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Effect of Different Proportions of Aerobic and Anaerobic Training on Left Ventricular Diastolic Diameter, Wall Thickness and Mass among Elite Athletes

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Abstract: *Systematic sports training leads to increase left ventricular cavity dilation,hypertrophy and mass of the heart. In this study we have used m-mode Doppler echocardiography to measure Left ventricular end diastolic diameter (LVEDD), Left ventricular wall thickness(LVWT) and Left ventricular mass (LVM). For this study 45 men elite athletes were taken to reach the purpose and subjects were divide into three groups Group-I 10% aerobic and 90% anaerobic proportions (200 mtr race) andGroup-II 50% aerobic and 50% anaerobic proportions (1500 mtr) and Group-III 90% aerobic and 10% anaerobic proportions (10000 mtr run).All the subjects underwent regular training program under the supervision of their regular coaches as per specialized sports event. The subject's age between 20 and 25 years and the sports age is 5years to 7 years.The results indicate that 90% aerobic and 10% anaerobic group athlete has markedly increased the LVEDD, LVWT and LVM as compared to other two experimental groups. Finallyit is concluded that 90% aerobic and 10% anaerobic training is an effective training proportion for significant improvement ofLVEDD, LVWT and LVM.*

Key words: *Sports training; Left ventricular end diastolic diameter; Left ventricular wall thickness; Left ventricular mass; Different proportions of aerobic and anaerobic training; Cardiac hypertrophy*

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I. Introduction

Sports produces a physiological hypertrophy but the prevalence varies depending on the duration and intensity of training regimens as well as on the kind of endurance sports performed **G. Iglesias Cuberoet al. (2000)**

Athlete's heart is generally considered as gentle increases in cardiac mass with specific circulatory and cardiac morphological alterations that represent a physiological adaptation to systematic training **Barry J Maron, Antonio Pellicia(2006).** Cardiac morphologic changes, including expanded left ventricular cavity measurements, wall thickness, left ventricular mass. The progressions appear as a part of adjustments to hemodynamic load delivered by long-term, intensive exercise regimen. The extent to which outright left ventricular cavity measurement is expanded by sympathetic training is more in many athletes **Antonio Pelliccia et al.(1999).**The cardiac performance depends on agreeable left ventricular function to guarantee a blood yield to all tissues **Stella S. Vieira et al.(2016**).

The marked arteries dilation that produces left ventricle eccentric hypertrophy by increasing venous return and consequently, left ventricular end diastolic volume is increased and left ventricular end systolic volume is reduced and hence, stroke volume and ejection fraction are augmented. This physiological hypertrophy is characterized by chamber enlargement and a proportional change in wall thickness **Moran Saghiv and Michael Saghiv (2017)**.

According to **Dibello et al. (1995)** the thickness of the interventricular septum and left ventricular posterior wall thickness of the marathon runner has increased as compared to untrained subjects. **Sharma et al. (2002)** explored the physiological limits of left ventricular hypertrophy in world class junior competitors. They find that the left ventricular posterior wall thickness in the group of athletes was expanded contrasted with untrained subjects.Exercise induced cardiac remodeling is considered a benign physiological adaptation to the hemodynamic load of systemic training and is characterized by an increase in cavity diameter, wall thickness and left ventricular mass **Aline Iskanda, Mohammed TokirMujtaba, Paul D. Thompson (2015).**

Those who exposed to regular and vigorous, isotonic exercise is characterized by left ventricular volume overload with increased left ventricular internal dimension, end-diastolic volume, stroke volume and myocardial mass. These changes are associated with enhanced left ventricular performance and peripheral adaptations **William E. Garrett Jr., and Donald T. Kirkendall, (2000**).

According to**Caselli et al. (2011)** showed Left ventricular end diastolic volume and mass increases in athletes as compared to untrained controls, with preserved left ventricle systolic function; male gender and endurance disciplines had the highest impacts on left ventricle end diastolic volume and mass.Exercise has several effects on cardiovascular mechanisms, including physiological hypertrophy and structural changes, which may improve cardiac functions such as better pumping mechanism because of increased heart mass and volume **David AJ, Savage CJ, Fennell L (2008).**

In this study the investigator is trying to put an effort to find out how 10% aerobic and 90% anaerobic and 50% aerobic and 50% anaerobic and 90% aerobic and 10% anaerobic trainings are going to influence on Left ventricular end diastolic diameter, Left ventricular wall thickness and left ventricular mass. To achieve this investigator has chosen an elite athlete who comes under the selected proportion of aerobic and anaerobic, all of them have been successfully participating at National and University level competitions. Subject underwent regular training program under the supervision of their regular coaches as per specialized sports event. The subjects age between 20 and 25 years. The training diary revealed that volunteered elite subject athletes were not informed any injuries during their training history and their sports age is 5 to 7 years.

II. Methodology

Forty Five (N=45) healthy male elite athletes were volunteered as subjects from different parts of Andhra Pradesh and Telangana state, India. The investigator has parted them into three groups according to their events and utilization of different aerobic and anaerobic proportions. Group I is 10% aerobic and 90% anaerobic proportion (200 mtr race) , Group II is 50% aerobic and 50% anaerobic proportion (1500 mtr race) and Group III is 90% aerobic and 10% anaerobic proportion (10,000 mtr race) **(Edward L. Fox, 1989).** The assessed Left ventricular end diastolic diameter, Left ventricular wall thickness and left ventricular mass at rest was measured by M-mode Doppler echocardiography **(Philips CX50 ultra image system Philips medical systems, USA, with 2.5 to 3.5 MHz transducer for was used to determine)** at Lakshya Cardiac Center, Prodatur, A.P. India.

III. Statistical Analysis

The collected data on Left ventricular end diastolic diameter, Left ventricular wall thickness and left ventricular mass has been analyzed and presented below. The data collected from experimental groups Left ventricular end diastolic diameter, Left ventricular wall thickness and left ventricular mass rest were statistically tested for significant difference, if any by employing Analysis of variance (ANOVA) and data were analyzed by using computer with IBM-25, SPSS package. The level of confidence was fixed at 0.05 for significance. To determine the significance difference among the means of three experimental groups, the Scheffe'S test was applied as post-hoc test.

IV. Results And Discussions

LEFT VENTRICULAR END DIASTOLIC DIAMETER AT REST

The means($\overline{X}$), standard deviation(σ) and analysis of variance (ANOVA)for data on Left ventricular end diastolic diameterat restof 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group were analyzed and presented in Table I.

TABLE I: Analysis of variance for the left ventricular end diastolic diameter at rest data on 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group

Test	10% Aerobic and 90% Anaerobic Group	50% Aerobic and 50% Anaerobic Group	90% Aerobic and 10% Anaerobic Group	Source of Variance	df	Sum of Squares	Mean Squares	Obtained 'F' Ratio	Table 'F' Ratio
$\overline{X}$	4.222	4.628	4.907	B:	2	3.556	1.778	72.090*	3.222
σ	0.043	0.199	0.179	W:	42	1.036	0.025		

Significant at 0.05 level of confidence. $\overline{X}$ *- Mean,* σ- Standard Deviation

The table value for significance at 0.05 level with df 2 and 42 is 3.222.

The table I shows that the means of 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group are 4.222, 4.628 and 4.907 cm respectively. The obtained 'F' ratio of 72.090 is greater than the table value of 3.222 for df 2 and 42 required for significant at 0.05 level.

The results of the study indicates that the significant difference exists among 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group on LVEDD at rest. To determine the significance difference among the means of three experimental groups, the Scheffe'S test was applied as post-hoc test and the results were presented in table I-A.

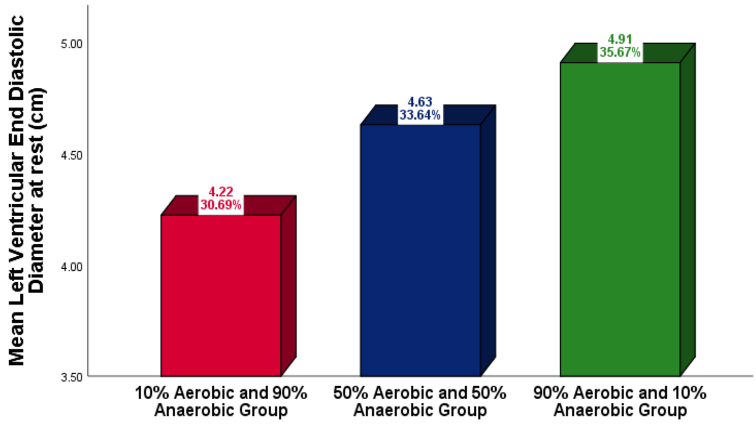
TABLE I-A: Scheffe'S post-hoc test for left ventricular end diastolic diameter at rest on the difference between 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobicand 10% anaerobic group

10% Aerobic and 90% Anaerobic Group	50% Aerobic and 50% Anaerobic Group	90% Aerobic and 10% Anaerobic Group	Mean Differences	Confidence Interval 0.05 Level
4.222	4.628	-	0.406*	0.104
4.222	-	4.907	0.685*	0.104
-	4.628	4.907	0.279*	0.104

Significant at 0.05 level of confidence.

Table I-A shows that the tests mean difference on LVEDD at rest between 10% aerobic and 90% anaerobic group and 50% aerobic and 50% anaerobic group is 0.406 which is greater than the confidence interval value 0.104 at 0.05 level of confidence. The test mean difference on LVEDD at rest between 10% aerobic and 90% anaerobic group and 90% aerobic and 10% anaerobic group is 0.685 which is greater than the confidence interval value 0.104 at 0.05 level of confidence. The test mean difference on LVEDD at rest between 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group is 0.279 which is greater than the confidence interval value 0.104 at 0.05 level of confidence. Hence, it is concluded from the results that the significant difference exists among three experimental groups on LVEDD at rest.

From the results it was concluded that, 90% aerobic and 10% anaerobic group has increased the LVEDD at rest as compared to other experimental groups.Further it is concluded that highest mean difference exists between 10% aerobic and 90% anaerobic group and 90% aerobic and 10% anaerobic group.
The test means values on LVEDD at restof three experimental groups were graphically depicted in Figure I.



FIGUREI: Bar diagram on left ventricular end diastolic diameter at rest means of 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group

LEFT VENTRICULAR WALL THICKNESS AT REST

The means($\bar{X}$), Standard deviation (σ) and analysis of variance (ANOVA) for data on Left Ventricular Wall Thickness at restof 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group were analyzed and displayed in table II.

TABLE II: Analysis of variance for the left ventricular wall thickness at rest data on 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group

Test	10% Aerobic and 90% Anaerobic Group	50% Aerobic and 50% Anaerobic Group	90% Aerobic and 10% Anaerobic Group	Source of Variance	df	Sum of Squares	Mean Squares	Obtained 'F' Ratio	Table 'F' Ratio
$\bar{X}$ σ	1.223 0.02	1.244 0.016	1.260 0.015	B: W:	2 42	0.010 0.012	0.005 0.000	17.604*	3.222

***Significant at 0.05 level of confidence.** $\bar{X}$ - *Mean,* σ- Standard Deviation

The table value for significance at 0.05 level with df 2 and 42 are 3.222.

The table II shows that the means of 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group are 1.223, 1.244 and 1.260 cm respectively. The obtained 'F' ratio of 17.604 is greater than the table value of 3.222 for df 2 and 42 required for significant at 0.05 level.

The results of the study indicates that the significant difference exists among 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group on LVWT at rest. To determine the significance difference among the means of three experimental groups, the Scheffe'S test was applied as post-hoc test and the results were presented in table II-A.

TABLE II-A: Scheffe'S post-hoc test for left ventricular wall thickness at rest on the difference between 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group

10% Aerobic and 90% Anaerobic Group	50% Aerobic and 50% Anaerobic Group	90% Aerobic and 10% Anaerobic Group	Mean Differences	Confidence Interval 0.05 Level
1.223	1.244	-	0.021*	0
1.223	-	1.26	0.037*	0
-	1.244	1.26	0.016*	0

Significant at 0.05 level of confidence.

Table II-A shows that the tests mean difference on LVWT at rest between 10% aerobic and 90% anaerobic group and 50% aerobic and 50% anaerobic group is 0.021 which is greater than the confidence interval value 0.0 at 0.05 level of confidence. The test mean difference on LVWT at rest between 10% aerobic and 90% anaerobic group and 90% aerobic and 10% anaerobic group is 0.037 which is much greater than the confidence interval value 0.0 at 0.05 level of confidence. The test mean difference on LVWT at rest between 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group is 0.016 which is greater than the confidence interval value 0.0 at 0.05 level of confidence. Hence, it is concluded from the results that there is a significant difference between 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group on LVWT at rest.

From the results it was concluded that, 90% aerobic and 10% anaerobic group has increased the LVWT at rest as compared to the other two experimental groups. Further it is concluded that highest mean difference exists between 10% aerobic and 90% anaerobic group and 90% aerobic and 10% anaerobic group.

The tests mean values on LVWT at rest of three experimental groups were graphically presented in Figure II.

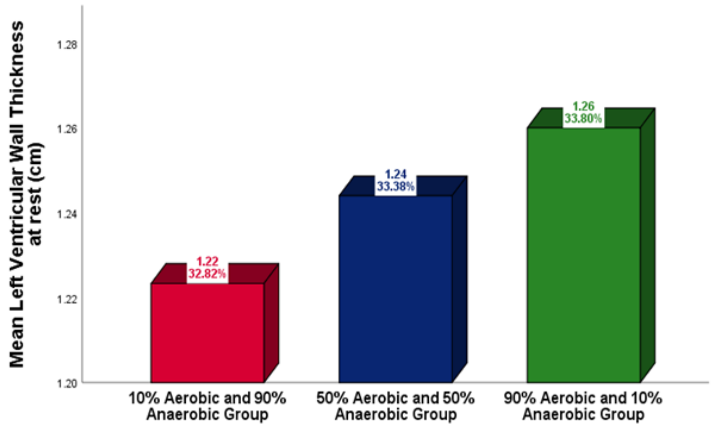


FIGURE II: Bar diagram on left ventricular wall thickness at rest means of 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group

LEFT VENTRICULAR MASS AT REST

The means($\bar{X}$), standard deviation (σ) and analysis of variance (ANOVA) for data on Left ventricular mass at restof 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group were analyzed and presented in Table III.

TABLE III: Analysis of variance for the left ventricular mass at rest data on 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group

Test	10% Aerobic and 90% Anaerobic Group	50% Aerobic and 50% Anaerobic Group	90% Aerobic and 10% Anaerobic Group	Source of Variance	df	Sum of Squares	Mean Squares	Obtained 'F' Ratio	Table 'F' Ratio
$\bar{X}$	121.80	125.866	127.33	B:	2	246.533	123.267		
σ	1.97	2.39	1.45	W:	42	163.467	3.892	31.671*	3.222

Significant at 0.05 level of confidence. $\bar{X}$ - *Mean,* σ- Standard Deviation

The table value for significance at 0.05 level with df 2 and 42 is 3.222.

The table III shows that the means of 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group are 121.80, 125.866 and 127.33 grams respectively. The obtained 'F' ratio of 31.671 is greater than the table value of 3.222 for df 2 and 42 required for significant at 0.05 level.

The results of the study shows that the significant difference among 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group on LVM. To determine the significance difference among the meansof three experimental groups, the Scheffe'S test was applied as post-hoc test and the results were presented in table III-A.

TABLE III-A: Scheffe'S post-hoc test for left ventricular mass at rest on the difference between 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group

10% Aerobic and 90% Anaerobic Group	50% Aerobic and 50% Anaerobic Group	90% Aerobic and 10% Anaerobic Group	Mean Differences	Confidence Interval 0.05 Level
121.80	125.866	-	4.066*	1.293
121.80	-	127.33	5.533*	1.293
-	125.866	127.33	1.464*	1.293

Significant at 0.05 level of confidence.

Table III-A shows that the test mean difference on LVM at rest between 10% aerobic and 90% anaerobic group and 50% aerobic and 50% anaerobic group is 4.066 which is greater than the confidence interval value 1.293 at 0.05 level of confidence. The tests mean difference on LVM at rest between 10% aerobic and 90% anaerobic group and 90% aerobic and 10% anaerobic group is 5.533 which is greater than the confidence interval value 1.293 at 0.05 level of confidence. The test means difference on LVM at rest between 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group is 1.464 which is greater than the confidence interval value 1.293 at 0.05 level of confidence. Hence, it is concluded from the results that the significant difference exists between 10% aerobic and 90% anaerobic, 50% aerobic and 50% anaerobic and 90% aerobic and 10% anaerobic groups on LVM at rest.

From the results it was concluded that, 90% aerobic and 10% anaerobic group has increased the LVM at rest as compared to other two experimental groups.Further it is concluded that highest mean difference exists between 10% aerobic and 90% anaerobic group and 90% aerobic and 10% anaerobic group.

The tests means values on LVM at rest of three experimental groups were graphically depicted in Figure III.

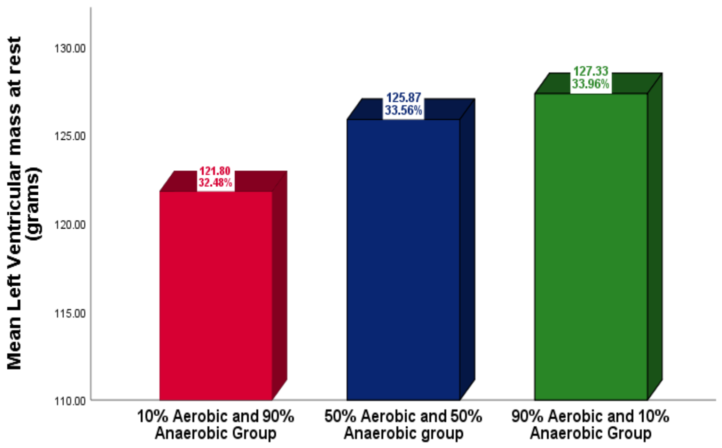


FIGURE III: Bar diagram on left ventricular mass at rest means of 10% aerobic and 90% anaerobic group, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group

V. Discussions

Left ventricular end diastolic diameter

From the results of the study it has been concluded that, all the three experimental groups 10% aerobic and 90% anaerobic, 50% aerobic and 50% anaerobic and 90% aerobic and 10% anaerobic groups has significantly increased the LVEDD at resthowever, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group has significantly increased LVEDD at restas compared with 10% aerobic and 90% anaerobic group. The results indicates that the significant difference exists among three groups on LVEDD at rest.

The left ventricular cavity size is the absolute most significant discriminator between physiological LVH and HCM. Practically all athletes with physiological LVH have corresponding growth of the left ventricular cavity. The estimations of LV cavity size in athletes with LVH range from 55 to 65 mm **PellicciaA, Culasso F (1999).**

Most of the elite athletes had absolute left ventricular cavity dimension within normal limits, but a substantial striking cavity enlargement with end diastolic dimension of up to 66mm in women and 70 mm in men **Antonia pelliccia et al. (1999).**

As previously reported, the LVEDD and EDV were larger in the endurance athletes than normal human and in the sprinters. The systolic shortening of the left ventricular minor axis diameter was better in the endurance athletes than in the short distance runners or sedentary individuals**Markku J. Ikaheimo et al. (1979).**

Puim (1999) and Spirito (1994) showed strong evidence that left ventricular cavity is enlarged in competitive endurance athletes who perform predominantly dynamic sports. According to **Andrea (2002)** an Italian scientist detected that the maximal effort workload achieved during bicycle ergometry was associated with left ventricular end diastolic diameter in long distance swimmers and runners. Hence, the researcher concluded that, 50% aerobic and 50% anaerobic and 90% aerobic and 10% anaerobic groups have increased LVEDD at rest. The present study concludes that the findings are inconformity with the above research findings.

Left ventricular wall thickness

From the results of the study it has been concluded that, all the three experimental groups 10% aerobic and 90% anaerobic, 50% aerobic and 50% anaerobic and 90% aerobic and 10% anaerobic group has significantly increased the LVWT at resthowever, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic groups have significantly increased LVWT at restas compared with 10% aerobic and 90% anaerobic group. The results indicates that the significant difference exists among three groups on LVWT at rest.

Regular sport activity normally induces walls thickness and LV chamber dimensions are particularly involved in this functional and structural adaptation **Alessio De Luca, Laura Stefani et al. (2011).**

Recent investigations of more than 700 pre-adult British Athletes taking an interest in an assortment of ball, racket and aerobic activities indicated that none of the athletes age<16 years old showed a left ventricular wall thickness greater than 11 mm. in this investigation just 3 athletes had left ventricular wall thickness greater than 12mm and all were aged greater than 16 years old **Sharma S, Maron BJ (2002)**. The sporting discipline is a significant determinant of LVH in athletes. Athletes partaking extremeendurance sport with a high isotonic and isometric segment, for example, rowing, canoeing, swimming, cycling, ultra-endurance running display the best increments in LVWT**John Rawlins, Amit Bhan, Sanjay Sharma (2009).**

There is developing proof that ethnicity may affect LVWT estimations in athletes. An underlying investigation of 260 dark American between university athletes indicated that 13% of the competitors showed left ventricular hypertrophy, with left ventricular wall thickness measurements ranging from 13 to 18 mm **Lewis JF, Maron BJ et al. (1989).** Extremely trained athletes unveil substantial left ventricular hypertrophy, with values amid 13 and 16 mm **Basavarajaiah S, Wilson M et al. (2008).**

Athletes doing predominantly isometric exercises have significant LVW hypertrophy and Endurance athletes have LV dilatation without noticeable wall hypertrophy when athletes doing isotonic exercise **Howald H, maire R et al. (1977).**Cardiovascular changes in long distance runners have been examined and increments in the left ventricular hypertrophy of the LVW caused by repeated and extended volume work in isotonic activity have been found**Markku J. Ikaheimo et al. (1979).**

In the event that the individual partakes in anaerobic exercise like marathon for quite a while, the eccentric LVH, in which the thickness of ventricle isn't huge though the left ventricular wall is a moderately expanded **Vinereanu et al. (2002).** Resistanceactivity like wrestling, weightlifting and body building work out for long time the concentric left ventricle hypertrophy, the ventricular wall isn't enormous though the thickness of ventricle is expanded. Likewise, cyclists and rowing competitors who have the qualities of both aerobic and anaerobic activity systems have eccentric-concentric LVH**Baggish et al. (2010).**

Sharma et al. (2000) said that due to exercise as physiological basis structure and function of the heart has changed, and also increases left ventricular wall thickness. These futures carried about by slow enlarge in the internal measurement of the cardiac muscle by performing aerobic exercise with continuous management of HR and BP, in addition Cardiac output increased **palatine et al. (1988).** Hence, the researcher concluded that, 50% aerobic and 50% anaerobic and 90% aerobic and 10% anaerobic groups have increased LVWT at rest. The present study concludes that the findings are inconformity with the above research findings.

Left ventricular mass

From the results of the study it has been concluded that, all the three experimental groups 10% aerobic and 90% anaerobic, 50% aerobic and 50% anaerobic and 90% aerobic and 10% anaerobic groups has significantly increased the LVM at resthowever, 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic groups have significantly increased LVM at restas compared with 10% aerobic and 90% anaerobic group. The results indicates that the significant difference exists among three groups on LVM at rest.

Left ventricular mass and right ventricular mass was significantly augmented in endurance athletes as compared with untrained controlled subjects. Moreover the left and right ventricular mass showed similar difference. The proportion of left ventricle to right ventricle mass was equal for athletes and control subjects **Scharhag et al. (2002).**An early investigation of two hundred and sixty black American university level athletes exhibited that 13% of the athletes presented left ventricular hypertrophy, hence, mass also increased **Lewis JF, Maron BJ et al. (1989).** Hence, the researcher concluded that, 50% aerobic and 50% anaerobic and 90% aerobic and 10% anaerobic groups have increased LVM at rest. The present study concludes that the findings are inconformity with the above research findings.

VI. Conclusions

1. Left ventricular end diastolic diameter was significantly increased by 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group as compared to 10% aerobic and 90% anaerobic group.
2. Left ventricular wall thickness at rest has significantly increased by 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group as compared to 10% aerobic and 90% anaerobic group.
3. Left ventricular mass at rest has been significantly increased by 50% aerobic and 50% anaerobic group and 90% aerobic and 10% anaerobic group as compared to 10% aerobic and 90% anaerobic group

VII.Recommendations

- 90% aerobic and 10% anaerobic training proportion is the better proportion to increases the LVEDD.
- 90% aerobic and 10% anaerobic training proportions is the better proportion to increase the left ventricular chamber dilation and also LVWT.
- 90% aerobic and 10% anaerobic training is quite suitable to increase the LVM at rest,

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