CHAPTER II

REVIEW OF RELATED LITERATURE

2.1 Introduction

2.2 Need for review

2.3 Reviews related to Circuit training

2.4 Reviews related to Interval training

2.5 Reviews related to the game Kabaddi

2.6 Reviews related to Physical variables

2.7 Reviews related to Physiological variables

2.8 Reviews related to Psychological variables
CHAPTER II

REVIEW OF RELATED LITERATURE

2.1 Introduction

A valuable study depends upon the relevant literature to get a clear picture and outlook with regard to the problem under the study. Thus review helps to bring out a deep and clear insight into the work to be done. Research is considered to be more structured and systematic process of controlled observation that may lead to development of an organized body of knowledge. This organized body is the result of a scientific analysis accurate observation and experimentation. As far a research is concerned it can never be undertake in isolation of the work that has already been done on the problems which are directly or indirectly related to a study proposed by an investigator. One of the important steps in the planning of any research study is a careful review of the research journals, books, dissertations, and other sources of informations on the problem to be investigated. Therefore, a review of the related literature must precede any well planned research study.

In the words of Mouly (1964) "A review of related literature is a very important step not only in finding a problem, but also in the formation of hypothesis, in the selection of methods and
tools to be employed. Besides it is essential to be developed of the problem and derivation of an effective approach to its solution”.

### 2.2 Need for review

According to Good, (1945) "The Key to the vast shore house of published literature may open doors to sources of significant problems and explanatory hypothesis, and provide helpful orientation for the significance of the problems, background for selection of procedure and comparative data for interpretation of results. In order to be truly creative and original, one must read extensively and critically as a stimulus to thinking”.

In the words of Best (1997) “A familiarity with the literature in any problems area helps the student to discover what is already known what other have attempted to find out, what methods of attack have been promising or disappointing and what problems remains to be unsolved”

Primary as well as secondary data can be used as related literature. Primary data of beginning or original, or all new data which have been gathered, are in the process of being gathered. While secondary data are those it that have been collected previously and reported by some individual other than the present investigator. The important objectives of the review of related literature are given below:

- To enable the investigator to define the limits of this field
- To avoid unfruitful and useless problem area.
- To avoid unintentional duplication of well established findings.
- To give an understanding of the research methodology
- To know previous recommendations

Chanda, & Sharma (1997).

In this chapter, the investigator includes the literature related to the present study, under the following heads.
2.3 Reviews related to Circuit training

*Taskin H, (2009)* conduct a study 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 (plus or minus) 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 post training 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 post testing for the CTG (pre test = 14.76 (plus or minus) 0.48 seconds, post test = 14.47 (plus or minus) 0.43 seconds). Also, there was a significant (p < 0.05) difference in anaerobic endurance between pre and post testing for the CG (pretest = 31.53 (plus or minus) 0.48 seconds, post test = 30.73 (plus or minus) 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.

*Gettman & Pollock, (1980-81)* have conducted an extensive review of the research that has been conducted in the area of circuit training and derived the advantages viz; (a) It is an activity that attends to the major components of athletic fitness, (b) It can be conducted in a very small area (small room with a multi station weight training machine); and (c) the complete workout (3sets) can be completed in less than 30 minutes. Further, the work out can be highly motivating.

*Olesen* (1981) studied the effect of a set of circuit training programme on strength and muscular endurance of college age men (N = 42) enrolled in weight training classes. Pre and post-test for 1RM straight absolute muscular endurance and relative muscular endurance were given of two workout session per week of seven weeks. In each session students were requested to complete two set of ten exercises. Both sets of an exercise were completed a student moved to the next
activity. A work result ratio of 20 sec/10 sec was used. The test/ retest procedure and pre and post test means changes were analysed using person's ‘r’ and dependent ‘t’ analysis. Men changes between pre and post tests for 1 RM strength in the bench press and by press, and relative muscular endurance in the bench press were significant (p < 0.05) no significant change in relative muscular endurance in the leg press (p < 0.05).

Simmons (1967) studied the effect of circuit training upon cardio vascular condition and motor performance. Fifteen male students physical education course were the subjects. The training was done twice in 9 week in thirty minutes of period for value weeks. The results of this study showed statistically significant mean improvement in nine to fourteen cardiovascular variables and in all thirteen motor fitness variables. Highest mean improvement observed in dynamometrical leg strength, dips and shoulder extension and flexibility.

Miller (1969) investigated the effectiveness of circuit training and weight training on upper body strength in ninth grade boys (N=50). The boys were administrated the Oregon simplification of Rogers's physical fitness index to assess the development of the upper body strength. After a six week training programme both weight training and circuit training programs produced significant gains in upper body with circuit gain being greater.

Randal R. Kirk (1969) in his study effects of circuit training on running half a mile for mid three groups, the first group (N=30) used interval training in the second had (N=30) circuit training addition to interval training and the third group (N=20) acted as the control group. The interval running programme was identified for both the experimental groups and was progressive included a battery of eight exercise with the objective of completing a circuit (consisting of three complete sets of exercise) in less time during each training session. The control group had instruction in Badminton. The experiment was conducted on alternate days, over an eight weeks period. The results showed that the interval training and the circuit training groups were significantly faster than the control group. No significant differences were found between the interval running group and the circuit training group.
Circuit training was developed by **R.E. Morgan and G.T. Anderson in (1953)** at the University of Leeds in England (Sorani, 1966). The term circuit refers to a number of careful sequences at the mentioned stations in a circuit. In the original format, 9 to 12 stations comprised the circuit. This number may vary according to the design of the program. Each participant moves from one station to the adjacent within 15 to 30 seconds and without rest, performing a 15 to 45 seconds workout of 8 to 20 repetitions at each station using a resistance of about 40% to 60% of one repetition maximum. The program may be performed with exercise machines, hand hold weights, elastic resistance, calisthenics or any combination.

**Allen et al (1976)** investigated a new concept in training that has a great deal of application for off-season conditioning. Thus emerged the circuit training concept with traditional weight training into a form of training, now referred circuit weight training.

**Hamrick (1968)** made a comparative analysis of the three days a week and two days a week schedules of circuit training. Two groups of male college freshmen (N = 22) were formed and they participated in an eight weeks circuit training programme which consisted of three hours of conditioning per week using an analysis of variance. It was found that the Mmonday - Wednesday Friday group, was significantly better, to the Tuesday - Thursday group. However, the data revealed no significant difference in improvement by either group in any other component of fitness. The 'F' ratio obtained for difference in pre and post test measures revealed significant improvement for both group in recovery pulse, agility, flexibility, arm strength, leg strength and abdominal strength. The Monday Wednesday and Friday group was also successful in improving terminal pulse.

**2.4 Reviews related to Interval training**

**Tabata I, Nishimura K, Kouzaki M, Hirai Y, Ogita F, Miyachi M, Yamamoto K. (2003)** Department of Physiology and Biomechanics, National Institute of Fitness and Sports, Kagoshima Prefecture, conducted the study consisting of two interval training experiments using a
mechanically braked cycle ergometer. First, the effect of 6 week of moderate-intensity endurance training (intensity: 70% of maximal oxygen uptake (VO\textsubscript{2max}), 60 min.d\textsuperscript{-1}, 5 d.wk\textsuperscript{-1}) on the anaerobic capacity (the maximal accumulated oxygen deficit) and VO\textsubscript{2max} was evaluated. After the training, the anaerobic capacity did not increase significantly (P > 0.10), while VO\textsubscript{2max} increased from 53 +/- 5 ml.kg\textsuperscript{-1} min\textsuperscript{-1} to 58 +/- 3 ml.kg\textsuperscript{-1}.min\textsuperscript{-1}(P < 0.01) (mean +/- SD). Second, to quantify the effect of high-intensity intermittent training on energy release, seven subjects performed an intermittent training exercise 5 d.wk\textsuperscript{-1} for 6 wk. The exhaustive intermittent training consisted of seven to eight sets of 20-s exercise at an intensity of about 170% of VO\textsubscript{2max} with a 10-s rest between each bout. After the training period, VO\textsubscript{2max} increased by 7 ml.kg\textsuperscript{-1}.min\textsuperscript{-1}, while the anaerobic capacity increased by 28%. In conclusion, this study showed that moderate-intensity aerobic training that improves the maximal aerobic power does not change anaerobic capacity and that adequate high-intensity intermittent training may improve both anaerobic and aerobic energy supplying systems significantly, probably through imposing intensive stimuli on both systems.

John A. Babraj, Niels B. J. Vollaard, Cameron Keast, Fergus M. Guppy, Greg Cottrell and James A. Timmons (2009) conducted an extremely low volume high-intensity interval training (HIT) to produce improvements to aerobic function. Sixteen young men (age: 21 ± 2 y; BMI: 23.7 ± 3.1 kg·m\textsuperscript{-2}; VO\textsubscript{2peak}: 48 ± 9 ml·kg\textsuperscript{-1}·min\textsuperscript{-1}) performed 2 weeks of supervised HIT comprising of a total of 15 min of exercise (6 sessions; 4–6 × 30-s cycle sprints per session). Aerobic performance (250-kJ self-paced cycling time trial), and glucose, insulin and NEFA responses to a 75-g oral glucose load (oral glucose tolerance test; OGTT) were determined before and after training. The efficacy of a high intensity exercise protocol, involving only ~250 kcal of work each week, to substantially improve insulin action in young sedentary subjects is remarkable. This novel time-efficient training paradigm can be used as a strategy to reduce metabolic risk factors in young and middle aged sedentary populations who otherwise would not adhere to time consuming traditional aerobic exercise regimes. Recently an extremely low volume high-intensity interval training paradigm (HIT), consisting of no more than 7.5 minutes of exercise per week, has been proposed as a novel, time-efficient exercise regime for improving aerobic fitness. We
speculated that it should be possible to substantially improve insulin action using HIT despite a negligible contribution to total energy expenditure as this training model would substantially reduce muscle glycogen stores. Compared to traditional strategies for reduction of risk factors of CVD and T2D, the extremely low volume of exercise required with HIT may promote adherence and thus represent a genuinely preventative public health strategy.

Twenty-five young healthy sedentary or recreationally active men were recruited to participate in this study, with none engaged in a structured endurance training program. Subjects were randomly allocated to one of two parts of the study. Sixteen subjects (mean ± SD: 21 ± 2 y; 82 ± 17 kg; 1.83 ± 0.08 m; BMI: 23.7 ± 3.1 kg·m$^{-2}$; VO$_2$max: 48 ± 9 ml·kg$^{-1}$·min$^{-1}$) were allocated to the main part of the study, and completed the full experimental procedures. The remaining nine subjects (mean ± SD: 23 ± 8 y; 73 ± 9 kg; 1.78 ± 0.09 m; 23.0 ± 1.4 kg·m$^{-2}$; VO$_2$max: 47 ± 11 ml·kg$^{-1}$·min$^{-1}$) took part in a separate experiment to determine intra-individual variation in response to an oral glucose tolerance test, and did not perform HIT. There were no significant differences in the age, height, weight, BMI or VO$_2$max between the two groups of subjects. Subjects were informed of the experimental protocol both verbally and in writing before giving informed consent. Furthermore, all subjects were informed about how potential life-style changes could affect the results of the study, and were requested to maintain their normal diet and levels of physical activity (apart from the training program) throughout the duration of the study. The sprint training protocol was similar to that used previously by Burgomaster et al. six sessions of sprint interval exercise were spread over 14 days, with 1 or 2 days of rest between each session. Each training session consisted of 4–6 repeated 30-s all-out cycling efforts against a resistance equivalent to 7.5% of body weight (Wingate tests), with 4 min of recovery between sprints. During recovery, subjects remained on the bike and either rested or cycled at a low cadence without resistance. The number of sprints increased from 4 during the first two sessions, to 5 in the third and fourth sessions, and 6 in the last two sessions. Total time commitment was 17–26 min per session, involving only 2–3 minutes sprint exercise.
Tuimil JL, Boullsa DA, Fernandez-del-Olmo MA, Rodriguez FA (2005), evaluated the effect of 2 different interval and continuous training programs on the maximal aerobic speed (MAS), time limit at MAS (T(lim)), and on the countermovement jump (CMJ). Twenty-two physically active men were randomly distributed in an interval training group (ITG), continuous training group (CTG), and control group. The CTG and ITG performed 2 different training programs (65-70 and 90-100% of the MAS for CTG and ITG, respectively) that consisted of 3 sessions per week during a period of 8 weeks with an identical external workload (% MAS × duration in minutes). The MAS, the T (lim) and the CMJ were recorded before and after the running training programs. The data analysis showed a significant and similar improvement (p < 0.01) of the MAS for both the ITG (5.8%) and CTG (8.3%). The T (lim) and CMJ did not change significantly for either group after the training period. Our results indicate that 8 weeks of continuous or interval running programs with externally equated load led to similar improvements in the MAS without changing T(lim) and CMJ performance in moderately trained nonrunners.

Buchheit M, Mendez-Villanueva A, Quod M, Quesnel T, Ahmaidi S (2009), analyse aim of the current study was to compare the effects of speed/agility (S/A) training with sprint interval training (SIT) on acceleration and repeated sprint ability (RSA) in well-trained male handball players. In addition to their normal training program, players performed either S/A (n = 7) or SIT (n = 7) training for 4 wk. Speed/agility sessions consisted of 3 to 4 series of 4 to 6 exercises (eg, agility drills, standing start and very short sprints, all of <5 s duration); each repetition and series was interspersed with 30 s and 3 min of passive recovery, respectively. Sprint interval training consisted of 3 to 5 repetitions of 30-s all-out shuttle sprints over 40 m, interspersed with 2 min of passive recovery. Pre- and posttests included a countermovement jump (CMJ), 10-m sprint (10m), RSA test and a graded intermittent aerobic test (30-15 Intermittent Fitness Test, V(IFT)).S/A training produced a very likely greater improvement in 10-m sprint (+4.6%, 90% CL 1.2 to 7.8), best (+2.7%, 90% CL 0.1 to 5.2) and mean (+2.2%, 90% CL -0.2 to 4.5) RSA times than SIT (all effect sizes [ES] greater than 0.79). In contrast, SIT resulted in an almost certain greater improvement in V(IFT) compared with S/A (+5.2%, 90% CL 3.5 to 6.9, with ES = -0.83).In well-trained handball
players, 4 wk of SIT is likely to have a moderate impact on intermittent endurance capacity only, whereas S/A training is likely to improve acceleration and repeated sprint performance.

**Fernandez-Fernandez J, Zimek R, Viewelhove T, Ferrauti A (2008),** analyse the aim of this study was to compare the effects of high-intensity interval training (HIIT) and repeated-sprint training (RST) on aerobic fitness, tennis-specific endurance, linear and repeated-sprint ability (RSA), and jumping ability. Thirty-one competitive male tennis players took part in a training intervention of 6 weeks. The players were matched into 3 groups, HIIT (n = 11), RST (n = 12), or control group (CON, n = 9). The results showed significant time × intervention interactions for \( \text{VO}_2\text{peak} \), with a significant increase in the \( \text{VO}_2\text{peak} \) level of 6.0% in HIIT (\( p = 0.008 \)) and 4.9% in RST (\( p = 0.010 \)), whereas no changes occurred in CON. However, the following differences were found between the intervention groups: The HIIT-induced greater improvements in tennis-specific endurance (HIIT 28.9% vs. RST 14.5%; \( p < 0.05 \)) and RST led to a significant improvement in RSA (i.e., reduction in the mean sprint time of 3.8%; \( p < 0.05 \)). Neither training strategy induced any effects on jumping and sprinting abilities. Both training interventions showed similar improvements in general aerobic fitness. Also, the present results suggest that RST represents a time-efficient stimulus for a simultaneous improvement of general and tennis-specific aerobic fitness as well for RSA.

**Billat (2001)** Studies of anaerobic interval training can be divided into 2 categories. The first category (the older studies) examined interval training at a fixed work-rate. They measured the time limit or the number of repetitions the individual was able to sustain for different pause durations. The intensities used in these studies were not maximal but were at about 130 to 160% of maximal oxygen uptake (\( \text{VO}_2\text{max} \)). Moreover, they used work periods of 10 to 15 seconds interrupted by short rest intervals (15 to 40 seconds). The second category (the more recent studies) asked the participants to repeat maximal bouts with different pause durations (30 seconds to 4 to 5 minutes). These studies examined the changes in maximal dynamic power during successive exercise periods and characterised the associated metabolic changes in muscle. Using short-interval training, it
seems to be very difficult to elicit exclusively anaerobic metabolism. However, these studies have clearly demonstrated that the contribution of glycogenolysis to the total energy demand was considerably less than that if work of a similar intensity was performed continuously. However, the latter studies used exercise intensities that cannot be described as maximal. This is the main characteristic of the second category of interval training performed above the minimal velocity associated with VO_{2max} determined in an incremental test (VO_{2max}). Many studies on the long term physiological effect of supramaximal intermittent exercise have demonstrated an improvement in VO_{2max} or running economy.

Kent (2010) BSMS, University of Sussex, Brighton, UK. Greater aerobic fitness is associated with improved cardiovascular health. Traditionally high volume (long duration and low intensity) endurance training (ET) has been used to increase aerobic fitness. Interval training where periods of hard exercise are interspersed with periods of recovery can also enhance endurance performance. Sprint interval training (SIT) is a low volume and high intensity form of interval training. Energy for SIT is produced via both the aerobic and anaerobic metabolic pathways and is potentially an efficient and effective means to improve aerobic fitness. The aim was to systematically review the effects of SIT on aerobic endurance performance in untrained individuals. PubMed, the Cochrane Library, ScienceDirect, and Sport discus were searched up to August 2008. The reference lists of relevant papers were also searched. Included articles were limited to English language, controlled studies, investigating SIT in healthy untrained or recreationally active participants (VO_{2max} < 55 ml/kg/min) with an outcome measure of endurance performance (as a measure of aerobic fitness). Studies fulfilling the selection criteria were assessed for methodological quality and relevant outcome data extracted. A consistent association was noted between SIT and improved endurance performance. SIT produced an improvement of ~ 4% (95%CI −0.2 to 8.7), ~8 to 10% (0.4 to 16), and ~15% (0.8 to 29) after 1, 2 and 6 weeks respectively. These improvements were of the same magnitude as the improvements noted for ET, but the training volume required was approximately 90% less. Short duration SIT is an effective and efficient form of improving aerobic fitness in untrained individuals. These results could have a significant impact upon physical
activity recommendations for health and fitness if further studies can confirm the health benefits associated with longer duration ET also occur with brief SIT interventions.

Costill (1980) has made the important distinction between three types of interval training, aerobic, aerobic-anaerobic and anaerobic. The future training process doesn't lie entirely with in the hands of those directly associated with it. On the contrary it will inevitably follow the trends and developments within our society as a whole. Note that, sports is effective in shaping the future, but it is only a part of a larger whole and is more likely to be guided by the actions of the largest until it create its own exclusive means of progress.

Humphreys and Holman (1985) credit the famous German Coach, Woldemar Ger Schler with the formalization of a structured system of interval training in 1980's with interval training, short to moderate periods, of work are alternated with short to moderate periods of rest or reduced activity. The interval training approach can be used in almost any sport or activities but has its greatest applications in track, cross country and swimming.

Fox and Mathews (1974) identified the five variables that must be individuals adjusted for each athlete and those are; Race and distance of work interval, number of repetition, and sets during each training session, duration of the rest, recovery of relief interval. As the athlete becomes better conditioned he/she will be able to increase the intensity or decrease the duration of the rest interval or both in the worldwide coaches are in various disciplines in sports have conducted research to find out an appropriate way of training programme for their athletes and players to improve their strength endurance which is special factor contributing towards athlete's performance.

Sebastian (1998) conducted a study on relative analysis of progressive training and alternate, high and low intensity training on speed, flexibility and explosive power of boys. Sixty boys were selected at random from the subjects who had successfully completed minimum strength requirement test. The selected subjects put at random into one of the three groups, (n = 20). Group 1 underwent conventional progressive training, group 2 underwent alternate high and low intensity
training and group 3 acted as control. The experimental groups were trained in their respective training programmes, five times a week for fourteen weeks. Prior to and after the training programme, the subjects were tested for speed, flexibility and explosive power. The data were examined by analysis of variance. Performance in speed, flexibility and explosive power improved significant for both progressive and alternate high and low intensity training when compared to the control group, and no significant difference existed between the training groups.

Dupont et al (2004) investigated the effects of in season, high intensity interval training on professional male soccer player's running performances. Twenty-two subjects participated in 2 consecutive training periods of 10 weeks. The first period was considered a control period and was compared with a period where 2 high-intensity interval training exercises were included in the usual training program. Intermittent runs consisted of 12-15 runs lasting 15 seconds at 120% of maximal aerobic speed alternated with 15 seconds of rest. Sprint repetitions consisted of 12-15 all-out 40m runs alternated with 30 seconds of rest. Results from the high-intensity interval training have shown that maximal aerobic speed was improved and mat the time of the 40-m sprint was decreased, whereas no change in either parameter was observed during the control period. This study shows that improvements in physical qualities can be made during the in season period.

Edge et al. (2005) compared the effects of high-intensity interval (HIT) and moderate-intensity continuous (MIT) training on changes in repeated-sprint ability (RSA) and muscle metabolism. Pre and post training, VO$_2$ (peak), lactate threshold (LT), and RSA (5 x 6-s sprints, every 30 s) were assessed in 20 females. Subjects were matched on RSA, randomly placed into the HIT (N = 10) or MIT (N = 10) group and performed 5 week (3 days per week) of cycle training; performing either HIT (6-10, 2-min intervals at 120-140% LT) or MIT (continuous, 20-30 min at 80-95% LT). Both groups had significant improvements in VO$_2$ (peak) and LT, with no significant differences between them. Both groups also had significant increases in RSA total work (kJ), with a significantly greater increase following HIT than MIT (13 vs 85%, respectively; P < 0.05). They
concluded that when total work is matched high intensity interval training results in greater improvements in repeated sprint ability than moderate intensity continuous training.

### 2.5 Reviews related to the game Kabaddi

**Bose, MNC (1997)** conducted a study on anthropometrical, Physical measures to predict the performance in Kabaddi playing. The purpose of the study was to investigate interpret and ascertain the factors that helps to predict the performance level of Kabaddi players both men and women who participated in the inter university Kabaddi tournament during 1991-92. The performance level of players depends on anthropometrical, physical, physiological and playing ability. The subjects were administered with the help of a battery of tests. One way analysis of variance was carried out for both the sexes to see the significant variation on selected variables among the successful and unsuccessful group. Pearson product moment correlation was carried out to find out the relationship of selected variable with playing ability. In addition, a multiple regression analysis was applied to find out the combined association of selected variable on playing ability.

**Dey, S K. G L Khanna, and M Batra** investigated Twenty five national Kabaddi players (Asiad gold medalists 1990), mean age 27.91 years, who attended a national camp at the Sports Authority of India, Bangalore before the Beijing Asian Games in 1990, for their physical characteristics, body fat, lean body mass (LBM) and somatotype. The physiological characteristics assessed included back strength, maximum oxygen uptake capacity and anaerobic capacity (oxygen debt) and related cardio respiratory parameters (oxygen pulse, breathing equivalent, maximum pulmonary ventilation, maximum heart rate). Body fat was calculated from skinfold thickness taken at four different sites, using Harpenden skinfold caliper. An exercise test (graded protocol) was performed on a bicycle ergometer (ER-900) using a computerized EOS Sprint (Jaeger, West Germany). The mean (s.d.) percentage body fat (17.56(3.48)) of Kabaddi players was found to be higher than normal sedentary people. Their physique was found to be endomorphic mesomorph (3.8-5.2-1.7). Mean (s.d.) back strength, maximum oxygen uptake capacity (VO$_2$max) and oxygen debt were found to be 162.6(18.08) kg, 42.6(4.91) ml kg$^{-1}$ min$^{-1}$ and 5.02(1.29) litre respectively.
Physical characteristics, percentage body fat, somatotype, maximum oxygen uptake capacity and anaerobic capacity (oxygen debt) and other cardiorespiratory parameters were compared with other national counterparts. Present data are comparable with data for judo, wrestling and weightlifting. Since no such study has been conducted on international counterparts, these data could not be compared. These data may act as a guideline in the selection of future Kabaddi players and to attain the physiological status comparable to the present gold medalists.

Muthumeena (2000) conducted a comparative study of Anthropometric, agility, aerobic and anaerobic capacity to the Manonmanium Sundaranar University women volley ball and Kabaddi players. The subjects were selected form Sivanthi Aditanar College of Physical Education, Tiruchendur, St. Mary's Collegof Tuticorin, Women Christian College, Nagarcoil and Holy cross Nagarcbil were represented in Indira University competition 12 players from volley ball and 12 players from Kabaddi were selected for this study. The weighing machine was used to asses the body weight. Skin fold caliper was used to asses the percentage of body fat, measuring tape are used to asses the leg length and arm length. Stop watch and hand grip dynamometer was used to asses the hand grip. The t-test was used to analysed the data. The hypothesis was partially rejected in case of variables of 0.05 level of confidence. There was a significant difference between Manonmaniam Sundaranar University women volley ball and Kabaddi players in anaerobic power and weight and percentage of body fat, grip strength, arm length and aerobic power, agility, leg length and height.

Ramesh (2000) conducted a study to analysis of selected strength and power characteristics among Kabaddi players, foot ball players and sprinters. For this purpose the following variables such as the arrn strength, leg strength, arm explosive power and leg elastic power were selected as dependant variables this purpose of selected subjects total of 90 college men students aged between 18 to 25 years from Dr. S.A.C.P.E., Dr. S.A.C.Eng., and Aditanar College of Arts and Science, Tiruchendur were selected as subjects. Tester's reliability and instrument reliability were established by the method of test retest. All the tests used were standard tests and their validity already accepted the one way analysis of variance (ANOVA) was used to find out the significant difference on selected strength and power characteristics among Kabaddi players, foot ball players and sprinters
the obtained 'F' ratio was significant, the scheffe's test was used as a post hoc test to find out the paired mean difference. All the hypotheses were tested as significance.

G L Khanna, P Majumdar, V Malik, T Vrinda, and M Mandal (1996) Faculty of Sports Sciences, Sports Authority of India, Netaji Subhas Southern Centre, Bangalore, India to determine the physical and physiological profile of Kabaddi players and the physiological demands of playing a Kabaddi match. Maximum aerobic capacity (VO\text{2max}), maximum ventilation (VE\text{max}), O\text{2} pulse, respiratory equivalent (RE), maximum heart rate, and O\text{2} debt were assessed on 16 players. The somatotype of the players was calculated by the Health and Carter method. Heart rate was monitored during a selection trial match on eight players who represented India in the Asian Games, 1994. From the playing heart rate, oxygen consumption (VO\text{2}) was computed through a heart rate v VO\text{2} regression equation. Maximum lactate was evaluated from the blood samples collected at the end of the match. The average heart rate and oxygen consumption during the match were 146.5 (SD 9.25) beats min-1 and 2.25(0.59) litre min-1 respectively. During raiding the maximum heart rate attained varied from 162.4(11.3) to 177.4(4.2) beats min-1. Out of 40 min of match play a raider raided on average on 8.13(2.03) occasions. The average time per raid was 20.8(6.26) s. The match heart rate and oxygen consumption was 72.3-83.3\% of the maximum heart rate, and 43.5-70.5\% of VO\text{2max} respectively. Maximum lactate at the end of the match was 6.13(2.53) mmol litre-1. Kabaddi players had the somatotype of 2.68-4.71-1.83, with absolute back strength of 175.0 kg. VO\text{2max} and O\text{2} debt were 3.59(0.36) litre min-1 [47.82(3.68) ml kg-1 min-1] and 5.3(1.85) litres (70 ml kg-1) respectively.

2.6 Reviews related to Physical variables

Jorge Ramírez-Lechuga, Mikel Zabala, Cristóbal Sánchez-Muñoz, Antonio Som, José Joaquín Muros and Pedro Femia, (2010) conducted a study on Fifty secondary-school children (32 boys, 18 girls; mean age of 17 years). Subjects participated in an 8-week endurance training program (2-3 h/week at aprox. 85\% VO\text{2} max), using different methods of training (continuous constant running -CCR-, Fartlek -FTK-, Circuit Training -CT-and Interval Training -IT-). The study
was conducted during the PE lessons. During the sessions, individual heart rate was continuously monitored (5s interval) using a heart rate monitor (Polar S810). Subjects were asked which method of training was their favourite one or was considered by them more motivational; also, they were asked about the intensity perceived according to the training method used (Borg’s CR10 scale, from 0 -no intense- to 10 -extremely intense-). To develop aerobic endurance, first it was preferred CT method (35.4%), followed by IT (25.0%), CCR (16.7%), FTK (12.5%), and “all the methods equally” (10.4%). The training method that students perceived as more intense was FTK (7.27±1.39), followed by “all the methods equally (7.21±1.10), CCR (6.92±1.64), IT (6.77±2.09), and CT (6.75±1.97). While for the boys the less intense method was CCR, for the girls it was CT, although there were no significant differences with regard to the other methods. In general, the PE lessons focused on the improvement of the aerobic endurance are perceived as very intense (7 on CR10 scale).

James (1977) predicted performance in tennis hand ball and badminton from certain physical traits. Regression equations using physical traits and class commitment as predictors were developed for determining potential skill in beginning tennis, badminton, and handball for college men. The physical trait used for agility, power, hand eye co-ordination and visual ability. Skill level was determined by each sport, were one hundred and forty college men enrolled in beginning classes for each sport and taught by the whole-part method. Control included one hundred and thirty eight students enrolled in at the beginning classes and taught by part method.

Uppal and Roy (1986.) conducted a study on assessment of motor fitness components as predictors of soccer playing ability for 30 male soccer players from Jiwaii University, Gwalior, conducted a study on motor fitness components as predictors of soccer playing ability. 30 male soccer players participated in this study in order to evaluate the extent to which the level of motor fitness can help to predict their performance in soccer. All subjects performed a series of five motor fitness components. They were speed, agility, explosive leg strength and cardio respiratory endurance. A multiple regression analysis was computed and the results indicated that reasonably accurate prediction of soccer playing ability might be made on the basis of the five tests of motor
fitness components. They were administered five tests for motor fitness components namely speed (50 yard dash), agility (4x10 meters shuttle run), max leg strength (standing broad jump) and cardiorespiratory endurance (cooper's 12 minute run/walk test). They concluded that all the (independent variables - strength and cardiovascular endurance) were significantly related to dependant variable (soccer playing ability).

Joseph (1983) determined the relationship of power, agility, shoulder flexibility, arm length and leg length to volleyball playing ability. Thirty male volleyball players of the Lakshmibai National College of physical education, Gwalior, were selected as subjects. Power was measured by Sargeant jump, flexibility by graded stick and arm length and leg length by steel tape, the playing ability was placed on the average of subjective judgement of three experts. Product moment correlation was used to statistically analyse the data and it was concluded that: (1) Power was the most reliable single variable in prediction of playing ability of men volleyball players; (2) Arm length and leg length were also reliable variable in prediction of playing ability of male volleyball and (3) the variables of agility and shoulder flexibility showed significant relationship and prediction of playing ability of male volleyball players.

Baley (1997) explains that each sports skill requires strength, power, muscular endurance, cardio-respiratory endurance, agility or flexibility in different areas. Participants in sports need all the qualities of physical fitness and but in some sports hand power is greatest importance. They need good flexibility to apply greater force. For example the Kabaddi players need more speed endurance; motor fitness may be defined as a readiness or preparedness for performance with special regard for muscle activity without undue fatigue. It concerns the capacity to move the body efficiently with force or a responsible length of time.

Jerry (1975) was to determine the relationship of selected physiological and psychological factors as they related to the beginning swimmers ability to perform the crawl stroke and contribute to the teachers understanding and instructional approach toward a beginning swimmer. Forty subjects who were members of two beginning swimming classes were used for this study. The
beginning swimming classes met for forty minutes twice a week. Prior to any swimming instruction, measurements were collected on shoulder rotation, shoulder extension strength, hip extension strength, body composition, swimming anxiety and swimming ability as measured by the power test (revised). After five weeks of crawl stroke instruction, measurements were again taken on swimming anxiety and swimming ability. The data were then analysed by using the Pearson product moment correlation to identify significant relationships. It was found that (1) shoulder rotation, shoulder extension strength, hip extension strength and body composition were not significant factors in the performance of crawl stroke and (2) a significant relationship was indicates between swimming anxiety and the ability to perform the crawl stroke.

Hasrani (1987) conducted a study to determine the relationship of selected physical fitness variables (speed, power and agility) to performance in basketball. The test was conducted on twenty five basketball players from professional college of physical education as subjects and administered the AAPHER physical fitness test to collect the data pertaining to the selected physical fitness variables, the result of the study revealed that the agility and power co-related significantly obtained value 0.7 and 0.52 respectively whereas speed did not show relationship to performance (obtained value is 0.05)

Ritchson (1968) conducted a study to compare hundred fourth grade boys and girls data. The following variable were collected the height, weight leg strength, body movement time, 50 yard dash, shuttle run and standing broad jump. The mean scores on test items were compared to national norms.

Robson and Bose (1981) conducted a study to determine the selected physical fitness components of boys and girls at different stages of elementary school level 20 boys ad 20 girls were selected at randomly each grade from one to five. Their age ranged from five to eleven years. The variables tested were speed, strength, and explosive power. It was found from the analysis of the data that boys had more shoulder strength than girls in all grades. It was also revealed that boys of grade four were significantly superior to the girls of the same grade in 50mts run and shuttle run.
Lutee and Amusa (1979) selected 46 subjects, who were conditional soccer player with at least 2 years playing experience at the college level. They were tested for running speed power, agility, max VO₂, strength anaerobic capacity and flexibility. In addition 11 anthropometric measurements consisting of skinfolds and body diameters were taken. Soccer playing ability served as the criterion and was measured by the ratings of three experienced soccer coaches based on selected soccer skill and strategies. Analysis of data was by zero order correlation and multiple regression analysis resulting in the following conclusions;

Age (experience) is the best predictor of playing ability weight, and height are considered good predictor of playing ability, max VO₂ and running speed are considered important factors in soccer performance. Flexibility, agility, lactate concentration and leg power are not considered as valid indications of playing ability.

Hills (1972) investigated the relationship of reaction time and movement time of primary grade children to the variables including age, sex, motor ability and physical fitness statistical analysis of data revealed that the reaction and movement time decreased significantly with increase in age.

Satinder Paul (2011) conducted this study to find out the correlation of eye-hand co-ordination and reaction time among handball players. The study was conducted on 20 Handball Players, State Level tournament held at Sujanpur Tira, Himachal Pradesh, North India during the year 2009-2010. The age group of players ranged from 17-21 years and all the samples selected from random basis. To find out the correlation between eye-hand coordination and hand reaction time, products Moment Correlation Method was used, \( r = 1.01 \) and \( N=20 \), to verify the significance of \( r \) at 95% confidence the tabulated value of \( r \) was seen from the table for \( N-2 = 18 \) degree of freedom. The value of \( r \) at .05 is .44 and hence, tabulated \( r \) is less than calculated \( r \); since calculated \( r = 1.01 \) is greater than tabulated \( r = .44 \) and hence correlation between eye hand co-ordination and hand reaction time of handball players, is significant at 95% confidence and also verify the significance of \( r \) at 99%. The value of \( r \) at .01 is .56 hence, tabulated \( r \) is less than calculated \( r \), and
thus correlation between eye hand co-ordination and hand reaction time of handball players, is significant at 99% confidence.

Salonikidis and Zafeiridis (2008) conducted a study on Reaction Time, first-step quickness, lateral (side steps), I and forward speed over short distances are important parameters for tennis performance, The aims of this study were: (i) to diagnose the presence of laterality in tennis lateral movements and (ii) to compare the effects of plyometric training (PT), tennis-specific drills training (TDT), and combined training (CT) on performance in tennis-specific movements and power/strength of lower limbs. Sixty-four novice tennis players (21.1 ± 1.3 years) were equally (n = 16) assigned to a control (C), PT, TDT, or CT. Training was given 3 times/week for 9 weeks. Testing was conducted before and after training for the evaluation of reaction time (single lateral step), 4-m lateral and forward sprints, 12-m forward sprints with and without turn, reactive ability, power, and strength. There was a significant difference in lateral speed (side-steps) between the 2 sides (P < 0.05). PT, TDT, or CT improved the 4-m lateral and forward sprints (P < 0.05). PT and CT improved also the reaction time of the "slow" side (P<0.05), whereas TDT and CT improved the 12-m sprint performances with and without turn (P < 0.05). Power and strength improved in most tests after PT and CT. Lateral and forward sprints were correlated (r = -0.50 to -0.75; P < 0.05) with power/strength. In conclusion, PT improved fitness characteristics that rely more on reactive strength and powerful push-off of legs such as, lateral reaction time, 4-m lateral and forward sprints, drop jump and maximal force, TDT improved all 4-m and 12-m sprint performances, whereas CT appeared to incorporate the advantage of both programs and improved most tests items. Tennis coaches should be aware that each training regimen may induce more favorable changes to different aspects of fitness.

Raman (1983) examined the relationship of grip strength, leg power, agility and hand and foot reaction time to performance in cricket. Study was conducted on 30 male cricket players from graduate and under-graduate courses at Lakshmibai National College of Physical Education, Gwalior, Data was collected on grip strength (grip dynamometer); leg power (standing broad jump);
agility (40 yard shuttle run) and hand and foot reaction time (Electronic Reaction). Timer and performance was the average of subjective ratings of three experts during practice and match situations. Product moment correlation was employed to examine the data. It was concluded that (1) hand foot reaction time is the most important variable in the prediction of performance of a cricketer; (2) leg power is another important variable in the prediction of performance in cricket; (3) grip strength is also an important variable in predicting cricket plating ability and (4) agility is not an important factor in the prediction of performance in cricket.

Ritchson (1968) conducted a study to compare hundred fourth grade boys and girls data. The following variable were collected the height, weight leg strength, body movement time, 50 yard dash, shuttle run and standing broad jump. The mean scores on test items were compared to national norms.

Voll (1979) predicted the basic modern dance skills through selected anthropometric and physical fitness measurements, data for this study were collected on twenty four female students participating in one of three non-eastern Pennsylvania Colleges. Measurements of height, weight, sitting vertex height, upper leg length, flexibility, abdominal strength, leg strength, cardio-vascular fitness and somototyping were taken. These measurements and six anthropometric ratios were statistically treated by step-wise regression programme developed by the health science computing facility, University of California at Losangeles. A regression equation with multiple ‘R’ of.8678 was presented by the author for the prediction of the ability in basic modern dance skills and prediction tables for its Computation were developed. The equation required for collection 5 anthropometric measurements and two physical fitness tests on the basis of the findings of this study, the author calculated that ability in modern dance skills can be predicted from selected anthropometric and physical fitness measurements.

Baumgarther and Jackson (1991) say that motor fitness is actually broader and less definitive in scope. It includes both health and fitness is concerned with performing skills better and more efficiently. It includes both physical fitness and motor ability factors, which includes not only
strength and endurance components, but also the factors of speed, power and agility. The seven components used to measure motor fitness are muscular strength, muscular endurance, circulatory-respiratory endurance, muscular power, agility, speed and flexibility.

Sridhar (1984) studied to determine the relationship of power, agility, flexibility, muscular endurance circulo-espiratory endurance sargent jump and agility by side step test, flexibility by trunk flexion test; muscular endurance by pull-ups and band knee sit-ups and circulo-respiratory endurance by one-minute lateral jump test. The playing ability was the subjective judgement of a panel of three experts for each subject. Product moment correlation was used to statistically analyse the data. On the basis of the finding of the study the following conclusions were drawn:

1. Power was the most significant motor fitness component underlying performance in the game of volleyball.
2. Muscular endurance, circulo-respiratory endurance and flexibility also contributed to the volleyball playing ability; and
3. Agility showed that in significant relationship to playing ability in volleyball.

Louis (1942) carried out to the study determine the nature of the relationship between "quickness of body movement" and success in athletics. Measurements were taken of seven hundred and fifty five men and boys in the University of Minnesota; Columbia Heights, Minnesota, High School; and the University of Minnesota High School. All subjects were placed under two categories. "Total body movement" was measured by a test consisting of a quick action of one arm, one foot, and the trunk consined into one movement, either to the left, to the right- or forward. A test was devised to measure "total body quickness" because none of the existing tests and techniques was found to be adequate measuring it. A 't' test and chi-square was used to statistically analyze the data and the following conclusions were drawn:

1. There is a positive relationship between the ability to more the body quickness and success in athletic activities.
2. The requirement in quickness of bodily movements not the same for all sports. A person with relatively slow total body reaction time has a better chance of obtaining success in the more individual activities such as gymnastics, swimming and wrestling than in baseball, basketball, football and the like.

**Majdell and Alexander (1985)** conducted a study to determine the effects of regular sprint training and combined over speed and overload training on the sprinting speed of college male athletes. Eighteen male Varsity football players were divided into three groups of six subjects each. The control group (C) participated in sprint training, free of any external loading, the second group (OS) participated in over speed two training a sprint master towing device and the third group (OSW) participated in over speed two training while wearing a ten pound weight vest. The subjects were timed for a maximal forty-meter sprint, as well as being filmed while sprinting at maximum speed both before and after the six-week training programme. The forty-meter sprint times as well as the most important kinematic variables in sprinting were calculated for each subject. Only seven of the twenty kinematic variables measured in this study were significantly different from the pretest to post test in one of the groups. The result of the ANCOVA indicated that there were significant differences between post test means of the three groups for eight of the variables, but least squares means test failed to produce significant, between group differences for all of these. It was concluded that sprinting speed can be improved by a six-week programme of training including conventional sprint exercises and over speed to training.

**Nunez V. M. et al. (2008)** studied the effect of a training program designed to increase strength and aerobic endurance. The study was conducted on 16 professional soccer players from Spain with a mean age of 28 +/- 3.37 years. The schedule comprised 4 macro cycles of 12 weeks of aerobic endurance and strength training. As much for the strength training as for the aerobic endurance, the program used a sequence of general, special, and specific exercises. Assessments were made with routine tests (i.e., squat jumps (SJs) counter movement jumps (CMJs), and countermovement jumps with arm swing (CMJas)) at the end of each macro cycle, and the Probst
test was used to assess aerobic endurance as a function of running speed and distance, at the start andend of the training schedule and at the start of the third macro cycle. Jumps were performed on an infrared platform fitted to the Muscle Lab system. The Probst test showed differences between the first evaluation and the second and third evaluations: 3,550 +/- 411.59 m vs. 2,006 +/- 207.20 m (P < 0.01). For 2 of the 3 jumps analyzed, the results were better in the last 2 than in the first 2 evaluations (SJ, 43.13 +/- 3.77 vs. 39.47 +/- 3.4 (P < 0.05); CMJ 49.80 +/- 3.77 vs. 46.67 +/- 3.76 (P < 0.05); CMJas, 56.24 +/- 5.2 vs. 52.98 +/- 4.54 (P > 0.05)). Improvement of aerobic endurance was produced on the first phase of the season as a consequence of the training. To increase strength, it is necessary to augment the number of training sessions of this type. It is convenient to separate aerobic endurance and strength training to create more ample blocks during the last 2 macro cycles.

Vescovi J. D. and others (2006) investigated to determine and compare positional characteristics (physical and physiological) of Division I college female soccer players. Sixty-four university soccer players volunteered to participate and were evaluated at the end of their spring season. Test items included height and body mass, acceleration (9.14 m), speed (18.28 and 36.58 ym/s), agility (Pro-agility and Illinois), lower body power (countermovement jump), and estimated aerobic capacity (20 meter beep test). Mean (+/-SD) height and body mass were 168.4 +/- 5.9 cm and 64.8 +/- 5.9 kg, respectively. No significant differences were observed between positions, however defenders and keepers tended to be taller and heavier compared to forwards and midfielders. Positional differences did not appear for any of the other performance test. Yet, defenders tended to show slightly slower times for the speed and agility tests while keepers tended to be slower on the agility tests compared to forwards and midfielders. Aerobic capacity was similar across the four positions. He concluded similar physical and physiological characteristics were found within this sample of Division I female college soccer players.

Sebastian (1998) conducted a study on relative analysis of progressive training and alternate, high and low intensity training on speed, flexibility and explosive power of boys. Sixty boys were selected at random from the subjects who had successfully completed minimum strength
requirement test. The selected subjects put at random into one of the three groups, \( n = 20 \). Group 1 underwent conventional progressive training, group 2 underwent alternate high and low intensity training and group 3 acted as control. The experimental groups were trained in their respective training programmes, five times a week for fourteen weeks. Prior to and after the training programme, the subjects were tested for speed, flexibility and explosive power. The data were examined by analysis of covariance. Performance in speed, flexibility and explosive power improved significantly for both progressive and alternate high and low intensity training when to the control group, and no significant difference existed between the training groups.

**Datta (1981)**, predicted hockey playing from physical, physiological and psychological factors. The subjects were seventy four male hockey players. The dependent variable was hockey playing ability. Hockey playing ability was determined by taking the average of subjective grading by three experts who based their judgment on straight field hockey rating scale. Physical variables included speed, grip strength, power, agility dynamic balance, flexibility and kinesthetic perception which were measured by test items i.e. 50 yard run, dynamometer, standing broad jump, jogging run. Johnson's modified of pass test, forward bend of trunk, upward backward movement of arms and a test of horizontal distance respectively. Physiological variables included cardio-respiratory endurance, resting pulse rate, reaction time, movement time, response time and body composition which were measured by Cooper's 12 minute run/walk test, heart beat per minute, Nelson's Hand and Arm Reaction Test. Nelson’s speed of movement test, four way alternate response test and skin fold calipers respectively. Psychological variables included anxiety and intelligence which were measured by the IPAT anxiety scale and culture fair test respectively. Analysis of total revealed significant relationship of hockey playing ability to each of the following physical physiological and psychological variables: speed \( (r =0.29) \), right grip strength \( (r =0.29) \), left grip strength \( (r=0.30) \), agility \( (r =0.30) \), balance \( (r =0.27) \) and kinesthetic perception \( r = 0.30 \), resting pulse rate \( ( r = -0.48) \) hand reaction time \( (r = -0.38) \), and body composition \( (r =-0.23) \), and anxiety \( (r = -0.46) \). The relationship shoulder flexibility and intelligence to hockey playing ability were not
found to be satisfactory correlation was computed to determine those physical/physiological variables which contributed.

**Toner (1981)**, examined the relationship of physical fitness skill and mood variables with success in female high school basketball candidates begin chosen to become varsity players. Nair’s profile mood states, cooper's 12 min run test, AAPHER jump and reach test, AAPHER shuttle run test, 30 yards dash, AAPHER under basket shot test, speed pass test, and dribble test were administered to 81 female high school basketball candidates. Each of the three teams was treated on 3 separate occasions during the regular mid-afternoon practice times for the teams. At the end of the testing and evaluation period, the jury of coaches on the basis of the observations during drills and competition independently rated each candidate as either a successful or an unsuccessful performer. Discriminant analysis procedures supported the hypothesis: (a) the fitness factors, skill test and personal factors (non together as preseason variables) was successful indicators of group membership while the POMS variables were to a lesser extent and (b) the battery of tests, preseason and POMS, did correlate with coach ratings.

**Little T and Williams AG, (2005)** Studied High-speed actions are known to impact soccer performance and can be categorized into actions requiring maximal speed, acceleration, or agility. Contradictory findings have been reported as to the extent of the relationship between the different speed components. This study comprised 106 professional soccer players who were assessed for 10-m sprint (acceleration), flying 20-m sprint (maximum speed), and zigzag agility performance. Although performances in the three tests were all significantly correlated (p < 0.0005), coefficients of determination (r(2)) between the tests were just 39, 12, and 21% for acceleration and maximum speed, acceleration and agility, and maximum speed and agility, respectively. Based on the low coefficients of determination, it was concluded that acceleration, maximum speed, and agility are specific qualities and relatively unrelated to one another. The findings suggest that specific testing and training Procedures for each speed component should be utilized when working with elite players.
Holland (1965) predicted the selected variables in determining the ability to play basketball in small high school. The measures included speed, agility, upper arm strength, power ball handling ability, reaction time, shooting ability, passing ability, height, weight, age and previous experience. The criterion was the rating of the basketball playing ability of each squad member by his coach. The most important variables were experience, ball handling ability, passing ability and shooting ability. The prediction equation of basketball playing ability included, number of years of experience, scores on speed dribble, scores on wall volley and scores on half minute shooting.

Cronin JB and Hansen KT. (2005) studied to identify the relationship between strength and power and measures of first step quickness (5-m time), acceleration (10-m time), and maximal speed (30-m time). The maximal strength (1repetition maximum), power (30-kg jump squat, countermovement and drop jumps), isokinetic strength measures (hamstring and quadriceps peak torques and ratios at 60 degrees s(-1) at 300 degrees s(-1) and 5m, 10m, and 30m sprint times of 26 part-time and full-time professional rugby league players (age 23.2 +/- 3.3 years) were measured. To examine the importance of the strength and power measures on sprint performance, a correlation approach and a comparison between means of the fastest and slowest players was used. The correlations between the 1RM, drop jump, isokinetic strength measures, and the 3 measures of sport speed were no significant. Correlations between the jump squat (height and relative power output) and countermovement jump height and the 3 speed measures were significant (r = -0.43 to -0.66, p < 0.05). The squat and countermovement jump heights as well as squat jump relative power output were the only variables found to be significantly greater in the fast players. It was suggested that improving the power to weight ratio as well as plyometric training involving countermovement and loaded jump-squat training may be more effective for enhancing sport speed in elite players.

Rajasekaran (2000) conducted a study to find out the effects of maximum strength and speed training in series and parallel on elastic strength components among physical education and sports male students. Fortyfive students selected at random and were divided in to three groups. Group I underwent series training, group II underwent parallel training and Group III acted as
control. Speed, explosive power, stride frequency, leg strength and back strength and anaerobic capacity were selected as criterion variable ANCOVA was applied to find out the effect of series and parallel training on selected dependent variables. The results of the study indicated that the series training and parallel training groups have significantly improved on speed, explosive power, stride frequency, leg strength, back strength and anaerobic capacity when compared with the control group. Parallel training group has significantly better in improving speed, stride frequency, explosive power and aerobic capacity when compared with series training group.

A well designed circuit provides a balanced workout that targets all the muscle groups and builds cardio-vascular endurance. Circuit routines can also be designed to correct the muscle imbalance that often occurs in one sport athletes who specialize in one type of exercise day after day. It can also provide a high intensity, skills training session or a high calorie burning workout in a short amount of time. Circuits also provide the perfect cross training for any athlete.

2.7 Reviews related to Physiological variables

Garden (1978) in his study determined the value of cardiovascular capacity measure (Coopers 12 minutes run/walk) a leg power measure modified (sergeant jump reach) or upper body muscular strength and endurance measure (flexed arm length) a percentage of body fat measure (Skin fold thickness) and measure of body height as predictors of basketball playing ability. The basketball playing ability or criterion measures were an ability rating, a personality ability rating, a composite ability personality rating, the comparative rating scale, and a ranking of the players by the coaches. The sample consisted of twenty female basketball players from the 1976-77 University of Arkanasa and northeastern Oklahoma State university teams. Ten players from each school participated in the study. Stepwise multiple regression programme was utilized to form prediction equation. The predictor variables were correlated with each of the five basketball playing ability measures. The prediction equation was selected using criteria only those variables, which had the lowest standard error of estimate and the greatest F value. The results indicated that the greatest prediction ability was the 12 minute run and height with the personality rating as the measure of the
basketball playing ability. The equation produced a correction coefficient of 0.786 and a standard error of estimate of =0.392.

**Stuvart and Colling (1979)** compared the vital capacity of 20 athletes to an equal number of nonathletes and found that mean vital capacity of the athletes was significantly higher than that of nonathletes. It was concluded that this significant difference in vital capacity was due to regular training.

**Ghosh and others (1985)** undertook a study on pulmonary capacities of different groups of sportsmen in India. Pulmonary functional capacities, vital capacity (VC), maximum voluntary ventilation (MVSS), forced expiratory volume in 1 second and FEV 1.0 (per cent VC) of 168 sportsmen belonging to different sports activities and of 10 sedentary individuals were undertaken for study. It was observed that the pulmonary function capacities of different groups of sportsmen were higher than those of the sedentary group. The mean VC of the basketball, boxing, cricket, football, hockey and the table tennis groups, the mean MVV of all the groups except the athletic, badminton and football groups, and the mean FEV 1.0 of football, hockey, swimming and football groups, and the mean FEV 1.0 of football, hockey, swimming and volleyball groups were significantly higher than those of the sedentary group. The mean values of all the three pulmonary function capacities of only the hockey group was found to be significantly higher than those of the sedentary individuals. The available reported pulmonary capacity values, except FEV 1.0 of a few groups of sportsmen studied abroad, were higher than those of their counterparts studied here. These might be due to the ethnic variation as well as the variation in age, body size and level of physical fitness which influences the different pulmonary capacities.

**Katch (1972)** studied the relationship between aerobic capacity (maxVO\(_2\)) endurance running performance and body composition was determined in 36 college student. Maximum VO\(_2\) was measured using the bulk treadmill test. Endurance running performance was evaluated by the Cooper's 12 minutes run/walk test, where the subjects run as fast as possible in 12 minutes. Percent body fat and lean body weight were calculated from whole body density measurements using
underwater weighing and residual volume techniques. Test retest reliability for max $\text{VO}_2$ (L/min) was $r=0.55$, percent body fat ($r=0.83$), lean body weight ($r=0.76$) and body weight ($r=0.66$). The correlations between 12 minutes run time with percent body weight ($r=0.55$) between max $\text{VO}_2$ (L/min) and the running performance was correlated for attainment from unreliability in the run and max $\text{VO}_2$ scores, the correlation increased slighted to $r=0.60$. Expressing max $\text{VO}_2$ in ml/kg, improved the correlation only slightly with the endurance run and body composition measurements.

It was concluded that the validity of Cooper's 12 minutes running performance and using max as the criterion $\text{VO}_2$ as the criterion was too low to be of much predictive usefulness as a test of cardiovascular fitness for the college student measured in this experiment. Percent body fat; lean body eight and body weight did not seem to affect the instance a college student could run in the Cooper's 12 minutes endurance run test.

James (1960) conducted a study on anthropometrical, physiological and psychological measures to predict performance in cross country skiing. The purpose of this study was to determine if the selected variables of lean body weight, physical work capacity and sport competition anxiety test were related to the successful performance of cross-country skiers in competitive racing. Also to determine a single variable or combination of variables indicated statistically significant relationship with cross country skiing performance. A total of seventy five volunteer subjects were included who participated in ski-training camps and cross-country ski-races sponsored by the Eastern Division of the United States Ski-Association during the winter of 1978-79. Pre-assessment tests to determine lean body weight, physical work capacity and sport competition anxiety test results were administered to the subjects prior to the ski-training and ski-races. These variables were combined with the demographic variables of age, height and weight to form six dependent variables which were compared with the dependent variables of ski-race time and statistically analysed using t’ tests, inter-correlation and multiple regression analysis. The conclusions were (i) No substantial significant correlations were found between the independent variables and ski-race time (ii) Negative relationships were revealed between physical work capacity in ski-race time (iii) No relationships were found between the sport competition anxiety test results and ski-race time (iv)
The relationship were found between combinations of two or more, variables and ski-race time (v) significant relationships were found for regression equations that predict ski-race time in three of the group studied.

**Stuvart and Collings (1979)** compared the vital capacity of twenty athletes with those of twenty” non-athletes and found that the mean vital capacity of the athletes was significantly higher than that of non-athletes. The author concluded that this significant difference in vital capacity was due to regular training. A group of sixty eight adolescent boys who took regular exercise gained 130cc in vital capacity in four months, while a group of fifty boys who did not exercise had a sex and size of the individual. It also shows a racial variation. Best correlation is obtained between height in centimeters and vital capacity. This predicted vital capacity in adult male is equal to height in centimeters x 20 milliliters and in females, height x 16 milliliters.

**Katch, Fredson and Sady (1978)** investigated the differences in actual and predicted vital capacity and residual lung volume in sixty male subjects who were classified as either, medium or small using a sizing technique based on weight and height criteria. Vital capacity and residual volume were significantly different between the three different groupings of subjects (small, medium, large). When attempting to predict vital capacity and residual volume from height, weight density, lean body mass, percent fat, chest girth and age, and the standard errors of prediction ranged from 9 to 11 percent for vital capacity and 17 to 19 percent for residual volume.

**Wenzel (1992)** tested the effect of speed training versus strength training approach in power development. It was hypothesized that a speed training programme would be more efficient in power development than a strength programme. Sixty five football players participated in an offseason weight training programme, all players lifting three times per week and used the same programme while the remaining 40 athletes performed a squat hip sled programme designed to develop strength. The Margaria Kalamen power test was used as a measure of power in watts. Baseline and follow-up weight / height2 (BMI), power clean, push press, squat and vertical jump measure were recorded. Using group comparison paired t-tests and analysis of .variance
ordinary east squares mathematical modeling procedures, no difference could be found between the two groups on any of the measures. Modeling was used to the effect of the training group on power development while test controlling for initial differences; no group differences in training effect were found. It was concluded, that while speed training was not found to be superior to strength training, it could be an equivalent substitute.

2.8 Reviews related to Psychological variables

Battles (1980) studied the prediction equation for selected of women inter collegiate basketball members. The subjects for this investigation were thirty three females who were participating in women basketball of three colleges in Florida. Each subject completed a personal data form the athletic motivational inventory (AMI) Sargent jump test and field goal speed test. Selected anthropometric measurements were also obtained from each subject. Each head coach and assistant were asked to rank each member of the team order of how contributed to team success. Three different team ranking were included in the statistical analysis. The ranking were head coach's ranking, the assistant coach ranking and the average ranking of the head and assistant coaches. Significant correlations (.05 level) were found to exist between the head Coaches ranking and age and college basketball experience and between the average of the head assistant coaches ranking and college basketball experience. Result of stepwise multiple regression indicated that players ranked high by head coaches tended to score high on a combination of physical and physiological variables. These variables included college basketball experience height, vertical jump, mental toughness and the AMI of total score. Assistant coaches tended to selected player with high scores on physiological variables, which included interest, responsibility, mental toughness and aggression. The average ranking of the head coach and assistant favoured players with college basketball experience, responsibility, mental toughness, age and self-confidence. Mental toughness was the only variable, which consistently appeared regardless of the method of ranking.

Kamalesh M.L, (1993) In addition to psychological assessments, the physiological assessments provides information on state of anxiety. The physiological aspects such as heart rate,
respiration rate, muscular tension, blood pressure etcetera may also provide information about anxiety and emotional status.

There are many dimensions of fear and anxiety in athletes and non-athletes, experienced and non-experienced athletes, team game and individual sports players are reported to differ on the level of pre-competition anxiety. While highly competitive situations shoot-up anxiety, yogic practices reduce the state of anxiety.

Annenrie Bird and Bernatte K. Cripe (1986), Anxiety is another Psychological factor, which differs from arousal in that it encompasses some degree of activation and an unpleasant emotional state. Thus the term anxiety is used to describe the combination of intensity of behaviour and directional effect or emotion. The direction of effect, a characteristic of anxiety, is negative in that it describes subjective feelings that are unpleasant.

R. Martens (1985), the degree of anxiety experienced by athletes during competitions and its subsequent, effects on performance has been a burning question in sports psychology. May investigators have observed that anxiety is not a unitary trait; rather it is more complex multi-dimensional construct that involves a set of psychological, physiological, behavioural response components.

Hatfield and Brody (1994) anxiety is a subjective experience of dread or apprehension. Uncertainty usually accompanies state anxiety. Although state anxiety appears negative, its effects on performance can be negative, neutral, or positive. For example, a certain level of anxiety will accompany competitive performance, attacking a new weight, or performing a new skill. It is a common belief among athletes that they need a little anxiety to perform at their best. Trait anxiety is a more permanent psychological characteristic that is part of one’s personality. Trait anxiety might be looked upon as the background anxiety against which state anxiety is expressed. Anxiety can also be classified as cognitive (e.g., psychological, as with apprehensive thoughts) and somatic
(e.g., muscle tension, increased heart rate, restlessness, and the sensation of butterflies in the stomach).

Scully et al (1998) conducted a study of anxiety is “distress or uneasiness of mind caused by fear of danger or misfortune.” It is a stage of apprehension. The results of over 30 published papers substantiate a link between acute and chronic exercise and the reduction of anxiety. Most of the research on exercise and anxiety involves aerobic training regimens. The few studies involving resistance training and flexibility have also shown a slight decrease in anxiety, but additional research is needed in this area. However, the data does indicate that aerobic exercise is more beneficial for the reduction of anxiety. In reference to the actual aerobic exercise prescription, there appears to be much debate about whether low-intensity, moderate-intensity or high-intensity exercise is most beneficial. For participant adherence, exercise intensity should be set at an adjustable level agreed on by the individual in consultation with a PFT or fitness instructor. It appears that even short bursts of 5 minutes of cardiovascular exercise stimulate anti-anxiety effects. The research also indicates that individuals who train for periods of 10–15 weeks receive the greatest beneficial effects.

Philip Wilson and Robert C. Eklund (1998) examine Leary’s (1992) contention that competitive anxiety revolves around the self-presentational implications of sport competition. Intercollegiate athletes (N=199) completed inventories assessing competitive trait anxiety and self-presentational concerns. Principal-axis factor analysis with direct oblim rotation of self-presentational concern items produced an interpretable four factor solution accounting for 62% of the variance. These factors were interpreted to represent self-presentational concerns about Performance/Composure Inadequacies, Appearing Fatigued/Lacking Energy, Physical Appearance, and Appearing Athletically Untalented. Correlational and structural equation modeling analyses revealed that self-presentational concern was more strongly associated with cognitive rather than somatic anxiety, and that substantial portions of variance in competitive anxiety could be accounted for by self-presentational concern variables. The results of this investigation provide support for
Leary's (1992) assertion regarding the relationship between self-presentational concern and competitive anxiety.

**Betty (1980)** studied the effect of anxiety on shooting proficiency college women basketball players. For the members of the 1977-78 South Dakota State University women's basketball team (N=12) were measured in State Anxiety Inventory (SAI); Sports Competition Anxiety Tests(SCAT); pre-game HR; game field goal %; game free throw %; season field goal % and season free throw %. Subjects in group one consisted of players who attempted over 95 field goals or less. Results from ANOVA indicated significant difference (p<.05) between groups on season field goals % and SAI, subsequently data analysis throughout the study incorporated only the value from group%. A significant difference was found between scores on the SAI and SCADT. Significant (p<.05) multiple regression equations to estimate field goal shooting proficiency from selected measures of anxiety produced multiple R's ranging from .47 to .66 and accounted for between 22 and 44% of the variance in performance. A multiple regression equation for proficiency free throw success was not significant (p<.05).

A meta-analysis of 128 studies examined the effects of extrinsic rewards on intrinsic motivation. As predicted, engagement-contingent, completion-contingent, and performance-contingent rewards significantly undermined free-choice intrinsic motivation ($d$–0.40, –0.36, and –0.28, respectively) as did all rewards, all tangible rewards, and all expected rewards. Engagement-contingent and completion-contingent rewards also significantly undermined self-reported interest ($d$–0.15, and = –0.17), as did all tangible rewards and all expected rewards. Positive feedback enhanced both free-choice behavior ($d0.33$) and self-reported interest ($d$ 0.31). Tangible rewards tended to be more detrimental for children = than college students, and verbal rewards tended to be less enhancing for children than college students. The authors review 4 previous meta-analyses of this literature and detail how this study's methods, analyses, and results differed from the previous ones.
Earl (1973) studied on the effect of anxiety and need achievement on the performance of high school wrestlers. Data were obtained from the Thematic Appreciation Test. The Test Anxiety Questionnaire, expectancy ratings by the individuals and by their coaches score boards and observation. It was concluded that the personality traits of anxiety and need for achievement had a tendency to influence both the expectancy and the actual performances of these high school wrestlers. Students who measured low in anxiety level performed better than those high in anxiety. The group scoring highest in performance was that of low anxiety and high need for achievement. The lowest level of performance was demonstrated by the group high in anxiety and low in need or achievement.

Hasrani (1987) analysed skills, motor abilities and psychological components as predictive factors of basketball playing ability at different levels achievement. Fifty four female basketball player from university level and fifty female basketball player from national level were selected as subject. Sixteen skills, motor abilities and psychological variables were statistically evaluated and prediction equation was developed. It was concluded that the skill variables namely dribble push pass for accuracy, front shot, jump and reach and vertical jump significantly related to basketball playing ability.

The Achievement Motivation Inventory (AMI) is a personality inventory designed to measure a broad construct of work-related achievement motivation. Achievement motivation is a personality variable that has been used to explain individual differences in a number of practical contexts: school, sports, and the world of work. The AMI is based on a trait-oriented concept of achievement motivation (Schuler & Prochaska, 2000, 2001). It was built on a new concept of how a wide variety of facets of achievement motivation are interrelated with each other. Many of the facets incorporated into the AMI are similar to traditional aspects of personality. For the first time the AMI integrates relevant social motives into a test measuring the construct of achievement motivation as well. Thus, in addition to traditional scales, e.g. Confidence in Success or Persistence, scales like Dominance or Status Orientation are integrated in the AMI.
Chapter II  
Review of Related Literature

The major applications of the AMI are for personnel selection, personnel development, professional counselling in regards to job decisions, and psychology in sports, as well as research applications in differential psychology and applied psychology. For personnel selection, the AMI can be used alongside traditional methods such as the assessment centre, employment interviews, biographical questionnaires and tests of general cognitive abilities or integrity. The AMI profile gives insight into an individual's achievement motivation structure and enables a precise and reliable evaluation of all major aspects of job-related achievement motivation.

Content validity was obtained by an intensive research work on all major aspects of achievement motivation and their integration within the test. Expert ratings assured only relevant aspects have been integrated. Additionally, confirmatory factor analysis yielded in a good model-fit of the theory. Construct validity is shown by correlations of AMI scales with related personality scales, e.g. from Big Five inventories (ranging up to r = .72). Criterion related validity was shown in regard to prediction of grade point averages in US colleges (r = .22 for the total score and up to r = .29 for single scales) and early academic achievements (ranging between r = .21 to r = .36 on different scales). Studies showed that there is high social validity in regard to acceptance of the test by examinees.

Ogilvie and Henschen (1995) analyse psychological literature on aspects of resistance training provides some insight into areas of mental health and sport psychology, including psychological well-being; self-concept, self-esteem, self-efficacy, and self-worth; body image; and arousal and anxiety. Psychological skills that may serve athletes and others participating in resistance training include goal setting, relaxation, concentration, imagery, and ritualization.

Callaghan (2004), analyse the effect appears to be more potent in those with lower self-esteem. Studies indicate that aerobic exercise may have a more pronounced effect than anaerobic exercise, but that may be because there is little research available on resistance training exercise and self-esteem. However, self-esteem is quite complex, and studies suggest that certain subcomponents
including perceived sport competence, physical condition, body image and strength contribute to self-esteem.

(Scully et al. 1998). Because of the many variables involved, it is important to note, for example, that a person may highly value his physical condition and yet have a negative evaluation of his body. Current research provides little direction regarding the type of exercise and dose recommendation for improving self-esteem (so perhaps the best thing is to follow the 2006 ACSM guidelines in the sidebar for now). In relation to exercise, it is interesting to note that important factors influencing a person’s self-esteem are perceptions of their body attractiveness and physical condition (McAuley et al. 2000).

Another investigation of the psychological benefits of weight training involved state law enforcement personnel. The study used a circuit weight training protocol and a control group on a wait list for the exercise program (Norvell and Belles 1993). Forty-three officers who were not regularly exercising participated in the four-month study. Significant increases in both cardiovascular and strength variables were noted. The exercising subjects also demonstrated improved mood, including decreased somatization, anxiety, depression, hostility, and reports of physical symptoms. Job satisfaction improved as well. Officers who dropped out of the program had shown significantly greater hostility, depression, and anxiety during the pretest, suggesting that some self-selection may have occurred. However, the investigators concluded that circuit weight training could provide important psychological benefits to law enforcement officers.

Fitness is comprised of many different components which must be viewed in relation to individual characteristics, needs, goals, and tasks that influence performance. As cited by Seidon (1990) and many other professionals classify the fitness components into two categories those pertaining to health and those pertaining to motor-skills performance. Health fitness is concerned with performing skills better and more efficiently. As stated by Jenson and Fisher (1979) the maximum ability of a person to perform in any athletic event is obviously limited by his physical characteristics. But beyond these broad restrictions psychological factors often play a decisive role.
HoIIman W (2007) studied the development of performance and maximum stress is presented for children and adolescents, and the importance of age appropriate sports for general health is also discussed. A description of the five form of the motor system as follows, i.e, coordination, flexibility, strength, speed, and endurance, and their effects on the performance parameters boys and girls from childhood to adolescence. Data on cardiopulmonary-metabolic performance parameters are discussed for children and adolescents. These include functional and morphological data on the heart, circulation, respiration, metabolism, and skeletal musculature. Precocious young people are, physically capable of a higher performance level and can tolerate more stress than the, normal counterparts or those with delayed development. With regard to the Jive forms of stress mentioned above, health questions related to the ability to tolerate stress and age-related levels of training are dealt with. The negative effects on health are considered with regard to the development of amenorrhea and a decrease in the mineral content of the skeletal system as a result of extensive endurance training training.

Joel R. Grossbard et al (2009) assessed the levels of cognitive and somatic anxiety among male and female youth sport participants. Confirmatory factor analyses with a sample of 9-14 year old athletes (N=1038) supported the viability of a three-factor model of anxiety involving somatic anxiety, worry, and concentration disruption previously demonstrated in high school and college samples. Tests for factorial invariance revealed that the three-factor model was an equally good fit for 9-11 year olds and 12-14 year olds, and for both males and females. Gender and age were modestly related to anxiety scores. Worry about performing poorly was highest in girls and in older athletes, whereas boys reported higher levels of concentration disruption in competitive sport situations. Implications for emotional perception and for the study of competitive anxiety in young athletes are discussed.