CHAPTER I

INTRODUCTION

Football has become a very popular game in the world. Almost all the nations play the game both for enjoyment and competition. Modern football is very fast by its nature; the spectators and the players enjoy the game of football with a great amount of merriment. It is a game of constant action and requires continuous adaptation to changing situations by the team as a whole as well as by the individual players. Although it is a team game, there is ample room for players to display their brilliance through individual performance with the ball as well as through team play involving improvisation and tactical knowledge. It is a game that sends people from all over the world into frenzy, creates National and International heroes too. As like Pele the great, of Brazil, Diego Maradona of Argentina, and the like. As a result, there is a constantly increasing demand for more knowledge and better training means to coach the game. Sports scientists, coaches and physical education teachers are charged with the responsibility of training and teaching their players football techniques and tactics, to develop teams who perform at the maximum level of effectiveness\(^1\).

Football is characterized as a high intensity intermittent sport. The game is played for 90 minutes, during which players run at different speeds and execute technical skills randomly. A high number of accelerations and decelerations, associated with the large number of changes of direction of play, tackles and jumps create an additional load to the muscles involved. As in any sport, those players better suited to cope with the demands of the game reach the elite level. Players who form part of professional clubs and national teams have excelled in their performance and thus are considered the elite. Therefore, the attention focused on different profile of these football players.

By various methods data can be obtained on the activities performed by a player during a match. The total distance covered by football players at the elite level is in the order of 7 to 14 km, and the distance covered at high intensity is usually around 10 to 20% of the total distance. The number of sprints and high speed runs are in the order of 20 and 60, respectively, with a mean time for every sprint and high speed run of 2.0 and 2.1 s, respectively. Owing to the nature of the game, two sprints could be separated by very short or long periods, consequently affecting the metabolic demands of a match. The intermittent high intensity pattern of activity during the match requires a high function of both the aerobic and anaerobic energy delivery pathways. The high number of accelerations and decelerations demands that the energy
delivery pathways also accelerate and decelerate their rates of energy provision.²

The degree of acidity is an important chemical property of blood and other body fluids. Acidity is expressed on a pH scale where 7.0 is neutral, above 7.0 is basic (alkaline), and below 7.0 is acidic. A strong acid has a very low pH (near 1.0). A strong base has a very high pH (near 14.0). Blood is normally slightly alkaline or basic. It has a pH range of 7.35-7.45. The balance of acid to base in blood is precisely controlled. Even a minor deviation from the normal range can severely affect many organs. Lactic acid (present in the blood as lactate ion) is a product of the breakdown of glucose to generate energy. It is found primarily in muscle cells and red blood cells. The lactate concentration in the blood depends on the rates of energy production and metabolism. Levels may increase significantly during exercise. Together, lactate and another substance called pyruvate form a reversible reaction regulated by the oxygen supply to the blood and tissues. When oxygen levels are deficient, pyruvate converts to lactate; when they are adequate, lactate converts to pyruvate. When the liver fails to metabolize lactose sufficiently or when too much pyruvate converts to lactate, lactic acidosis occurs. Measurement of blood lactate levels is recommended for all patients with symptoms of lactic

² [www.sportsci.org](http://www.sportsci.org)
acidosis. Testing is generally indicated if the blood pH level falls below 7.25-7.35. Because of the close relationship between pyruvate and lactate, comparison of blood levels of the two substances can provide reliable information about tissue oxidation. However, pyruvate measurement is technically difficult and seldom performed. Lactic acid is measured more often, in either venous or arterial blood samples. High blood lactate levels, together with decreased oxygen in tissues, may be caused by strenuous muscle exercise, shock, hemorrhage, severe infection in the blood stream, heart attack, or cardiac arrest. When tissue oxygenation is low for no apparent reason, increased lactate levels may be caused by systemic disorders like diabetes, leukemia, liver disease, or kidney failure. Defects in enzymes may also be responsible, as in glycogen storage disease (von Gierke's disease). Lactate is also increased in certain instances of intestinal obstruction. Lactic acidosis can be caused by taking large doses of acetaminophen and alcohol and by intravenous infusion of epinephrine, glucagon, fructose, or sorbitol. Antifreeze poisoning can also cause lactic acidosis. In rare instances, a diabetic medication, metformin (Glucophage), causes lactic acidosis. People with weak kidneys should not take metformin.³

³www. Altavista.co/ lactic acid
Physiological measurements during football playing, with the exception of heart rate, are difficult to obtain. Most studies have been limited to determine weight-loss, increase in core temperature, and blood or muscle tissue metabolites at half time and at the end of the game. There is more understanding of the physiological need for acclimatization. There is better medical control over chances of infections, above all, there is greater attention paid to the development of the psychological attitude necessary to successful competition. But mostly the improvement are due to the athletes themselves in sprints, jumps and the throwing events. Alternatively, it is hard to resist the conclusion that the modern athlete is actually better endowed physically, better suited to his particular task. In events such as the Shot Put, there has been advance most in technique too. Clearly the research for betterment has been successful.

During intense exercise, such as sprinting type activities, when the rate of demand for energy is high, lactate is produced faster than the ability of the tissues to remove it and lactate concentration begins to rise. This is a beneficial process since the regeneration of NAD+ ensures that energy production is maintained and exercise can continue. Contrary to popular belief, this increased concentration of lactate does not directly cause

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4 Ibid
5 J.M. Tanner, "The physique of the Olympic athletes" (London Allon and union ltd., 1964) p.53
acidosis, nor is it responsible for muscle pain or "burning".[1] This is because lactate itself is not capable of releasing a proton, and secondly, the acidic form of lactate (lactic acid) cannot be formed under normal circumstances in human tissues. Analysis of the glycolytic pathway in humans indicates that there are not enough hydrogen ions present in the glycolytic intermediates to produce lactic or any other acid. The acidosis that is associated with increases in lactate concentration during heavy exercise arises from a separate reaction. When ATP is hydrolysed, a hydrogen ion is released. ATP-derived hydrogen ions are primarily responsible for the decrease in pH. During intense exercise, oxidative metabolism (aerobic) cannot produce ATP quickly enough to supply the demands of the muscle. As a result, glycolysis (i.e. anaerobic metabolism) becomes the dominant energy producing pathway as it can form ATP at high rates. Due to the large amounts of ATP being produced and hydrolysed in a short period of time, the buffering systems of the tissues are overcome, causing pH to fall and creating a state of acidosis. This may be one factor, among many, that contributes to the acute muscular discomfort experienced shortly after intense exercise. Although it is not firmly established, it is possible that lactate may contribute to an acidotic effect via the strong ion difference, however this has not been
well investigated in exercise physiology research and so its contribution is still uncertain.⁶

In today’s techno-scientific age, the world has completely changed in all aspects due to discovery and research. In the field of games and sports also, there has been a great change with the help of scientific coaching and training. The athlete are being trained on scientific guidelines with highly sophisticated means for better achievement in their concerned sport to enable the coaches to get optimum performance with minimum expenditure of energy and time. They are being exposed to the exercise and training methods, which have got beneficial effect for achieving higher standard.

Lactic acid does not necessarily accumulate at all levels of exercise. The general relationship between oxygen consumption, expressed as a percentage of maximum, and blood lactic acid during light, moderate, and heavy exercise in endurance athletes and untrained subjects. During light and moderate exercise, the energy demands of both groups are adequately met by reactions that use oxygen. In biochemical terms, the ATP for muscular contraction is made available predominantly through energy generated by the oxidation of hydrogen. Any lactic acid formed in light

⁶ http://www.answers.com/topic/lactic-acid
exercise is rapidly oxidized. As such, the blood lactic acid level remains fairly stable even though oxygen consumption increase.  

Lactic acid begins to accumulate and rise in an exponential fashion at about 55% of the healthy, untrained subject’s maximal capacity for aerobic metabolism.  

The increase in lactic acid becomes greater as exercise as exercise become more intense and the muscle cells cannot meet the additional energy demand aerobically. This pattern is essentially similar for the trained subjects except the threshold for lactate buildup, termed the anaerobic threshold or more precisely blood lactate threshold, occurs at a higher percentage of the athlete’s aerobic capacity.  

The main aspect to be emphasized in order to achieve high level of performance is the efficient function of the body. They must function well enough to support the particular activity that the individual is performing since different activities make different demands upon the organism with respect to blood circulation, respiration, metabolic neurological and temperature regulating functions, Physiological fitness is specific to activity. Human body is highly adaptable to exercise. The response of each system is discrete, hard work in the heat is necessary to

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8 Ibid p. 125

9 Ibid p. 126
improve the fitness of the temperature regulatory mechanism. Each task has its major physiological components and fitness for the task required are effective functioning of the appropriate system\textsuperscript{10}.

Football has figured in the Olympic since 1986 even through the Federation International Football Association (FIFA) was formed only in 1904. It has also figured in the Asian Games since their inception in 1951 in New Delhi. In India the origin of football has been traced back to the imperialism era of the Britisher’s. Football was introduced to this country by East India Company during the British reign over India. All Indian Football Association was formed in 1937 and the National Championship was first instituted in the year 1940. India first appeared in the Olympics in 1948 in London under captaincy of Tali Ao. In 1956, Olympic in Melbourne, India become the first Asian nation to enter semi finals of an Olympic beating Australia in the quarterfinal 4-2.

Modern football is a vigorous and fast game, which requires accelerating sprint, rough tackling, power in kicking and endurance to sustain skillful play for ninety minutes. The skills involved in the game are simple, natural and highly stimulating and satisfying to any one who participates in the games. The skills include kicking, running, jumping,

\textsuperscript{4} Narrotam Puri And V.Krishna Swamy, "Limea Book Of Records" ( Bombay: Bisleri Beverages Ltd., 1992 ), PP-235-236.
\textsuperscript{5} Ibid.
throwing, dodging and so on. Physical qualities such as speed, strength, agility, muscular power and endurance etc. are very important for a successful football player.

Modern scientific methods of training players or team place greater responsibility on the coaches and physical educators. They are also responsible for the selection of team taking into consideration the physical and physiological qualities essential for the game.

An alternate explanation for lactic acid buildup is based on studies that use radioactive tracers to label the carbon in the carbohydrate moles. These studies show that lactic acid is formed continuously at rest and in light exercise. Under aerobic conditions, however, lactic acid formation is matched by its rate of removal so the concentration of lactic acid remains fairly stable. With aerobic training, lactic acid removal keeps pace with its production, a buildup or accumulation occurs only at higher levels of exercise.11

The lactic acid system is capable of releasing energy to resynthesise ATP without the involvement of oxygen and is called anaerobic glycolysis. Glycolysis (breakdown of carbohydrates) results in the formation of

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pyruvic acid and hydrogens ions (H+). A build up of H+ will make the muscle cells acidic and interfere with their operation so carrier molecules, called nicotinamide adenine dinucleotide (NAD+), remove the H+. The NAD+ is reduced to NADH which deposit the H+ at the electron transport gate (ETC) in the mitochondria to be combined with oxygen to form water (H2O). If there is insufficient oxygen then NADH cannot release the H+ and they build up in the cell. To prevent the rise in acidity pyruvic acid accepts H+ forming lactic acid which then dissociates into lactate and H+. Some of the lactate diffuses into the blood stream and takes some H+ with it as a way of reducing the H+ concentration in the muscle cell. The normal pH of the muscle cell is 7.1 but if the build up of H+ continues and pH is reduced to around 6.5 then muscle contraction may be impaired and the low pH will stimulate the free nerve endings in the muscle resulting in the perception of pain (the burn). This point is often measured as the lactic threshold or anaerobic threshold or onset of blood lactate accumulation (OBLA). The process of lactic acid removal takes approx. one hour, but this can be accelerated by undertaking an appropriate warm down which ensures a rapid and continuous supply of oxygen to the muscles. The normal amount of lactic acid circulating in the blood is about 1 to 2 millimoles/litre of blood. The onset of blood lactate accumulation (OBLA) occurs between 2 and 4 millimoles/litre of
blood. In non athletes this point is about 50% to 60% VO2 max and in 
trained athletes around 70% to 80% VO2 max.

An important phase of the physical education profession is 
applied to testing of an individual's ability to meet the demands of 
varying types of tasks. An equally important application of testing the 
programme is made by sports scientists and sports trainers in order to 
assess physical abilities in terms of one's physical, psychological and 
physiological limits, so as to provide each sportsperson with 
individualized and properly guided programme schedules for effective 
training programmes. Such an effort automatically ensures result oriented 
training plans.

The present day football requires new or constructive changes in 
teaching methods. So, it should be kept abreast with the latest technology 
and skill development. It is the administration or teaching of these latest 
methods to keep first rate standards of these sports and games to uplift the 
total performance.\textsuperscript{12}

The performance of football depends upon many characteristics. 
The skill and physical condition play major role, but the physiological 
factors and games experience cannot be over-looked. In India, men 
football is in infancy stage. It has to go long way to catch the world

\textsuperscript{12} Karl N. Heddergott, New Football Manual. (Bad Hamburg, Lim Bent Verlog Gmbttt. 
1973)P.7
standard and in order to catch the world standard, there should be proper planning and implementation of the programme. And the implemented programme should be evaluated from time to time so that the best result can be attained. To move in the above direction there should be continuous research on the players.

If one anticipates the future of Indian football to be of world standard, it has to be planned sensibly. The needs for planning are clear also. First of all we have to have improved facilities for playing, coaching and watching. Added to this we have to have more and even better coaches, and managers and programmes of football activities. Football must demand the best at all levels. This requires thought and action from everyone who loves the game.

One can look forward confidently to the future of football provided all are prepared to accept change- change that is for the better. After all, football is the best game in the world and it’s worth fighting and changing for. If one carefully goes through the above-mentioned developments in Indian football, one will come to the conclusion that Indian football is moving professionalism. At the same time our performance at the international level is in a poor state and that may be due to the standard of football in the country. Therefore, to find out the reasons of poor quality / standard of football in the country and to suggest remedies to improve the football standard, and above all, to study the
entire developments that have taken place in Indian football with the introduction of NFL in the country, the present study has been undertaken by the research scholar.

With all round advancement in the science of sports the new disciplines are emerging with micro-specializations. The elements, of scientific basis of selection are being inducted in the procedure of selection of athletes at various levels in some of the advanced countries. The knowledge from many scientific disciplines is being used for improving the criteria for the selection of talents. The physical educationists have designed test procedures for evaluating the fitness of young children. The structures of performance for different games and events is being worked out. The general physical fitness of top—ranking athletes has been evaluated. Human growth and performance is also an important field in this regard. The physiological factors limiting one's performance in sports are also well known. It is the understanding of interaction of all these factors that can help us in designing the way for selecting the children for appropriate game and training.13

Coaches and personal trainers tell athletes and exercisers that they have to learn to work out at just below their "lactic threshold," that point of diminishing returns when lactic acid starts to accumulate. Some

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athletes even have blood tests to find their personal lactic thresholds. But that, it turns out, is all wrong. Lactic acid is actually a fuel, not a caustic waste product. Muscles make it deliberately, producing it from glucose, and they burn it to obtain energy. The reason trained athletes can perform so hard and so long is because their intense training causes their muscles to adapt so they more readily and efficiently absorb lactic acid. Athletes were told that they should spend most of their effort exercising aerobically, using glucose as a fuel. If they tried to spend too much time exercising harder, in the anaerobic zone, they were told, they would pay a price, that lactic acid would accumulate in the muscles, forcing them to stop.\textsuperscript{14}

As above mentioned literature clarifies that the lactic acid play very important role in determining the performance of football players. It is also established beyond doubt that no serious study on the football players in relation to lactic acid was ever taken-up in order to spot out the gaps and subsequently bridge them especially in Indian circumstances.\

As football becoming are very popular in our country, hence, the scholar in the form of present study is making modest effort in this direction to determine the blood lactic level at different mode of exercise.

\textsuperscript{14} http://www.nytimes.com
Statement of the Problem

The purpose of the study was to determine the level of lactic acid kinetic during a standardized exercise programme.

Secondly the other purpose of this study was to compare the level of lactic acid at different level of exercise programme.

Delimitations

1. The study was delimited to Lactic acid only.
2. The study was further delimited to 25 male All India interuniversity level football players.
3. The standardized exercise programme was set at 0% (resting level), 25%, 50%, 75% and 90% level of maximum fitness (till exhaustion).
4. The data for lactic acid was collected by performing an exercises on bicycle ergometer in well furnished laboratory of Lakshmibai National Institute of Physical Education, Gwalior (MP).
Limitations

Certain factors like genetic, lab temperature, humidity, initial fitness of the football players, internal motivation that may affect the results of the study were considered as the limitations of the study.

Hypothesis

From the scholar's own understanding of the problem and as gleaned through the available literature, it was hypothesized that there would be no significant difference between lactic acid kinetics at different mode of standardized exercise programme.

Definition and Explanation of the Terms

Definition of Lactic Acid: Lactic Acid, common name for 2-hydroxypropanoic acid, colourless compound of formula CH₃CHOHCOOH. It exists in two optically active forms, dextro- and laevo-, designated as (+)-lactic (formerly d-lactic) acid and (-)-lactic (formerly l-lactic) acid respectively. The ordinary acid is an optically inactive mixture made up of equal parts of the (+)- and (-)-forms. This is often called a racemic mixture.¹⁵

¹⁵ Microsoft® Encarta® Encyclopedia. © 1993-2001 Microsoft Corporation. All rights reserved.
**Explanation of Lactic Acid** The molecule produced as the end point of the glycolysis process for the regeneration of ATP (which is then available for energy release) when there is no oxygen present. The reason for muscle pain during intense exercise is the presence in muscle of large amount of lactic acid in blood.

Lactic acid is a weak acid produced by cells during chemical processes in the body that do not require oxygen (anaerobic metabolism). Anaerobic metabolism occurs only when too little oxygen is present for the more usual aerobic metabolism. Lactic acid is a contributing factor in muscle cramps. It is also produced in tissues when conditions such as heart attack or shock reduce the blood supply responsible for carrying oxygen. Normally, lactic acid is removed from the blood by the liver. When an excess of lactic acid accumulates for any reason, the result is a condition called lactic acidosis.

**Lactic acid**

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†http://www.answers.com/topic/lactic-acid
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**Significance of the Study**

Football is a wonderful game, a sport which knows no boundaries of race, age, wealth, sex or religion. Football is a sport, which reaches everyone, all over the world. People of young, old play it, watch it and read about it. People often forget that for all its drama and beauty, Football is a simple skill built on a set of individual skill allied to work together as a team.\(^7\)

Thus we have seen above how physiology provides the information about the overall fitness requirement. Today in the modern competitive era every sportsman is in a race to excel others, and competition has become a fundamental mode of human expression, as it is one of the very important function by which National and International recognition and prestige is gained. At each level of competition the standard performance is raised and new records are set. It is due to the improvement in sports facility and equipment along with the development of modern training.

\(^7\) Clive Gifferd (2002) *Football the ultimate guide to the beautiful game. King fischer publications.*
where all the factors, which affect the performance, have to be kept in mind.

Some athletes are simply better suited to running faster than others. It does not mean that they are better people; but their physiological blueprint enables them to start out with a physical advantage in that particular movement. 18 Thus the present study may contribute as below mentioned -

i. The study may help to know the degree of adaptive changes that are brought about by strenuous activity.

ii. It may also add the knowledge of Exercise Physiology and may act as a pathological screening tool.

iii. The study may help to assess improvement throughout the phase of conditioning which will help to predict performance success.

iv. The study may reveal true facts about the standard / level of Indian football players.

v. From a practical standpoint, this study is important for coaches and trainer to adjust training regimes and concentrate on the variable that is specific to improve performance and achieve success in football.

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