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Imperative analysis on the effects of different exigencies on cardiac output among elite athletes

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Abstract: *The extreme advantage of the sports training stimulus is acquired when reproduce the development on vital system engaged with the sports. The body will always undergo significant adaptations as a result of a planned, systematic physical and physiological training regimen. Based on this empirical evidence the researcher is concentrating on how different exigencies through long distance running, middle distance running and weightlifting, activities will have a positive impact on particular cardiovascular parameters. To meet the purpose the investigator has chosen (N=45) women volunteered elite athletes of each (N=15) of long distance running, middle distance running and weight lifting athletes between 18 and 22 years. All the volunteered elite athletes are trained by their coaches for about 7 to 9 years. The criterian parameter is cardiac output and it was measured by multiplying the heart rate with stroke volume. The heart rate and stroke volume were measured by using M-Mode Doppler Echo Cardiography. The level of significance is set at 0.05 level of assurance. The study concluded that a regular and systematic long distance running, middle distance running and weight lifting training significantly brought changes in selected variables as compared to the normal, healthy, and untrained women. Further, it is concluded that the insignificant difference existed between long distance running group and middle distance running group, middle distance running group and weight lifting groups on cardiac output. Long distance running group has increased the cardiac output as compared to the middle distance running group and weight lifting group. In ordered to find out the significant difference analysis of variance (ANOVA) is 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 parameter.*

Keywords: *long distance running, middle distance running, weightlifting, Cardiac output at rest, Heart rate at rest, Stroke Volume at rest.*

1. INTRODUCTION:

Elite female long-distance runners exhibit increased stroke volume both at rest and during exercise due to larger left ventricles and improved ventricular function. This increased stroke volume contributes to a higher maximal cardiac output, essential for sustained aerobic performance. As a result of higher stroke volume, these athletes often have a lower resting heart rate (athletic bradycardia), indicating cardiovascular efficiency. Training increases plasma volume, improving venous return and stroke volume, thereby enhancing cardiac output. High stroke volume, low resting heart rate, and high maximal cardiac output due to extensive aerobic training. **Wilmore, J.H., Costill, D.L., & Kenney, W.L. (2008).**

Middle-distance runners benefit from both aerobic and anaerobic training, leading to improved stroke volume and a higher maximal heart rate. Their cardiac output is higher than non-athletes but lower than long-distance runners due to the combination of aerobic and anaerobic demands. Training improves cardiovascular efficiency, allowing for effective oxygen delivery during high-intensity efforts. Adaptations include increased left ventricular mass and improved myocardial contractility. Moderate increases in stroke volume and cardiac output with balanced aerobic and anaerobic training. **Noakes, T. (2001).**

Weightlifters experience modest increases in stroke volume due to strength training, which primarily increases left ventricular wall thickness. Compared to endurance athletes, weightlifters have a lower cardiac output, as their training emphasizes short, intense bursts of activity rather than sustained aerobic exercise. Weightlifting induces a different heart rate response, often with significant increases during lifting due to the Valsalva maneuver, but does not enhance resting heart rate or stroke volume as significantly as endurance training. The focus on anaerobic capacity and muscle strength results in less pronounced cardiovascular adaptations compared to endurance athletes. Modest increases in stroke volume, lower cardiac output compared to endurance athletes, and adaptations focused on short, intense efforts. **Zatsiorsky, V.M., & Kraemer, W.J. (2006).**

Concentrated physical exercise is related with focal and fringe cardiovascular adjustments that encourage the generation of enormous and continued cardiac output and improve the extraction of oxygen from practicing muscle for aerobic glycolysis **John Rawlins, Amit Bhan, and Sanjay Sharma (2009)**. Aerobic exercise upsurges the mechanical efficacy of the heart by aggregate cardiac output **Anju Madan Gupt and Mukesh Kumar et al., (2015).** High Stroke volume (SV) is upheld with a low heart rate, while low SV is kept up with a high Herat rate (HR). Likewise, regular exercise makes the progression of the venous blood smooth, in this way expanding the amount of blood coming back to the diastolic heart, which increments. **Maron, (1986)**. **Enrique Z. Fishman and Michael Motro et al. (2002)** viewed that noticeably augmented fundamentally through prominent increment in SV; their activity HR was like that of stationary people. **Turkvich et al. (1988),** concluded that highly trained endurance athletes heart have adjusted to training, by radically growing SV, and lower HR can give ideal. According to **Richard Allen (1999)**, the cardiovascular system achieves this by increasing and redistributing blood Stream to the dynamic muscle by means of neural procedures of the hemodynamic reactions and local regulation of the flow within the active muscle. This blood (250 to 400 ml/100g /min) neural guideline of the cardiovascular system directs hemodynamic responses by increasing HR, SV, and O_2 extraction at the tissue level. **Scharhag et al., (2002**) revealed that the cardiac output at rest will be unaffected and it will be the same in athletes as well as in a controlled group.

Cardiac output is the volume of blood pumped by the heart per minute, and is the product of the heart rate and stroke volume. The stroke volume of the ventricle is determined by the interactions between its preload, contractility and afterload. Clinical indicators such as capillary refill, urine output, serum lactate, core peripheral temperature gradient and level of consciousness are inaccurate and non-specific, especially with large variations in cardiac output. One of the most significant physiological indicators is cardiac output (Q), which accurately and proportionally represents the body's overall metabolism. Cardiac output is the product of heart rate and stroke volume and represents the total systemic flow per minute. The heart's capacity to raise heart rate and stroke volume results in the body's ability to adjust to increasing exertion and consequently metabolism. Elite women athletes with improved heart rate and stroke volume will certainly show a greater cardiac output.

It is possible that the most straightforward way to visualize cardiac output is by heart rate; the faster a heart beats the more blood it can pump in a given amount of time. To use our comparison, a bicycle will move more quickly if the rider pedals faster. It's not quite that easy, though! Recalling the bicycle analogy, it is simple to see how a rider who pedals too quickly for an extended period of time could tire out and be unable to continue pedaling at that pace, causing the bicycle to slow down. The right amount of pedaling is necessary to avoid tiring the rider too soon and force them to slow down; on the other hand, pedaling too slowly would prevent the bicycle from moving rapidly enough to cover; if the pace is too slow, the bicycle won't be able to travel the necessary distance. Likewise, cardiac output may be compromised if the heart rate is excessively fast or too slow, which are typically recognized as signs of a severe bradyarrhythmia. Cardiogenic shock and decreased cardiac output can also be caused by acute supraventricular or ventricular tachycardia. Looking at the cardiac functions of people who do long-term aerobic exercises, the resting heart rate is 40–60 times, which is close to bradyarrhythmia. Also, stroke volume (SV) is large. The development of cardiac structure is called "athletic heart," which is remarkable but distinguishable from pathologic symptoms. It is said that such athletic hearts bring transfiguration in cardiac structure and function, if they are exposed to exercises for a long time, like the size of muscles or body forms change by types of exercises **Maron and Pelliccia, (2006) Paterick et al., (2014), Pluim et al., (2000).** The exercise type of these phenomena can be divided into aerobic exercise, anaerobic exercise, and complex exercise of aerobic and anaerobic exercises.

If a person participates in endurance exercise like marathon for a long time, the eccentric left ventricle hypertrophy, in which the thickness of ventricle is not large whereas the left ventricular wall is a relatively increased, will be produced by **Vinereanu et al., (2002).** Conversely, for resistive exercises like wrestling, weightlifting, and body building, the characteristics of the concentric left ventricle hypertrophy, in which the ventricular wall is not large whereas the thickness of ventricle is increased. In addition, cyclists and rowing athletes who have the characteristics of both aerobic and anaerobic exercise systems have eccentric-concentric left ventricle hypertrophy **Baggish et al., (2010), Pluim et al., (2000).** The biggest causes of such physiological reformation are heart rate and blood pressure due to exercises **Mihl et al., (2008).** Endurance exercise, despite having individual difference, has a systolic blood pressure that is not more than 200 mmHg and maintains a cardiac output (Q) through adequate blood pressure reaction without causing a big burden to the heart muscle, thus increasing the vein return rate and showing an increase of the internal dimension with the increase of cardiac output **Palatini et al., (1988).** However, in resistive exercise, a momentary high increase of blood pressure and increase of heart rate are shown, but these phenomena repeat motions. Also, high blood pressure becomes the cause of myocardial hypertrophy as it increases the pressure of ventricular dimension **Kasikcioglu et al., (2004).** In addition, it was studied under the hypothesis that because heart transfiguration differs depending on the exercise types, they may affect the function of the heart, but it was reported that most of them displayed no difference from ordinary people **Pluim et al., (2000)**. Recently, aerobic exercises are often to enhance physical and mental health **Banz et al., (2003).** Thus, the purpose of this study is to investigate how the cardiac output after as a result of regular exercise as well as the positive and negative effects of exercise.

2. METHODOLOGY:

The main goal of this investigation is to ascertain how regular training among elite female athletes affects cardiovascular measures is the criteria. To achieve the purpose of this study 45 (N=45) women athletes elite national varsity athletes were randomly selected as subjects 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. All of the subjects were in good health and trained by their coaches, and they competed at a national level and the subject’s sports age is between 7 and 9 years. Since the test was non-invasive, no ethical committee permission was required. Participants in the specified test engaged in lively participation. The circulatory system's efficacy is essentially needed by athletes in three different sports in order to succeed in competitive sports and activities. Every sport has specific cardiovascular indices and exigencies for elite performance, to achieve more success in specific sports parameters, such as cardiac output. One of the study's limitations is that the subjects' social, economic, or cultural backgrounds were not taken into consideration. This study includes assessments of heart rate and stroke volume for female elite athletes by using M-Mode Doppler Echo Cardiography.

3. 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 conviction for purport was set at 0.05. 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 CARDIAC OUTPUT 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 Squares	Mean Squares	Obtained 'F' Ratio	Table 'F' Ratio
$\bar{X}$	4914.93	4807.66	4712.33	B:	2	308206.71	154103.35	10.904*	**3.222**
σ	123.32	139.13	88.49	W:	42	593577.60	14132.80		

*Significant at 0.05 level of assurance.

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

The table I displays that the means of long distance running group, middle distance running group and weight lifting groups are 4914.93, 4807.66 and 4712.33 Seconds severally. The attained 'F' ratio of 10.904 is much greater than the table value of 3.222 for df 2 and 42 requisite for significant at 0.05 level.

The results of the study indicates that the significant difference exists among Long distance running group, middle distance running group and weight lifting group on cardiac output**.** To define the noteworthy variation 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 CARDIAC OUTPUT 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
4914.933	4807.667	--	107.266	135.270
4914.933	--	4712.333	202.6*	135.270
--	4807.667	4712.333	95.334	135.270

***Significant at 0.05 level of assurance.**

The table I A displayed the test mean difference on cardiac output between long distance running and middle distance running group is 107.266, and mean difference between middle distance running group and weight lifting group is 95.334 which are less than the confidence interval value 135.270 at 0.05 level of assurance. Hence, the insignificant difference existed between long distance running group and middle distance running group, middle distance running group and weight lifting groups on cardiac output. The mean difference on cardiac output between long distance running group and weight lifting group is 202.6 which is greater than the confidence interval value is 135.270 at 0.05 level assurance. Hence, it is concluded from the consequence that the noteworthy difference existed between long distance running group and weight lifting group on cardiac output. From the results it was concluded that, long distance running group has increased the cardiac output as compared to the middle distance running group and weight lifting group. Further it is concluded that highest mean difference existed between long distance running group and weight lifting group. The test mean values on the cardiac output of three experimental groups are graphically exhibited in Figure I.

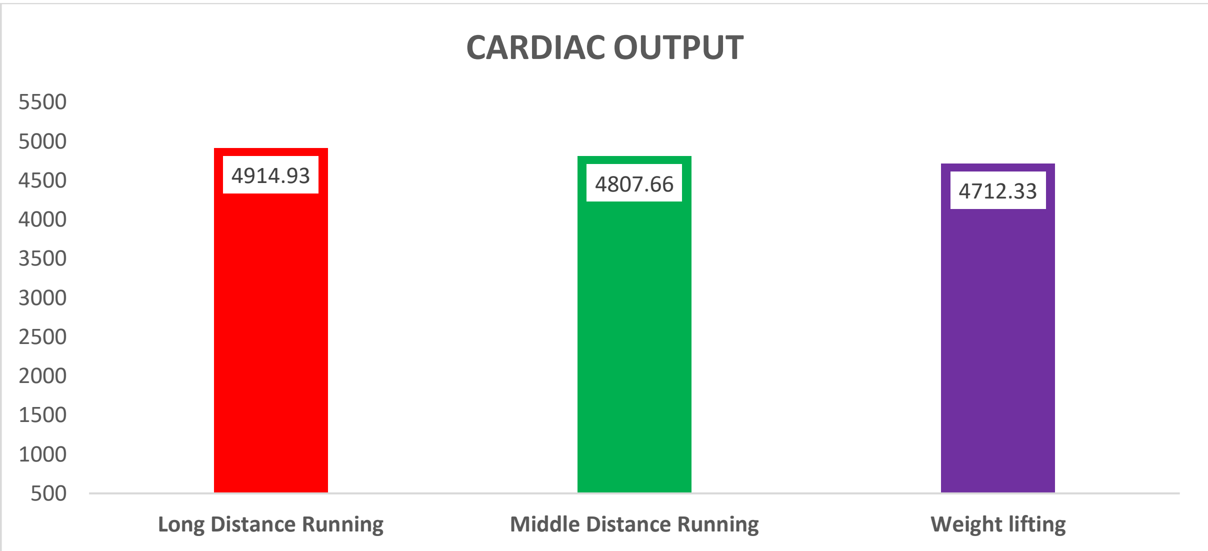

FIGURE 1: BAR GRAPH ON CARDIAC OUTPUT MEANS OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

4. DISCUSSION:

The results of this study show that distinct categories of aerobic, anaerobic and aerobic and anaerobic exigencies cause a significant variation in selected cardiovascular parameter. Based on the findings, there is a significant difference existed among the three experimental groups and a favorable impact was made on cardiac output at rest as compared to the resting value of healthy untrained women. Further it indicates that long distance running group have better adaptability than that of middle distance running group and weight lifting group.

In this study, the researcher hypothesized that there would be a significantly varied cardiac output at rest among elite female athletes which is proved by the research evidence that is clinically relevant to the present study.

5. CONCLUSION AND IMPLICATIONS:

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

Cardiac output has been significantly increased by long distance running group, as compared other two experimental groups. Based on this prolonged long distance running is highly recommended to produce a noticeable alterations in cardiac output.

Conflict of Interest: No

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