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Effect of aerobic training and resistance training in series and parallel on heart rate at rest, stroke volume at rest and cardiac output

[1] K Sreenivasulu Reddy, [2] Dr. K Rama Subba Reddy
[1] Research Scholar, Rayala Seema University, Kurnool, Andhra Pradesh, India.
[2] Asst. Director, Secretary, Sports Board, Department of Physical Education and Sports Sciences, Yogi Vemana University, Kadapa YSR, Andhra Pradesh, India

Abstract
The aim of this study was to determine the Effect of Aerobic Training and Resistance training in series and parallel on Heart rate at rest, Stroke volume at rest and Cardiac output. To achieve these purpose forty five (N=45) B.P.Ed., women students were selected during the academic year 2015-2016 randomly from Rayala Seema College of Physical Education, Rayavaram, Proddatur, Y.S.R District, Andhra Pradesh, India. Their age is between 20 and 22 years. The subjects were randomly divided into three groups and each group contained fifteen (n=15) subjects. Group I underwent Aerobic training and Resistance training in series, group II underwent Aerobic training and Resistance training in parallel and group III acted as control. The subjects were free to withdraw their consent in case they feel any difficulty during experiment and testing period.

Keywords: aerobic training, resistance training, series, parallel, heart rate at rest, stroke volume at rest and cardiac output

Introduction
The human body is a marvel. It is the temple of soul to reach harmony of body, mind and spirit that is why our body must be physically fit. Hence, where there is a sound body there we can ensure a sound mind. The development of sports is essential to our health and keep us physically, mentally and spiritually strong Jyothi Joshi (2007) [5].
Specificity of exercise and overload principle should be followed in order to enhance the functioning efficiency of the various systems of the body Veadmir (1995) [7]. Sports training are a conscious human activity. Also, it is a goal oriented activity. Hence, sports training gives high weight age for studying the nature and genesis of sports performance in training and competition, similarly a large portion of sports training is devoted to the study of performance capacity which further comprises of physical condition, technique, coordinative abilities tactics, physique and psychic factors Haradayal Singh (1991) [6].
It is true that organs and muscles that are used will develop and those are not used will atrophy or disappear. For proper growth and development man needs vigorous exercise. For the need of strengthened muscles it must be overloaded. It is inevitable for a man to have suitable existence, effective and efficiency. In order to withstand the strain in life, man must have had stronger body. Every athlete needs proper strength that enables him for efficient and appreciable performances. Gene Hooks (1974) states "The good big man will always beat the good little man". The statement would be even truer if it reads "The good strong man will always beat the good weak man.
According to Boucher.C (1993) to enhance physiological improvement effectively and to bring about a change, specific exercise and overload must be followed. By undergoing a systematic training at a level above normal, a variety of physiological adaptations take place in the body that makes it function more effectively. Numerous training procedures are in practice to improve each and every physical and motor fitness quality at various levels. The best training program is that which increase the desired quality at a higher rate without causing unwanted effects. Haradayal Singh (1991) [6] points out the positive effect of endurance activity on various physiological systems that is cardio respiratory, digestion and metabolism.
Gary Moran & Georgy Mc Glynn (1990) revealed that RT is an exercise program where force or stationary weights are used for the purpose of increasing muscular strength, muscular endurance and power through which skill can be improved.
Dudley. GA (1985) reveals that combined resistance and aerobic activities appears to interpreter primarily with strong performance at high velocities of movement. When strength and aerobic training are alone in excess, maximal power performance is blunted. Possible explanations for this less than optimal strength and power development include adverse neural changes and the alterations of muscle proteins in the fibers. In contrast no adverse effects on aerobic power have yet been observed, despite the expected cellular changes caused by heavy resistance exercise.

Methodology
To achieve these purpose 45 girls of 15 each students from B.P.Ed., women students were selected during the academic year 2015-2016 randomly from Rayala Seema College of Physical Education, Rayavaram, Proddatur, Y.S.R District, Andhra Pradesh, India. Their age is between 20 and 22 years.

The subjects were successfully completed the minimum strength requirement test recommended by Voight and Draovitch (1991), Which consisted of five push-ups, five squat thrust, standing long jump and skipping rope for thirty seconds. The subjects were randomly divided into three groups and each group contained fifteen (n=15) subjects. Group I underwent Aerobic Training and Resistance training in series, group II underwent Aerobic Training and Resistance training in parallel and group III acted as control. The subjects were free to withdraw their consent in case they feel any difficulty during experiment and testing period. However there were no dropouts in the study and all the volunteered subjects cooperated well throughout the period of experimentation.

Training Programme

During training period the two experimental groups namely series training group and parallel training group underwent their respective training program, four days for week for 12 week in addition to their regular physical education activities. Group I (series group) underwent Aerobic training only for six weeks and resistance training in the next six weeks. Group II (parallel group) underwent Aerobic training and Resistance training in alternative sessions. Every training session workout lasted for about 45-60 minutes including warm-up and limbering down exercise. Group III (control group) did not participate in any specific training. However, they performed regular physical education activities. The subjects were verbally motivated to perform better in training. All the training sessions were fully supervised and none of them reported any injury. However, muscle soreness, discomfort and fatigue were reported in the early weeks which subside later and there were no dropout in the study.

Testing procedure

Heart rate at rest

Heart rate at rest of each subject was recorded in the morning time between 6.00 am and 7.00am. Ten minutes before taking the heart rate the subject was asked to sit and rest himself comfortably on a chair. The investigator wraps the cuff around the arm by placing arm on a table so that the cuff will be at the level of the heart. Just pres start/stop button and the cuff will start to inflate automatically. When the measurement is complete the arm cuff automatically deflates and the heart rate at rest and blood pressure systolic/diastolic are displayed.

Stroke volume at rest

Stroke volume at rest, Rowland *et al*., (2000) and Vinet *et al*., procedure was used.

Cardiac Output

After collecting data from the subjects on SV and HR both the values were mathematically interpreted and the calculated Cardiac Output is given below Richard Allen Williams (1991).

Statistical Analysis

The data were collected from the three groups prior to and after the experiment period. Heart rate at rest, Stroke volume at rest and Cardiac output was statistically examined by employing analysis of covariance (ANCOVA). To find out significant difference level of confidence was fixed at 0.05.

Results & Discussion

Heart rate at rest

The analysis of covariance for pre-test and post-test data on Heart rate at rest of series, parallel and control groups were analyzed and presented in table - I.

Table 1: Analysis of covariance for the pre-test and post-test data on heart rate at rest of series, parallel and control groups

Test		Series group	Parallel group	Control group	Source of variance	df	Sum of square	Means square	Obtained 'F' ratio
Pre-test	X	77.13	77.20	77.13	B	2	0.031	0.016	
	σ	2.10	1.86	1.73	W	42	151.875	3.616	0.004
Post -test	X	76.60	74.33	77.27	B	2	70.938	35.469	
	σ	1.86	2.03	1.35	W	42	127.859	3.044	11.651*
Adjusted Post–test	X	76.62	74.30	78.88	B	2	73.708	36.854	
					W	41	32.600	0.795	46.351*

* Significant at 0.05 level of confidence.

The table value for significance at 0.05 level with df 2 and 42 and 2 and 41 are 3.22 and 3.23 respectively.

Table I shows that the pre–test means of series, parallel and control groups are 77.13, 77.20 and 77.13 bpm respectively. The obtained 'F' ratio of 0.004 for pre-test means is less than the table value of 3.22 for df 2 and 42 required for significance at 0.05 level. The post-test means of series, parallel and control groups are 76.60, 74.33 and 77.27 78.88 respectively. The obtained 'F' ratio of 11.651 for post-test means is greater than the table value of 3.22 for df 2 and 42 required for significance at 0.05 level.

The adjusted post-test means of series, parallel and control groups are 76.62, 74.30 and 77.28 respectively. The obtained 'F' ratio of 46.351 is greater than the table value of 3.23 for 2 and 41 required for significance at 0.05 level.

The results of the study indicate that there is a significance among adjusted post-test means of series, parallel and control groups on Heart rate at rest. To determine the significance difference among the three-paired means, the Scheffe'S test was applied as post-hoc test and results are presented in table I-A.

Table I-A: Scheffe's test for the difference between the adjusted post-test paired means of heart rate at rest

Adjusted Post test Means			Mean differences	Confidence interval 0.05 Level
Series Group	Parallel Group	Control Group		
76.62	74.30	-	2.32*	1.01
76.62	-	78.88	1.66*	1.01
-	74.30	78.88	2.98*	1.01

* Significant at 0.05 of confidence

The table I-A shows that the adjusted post-test mean difference on Heart rate at rest between series group and parallel group, series group and control group and parallel group and control group are 2.32, 1.66 and 2.98 respectively which are greater than the confidence interval value 1.01.

It may concluded from the results that the significant difference exists between series group and parallel group, parallel group and control group and parallel group and control group on Heart rate at rest.

The adjusted post-test mean values on Heart rate at rest of series group, parallel group and control groups are graphically depicted in figure-I.

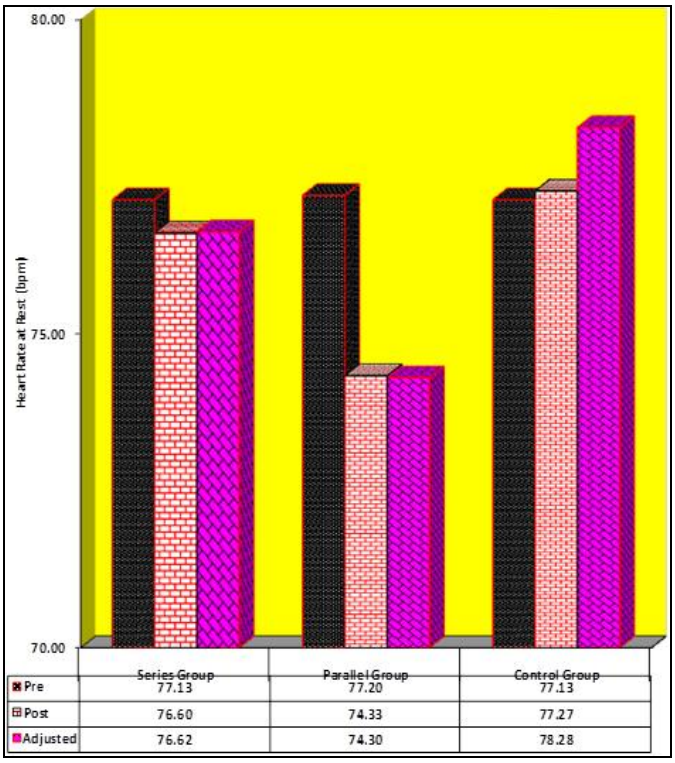

Fig 1: Bar diagram on heart rate at rest of pre, post and adjusted post test means of series, parallel and control groups.

Stroke volume at rest

The analysis of covariance for pre-test and post-test data on Stroke Volume at rest of series, parallel and control groups were analyzed and presented in table II.

Table 2: Analysis of covariance for the pre-test and post-test data on stroke volume at rest of series, parallel and control groups.

Test		Series group	Parallel group	Control group	Source of variance	df	Sum of square	Means square	Obtained 'F' ratio
Pre-test	X	74.53	74.60	74.60	B	2	0.047	0.023	0.002
	σ	3.96	3.44	2.82	W	42	496.938	11.832	
Post - test	X	76.80	79.09	74.60	B	2	149.625	74.813	4.287*
	σ	4.06	5.18	3.02	W	42	732.938	17.451	
Adjusted Post–test	X	76.85	79.04	73.58	B	2	149.578	74.789	17.966*
					W	41	170.671	4.163	

* Significant at 0.05 level of confidence.

The table value for significance at 0.05 level with df 2 and 42 and 2 and 41 are 3.22 and 3.23 respectively.

Table II shows that the pre–test means of series, parallel and control groups are 74.53, 74.60 and 74.60 ml respectively. The obtained 'F' ratio of 0.002 for pre-test means is less than the table value of 3.22 for df 2 and 42 required for significance at 0.05 level. The post-test means of series, parallel and control groups are 76.80, 79.09 and 74.60 ml

respectively. The obtained 'F' ratio of 4.287 for post-test means is greater than the table value of 3.22 for df 2 and 42 required for significant at 0.05 level.

The adjusted post-test means of series, parallel and control groups are 76.85, 79.04 and 73.58 ml respectively. The obtained 'F' ratio of 17.966 is greater than the table value of 3.21for 2 and 41 required for significance at 0.05 level. The results of the study indicate that there is a significance among adjusted post-test means of series, parallel and control groups on Stroke volume at rest.

To determine the significance difference among the three-paired means, the Scheffe'S test was applied as post-hoc test and results are presented in table II-A.

Table 2-A: Scheffe's test for the difference between the adjusted post-test paired means of stroke volume at rest

Adjusted Post test Means			Mean differences	Confidence interval 0.05 Level
Series Group	**Parallel Group**	**Control Group**		
76.85	79.04	-	2.19*	2.36
76.85	-	73.58	3.27*	2.36
-	79.04	73.58	5.46*	2.36

* Significant at 0.05 of confidence

The table II-A shows that the adjusted post-test mean difference on Stroke volume at rest between series group and control group and parallel group and control group are 3.27 and 5.46 respectively which are greater than the confidence interval value 2.36. It may concluded from the results that there is a significant difference between series group and control group and parallel group and control group on Stroke volume at rest.

Table II-A shows that the adjusted post-test mean difference on Stroke volume at rest between series and parallel groups are 2.19 which is lesser than the confidence interval value 2.36. Hence, the results of the study concluded that there is in significant difference exists on Stroke volume at rest between series group and parallel group.

The adjusted post-test mean values on Stroke volume at rest of series group, parallel group and control groups are graphically depicted in figure -II.

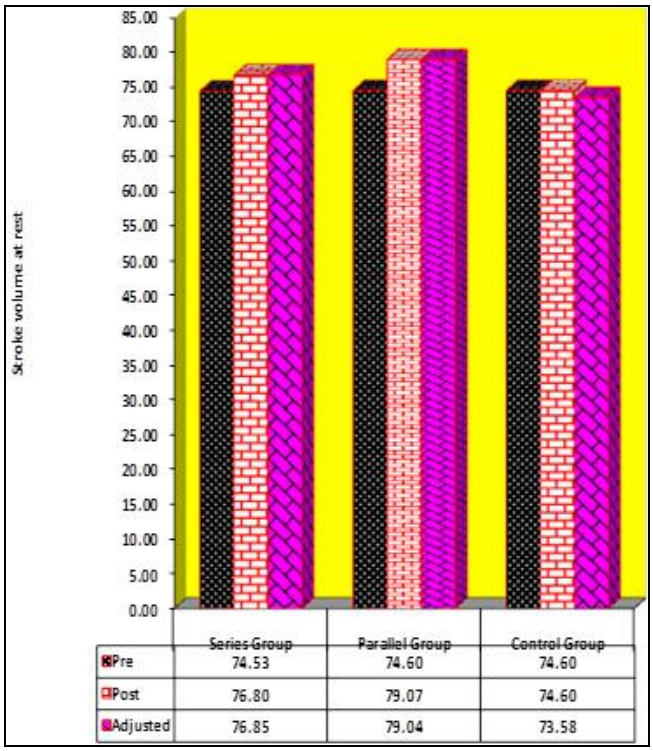

Fig 2: Bar diagram on stroke volume at rest of pre, post and adjusted post-test means of series, parallel and control groups.

Cardiac Output

The analysis of covariance for pre-test and post-test data on cardiac output of series, parallel and control groups were analyzed and presented in table- III.

Table 3: Analysis of covariance for the pre-test and post-test data on cardiac output of series, parallel and control groups.

Test		Series group	Parallel group	Control group	Source of variance	df	Sum of square	Means square	Obtained 'F' ratio
Pre-test	X	5.07	5.13	5.13	B	2	0.044	0.022	0.146
	σ	0.26	0.52	0.35	W	27	6.400	0.152	
Post -test	X	5.39	5.77	5.15	B	2	2.932	1.466	11.327*
	σ	0.27	0.41	0.39	W	27	5.436	0.129	
Adjusted Post–test	X	5.43	5.76	5.07	B	2	2.887	1.444	31.062*
					W	26	1.906	0.046	

* Significant at 0.05 level of confidence.
The table value for significance at 0.05 level with df 2 and 42 and 2 and 41 are 3.22 and 3.23 respectively.

Table III shows that the pre–test means of series, parallel and control groups are 5.07, 5.13 and 5.13 ltr respectively. The obtained 'F' ratio of 0.146 for pre-test means is less than the table value of 3.22 for df 2 and 42 required for significance at 0.05 level.

The post-test means of series, parallel and control groups are 5.39, 5.77 and 5.15 ltr respectively. The obtained 'F' ratio 11.327 for post-test means is greater than the table value of 3.22 for df 2 and 42 required for significance at 0.05 level. The adjusted post-test means of series, parallel and control groups are 5.43, 5.76 and 5.07 ltr respectively. The obtained 'F' ratio of 31.062 is also much greater than the table value of 3.23 for 2 and 41 required for significance at 0.05 level.

The results of the study indicate that there is significance among adjusted post-test means of series, parallel and control groups on cardiac output. To determine the significance difference among the three-paired means, the Scheffe'S test was applied as post-hoc test and results are presented in table III-A.

Table 3-A: Scheffe's test for the difference between the adjusted post-test paired means of cardiac output

Adjusted Post test Means			Mean differences	Confidence interval 0.05 Level
Series Group	Parallel Group	Control Group		
5.43	5.76	-	0.33*	0.35
5.43	-	5.07	0.36*	0.35
-	5.76	5.07	0.62*	0.35

* Significant at 0.05 of confidence

The table III-A shows that the adjusted post-test mean difference on Cardiac output between series group and control group and parallel group and control group are 0.36 and 0.62 respectively which are greater than the confidence interval value 0.35. It may concluded from the results that there is a significant difference between series group and control group and parallel group and control group on Cardiac output.

Table III-A shows that the adjusted post-test mean difference on Cardiac output between series and parallel groups are 0.33 which is less than the confidence interval value 0.35. Hence, the results of the study concluded that there is no significant difference exists on Cardiac output between series group and parallel group. The adjusted post-test mean values on Cardiac output of series group, parallel group and control groups are graphically depicted in figure -III.

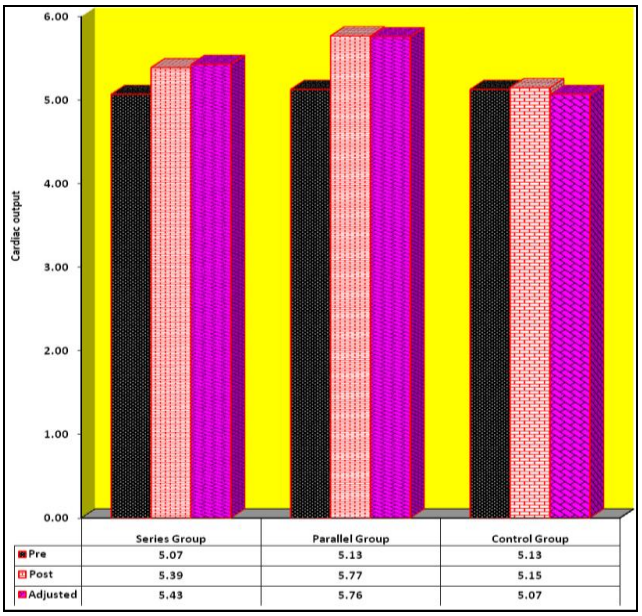

Fig 3: Bar diagram on cardiac output of pre, post and adjusted post-test means of series, parallel and control groups.

Conclusions

- There is significant difference exists between training groups on Heart rate at rest.
- Stroke volume at rest is significantly increased by series and parallel groups.
- There is significant difference between both the training groups on Stroke volume at rest.
- Cardiac output is significantly increased both the training groups.
- There is significant difference between both the training groups on Cardiac output.

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