INTRODUCTION

1.1 Background of the Study

Circulo-respiratory function is considered as most important fitness component in human. It helps to deliver essential nutrients, especially oxygen, to the working muscles of the body and to remove waste products during prolonged physical exertion. It involves the efficient functioning of the heart, blood vessels, and lungs. If a person is having low levels of cardiovascular efficiency, the heart has to work very hard during normal daily activities and may not be able to work hard enough to sustain high-intensity physical activity in an emergency or in some of the sports events. As cardiorespiratory fitness improves, the heart begins to function more efficiently. It doesn’t have to work as hard at rest or during low levels of exercise. The heart pumps more blood per heartbeat, resting heart rate slows down, blood volume increases, blood supply to the tissues improves, the body is better able to cool itself, and resting blood pressure decreases. A healthy heart can better withstand the strains of everyday life, the stress of occasional emergencies, and the wear and tear of time. Cardiorespiratory endurance training also improves the functioning of the muscles and liver which enhances the body’s ability to use energy supplied by food.

Pranayama techniques are known to improve one’s overall functional ability of lungs and heart too. Pranayama (breathing exercise) is known to be a part of yogic techniques. Patanjali in his Yoga Sutra describes- Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyana and Samadhi as eight angas (parts) of yoga. Amongst them, in the present materialistic world, the third and fourth part, Pranayama and Asana (Postures) are considered as very important part and prescribed by modern medicine too. Many physicians now recommend yoga to patients at risk for heart and lungs diseases, as well as those with back pain,
arthritics, depression and other chronic diseases. The beneficial effects of different Pranayama are well reported and have sound scientific basis (Joshi et al., 1992 and Raghuraj et al., 1998). There are different types Pranayama and it has been found that these techniques influence cardio-respiratory and autonomic functions and also help in reducing the scores of anxiety and stress.

Therefore, to reduce the risk of various diseases and to improve work capacity one must improve the cardiovascular and respiratory function. Therefore, it has been a longstanding effort from various researchers to identify the cardio-vascular efficiency and lung function ability of adolescents. A number of approaches have been made through various faculties of medicine, in this quest, one of the significant approaches seems to be the traditional Yoga’s Pranayama techniques. Various aspects that improve the cardio-respiratory endurance need to be studied and evaluated, so as to form a comprehensive program of yoga exercise for enriching one’s heart and lungs function. Being a non-invasive, drugless and non-expensive technique, Pranayama methods can be promoted to the adolescents at gross levels for enhancing their cardiorespiratory fitness.

1.2 Rationale of pranayamic breathing for circulo-respiratory functions

Breathing is unique as a physiological function, as it lies midway between the internal organs and the voluntary muscles, insofar as the ease with which it can be consciously controlled is concerned. For example, depending upon one’s proficiency in dealing with the breath, the rate and depth of breathing can be altered, but involuntary reflex activity limits the degree to which this can occur. These reflexes act as safeguard to prevent overextension of one's capacity. They are especially important in connection with breathing, since the flow of breath is essential to life, and the need to breathe is one of the most fundamental survival instincts. This in part reflects the key role played by
oxygen in metabolism (for the process of supplying energy to the body), for without oxygen the body cannot convert food into usable energy.

Modern science has come to understand many of the principles involved in the physical aspect of breathing, from the muscles and organs which transport oxygen into and throughout the body down to the molecular reactions of metabolism. However, the purely intellectual appeal of these complex physiological systems has limited the scientific community's concept of the breath to the physical level only, even though the most casual reflection indicates that the significance of breath extends beyond its purely metabolic functions. For example, one's own personal experience suggests that there is a relationship between emotions and breath, for most emotional states, especially if they are intense, appear to be associated with changes in breathing. The sob of grief and the trembling breath of anger are common examples that reflect this interconnection. In addition, physical stimuli such as pain and exercise can act to change both the breath and the emotional state.

Once these observations are studied a whole series of questions arises: What is the nature of the relationship between emotions and body and breath? What is the underlying vehicle? Does the breath interact with other realms of mind? Can emotional and physical states be altered by changing the breathing patterns?

These are some of the questions to which science of breath addresses itself. In fact, breath is the link between body and mind. With an increased awareness and control of the subtle aspects of breathing, deep effect in physical and psychological changes is seen and also provides a powerful tool in the pursuit of truly holistic health and personal growth.
Breath – a scientific phenomenon

Breathing may be considered as the most important of all of the functions of the body, for, indeed, all the other functions depend upon it. Man may exist some time without eating; a shorter time without drinking; but without breathing his existence may be measured by a few minutes. Breathing is natural but correct habits of breathing provide a continued vitality and freedom from disease. An intelligent control of our breathing power helps to lengthen our days upon the earth by giving us increased vitality and powers of resistance. As man has contracted improper methods and attitudes of walking, standing and sitting, which have robbed him of his birthright of natural and correct breathing. He has paid a high price for civilization. The savage, today, breathes naturally, unless he has been contaminated by the habits of civilized man. The percentage of civilized men who breathe correctly is quite small, and the result is shown in contracted chests and stooping shoulders, and the terrible increase in diseases of the respiratory organs, including that dread monster, consumption, “the white scourge” (Rama et al., 1981).

The physical health depends very materially upon correct breathing – as revealed by the Occidental teachings. The Oriental teachers not only admit that their Occidental brothers are right, but say that in addition to physical benefit derived from correct habits of breathing, man’s mental power, happiness, self-control, clear-sightedness, morals, and even his spiritual growth may be increased by an understanding of the ‘Science of Breath.’

Breath - Exoteric Theory

The organs of respiration consist of the lungs and the air passages leading to them. The lungs are two in number, and occupy the pleural chamber of the thorax, one on each side of the median line, being separated from each other by the heart, the greater blood vessels and the larger air tubes. Each lung is free in all directions, except at the root, which consists chiefly of the bronchi,
arteries and veins connecting the lungs with the trachea and heart. The lungs are spongy and porous, and their tissues are very elastic. They are covered with a delicately constructed but strong sac, known as the pleural sac. One wall of pleural sac closely adheres to the lung, and the other to the inner wall of the chest, and that secretes a fluid which allows the inner surfaces of the walls to glide easily upon each other in the act of breathing. The air passages consist of the interior of the nose, pharynx, larynx, windpipe or trachea, and the bronchial tubes. When we breathe, we draw in the air through the nose. The air is drawn into the lungs by the action of the diaphragm, a great, strong, flat, sheet-like muscle, stretched across the chest, separating the chest-box from the abdomen.

The blood starts on its arterial journey, bright red and rich, laden with life-giving qualities and properties. It returns by the venous route with waste matter of the system. The foul stream goes to the right auricle of the heart which in turn sends it on to the lungs. The foul stream of blood is now distributed among the millions of tiny air cells in the lungs. A breath of air is inhaled and the oxygen of the air comes in contact with the impure blood through the thin walls of the capillary bed, where the CO₂ is forced out. The blood thus purified and oxygenated is carried to the left auricle, then to the left ventricle and to all parts of our body.

It is evident that unless fresh air in sufficient quantities reaches the lungs, the foul stream of venous blood cannot be purified. Consequently not only is the body thus robbed of nourishment, but the waste products that should have been destroyed are returned to the circulation and poison the system and death ensues. This, in fact, is an improper breathing which signifies imperfect nutrition, imperfect elimination and ill health. Imperfect breathing shallows respiration so that only a portion of the lung cells are brought into play, and a great portion of the lung capacity is lost. On the other hand, in proper breathing, the blood is properly exposed to the air in the lungs and
invigorates as well as strengthens, replacing the worn-out cells and tissue by new materials which Nature converts to her use.

**Breath - Esoteric Theory**

The esoteric phase considers the internal and/or eternal principles as found in our ancient teaching and philosophies. In order to avoid misconceptions arising from the various theories, bringing the concept of ‘Prana’ (the Sanskrit term meaning Absolute Energy, the universal principle) is justified. The *Prana* i.e., vital force, is evident in all living entity. It is found in all forms of life, from the amoeba to man – from most elementary form of plant life to the highest form of animal life. It is the only aspect which differentiates the lifeless things from living beings. In fact, *Prana* is every where, in everything. *Prana* must not be confounded with the Ego – that bit of Divine Spirit in every soul, around which clusters matter and energy. *Prana* is merely a form of energy used by the Ego in its material manifestation. When Ego leaves the body, the *Prana* (being no longer under its control) responds only to the orders of the individual atoms forming the body. And as the body disintegrates and is resolved to its original elements each atom takes with it sufficient *Prana* to enable it to form new combinations, the unused *Prana* returning to the great universal storehouse from which it came.

In fact, *Prana* is designated as a universal principle which is the essence of all motion, force or energy, whether manifested in gravitation, electricity, the revolution of the planets, and all forms of life, from the highest to the lowest. It may be called as Force or Energy in all forms, and that principle which, operating in a certain way, causes that form of activity which accompanies Life. This great principle is in all forms of matter, and yet it is not matter. It is in the air, but it is neither the air nor one of its chemical constituents. Animal and plat life breathe it in with the air, and yet if the air contained it not they would die even though they might be filled with air. It is taken up by the system along with the oxygen and yet is not the oxygen.
Prana is in the atmospheric air, but it is also elsewhere, and it penetrates where the air cannot reach. The oxygen in the air plays an important part in sustaining animal life, and the carbondioxide plays a similar part with plant life, but Prana has its own distinct part to play in the manifests of life, aside from the physiological functions.

During ordinary breathing we absorb and extract a normal supply of Prana, but by controlled and regulated breathing (generally known as Yogic breathing) we are enabled to extract a greater supply, which is stored away in the brain and nerve centres, to be used when necessary. We may store away Prana, just as the storage battery stores away electricity. The many powers attributed to advanced occultists are due largely to their knowledge of this fact and their intelligent use of this stored-up energy. It is well known in Yoga that by certain forms of breathing the practitioners establish certain relations with the supply of Prana and may draw on the same for what they require. Not only do they strengthen all parts of their body in this way, but the brain itself may receive increased energy from the same source and latent faculties be developed and psychic powers attained. One who has mastered the science of storing away Prana, either consciously or unconsciously, often radiates vitality and strength which is felt by those coming in contact with him, and such a person may impart this strength to others, and give them increased vitality and health. In fact, the oxygen in the air is appropriated by the blood and is made use of by the circulatory system. The Prana in the air is appropriated by the nervous system, and is used in its work. And as the oxygenated blood is carried to all parts of the system, building up and replenishing, so is the Prana carried to all parts of the nervous system, adding strength and vitality. If we think of Prana as being the active principle of what we call ‘vitality’, we may be able to form a much clearer idea of what an important part it plays in our lives. Just as is the oxygen in the blood used up by the wants of the system, so the supply of Prana taken up by the nervous system is exhausted by our thinking, willing,
acting etc., and in consequence constant replenishing it necessary. Every thought, every act, every effort of the will, every motion of a muscle, uses up a certain amount of what we call nerve force, which is really a form of Prana. To move a muscle the brain sends out an impulse over the nerves, and the muscle contracts, and so much Prana is expended. When it is remembered that the greater portion of Prana acquired by man comes to him from the air inhaled, the importance of proper breathing is readily understood.

**Neurophysiological aspects of Pranayamic Breathing**

From this description of Puraka, Kumbhaka and Rechaka, one can clearly understand all the salient features of the techniques of ‘Basic pattern of Pranayamic breathing’. We can briefly summarize it as follows:

The **main important features** of Pranayamic breathing includes:

1. deep and excessively slow inhalation and more slow exhalation, intervened with the phase of inner retention of breath,

2. full conscious control at every stage, and

3. maintenance of increased internal pressure with the help of Bandhas, as well as,

4. heightened awareness of all the internal sensations associated with this act of breathing.

The excessive prolongation of Puraka and Rechaka is brought about mainly by two maneuvers. One involves the active control, exercised over the muscles of the chest, thoracic diaphragm, abdomen and pelvic diaphragm. The second one involves the creation of finely controlled, resistance, to the air-flow at three points of the air passage:
a) at the entry point - by closing one nostril as in the practice of *Anuloma-Viloma* or *Suryabhedana Pranayama*;

b) at the junction of nasopharynx and oropharynx by tightening the free border of the soft palate as in the practice of *Bhramari Pranayama*; and

c) at the level of vocal cords - by partial closure of the glottis as in *Ujjayi Pranayama*.

The breathing mechanism of Man is so constructed that he may breathe either through the mouth or nasal tubes; but it is a matter of vital importance to him which method he follows, as one brings health and strength, whereas the other suffers from disease and weakness.

The feature of mouth-breathing is that the nasal passages, being thus comparatively unused, consequently fail to keep themselves clean and clear, and become clogged up and unclean, and are apt to contract local diseases. One, who habitually breathes through the nostrils, is not likely to be troubled with clogged or stuffy nostrils. But for the benefit of those who have been more or less addicted to the unnatural mouth-breathing, and those who wish to acquire the natural and rational method, it may perhaps be well to add a few words regarding the way to keep their nostrils clean and free from impurities.

On the other hand, the nostrils and nasal passages show evidence of the careful design of nature in this respect. The nostrils are two narrow, tortuous channels, containing numerous bristly hairs which serve the purpose of a filter or sieve to strain the air of its impurities, etc., which are expelled when the breath is exhaled. Not only do the nostrils serve this important purpose, but they also perform an important function in warming the air inhaled. The long narrow winding nostrils are filled with warm mucous membrane, which coming in contact with the inhaled air warms it so that it can do no damage to the delicate organs of the throat, or to the lungs.
Patanjali, the codifier of Yoga science, explains that the control of *Prana* is the regulation of inhalation and exhalation and this is accomplished by eliminating the pause between inhalation and exhalation or expanding it by retention. Then by regulating the motion of the lungs, the heart and the vagus nerve are controlled. The autonomic nervous system regulates processes in our bodies which are not normally under our voluntary control - processes such as secretion by the digestive organs, the beating of the heart and the movement of the lungs. The science of *Pranayama* is thus intimately connected with the autonomic nervous system and brings its functions under conscious control through the functioning of the lungs. Here is a unique exception to the rule that the autonomic nervous system governs processes that are self-regulating and not under voluntary control. Though the act of respiration is for the most part involuntary, voluntary control in this area is easily achieved, for the depth, duration and frequency of respiration can be consciously modulated quite readily. It is for this reason that control of breath constitutes an obvious starting point toward attainment of control over the functioning of the autonomic nervous system.

Breathing exercise (*Pranayama*) can bring the autonomic nervous system under control. It educates one to regulate the motion of lungs so that the heart function is regulated. The right vagus nerve is brought under conscious control, and the portion of the mind that coordinates with the involuntary system.

Modern scientists give importance to breathing exercises only from the viewpoint of oxygen intake, and their concern is with the absorption of oxygen in large enough quantities to vitalize the nervous system (Wallance & Benson, 1972; Wenger & Bagchi, 1961). But experimental evidences indicate the opposite view i.e., breathing related to *Pranayama* accumulates more carbon dioxide in the body. The ancient manuals of Yoga anatomy, for instance, describe a network of several thousand *nadis* or channels, through which the currents of *Prana* flow, energizing and sustaining all parts of the body as well as the several thousand *nadis*.
The words *nadis*, channels and vehicles are meant to explain one and the same force which is called *pranic force*. According to some manuals the number of *nadis* is 72,000 (other manuals talk about 350,000 *nadis*). Fourteen are more important than the others, but the most important among these are six: *ida*, *pingala*, *sushumna*, *brahmani*, *chitrani*, and *vijnana*. Among these six, three are the most important: *pingala* (*surya*) which flows through the right nostril; *ida* (*chandra*) which flows through the left nostril; *sushumna* which is a moment when both nostrils flow freely without any obstruction. Expansion of that moment is called *sandhya*, and for meditation the application of *sushumna* is of prime importance.

All three of the major *nadis* originate at the base of the spine and travel upwards. The *sushumna nadi* is centrally located and travels along the spinal canal. At the level of the larynx it divides into an anterior portion and a posterior portion, both of which terminate in the *brahmarandhra*, or Cavity of *Brahma*, which corresponds to the ventricular cavity in the physical body. The *ida* and *pingala nadis* also travel upwards along the spinal column, but they crisscross each other and the *sushumna* before terminating in the left and right nostrils, respectively.

The junction of *ida*, *pingala* and *sushumna* along the spinal column is called *Chakras* (viz., *muladhara*: at the base of the spine at the level of the pelvic plexus in the physical body; *swadhisthana*: at the level of the hypogastric plexus; *manipura*: at the level of the solar plexus; *anahata*: at the level of the cardiac plexus; *vishuddha*: at the level of the pharangeal plexus; *ajna*: at the level of the nasociliary plexus; and *sahasrara*: at the top of the head.

Scientists have made many attempts to identify the *nadis* with what we know of modern anatomy, but they have not been able to do so. Yoga anatomy and physiology, however, is very clear and accurate to those who systematically practice and study the science of yoga, and they find that it reveals more about internal functioning of human body. Some scientists have
tried to establish a correspondence between the two systems, but the assumption behind such an attempt is that the nerves and plexuses belong to the physical body while the *nadis* and *chakras* belong to what is known in yoga science as the subtle body. The currents of *Prana* flowing through these *nadis* are the subtle counterparts of the nerve impulses. Thus, controlled regulation of *Prana* may lead to healthy body that in turn may help to improve performance abilities.

### 1.3 Rationale of circulatory functions

**Cardiorespiratory Fitness**

Cardiorespiratory fitness is a measure of how well body is able to transport oxygen to muscles during prolonged exercise, and also of how well muscles are able to absorb and use the oxygen, once it has been delivered, to generate adenosine triphosphate (ATP) energy via cellular respiration (cellular respiration is a chemical process in body's cells that converts the energy stored in the food into the ATP form of energy that is recruited for use by muscles). Essentially, cardiorespiratory fitness level is a measure of the strength of aerobic energy system.

**Physiological basis of Cardiorespiratory fitness**

The body's ability to *transport oxygen* to muscles is dependent on the coordinated activities of heart, arteries, veins, and lungs. The process works as follows:

1. When a person breathe air into lungs. The oxygen in the air is absorbed into the blood in the capillaries that surround lungs and then transported via the pulmonary vein into the left side of the heart.

2. The oxygenated blood is pumped out of the left side of heart and into the arteries that deliver it throughout body to muscles.
3. When the oxygenated blood reaches muscles the oxygen is absorbed into the muscle cells from the blood capillaries that surround them. At the same time that blood is providing oxygen to muscles, it is also removing carbon dioxide, a waste product from muscle cellular respiration, from them. The now de-oxygenated and carbon dioxide rich blood is returned to the right side of the heart via veins.

4. The de-oxygenated and carbon dioxide rich blood is pumped out of the right side of the heart to lungs via pulmonary artery. Once in the lungs, blood releases the carbon dioxide into the air that you breathe out and absorbs more oxygen from the air that you breathe in, and the entire process begins again.

1.4 Statement of the Problem

With the increased incidence of disorders of cardio-respiratory functions mostly due to altered life style, the time has come for us to address these without drug. Further, the public health burden of lifestyle-related diseases is increasing. The most common causes of morbidity and mortality are coronary heart disease, stroke, obesity, hypertension, type-2 diabetes, allergies and several cancers. A sedentary lifestyle is a major risk factor for these diseases (Mokdad et al. 2004). Evidence suggests that sedentary behavior, low levels of physical activity, and cardiorespiratory fitness in youth track into adulthood (Malina 1996). Similarly, metabolic risk factors also appear to track over time (Chen et al., 2007), and may predispose young people to disease later in life (Hasselstrom et al., 2002).

Nevertheless, the protective effect of intentional physical activity on the above mentioned non-communicable diseases has been widely reported in people of all ages (Strong et al. 2005; Jonker et al. 2006), which is equally applicable for the College going students. Regular participation in moderate and vigorous levels of exercise increases physical fitness, which can lead to
many health benefits (Ruiz et al. 2006a). In adults especially for College students, low physical fitness (mainly low cardio-respiratory fitness and low muscular strength) seems to be a stronger predictor of both cardiovascular and all-cause mortality than any other well established risk factors (Myers et al. 2002). In fact, Physical fitness refers to the full range of physical qualities, i.e. cardiorespiratory fitness, muscular strength, speed of movement, agility, coordination, and flexibility. It can be understood as an integrated measurement of all functions (skeletomuscular, cardiorespiratory, haematocirculatory, psychoneurological and endocrine–metabolic) and structures involved in the performance of physical activity and/or physical exercise (Castillo Garzon et al. 2005). Although numerous studies indicate health benefits of physical activity but there is dearth of studies examining benefits of Indian traditional yoga practices on cardio-respiratory functions in College students. As the young generation is leading to sedentary lifestyle there is need to develop a programme which can be effective in improving cardio-respiratory performance of college going students. Hence, the researcher has undertaken this study to see the effect of pranayama on cardiovascular and respiratory functions in college students.

1.5 Problem and its Relevance

In adults, there is a substantial body of evidence that physical inactivity or low cardiorespiratory fitness levels are strongly associated with the development of metabolic syndrome. Increase in urbanization and industrialization induced the threat of pollution which in turn can be hazardous to general public health. Increasing environmental pollution is responsible to decline health in facilitating cardiorespiratory ailments.

With increased awareness and interest in health, people are now showing much interest towards natural remedies, where inclination towards yogic techniques is found very attractive. Recent exponents of yoga are also trying to popularize it, where pranayama gains more importance.
Pranayama literally means control of prana. Prana, in Indian philosophy, refers to all forms of energy in the universe. Physiologically, it is understood that certain yoga postures with controlled breathing regulates the blood circulation and functioning of heart and lungs. If such yoga practices are performed for a long period of time, it will have therapeutic effect on functions of heart and lungs. Almost none of us use the full capacity of our lungs. The primary question is how one can regulate breathing process. By training our body to breathe in a particular pattern, we can activate our autonomic system to use the new system of breathing. Yoga enhances relaxation to the bronchial functioning. Yoga also strengthens endurance, pain tolerance, and muscle tone. In pranayama, lungs are inflated to the maximum capacity and air pressure is increased in the lungs. This further leads to better oxygenation of the body which augments adequate release of chemicals in brain and endocrine glands. Heart beat also stabilizes because of breathing exercises mediated through autonomic nervous system.

Further, growing number of evidences have claimed that yoga practices increases longevity (Bharshankar et al., 2003), has therapeutic (Khanam et al., 1996) and rehabilitative effects (Katiyar 2006). The beneficial effects of six weeks practice of different pranayamas are well reported and have sound scientific basis (Joshi et al., 1992). Different types of pranayama along with asanas produce different physiological responses in normal young individuals. Breathing exercises for three weeks are reported to influence cardiorespiratory and autonomic functions (Madanmohan 2005). Pranayama breathing has been shown to alter autonomic activity. A study by Udupa et al., (1975) indicates that pranayama training produces a decrease in basal sympathetic tone. Raghuraj et al., (1998) have reported that Nadi-shodhana pranayama increases parasympathetic activity. Slow and deep breathing itself has a calming effect on the mind and helps an individual to de-stress (Sandeep et al., 2002). This calming effect may also exert profound physiological effects on pulmonary, cardiovascular, and mental functions of the brain.
These observations suggest that yogic practices can be used to promote or enhance cardiovascular efficiency in adolescents. Based on this information, the researcher has planned this study entitled, “Effect of Pranayama on Respiratory and Cardiovascular Function of Collegiate Students.”

1.6 Objectives of the study

This study was conducted with the following objectives in perspective:

- To assess the respiratory function of college students.
- To assess the cardiovascular function of college students.
- To prepare pranayama schedule for imparting training to the selected subjects with a view to improve lungs and heart function.
- To assess the impact of Pranayama on respiratory and cardiovascular function of college students through a control experiment.

1.7 Hypotheses

On the basis of related literature, the present investigator has formulated the hypotheses as follows:

HO1: The training programme of Pranayama would not improve respiratory function.

HO2: Pranayama training would not help to improve cardiovascular function.

1.8 Delimitation of the Study

The present investigator has delimited the study as follows:

- There are varieties of pranayama techniques being practiced by different people; however, only five of them have been selected for this study.
• This study was delimited to 70 male students from College of Physical Education, Pusad, Dist. Yewatmal (Maharashtra, India).

• The age group of subjects was restricted from 18 to 25 years.

• The environmental condition during the experiment was not considered for this study.

1.9 Limitations of the Study

While conducting the experiment, the present investigator noted some drawbacks, which have been confessed as follows:

• All eight varieties of pranayama could not be considered due to the constraint of time.

• Although there were no drop-outs from the experiment, some students were found irregular in the pranayama training session. Thus, 100 percent presence in the training session could not be attained.

• The researcher has to depend up on some of the assistants who helped the researcher for data collection. Although they were given training about the process of data collection, yet inter individual variation might have been affected the results.

• Vital capacity depends upon physical built (height, weight, anatomical body size) development and tone of respiratory muscles (intercostals, diaphragm) and the resiliency of lung tissue is beyond the capacity which might affect the results.
1.10 Significance of the Study

The following points represent the significance of conducting this investigation:

- Present investigation may be significant because pranayamic breathing may influence respiratory and cardiovascular functions in relation to exhibit better athletic performance of collegiate students.

- Sports coaches and physical education professionals may take advantage of the result of this study. They may consider the pranayama-training schedule for improvement circulo-respiratory functions.

- This study will help to establish the application of pranayama in the field of games and sports.

- Although further research is necessary, the common people and student population may take advantage of the results of this piece of research for their health benefit.

1.11 Operational Definitions of Terms Used

**Pranayama**

It is a voluntarily controlled breathing. Many of the studies, available so far, have not stressed up on the “kumbhaka” state of pranayama and how its ratio is useful for respiratory and cardiovascular function is not known. Therefore, the investigator has included the particular ratio of Kumbhaka in pranayama. For this, he has taken *Anuloma-Viloma, Surya Bhedan, Bhastrika, Sitali, Sitkari, Bharamari and Plavini* as the experimental intervention, where kumbhaka state will be given importance.
**Respiratory function**

Lungs capacity enhances vital capacity that in turn enhances overall respiratory function. There are two types of respiration viz., internal respiration and external respiration. External respiration links between atmospheric air and lungs, however, internal respiration generates process of diffusion of oxygen into blood stream and carbondioxide into atmospheric air. Overall lungs function in terms of *peak exploratory flow rate and vital capacity* will be measured in this study.

**Circulo-respiratory function**

Respiration is positively related to the process of blood circulation by human heart. The oxygen, the vital energy, enters in to the lungs and through diffusion the oxygen enters in to the blood stream, which further enters in to every cell with the functional ability of one’s heart. Thus, the composite of function of lungs and heart is known as circulo-respiratory function.

**Cardiovascular Function**

Cardiovascular efficiency is related to an individual's ability to use the large muscles for prolonged periods of dynamic, moderate-to-high intensity exercise.

Level of cardio-vascular fitness is dependent on the condition of the respiratory, cardiovascular and skeletal muscle systems. Analysis of cardio-vascular fitness is important because of its relationship to health and wellness.
Poor cardio-vascular fitness is related to a marked increase in risk of premature death from all causes, but particularly, from cardiovascular disease. Furthermore, improvement in cardio-vascular fitness is related to a reduction in premature death from all causes. Here it will be measured by 12 mins run and walk test, which a standard test to measure cardiovascular functions.

**Collegiate students**

Generally, the students studying in any affiliated college of university are considered as collegiate students. The students admitted in J.S.P.M. College of Physical Education in the B.P.E. (Bachelor of Physical Education -3 years) Degree course treated as collegiate students.