CHAPTER I

INTRODUCTION

1.1 SCIENCE AND SOCCER

Sports and Science are as old as human civilization. Sports have its own history, culture and language. Similarly science has its own developmental history and made phenomenal contribution to human progress. In recent years these two different social institutions have come closer for mutual benefit and made significant impact not only in the field of sports but also towards health and wellbeing quality of life in general. In soccer (football) and many other spectator sports, science and technology are being used to improved efficiency and effectiveness of players, erase and quest for high performance in sports, though not new, have obtained new dimensions. Genetic potential opportunities, incentives, rewarding experience, intensive training, skill etc. are not only factors for victory, there are lot more internal and external factor which affect a performer and make crucial difference in sports performance. Identification of factors are therefore an important task to all those concerned with sports. Soccer is one of the most demanding of all sports. Soccer is a physical contact sports and lot of movements and skills are involved, a high level of physical demand is required for match play, which involves speed, power, strength, agility, endurance, flexibility, skill etc.

Soccer is a game where anaerobic & aerobic capacity both is equally important. The activities of the game include short sprinting as well as casual recovery movements. As the players have to cover a big area in the ground during attack and defense. Therefore, the game demands for aerobic as well as anaerobic fitness (Railly, 1996 & 2000). In India, football (soccer) is gaining popularity in recent years. FIFA also
selected this country as future focused. For the selection of soccer players, evaluating the development of performance and achievement in national and international level, Indian scientists were examining and searching the best methods of internal and external quality measurement.

1.2 DEMAND OF SOCCER

In the past many researchers have addressed the metabolic demands imposed on soccer players during competitive and friendly matches. These analysis have demonstrated, that the majority of the body’s physiological systems are stressed during the course of a soccer game and often also by a strenuous training program. These include metabolic energy systems, the musculoskeletal system and perhaps also the nervous and immune system. It is widely documented that the aerobic system is the main source of energy provision in soccer match play where players have to sustain a high rate of work for a period of at least 90 minutes. However, soccer is characterized by an intermittent activity profile with high intensity anaerobic efforts superimposed on a background of aerobic activity. This varying intensity places high metabolic demands on the energy delivery pathways (Thompson et al., 2003). In this high intensity intermittent sport, may other factors such as speed, power, strength, agility, flexibility and anaerobic capacity all combine with aerobic capacity also contribute to a successful game. Previous studies have demonstrated, that the higher the fitness level of the soccer player, the more frequently the player is capable of high intensity phases of play and that a high level of fitness from all players in a team helps to allow for a high work rate and maintenance of good technique throughout a match. From the metabolic point of view, soccer is classified as an alternating aerobic / anaerobic engagement sport. In fact, it alternates high intensity phases of play and phases in which the player carries
out active recovery. During an intermittent exercise, well trained athletes can regularly make use of the system of oxygen transport without creating high lactate levels in the muscles and in the blood. Even if there are differences depending on the players position, time and motion analyses of soccer matches demonstrate, that soccer players may cover as much as 10-12 km during a match lasting 90 minutes (actual playing time 55-62 minutes), involving a combination of high intensity sprinting, prolonged running at more moderate speed and periods walking (FIFA, 1989; Meyer et al., 2000; Tumilty, 2000). The highest distances covered by an individual player are reported to be about 14 km (Ekblom, 1986; Bangsbo, 1993). Therefore aerobic endurance must play an important role in the team performance. It is interesting to note that recreational players cover about the same distance per unit of time as professional players do and that the mean distance for the first and second halves are about the same (Ekblom, 1986).

Superimposed on this background of running and walking activities these are several other movement patterns like jumping, dribbling, tackling shooting as well as rapid changes in speed and direction. Match analysis provide some insight into the physical demands of soccer in terms distance covered, both absolutely and at different intensities. These observations also provide information about the work-to-rest ratio, number of physical contacts; time spent in possession of the ball, number of tackles, heading and other activity modes increasing energy expenditure. A recent match analysis done by some researchers and co-workers showed that there are about 1431±206 different actions with and without a ball within a single match. This study also showed that on average activities of a player change every four seconds within a game. According to Withers et al., (1982) 26.3% total play time is made up of phases of walk, 64.6% of slow runs, 18.9% of quick runs and sprints, and 1.1% of
phases of possession of the ball. In 1985 Mayhew and Wenger established that during his game a soccer player walks 46.6%, runs slowly 38%, runs quickly or sprints 11.3% and stands without moving 2.3% of total playing time. During a match, soccer players perform different types of physical activities, ranging from standing still to maximum speed runs, the intensity of which may change at any given time. According to J. Bangsbo (1996), the types of runs during a soccer match (for a total length of 8-12 km) can be expressed as follows, keeping in mind, however, that both the total distance covered and the intensity of the runs are extremely variable with regard to the physical conditioning level and the player’s position. Walk:  4 km/h (distance covered: about 3400 meters), jogging 8 km/h (distance covered; about 3200 meters), low speed run:  12 km/h (distance covered: about 2500 meters), moderate speed run:  16 km/h (distance covered: about 1700 meters), high speed run:  21 km/h (distance covered: about 700 meters), and sprint 30 km/h (distance covered: about 400 meters).

1.3 ENERGY DEMAND IN SOCCER

In elite outfield players, the average work rate during a soccer match as estimated from variables such as heart rate is approximately 70% of maximal oxygen uptake (VO₂ max). Aerobic energy production appears to account for more than 90% of total energy consumption. Nevertheless, anaerobic energy production plays an essential role during soccer matches. During intensive exercise period of a game, creatine phosphate, and to a lesser extent the stored adenosine triphosphate, are utilize. Both compounds are partly restored during a subsequent prolonged rest period. In blood samples taken after top-class soccer matches, the lactate concentration averages 3-9 mM, and individual values frequently exceed 10 mM during match-play. Furthermore, the adenosine diphosphate degradation production
ammonia / ammonium, hypoxanthine and uric acid are elevated in the blood during soccer matches. Thus the anaerobic energy systems are heavily taxes during periods of match play. Glycogen in the working muscle seems to be the most important substrate for energy production during soccer matches. However, muscle triglycerides, blood free fatty acid and glycogen are also used as substrates for oxidative metabolism in the muscles (Bangsbo, 1994). The physical demands during a soccer match, as estimated by heart rate and body temperature measurements, correspond to 70% of maximum oxygen uptake. Therefore, aerobic energy production is highly taxed in most of the game accounting for approximately 90% of total energy consumption. During a competitive match, a top-class player perform 150-250 intense actions as demonstrated by reduced muscle creatine phosphate and pH levels, and by increased muscle lactate concentrations. Thus, the anaerobic energy system is heavily stimulated during periods of game. Muscle glycogen is reduced 40-90% during a game and is probably the most important substrate for energy production. Muscle triglycerides, blood free fatty acids and glycogen are also progressively utilized as substrates for oxidative metabolism, likely for compensating the lowering of muscle glycogen (Bangsbo J., 2007). There is still much uncertainty and debate surrounding its physiological requirements because emphasis is on skills to the neglect of fitness, conservative training methods and the difficulty of studying the sport scientifically. The frequently found values for total distance covered in a game of about 10 km and an about average though not outstanding, maximum oxygen uptake of 60 ml/kg/min suggest a moderate overall aerobic demand. A comparison of top teams and players with less able participants indicates that the components of anaerobic fitness. Speed, power, strength and the capacity of the lactic acid system may differentiate better between the two groups. Generally, there
is a reduction in the level of activity in the second half of games compared with the first. There is some evidence that increased aerobic fitness may help counteract this. Progressively lower muscle glycogen stores are one likely cause of reduction in activity, and nutrition also appears to be a key factor in minimizing performance deterioration, both in terms of overall diet and more particularly, the ingestion of carbohydrates immediately before, during and after a game.

1.4 SOCCER: AEROBIC AND ANAEROBIC CAPACITY

With the advancement of science and technology, sports person and their coaches, trainer has utilized new information of knowledge towards development of athletic ability. Only around 1960 the aerobic capacity and anaerobic capacity have been identified as the important factors determining sports performance to a large extent. All most in every sport, strength, aerobic capacity and anaerobic capacity with a good combination of motivation determine the performance level according to potentiality.

1.4. a AEROBIC CAPACITY AND SOCCER

‘Aerobic Capacity’ describes the functional capacity of the cardiorespiratory system (the heart, lungs, blood vessels). Aerobic capacity is defined as the maximum amount of oxygen, the body can use during specified period, usually during intense exercise. It is a function both of cardio-respiratory performance and the maximum ability to utilize oxygen from circulating blood. To measure maximal aerobic capacity and exercise physiologist or physician will perform a VO\textsubscript{2} max test. Aerobic activities depend upon a continuous and sufficient supply of oxygen in order to burn fats and carbohydrates to support endurance or sustained activity. For aerobic exercise the level of intensity is such that the oxygen needs of the activity
can be adequately supplied by the body during the activity; in other words, the participant achieves a balance or “steady state” between oxygen supply and demand. Walking, jogging, hiking, swimming and aerobic dancing are some of the most popular forms of aerobic exercise.

**VO₂ max:** VO₂ max is the individual maximum volume of oxygen intake capacity. It is expressed as ml/kg/min. The degree to which aerobic capacity can be improve by exercise varies very widely in the human population. While the average response to training is an approximately 17% increase in VO₂ max, in any population there are “high responders” who may as much as double their capacity, and “low responders” who will see little or no benefit for training. A professional soccer player should ideally be able to maintain a high level of intensity throughout the whole game. However, some studies have shown a reduction in distance covered, a lower fractional work intensity, reduced maximal heart rate reduce sugar level and reduce lactate level in the second half of games compared with the first half.

There have been several attempts to determine the aerobic contribution to metabolism by measuring oxygen uptake (VO₂) during match play. However, data obtained is probably not representative of oxygen uptake during match play because, since measurement procedure interferes with normal play (Bangsbo, 1994). Information about the aerobic energy expenditure during soccer can also be obtained from continuous heart rate measurement during the match. Best on individual relationship between heart rate and VO₂ during a standardized exercise protocol in the laboratory the heart rate determinations for each player during match play can be transformed to oxygen uptake (Bangsbo, 1994). By such estimation, mean values of about 75% VO₂ max have been obtained (Reilly & Thomas, 1979; Ekblom, 1986; Bangsbo, 1994). However, Bangsbo (1994) speculates that these value of 75% is
over estimating (emotional and thermal stress) the mean relative work load and this author believes that the real value might be closed to 70% VO$_2$ max corresponding to an energy production of 1360 Kcal for a person weighing 75 kg with a maximal oxygen uptake of 60 ml/kg/min. Mean heart rate during soccer match play have been found to be in a range from 165-175 beats/min with value usually being slightly higher during the first half of the game. According to Smollake (1978) this heart rate is closed to 85% of maximum theoretical heart beat for long periods of play. Similar values have been described also by Ekblom et al. (1986). Some researchers showed that for 63% for the game heart rate was in a range between 73% and 92% of maximum heart rate – 26% of match play heart rate was higher than 92% and only 11% of the playing time heart rate was below 73% of HR$_{max}$. In a research of professional soccer players, Baron et al. (1986) pointed out that the anaerobic threshold is about 78% (±6.9) of maximum VO$_2$, thus confirming above mentions findings other more recent study by Reilly (1994) also showed that the average work intensity, measured as per cent of maximal heart rate, during a 90 minute match is closed to lactate threshold or 82-90% of the maximal heart rate. This means that during a soccer match and alternating aerobic / anaerobic metabolic system takes place, in relation to intense technical – tactical it has to be pointed out that expressing intensity as an average over 90 minutes could result in a substantial loss of specific information. Indeed, as mentioned above, soccer matches have periods and situations of high intensity where accumulation of lactate takes place. Therefore the players need periods of lower intensity to remove lactate from the working muscles.

In determining aerobic endurance, VO$_2$ max is considered the most important element. Other important elements are lactate threshold (a higher lactate threshold theoretically means, that a player is able to maintain a higher average intensity in an
activity without accumulation of lactate) and running economy (cardiovascular efficiency). Several studies have determine the VO₂ max for male elite adult players, and mean values in a range between 55 and 65 ml/kg/min have been reported with few individual value over 70 ml/kg/min (Ekblom, 1986; Chin et al., 1992, 1994; Bangsbow, 1994). Reviewing available VO₂ max value of the last decade of international elite team shows that these magnitudes did not change significantly compared with values from the 1980’s. Although several studies observe higher VO₂ max values of elite players of top class teams compared to lower rank teams. Other studies failed to show any relationship which indicates that these variable is not crucial for good performance in soccer (Bangsbo & Michalsik, 2002). Several studies have determine the VO₂ max for male elite players based on their positional role within the team (Bangsbo et al., 2002). However, most of these studies failed to evaluate significant differences between different positions (exception goal keepers).

1.4. b ANAEROBIC CAPACITY AND SOCCER

Football (soccer), weight lifting and other short duration, maximal effort physical activities that require rapid energy release rely nearly exclusively on energy from the intramuscular high energy phosphates. Performance tests that maximally activate the ATP-PC energy system serve as practical field tests to evaluate the capacity for ‘immediate’ energy transfer. Two assumptions underlie use of performance test scores to infer the power generating capacity of high energy phosphates:

1. All ATP at maximal power output regenerates via ATP-PC hydrolysis.

2. Adequate ATP and PC exist to support maximal performance for about 6 second duration.
Anaerobic means without oxygen (insufficient) and high level performance in short sprint; jump, throw, etc. require a high level anaerobic capacity. Anaerobic energy yielding metabolic process plays an increasingly greater role as the severity of workload increases. The oxygen demand on these activities is higher than that which can be supplied by the body during their performance. As a result these events rely upon the short term fuel supplies of ATP or CP stored in the muscle that can be mobilized rapidly in the absence of adequate oxygen.

During heavier exercise, the lactic acid production and therefore, the rise in blood lactate concentration are higher and remain high throughout the work period.

During very severe exercise, there is a continuously growing oxygen deficit and an increase in the lactate content of blood because of the pre-dominantly anaerobic metabolism.

Anaerobic energy production is extremely important in soccer as it provide energy at a very highly rate during periods of intense exercise in a match. The concentration of lactate in the blood is frequently used as an indicator of anaerobic lactacid energy production in soccer. High level of lactic acid in the blood of soccer player during a match, with peaks of 12 mmol/lt (average value 3-8 mmol/lt) are evidence of high energy intensity of some fractions of play (Tschan et al., 2001). Explosive actions (sprint with quick change of direction, jumps, tackles, kicks) mainly require an anaerobic alactacid metabolism and are repeated with remarkable frequently during a match and making about 15-20% of total playing time. When explosive actions are spaced very closely, there is a shift from aerobic to anaerobic metabolism and this account for high accumulation of lactic acid during a match play. Soccer requires intermittent physically activity in which sequences of actions requiring a variety of skills of varying intensities are strung together (Cometti et al., 2001). This energy
pattern is characterized by repeated short duration bouts of high intensity exercise interspersed with longer periods of lower intensity exercise and passive recovery. Although the total duration of high intensity exercise performed during a multiple sprint sport only accounts for very small proportion of the total game time, such periods are most often instrumental in determining the outcomes of the game. Many activities in soccer require forceful and explosive burst of energy including tackling, jumping, kicking, turning and changing pace. The power output during such activities is critical in determining the overall success of performance (Strudwick et al., 2002). In order to cope with the physical requirements for elite soccer match play, it is important that the players have a high level of speed, muscular strength and anaerobic power.

1.5 CELLULAR BODY COMPOSITION

Human body composed with 75% of water and 30% of solid mass. Solid mass extracted from muscles, bones, internal organs, etc. Inside this solid mass there are different types of tissue and cell. These cells are composed with many molecules and obviously different types of atoms. Now the body composition has been measured in different level as per the requirement of that situation. Basically there are 5 types of body composition measurement:

1. Whole body level (muscle mass, fat mass, bone mass, etc.),
2. Tissue level (measurement of different tissue volume),
3. Cellular level (intracellular solid and liquid, extracellular solid and liquid, etc.),
4. Molecular level (C₆H₁₂O₆, etc.),
5. Atomic level (Ca⁺⁺, Cl⁻, K⁺, Fe⁺, etc.)
In cellular body composition there are extra cellular water intracellular water, body cell mass, extracellular mass, protein mass, mineral mass, total body potassium mass, total body calcium mass, glycogen mass, extracellular solid, extracellular fluid, plasma fluid (intra vascular), interstitial fluid (extra vascular), body density, etc. The detail of the cellular body composition parameters is describes in the methodology chapter.

There are many researches on soccer players. One of the very important area is energy metabolism in the time of soccer playing for that some researcher engage themselves on the measurement of aerobic power and other groups are searching anaerobic power capacities. There are very few researchers who tried to judge aerobic and anaerobic power of soccer players. Another very important area of this research is to recent cellular body composition with anaerobic and aerobic power capacity of soccer players. Till date the present researcher could not found any research on cellular body composition and aerobic anaerobic power in soccer from the available scientific literatures. After identifying this scientific information gap the present researcher motivated to start this research and want to give some contribution in sports sciences literature.

1.6 RELEVANCE OF THE STUDY

In football (soccer) both aerobic and anaerobic metabolism are very important. Football is a long duration game, so the aerobic capacity is essential. On the other hand, anaerobic power plays a very vital role in the time of short running with and without ball, kicking, heading and throwing. These anaerobic and aerobic metabolisms are started in the cellular level. So, cellular composition plays a very vital role. The present researcher wanted to identify the individual cellular body composition and its relation with aerobic / anaerobic power of soccer player.
Particularly the expression of aerobic / anaerobic power is the outcome of cellular level body composition. But this particular area is till now virgin and invites mechanism study.

1.7 OBJECTIVES

Present study was design to measure the aerobic, anaerobic and cellular body composition status of district level Indian soccer players. The main objectives of the study were as follows:

I. To evaluate anaerobic power of district level Indian soccer players.
II. To measure aerobic power of district level Indian soccer players.
III. Collect data on cellular body composition of district level Indian soccer players.
IV. To establish a relationship between cellular body composition and aerobic and anaerobic capacity of soccer players.

1.8 HYPOTHESES

\( H_1 \): Aerobic capacity of district level Indian soccer players may far behind from the national and international level.

\( H_2 \): Anaerobic capacity may also far behind from the national and international level.

\( H_3 \): Cellular body compositions may below the establish normal range.

1.9 DELIMITATION OF THE STUDY

1. In this study the subjects were selected from district level soccer players from Bhirbhum district of West Bengal, India.

2. Only the healthy male youth soccer players were participated in this study.
3. For measuring aerobic power two field test methods and one laboratory test was applied.

4. Also for measuring anaerobic power two field tests were applied.

5. For cellular body composition measurement only the Bio-Impedance technique was used.

6. Injured, ill, medical drug user, and less motivated soccer players were excluded from this study.

1.10 LIMITATION OF THE STUDY

1. Socio-economic background was one of the limitations of the study.

2. Finance was another constrain of the study.

3. Soccer players were not motivated to give all tests in a single day.

4. Also in the time of retest days the present researcher faced lot of adjustment problem with the subjects.

5. Sophisticate instruments for collecting data was another limitation.

6. Availability of subjects was one of the major limitations of the study.

1.11 SIGNIFICANCE OF THE STUDY

1. This study may provide a reference data of cellular body composition of Indian district level rural soccer player.

2. The aerobic data of this study may be compared with national and international data and the coaches, physical education teacher may get proper scientific information.

3. The field method anaerobic data of district level Indian soccer player may also provide the reference range.
4. Correlational analysis of cellular body composition, anaerobic / aerobic data may open a new area for the development of higher performance and further research.

5. The result of this study may provide a guideline for selection of team, better performance analysis and the time of recovery this results may guide the rehabilitator.

6. This study may be a good source of scientific material for Physical Education teachers, Sports Coaches, Administrators and Policy Makers.

7. Soccer players can judge themselves from this study result and develop their physiological potentialities.