EFFECT OF PLYOMETRIC TRAINING, RESISTANCE TRAINING AND THEIR COMBINATION ON THE FITNESS LEVEL OF NATIONAL LEVEL FEMALE BASKETBALL PLAYERS

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ABSTRACT
A total of sixty female (N=60) School National level basketball players ranging between 16-19 years of age were taken as subjects for the purpose of the study. The subjects were randomly selected and training was conducted at Government Senior Secondary Girls School, Mall Road, Amritsar. The subjects were divided into two groups namely: Experimental Group (45 subjects in total) and Control Group (15 subjects). The Experimental group was further sub-divided into three groups of 15 subjects in each group. Experimental Group-I was given (Plyometric Training), Experimental Group-II (Resistance Training) and Experimental Group-III (Combined Training). The fitness variables were selected for the purpose of the study: flexibility test (sit and reach test), strength test (vertical jump test), speed test (50m dash test), agility (shuttle run test) and cardio-vascular fitness test (cooper 12 minute run-walk test). In order to find out the differential effects of the two treatment groups (Plyometric and Resistance) and one control group, ANCOVA test was computed. It is evident from the results that Resistance training group demonstrated maximum effect on the flexibility with improved performance in sit and reach than other three groups. Whereas combined training group was the next effective treatment group on flexibility than Plyometric training group and control group. These results indicate that Combined (Plyometric and Resistance) training proved to be most effective experimental method for improving fitness variables namely explosive leg strength, running ability, agility and endurance ability as compared to other two experimental groups.
Keywords: Resistance Training, Fitness, Female, Basketball Players

INTRODUCTION

Sports coaches and sports scientists always look for new, better or different ways to improve performance. What is now popularly known as Plyometrics was discovered and refined over the past 30 or so years. Plyometric Exercises are specialized high intensity training technique used to develop strength and speed. Plyometric movements are those in which a muscle is loaded and then contracted in rapid sequence, use the strength, elasticity and innervations of muscle and surrounding tissues to jump higher, run faster or hit harder, depending on desired training goal. Performing Plyometrics at high amounts and intensity is very dangerous. As fatigue sets in, one becomes more prone to lose form and perform the movement incorrectly. These jumps should be done sparingly and each jump should be done for quality not quantity so doing death jumps from the top of your garage roof over and over again, isn't going to help you much. This simply means performing Plyometrics is same as to lift weights. Concentrate, keep perfect form and give it all you got; jumping as high as possible. Plyometric refers to exercise that enables a muscle to reach maximum force in the shortest possible time. The muscle is loaded with an eccentric (lengthening) action, followed immediately by a concentric (shortening) action. This study outlines the physiology behind how and why plyometrics works. It also examines the research that demonstrates why, as a form of power training, plyometric training is very effective.

A combination of plyometrics and resistance training during a training cycle should be structured to allow maximal efficacy and physical improvement. To our knowledge, no randomized studies have compared the effects of combined plyometric training and prospective resistance training in children and adolescents.

Basketball is one of the sports characterized by many of the basic and variable skills. The basketball player perfection to do such skills, defensive or offensive, needs development in the physical qualities of the basketball player, which enables him to do the required duties throughout the match. Special physical preparation in basketball is the main pillar for the players to carry out the special requirements (physical, skillful and tactical).Without these requirements, the player cannot achieve the objectives set up for the training or competition. The skillful performance is often measured by the level of the player to acquire physical abilities (Abdel et.al 1992).

The combination of plyometric exercise and weight training increased (Adams et al., 1992; Baur et al., 1990; Ioannis et al., 2000) or maintained as unaffected the vertical jumping performance (Stone & O'Bryant, 1986). (Adams et.al 1992) suggested that this combination may provide a more powerful training stimulus to the vertical jumping performance than either weight training or plyometric training alone. However, (Clutch et. al 1983) did not reach similar conclusions. It seems that researchers have not come to an agreement about the relative effectiveness of plyometric training compared with weight training or the combination of both in the development of explosive power performance. Therefore, the purpose of the present investigation was to compare the effects of 8-week

training period of plyometric, resistance and combined plyometric and resistance training with fitness and performance in youth Basketball players.

PROCEDURE AND METHOD

The present study was conducted on sixty (60) school national level female basketball players ranging between 16-18 years of age. The subjects were randomly selected and training was conducted at Government Senior Secondary Girls School, Mall Road, Amritsar (Punjab). The subjects were divided into two groups namely: Experimental Group (45 subjects) and Control Group (15 subjects). The Experimental group was further sub-divided into three groups of 15 subjects in each group. Experimental Group-I was given (Plyometric Training), Experimental Group-II (Resistance Training) and Experimental Group-III (Combined Training). All the subjects were local residents.

Measurements for variables were taken at the beginning (pre-test) and at the end of experimental training period after eight weeks (post-test). During data collection period, the subjects were not allowed to participate in any competition except daily training schedule. The fitness variables were selected for the purpose of the study: flexibility test (sit and reach test), strength test (vertical jump test), speed test (50m dash test), agility (shuttle run test), cardio-vascular fitness test (cooper 12 minute run-walk test). The performance variables were: Performance (Johnson Basketball Test, C. Meyers) -Field Goal Speed Test, Basketball Throw for Accuracy, Dribble Test. In order to find out the differential effects of the three treatment groups (Plyometric, Resistance and Combined Plyometric & Resistance) and one control group, ANCOVA test was computed with the help of SPSS computer software. The LSD post-hoc test was applied in cases where 'F'-ratio has shown significance to find out which of the differences of the paired means were significant. The level of significance chosen was .05.

DATA ANALYSIS AND RESULTS

The Analysis of Covariance for different Training groups (Exp GP-1:Plyometric group, Exp GP-2:Resistance group, Exp group GP-3:Combined group) and control group of school national level basketball players for fitness variables comprising of sit and reach is presented in table- 1.

TABLE-1
ANALYSIS OF CO-VARIANCE ON FITNESS LEVEL (SIT & REACH) OF SCHOOL NATIONAL LEVEL FEMALE BASKETBALL PLAYERS

TESTS	GROUPS (MEAN)				Source of Variance	Sum of Square	df	Mean Square	'F' Value
	Exp GP-1	Exp GP-2	Exp GP-3	Cont GP.					
Pre-Test Means	2.19	2.05	2.04	1.94	Between Groups	.462	3	.154	.240
					Within Groups	35.89	56	.641	
Post-Test Means	2.46	2.09	2.75	2.08	Between Groups	4.67	3	1.56	2.38
					Within Groups	36.68	56	.655	
Adjusted Final Mean	2.37	2.09	2.76	2.16	Between Groups	4.07	3	1.34	4.07*
					Within Groups	18.23	55	.331	

*Significant at 0.05 level 'F' $_{0.05}$ (3, 55) = 2.77

Table above indicated that pre-test means for plyometric group, resistance group, combined (Plyometric & Resistance) group and control group were 2.19, 2.05, 2.04 and 1.94 respectively. The resultant 'F' value of .240 was

not significant at 0.05 level. This indicates that all the groups had shown significant difference in their initial means. The post-test mean of 2.46 for Plyometric group, 2.09 for Resistance group, 2.75 for combined group and 2.08 for control group were recorded and resultant 'F' value of 2.38 which was also not significant at 0.05 level. Since, 'F' value (ANCOVA) for adjusted mean were found significant, LSD post-hoc test was applied to find out, which of the mean difference between the paired adjusted means were significant. The data pertaining to this has been presented in table-2.

TABLE-2
SIGNIFICANT DIFFERENCES BETWEEN THE PAIRED ADJUSTED FINAL MEANS OF SIT AND REACH FITNESS VARIABLE AMONG DIFFERENT TRAINING GROUPS

FITNESS VARIABLES	GROUPS (MEAN)				M.D
	EXP. GP-1	EXP. GP-2	EXP. GP-3	CONT. GP.	
Sit And Reach	2.37	2.09			.278
	2.37		2.76		.392
	2.37			2.16	.203
		2.09	2.76		.670*
		2.09		2.16	.075
			2.76	2.16	.600*

*Significant at .05 level $I_{.05}(3, 55) = 0.60$

From the description presented in table-2, it has been found that there was no significant difference in the adjusted means between Plyometric and Resistance group, Plyometric and Combined group, plyometric and control group, resistance and control group. However, Resistance group recorded significant difference in comparison to combined group and combined group recorded significant difference in comparison to control group as final adjusted means of .670 and .595 were found greater than the critical ratio (I=0.60). The Analysis of Covariance for different Training groups (Exp GP-1: Plyometric group, Exp GP-2: Resistance group, Exp group GP-3: Combined group) and control group of school national level female basketball players for fitness variables comprising of vertical jump is presented in table-3.

TABLE-3
ANCOVA ON FITNESS LEVEL (VERTICAL JUMP) OF SCHOOL NATIONAL LEVEL FEMALE BASKETBALL PLAYERS

TESTS	GROUPS (MEAN)				Source of Variance	Sum of Square	df	Mean Square	'F' Value
	EXP GP-1	EXP GP-2	EXP GP-3	CONT GP.					
Pre-Test Means	6.95	8.53	7.93	6.18	Between Groups	48.72	3	16.24	18.27*
					Within Groups	49.76	56	.889	
Post-Test Means	8.00	9.23	9.21	6.32	Between Groups	84.83	3	28.28	30.37*
					Within Groups	52.15	56	.931	
Adj. Final	8.41	8.22	8.73	7.42	Between Groups	10.89	3	3.63	16.94*

Mean					Within Groups	11.78	55	.214	

*Significant at 0.05 level 'F' $_{0.05}$ (3, 55) = 2.77

The above table indicate that there has been a significant difference among pre-test and post-test mean scores of various training groups of school national level female basketball players among fitness variables comprising of vertical jump as the obtained 'F' value (pre-test : 18.27 and post-test : 30.37) was found to be greater than the table value of 2.77, which is required to be significant at 0.05 level of significance. Further, the results of adjusted final means indicated significant difference among four groups at 0.05level as obtained 'F' value 16.94 was much more than the table value of 2.77. It is clear from the results that there was meaningful effect of experimental treatment on the groups as the 'F' value is higher than the table value.LSD post-hoc test of significance was applied to find the actual effect of Experimental treatment on the groups. The results have been presented in table- 4.

TABLE- 4
SIGNIFICANT DIFFERENCES BETWEEN THE PAIRED ADJUSTED FINAL MEANS OF VERTICAL JUMP FITNESS VARIABLE AMONG DIFFERENT TRAINING GROUPS

FITNESS VARIABLES	GROUPS (MEAN)				MD
	EXP. GP-1	EXP. GP-2	EXP. GP-3	CONT. GP.	
Vertical Jump	8.41	8.22			.190
	8.41		8.72		.318
	8.41			7.42	.990*
		8.22	8.72		.508*
		8.22		7.42	.800*
			8.72	7.42	1.31*

*Significant at .05 level I $_{.05}$ (3, 55) = 0.48

The results in table-4 show that the mean difference between adjusted paired means was statistically significant in Plyometric, resistance and combined group groups in comparison to control group and resistance and combined group at 0.05 levels as final adjusted means of .990, .800, 1.31 and .508 were found greater than the critical ratio (I=0.48). However the mean differences between the remaining groups when compared to each other were not found significant.

The Analysis of Covariance for different Training groups (Experimental group 1: Plyometric group, Experimental group 2: Resistance group, Experimental group 3: Combined group) and control group of school national level female basketball Players for fitness variables comprising of 50m dash is presented in table-5.

TABLE-5
ANALYSIS OF CO-VARIANCE ON FITNESS LEVEL (50 M DASH) OF SCHOOL NATIONAL LEVEL FEMALE BASKETBALL PLAYERS

TESTS	GROUPS (MEAN)				Source of Variance	Sum of Square	df	Mean Square	'F' Value
	EXP GP-1	EXP GP-2	EXP GP-3	CONT GP.					
Pre-Test Means	8.97	8.97	8.92	8.85	Between Groups	.144	3	.048	.256
					Within Groups	10.52	56	.188	
Post-Test Means	8.25	8.57	8.43	8.61	Between Groups	1.15	3	.382	2.305
					Within Groups	9.29	56	.166	

Adj. Final Mean	8.22	8.54	8.44	8.67	Between Groups	1.617	3	.539	13.21*
					Within Groups	2.245	55	.041	

*Significant at 0.05 level 'F' $_{0.05}$ (3, 55) = 2.77

Table -5 indicated that pre- test means for Plyometric group, Resistance group, Combined (Plyometric & Resistance) group and control group were 8.97, 8.97, 8.92 and 8.85 respectively. The resultant 'F' value of .256 was not significant at 0.05 level. This indicates that all the groups had shown significant difference in their initial means. The post test means of 8.25 for Plyometric group, 8.57 for Resistance group, 8.43 for combined group and 8.61 for control group were recorded and resultant 'F' value of 2.305 which was also not significant at 0.05 level. The adjusted final means were 8.22, 8.54, 8.44 and 8.67 for Plyometric, Resistance, Combined and control group respectively, yielded 'F' value of 13.21, which was statistically significant at 0.05 level. 'F' value (ANCOVA) for adjusted mean were found significant, LSD post-hoc test was applied to find out, which of the mean difference between the paired adjusted means were significant. The data pertaining to this has been presented in table-6.

TABLE- 6

SIGNIFICANT DIFFERENCES BETWEEN THE PAIRED ADJUSTED FINAL MEANS OF 50 M DASH FITNESS VARIABLE AMONG DIFFERENT TRAINING GROUPS

FITNESS VARIABLES	GROUPS (MEAN)				MD
	EXP. GP-1	EXP. GP-2	EXP. GP-3	CONT. GP.	
50 M Dash	8.22	8.54			.315*
	8.22		8.45		.217*
	8.22			8.67	.452*
		8.54	8.45		.098
		8.54		8.67	.137
			8.45	8.67	.235*

*Significant at .05 level I $_{.05}$ (3,55) = 0.21

The result in table-6 show that the mean differences between adjusted paired means were statistically significant in all the groups at 0.05 level, except between Resistance group and Combined group, Resistance group and Control group as the mean difference were higher than the critical ratio (I=0.21). It is clear that in case of plyometric group, 50m dash has most significantly effected as compared to Resistance group, combined group and control group. The combined group also had significant effect in comparison to resistance and control group.

The Analysis of Covariance for different Training groups (Experimental group 1: Plyometric group, Experimental group 2: Resistance group, Experimental group 3: Combined group)and control group of school national level female basketball Players for fitness variables comprising of shuttle run is presented in table-7.

TABLE-7

ANCOVA ON FITNESS LEVEL (SHUTTLE RUN) OF SCHOOL NATIONAL LEVEL FEMALE BASKETBALL PLAYERS

TESTS	GROUPS (MEAN)				Source of Variance	Sum of Square	df	Mean Square	'F' Value
	EXP GP-1	EXP GP-2	EXP GP-3	CONT GP.					
Pre-Test Means	11.95	11.90	11.87	11.92	Between Groups	.051	3	.017	.080
					Within Groups	11.90	56	.213	

Post-Test Means	11.44	11.15	10.83	11.59	Between Groups	5.06	3	1.69	5.85*
					Within Groups	16.16	56	.289	
Adj. Final Mean	11.41	11.16	10.87	11.58	Between Groups	4.276	3	1.425	13.83*
					Within Groups	5.668	55	.103	

*Significant at 0.05 level 'F' 0.05 (3, 55) = 2.77

The above results indicate that there has been a significant difference among post-test mean scores of various training groups of school national level female basketball players among fitness variables comprising of shuttle run as the obtained 'F' value (post-test 5.85) was found to be greater than the table value of 2.77, which is required to be significant at 0.05 level of significance. Further, the results of adjusted final means indicated significant difference among four groups at 0.05 level as obtained 'F' value 13.83 was much more than the table value of 2.77. It is clear from the results that there was meaningful effect of experimental treatment on the groups as the 'F' value is higher than the table value. LSD post-hoc test of significance was applied to find the actual effect of Experimental treatment on the groups. The results have been presented in table- 8.

TABLE-8
SIGNIFICANT DIFFERENCES BETWEEN THE PAIRED ADJUSTED FINAL MEANS OF SHUTTLE RUN FITNESS VARIABLE AMONG DIFFERENT TRAINING GROUPS

FITNESS VARIABLES	GROUPS (MEAN)				MD
	EXP. GP-1	EXP. GP-2	EXP. GP-3	CONT. GP.	
Shuttle Run	11.41	11.16			.246*
	11.41		10.87		.536*
	11.41			11.58	.174
		11.16	10.87		.290*
		11.16		11.58	.420*
			10.87	11.58	.710*

*Significant at .05 level $I_{.05}$ (3, 55) = 0.24

It is observed from table- 8 that the mean differences between adjusted means were statistically significant in all the groups at 0.05 level of significance, except between Plyometric group and Control group as the mean difference was higher than the critical ratio (I=0.24). The Analysis of Covariance for different Training groups (Experimental group 1: Plyometric group, Experimental group 2: Resistance group, Experimental group 3: Combined group)and control group of school national level female basketball players for fitness variables comprising of shuttle run is presented in table-9.

TABLE-9
ANCOVA ON FITNESS LEVEL (COOPER 12 MIN. RUN WALK) OF SCHOOL NATIONAL LEVEL FEMALE BASKETBALL PLAYERS

TESTS	GROUPS (MEAN)				Source of Variance	Sum of Square	df	Mean Square	'F' Value
	EXP GP-1	EXP GP-2	EXP GP-3	CONT GP.					
Pre-Test Means	1902.7	1857.3	1849.3	1806.7	Between Groups	69626.7	3	23208.9	.653
					Within Groups	1990613.3	56	35546.7	
Post-Test Means	1990.0	2012.7	2146.7	1820.7	Between Groups	805605	3	268535	6.19*
					Within Groups	2428120	56	43359.3	
Adj. Final Mean	1938.6	2009.1	2151.6	1870.7	Between Groups	649383.4	3	216461.1	58.05*
					Within Groups	205106.2	55	3729.2	

*Significant at 0.05 level 'F' $_{0.05}$ (3, 55) = 2.77

The above table indicates that there has been a significant difference among post-test mean scores of various training groups of school national level female basketball players among fitness variables comprising of cooper 12 min run walk as the obtained 'F' value (Post-test : 6.19) was found to be greater than the table value of 2.77, which is required to be significant at 0.05 level of significance.
Further, the results of adjusted final means indicated significant difference among four groups at 0.05level as obtained 'F' value 58.05 was much more than the table value of 2.77.
LSD post-hoc test of significance was applied to find the actual effect of Experimental treatment on the groups. The results have been presented in table- 10.

TABLE-10
SIGNIFICANT DIFFERENCES BETWEEN THE PAIRED ADJUSTED FINAL MEANS OF COOPER 12 MIN RUN WALK FITNESS VARIABLE AMONG DIFFERENT TRAINING GROUPS

FITNESS VARIABLES	GROUPS (MEAN)				MD
	EXP. GP-1	EXP. GP-2	EXP. GP-3	CONT. GP.	
Cooper 12 Min. Run Walk	1938.57	2009.14			70.57*
	1938.57		2151.59		213.03*
	1938.57			1870.69	67.88*
		2009.14	2151.59		142.45*
		2009.14		1870.69	138.46*
			2151.59	1870.69	280.91*

*Significant at .05 level I $_{.05}$ (3, 55) = 64.28

It is observed from table-10 that the mean differences between adjusted-paired means were statistically significant in all the groups at 0.05 level of significance as the adjusted mean differences of all three groups was higher than the critical ratio (I=64.28). All the three experimental groups showed significant improvement in 12 cooper run walk test as compared to control group.

CONCLUSION

It is evident from the results that Resistance group demonstrated maximum effect on the flexibility with improved performance in sit and reach than other three groups. Whereas combined group was the next effective treatment group on flexibility than Plyometric group and control group. These results indicate that Combined (Plyometric and Resistance) training proved to be most effective experimental method for improving fitness variables namely explosive leg strength, running ability, agility and endurance ability as compared to other two experimental groups.

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