Chapter 1

INTRODUCTION
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Aches and pains, spills and sprains, the agony of defeat and the ecstasy of victory—sport is a delightful mix of a high level of physical performance, mental agility and turbulent emotions. We live in an era where sports, professional as well as amateur, has entered the international arena and increasing number of men and women are taking part in competitions where titles and records are won or lost by the smallest fraction of a time or distance. The single most important factor responsible for the performance explosion of this century is the application of science and technology in sports, which makes an ocean of difference in the achievements and health benefits of the athletes.

Athletes engaged in physical activity, make greater demand for energy than men engaged in all the other forms of human activity. In sprint running and swimming, for example, the energy output from the working muscle is 120 times higher than at rest. Depending on the intensity and duration of exercise, fitness of participant, the relative contribution of body's various means for energy transfer differs markedly. The short-duration and high-intensity exercise requires an immediate and rapid supply of energy, which is provided by ATP and creatine phosphate. For intense exercise of shorter duration, energy is generated mainly through the anaerobic glycolysis—short term energy system. As duration of exercise increases, the aerobic system predominates and O₂ uptake becomes an important factor—long term energy system.

A steady rate of O₂ uptake is necessary for the maintenance of balance between the energy utilisation and aerobic synthesis of ATP. Inadequate supply of
O₂ results in imbalance between anaerobic and aerobic metabolism, results in accumulation of lactic acid which in turn results in acidity and fatigue. A continuous supply of O₂ can prevent fatigue. During exercise, there is a disproportionate CO₂ elimination with that of O₂ intake. An efficient ventilatory mechanism in athlete is required to meet this disproportionate ventilation. Physical training influences lung functions in athletes resulting in increase in vital capacity, total lung capacity, residual volume, maximum voluntary ventilation, and forced expiratory volume. Physical training in athletes also helps in developing greater endurance in respiratory muscles. Respiratory functions are influenced by physical factors viz. age, sex, height, weight, and race. The ability of the individual to inflate and deflate the lungs depends on the strength of the thoracic and the abdominal muscles, posture of the individual and elasticity of lungs. Lung recoil and chest elasticity with co-ordinated neuromuscular functions, maintenance of breathing effort together with thoracic and abdominal muscle strength play an important role in most of the pulmonary functions.

Regular exercise brings about specific metabolic and physiological adaptations. The development of aerobic fitness in sports involving repetitive actions (running, swimming, rowing) and those in which pattern of play is always changing (football, badminton, hockey) is achieved by the exerciser through the training of specific muscles involved in desired performance. In recent years, physiological studies were carried out by collecting data on physiological characteristics of individual athletes, as well as physiological requirement of specific athletic event. Such specific physiological information provides a foundation for the selection of athlete, for analytical evaluation of techniques and methods of training and their evaluation. Despite the large human population in India, identification of right athletes to achieve less performance in the international arena remains unresolved. The researchers in this area are working hard to build up
athletes of international standards. As the field is in its infancy in our country, a
concrete idea about the scientific reasons for the poor performance of athletes is
lacking. The present study on “Respiratory Functions in Athletes” engaged in
specific discipline of sports-science, is a pioneer work carried out in Kerala and a
part of the quest throughout the nation for the improvement of athletes. The major
lung functions studied with spirometer are vital capacity, inspiratory vital capacity,
forced vital capacity, forced expiratory volumes in different time intervals,
maximum voluntary ventilation (indirect), residual volume (indirect) and various
forced expiratory and inspiratory flow rates.

The study was carried out in elite athletes engaged in different disciplines of
sports events, viz., gymnastics, rowing, swimming and running. An extensive
study was taken up for the first time on respiratory functions in snake-boat rowers
and kalaripayattu warriors (martial arts), a traditional sports form of the state. The
lung functions during warm-up exercise of athletes were also studied separately.

Aims and Objectives of the Study

The “studies on respiratory functions in athletes” was taken up as a research
topic as there were no systematic reports on lung functions in athletes of Kerala.
Another feature of the research programme was the respiratory function study on
athletes engaged in traditional sports, viz. snake-boat rowers and kalaripayattu
warriors, especially seen in Kerala. The studies on lung functions in Indian athletes
were always concentrated on the comparison with athletes of European and Asian
counterparts. In the context of respiratory functions being influenced by factors
like age, height, geographical area etc. there is a need for an extensive study of
athletes of each state rather than comparison between athletes of different states.
Although, several reports of athletic lung functions were available, the interest was
always made towards the study of some of the parameters of lung functions.
So a complete analysis of different parameters of respiratory functions with most improved version of spirometer with all lung functions will be an asset to the state of knowledge in this context.

The elite athletes selected for the study have undergone systematic athletic training in different disciplines for the past few years. The selection of each discipline of athletics for the lung function study was undertaken on the basis of the following major classification:

- Endurance sports events, viz. long distance running, swimming, rowing and snake-boat rowing.
- Combative sports events, viz. kalaripayattu.
- Technical acrobatic sports events, viz. gymnastics.
- Warm-up exercises of athletes prior to sporting activity.

The above-mentioned selection of athletics was carried out, as their energy demands and O₂ utilisation by the body for different disciplines of sports events vary according to the needs of physical exertion. Studies based on the athletic lung functions of different disciplines included in a research work in Indian context were scanty. Hence the present investigation on lung functions in athletes of different disciplines—traditional kalaripayattu warriors and snake-boat rowers for the first time—seems to be highly rewarding.

The study was broadly classified into three phases:

- To study and compare the alterations in ‘lung volumes’ and ‘flow rates’ in athletes, ‘immediately after exercise’ to ‘before exercise’.
- To study and compare the resting ‘lung volumes’ and ‘flow rates’ in each discipline of athletes and non-athletes.
- To study and compare the resting ‘lung volumes’ and ‘flow rates’ in different disciplines of athletes.
Alterations of lung volumes and flow rates in athletes ‘after exercise’ were compared to ‘before exercise’ for assessing, whether respiratory adjustments during ‘stress’ will lead to alterations in the lung volumes and flow rates from resting state leading to after exercise. The resting ‘lung volumes’ and ‘flow rates’ of athletes and non-athletes were compared in order to assess whether athletic training in each discipline of sports influences the lung functions of athletes. The highest capacity achieved for each parameter of lung functions among athletes was studied from the comparative study of respiratory functions of different category of athletes at resting state. This may also lead to more information about the athletic training of different disciplines of sports and its influence on each parameter of ‘lung volumes’ and ‘flow rates’ at resting state.