In this era of technological advancement, scientific measures play an important role in the successful conduct of physical education, athletic training and other health related physical activity programme. Hence, more than ever, it is necessary for physical educators, coaches, trainers and fitness instructors to understand the role of scientific advancement in sports science and its uses for the enhancement of human performance. Over the past forty years the number of exercise physiology laboratories have increased tremendously. The experimental studies and researches conducted through this laboratories have contributed very much to the information and knowledge in this area. This influx of knowledge have again contributed to the development of health related fitness and for the training of athletic teams in a better way. All these have enriched the scientific literature on the subject of sports science.

The scientific study of exercise physiology is becoming increasingly important with the growing realization of the relation of exercise to health. Field and laboratory observations of exercise in human subject are being supplemented with physiological and biochemical studies on laboratory animals. With the result many of the phenomena associated with acute and chronic exercise can now be explained at cellular and molecular levels (More house & Miller, 1976).

The sports performances are always interconnected and interlinked with many factors related to sports physiology, exercise physiology, biomechanics and anthropometric measurements. Sports performance area can be improved only through the co-ordinated functioning of allied branches mentioned above. In the above backgrounds those who work in this field should have thorough knowledge of these newly emerging branches of sports science.

Sports performance is indeed an aspect of complex human performances, which has several dimensions. Hence, several disciplines of sports sciences are
required to work in a co-ordinated manner to explore the nature of sports performance, and the process of improving sports performance. In the last few decades several disciplines of sports sciences namely Sports Medicine, Sports Physiology, Sports biomechanics, Sports Psychology, Sports Nutrition, etc. have been established. These sports sciences work as an integrated whole to give a superb performance (Sing, 1991).

Marathon running, cross-country race and road cycling competition have been very popular from the beginning of competitive sports. These sports events gained this popularity and importance by reason of the characteristic of high endurance activity. The performance of the high endurance activity is directly related to the size of the heart of the athletes, among other factors. This fact has been proved through the experiments and studies conducted from time to time.

Endurance primarily depend upon the various aspects of cardiac efficiency, which in turn exerts influence on the performance of the other portion of the human organism. Heart size will increase as a result of a training program. The thickening of the heart muscle causes the increase heart size. It result in a more powerful contraction and accordingly, a larger volume output of blood per stroke. The heart rate becomes slower as training progresses (Klafs and Arnhein, 1981).

The long period of continuous and vigorous training makes an athlete achieve the qualities of long distance runner and long distance cyclist. Endurance training induced major changes that are apparent at rest period are: changes in heart size; the size of the heart increases. The cardiac hypertrophy of endurance athlete is characterized by large ventricular cavity and normal thickness of ventricular wall. This means that the volume of blood that fills the ventricle during diastole is also larger. Also volume capacities of endurance athlete will be greater than those of non-endurance athletes. Besides these, there are numerous biochemical changes involved in the endurance athletes. The training increases the volume of blood which in turn increases the presence of haemoglobin contents in the blood. This means that the amount of oxygen supply to the working muscle
fibres is more. Continuous training leads to fall in the level of blood cholesterol. Consequently the presence of body fat reduces.

A normal sized ventricular cavity and thicker ventricular wall characterized athletes engaged in high resistance and isometric type of activities. Therefore the stroke volume capabilities is less when compared to endurance athletes resting heart rate will be decreased and stroke volume will be increased proportionately. Volume of blood and haemoglobin content in the blood increases by training. Regular exercise programme causes decrease in both blood cholesterol and triglyceride levels. This change is apparent in individuals who initially have very high blood levels prior to training. Training causes decrease in total body fat. The loss of body fat is dependent upon the balanced between calories taken and calories expended; it is not how fast you run but rather how far you travel (Dick, 1980).

The lipoproteins generated through the digestive process break down into several components, ie., cholesterol, phospholipids, triglycerides and lipoproteins. The lipoproteins are of two types of which the high density lipoprotein is considered to be very healthy to the human body since this does not get deposited in the inner linings of the arteries. The low density lipoprotein normally get deposited in the inner linings of the arteries. The high density lipoproteins get these deposits break down and removed. The scientific literature shows that continuous training helps to increase the high density lipoprotein fraction in the blood which in turn enhance the circulation of blood.

In the post-absorptive state i.e. over 95% of all the lipids in the plasma (in terms of mass, but not in terms of rate of transport) are in the form of lipoproteins, which are small particles, constraining mixtures of triglycerides, phospholipids, cholesterol and proteins. The protein in the mixture averages about one fourth to one third of the total constituents, and the remainder is lipids. The total concentration of lipoproteins in the plasma average about 700 mg per 100 ml, and this can be broken down into cholesterol, phospholipids, triglycerides and lipoproteins (Guyton, 1976).
Regular exercise programmes have been shown to increase HDL fraction. One of the reasons why HDLs are not harmful is that they do not collect or adhere to the inner linings of arteries. Infact they may actually help to break down the fatty deposits already present. The fatty atherosclerotic deposits are composed of low density lipoprotein (LDL) and very low density lipoprotein (VLDL). The LDL is the primary carrier of cholesterol in the blood stream, whereas the principal lipid components of VLDL are triglycerides (Fox, Bawers and Foss, 1989).

Long distance cycling is considered to be a strenuous physical activity. This activity demands much preparation and training for successful participation in the event. These preparations include streamlining of eating habits, training schedules etc. The ultra endurance event of road cycling competition can be successfully conducted only if all these components are successfully managed.

Road – racing cyclists have a special position in various types of endurance sport. Infact they could be labelled “the kings of the athletes” as they are more powerful than other sportspeople. Professional road racing cyclists train over distance of approximately 30000 – 35000 KM. per year (Konopka, 1989).

Though both activities are considered as long endurance activities both are characterized by similarities and differences in many aspects. Physiological factors, physical dimensions, bio-mechanical factors etc. are the areas in which the difference and similarities are prominent. The training programs are to be formulated giving special stress on these factors.

Even though both long distance running and long distance cycling are placed in the list of endurance activities, there are too many similarities as well as differences between both type of activities, as body types, training methods, skill etc. Distance runners performed the skill in upright position, while cyclists are in saddle position with forward leaning of trunk. Body movements are entirely different in both the sports activities (Hyman et al.)

Running and cycling activity is performed by muscle contraction of the
lower limbs. The main muscle group that are involved in cycling and running are the quadriceps and plantar flexors respectively. An exception to this is during uphill running when the recruitment of the quadriceps muscle is increased. Along with this remarkable physiological differences are also taken into account,

Physiological differences between cycling and running are addressed: heart rate is different between the two activities both for maximal and sub-maximal intensities. The delta efficiency is higher in running. Ventilation is more impaired in cycling than in running. It has also been shown that pedaling cadence affects the metabolic responses during cycling (Millet et al., 2009).

The endurance capacity can be increased only through increasing the aerobic capacity. Endurance training is a process involving several stages progressively. The length of the training programme depends upon the availability of time. The athletes are given basic endurance training in the first stage. The specific endurance can be started only after achieving the basic endurance. Only then can the athletes be brought up to the competitive participation level, to ensure better performance.

There are two different types of endurance within cycling.

1. Fundamental or basic endurance – Fundamental endurance forms the basis for all other forms of endurance, it allows in the tolerance of intensive training loads and increase the ability to regenerate muscle fibres.
2. Racing – specific endurance: short duration endurance, medium duration endurance, long duration endurance, power endurance, speed endurance.

These forms of endurance are interrelated. Fundamental endurance forms the basis for all other forms of endurance. Long duration endurance is required for performance which last between 10 minutes and a number of hours as is common in road races (Konopaka, 1989).
The aerobic capacity of the athletes is increased through regular exercise for a longer period. This is accomplished through the incremental difference in the heart size. It is through the regular exercise of the athlete that the heart muscles indirectly get exercised. The heart size is increased as a result of these exercises. The increase in heart size through endurance training is manifested in the increase of size of the left ventricle. Previously it was thought that the increased capacity of left ventricle is a hereditary factor. Now studies and research in this area has revealed that the increase in size of the left ventricle is largely due to the training and due to some hereditary factor, to some extent.

The more long interval or steady-state training you do, the larger your heart becomes and the more blood it contains. The muscle surrounding the heart will grow stronger as well, but not at the same rate. That is the mark of an endurance athlete. Among sportsmen with the largest hearts, therefore, you’d expect to find long-distance cyclist, marathon runners, other long distance runners, rowers and boxers (Woodland, 1986).

In comparison with non-athletes endurance athletes have a larger left ventricular end diastolic diameter at rest. From several studies it has been shown that during dynamic physical exercise trained subjects increase end diastolic left ventricular internal dimension and ejection fraction to develop a high stroke volume, cardiac output and oxygen uptake. In contrast, sedentary subjects rely more on an increase of ejection fraction than on an increase of left ventricular dimension. These studies emphasis the effect of physical training, but cannot exclude a genetic predisposition in the athletes to increase preload during exercise (Beilen and Ameny, 1991).

The increase in size of the left ventricle chamber of the athletes of long duration activity help them to increase the stroke volume, heart rate and cardiac out-put which in turn helps the functional activity of the heart in general.

It is most interesting that one of the adaptation of marathon running is an increase in size of the ventricular chambers. The increased stroke volume, together
with a lower heart rate inorder to maintain a very high level cardia output, also provides optimum heart muscle perfusion the time in between beats ever during exercise is till fairly long (Martin, 1995).

By the advent of echo-cardiography, the study of left ventricle of the endurance athletes have been developed to a great extend. The heart rate ascertained manually has been switched over to the electro cardiograph instrument reading by super imposing code to the strip chart of E.C.G. Machine.

Since the advent of echocardiography, investigations into the nature of the athletes heart and long term effects of vigourous exercise on cardiac dimensions and function have intensified. The athletes engaged in different types of exercise developed different patterns of left ventricular hypertrophy. Athletes involved in dynamic and isotonic exercise, such as distance runners, swimmers and cyclists, developed predominantly increased left ventricular chamber size, presumably on the basis of the volume overload associated with the high cardiac output of this type of exercise (Lewin, 1979).

The relationship between exercise and blood lipid levels has been investigated extensively in recent years. Cross sectional studies find that, compared with non athletes, athletes generally have higher levels of HDL cholesterol, while levels of total and LDL cholesterol may be similar or some what lower.

When body weight is maintained during an exercise programme modestly favourable changes in blood lipids are observed (i.e. decrease in total and LDL cholesterol and increase in HDL cholesterol). These changes are more pronounced when weight loss occurs during the exercise programme (Barr et al., 1991)

The Anthropometric measurement has assumed an important role among other branches of sports science. Anthropometric measurement is employed from the selection of suitable activity for an athlete to the direction of the athlete to the speciality event, suitable for him. Thus the subject plays an important role in the
career of the athlete from the very beginning his career. The scientific literature has also revealed that elaborate study had been conducted in this field. The studies largely relate to the sports performance of athletes in relation to the anthropometric measurement. The possibilities for further studies on the subject are enormous.

The measurement of structure and proportion of the body are called anthropometry. It has wide application as one of the essential parameters constituting the selective diagnosis of any game or sports. Measurement of body size include such descriptive information as height, weight and surface area, while measurement of body proportion describes the relationship between height and weight and among lengths, widths and circumference of various body segments. It has been found that top athletes in some sports tend to have those proportions that biomechanically aid the particular performance required (Zeigler, 1982).

The special features of the long distance activities demand varying requirements in physical dimension. Marathon runners are lean and thin when compared to the road cyclist. The length of lower extremities give mechanical advantage in Marathon runner. In long distance cycling the terrain is an important factor, which has greater influence on the body weight and muscles recruitment pattern. These are evident from the scientific literature.

Road cycling is a sport that requires performing in a great variety of terrains (i.e. level vs uphill roads) and competitive situations. In turn cycling performance in each of the competition terrains is partly determined by individual morphological characteristics (body mass, height, body surface and frontal areas, body mass index (BMI). Anthropometric variables might thus greatly differ depending on each cyclists specialty (Lucia, 2005).

A great deal of research has been devoted by the researchers to know the contribution of cardiac performance, biochemical and anthropometric variables to improve the performance of endurance type sports.
Both distance running and distance cycling are counted as endurance type activities. To the knowledge of the research scholar, after going through the available literature, physiological adaptations and effect of anthropometric profiles have been treated in a very general manner in the completed studies. This study intends to differentiate the effort of endurance cycling and endurance running on athletics in terms of cardiac performance, biochemical and anthropometric variables.

**Statement of the Problem**

The purpose of the study was to find out the relationship of cardiac performance, biochemical and anthropometric variables to the performance of long distance running and long distance cycling.

**Delimitations**

1) The study was delimited to thirty university level athletes and cyclists, 15 long distance runners (Cross Country and Athletics) and 15 long distance cyclists (Road race members and 40 Kilometer point race members).

2) The study was delimited to the athletes and cyclists aged between 18 and 24.

3) The study was confined to the following variables.

**Cardiac Performance Variables**

1) Resting Heart Rate
2) Left ventricular end – systolic diameter
3) Left Ventricular end – diastolic diameter
4) Ejection fraction
5) Fractional shortening
6) Stroke volume
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Biochemical Variables:

1) Total serum cholesterol
2) Serum triglyceride
3) High density lipoprotein cholesterol
4) Low density lipoprotein cholesterol
5) Blood haemoglobin
6) Red blood cells
7) White blood cells

Anthropometric Variables:

1. Weight
2. Height
3. Total leg length
4. Calf Girth
5. Thigh Girth

Limitations

1) No motivational technique was used to motivate the subjects and differences in the performance due to lack of motivation was considered as a limitation of this study.

2) Influence of involvement in other physical activities, diet, inborn discriminations etc. should be considered as limitation of this study.

3) Laboratory errors was considered as another limitation of the study.

Hypothesis

On the basis of literature reviewed, expert opinion and scholars understanding of the problem, it was hypothesized that:

There will be significant relationship between selected cardiac performance, biochemical and anthropometric variables to the performance of
long distance runners and long distance cyclists.

**Definition and Explanation of the terms**

**Resting heart rate**

The number of times the heart beats (Fox and Donald, 1981).

**Left Ventricular end-Systolic Diameter**

Peak upward motion of the posterior left ventricular endocardium as end systole. The diameter of the ventricle at the end of systolic is end systolic diameter (Ganong, 1997).

**Left Ventricular end-Diastolic Diameter**

The diameter of the ventricle of the end of diastole is end diastolic diameter (Ganong, 1997).

**Ejection Fraction**

The percent of the end-diastolic ventricular volume that is ejected with each stroke. The ejection fraction is a value index of ventricular function (Ganong, 1997).

**Fractional shortening**

It is the percentage change of the left ventricular muscle length in systole and diastole (Baun, 1994).

**Stroke Volume**

The amount of blood pumped out of each ventricle per beat.

The stroke volume of resting man of average size in the supine position is 70 ml from each ventricle (Ganong, 1997).
Serum Cholesterol

A fat like material (a sterol) present in the blood and most tissues, especially nervous tissue. Cholesterol is synthesized in the body from acetate mainly in the level and its blood concentration is normally 140-300 mg/100 ml (Consise Medical Dictionary).

Serum Triglycerides

Triglycerides are the esters of fatty acids with the trihydroxyl alcohol glycerol. These are neutral fat, which are insoluble in water and soluble in non polar solvents (White et.al., 1959)

Lipoproteins

Combination of fat and proteins (lipoproteins) are important cellular constituents occurring both in the cell membrane and in the mitochondria within the cytoplasm and serving also as the means of transporting lipids in the blood.

Low density lipoproteins and high density lipoproteins

These are two classes of lipoproteins

Low density lipoprotein contain relatively few triglycerides but a very high percentage of cholesterol.

High density lipoprotein contain about 50% protein with smaller concentrations of the lipids (Guyton, 1976).

Blood Haemoglobin

A substance contained within the red blood cells and responsible for their colour composed of the pigment haem (an iron containing propluyrin) linked to the protein globin: Heamo globin has the unique property of combining reversibly with oxygen is transported with in the body (Consise medical Dictionary)
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Red Blood Cells

They are small circular bi-concave discs, pale buff in colour when seen singly, but in masses appear red and give colour to the blood. It consists of heamoglobin (Pearce, 1993).

White Blood Cells

They are transparent and not coloured, are larger and fewer than the red, they are from 6000 to 10000 (with an average of 8000) in each cubic milimetre of blood. They play very important role in protecting the body from microorganisms. Neutrophils, Lymphocytes and esinophils are constitutes of white blood cells (Pearce, 1993).

Anthropometric Measurements

Anthropometric measurements are dimensions of the structure of the human body taken at specific sites to give measures of length, girth and width (Mathews, 1978).

Weight

Weight is a composite measure of total body size (Lohman & Co workers 1988.)

Height

Height is the length from the vertex of the head to the ground (Croney, 1981)

Total leg length

Total leg length is measurement from the greater trochanter to this inferior point of the ischial tuberocity (Croney, 1981).
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**Calf Girth**

Calf Girth is estimate of cross-sectional muscle and adipose tissue areas of the Calf (Lohman & Co workers 1988).

**Thigh Girth**

Thigh Girth is the estimated circumference between the greater trochanter and the proximal border of the patella. The inguinal crease has been chosen instead of the trochanter as a proximal land mark (Lohman & Co worker, 1988).

**Significance of the study**

At the elite level, the successful performance does not merely depend on one or two basic performance traits; it also relies on many more elements which individually as well as collectively contribute to the performance standard. For outstanding sports performance as well as general fitness cardiac efficiency, lipid profile and anthropometric profile of an individual count a lot. Long distance runners and long distance cyclists are categorised as high fitness group in terms of cardiac performance, biochemical and anthropometric variables. It has to be found whether, there is disparaty between these groups. The possibilities of physical activity and athletic participation in improving cardiovascular and physical fitness has been commonly accepted. The present study will be of significance in the following ways:

1) This study will provide a descriptive information of cardiac performance, biochemical and anthropometric variables of long distance runners and long distance cyclists.

2) The study will further attempt to find out the relationship of selected cardiac performance, biochemical and anthropometric variables to performance of long distance runners and long distance cyclists.
3. The findings of the study will also provide comparative information of the selected cardiac performance, biochemical and anthropometric variables between long distance runners and long distance cyclists.

4. The results of this is likely to throw light an abnormalities / beneficiaries if any among athletes and cyclists in lipid profile, anthropometric profile and cardiac function.

5. This study will help the beginners to choose the activity according to their cardiac, biochemical and anthropometric profiles.