Discussion of Findings

Long term endurance training are associated with the improvement of cardiac performance, changes in biochemistry and physical changes. The exact effects on these factors depend upon the type of training and the nature of activities involved. Both long distance running and long distance cycling, improve the endurance capacity of the athletes, since these activities are prolonged and aerobic in nature. These activities make the body organs and its functional capacity to adapt as per the requirement of the activity.

Numerous variety of regulating and structural responses can augment cardiac performance as training proceeds. Changes include a slowing of heart rate, an increase of stroke volume both at rest and during exercise and increase in physical dimensions of the heart. Physical changes of athletes also occurred gradually.

The present study tried to establish the relationship of cardiac performance, biochemical variables and anthropometric variables to the performance of long distance runners and long distance cyclists.

The finding of the relationship of cardiac performance variables to running performance (12.5 Km) of long distance runners revealed significant positive correlation for heart rate (0.708) and significant negative correlations for stroke volume (-0.752) and left ventricular end diastolic diameter (-0.682). The other variables namely left ventricular end systolic diameter, ejection fraction and fractional shortening however did not show any significant relationship to long distance running performance. In case of the relationship of cardiac performance variables to cycling performance none of the selected variables showed significant relationship.

In the case of distance running performance, resting heart rate showed significant relationship to performance. A lower resting heart rate is a prerequisite
for prolonged endurance activities. One of the most obvious and earliest of training induced change is a decrease in resting heart rate both at rest and at fixed intensity of sub-maximal exercise.

Though there were no significant difference between the long distance runners and long distance cyclists in resting heart rate, both the groups showed lower level of resting heart rate, this may be due to the enlargement of ventricular cavity and increased parasympathetic inhibition. Athletes participating in high endurance events like marathon running, marathon skiing, triatholon etc., enlarged ventricular cavity and normal thickness of ventricular wall of their heart, which enhance the efficiency of heart by reducing rate of stroke.

Pollock et.al., reports from the conclusion drawn from 19 reports that aerobic training decreased the heart rate by 6.6. beats /minute under resting conditions. Shepherd noted that the main reason for the development of a resting bradycardia seems to be increased parasympathetic nerve activity possibly reflecting a change in bradycardic activity of the arterial baro receptors.

The present study observed significant correlation between stroke volume and distance running performance of long distance runners. Lower heart rate and increased stroke volume are the effect of long term aerobic exercise. Training induced changes in cardiac performance include slowing of heart rate, increase in stroke volume, both at rest and during exercise and an increase in the physical dimensions of the heart.

The comparison between long distance runners and long distance cyclists, revealed significantly increased stroke volume for the long distance runners. Dwyer reported that, training for several hours at a time, in the saddle position may alter cardiac loading in road race cyclists, leading to structural adaptations different from those observed in runners.

Mc Ardle et.al., reports that increase in stroke volume in upright exercise are generally the result of more complete systolic emptying rather than a greater filling of the ventricles during diastole. Systolic ejection is augmented by
Review of Related Literature

sympathetic hormones. Endurance training improves myocardial strength, which contributes to stroke power during systole.

Significant correlation was observed for left ventricular end diastolic diameter and running performance. This inverse relationship is remarkably similar to the observations made by Morganroth, who found runners to have increased left ventricular end diastolic diameter, when compared to control group and isometrically trained subjects.

The hypertrophy of endurance trained athletes are normally characterized by increased ventricular cavity rather than a thickness of the ventricular wall. It has been shown that in dynamic physical exercise trained subjects increase end diastolic left ventricular internal dimension and ejection fraction to develop of high stroke volume, cardiac output and oxygen uptake.

Dibello et.al., reports that intense training of elite endurance runners induces a number of cardiovascular adjustments, which integrated by complex neuro-physiological modification and athletes genetic characteristics are major determinants of athletic fitness and power. The dialation of left ventricular chamber due to left ventricular hypertrophy will occur. This increased ventricular cavity obviously results in the increased left ventricular end diastolic diameter.

These results are in consonance with the findings of Weiling and co-workers.

No significant relations were observed for the other cardiac performance variables (left ventricular end systolic diameter, ejection fraction and fractional shortening) to long distance running performance and long distance cycling performance. The comparison between long distance runners and cyclists on the above said variables also showed no significant difference between the mean performance of the two groups. Cardiac adaptations to dynamic and prolonged exercise need not induce changes in variables like left ventricular end systolic diameter and ejection fraction.
It has been reported by Gilbert et al., the customary maker of myocardial contractility is the ejection fraction, the quotient of stroke volume divided by end diastolic volume and expressed as percentage. The ejection fraction has not been found to be greater in athletes compared with normal. The increased size of the athletes heart is accompanied by normal ejection fractions, it follows that the capacity to eject blood must be increased in the athletes.

The findings in case of biochemical variables reveals no significant relationship of the selected biochemical variables to running performance in case of long distance runners. Whereas in the case of long distance cyclists heamoglobin showed significant correlation to cycling performance.

The relationship of haemoglobin to performance among cyclists is quite obvious since heamoglobin is concerned with oxygen carrying capacity and the diffusion capacity of the cardio respiratory functioning. The variable like heamoglobin is a determinant for long duration and oxygen demanding activities like endurance running and endurance cycling.

The comparison of the biochemical variables between the long distance runners and long distance cyclists revealed significant between the groups in total cholesterol, triglycerides and low density lipoprotein cholesterol with higher values for the cycling group.

Prolonged exercises and long term endurance training have shown to bring about beneficial physiological changes in terms of increased levels of high density lipoprotein cholesterol and triglycerides. However the extent of these changes are dependent upon the intensity and duration of training programmes. Medium intensity exercise training even if only performed for few weeks is capable of reducing the plasma concentrations of very low density lipoprotein and of the triglycerides. The effect of exercise in this respect seems to be the activation of the enzyme lipoprotein liapase, present in the type 1 muscle fibre and in the myocardiam, which is responsible for the hydrolysis of triglycerides. The long term endurance training, especially cross country running meets the necessary
requirements for the intensity and duration of exercise to bring about the above said exercise induced changes.

In comparison to runners, in long distance cyclists, high relative fat appear to be a predominant metabolic feature. The duration of activity is more higher than that of runners. Infact greater duration needs more energy. Burke reported that the main source of energy during cycling is derived from the metabolism of fats and carbohydrates. During endurance cycling, energy is supplied to active muscles by fact and glycogen. The increased capacity of trained cyclists to utilize fats, combined with their ability to release free fatty acids from adipose tissue. Reciprocally the cyclists may have higher levels of total cholesterol and corresponding levels of triglyceride and low density lipoprotein cholesterol as compared to endurance runners.

The above findings of the present study are in consonance with the findings of Kerbs, Barr et.al., and Garvican.

The findings in case of anthropometric variables reveal no significant relationship of the selected anthropometric variables to running performance in the case of long distance runners. Whereas in case of long distance cyclists, weight and thigh girth showed significant correlation to cycling performance.

In the case of distance cycling performance, body weight showed significant relationship to performance. Costa reports the correlations between anthropometric, aerobic and anaerobic variables with cycling time trial performance. In long time trial competitions (above 50 Km. distance), cycling performance is partly related to power output that elicits the ventilatory threshold. In addition, the level of ground can dramatically affect cyclist time trial performance. Therefore, rolling resistance, air resistance and force gravity can partly explain why larger cyclists are better on flat ground and smaller cyclists are better on up-hill terrain.
The comparison between long distance runners and long distance cyclists, revealed significantly higher body weight for the long distance cyclists. Millet et. al, reported that road cycling is a sport that requires performing in a great variety of terrains and competitive situations. In turn, cycling performance in each of the competition terrain is partly determined by individuals morphological characteristics. Flat terrain specialists are usually taller and heavier than those who excel in marathon running.

Significant correlation was observed for thigh girth and long distance cycling performance. Higher circumference of thighs is an important component of exercise adaptation during exercise. Millet et.al., reported that cycling requires a considerable muscular strength component for performance in the activity. The relative volume of training performed in cycling may affect these responses in cycling. Generating more strength during pedaling is the resultant development of the muscles of lower extremities.

No significant relations were observed for the other anthropometric variables (height, total leg length and calf girth) to long distance cycling performance. The comparison between long distance runners and cyclists on the variables (height, total leg length, calf girth and thigh girth) also showed no significant differences between the mean performance of the two groups.

These results are in consonance with the findings of Lucia and Modlesky.
Discussion of Hypothesis

Understanding the relationship of cardiac performance, biochemical and anthropometric variables to long distance running and long distance cycling performance, have greater importance in the field of sports medicine, exercise physiology and kinanthropometry.

The present study was undertaken with the hypothesis that there would be significant relationship of selected cardiac performance, biochemical and anthropometric variables to performance of long distance runners and long distance cyclists.

Among the cardiac performance variables the above hypothesis is accepted in case of resting heart rate, stroke volume and left ventricular end diastolic diameter, since these variables showed significant relationship to distance running performance. In the case of the rest of the cardiac performance variables for long distance runners, and all the cardiac performance variables of long distance cyclists, the hypothesis remains rejected.

Among the selected biochemical variables, in the case of blood heamoglobin of long distance cyclists, the hypothesis is accepted, whereas for the rest of the biochemical variables of the long distance cyclists and all the biochemical variables of long distance runners, the hypothesis is rejected.

Among the selected anthropometric variables in the case of weight and thigh girth of long distance cyclists, the hypothesis is accepted, whereas for the rest of the anthropometric variables of the long distance cyclists and all the anthropometric variables of long distance runners, the hypotheses are rejected.