Chapter I
INTRODUCTION

Vital capacity is closely related with motor qualities especially endurance. Endurance is one of the elements of physical fitness and it is determined first and foremost by the functional efficiency of the cardio-vascular metabolic and nervous systems as well as the level of co-orientation of the activities of the systems of the body.

Vital capacity is very essential in the games like Kho-Kho and Kabaddi where the players have to perform with endurance and strength endurance for a longer period with breathing mechanism. The players of such games need to have larger lung volume to supply sufficient amount of oxygen to working muscle groups for effective performance. Similarly the proportion of body mass index is also very essential in the above mentioned games.

Keeping these aspects ahead the present study aims to find out the vital capacity and body mass index among the high school Kho-Kho and Kabaddi players of Hyderabad Karnataka region. The researcher ventured to undertake this study as there was no evidence of any study made to show the vital capacity and body mass index of high school Kho-Kho and Kabaddi players of Hyderabad Karnataka region.
Sports has emerged as a discipline not merely to discuss performance, techniques or records but also to study it as a means by which greater societal forces may be analyzed and through which various problems may be remedied.

Application of science and technology has greatly influenced modern sports. Sports performances are reaching to newer heights and success in sports performance today is not only a chance. Based on the knowledge of modern sports sciences, scientific principles of training and coaching and application of sophisticated modern scientific testing and measuring techniques, it has now become possible to predict performance of the athletes at different levels of competitions.

Lung volumes have been frequently appraised as tests of pulmonary function to assess the normal athletic or the pathological conditions of persons in respiratory physiology. One such important lung volumes is the vital capacity, which is the maximal volume of air that can be expelled from the lungs by force full effort following maximal inspiration.

Actively it is very important for the growth and development of an individual. According to oberteuffer “It is essential for a man to take account of the biological consideration in heart in movement. Biological integrity is
acquired by understanding a specific amount of physiological work”.

The whole body is functioning in relation to one another; therefore strenuous activities help to develop one’s capacity in action. During respiration gaseous exchange takes place between the blood in the capillaries and the air in the alveoli sacs. Under bases conditions, an energy output as about forty kilocalories per hour. With increasing level of physical activities, the energy expenditure increase and in the heavy activities, the physical fitness depends mostly on the physiological capacity of the human machine.

Some investigators have been done to find out the relationship of vital capacity and athletic states of individual. Karporich states that there have been exceptional athletics with low vital capacity and poor ones with larger vital capacity. Even in athletic the vital capacity differs for more type of actively another. It is reported that swimmers and other more active groups have larger vital capacity.

Regular exercise leads to numerous and varied physiological changes that are beneficial from a health standpoint. They include improved cardio-respiratory function and skeletal muscle function; higher levels of high-density lipoprotein cholesterol (the so-called "good" cholesterol);
improved blood pressure, body composition, and bone density; decreased insulin need and improved glucose tolerance; enhanced performance of work, recreational and sport activities; and many positive psychological benefits.

These changes, in turn, help lower death rates from illnesses such as cardiovascular disease (including heart attack and stroke); type-2 diabetes; and certain cancers, including colon, breast and lung; and lower disease rates for high blood pressure, obesity, osteoarthritis and osteoporosis.

Because of the many benefits of physical activity and exercise, the federal government now encourages all adults to increase their physical activity levels so they accumulate 30 minutes, or more, of moderate intensity physical activity most days of the week.

Improved cardio-respiratory function means that the body is able to perform exercise much more efficiently. This results mainly from the body more effectively getting oxygen into the blood stream and transporting it to the working muscles, where it is needed for the metabolic processing of energy. In other words, the regular exerciser's body is much more proficient at loading, transporting and utilizing oxygen.
He thus finds exercise such as climbing stairs far less strenuous than a person who does not exercise and is out of shape. Improvement in cardio-respiratory function does not result from changes in the lung's ability to expand, however.

In general regular exercise does not substantially change measures of pulmonary function such as total lung capacity, the volume of air in the lungs after taking the largest breath possible (TLC), and forced vital capacity, the amount of air able to be blown out after taking the largest breath possible (FVC). Studies comparing TLC and FVC show little difference between regular exercisers and non-exercisers, in fact.

So even though people often report feeling out of breath during exercise, it is unlikely that pulmonary function limits their ability to exercise, unless they have a disease that specifically impairs lung function such as asthma, bronchitis or emphysema.

One of the largest differences between an exerciser and a non-exerciser concerns the heart's ability to pump blood and consequently deliver oxygen to working muscles. Cardiac output is a major limiting factor for prolonged exercise. In addition, an exerciser typically has a larger blood volume, is better able to extract oxygen from the air in the lungs and is
better able to extract oxygen from the blood at the working muscles than a sedentary individual is.

Gas exchange involves not only oxygen delivery but also the removal of carbon dioxide, which is a byproduct of energy metabolism, and this process is also more efficient in an exerciser.

When all is said and done, regular exercise produces numerous favorable changes that collectively result in the body being able to work in a far more efficient manner. All of us are born with the ability to increase our physical fitness levels through regular exercise so it is unfortunate that many peoples' sedentary lifestyles and lack of exercise result in unfavorable outcomes in terms of disease.

Perhaps one of the greatest challenges we face in developed societies is how to facilitate and encourage healthier lifestyles that include regular physical activity. Left unchecked, this problem will contribute to ever-increasing health care costs and higher disease rates. Regular exercise is not the "magic bullet" in terms of disease prevention, but, when combined with a healthy diet, it may be the best intervention currently available to anyone who is willing to get up off the couch.
Fitness can be measured by the volume of oxygen you can consume while exercising at your maximum capacity. VO$_2$ max is the maximum amount of oxygen in milliliters, one can use in one minute per kilogram of body weight.

Athletic performance is directly related to the amount of oxygen supplied to the muscles. The supply of oxygen is dictated by how often the heart beats, the volume of blood transported by every beat and the amount of oxygen in that blood. It is also dependent on how well the tissue or muscle extracts the oxygen (O$_2$).

So if we could find the volume of blood pumped in one minute and the difference between the amount of oxygen in arterial and venous blood we would have all the data we need. The stroke volume is usually measured in milliliters per beat. The cardiac output is the product of stroke volume and heart rate and is measured in milliliters per minute. Multiply this by the difference in oxygen concentration and we have the liters of O$_2$ processed per minute. If we make these measurements when the athlete is working at his or her maximum heart rate, we have VO$_2$ max.

Those who are fit have higher VO$_2$ max values and can exercise more intensely than those who are not as well conditioned. Numerous studies show that you can increase
your VO₂ max by working out at an intensity that raises your heart rate to between 65 and 85% of its maximum for at least 20 minutes three to five times a week.

A mean value of VO₂ max for male athletes is about 3.5 litres/minute and for female athletes it is about 2.7 litres/minute.

To measure VO₂ Max directly an athlete has to be wired to a computer and breathe into an apparatus that analyses exhaled air while he runs on an appropriate ergometer – treadmill or a stationary bicycle. The exercise workloads are selected to gradually progress from moderate to maximal intensity.

We need a big and efficient pump to deliver oxygen-rich blood to the muscles, and we need mitochondria-rich muscles to use the oxygen and support high rates of exercise. Which variable is the limiting factor in VO₂ max, oxygen delivery or oxygen utilization? This is a central question that has created considerable debate among exercise physiologists over the years.

Vital capacity has been investigated widely during the last century (Hutchinson, 1846; Dreyer, 1919; Hewlett and Jackson, 1922; Cureton, 1936) and attempts have been made to relate it to physical fitness status (Cureton, 1936;
Davis, 1959). Attempts were made to determine the effects of training on vital capacity without great success (Davis, 1959; Adams, 1968; Wilmore et al., 1970).

Barring pathological conditions, the questions of the contribution of vital capacity to athletic performance and the association between anthropometric parameters and vital capacity were yet unsolved. Initial investigation (Hutchinson, 1846) determined strong relationships between vital capacity and height and weight, with height being the most consistent. Contraindicatively, Dreyer (1919) found that weight exhibited the most consistent relationship with vital capacity. Hewlett and Jackson (1922) found the correlations of vital capacity with weight and with height to be approximately equal.

Cureton (1936) indicated that the two variables contributed 75 per cent to the variance of the vital capacity but failed to state which contributed the most. Lemon and Moersch (1924) found that vital capacity was more a function of body surface area than of either height or weight taken singularly. Early investigation of the relationship of vital capacity to athletic performance was inconclusive (Gordon, Levine, and Wilmaers, 1924).
More recent studies (Davies, 1959; Costiu, 1964) have concluded that there is no relationship between vital capacity and endurance performance. A previous article (McKethan and Mayhew, 1972) confirmed earlier observations that the zero order correlation between vital capacity and endurance performance was essentially nil.

The developing tendencies in international sports, especially in team games are identified as the increase in game tempo, tougher body game and greater variability in technique and tactics. An increased performance level can only be achieved by working and training of all major components i.e. technique, coordination, tactics, physical fitness, physiological qualities and psychological qualities.

Long-term exercise for females is accepted as systematic exercise. Oxygen demand increases in exercise hence, the respiratory system is also physiologically adapted to changing conditions. Repeated exercise 2 to 3 times per week is accepted as regular exercise for health and body composition changes significantly. This change can be observed in all age groups (Akgün, 1986; Heyward, 1998; Lohman, 1995).

Regular endurance training gives rise to many adaptive changes in the cardiovascular system which include expansion
of plasma volume, resting bradycardia, increased vagal tone, reduced sympathetic outflow, inhibited sympathetic baroreflexes, increased stroke volume and enhanced coronary circulation (Gallagher et al., 1999).

Many of the beneficial, adaptive responses in the hearts of athletes, giving rise to increased contractility and cardiac power output, take place at the level of the cardiac myocyte, although changes in the nervous supply and in the peripheral circulation make important contributions (Hart, 2003).

Athletic training in female commonly results in prolongation of the echocardiography (ECG) intervals. It has been demonstrated that long-term physical activities increase physiological capacities, particularly in cardiovascular and respiratory system in young population. It becomes interesting to determine duration and what kind of activities are the most beneficial for physical development during growth.

In the present study, we aimed to evaluate the effects of long-term handball training of young female athletes on respiratory function and ECG values. It was seen that long-term handball trainings affect the level physical development, pulmonary functions and ECG values of young girls significantly.
Long-term regular training also has the beneficial effects on all the organ systems such as exercise hypertrophy which is more specific in girls than men due to exercise intensity. Even though handball is a common known sport, it has high dynamic played by girls in the world; the girls are less physically active than men (Vicente-Rodrigueza et al., 2004; Dzudie et al., 2007).

Especially, body weight and height gain in puberty may be strongly influenced by developmental change (Vicente-Rodrigueza et al., 2004).

They are related with exercise mode to sport-specific and developmental period of girl’s the skeleton and muscle systems. Height and weight are important for performance in handball. But it is not safe to overestimate the anthropometric characteristics of junior players as predictors of their future anthropometric profile (Williams and Reilly, 2000).

Long-term training is quite effective on circulation and respiratory functions. In fact, the organism needs more oxygen during training. The circulation and respiratory systems show physiologic compatibility in line with this increase in order to meet the need. While a resting person takes 12 to 16 breaths per minute, breathing frequency may increase upto 40 to 50 during training (Ghosh et al., 1985).
In our study, significant differences were found in FVC Pred and FEV 1 Pred values and in FVC-MEAS, FEV1-MEAS and FEV1-FVC Pred values at the end of long-term handball training. Also, Doherty and Dimitriou (1997) found the significant differences in VC, FVC and FEV1 parameters of athletes than control group.

In the last years, important physiological and functional differences have been noted between the male and female response to dynamic exercise where sex differences have been reported for most of the major determinants of exercise capacity. Sex differences have been shown in resting pulmonary function, which may impact on the respiratory response to exercise.

Women typically have smaller lung volumes and maximal expiratory flow rates even when corrected for height relative to men. Expiratory flow limitation and a high work of breathing are seen in women. Pulmonary system limitations, in particular exercise-induced arterial hypoxia, have been reported in both men and women; however, the prevalence in women is not yet clear (Sheel et al., 2004).

A study observed that the mean FVC and FEV1 values were lower than the predicted mean values of normal
Nigerians when matched for age, sex, height and weight. However, the mean observed FVC value of athletes was higher than the observed FVC value of non-athletes. It was also noted that the mean FVC value of the sportsmen correlates with their sporting events, which are determined by the extent of regular and strenuous physical training (Onadeko et al., 1976).

Participation in long-term training is associated with ECG changes in the athlete’s heart that provide structural and functional changes for prolonged periods. When we investigated the effect of ECG parameters, significant differences were not found in PR and QRS values. However, we found significant differences in HR, QT interval and QTc interval values.

It has been reported that first degree heart block occurs in up to 33% and Mobitz type I second degree heart block in upto 10% of athletes. Sinoatrial exit block and higher degrees of atrio-ventricular block are less common but have been reported (Holly et al., 1998).

All of these conduction abnormalities disappear on exercise or following detraining, if they are attributable to physical conditioning. Prolongation of the QT and the rate QTc intervals in trained athletes has been described in several
studies (Jordaens et al., 1994; Sharma et al., 1999; Stolt et al., 1997).

Furthermore, it has been proposed that the structural cardiac adaptation to endurance exercise training depends on the group of muscles, that is, those of lower or upper extremities, primarily involved (Csanady and Gruber, 1984; Gates et al., 2003).

Subsequent studies, however, were frequently in discord with that dichotomy of the cardiac structural patterns in athletes. For instance, even very intense strength training aimed at increasing skeletal muscle power/strength/mass would not necessarily result in cardiac wall thickening (Bertovic et al., 1999; Haykowsky et al., 2002; Pelliccia et al., 1993; Wernstedt et al., 2002; Whyte et al., 2004) or the resultant myocardial structure in strength/power athletes would not differ from that of endurance athletes (Legaz Arrese et al., 2005; Pelliccia et al., 1999; Urhausen and Kindermann, 1999).

In order to prove if athlete's heart generally has no risk in terms of cardiac arrhythmia, there are requirement to new studies which comprise participates in different sport branches.
Dutta (1988) stated that there is hardly a corner of the earth where people of all ages and both sexes have not been attracted by this game of fast movement, amazing accuracy and thrill, sometimes extraordinary finishes. The intricate blend of cooperative and individual skills, flexible enough to accommodate the fire works of personal duties yet remaining essentially a team sport, is a unique attraction. Team games were sports where size, shape, body composition and fitness all play an important part in providing distinct advantage for specific playing positions particularly at the higher level, where there is a high degree of player specialization (Dey, Kar & Debray, 2010).

**Significance of Vital Capacity**

Vital capacity is especially important during intense physical activity such as exercise, sport, rigorous work or running away from a dangerous situation. Such demands require more air and oxygen in the lungs to fuel body organs, especially those of the musculoskeletal, cardiovascular, respiratory and nervous systems. If you are unfit and overweight, you will not have the lung capacity to increase the volume of air you inhale and exhale beyond normal breathing.
You will become out of breath and be unable to perform many activities more difficult than sitting or lying down. Participating in sports you enjoy, such as kho-kho and kabaddi can be a win-win situation. It helps you to get in shape without you really realizing how hard you're working because you're having fun. Playing kho-kho and kabaddi can condition your body and strengthen your cardiovascular system. But while exercise has many far-reaching benefits, expanding your lung capacity can't be achieved through working out.

**STATEMENT OF THE PROBLEM**

The problem formulated for the present study is “Study on vital capacity and body mass index of selected district high school Kho-Kho and Kabaddi players of Karnataka State”.

**PURPOSE OF THE STUDY**

The major purpose of this research is “Study on Vital Capacity and Body Mass Index of selected District High School Kho-Kho and Kabaddi players of Karnataka State”. The study is conducted on selected districts high school Kho-Kho and Kabaddi players of Hyderabad Karnataka region, Karnataka State which compromises of six districts like Gulbarga, Bidar, Yadgir, Raichur, Koppal and Bellary.
The study aims to find out the vital capacity and body mass index (BMI) level among the high school kho-kho and kabaddi players. The study also makes the comparisons on vital capacity and body mass index among the six districts high school kho-kho and kabaddi players.

Also present study attempts to make the suggestions and recommendations to the Department of Public Instructions and Department of Youth and Sports Affairs, Karnataka for developing the vital capacity and body mass index (BMI) level through scientific method of training among Kho-Kho and Kabaddi players of Hyderabad Karnataka region, Karnataka State.

Further the study makes recommendations and gives suggestions to improve the basic infrastructure facilities at high school level for the promotion and development of Kho-Kho and Kabaddi games in selected six districts of Hyderabad Karnataka region, Karnataka State.

**OBJECTIVES OF THE STUDY**

- To find out the vital capacity level and body mass index among selected six districts high school Kho-Kho and Kabaddi players of Hyderabad Karnataka region, Karnataka State.
• To compare and analyze the vital capacity level and body mass index among selected six districts high school Kho-Kho and Kabaddi players of Hyderabad Karnataka region, Karnataka State.

• To compare the vital capacity level and body mass index among six districts high school Kho-Kho and Kabaddi players with standard norms to find out in which category they will fall in.

• To make suggestions and recommendations to the Department of Public Instructions and Department of Youth and Sports Affairs, Karnataka for developing the vital capacity and body mass index (BMI) level through scientific method of training among Kho-Kho and Kabaddi players of Hyderabad Karnataka region, Karnataka State.

• To make further recommendations and suggestions to improve the basic infrastructure facilities at high school level for the promotion and development of Kho-Kho and Kabaddi games in selected six districts of Hyderabad Karnataka region, Karnataka State.
HYPOTHESES OF THE STUDY

- There would be a better a vital capacity and body mass index level among high school Kho-Kho and Kabaddi players of Hyderabad Karnataka region, Karnataka State.
- There would be differences in the vital capacity and body mass index level among selected six districts high school Kho-Kho and Kabaddi players of Hyderabad Karnataka region, Karnataka State.
- The study would make suggestions and recommendations to the Department of Public Instructions and Department of Youth and Sports Affairs, Karnataka for developing the vital capacity and body mass index (BMI) level through scientific method of training among Kho-Kho and Kabaddi players of Hyderabad Karnataka region, Karnataka State.
- Further recommendations and suggestions would be made to improve the basic infrastructure facilities for the promotion and development of Kho-Kho and Kabaddi games in selected districts of Hyderabad Karnataka region, Karnataka State.
SIGNIFICANCE OF THE STUDY

- This study assumes a great significance given to its comprehensive study to delineate the vital capacity level and body mass index among selected districts high school Kho-Kho and Kabaddi players of Hyderabad Karnataka region.

- The promotion and development of rural games like Kho-Kho and Kabaddi is a primary need in the six districts of Hyderabad Karnataka region. Because most of the high school children’s in this region play Kho-Kho and Kabaddi games without adequate facilities, training, coaching and support with lot of enthusiasm.

- The study also reveals the present level of vital capacity and body mass index of Kho-Kho and Kabaddi players according to the standard norms, which enables to find out the category of each player.

- Further this study reveals the vital capacity level and body mass index among high school Kho-Kho and Kabaddi players which enables to get the knowledge of their body capacity, body type and which further helps for making scientific training suggestions to various high schools and concerned departments of Hyderabad Karnataka region for the improvement of performances.
LIMITATIONS OF THE STUDY

- The study is limited to selected six districts like Gulbarga, Bidar, Raichur, Yadgir, Koppal and Bellary of Hyderabad Karnataka region, Karnataka State.
- The study is limited to measurement of vital capacity and body mass index level among high school Kho-Kho and Kabaddi players.
- The study data collection is limited to academic year 2013-14.

DELIMITATIONS OF THE STUDY

- This study is delimited to selected districts high school Kho-Kho and Kabaddi players.
- The psychological conditions during tests like anxiety, stress and strain of the subject are not considered here. Hence these are considered as delimitations of the study.

DEFINITIONS OF THE TERMS

Vital Capacity

It is the maximal volume of air, which can be expelled from the lungs by forceful effort following a maximal inspiration. Samson Wright, Applied physiology Eleventh Edition (Great Britain Oxford University Press 1966) P.279 vital also can also be summation of vital volume aspiratory reserve
volume. Expiratory reserve volume plus the vital volume which present in lungs after a maximal expiration.

Vital capacity is the amount of air that can be forced out of the lungs after a maximal inspiration. Emphasis on completeness of expiration. The maximum volume of air that can be voluntarily moved in and out of the respiratory system.

**VO2 Max**

VO2 max is the maximum amount of oxygen in milliliters, one can use in one minute per kilogram of body weight. Those who are fit have higher VO2 max values and can exercise more intensely than those who are not as well conditioned.

**Vital capacity test**

The Vital capacity test is one of the oldest and most common respiratory tests. The measurement of vital capacity (VC) simply requires that an individual blow as large a breath of air as possible into a spirometer. Thus, the person expels three of the four components of the total lung volume when performing the vital test.

There are inspiratory reserve volume (IRV), tidal volume (TV) and expiratory reserve volume (ERV). It provides an indirect indication of the size of the lung, although it is not a
complete measure of the entire lung size because it does not account for residual volume. In general facts, vital capacity relate to three uncontrolled characteristics which are age, stature and gender.

**Forced vital Capacity (FVC)**

Forced vital Capacity (FVC) is a measure of the amount of air someone can forcibly expel out of the lungs after taking a breath to fill the lungs as much as possible. A value in liters of air is typically used to express FVC. This measure is an important indicator of lung health. In people like conditions with chronic obstructive pulmonary disorder (COPD) and asthma, forced vital capacity is usually lower than expected for people of a similar gender, height, fitness level, and weight. During lung function testing, known as spirometry, FVC is one of the things that will be measured. The person is asked to take a deep breath to fill the lungs as much as possible. This breath does not need to be fast or forceful. Once the lungs are full, the person blows out as hard and as fast as possible into a device capable of measuring the amount of air that the person expels.

Forced vital capacity is plotted on a graph that typically shows a spike and a long downward tail. The spike represents the initial burst of air released from the lungs. As the person's
lungs deflate, less air is emitted, and the amount of air released over time falls as a result. This creates the distinctive tail seen on a FVC graph. This test is usually repeated several times to develop an average. Persons may have trouble adjusting to the equipment and this can result in a skewed initial value. As persons get accustomed to the equipment and the process, the values will be more accurate. Averaging allows the clinician to even out the score across several measures to come up with a meaningful value.

Athletes usually have a higher forced vital capacity because their lungs are more developed, especially if they have been playing sports and working out for a long time. People like swimmers, runners, and cyclists can have significantly better lung health than other individuals. Larger people also tend to have higher values because their lungs are bigger.

Charts are available to compare athlete’s results to profile of standard norms to determine whether they fall within normal values. If the values of a forced vital capacity test are unusually low, it is an indicator that something is wrong with the athlete's lungs. Additional testing may be needed to learn more about what is happening inside the athlete's body and why.
**Body Mass Index (BMI)**

The body mass index (BMI) is a heuristic proxy for human body fat based on an individual's weight and height. BMI does not actually measure the percentage of body fat. It was devised between 1830 and 1850 by the Belgian polymath Adolphe Quetelet during the course of developing "social physics".

Body mass index is defined as the individual's body mass divided by the square of his or her height. The formulae universally used in medicine produce a unit of measure of kg/m. BMI can also be determined using a BMI chart, which displays BMI as a function of weight (horizontal axis) and height (vertical axis) using contour lines for different values of BMI or colors for different BMI categories.

Body Mass Index (BMI) is a number calculated from a person's weight and height. BMI is a fairly reliable indicator of body fatness for most people. BMI does not measure body fat directly, but research has shown that BMI correlates to direct measures of body fat, such as underwater weighing and dual energy x-ray absorptiometry (DXA). BMI can be considered an alternative for direct measures of body fat. Additionally, BMI is an inexpensive and easy-to-perform method of screening for weight categories.
**Height**

Height is the measurement of vertical distance, but has two meanings in common use. It can either indicate how "tall" something is, or how "high up" it is. Human height is one of the areas of study within anthropometry, while height variations within a population are largely genetic, height variations between populations are mostly environmental.

**Weight and Body Weight**

Weight is the vertical force exerted by a mass as a result of gravity. And the body weight is the weight of a person’s body or object.

**Spirometer**

Spirometer is the measurement instruments most used in the evaluation of the pulmonary capacity. From its invention in the year of 1846, its use has become popular at world-wide level. At the present time, the spirometers are in their majority portable and usually computerized.

A spirometer is a device for measuring timed expired and inspired volumes, and hence indicates how quickly and effectively the lungs can be emptied and filled. A spirometer is an apparatus for measuring the volume of air inspired and expired by the lungs.
It is a precision differential pressure transducer for the measurements of respiration flow rates. The spirometer records the amount of air and the rate of air that is breathed in and out over a specified period.

**Electronic Spirometer**

Electronic spirometers have been developed that compute airflow rates in a channel without the need for fine meshes or moving parts. They operate by measuring the speed of the airflow with techniques such as ultrasonic transducers, or by measuring pressure difference in the channel. This spirometer have greater accuracy by eliminating the momentum and resistance errors associated with moving parts such as windmills or flow valves for flow measurement.

**Kabaddi**

Kabaddi originated in India where it is still a very popular game. It is played with two teams of 12 players each, five of them substitutes. The object of the game is to reach the highest score by touching or capturing the opposing team's players, all the while chanting "Kabaddi-Kabaddi". The word Kabaddi is derived from a Tamil word Kai-pidi, literally meaning "(let's) Hold Hands", which is indeed the crucial aspect of play. It is the national game of Bangladesh, and the state game of
Tamil Nadu, Andhra Pradesh and Punjab in India. In the international team version of kabaddi, two teams of seven members each occupy opposite halves of a field of 10 m × 13 m in case of men and 8 m × 12 m in case of women. Each has three supplementary players held in reserve. The game is played with 20-minute halves and a five-minute halftime break during which the teams exchange sides.

The rules of the game are as follows, the teams take turns sending a "raider" into the other half. To win a point, the raider must take a breath, run into the opposing half, tag one or more members of the opposite team, then return to his home half before inhaling again. The raider will chant "kabaddi, kabaddi" with his exhaling breath to show the referee he has not inhaled.

The raider will be declared "out" and not gain the point if he inhales before returning to his side, or returns without touching an opponent. The tagged defender(s) will be "out" if they do not succeed in catching the raider who tagged them. Wrestling the raider to the ground can prevent him escaping before he needs to inhale.

Defenders may not cross the centre line (the "lobby") of the field and the raider may not cross the boundary lines.
However, there is one bonus line which can grant extra points for the raider if he manages to touch it and return successfully.

Players who are out are temporarily sent off the field. Each time a player is out, the opposing team earns a point. A team scores a bonus of two points (called a "lona"), if the entire opposing team is declared out. At the end of the game, the team with the most points wins.

**Kho-Kho**

Kho-Kho is a tag sport played by teams of twelve players who try to avoid being touched by members of the opposing team; only 9 players of the team enter the field. It is one of the two most popular traditional tag games of South Asia. Kho Kho is the game of chase was then also regarded as legend, as it used in phraseology as "putting Kho to someone’s active chase meaning putting an effective block and stopping the progress".