation and practice history plus the role that variables other than the quantum of cricket experience may play in developing anticipation.

The laws of bowling (**Marshall R and Ferdinands R, 2003**)in cricket state 'a ball is fairly delivered in respect of the arm if, once the bowler's arm has reached the level of the shoulder in the delivery swing, the elbow joint is not straightened partially or completely from that point until the ball has left the hand. Recently two prominent bowlers, under suspicion for transgressing this law, suggested that they are not 'throwing' but due to an elbow deformity are forced to bowl with a bent bowling arm. This study examined whether such bowlers can produce an additional contribution to wrist/ball release speed by internal rotation of the upper arm. The kinematics of a bowling arm were calculated using a simple two-link model (upper arm and forearm). Using reported internal rotation speeds of the upper arm from baseball and waterpolo, and bowling arm kinematics from cricket, the change in wrist speed was calculated as a function of effective arm length, and wrist distance from the internal rotation axis. A significant increase in wrist speed was noted. This suggests that bowlers who can maintain a fixed elbow flexion during delivery can produce distinctly greater wrist/ball speeds by using upper arm internal rotation.

In this study (**Portus M,et.al.,2004)** we analysed technique, ball speed and trunk injury data collected at the Australian Institute of Sport (AIS) from 42 high performance male fast bowlers over a four year period. We found several notable technique inter-relationships, technique and ball speed relationships, and associations between technique and trunk injuries. A more front-on shoulder alignment at back foot contact was significantly related to increased shoulder counter-rotation ($p < 0.001$). Bowlers who released the ball at greater speeds had an extended front knee, or extended their front knee, during the front foot contact phase ($p < 0.05$). They also recorded higher braking and vertical impact forces during the front foot contact phase and developed those forces more rapidly (p < or =0.05). A maximum hip-shoulder separation angle occurring later in the delivery stride ($p = 0.05$) and a larger shoulder rotation to ball release ($p = 0.05$) were also characteristics of faster bowlers. Bowlers suffering lower back injuries exhibited typical characteristics of the 'mixed' technique. Specifically, the hip to shoulder separation angle at back foot contact was greater in bowlers who reported soft tissue injuries than in non trunk-injured bowlers ($p = 0.03$), and shoulder counter-rotation was significantly higher in bowlers who reported lumbar spine stress fractures than non trunk-injured bowlers ($p = 0.01$). The stress fracture group was also characterised by a larger hip angle at front foot contact and ball release, whereas a more flexed front knee at ball release characterised the non trunk-injured group.

The aim of this study (**Roca M, et.al.,2006**)was to examine the relationship between shoulder alignment and elbow angle during the delivery action of fast-medium bowlers. The elbow and upper trunk alignment were recorded for 13 high-performance bowlers (mean age 20 years) using a 12-camera Vicon motion analysis system operating at 250 Hz. The three highest velocity trials for "good" and "short" length deliveries were analysed. Results showed that bowlers with a more front-on shoulder alignment at back-foot impact and when the upper arm was horizontal to the ground experienced a significantly greater elbow flexion--extension range when compared with those who had a more side-on orientation at the same point in the delivery action. Bowlers with greater shoulder counter-rotation also recorded higher elbow flexion and subsequently extension during the period from upper arm horizontal to ball release. Shoulder alignment and elbow angles were similar for "short" and "good" length deliveries. It was concluded that bowlers with a more front-on shoulder orientation at back-foot impact demonstrated a higher elbow extension from upper arm horizontal to ball release and are therefore more likely to infringe International Cricket Council elbow tolerance levels, compared with those who adopt a more side-on shoulder orientation at back-foot impact.

The effects of training (**Carl Petersena, et.al., 2004**) with overweight and underweight cricket balls on fast-bowling speed and accuracy were investigated in senior club cricket bowlers randomly assigned to either a traditional ($n = 9$) or modified-implement training ($n = 7$) group. Both groups performed bowling training three times a week for 10 weeks. The traditional training group bowled only regulation cricket balls (156 g), whereas the modified-implement training group bowled a combination of overweight (161 - 181 g), underweight (151 - 131 g) and regulation cricket balls. A radar gun measured the speed of 18 consecutive deliveries for each bowler before, during and after the training period. Video recordings of the deliveries were also analysed to determine bowling accuracy in terms of first-bounce distance from the stumps. Bowling speed, which was initially 108±5 km·h−1 (mean±standard deviation), increased in the modified-implement training group by 4.0 km·h−1 and in the traditional training group by 1.3 km·h−1 (difference, 2.7 km·h−1; 90% confidence limits, 1.2 to 4.2 km·h−1). For a minimum worthwhile change of 5 km·h−1, the chances that the true effect on bowling speed was practically beneficial/trivial/harmful were 1.0/99/<0.1%. For bowling accuracy, the chances were 1/48/51%. This modified-implement training programme is not a useful training strategy for club cricketers.

Throwing performance (**Jonathan Freestona&KieronRooneya, 2008**)is vital within the sport of cricket. However, little published evidence exists regarding methods to improve throwing velocity and/or accuracy in any cricket-playing population. This study, therefore, assessed the efficacy of progressive velocity throwing training on throwing velocity and accuracy in a cricket-specific test. Eighteen sub-elite male cricket players were assessed for maximal throwing velocity and throwing accuracy at four different throwing velocities relative to maximal throwing velocity. The participants were randomly assigned to either an intervention (n=9) or control (n=9) group. Both groups performed usual pre-season activities for 8 weeks, during which the intervention group performed two additional specific throwing training sessions per week. Maximal throwing velocity was re-assessed at 4 weeks and the progressive velocity throwing programme was adjusted accordingly. The 8-week progressive velocity throwing training significantly increased peak and mean maximal throwing velocity ($P = 0.01$). Absolute changes in peak and mean maximal throwing velocity were negatively and significantly correlated with initial maximal throwing velocity at 4 weeks ($r=-0.805$, $P = 0.01$ and $r=-0.806$, $P = 0.01$ respectively) but not at 8 weeks. No significant difference was observed in accuracy for either group at any time. This is the first published study to describe the effectiveness of a progressive velocity throwing training programme on throwing performance in a group of sub-elite cricket players. The addition of two specific throwing training sessions per week can increase maximal throwing velocity without detriment to throwing accuracy.

2.3 OVERVIEW ON THE REVIEWS

Researcher selected three types of strength training programmes namely weight training, circuit training and interval strength training and the physical variables speed, strength, explosive power, agility, endurance and performance variables batting, bowling and fielding in cricket. The reviews of the studies showed that systematic strength training improved the physical variables. Few studies specifically mentioned that strength training with proper recovery improved cardio respiratory endurance and muscular endurance of the participants.A specific exercise in strength training develops the strength of the respiratory muscles and respiratory passage. As cricketer needs lot of physical fitness to play over 3 hours continuously it can be achieved through strength training and it supports the skill development of batting, bowling and fielding.