CHAPTER–1
GENERAL INTRODUCTION

1.1 Introduction
Identification, selection and physical development of youngsters have become an important area of research in games and sports. In competitive sports, only that person who has the potential and proper training can excel and will have a chance of winning a medal in an international competition. The search for potential sports persons with good health and motivation is a recent phenomenon in India. Interest in searching potential and talented sports persons in all sports has dramatically increased in recent times in our country. It has been realized that truly outstanding sporting performance, with the best coaching methods, and optimal training condition, can be achieved only by the individual who follows the disciplined schedules that is most essential to become best performer in the sports. Naturally gifted sports persons do have a greater chance of success in comparison to trained players, given the same amount of training and coaching.

In India identification and development of potential sports persons has been going on since last 30 years. Potential sports persons, till recent years were based on personal experience and institutional initiative. Few efforts have been made for potential hunt by the Indian Hockey Federation in 1969 and now at present by Sports Authority of India (SAI). Search for potential sportspersons in sports has recently been a discussion point in Indian sports circle after not performing very well in all fields of game in international competitions, especially in Asian Games, Olympic games and other world championships.

To achieve high performance in sports, the pre–requisites are good physique, motor abilities, technical skills, tactical efficiency, personality, trainees’ motivation and interests etc. The identification of strength with a high degree of accuracy also helps to predict whether a sportsperson will be able to successfully develop for competing in the various stages of training and performance. In other words, assessment of
potentiality of sports person is a process of determining the performance reconditions which are the abilities a person must have in order to reach a high level of performance and which must be spotted by using appropriate diagnostic technique.

Performance of the human machine in the field and factory depends largely on the health of the persons. There is a specific requirement of performance in the play field, which means different games, and sports activities. If we consider the battlefield, the performance also depends on the various biomechanical, physiological, and anatomical parameters. There is a wide difference in the performance levels among the various races in our planet. The performance of Caucasians, Africans, South East Asians, Central Asians and Indians are different.

But all these people over the globe will have to compete in the various fields of human endeavor and will have to compete with each other for survival and well being. Over the years, competition is almost in all levels and events of sports and games have intensified. So improvement of performance is becoming mandatory. Slowly but surely, we will have to understand and realize this firmly if we want to compete this open market era in the Global Village.

It is imperative that the performance is dependent on practice, appropriate diet, and regular exercise. This aspect was not addressed to the extent necessary to our sports activities. These lacunae have been identified in our country and sports related subjects are being introduced in the universities while the rest of the world has advanced at a rapid pace. Australia is one such country to introduce sports medicine and sports biomechanics as degree level subjects. From the early days of development of competitive sports, there
was an effort to develop and improve it by various ways and means. In recently, sports with the evaluation of biomechanical and physiological parameters and their relationship by scientific ways are increasing. It has now taken a shape of necessity, and the terms goes like sports mechanics and sports physiology. High sports performance is possible after a regular and systematic training of about 8–10 years. Training of children has to be based as principles of development especially on motor development.

From the standpoint of sports the development of motor abilities, movement skills and motors performance is of great importance. This aspect of growth and development is known as motor development and has been accepted as a vital field of knowledge for Biomedical Engineering and Physiological views.

**Biomechanics and Physiology in Sports**

Development is proportional to the various aspects such as Biomechanical and psychological parameters. The Biomechanical and Physiological aspect of development help to study the changes in muscle strength, B.M.I (Body Mass Index), body height and weight, body fat percentage, blood pressure and pulse rate.

Nowadays due to technological innovation in sports mechanics and sports physiology, simultaneous evaluation and identification of the sportspersons have become easier for the coaches. These factors play an important role in high performance in sports.

Biomechanical studies solve the problems that have physiological implications such as mechanical efficiency and neuromuscular control of movement. By the same time many physiological studies are examining phenomena in muscle that are mechanical in nature. Sports biomechanics developed rapidly in the 1970s where its progress and growth were unrivaled in the exercise and sport sciences. After the formation of the International Society of Biomechanics in 1973, international exchange and contacts among scientists grew rapidly. New instrumentation was developed and this enabled researchers to undertake more studies many of which were very demanding and
formation of the International Society of Biomechanics in 1973, international exchange and contacts among scientists grew rapidly. New instrumentation was developed and this enabled researchers to undertake more studies many of which were very demanding and complex. The conventional research and testing approach in sport biomechanics that has an emerged kinematics, which is concerned, with the description of how a body moves in space. The parameters, which can be measured through kinematics, are such as position, linear acceleration, angular displacement, angular velocity, and acceleration. These parameters can easily be analyzed in sports movement. Accelerometers and electrogoniometers produce valuable basic scientific information, which helps to exercises for more practical purpose in athletic training.

The forces, energy, power and efficiency involved in human movement are necessary elements for the understanding of motion in a more complete way. Integration of biomechanics research with the help of physiology becomes more appropriate and useful where kinetic methods are being applied.

Muscular forces and moments of forces provide information regarding the level of exertion by the athlete during competitive or training situation. Joint reaction forces are useful in evaluating—the loading characteristics of the human body especially during activities which produce long impact forces, such as Sky jump, gymnastics, boxing etc.

In the case of biomechanical and physiological research, proper investigations depend on the performance of the laboratory setting. A good biomechanics laboratory, which has a kin interest in advancing training methods of athlete, will have facilities where sport activities can either be stimulated or actually performed in controlled situations. For true impact of scientific research for the athlete required training, technique and equipment. Progress has been made by detailed biomechanical and physiological demands of the sport event.

Nowadays, sport is a profession that can earn decent livelihood. It is more recreational thing with some kind of interest apart from making money from playing.
Currently with globalization sports are genuinely pursued at the school level. As sports and games are becoming popular day by day, there is a need of sports devices and other accessories within the means of the Indian sportspersons.

The Sports Authority of India has initiated several schemes to spot talent and provide facilities for nurturing them. Those with talent are spotted much before they leave school. To qualify, a candidate must conform to the standards of tests to check strength along with agility, endurance, balance and skill specific to a particular sport.

Now–a–days it has been observed that many sportspersons especially world class cricketers are suffering from severe injury. There is almost no scientific study of the sports in our country. Recently, there are increasing numbers of injured cricketers, badminton and hockey players. Many sportspersons are bound to leave the field or death can even occur due to certain injuries. Injury occurs in the sports field either due to their negligence for taking various physical strength tests or not wearing hand gloves, face guards, helmets etc before participation in the high level action packed games. Some coaches or medical personnel avoid the proper diagnosis and treatment to the sportspersons before participation in the competitions. It may be because of unavailability of low cost strength and physiological factors measuring devices and also sufficient experts of medical facilities providers.

1.2. Motivation of the work

Olympic, Asian and commonwealth games have enthused all concerned to take more interest in sports and games. This will evidently inspire the study of sports biomechanics for better performance of the sportspersons. Now–a–days Indian sportspersons are participating in the various types of sports and games because Government of India is spending huge sum over years to popularize and improvement of quality of sportspersons by developing the Sports Authority of India and constructing many stadium, gymnasium, etc. in our country. Still we are depended on foreign equipments, coaches, biomechanicians and equipments for achieving excellence in our sports
activities. Arjuna Award is given by the Government of India for the brilliant performance at the National and International level. Very recently India Government as well as State Govt. is providing various facilities to the good performers in the various events of sports and games. Topmost world-class Indian cricketers, table tennis and boxers also

were felicitated through different types of award. Therefore, number of awardees in the sports field is increasing rapidly. Therefore, Indians have more expectation from the sportspersons. Medical personnel also took more care for the sportspersons for their improvement. More number of female sportspersons and physicians are involved for the development of sports. Physical education course is running by different institutions for giving more importance on health care to the sportspersons.

Recently, Indian boxers also won world championship in youth boxing and Asian championship. Beside this Indian boxer achieved gold medal in commonwealth games. Indian boxers in Olympic at Beijing also had world ranking. This is the first time that Indian boxer won bronze medal from World boxing.

**Some recent achievements in Sports**

The talented National champion Sharath dominated the men’s singles of Indian men’s table tennis by training and playing with the top players of Europe (Sportstar–Feb–10, 2011). He scored highest ranked Indian in the world eclipsed former National champion Kamlesh Mehta’s record by winning his fifth successive title (Sportstar–Feb–10, Vol.34, No.6.page–32, 2011). Mahesh Bhupathi and Leander Paes of India, were one of the World’s best teams before the Bryans chest–bumped [(Sportstar, Feb–10, 2011), page–11). Suma Shirur struck form to win the air rifle gold [(Sportstar, Feb.–17, Vol. 34, No.7 2011), page–35]. In so many ways April 2 could be a day to remember a day to put alongside the precious few whose fate, it is to be plucked out by ancients with the time, honoured words, It is the end of a long hard road, a time of upliftment. (Sportstar, February–24, Vol 34, No.8 2011).
Indian shooting’s focus should have been on gaining as many quota places as possible for the London Olympic, one with any two quota places secured so through Gagan Narang in air rifle and Harion Singh in free rifle prone (Sportstar, March–3, Vol 34, No.9, 2011), page–38]. Olympian Suresh Babu, who had inspired a lot of younger to take up athletics in the 1970s and 80s. Suresh Babu, who won the long jump gold medal in the 1978 Asian Games, (Sportstar, March–3, 2011), page–38] dominated the track and field between 1972 and 1979 and was a recipient of the Arjuna Award. He first represented India at the Olympics–March, 1972 at the age of 19. Though Indian cricket team did better with limited facilities and recently Indian cricket team became world champion in 2011. Now a days boxing is also a popular game in India like other countries. Over the past several years the ICC has looked to expand the game globally (Sportstar, March 24, Vol 34, No.12, 2011). Previously teams with players who are total amateur playing for the love of the game and fun they get in a team environment but now days players playing with professional attitude (Sportstar, March 24, 2011). Mahesh Bhupati and Leander Paes defeated Danish Nestor and Max Mirnji 6–7,6–2,10–5 in the Song Eriesson open doubles final to regain the No.1 doubles ranking in the world in Lawn Tanis [Sportstar, March–5,2011(page–16)] Virdhawal got eight gold medals, all in Games–record times, two silver and two bronze. He was also adjudged the best male Athlete of the National Games. (Sportstar, March–17, 2011). Winner of 10,000 m gold in the 2010 Asian Games in Guangzhou, Preeja Sreedharam’s profile has changed for her remarkable performance in the 2010 Asian Games,[(Sportstar,March–17,2011), page–29]. Rajyavardhan Singh Rathore who won the gold in double trap and subsequently returned to the National squad after having missed the World Championship, Commonwealth Games and Asian Games. [(Sportstar, March–17, 2011), page–35]. Though many nations play football, very few can equal its history in India, which has been playing it for more than a hundred years. System will be developed to bring 11 world class players from India having a population of more than a billion."Considering India’s long football history we are trying to forge a strategic alliance between India and Franch in term of football development’’—Vikash Dhorasoo
added while introducing his partners Walfisz, Jonathan Sinivassance and friend Arunava Chaudhuri, who is a journalist and football expert based in Germany [Sportstar, March 24, 2011(page–36)]

Arundhati Pantawance was runner–up in an international tournament in Estonia [Sportstar, March–24, Vol 34, No.12, 2011(page–38)]. Saina Nehwal is indifferent start to the 2011 season before winning the Swiss open–which happens to be her ninth major title including four super series, three Grand Prix Gold and two grand Prix crown besides the commonwealth Games gold (Sportstar–April–7, Vol 34, No.14, 2011). World cup winning in cricket started at Lord’s in 1983 [International Cricket Council (ICC) cricket world cup] where few had expected the team to do it and at the Wankhede Stadium 28 years later, few expected Indian not to win but Indian cricket team capped the progress with victory, 2011.Mahendra Singh Dhoni was a captain who pass the winning tempo to the next generation Indian players who are getting a lot of money and respect.(Sportstar–April–14, 2011). After the history, the hysteria, India were favorites ahead of the World Cup, then slipped into mediocrity in the group phase before beating three former champions in a row to claim the title (Sportstar, April–14, Vol. 34, No.15, 2011). Force measuring devices tuneup to the responsibilities entrusted upon the players.

Indians cricket players have brought the smile to Indians’ face in the World Cup tournament in 2011. It was great team effort, a superb effort by the Indian cricket players. They had beaten all the big teams. That shows India is clearly the best team in the World (National Selector Kris Srikkanth) (Sportstar, April–14, 2011). After the debacle of 2007, the Indian team was in turmoil and Gary Kirsten Changed the scenario of the team. He brought sense calmness to his outfit. Sunil Gavaskar (Sportstar, April–14., Vol. 34, No.15, 2011).

Most two–handed players (like Novak Djokovic in Pic) have a dominant left hand for right–hand players. And therefore, they would have more of a controlling influence on the racquet with their lower hand.Dr.Bruce Elliott, the senior Bio–mechanist and HOD of School of Sport Science, Exercises and health at the University of Western
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Australia, says one needs some force of Firmness which gripping the racquet. But you certainly do not need a vice–like grip [Sportstar, May–5, Vol. 34, No.14, 2011 (page–12)]. Different electronics giant companies are coming forward to lend their hands to help the sportspersons to move upward. Various institutions are conducting Sports management courses. It has been observed that job facilities are given by the various organizations to the sportspersons. Previously Boxing was the only games where female boxers were not allowed to participate in Olympic games. But now this scenario has changed. Female boxers will be allowed to participate in the Olympic from 2012 to be held in London.

Accessibility to health care and essential testing in the sports arena still remains inadequate. Irrational use of medicines, non–availability of sufficient number of health care providers in the sports fields are challenging. So it need to be overcome. Now a days female Indian cricketer participates in the world cup competition. Female also participate in the kick boxing in the Olympic. Indian youth participate in the world–class table tennis competition. Exercise is an important in minimizing risk of conditions including mental health disorders, stroke and premature death, coronary heart diseases, hypertension. Exercise is important in promoting health. However, it is not uncommon for exercise participants to be injured. Most General Introduction injuries are not severe. Finch et al.2006 found that in Latrobe Valley these was 1 sports and exercise related hospitalization for every 10 emergency admissions and 12 general practice consultations.

1.3. Approach to the problem

Now to address to the above cited problems that includes identification, evaluation and quantification of performance, we have undertaken a study to develop various type of force measuring devices (dynamometer) for the measurement of physical strength of Indian youth specifically from Eastern and North–eastern region. With the help of these devices, the strength of boxing punch for boxers, grip–strength for cricketer, racket, bat or stick based players like hockey, badminton, tennis and others can be measured. The sportspersons especially boxers usually practice on a sand fill hanging
sack. This arrangement do not give any idea about the development of the boxers ability except qualitatively. To address to this problem the present research envision to develope a Punch dynamometer along with strain gage based load cell for quantification of the fist blow on the target pad. Also pinch strength is important for players who comeback from finger injury in any racket, bat or stick based sports. Back strength measurement is also essential in many of the athelatic, games and sports activity, like load lifting, hokey, football, wicket keeping, fielding etc.
Figure 1.1: Front view of upper extremity or limb

Figure 1.2: Back view of upper extremity or limb
1.4 Anatomy of human upper arm

Human upper arm were mainly involved for the measurement of physical strength such as for punching, pinching, gripping and pulling and also other associated factors like as blood pressure, pulse rate measurement so surface anatomy of the upper arm is discussed in a nutshell.

Skin

The skin covering the shoulder and arm is smooth and very movable on the underlying structures. In the axilla there are numerous hairs and many soporiferous and sebaceous glands. Over the medial side and front of the forearm the skin is thin and smooth, and contains few hairs but many sudoriferous glands; over the lateral side and back of the arm and forearm it is thicker, denser, and contains more hairs but fewer sudoriferous glands. In the region of the olecranon it is thick and rough, and is very loosely connected to the underlying tissue so that it falls into transverse wrinkles when the forearm is extended. At the front of the wrist there are three transverse furrows in the skin; they correspond respectively from above downward to the positions of the styled process of the ulna, the wrist–joint, and the metacarpal joint. The skin of the palm of the hand differs considerably from that of the forearm. At the wrist it suddenly becomes hard and dense and covered with a thick layer of epidermis; on thinner eminence these characteristics are less marked than else where. In spite of its hardness and density the skin of the palm is exceedingly sensitive and very vascular, but it is destitute of hairs and sebaceous glands. It is tied down by fibrous bands along the lines of flexion of the digits, exhibiting certain furrows of a permanent character. One of these, starting in front of the wrist at the tuberosity of the navicular bone, curves around the thinner eminence and ends on the radial border of the hand a little above the metacarpophalangeal joint of the index finger. A second line begins at the end of the first and extends obliquely across the palm to reach the ulnar border about the middle of the fifth metacarpal bone. A third line begins at the ulnar border about 2.5 cm. distal to the end of the second and extends across the heads of the fifth, fourth, and third metacarpal bones. The proximal segments of the fingers are joined to one another on the volar aspect by folds of skin constituting the “web” of the fingers; these folds extend across about the level of the centers of the
proximal phalanges and their free margins are continuous with the transverse furrows at shorter when viewed from in front than from behind. Over the fingers and thumb the skin again becomes thinner, especially at the flexures of the joints (where it is crossed by transverse furrows) and over the terminal phalanges; it is disposed on numerous ridges in consequence of the arrangement of the papillae in it. These ridges form, in different individuals, distinctive and permanent patterns which can be used for purposes of identification. The superficial fascia in the palm of the hand is made up of dense fibro–fatty tissue which binds the skin so firmly to the palmar aponeurosis that very little movement is permitted between the roots of fingers. Since the web is confined to the volar aspect the fingers appear shorter when viewed from in front than from behind. Over the fingers and thumb the skin again becomes thinner, especially at the flexures of the joints (where it is crossed by transverse furrows) and over the terminal phalanges; it is disposed on numerous ridges in consequence of the arrangement of the papillae in it. These ridges form, in different individuals, distinctive and permanent patterns which can be used for purposes of identification. The superficial fascia in the palm of the hand is made up of dense fibro–fatty tissue which binds the skin so firmly to the palmar aponeurosis that very little movement is permitted between the two. The clavicle can be felt throughout its entire length. The enlarged sternal extremity projects above the upper margin of the sternum at the side of the jugular notch, and from this the body of the bone can be traced lateral ward immediately under the skin. The medial part is convex forward, but the surface is partially obscured by the attachments of

On the back of the hand and fingers the subcutaneous tissue is lax, so that the skin is freely movable on the underlying parts. Over the interphalangeal joints the skin is very loose and is thrown into transverse wrinkles when the fingers are extended.
Bones
Sternocleidomastoideus and Pectoralis major; the lateral third is concave forward and ends at the acromion of the scapula in a slight enlargement. The clavicle is almost horizontal when the arm is lying by the side, although in muscular subjects it may incline a little upward at its acromial end, which is on a plane posterior to the sternal end.

The only parts of the scapula that are truly subcutaneous are the spine and acromion, but the coracoids process, the vertebral border, the inferior angle, and to a lesser extent the auxiliary border can also be readily defined. The acromion and spine are easily recognizable throughout their entire extent, forming with the clavicle the arch of the shoulder. The acromion forms the point of the shoulder; it joins the clavicle at an acute angle—the acromial angle—slightly medial to, and behind the tip of the acromion. The spine can be felt as a distinct ridge, marked on the surface as an oblique depression, which becomes less distinct and ends in a slight dimple a little lateral to the spinous processes of the vertebrae. Below this point the vertebral border can be traced downward and lateral ward to the inferior angle, which can be identified although covered by Latissimus dorsi. From the inferior angle the axillary border can usually be traced upward through its thick muscular covering, forming with its enveloping muscles the posterior fold of the axilla. The coracoid process is situated about 2 cm. below the

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the posterior fold of the axilla. The coracoid process is situated about 2 cm. below the junction of the intermediate and lateral thirds of the clavicle; it is covered by the anterior border of Deltoideus, and thus lies a little lateral to the infraclavicular fossa or depression which marks the interval between the Pectoralis major and Deltoideus.
lateral supracondylar ridge runs upward. The most prominent part of the ulna, the olecranon, can always be identified at the back of the elbow–joint. When the forearm is flexed the upper quadrilateral surface is palpable, but during extension it recedes into the olecranon fossa. During extension the upper border of the olecranon is slightly above the level of the medial epicondyle and nearer to this than to the lateral; when the forearm is fully flexed the olecranon and the epicondyles form the angles of an equilateral triangle. On the back of the olecranon is a smooth triangular subcutaneous surface, and running down the back of the forearm from the apex of this triangle the prominent dorsal border of the ulna can be felt in its whole length: it has a sinuous outline, and is situated in the middle of the back of the limb above; but below, where it is rounded off, it can be traced to the small subcutaneous surface of the styloid process on the medial side of the wrist. The styloid process forms a prominent tubercle continuous above with the dorsal border and ending below in a blunt apex at the level of the wrist–joint; it is most evident when the hand is in a position midway between supination and pronation. When the forearm is pronated another prominence, the head of the ulna, appears behind and above the styloid process. The enlarged ends of the phalanges can be easily felt. When the digits are bent the proximal phalanges form prominences, which in the joints between the first and second phalanges are slightly hollow, but flattened and square–shaped in those between the second and third.

**Articulations.**—The sternoclavicular joint is subcutaneous, and its position is indicated by the enlarged sternal extremity of the clavicle, lateral to the long cord–like sternal head of Sternocleidomastoideus. If this muscle be relaxed a depression between the end of the clavicle and the sternum can be felt, defining the exact position of the joint.
The position of the acromioclavicular joint can generally be ascertained by determining the slightly enlarged acromial end of the clavicle which projects above the level of the acromion; sometimes this enlargement is so considerable as to form a rounded eminence. The shoulder–joint is deeply seated and cannot be palpated. If the forearm be slightly flexed a curved crease or fold with its convexity downward is seen in front of the elbow, extending from one epicondyle to the other; the elbow–joint is slightly distal to the center of the fold. The position of the radiohumeral joint can be ascertained by feeling for a slight groove or depression between the head of the radius and the capitulum of the humerus, at the back of the elbow–joint. The position of the proximal radioulnar joint is marked on the surface at the back of the elbow by the dimple which indicates the position of the head of the radius. The site of the distal radioulnar joint can be defined by feeling for the slight groove at the back of the wrist between the prominent head of the ulna and the lower end of the radius, when the forearm is in a state of almost complete pronation.

Of the three transverse skin furrows on the front of the wrist, the middle corresponds fairly accurately with the wrist–joint, while the most distal indicates the position of the midcarpal articulation. The metacarpophalangeal and interphalangeal joints are readily available for surface examination; the former are situated just distal to the prominences of the knuckles, the latter are sufficiently indicated by the furrows on the volar, and the wrinkles on the dorsal surfaces. Muscles the anterior border of the Trapezius presents as a slight ridge running downward and forward from the superior nuchal line of the occipital bone to the junction of the intermediate and lateral thirds of the clavicle. The inferior border of the muscle forms an undulating ridge passing downward and medial ward from the root of the spine of the scapula to the spinous process of the twelfth thoracic vertebra. The lateral border of the Latissimus dorsi may be traced, when the muscle is in action, as a rounded edge starting from the iliac crest.
and slanting obliquely forward and upward to the axilla, where it takes part with the Teres major in forming the posterior axillary fold.

The Pectoralis major conceals a considerable part of the thoracic wall in front. Its sternal origin presents a border which bounds, and determines the width of the sternal furrow. The upper margin is generally well-marked medially and forms the medial boundary of a triangular depression, the infraclavicular fossa, which separates the Pectoralis major from the Deltoideus; it gradually becomes less marked as it approaches the tendon of insertion and is closely blended with the Deltoideus. The lower border of Pectoralis major forms the rounded anterior axillary fold. Occasionally a gap is visible between the clavicular and sternal parts of the muscle. When the arm is raised the lowest slip of origin of Pectoralis minor produces a fulness just below the anterior axillary fold and serves to break the sharp outline of the lower border of Pectoralis major. The origin of the Serratus anterior causes a very characteristic surface marking. When the arm is abducted the lower five or six serrations form a zigzag line with a general convexity forward; when the arm is by the side the highest visible serration is that attached to the fifth rib. The Deltoideus with the prominence of the upper end of the humerus produces the rounded contour of the shoulder; it is rounded and fuller in front than behind, where it presents a somewhat flattened form. Above, its anterior border presents a slightly curved eminence which forms the lateral boundary of the infraclavicular fossa; below, it is closely united with the Pectoralis major. Its posterior border is thin, flattened, and scarcely marked above, but is thicker and more prominent below. The insertion of Deltoideus is marked by a depression on the lateral side of the middle of the arm.
1.5. Physical Strength

Physical strength is nothing but natural strength of a body or its limbs and its subunits, e.g. upper arm, hands, fingers of the body. Non–invasive physical tests of upper arm of right and left hand were considered. Punch, pinch, grip and back forces were the active measurable parameters for the physical tests besides others passive physiological Parameters such as BMI, body fat percentage, blood pressure and pulse rate. For the measurement of those physical parameters the designing and development of various types of dynamometers were one of the critical step towards analyzing the performance of the students, sportspersons as well as boxer. The repeatability and accuracy of the dynamometers were assessed by applying straight punches, pinching, gripping and pulling by the right and left hands on appropriate device. Discrimination efficacy were assessed by comparison of the maximum punching, pinching, gripping and pulling force of few numbers same age group with different type of (skill) in respect of their right hand and left hand.

Punch strength

Boxing is no different from other sports. Previously, the correct measuring blows are evaluated and identified by the only judges without using electronics measurable devices. Boxing is a popular international sport on both amateur and professional levels. It makes high demand on strength capacities. In boxing, majority of the Indian boxers are young untried those are performing offensive and defensive actions. Since boxing involves forceful, repetitive punching, precautions must be taken to prevent damage to bones in the hand. Most trainers do not allow boxers to train and spar without hand/wrist wraps and boxing gloves. Hand wraps are used to secure the bones in the hand, and the gloves are used to protect the hands from blunt injury, allowing boxers to throw punches with more force than if they did not utilize them. Gloves had been used in competition since the late nineteenth century, though modern boxing gloves are much heavier than
those worn by early twentieth-century fighters. Prior to a bout, both boxers agree upon the weight of gloves to be used in the bout, with the understanding that lighter gloves allow heavy punchers to inflict more damage. The brand of gloves can also affect the impact of punches, so this too is usually stipulated before a bout. A mouth guard is important to protect the teeth and gums from injury, and to cushion the jaw, resulting in a decreased chance of knockout.

Boxers practice their skills on two basic types of punching bags. A small, tear-drop-shaped "speed bag" is used to hone reflexes and repetitive punching skills, while a large cylindrical "heavy bag" filled with sand or a synthetic substitute is used to practice power punching and body blows. In addition to these distinctive pieces of equipment, boxers also utilize more general use training equipment to build strength, speed, and agility. Common training equipment includes free weights, rowing machines, jump rope, and medicine balls.

**Training Equipment**

There are different types of punching bags, with different names based on their size, use and mounting method. Almost all punching bags are covered with leather or synthetic materials such as vinyl which resist abrasion and mildew. Canvas is also used as a bag material where there is lesser use and humidity.

Speed bags are small, air-filled and anchored at the top to a rebound platform parallel to the ground. Speed bags help a fighter learn to keep his hands up, improve hand-eye coordination and learn to shift weight between feet when punching. Double-end bags or Focus bags are light, round and often anchored to floor and ceiling with elastic or semi-elastic materials. These types of bags are used to practice mobility and accuracy on a moving target. Maize bags are not punched with great force but are used in boxing training to improve the athlete's head motion and ability to evade an opponent’s. A heavy bag is a larger, cylindrical bag, usually suspended by chains or ropes for practicing powerful body punches. Pedestal bags or tower bags are heavy bags
mounted on a weighted pedestal rather than being hung from above. Other variations on the standard heavy bag include horizontal suspension from both ends to practice uppercut punches and non-cylindrical shapes. The Maize Bag: Used to practice head movement and close-range combinations, such as uppercut/hook combinations. The upper cut punch bag (Fig.1.3) started showing itself towards the beginning of the century. With so many different variations of bags and training equipment for boxing taking off, the upper cut bag is still a common sight in clubs and gyms. The bags are designed for upper cut practice, jabbing, curl punching and low quick burst of high and low punching practice. It allows the fighter to punch at different lengths; different speeds and different forces compared to the standard average 3.5 m straight PU (polyurethane) punch bags.

![Uppercut Punch Bag](a)

![Human-like Punch Pad](b)

**Figure 1.3 (a): The upper cut punch bag Figure. 1.3 (b): The human like Punch pad (adopted from Wikipedia)**

As boxing is a specific on strength capacities so its apparent is in the form of punching strength. The powerful blows must have another essential part namely that has to be performed explosively. However, it is not sufficient to perform the blows
explosively and vigorously. Strength for explosive punches as well as for normal punches are essential. In the form of punch strength a punch requires explosiveness for its effectiveness as we are well aware that in boxing speed and snapping movements plays effective role for the successes and hence explosive strength is required.

The explosive strength quality is the boxer’s ability to overcome resistance with high contraction speed in shortest possible time. The level of motor coordination required for the movement influences explosive strength performance. The proportion of strength and speed will differ depending upon the nature and the combination of strength and speed.

Indian Amateur Boxing Federation wished to measure the impact force received by the boxers during the punch with the help of a low cost measurement system. A boxing dynamometer has mainly three major applications. First, it can be used as an assessment tool to identify particular strengths and weaknesses of an individual boxer’s technique. Secondly, it helps coaches for evaluation of the trainee boxers. Thirdly, it is suitable or not for a particular group of boxers or boxers from a particular region. Previously, Indian women boxers participated only at the Asian Womens’ Championship. But now they will be allowed to participate in the Olympic 2012 to be held in London.

Our women boxers have not performed upto the mark for winning number of medals in the World Cup, the Commonwealth Games and the Asian Boxing Championship. Indian junior and sub–juniors are also not performing well abroad and in international program.

Before 1978, for Commonwealth games there were no dedicated boxing coaches in India. After that medal winner dedicated boxing coaches were assigned by the Indian Amateur Boxing Federation to coach the new generation junior and sub–junior boxers. But till now highly beneficial influencer in the boxing is lacking and not upto the mark indigenous punching force measuring devices are available.

In boxing, two boxers meet and exchange the punches. The strength plays a vital
role to execute offensive and defensive actions of a boxer. Its mechanism includes the obvious movements of the upper extremity as well as movements of the lower extremity.

The boxer needs strength to overcome the resistance. The execution of the punch depends upon the acceleration of the fist and defending the opponent’s punches depends on the defensive tactics. The sportspersons specially boxers usually practice on a sand fill hanging sack. This arrangement do not give any idea about the development of the boxers ability except qualitatively. Development of a Punch dynamometer indigenously will be very useful and beneficial to the Indian boxers.

Boxing is a body contact injury prone popular sport world over. Recently India emerged as a winner in the Beijing Olympic 2008, which has enthused all concerned to study the mechanics of the boxers performance. There is almost no scientific study of the sports in our country. This has prompted us to study the subject scientifically. Proper selection of a boxer in the sports world is a vital task of a coach / trainer for improving and assessing the performance level of a boxer. Here measurable parameters such as Punch force and Speed of hit are not only involved but also involvement of measurable parameters like as  skill and reflex. Punch force can be measured by various types of dynamometers but usually unaffordable to the Indian boxers.

**Pinch Strength**

Pinch force measurement is also necessary for designing robotic hands. Designing and development of a pinch dynamometer indigenously will be helpful for the evaluation and assessment to eliminate the pain of the orthopedral disorder on the fingers of hands of the Indians. It helps for physically fit and talented cricketers, boxers, table tennis, badminton, basketball and hockey players and also health care providers including coaches/ fitness trainers, physiotherapists and also physical education teachers.

Medical injury rehabilitation of Indians such as factory workers, sportspersons, cricketers, badminton players and volleyball players is a vital task for the medical practitioners. Proper rehabilitation, sportsperson in the normal life and sports world is a vital task of a medical practitioner and also coach / trainer for improving and assessing
the performance level of them. Pinch force can be measured by various types of pinch dynamometer but usually unaffordable to the Indian student, sportspersons and boxers.

Pinch strength of the fingers of both the hands was measured by pinch force measuring dynamometer. The development of pinch dynamometer is one of the most essential phenomena for analyzing the performance of Indian young persons specially sportspersons including boxers and students, in the field of sports and games.

**Hand–Grip Strength**

Grip strength is essential in holding the cricket bat and ball, tennis and badminton rackets, shot put, hammer throwing hammer and various other sports. Apart from these for supporting day to day activities such as holding the rods of buses and trains as well as while detraining. Grip dynamometer will be helpful for the diagnosis of the strength in the grip as well as fist of hand for the cricketers, boxers, table tennis, badminton and hockey players and also health personnel and guides.

**Back Strength**

Present day IT–oriented work and other office work are performed in sitting posture. They are suffering from of the back pain of the body for continuous work on computer. Many sportspersons also suffer from severe pain on vertebral column. Back pain phenomena are also observed in the various competitive fields. To address this problem, the present study considered the Back strength measurement of students, sportspersons including boxers with a simple technique at an affordable cost. It helps for immediate diagnosis for the treatment to eliminate the pain of the orthopedical disorder on the spine of subject. This is a vital task of the health care personnel including medical practitioners, paramedical staffs for improving and judging the better performance level.

Accurate medical injury rehabilitation of Indian youth such as factory workers students, sportspersons, specially cricketers and two wheeler drivers is a vital task for the medical practitioners as well as paramedical staff and health worker. After injury rehabilitation, it is also important for the coaches and trainers to increase the achievable performance level.
1.6. Strength measurement System

The success in competitions depends not only on the technique of the sportspersons but also to a large extent on the perfection of the measuring system.

The performance is not only depended on practice, appropriate diet, regular exercise, skill for promoting lifestyle change for specific games, sports and psychological motivation but also quantification of the strength measurements. This aspect was not addressed to the extent necessary to our sports activities though Govt. has invested huge sum over years. Many machines have been designed that are better suited for a specific task than humans (e.g. a computer for fast and accurate calculations), however none are as versatile as the human machine. So much so, that a field of study has been developed that takes leads from the human body (or other living organisms) to solve various engineering problems—Biomimetics (literally ‘mimicking life’).

Any measurement device needs to demonstrate good measurement accuracy, repeatability and resolution, but also the sensitivity to discriminate between different standards of sport performer (Joch et. al.1981 and VanGweluwe et. al., 1988 and Karpilowski et al., 1994).

1.7. Factors related to strength

Medical fitness of Indian youth such as industry workers, students, sportspersons, cricketers, athletes and kabaddi and football players are essential. Simultaneously it is a challenging job for the medical practitioners and also guides for identification, selection and evaluation through diagnosis for gradually increasing the actual performance level. It involves reflex, agility, energy, body strength, speed and physiological parameters. Apart from these some measurable parameters are Body Mass Index (BMI), Body fat percentage (Body fat %), Blood pressure (BP) and pulse rate (PR) are of most important from the physiological point of view with the accurately non measurable such as talent, skill, body balance and reflex. For measuring those, various types of sophisticated
equipments are available internationally to measure those parameters. Individual student and sportsperson cannot afford and maintain those instruments because it requires expertise for calibration and measurement, in health center along with proper documentation.

Various types of physiological factors like as BMI, body fat %, BP and PR are influenced in various type of physical strengths such as punch, pinch, grip and back.

Body Mass Index
WHO has prepared index for obesity which is called Body Mass Index or B.M.I. Right weight when B.M.I of a man or woman is 18.5 to 24.90. A person is over weight when his and her B.M.I is more than 25. When it rises over 35, a person suffers from excess obesity. Indian youth are not in general so serious about their health. Now a days majority of Indian youth specially students are not involved in exercises. Apart from Students, Sportspersons including boxers are suffering from various cardiac diseases because of negligence of health care. Athletes, such as runners, who do a lot of cardiovascular conditioning, may have heart rates near 40 beats per minute.

The overweight create problem such as hypertension, stroke and hyperglacemia or diabetes and also problem associated with other organs like liver, pancreas and gallbladder. There are more than 100 million over weight people in India among whom majority are young boys and girls. Cross –sectional survey report shows that over weight causes disease of coronary artery But in India, BMI is above 25 kg/m² and its average distribution between male and female is 53.2 and 34.7% in industry, 48.6 and 35.2% in city, and 11.4 and 7.9% in village respectively. More body weight is harmful for health even if BMI is 25 kg/m². Specially in case of female, when weight increases 5 kg more than normal BMI, they may suffer from diseases like diabetes and heart attack. Any person of 25 years and above age may suffer from different diseases with every increase in weight above the normals. Over weight causes heart diseases, brain stroke,
hypertension, diabetes etc. According to National Institute, Hyderabad (India), “Overweight makes a beautiful figure ugly”. If BMI of a person is 20 % more than normal BMI then the person is suffering from obesity. With increase in obesity physical, structural problem arises like osteoarthritis, hernia; problems like stone in gallbladder, increase in cholesterol, high B.P & heart disease are generally observed in a person suffering from obesity. According to eminent researcher and physician of Women’s Hospital, Boston, Dr. Torious Kurth there is a chance of stroke when B.M.I is 30 or, more. But there is no chance of danger when B.M.I is 23 or less.

**Body Fat Percentage**

Body fat percentage (Body fat %) measurement is necessary for the diagnosis and prevention of the diseases of Indian youth. Now days it has been observed that many students and sportspersons including cricketers, football players, athletes and kabaddi players are suffering from many severe diseases. There is almost no serious technical study of the sports in our country. Athletes, football and kabaddi players especially boxers require fast movement. Very simple devices and techniques can measure body fat percentage. But Indian youth as well as experts do not usually follows this technique due to their negligence and also lack of interest. Recent research has found that percentage of body fat indicators are just as indicative risk for heart disease as are serum cholesterol levels and blood pressure (Gallagher et al., 2000).

**Blood Pressure and Pulse rate**

Blood pressure (B.P) and pulse rate (PR) measurements are one of the basic parameters for health care and well-being. Blood pressure depends on food habits, physical exercises and life style, stages of life, working habits, different weather, physiological condition (infectious diseases), specially women (menstrual cycle), medications, antibiotics, narcotics, barbiturates, antihistamines. Severe cardiac diseases such as ischemic heart disease heart block are a life-threatening medical condition, requiring emergency medical treatment. Diversifications of the professional fields in this globe
including India also cause of the hypertension among youth. Nowadays youths are moving fast from one place to others for their survival. Normal ranges of systolic and diastolic blood pressure of adults are 100–140 mm–Hg and 60–86 mm–Hg respectively.

1.8. Objective of work
Evaluation of ‘biomechanical parameters’ as well as ‘physiological parameters’ are essential to achieve improved performance for sportspersons. For that purpose, the indigenous design and development of various types of dynamometers are essential along with their calibration. With the help of these devices, accurate quantification on ‘biomechanical parameters’ such as punch strength during the punching, pinch strength during pinching by fingers, grip strength during gripping and back strength during pulling by hands can be made for the male and female sports persons including boxers and students of this country, specially of Eastern Region. Another objective is also to quantify different ‘physiological parameters’ such as body mass index (BMI), body fat percentage, blood pressure (BP) and pulse rate (PR) for the participants in this study.
1.9. Organization of the thesis

To serve the purpose of the objective of the thesis, the 2nd chapter deals with the review of literature relevant to the Biomechanical and Physiological strength measuring devices used in this study. Also characteristics of strength and related other factors were reviewed. The 3rd chapter concentrated on the designing of various types dynamometers along with introduction of its including designing of punch, load cell, pinch dynamometer. Besides these other dynamometers such as Hand–grip and back strength dynamometers. This chapter included calibration of punch, load cell, hand grip and back strength dynamometer along with validation of punch, load cell, pinch, hand–grip and Back strength dynamometer with conclusion. In the 4th chapter the punch strength was measured and introduction, material and methods, result and discussions, conclusion and reference were incorporated. Pinch strength was measured in the 5th chapter along with of its introduction, material and methods, results and discussion, conclusion and reference. In the 6th chapter, Hand grip measurement was discussed along with its introduction, material and methods, results and discussion, conclusion and reference. Back strength was measured in the 7th chapter including its introduction, material and methods, results and discussion, conclusion and reference. In the 8th chapter factor effecting of physical strength was discussed including its introduction, material and method for calibration and experiments including its result and discussion with conclusions and reference. In the 9th chapter, conclusions based on the physical strength measuring parameters such as punch, pinch, hand–grip and back strength along with some factors. Finally future direction of the work that could be under taken was discussed. At last indicated Cited references and non cited reference