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A Scientific Analysis on the Impact of Long-Distance Run, Middle Distance Run & Weightlifting Events on Heart Rate at Rest & Stroke Volume At Rest

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Abstract

Background and need of study: A Planed & systematic training augment physical, physiological parameters among target groups. There are numerous empirical evidences indicates that chronic long , middle distance races and weight lifting activities bring a significant shift in structure and functions of different organs of the body, among the effected physiological functions cardiovascular system is one The investigator after thoroughly going through the impacts of different regimens on cardiovascular systems, after sensitizing on the facts of training he has chosen the present study to examine the impact of long distance , middle distance runs & weight lifting events on selected structural & functional parameters of cardiovascular system among elite varsity long distance , middle distance athletes as well as weight lifters.

Methodology: For the study (N= 45) elite long, middle distance athletes & weight lifters were volunteered as subjects, each group consists of 15 subjects. All the volunteered players are national varsity participants in their respective selected events such as long distance, middle distance runs & weight lifting competitions. All the selected elite players are with 5 to 7 years of sports age, the selected criterion variables are heart rate at rest & stroke volume at rest. The selected variables were measured by using M-mode Doppler echo cardiogram with the help of cardiologist.

Results: HEART rate at rest –The result indicates that the long distance, middle distance runs & weight lifting activities have significantly influenced on resting heart rate & stroke volume at rest. In order to find out the significance difference among three experimental groups One way Analysis of variance (ANOVA) is employed the attained 'F' ratio of 106.402 is much greater than the table value 3.222 with df 2 and 42 requisite for significant at 0.05 level. Further the result indicates that the long distance run has significantly decreased the heart rate at rest as compared to middle distance run & weight lifters. STROKE volume at rest – The stroke volume also significantly increased due to the selected subject sports activities long, middle distance runs & weight lifting. The result indicates that the attained 'F' Ratio of 930.136 is much greater than the table value of 3.222 for df 2 and 42 requisite for significant at 0.05 level of confidences, For both the variables post hoc test was applied to find out the paired means significant difference.

Conclusion and implication: A regular intensive chronic training in long distance runs , middle distance runs & weight lifting significantly influenced on the selected variables and leads to varieties of

adaptations. The independent variables have also reduce the heart rate at rest and to enhance stroke volume where both of them are true indicators to indicate cardiovascular efficacy. Hence , the present study has concluded that the aerobic training is well recommended for all the sports activities which are aerobic by nature.

Keywords: long distance run, middle distance run, weight lifting, heart, stroke volume.

Introduction:

The athlete's heart is one of the oldest and most stimulating subjects for research in sports medicine. Credit for the first description of the athlete's heart belongs to **Henschen (1899),** who published two papers on the subject in the late 19th century. The recognition of athlete's heart and the development of modern, high-performance athletes are more than coincidental, only competitive sports lead to the development of athlete's heart, by virtue of the training. Other physical activities, even occupation-related ones, been claimed repeatedly. Henschen's concept that this is truly an 'athlete's heart ' is valid. Assessment of the athlete's heart has always been a scientific tug- of- war between those who view it as a physiologically adapted, extremely effective and healthy heart, and those who regard it as a sick heart or, at least, a heart on the borderline of the pathological. Further he arrived at his findings through simple physical diagnostic techniques. The size of the heart was determined through carefully performed percussion. When we consider the later, mistaken, interpretations of athlete's heart made by authors who had mush more sophisticated tools at their command, it may be worthwhile quoting **Henschen(1899)** it follows from this that skiing causes an enlargement of the heart and that this enlarged heart can perform more work than the normal heart. There is wherefore, a physiology enlargement of the heart, due to athletic activity: the athlete's heart. In spite of this ingenious interpretation many subsequent investigations considered athletes. The athlete's heart expands in response to repeated exercise stimuli, allowing for greater maximal stroke volume and cardiac output adaptations, which drive an increase in oxygen delivery in the trained state because there is no training effect on maximal heart rate. It is a benchmark for professional athletes. **Mark J. Haykowsky et al. (2018).** Regular and systematic exercises will cause modification to the various systems of the body. Such changes may be beneficial to those who receive training, which not only contribute to better performance but also to one's health fitness. Cardiac output is approximately 5 L/min at rest, and the cardiac output increase 5 to 6 L/min for every 1-L/min increase in oxygen uptake during dynamic exercise .The increase in cardiac output is due to increase in the heart rate and stroke volume. The product of heart rate and volume equals cardiac output as follows.

$$Q=HR*SV$$

Where Q is cardiac output, HR is heart rate, and SV is stroke volume.

Maximal cardiac output ordinarily achieves 20 to 25 L/min in normally active boys and men but is capable of reaching 40L/min in endurance-trained athletes. Heart rate ranges between 60 and 70 beats/min at rest increase linearly with oxygen uptake to a maximal heart rate of 190 to 200 beats/min. It is generally considered that the initial increase in heart rate (upto100beats/min) is predominately due to the with drawl of vagal influences on the control of heart rate. Additional increase, sympathetic drive along with a decreasing amount of vagal activation. Heart rate changes of more than 150 beats/min to maximal heart rate are the result of further increase in sympathetic influence on the heart rate.

Stroke volume is approximately 70 to 80 ml/beat at rest in normally active men can be as high as 130 to

150 ml/beat in endurance-trained athletes. The stroke volume of average fit individual increase at the onset of exercise and continually increase until value of 120 to 140 ml/beat have been attained at 40 % to 50% of maximal oxygen consumption. In contract, recent evidence suggests that, in endurance-trained athletes, stroke volume can progressively increase until VO_2 max has been attained reaching amount of 200 to 220 ml/beat.

Methodology:

The principle aim of this investigation was to find out the variations on cardiovascular variables among elite athletes, to achieve the purpose of this study 45 (N=45) men elite National varsity athletes were randomly selected as subjects of fifteen each, Group I - fifteen athletes (n=15) from long distance run (5000/10000 mtr race) Aerobic & Group II - fifteen athletes (n=15) from middle distance run (800/1500 mtr race) Aerobic & Anaerobic and Group III- fifteen athletes (n=15) from weight lifting (any weight category) Anaerobic. The Athlete's age is between 19 and 23 years, all the athletes were in top form. The investigator informed all of the selected 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 5 and 7 years. Investigation was entirely non-invasive, no authorization from the ethical committee was required, and All the subjects enthusiastically participated in prescribed test. The cardiovascular systems effectiveness is crucial to success in competitive sports and activities. For top-level performance, each sport has particular cardiovascular system requirements. As a result, under the heading of cardiovascular parameters, the following criterion variables were chosen.

1. Heart rate at rest (HR)
2. Stroke volume at rest (SV)

Michael Scharf et.al (2010). The cardiovascular system's effectiveness is crucial to success in competitive sports and activities. Coaches, fitness trainers, and players who benefit from various training methods and approaches always switch from one to another best or combine two or more training methods to get the most benefits and achieve their sports goals.

An athlete's resting heart rate may be considered low when compared to the general population. In Sports Heart rate is widely used as a marker for exercise intensity. Heart rate is the "individual aerobic threshold" **Rocker and Horstmann et al. (1998).**

Resting and post exercise heart rate variability are responsive to the effects of training loads in endurance and team sports. Vagally related heart rate variability indices at rest are increased in response to training leads to improve exercise performance **Nummela et al. (2010)**. Heart rate variability is useful for sprinters to know the possibility of training related adaptations **Cesar Abad et al. (2017).**

The use of heart rate as an anchor point for training suggestions based on performance assessment is common. Because heart rate is frequently used as a link between laboratory testing findings and regular training activity, there is a need for accurate data on the relationship between HR and objective exercise intensity. This applied to endurance and recreational sports. Cardiovascular function is determined by stroke volume and cardiac output.. Accurate measurements of stroke volume and cardiac output during exercise are critical for detecting changes due to age and training level. Stroke volume refers to the volume of blood ejected per beat from the left or right ventricle and increases from approximately 1000 mL (2–2.5 mL/kg) at rest up to 1700 mL (3–4 mL/kg) or higher at maximal exercise If a maximum heart rate, stroke volume increases sharply at exercise onset up to around 40%. In a basic sense, cardiac

output (CO) represents the total volume of blood pumped by the ventricle, and is the product of heart rate (HR) and stroke volume (SV), while heart rate reflects the number of beats per minute. The three are often expressed together in the formula CO= HR x SV. For the average adult, stroke volume at rest in a standing position will be between 60 and 80 milliliters, resulting in a resting heart rate of between 60 and 80 beats per minute, although resting heart rate can be as high as 100 beats per minute. Therefore, resting cardiac output is typically between 4.8 and 6.4 liters per minute. These numbers, however, are for an average person and not an athlete. Elite athletes have been found to have resting heart rates as low as 28 to 40 beats per minute, resulting in a much lower corresponding cardiac output.

Outcome measure:

Subjects were laydown on left side lateral position on the table of Doppler echo cardiograph. Transducer was placed on the chest of the subject. At the same time transmitter of ultrasonic impulse and receiver for the reflected echoes placed on the interior chest wall in inter costal parasternal space on the left side. Ultra sound rays were passed to the chest wall, then the left ventricle. The ultrasound rays passed through the front chest wall, next to right ventricle. The path of the ultrasound rays to the intra ventricular septum (IVS) after entered to right ventricle, then to cavity of the left ventricle, finally reached to the posterior cardiac wall. In this process the echo curves which were visible on the screen could be photo graphed and kept for record purpose.

For the collection of data M-mode Doppler echocardiography was used as per **Rowland et al. (2000)** and **Vinet et al. (2001).** Firstly SV at rest was assessed as the result of the aortic root region and the essential of the arising blood velocity and time utilizing a standard M-mode Doppler echocardiography method. The rapidity of blood in the arising aorta was noted with 3.5 MHz uninterrupted wave Doppler transducer engaged from the suprasternal notch. The outline counter of the VTI was traced physically by trained cardiologist toward the finish of each VTI was taken as detected closure of the aortic value. In this process EDV and ESV were noted by m-mode Doppler echo cardiograph. Stroke volume at rest was calculated by subtraction of ESV from EDV. SV=EDV-ESV, SV= Stroke Volume, EDV= End diastolic volume. ESV= End systolic volume.

Score: Stroke volume of each subject noted as ml/beat

Statistical analysis: The data was analyzed by using the Microsoft Excel and SPSS v25. The mean and standard deviation (SD) were calculated and reported for the quantitative variables. The numerical data on selected cardiovascular parameters taken from all three experimental groups was statistically evaluated for any suggestive variation using ANOVA. The Indian Business Management Statistical Package for Social Sciences version 25 was used to analyses the complete dataset. Because the number of individuals was limited, the degree of conviction was set at 0.05 for purport. Due to numerous external influences, the chosen criterion may vary. 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 the each parameter separately.

Results:

The analysis of variance for data on heart rate at rest of three groups, long distance run, middle distance run and weight lifters were analyzed and displayed in Table I.

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

Test	Long distance run	Middle distance run	Weight lifting	Source of Variance	Df	Sum of Squares	Mean Squares	Obtained 'F' Ratio	Table 'F' Ratio
$\bar{x}$	47.066	50.600	55.333	B:	2	516.133	258.067	106.419	3.222
σ	1.437	1.352	1.838	W:	42	101.867	2.425		

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

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

The table I displays that the means of long distance run group, middle distance run group and weight lifting groups are 47.066, 50.600 and 55.333 beats/ min severally. The attained 'F' ratio of 106.419 is much greater than the table value of 3.222 for df 2 and 42 requisite for significant at 0.05 level.

The consequences of the study indicates that the significant difference exists among Long Distance Run Group, Middle Distance Run Group And Weight Lifting Group on HR at rest**.** 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 HEART RATE AT REST ON THE DIFFERENCE BETWEEN LONG DISTANCE RUN , MIDDLE DISTANCE RUN AND WEIGHT LIFTING GROUPS.

Long distance run	Middle distance Run	Weight lifting	Mean deviations	Confidence Interval 0.05 Level
47.066	50.600	-	3.534	0.3953015
47.066	-	55.333	8.266	0.3953015
-	50.600	55.333	4.733	0.3953015

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

The table I-A displays that the test mean deviation on HR at rest between long distance run and middle distance run group is 3.534 which is much greater than the confidence interval value 0.3953 at 0.05 level of assurance. The test mean deviation on HR at rest between long distance run group and weight lifting group is 8.266 which is much greater than the confidence interval value 0.3953015 at 0.05 level of assurance. The least tests mean deviation on HR at rest between middle distance run group and weight lifting group is 4.733. Hence, it is concludek65d from the consequence that the noteworthy deviation exists between long distance run group, middle distance run group and weight lifting groups

on HR at rest.

From the results it was concluded that, long distance run group has decreased the HR at rest as compared to the middle distance run and weight lifting group. Further it is concluded that highest mean deviation exists between long distance run group and weight lifting group.

The tests mean values on HR at rest of three experimental groups are graphically depicted in Figure I.

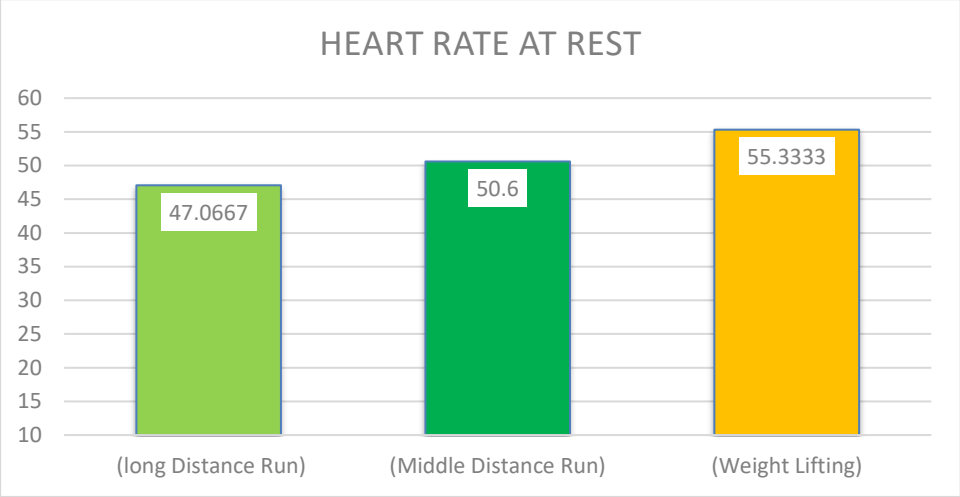

FIGURE I: BAR CHART ON HEART RATE AT REST MEANS OF LONG DISTANCE RUN, MIDDLE DISTANCE RUN AND WEIGHT LIFTING GROUPS.

The analysis of variance for data on stroke volume at rest of three groups, long distance run, middle distance run and weight lifters were analyzed and displayed in Table II

TABLE II ANALYSIS OF VARIANCE FOR THE STROKE VOLUME AT REST DATA ON LONG DISTANCE RUN , MIDDLE DISTANCE RUN AND WEIGHT LIFTING GROUPS.

Test	Long distance run	Middle distance run	Weight lifting	Source of Variance	Df	Sum of Squares	Mean Squares	Obtained 'F' Ratio	Table 'F' Ratio
$\bar{X}$	101.780	91.100	82.066	B:	2	2921.395	1460.698	930.380	3.222
σ	**1.236**	**0.931**	**1.521**	**W:**	**42**	**65.957**	**1.570**		

***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 II displays that the means of long distance run, middle distance run and weight lifting groups are 101.780, 91.100 and 82.066 ml/beat severally. The attained 'F' Ratio of 930.380 is much greater than the table value of 3.222 for df 2 and 42 required for significant at 0.05 level.

The consequences of the study indicates that the significant difference exists among long distance run, middle distance run and weight lifting groups on SV at rest. To define the noteworthy variation among the means of three experimental group, the Scheffe'S test was employed as post-hoc test and the

outcomes were exhibited in table II-A.

TABLE II-A SCHEFFE'S POST-HOC TEST FOR STROKE VOLUME AT REST ON THE DIFFERENCE BETWEEN LONG DISTANCE RUN , MIDDLE DISTANCE RUN AND WEIGHT LIFTING GROUPS.

Long distance run	Middle distance Run	Weight lifting	Mean deviations	Confidence Interval 0.05 Level
101.780	91.100	-	10.680	0.318
101.780	-	82.066	19.713	0.318
-	91.100	82.066	9.033	0.318

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

The table II-A displays that the test mean deviation on SV at rest between Long distance run group and Middle distance Run group is 10.680 which is greater than the confidence interval value 0.318 at 0.05 level of assurance. The test mean deviation on SV at rest between Long distance run group and Weight lifting group is 19.713 which is much greater than the confidence interval value 0.318 at 0.05 level of assurance. The tests mean deviation on SV at rest between Middle distance Run group and Weight lifting group is 9.033 which is greater than the confidence interval value 0.318 at 0.05 level of assurance. Hence, it is concluded from the consequences that the noteworthy deviation exists among three experimental groups on SV at rest.

From the results it was concluded that, Long distance run group has increased the SV at rest as compared to the Weight lifting group and Middle distance Run group. Further it is concluded that highest mean deviation exists between long distance run and weight lifting group.

The test means values on SV of long distance run group, middle distance run group and weight lifting groups were graphically presented in Figure II.

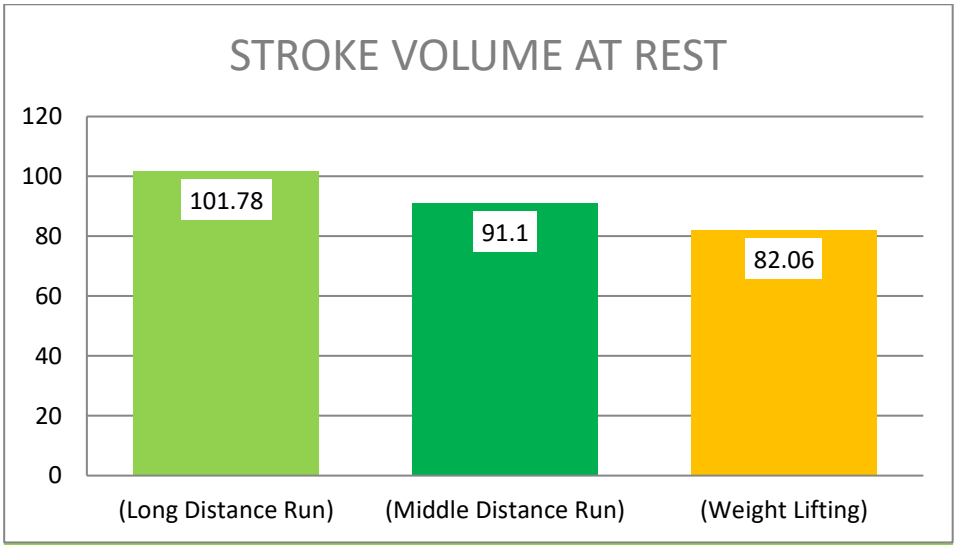

FIGURE II: BAR CHART ON STROKE VOLUME AT REST MEANS OF LONG DISTANCE RUN, MIDDLE DISTANCE RUN AND WEIGHT LIFTING GROUPS.

Discussion:

In the present study reveals that there is a noteworthy difference in chosen cardiovascular variables due to different groups ofaerobic and anaerobic demands. The results of the study shows that HR at rest, SV at rest, are positively influenced as a result of long distance run, Middle distance run and Weight lifting groups and the significant difference exists among three experimental groups. The following ungovernable factors which were affiliated with the study were considered as limitations.

- No special motivation techniques were used during testing, therefore the difference that occurred in performance due to the lack of motivation were recognized as a limitation for the study.
- Even though the subject stayed in the hostel, the investigator did not put any effort to control or assess the quality and quantity of food ingested separately for each individual.
- Factors such as rest body position, activity and emotional changes may alter heart rate and which were considered as limitations of the study.
- The quantum of physical exertion, life style and physiological stress and other factors that affect the metabolic functions were considered as limitations.
- The subject's social, economic and cultural backgrounds were not taken in to consideration. Present study is only limited to men students and cardiovascular parameters.

Conclusion and Implications:

From the outcomes of the investigation the succeeding completions were drawn.

1. Heart rate at rest has been significantly reduced by long distance , Middle distance run group and Weight lifting group but low heart rate was found with long distance run group.
2. Stroke Volume at rest has been significantly increased by all the experimental group , however higher improvement is in favor of long distance running group .
3. Long distance running is quite recommendable to bring significant adaptive changes in heart rate and stroke volume as compared to other physical activities.

Conflict of Interest: No

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