Effects of Chronic Exigencies on Efficacy of Myogenic Engine Among Elite Women

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Abstract:

The heart is a myogenic engine of human body which propell the blood to meet the need of working muscles by supplying nutrients, oxygen and clear waste products. The human heart is a myogenic engine which is a hollow organ that will undergo the direct physical stress laid out by the performer when he/she exposed to a regular, panned, systematic and scientific training regimen. The acute and chronic impacts on the structure and functions of hollow myogenic organs leads to a variety of adaptations. The popularly coined statement that either structure decide the function or function decide the structure. This statement is complimentary with each other for any kind of physical stress. The heart will get direct impact, if the same stress in laydown for a prolonged period, then the heart will get certain changes those changes play an important role in deciding the cardiac dynamics like Heart rate at rest (HR), Stroke volume at rest (SV) and cardiac output at rest ($\dot{Q}$). Based on these facts in the present study, the investigator would like to enlighten how a planned, systematic, prolonged physical stimulations will put impact on uninterruptedly working myogenic engine of elite athletes. To fulfill the condition of the study an elite woman of (N=15) fifteen each from long distance training, middle distance training, and weight lifting training were chosen as clients. All the volunteered clients had 7 to 9 years of sports age and trained by their respective coaches in their specific sports. The selected criterian parameters are Heart Rate at rest (HR), Stroke Volume at rest (SV) and Cardiac Output at rest ($\dot{Q}$) and they were measure by M- Mode Doppler Echocardiography with the support of qualified cardiologist. Finally, the investigator came to an end that elite athletes from three experimental groups, underwent a significant alterations in the dynamics of myogenic engine. The level of significance was set at 0.01 level of assurance. 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, Stroke volume at rest, Cardiac output at rest, Myogenic Engine.

Introduction:

Understanding the effects of aerobic endurance training on the body systems is important for assessing physical or athletic performance and determining the impact of endurance training protocols. This section deals with the effects of aerobic endurance training on the cardiovascular modifications among elite women. Oxygen uptake is the amount of oxygen consumed by the body's tissues. The oxygen demand of working muscles increases during an acute bout of aerobic exercise and is directly related to the mass of exercising muscle, metabolic efficiency, and exercise intensity. Aerobic exercise involving a larger mass of muscle or a greater level of work is likely to be associated with a higher total oxygen uptake. Increased metabolic efficiency allows for an increase in oxygen uptake, especially at maximal exercise.

Maximal oxygen uptake is the greatest amount of oxygen that can be used at the cellular level for the entire body. Maximal oxygen uptake has been found to correlate well with the degree of physical conditioning and is recognized as the most widely accepted measure of cardiorespiratory fitness. The capacity to use oxygen is related primarily to the ability of the heart and circulatory system to transport oxygen and the ability of body tissues to use it. Resting oxygen uptake is estimated at 3.5 ml of oxygen per kilogram of body weight per minute (ml-kg-min^{-1}) for an average person this value is defined as 1 metabolic equivalent (MET). Maximal oxygen uptake values in normal, healthy individuals generally range from 25 to 80 ml-kg-min¹, or 7.1 to 22.9 METs, and depend on a variety of physiological parameters, including age and conditioning level.

Aerobic endurance training results in several changes in cardiovascular function, including increased maximal cardiac output, increased stroke volume, and reduced heart rate at rest. In addition, muscle fiber capillary density increases as a result of aerobic endurance training, supporting delivery of oxygen and removal of carbon dioxide. Aerobic exercise provides for the greatest impact on both oxygen uptake and carbon dioxide production as compared to other types of exercise.

For optimal aerobic exercise performance, increasing maximal oxygen uptake is of paramount importance. One of the primary mechanisms for increasing maximal oxygen uptake is the enhancement of central cardiovascular function (cardiac output). The normal discharge rate of the sinoatrial (SA) node ranges from 60 to 80 times per minute. Aerobic endurance training results in a significantly slower discharge rate due to an increase in parasympathetic tone Increased stroke volume also affects the resting heart rate more blood is pumped per contraction, so the heart needs to contract less frequently to meet the same cardiac output Aerobic endurance training can increase the heart's ability to pump blood per contraction at rest and thus may account for some of the significant bradycardia (slower heart rate).

Aerobic training, especially running, is often associated with an increase in net Protein breakdown from the muscle, brought in part by stress-induced body systems affected by aerobic exercise include musculoskeletal, cardiovascular, and respiratory. Adaptations in Cardiovascular system is related to decreased heart rate for fixed submaximal workloads associated with increased stroke volume and cardiac output. Aerobic power (maximal oxygen uptake) arguably the most significant change in physiological variables with aerobic exercise training is an increase in maximal oxygen uptake (VO, max), often used as the criterion variable for cardiovascular fitness. During aerobic exercise, blood flow to active muscles is considerably increased by the dilation of local arterioles; at the same time, blood flow to other organ systems is reduced by constriction of the arterioles. At rest, 15% to 20% of cardiac output is distributed to skeletal muscle, whereas with vigorous exercise this value may rise to 90% of cardiac output. Acute aerobic exercise results in increased cardiac output, stroke volume, heart rate, oxygen uptake, systolic blood pressure, blood flow to active muscles and a decrease in diastolic blood pressure. **Ann Swank, and Carwyn Sharp (2021).**

Skeletal muscle adaptations following anaerobic training occur in both structure and function, with reported changes encompassing increases in size, fiber type transitions, and enhanced biochemical and ultra-structural components (i.e., muscle architecture, enzyme activity, and substrate concentrations). Collectively, these adaptations result in enhanced performance characteristics that include strength, power, and muscular endurance, all of which are critical to athletic success. As muscular strength and hypertrophy increase in response to anaerobic training modalities, the forces generated by the increased muscle contractions subsequently increase the mechanical stress on bone, and the bone itself must increase in mass and strength to provide an adequate support structure.

Adherence to a long-term resistance training program results in an increased ability to exert greater levels of muscular force, with relative training intensities increasing over time as the body adapts to tolerate progressively heavier loads. Consistent anaerobic exercise that exceeds the threshold of strain has a positive effect on stimulating connective tissue changes. Empirical evidence suggests that connective tissues must increase their functional capabilities in response to increased muscle strength. High-intensity anaerobic training results in connective tissue growth and other ultra-structural changes that enhance force transmission. Strength/power training and work capacity-endurance training have divergent physiology that present a programming challenge to the strength and conditioning professional working to optimize concurrent gains in both these physical and physiological characteristics. Combining resistance and aerobic endurance training may interfere with strength and power gains, primarily if the aerobic endurance training is high in intensity, volume, or frequency.

During a set of resistance exercises, stroke volume and cardiac output increase mostly during the eccentric phase of each repetition, especially when the Valsalva technique is used. Because the concentric phase of repetition is much more difficult and elevations in intrathoracic and intra-abdominal pressures are more prominent (via the Valsalva maneuver), limiting venous return and reducing end-diastolic volume, the hemodynamic response of resistance exercise is delayed such that cardiac output increases more.

Anaerobic training generally results in fewer acute and chronic responses in the cardiovascular and respiratory systems, although low-intensity, high-volume resistance exercise produces some responses that are similar to those with aerobic exercise. Collectively, improved neuromuscular, musculoskeletal, endocrine, and cardiovascular function contribute to enhanced muscle strength, power, hypertrophy, muscular endurance, and motor performance of which contribute to increased athletic performance. The adaptations observed in athletes are directly related to the quality of the exercise stimulus and accordingly to the levels of progressive overload, specificity, and variation incorporated into program design. The scientific basis of program design is ultimately seen in the effectiveness with which the athlete improves performance. **Ducan French, (2021).**

Middle-distance runners engage in a mix of high-intensity and moderate-intensity training to optimize both aerobic and anaerobic energy systems. A balance between Type I (slow-twitch) and Type II (fast-twitch) muscle fibers allows for both endurance and explosive power. Increased efficiency in both glycolytic (anaerobic) and oxidative (aerobic) pathways to support sustained and high-intensity efforts. Training enhances the ability to buffer and clear lactate, delaying the onset of fatigue during high-intensity efforts. **Billat, V. L., Lepretre, P. M., Heugas, A. M., Laurence, M. H., Salim, D., & Koralsztein, J. P. (2003).**

Weightlifters engage in high-intensity, low-volume resistance training, leading to specific muscle adaptations. Significant hypertrophy of Type II (fast-twitch) muscle fibers, which are optimized for power and strength rather than endurance. Improved motor unit recruitment and synchronization contribute to greater force production. Lower oxidative capacity and fewer adaptations related to sustained aerobic activity, leading to higher fatigue during prolonged exertion. **Kraemer, W. J., Fleck, S. J., & Evans, W. J. (1996).**

Methodology:

The primary purpose of this study is to know about the effects of chronic exigencies on efficacy of myogenic engine 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 (5000/10000 mts race) Aerobic. Group II–fifteen athletes (N=15) from middle distance running (800/1500 mts race) Aerobic and Anaerobic. Group III-fifteen athletes (N=15) weight lifting (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, they have given written consent to 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 myogenic engine is conveyed through the lowered heart rate at rest, increased stroke volume at rest and cardiac output at rest, which are essentially needed by athletes in three different sports in order to excel in competitive sports. One of the study's limitations is that the elite performers were taken into consideration. This study includes assessment of all the three criterion variables for the experimental groups by using M-Mode Doppler Echo Cardiography.

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 0.01. 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
$\bar{X}$	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 all three experimental groups are 48.733, 52.600 and 56.733 beats per minute respectively. The attained 'F' ratio of 269.158 is much greater than the table value of 5.168 for df 2 and 42 requisite for significance 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 OF 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 concluded from the results that the noteworthy difference existed among three experimental groups on Heart rate at rest. From the results it was concluded that, long distance running group has decreased the Heart rate at rest as compared to the middle distance running group and weight lifting group. Further, it is wind up that highest mean difference existed between long distance running and weight lifting groups. The test mean values on Heart rate at rest of the three experimental groups are graphically exhibited in Figure I.

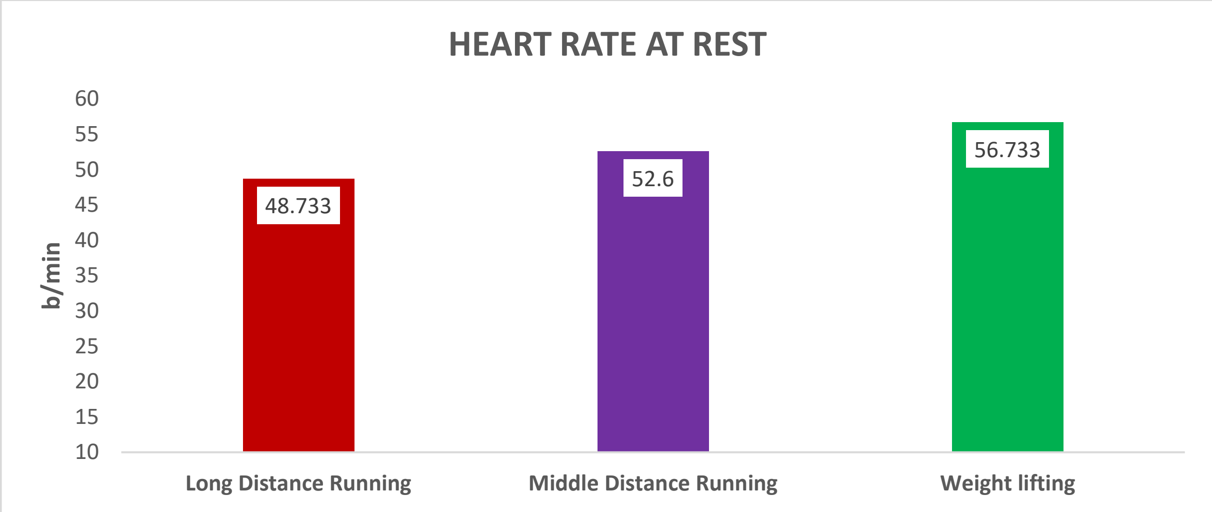

FIGURE II: BAR CHART ON HEART RATE AT REST MEANS OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

TABLE -II
ANALYSIS OF VARIANCE FOR THE STROKE VOLUME 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
$\bar{X}$	100.867	91.400	83.067	B:	2	2379.511	1189.756	319.740*	**5.168**
σ	2.416	1.804	1.437	W:	42	156.267	3.721		

***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 displays that the means of stroke volume at rest of all three experimental groups are 100.867, 91.400 and 83.067 ml/beat respectively. The derived 'F' ratio of 319.740 is much greater than the table value of 5.168 for df 2 and 42 requisite for significance at 0.01 level.

The results of the study indicates that the significant difference exists among elite women athletes of three experimental groups on stroke volume 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 potrayed in Table II A.

TABLE-II A

SCHEFFE'S POST HOC TEST FOR STROKE VOLUME AT REST ON THE MEAN DIFFERENCE OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

Long Distance Running	Middle Distance Running	Weight Lifting	Mean Difference	Confidence Interval Value
100.867	91.400	--	9.467*	2.779
100.867	--	83.067	17.8*	2.779
--	91.400	83.067	8.333*	2.779

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

The Table II A displayed the test mean difference on Stroke volume at rest among the elite women athletes of all three experimental groups are 9.467, 17.8 and 8.333 milliliters per beat respectively, which are higher than that of confidence interval value 2.779 at 0.01 level of assurance. Hence, it is concluded from the results that the noteworthy difference existed among three experimental groups on Stroke volume at rest. From the results it was concluded that, long distance running has increased the Stroke volume at rest as compared to the middle distance running group and weight lifting group. Further, it is dissolving that highest mean difference existed between long distance running and weight lifting groups. The test mean values on the Stroke volume at rest of the three experimental groups are graphically potrayed in Figure II.

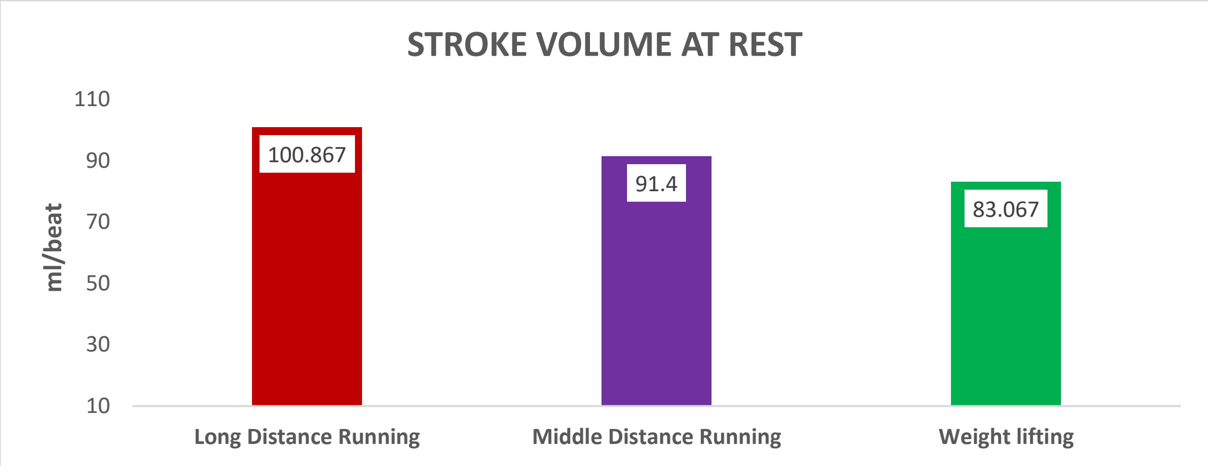

FIGURE II: BAR CHART ON STROKE VOLUME AT REST MEANS OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

TABLE -III
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 Square	Mean Square	Obtained 'F' Ratio	Table 'F' Ratio
$\bar{X}$	4914.93	4807.66	4712.33	B:	2	308206.71	154103.35	10.904*	**5.168**
σ	123.32	139.13	88.49	W:	42	593577.60	14132.80		

***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 III displays that the means of cardiac output at rest of all three experimental groups are 4914.93, 4807.66 and 4712.33 milliliters per minute respectively. The attained 'F' ratio of 10.904 is much greater than the table value of 5.168 for df 2 and 42 requisite for significance at 0.01 level.
The results of the study indicates that the significant difference exists among elite women athletes of three experimental groups on cardiac output 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 depicted in Table III A.

TABLE-III A

SCHEFFE'S POST HOC TEST FOR CARDIAC OUTPUT ON THE MEAN DIFFERENCE OF 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	171.299
4914.933	--	4712.333	202.6*	171.299
--	4807.667	4712.333	95.334	171.299

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

The table III A displayed the test mean difference on cardiac output between long distance running and middle distance running groups is 107.266, and mean difference between middle distance running group and weight lifting group is 95.334 which is less than the confidence interval value of 171.299 at 0.01 level of assurance. Hence, an insignificant difference existed between long distance running group and middle distance running group, middle distance running group and weight lifting groups on cardiac output at rest. 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 171.299 at 0.01 level assurance. Hence, it is concluded from the findings that the noteworthy difference existed between long distance running group and weight lifting group on cardiac output at rest. 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 culminate that highest mean difference existed between long distance running group and weight lifting group. The test mean values on the cardiac output at rest of three experimental groups are graphically exhibited in Figure III.

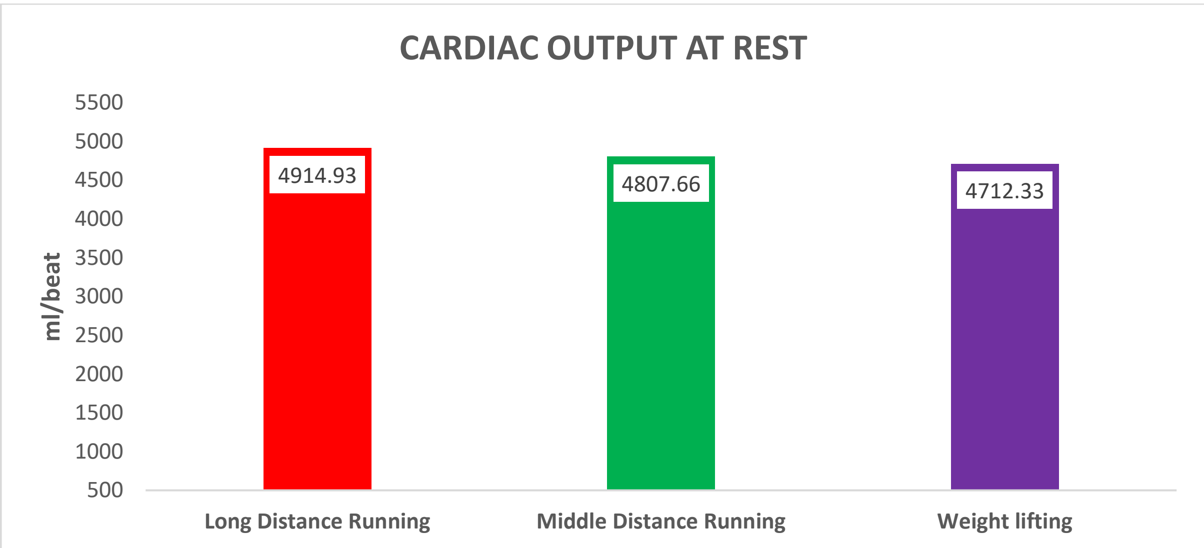

FIGURE I: BAR CHART ON CARDIAC OUTPUT MEANS OF LONG DISTANCE RUNNING, MIDDLE DISTANCE RUNNING AND WEIGHT LIFTING GROUPS.

Discussion:

The study's findings demonstrate that the myogenic engine significantly underwent the functional modifications. Based on the findings, there is a significant difference existed among the three experimental groups and a favorable influence on heart rate at rest, stroke volume at rest and cardiac output at rest as compared to the resting value of healthy untrained women reference values. Further, it indicates that long distance training has better adaptability than that of middle distance training and weight lifting training on myogenic engine. One of the study's limitations is the potential for heart rate to be influenced by variables such as activity, emotional fluctuations, and resting body position. Constraints included the level of physical exertion, lifestyle choices, physiological stress, and other factors affecting metabolic processes. The subjects' social, economic, or cultural backgrounds were not taken into consideration. This study only included cardiovascular measurements for female elite athletes.

The existing to the research evidence that are clinically relevant to the current investigation, there would be a much larger cardiac output and stroke volume as well as a significantly lowered resting heart rate. The researcher felt the notable changes on chosen criterions in this study.

Conclusion and implication:

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

Heart rate at rest has been significantly reduced by long distance, Middle distance training group but the lowest heart rate was found with long distance runners group. Stroke Volume at rest has been significantly increased by other experimental groups, however, higher improvement is in favor of long distance runners group as compared to other experimental groups. cardiac output at rest has been significantly increased by long distance as compared to other experimental groups. however, it come to an end that higher improvement is in favor of all three experimental groups as compared to the normal reference values. Eventually long distance training is highly advised to produce a noticeable adaptations in heart rate, stroke volume, and cardiac output.

Conflict of interest: No

Reference:

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