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A SCIENTIFIC STUDY ON HEART RATE AND MUSCULAR ENDURANCE OF AEROBIC, ANAEROBIC AND COMBINED AEROBIC AND ANAEROBIC ACTIVITIES AMONG ELITE WOMEN

Polakala Krishna Moorthy[1], Dr K Rama Subba Reddy[2]
[1]*Research Scholar, PhD Regular, DPESS, Yogi Vemana University, Kadapa, AP, India.*
[2]*Research Supervisor, Head, DPESS, Yogi Vemana University, Kadapa, AP, India.*

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ABSTRACT
A planned, systematic and chronic training regimen will always leads to significant adaptations on physical and cardiac functions. The heart is an involuntary organ which directly get impact by any systematic training protocol as compared to any other organ of the body, based on this the investigator is throwing a light on how a long distance running training, middle distance running and weight lifting training protocol leads to a significant impact on heart rate at rest and muscular endurance. To fulfill the objectives of the study the investigator has chosen (N=45) elite women volunteered athletes of each (N=15) of long distance running, middle distance running and weight lifting, between 18 to 22 years. All the volunteered elite athletes are trained by their coaches for about 7 to 9 years. The selected criterian parameters are Heart Rate at rest (HR) and Muscular endurance, and they were measure by M-Mode Doppler Echocardiography with the support of qualified cardiologist and bent knee sit-ups (1 min) respectively. The level of significance is set at 0.01 level of assurance. The investigator has concluded that a regular and systematic long distance running, middle distance running and weight lifting training have significantly brought desired changes in heart rate at rest and muscular endurance as compared the normal, healthy, and untrained women reference values. Further, the investigation come to an that the long distance running has significantly lowered heart rate at rest, and significantly enhanced muscular endurance as compared to the middle distance running and weight lifting groups. In ordered to find out the significant difference the analysis of variance (ANOVA) was employed. When the 'F' ratio is significant, the Scheffe's post-hock test was used to find the paired mean significant difference, if any, among the groups of chosen parameters.

KEYWORDS: ***long distance running, middle distance running, weight lifting, heart rate at rest, muscular endurance.***

INTRODUCTION
The quantity of female distance runners and their chances of participating in long-distance races have grown recently. Enhancing athletic performance requires exercises that increase maximal muscle strength and maximal aerobic endurance capacity. People need to move in order to survive because they are dynamic beings. We can guarantee our physical and physiological well-being if the movement is carried out according to certain guidelines and norms. Evidence from the **World Health Organization (2004)** and **Armstrong et al. (2006)** indicates that a significant contributor to early death and morbidity from chronic diseases is physical inactivity. Physical inertia affects all individuals in the modern world. Issues include muscular atrophy, obesity, and hypertension cardiac issues.

Fitness is made up of various elements, such as muscular strength and cardiovascular endurance. Numerous health and performance factors, particularly cardiovascular endurance, have been shown to significant increase with aerobic endurance training (ET).
Even while ET improves some aspects of fitness, Predictable cardiovascular changes also result from regular athletic training. Individuals who train aerobically and those who train resistance exhibit distinct physical and physiological dissimilarities. People who exercise regularly over an extended period of time will experience some degree of cardiac hypertrophy. Different forms of exercise have been shown to cause anatomical changes in the heart. During aerobic activity, the body experiences acute short-term physiological responses such as elevated blood pressure, heart rate, breathing rate, and tidal volume. Chronic aerobic exercise has been shown to raise maximal oxygen consumption during high-intensity aerobic exercise, decrease resting blood pressure and heart rate, reduce body fat mass, and increase muscle mass; on the other hand, low cardiovascular fitness is linked to a higher risk of dying young **Ehrman et al., (2009).** For this reason, aerobic activity is crucial in lowering the chance of cardiovascular issues on the other hand and it helps to improve cardiovascular fitness. The competition's outcome is impacted by the unpredictable and forceful acts that are part of these sports' performances **Matsushigue et al., (2009), Del Vecchio et al., (2011).** Physiological (aerobic and anaerobic energy systems, cardiovascular and metabolic competence), bio motor (strength, ability, mobility, flexibility), technical, and tactical traits are all evident.

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Athletic performance encompasses an athlete's physical, physiological, bio motor (bio-motor: strength, speed, endurance, mobility, flexibility, coordination), psycho-mental, technical, and tactical abilities. Numerous external and internal elements that impact performance are recognized to be effective **Kilinç, (2003)**. It is crucial that the performance outcomes match the traits (physiological, bio motor, psychological, technical, and tactical) of the field in which it has been used. For instance, while assessing a distance runner's performance state, aerobic capacity ($MaxVO_2$) differs from physiological traits while anaerobic power values. Many studies have found that concurrent exercise (CE), which combines strength and aerobic endurance training in the same workouts or regimen, impedes the growth of muscle power or strength. Brief preresistance aerobic activity raises heart rate (HR) during anaerobic resistance training.

Maximum oxygen absorption (VO_2 max), fractional utilization of VO_2 max, and running economy have historically been proposed as the determinants of endurance performance, such as distance running. Varying significantly in endurance running performance, athletes with comparable VO_2 max may have varied running economies. Furthermore, there is proof that anaerobic work capacity can have a significant impact on distance runners' running performance. We predicted, based on specificity considerations that heart rate variability(HRV) assessments between athletes with endurance training and those with anaerobic or higher power output training would differ significantly at the elite level. A wide range of highly skilled track and field athletes did not differ in the time or frequency domain, according to our results. Anaerobic power is thought to be crucial for effective performance. **Platzer et al., Gross et al., (2009); Hogg, (2003).**

According to **Neumayer et al. (2003),** having a high aerobic physical efficiency improves one's capacity to recover from repeated bouts of anaerobic exercise, as well as enabling one to withstand higher training loads and lower the danger of overtraining. It also enhances muscle endurance. Activating aerobic metabolism by exercise at VO_2 max is facilitated by training for aerobic power and endurance **Bangsbo et al., (2000), Coyle, (1995).** Throughout the yearly training cycle, the exercise intensity should be below the anaerobic threshold (AT) and suitably adjusted to AT constraints.

Elite female long-distance runners exhibit high levels of muscular endurance due to extensive aerobic training. Increased mitochondrial density, capillary networks, and oxidative enzymes improve fatigue resistance, enabling prolonged muscle activity. **Joyner, M. J., & Coyle, E. F. (2008)**. Long-distance runners typically have a significantly lower resting heart rate due to increased stroke volume and cardiac efficiency. Enhanced parasympathetic tone and reduced sympathetic activity contribute to lower heart rates in these athletes. **Carter, J. B., Banister, E. W., & Blaber, A. P. (2003).**

Elite female middle-distance runners exhibit moderate muscular endurance due to a combination of aerobic and anaerobic training. Development of both Type I (slow-twitch) and Type II (fast-twitch) muscle fibers enhances endurance and power. **Harber, M. P., Konopka, A. R., Undem, M. K., Hinkley, J. M., Minchev, K., Kaminsky, L. A., Trappe, T. A., & Trappe, S. (2012).** Middle-distance runners experience a moderate decrease in resting heart rate, reflecting the benefits of both aerobic and anaerobic conditioning. Combined training regimes enhance stroke volume and cardiac output, although decrease in heart rate is not as pronounced as in long-distance runners. **Seiler, S., & Tønnessen, E. (2009).** Elite female weightlifters typically have lower muscular endurance compared to endurance athletes, as their training focuses on strength and power. Increased muscle fiber size and strength, with fewer adaptations for sustained muscle activity. **Hakkinen, K., & Pakarinen, A. (1993).** Strength training can lead to a slight reduction in resting heart rate due to improved cardiovascular health, but the effect is generally less pronounced compared to endurance training. Increased stroke volume and overall cardiac efficiency, although these changes are not as substantial as those seen in endurance athletes. **Kokkinos, P. F., & Myers, J. (2010).**

METHODOLOGY

The primary purpose of this study is to conduct a scientific study on heart rate at rest and muscular endurance of aerobic, anaerobic and combined aerobic and anaerobic activities among elite women. To fulfill the goals of the investigation, 45 (N=45) female elite national varsity athletes were randomly chosen to be subjects in groups of fifteen each, Group I- fifteen athletes (N=15) from long distance running group (5000/10000 mts race) Aerobic. Group II–fifteen athletes (N=15) from middle distance running group (800/1500 mts race) Aerobic and Anaerobic. Group III-fifteen athletes (N=15) weight lifting group (any weight category) Anaerobic, age of 18 to 22 years and all the athletes were in top form. The investigator informed to all volunteered elite athletes about the requirements of the study, and they all agreed to participate in the testing procedure. Volunteered subjects were in good health and trained by their coaches, and they have the national level playing experience and the sports age is between 7 and 9 years. Since the test was non-invasive, no ethical committee authorization was required. Participants in the specified test engaged in lively participation. The efficacy of hemodynamic system and muscular endurance are essentially needed by athletes in three different sports in order to excel in competitive sports. Every sport has specific physical and cardiovascular indices and exigencies for elite performance, in the same way, better heart rate at rest and muscular endurance are needed. One of the study's limitations is that the elite performers were taken into consideration. This study includes assessments of the heart rate at rest and muscular endurance among female elite athletes by using M-Mode Doppler Echo Cardiography and bent knee sit-ups (1 min).

STATISTICAL ANALYSIS

SPSS v25 and Microsoft Excel were used to analyze the data. The quantitative variables were analyzed by Using ANOVA, the numerical data on physical parameters from each of the three experimental groups were statistically analyzed to look for any suggestive variance. The whole data set was analyzed by using 25 version of the Indian Business Management Statistical Package for Social Sciences. The degree of

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conviction for purport was set at 0.01. The data is given below for analysis on criterion variables. When the F-Ratio is significant, the Scheffe's post hock test was used to find the paired mean significant difference, if any, among the groups of parameters separately.

TABLE -I

ANALYSIS OF VARIANCE FOR THE HEART RATE AT REST OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

Test	Long Distance Running	Middle Distance Running	Weight lifting	Source of Variance	df	Sum of Square	Mean Square	Obtained 'F' Ratio	Table 'F' Ratio
$\overline{X}$	48.733	52.600	56.733	B:	2	480.178	240.089	269.158*	**5.168**
σ	0.883	1.121	0.798	W:	42	37.467	0.892		

***Significant at 0.01 level of assurance.**

The table value for purport at 0.01 level with df 2 and 42 is 5.168.

The table I displays that the means of heart rate at rest of long distance running , middle distance running and weight lifting groups are 48.733, 52.600 and 56.733 b/min respectively. The obtained 'F' ratio of 269.158 is much greater than the table value of 5.168 for df 2 and 42 requisite for significant at 0.01 level.

The results of the study indicates that the significant difference exists among elite women athletes of three experimental groups on Heart rate at rest. To define the noteworthy variations among the means of three experimental groups, the Scheffe'S test was employed as post-hoc test and the outcomes were exhibited in Table I A.

TABLE-I A

SCHEFFE'S POST HOC TEST FOR HEART RATE AT REST ON THE MEAN DIFFERENCE BETWEEN LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

Long Distance Running	Middle Distance Running	Weight Lifting	Mean Difference	Confidence Interval Value
48.733	52.600	--	3.867*	1.360
48.733	--	56.733	8.0*	1.360
--	52.600	56.733	4.133*	1.360

***Significant at 0.01 level of assurance.**

The Table IA displayed the test mean difference on Heart rate at rest among the elite women athletes of all three experimental groups are 3.867, 8.0 and 4.133 b/min respectively, which are higher than that of confidence interval value 1.360 at 0.01 level of assurance. Hence, it is culminated from the results that the noteworthy difference existed among three experimental groups on Heart rate at rest, and also concluded that, long distance training has significantly lowered the Heart rate at rest as compared to the middle distance running and weight lifting groups. Further, it is windup that highest mean difference existed between long-distance running and weight lifting groups. The test mean values on Heart rate at rest of three experimental groups are graphically exhibited in Figure I.

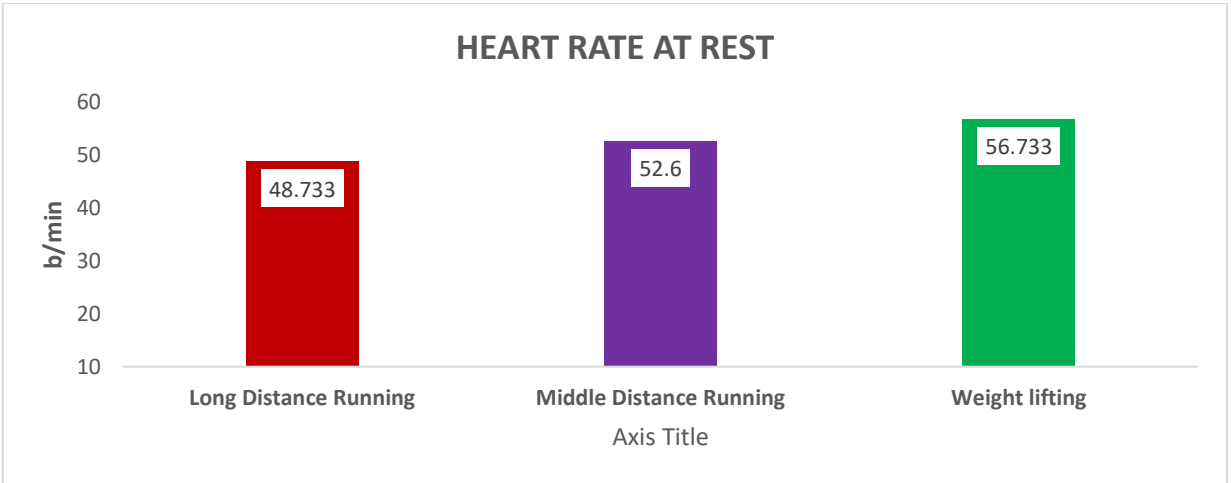

FIGURE II: BAR GRAPH ON HEART RATE AT REST MEANS OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

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TABLE-II
ANALYSIS OF VARIANCE FOR THE MSCULAR ENDURANCE OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

Test	Long Distance Running	Middle Distance Running	Weight lifting	Source of Variance	df	Sum of Square	Mean Square	Obtained 'F' Ratio	Table 'F' Ratio
$\overline{X}$	29.066	26.133	25.066	B:	2	128.711	64.356	75.891*	**5.168**
σ	0.961	0.833	0.961	W:	42	35.600	0.848		

***Significant at 0.01 level of assurance.**

The table value for purport at 0.01 level with df 2 and 42 is 5.168.
The Table II displayed the means of long distance running, middle distance running and weight lifting groups are 29.066, 26.133 and 25.066 Seconds severally. The attained 'F' Ratio of 75.891 is much greater than the table value of 5.168 for df 2 and 42 required for significant at 0.01 level. The results of the study shows that the significant difference exists among three experimental groups on Muscular endurance. To define the significant variations among the means of three experimental groups, the Scheffe'S test was employed as post-hoc test and the outcomes were illustrated in Table II-A.

TABLE-II A
SCHEFFE'S POST HOC TEST FOR MUSCULAR ENDURANCE ON THE MEAN DIFFERENCE BETWEEN LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

Long Distance Running	Middle Distance Running	Weight Lifting	Mean Difference	Confidence Interval Value
29.066	26.133	--	2.933*	1.324
29.066	--	25.066	4.0*	1.324
--	26.133	25.066	1.067	1.324

***Significant at 0.01 level of assurance**

The Table II-A displays the test mean difference on Muscular endurance between long distance running and middle distance running is 2.933, and mean difference between long distance running group and weight lifting group is 4.0 which are greater than the confidence interval value 1.324 at 0.01 level of assurance. The mean difference on Muscular endurance between middle distance running group and weight lifting group is 1.067 which is less than the confidence interval value 1.324 at 0.01 level of assurance. Hence, the insignificant difference existed between middle distance running group and weight lifting groups on muscular endurance. Hence, it is concluded from the results of the study that the significant difference existed between long distance running and middle distance running, long distance running and weight lifting group on Muscular endurance.

From the results the investigation has concluded that, the long distance running has increased the Muscular endurance as compared to other experimental groups. Further, it is concluded that highest mean difference existed between long distance running group and weight lifting group.

The test means values on Muscular endurance of three experimental groups were graphically illustrated in Figure II.

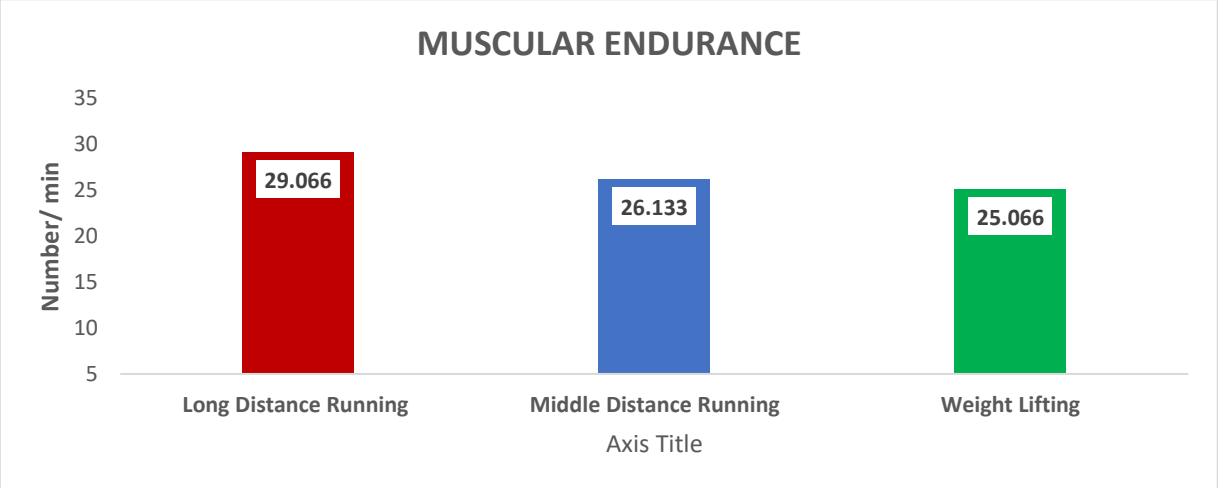

FIGURE III: BAR CHART ON MUSCULAR ENDURANCE MEANS OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS

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DISCUSSION

The results of the study shows that distinct categories of pure aerobic, aerobic and anaerobic and anaerobic demand cause a significant alteration in heart rate at rest and muscular endurance. Based on the evidence there is a significant difference existed among the three experimental groups. The heart rate at rest is significantly lowered and enhanced muscular endurance by long distance running group, as compared to other two experimental groups.

In this study, the researcher hypothesized that there would be a significant shift in heart rate at rest and muscular endurance among elite female athletes which is proved by the present investigation findings that are clinically relevant to existing empherical evidence.

CONCLUSION AND IMPLICATION

The subsequent completions were inferred from the investigation's findings.

Based on the above research facts the investigator implied that the heart has a better adaptability through lower heart rate at rest and improved muscular endurance by the chronic long distance running training as compared other two experimental training groups.

Conflict of Interest: No

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