CHAPTER I

INTRODUCTION AND BACKGROUND

‘If we want to be masters of our future, we must
Fundamentally pose the question of what today is.’
(Michael Foucault)

The role of sport in society has been debated for many decades. Sport is a part of society as both an educational fixture and an entertainment enterprise. Sport forms part of human and social development; it can contribute to social cohesion, tolerance and Integration and is an effective channel for physical and socio-economic development. As a universal language, sport can be a powerful medium for social and economic change: it can be utilized to bridge cultural gaps, resolve conflict and educate people in ways that very few activities can. Sport is characterized by a hierarchical organization in which the level of performance of a player is described by the appropriate level of competition (e.g., local, regional, national, and international). Expert performance in sports can be defined as the consistent superior athletic performance over an extended period (Strakes et al, 1993).
For the developing country like India, if we are to make some place in international sports competition, it is essential for the sportsmen, researchers, coaches & teachers to study all the factors affecting performance with scientific approach, keeping in mind the ethical and moral values in sports.

Athletes are constantly striving to improve performance and searching for the winning edge. Because athletes have become more powerful and athletic performances have continued to improve with improvements in training methods. Scientists, coaches and athletes are constantly searching for improvements in performance by assessing methods that can enhance athletic ability. Warren et al (1999) explained that exceptional achievement of today’s athletes is a result of an integration of many factors such as, training, genetics, health status, psychology, physiology, biomechanics and skills.

Because now sports in the modern world has become a science where various scientific equipment are being used for conducting experiments on the sports persons and from the results the scientist arrived at some conclusion at higher efficiencies of the athletes.

Allawy & Radhwan (1989) and Ahmed (1999) agreed that the scientific measurements are of the most important means of evaluating
athletes performance in general, either standing on their general or particular physical capabilities for specialized activities they practiced or acknowledging the strength, weak points and the extent of progress for individual performance in the programs and also determine the attributes and characteristics of players in terms of kinetic, physical, physiological, mental aspect as well as to determine the level of the performance for the player.

According to Hassaneen (2000), evaluation, the field of sport training, plays a positive role in raising the level of performance either in senior level or junior level. Evaluation is a process that judges the measurements results and objective tests in the light of specific considerations for the performance specification.

During the past twenty years there have been great developments in the scientific understanding of the role of Exercise Physiology in health and physical performance. Exercise physiology is a scientific discipline that focuses on how an organism responds to exercise. Exercise represents one of the greatest stresses that an organism can encounter. Therefore exercise represents an outstanding model for studying human and animal physiology.
In order for Exercise Physiologists to construct and implement specific training programs, they must have access to the fundamental information concerning the qualities that contribute to successful athletic performance. This may include the development of a functional training model to determine the relative contributions and kinetics of metabolism and other physiological factors that contribute to performance. Knowledge of the kinetics of Metabolism and complete understanding of the physiologic components that influence performance will enable exercise physiologists and trainers to effectively prescribe specific training programs, develop adequate assessment protocols and maximize training and competitive performance.

Multiple physiological variables influence athletic performance. Like those variables that influence performance, percent body fat, \( \text{VO}_2 \text{max} \), the anaerobic threshold, anaerobic power, running economy, and anaerobic capacity. Several of these variables can distinguish between highly trained and untrained subjects. However, within the trained population there is considerable variability for each. For example, highly trained athletes tend to have higher \( \text{VO}_2 \text{max} \) values than untrained individuals. These high \( \text{VO}_2 \text{max} \) values are partly responsible for the better endurance performance of the highly trained...
runner. The same cannot be said about a group of highly trained athletes: the person with the highest VO\textsubscript{2}max values are not necessarily the best runners, nor vise versa. There are many examples in the literature of outstanding athletes with modest VO\textsubscript{2}max values or relatively untrained individuals with outstanding VO\textsubscript{2}max values (likely due to genetic endowment). So, physiological testing helps athletes and coaches in many ways.

Major benefit of the evaluation of these physiological variables is that they allow us to better isolate specific components related to performance. Maximum aerobic capacity (VO\textsubscript{2} max) is one of the most important physiological variables, as it represents the ability of an organism, to utilize atmospheric oxygen for cellular energetics (Sharon, 1984, and Shepard, 1986 and Astrand and Rodahl, 1986). Developed countries in Europe and United States have provided valuable information in various physiological aspects (Cunnigham, 1973; Bonen et al., 1979; Macek and Vavra, 1980; Kemper, 1985 and Shephard 1986). In Asian region, Japan, Malaysia and China are the leading countries to study the physiological responses to ergometry in children (Matsui et al, 1971; Kobayashi et al, 1978, and Tanaka and Shindo, 1985). However, most of the scientific work in Asian
countries had been focused on the evaluation of cardio-respiratory responses in sportspersons.

The most thorough method of estimation of cardiopulmonary testing is a direct measurement of the oxygen uptake (VO$_2$) at the maximal exercise test. Maximum aerobic capacity best measured directly in the athlete by determining maximal rate of oxygen consumption (VO$_2$ max), is the single best measure of an athlete's maximum ability to take in oxygen from the air, load it into the blood, and transport it to the working muscles to sustain exercise aerobically. “Aerobic fitness” refers to endurance, or the ability to sustain work for prolonged periods. It represents the ability of the cardiovascular and respiratory systems to accommodate the oxygen needs of the muscular system over a sustained period of time, as in endurance events such as distance running, swimming and bicycling.

Every activity which may be very individual has a desirable speed of performance that is combined with a maximal level of useable strength (Ellis et al 1998, Rushall and Pyke 1990). This is important when considering power in regards to performance.

Power is also the most important factor in assessing an athlete’s capacity for performance in particular sport. In most sports activities,
the greatest energy produced in shortest period of time like jumping, sprinting is the important factor in successful performance. Power is normally indicated by the rapid ability of the muscle to shorten and produce contraction and it depends on the ability of the muscle to contract with speed and force. Brukner and Khan (1997) noted power as the equivalent of explosive strength.

Abernethy et al (1995) additionally suggests that strength and power can be considered the forces or torques generated during sporting activity. Because strength is a component of power it must also be considered an important factor when measuring performance. Brukner and Kahn (1997) note power as the equivalent of explosive strength. This relates to the so called power events such as jumps, sprints and throwing events where the athletes body is propelled - by jumping or sprinting or an external object is projected such as a shot or javelin (Watson 1986).

Anaerobic power is the power produced without the requirement for oxygen to be present. Sprinting, mainly at the end of a race, is predominately an anaerobic activity. Anaerobic literally means without oxygen. It relates to short-term high-energy production where the predominant fuels are produced without the necessity of oxygen.
Tests for anaerobic performance aim to assess relatively short duration exercise bouts.

Anaerobic power or capacity is an expression used for the maximal exercise up to a maximum of two minutes and the energy used during the workload is provided in large measure without necessitating oxygen, since the stored phosphagenes and glycogen in the muscles would be enough up to two minutes. At the onset of the exercise, since ready energy materials are used, lactate is not formed.

Anaerobic power is exhibited in many sports as highly explosive movements lasting from the fraction of sports of a second to approximately 5 sec. (Astrand et al 1986) and energetically fuelled by immediate ATP and creatine phosphate sources without significant contribution from glycolytic pathway (di Pamero 1981).

Anaerobic capacity is the ability to keep violent muscle contraction that depends genuinely on anaerobic mechanism in providing energy (Radhwan 1998). The oxygen debt, defined as the recovery oxygen uptake above resting metabolic rates, has been discredited as a valid and reliable measure of the anaerobic capacity power as it is generally acknowledged that mechanisms other than the
metabolism of lactate also contribute to the post-exercise oxygen uptake. (Medbo et al, 1989)

In general, oxygen debt (O₂ debt) has been successfully used to distinguish between trained and untrained person by some scientists (Hermansen, 1969). As O₂ debt is in widespread use over some 5 decades in scientific literature, it is studied as an indicator of anaerobic capacity, for comparative assessment. The anaerobic capacity is less in children, as compared to normal adult population. The trained children have lower O₂ debt as compared to the Indian junior sports persons (Khanna et al, 1991).

Besides all these parameters during exercise, heart rate must increase to meet the demands of active muscles. When the exercise bout is completed, heart rate does not instantly return to its resting level. Instead, it remains elevated for a while and slowly returns to its resting rate. The time it takes, for the heart to return to its resting rate, is called the heart rate recovery period. Following a period of training, heart rate returns to its resting level, much more quickly after exercise than it does before training. This is true, after standardized submaximal exercise, as well as after maximal exercise. As the heart rate recovery period is shortened by endurance training, this
measurement has been used as an index of cardiorespiratory fitness. In general, a more fit person recovers faster, after a standardized rate of work than a less fit person. The heart rate recovery curve is an excellent tool for tracking a person’s progress during a training program. The recovery response for the present study is designed for three minute which is purely neurogenic and referred to as alactate recovery, influenced by temperature, altitude etc. Therefore, we have studied only the alactic phase of recovery.

Many other factors contribute to athletic success with skill, the right affective and cognitive psychological characteristics, and powerful and capacious energy-production systems including morphology. Athletics incorporates a range of sporting disciplines and specific physique or morphological features play a major, arguably critical role in competition success. One major factor for success in sports is body size and shape, or morphology (e.g. Claessens et al 1994).

The Importance of morphology is obvious even to casual observers, who notice that sprinters tend to be muscular, marathoners small and lean, and throwers very large with high levels of adiposity. A guiding concept here is morphological optimization, the notion of an ideal body morphology, or narrow range of morphologies, most
likely to be associated with success in various disciplines (Norton et. al. 1996).

Success at the highest levels of many sports requires a specific physique. Body composition is one variable related to physique. A very basic assessment of body composition allows for the division of the body components into fat tissue and lean tissue. Percent Body fat (%BF) is the proportion of one's body made that consists of fats.

The somatotype is a description composed by the individual’s physique, and it is defined by a set of components (Song & Perusse et al, 1994). Nevertheless, it was observed that the circumference of the athletes’ thigh compared to the control individuals had a higher increase. (Nevill et al, 2003). Furthermore, generally, the endurance athlete has an increased body density, muscular mass and reduced cutaneous folds compared to non-athlete individuals with the same weight. The physical aerobic activities have a predominant effect on the fat catabolism with little muscular improvement (Powers SK et al, 1989, Fett et al, 2002). Therefore, the body composition is capable to perform the evolution assessment aside from the slim and fat mass. The general anthropometric formulas to calculate the body composition are more comprising, and those for specific populations are more accurate (Salem M. et al, 2004).
Body composition assessment measures the percentage of fat mass and lean body mass. It can be an important tool in helping an athlete to achieve his or her ideal weight to optimize performance. A lack of lean body mass impedes strength and endurance and increases susceptibility to injury. To improve lean body and reduce fat mass, it is important for an athlete to engage in a scientifically designed sports-specific nutrition and exercise program. Athletes who carry too much body fat for their sport may experience decreased performance through compromised speed, agility, premature fatigue, and injury. To help design an effective nutrition and exercise program, athletes should consider consulting with a registered dietitian and exercise physiologist for professional guidance.

Body composition directly correlates with sports performance. Several studies have shown that higher body fat adversely affects maximal aerobic capacity and performance during endurance events. Body composition differs between men and women. Average body fat levels for men are between 15% and 18%, and 22% and 25% for women. Athletes are often lower than the average ranges but should not fall below 5% for men or 12% for women. Falling below these...
ranges can lead to potential health consequences that include diminished bone density, a reduction in testosterone levels in males, and decreased estrogen and progesterone levels in females. Many athletes, depending on their sport, have levels that are significantly lower or higher than the average and should be aware that letting body fat levels exceed the ranges may negatively impact health and athletic performance.

Further, the practical problem in dealing with Indian sportspersons is that, it is still questionable, how much training is optimal to bring about the desired physiological responses, without causing musculo-skeletal problem or easy burn out.

The study will produce guidelines for trainers and coaches to develop training programme for persons engaged in competitive sports. The need for scientific selection and training of athlete at young age has attracted the attention of the exercise physiologists, to study the physiological responses to exercise.

Attempt is made to find out the changes of physiological and morphological variables, related to three different demands of sports
which can be useful for selection of sportsmen and to identify the potential deficiencies, and to undertake remedial measures to overcome the training stresses.

Physiological testing is a valuable tool for athletes and the off field team. Sport specificity of the tests maximizes validity and reliable testing procedures enable national and international comparisons of athletes. Refinement of the tests available to date will continue to improve the results derived from physiological assessment. Elite hockey players are not identified by specific physical characteristics.

It was with this background that present study was undertaken.

1.1 Statement of the Problem
The purpose of the investigation was to conduct a study of Maximal Aerobic Capacity, Anaerobic Capacity and Anaerobic Power Output of Sports Persons: Relationship with Body Composition Profile.
1.2 Aims and Objectives

The present study was undertaken with following aims and objectives:

1. To examine the status of selected Physiological variables (maximal aerobic, anaerobic capacity and anaerobic power output) among different group of sports persons.

2. To study the status of selected morphological variables (Body fat %, muscle mass, bone mass, somatotype) among in different group of sports persons.

3. The study also enables to find out the relationship between morphological and physiological variables among the different groups of sportspersons, if any.

1.3 Hypothesis

The study made of the following hypothesis:

1. It was hypothesized that there would be the differences in morphological and physiological variables among the different groups of sportspersons.

2. It was hypothesized that there may some relationship between morphological and physiological variables among the different groups of sportspersons.
1.4 **Delimitations**

The following were the delimitations of the study:

1. The study was delimited to 178 sportspersons who were recruited from the Center of excellence and various camps that were held at Netaji Subhas National Institute of Sports, Patiala during the period of study.

2. The study was be delimited to determine to selected physiological variables viz. maximal aerobic, anaerobic capacity and anaerobic power output, recovery heart rate.

3. The study was delimited to combat (judo), (intermittent) hockey, (endurance) cycling sports disciplines.

1.5 **Limitations**

The following were the delimitations of the study:

1. The equipment used to assess the physiological variables were standard, computerized / electronic and latest ones imported for the routine assessment of the national players.

2. The previous training structure, load dynamics (intensity, duration and repetition) and food habits of the players were not taken into consideration while assessing the variables.
3. The assessment was carried out in the Sports Physiology and Sports Anthropometry Laboratories of Sports Authority of India, Netaji Subhas National Institute of Sports, Patiala.

4. Pre training Status of the subjects may have its own influence upon anthropometrical and physiological variables.

5. Positional differences in field games were not taken into consideration.

6. No specific motivational techniques will be used while collecting the data on physiological variables.

1.6 Exclusion Criteria

The exclusion criteria were:

1. A history of heart disease.

2. A musculoskeletal dysfunction.

3. Known metabolic disease

4. Use of any performance enhancing substance with in the past 20 days.

5. Smoking / Drinking

6. An impaired response to physiological test.
1.7 Significance of the Study

In sports fraternity, records and scores may not be there for long. They are usually being broken constantly. This now appears to be axiomatic that records of performance and human endurance will go on registering new heights in the days to come. The present study may be significant in the following ways:

1. The study may help to set up the target of physiological variables to be achieved, keeping in view the physiological demand in different sports categories.

2. The study may help to identify the training related changes in various sports categories and its physiological adaptation.

3. The morpho-physiological variables selected for this study, from various sports, can be a frame of reference, for assessing the implication of training and its effectiveness, keeping in view, the growth and developmental aspects underneath various sports categories.

4. The study would provide additional evidence either to substantiate or negate the findings of the studies reported in other sports dominated countries.

5. The study would promote enthusiasm and interest among scholars for further research in the field of sports.