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Effect of different intensity of circuit weight training and detraining on leg strength of physical education students

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Abstract
The purpose of the study was to find out the effect of different intensity circuit weight training on Leg Strength of Physical Education Students. To achieve the purpose of the study, 45 male students from the department of physical education and sports sciences, Annamalai University, Chidambaram, Tamilnadu, India were selected at random as subjects, in the age group of 18 to 20 years. The chosen subjects were randomly assigned into three groups of 15 each. Group-I acted as control, group-II followed intensive circuit weight training and group-III subjects underwent extensive circuit weight training. Both experimental groups have significantly increased the Leg strength as compared to control group. Further, the improvement of fore Leg strength is significant for intensive circuit weight training group than extensive circuit weight training group.

Keywords: Leg strength, circuit weight training, physical education students

1. Introduction
All forms of physical activities which through casual or organized participation aim at improving physical fitness and mental well-being, forming social relationships or obtaining results in competition at all levels. (Council of Europe)

To develop a healthy, disciplined, united and productive society through greater participation in sport and physical recreation by all members of the society. In this regard, special opportunities are to be made available to children, young people, women, girls, senior citizens and the specially challenged.

Circuit weight training is a form of exercise that uses a number of weight training exercise sets separated by short intervals. The cardiovascular effort to recover from each set serves a function similar to an aerobic exercise, but this is not the same as saying that a weight training set is itself an aerobic process.

2. Methodology
Selection of Subjects
The purpose of the study was to find out the effect of different intensity circuit weight training on Leg strength. To achieve the purpose of the study, 45 male students from the department of physical education and sports sciences, Annamalai University, Chidambaram, Tamilnadu, India were selected at random as subjects, in the age group of 18 to 20 years. The chosen subjects were randomly assigned into three groups of 15 each. Group-I acted as control, group-II followed intensive circuit weight training and group-III subjects underwent extensive circuit weight training.

3. Selection of Variables
Experimental Variables
The experimental variables used in the present study were two intensities of circuit weight training such as:

- High Intensity circuit weight training
- Moderate intensity circuit weight training

Criterion Variables
The criterion variables chosen for the present research were anthropometric measurement.

a. Leg Strength

Table 1: Tests used for Criterion Variables

S.No.	Criterion Variables	Instrument/Test / Method / Formula	Unit of Measurement
Anthropometric measurements			
1	Leg Strength	Leg Dynomometer	Kilograms

Experimental Design
The experimental design used for the present study was random group design involving 45 volunteers as subjects. This study consisted of two experimental variables such as moderate circuit weight training and High Intensity circuit weight training. Among the three groups, group-I was treated as Moderate group, group-II was followed Highintensity circuit weight training and
group-III performed controgroup. Each group consists of 15 subjects and they were tested prior and after ten weeks of circuit weight training.

To examine the effect of intensive and extensive circuit weight training on Leg strength, analysis of covariance (ANCOVA) was computed (Clarke & Clarke, 1972) for the data collected from the control and experimental groups during pretest and posttest separately for each variable. Further, since three groups were involved, whenever the ‘F’ ratio was significant, Scheffé S post hoc test was used to determine which of the paired mean differed significantly.

Leg Lift with Dynamometer
Purpose
To quantify the maximum strength of the leg muscles.

Description of Back and Leg Dynamometer
The dynamometer consists of a dial, which measures from 0 to 100 kilograms in 500 grams increments. The score shown in the dial was multiplied by two, to arrive the final score. The dial is attached to a strong platform and has a chain and bar. The chain can be adjusted according to the height of the subject. High reliability has been reported for tests with this equipment and the investigator found the reliability of 0.953. Hence, the back and leg dynamometer was used in the present investigation.

Testing Procedure
The back and leg dynamometer was kept on a platform to have clear vision on the dial. The subject stood erect on the base of the dynamometer, with hands in front of the thighs. The feet were placed parallel about six inches apart and body weight was equally balanced on both feet. The knees were flexed between 115 and 125 degrees. The bar was placed at top of the thigh and grasp firmly at the ends with pronated grip. The experienced tester hooked the chain according to the height of the subject. The arms and back were straight, the head erect and chest up throughout the lift. The subject pushes down with legs attempting to straighten the legs steadily without jerking. The maximum lift occurred when the subject’s legs were straight. Whenever any deviations from proper procedures were noticed, the test was repeated. For each subject the test was administered three times with adequate rest in between.

Scoring
As instructed in the back and leg dynamometer, the score shown in the dial during the maximal lift, was multiplied by two to arrive at the final score. The best of three trails was recorded in kilograms (Basco & Gustafson, 1983).

4. Analysis of Leg Strength
Training Effect
The mean and standard deviation values on leg strength of moderate intensity circuit training group, high intensity circuit training group and control group during six different testing periods have been presented in table 2.

Table 2: Mean and Standard Deviation on Leg Strength (kg) of Pretest, Posttest and Four Cessations Data of Experimental and Control Groups

Groups		Pre Test	Post Test	First Cessation	Second Cessation	Third Cessation	Fourth Cessation
Moderate Intensity Circuit Training Group	Mean	92.33	99.27	98.53	97.87	95.93	95.20
	SD	5.47	5.19	4.96	4.67	4.70	5.00
High Intensity Circuit Training Group	Mean	91.53	103.87	103.20	102.53	98.13	97.40
	SD	4.43	3.02	2.51	2.75	2.77	2.84
Control Group	Mean	92.27	94.13	94.20	94.40	94.40	94.53
	SD	4.87	3.68	3.21	3.42	3.11	3.07

The details of leg strength during six testing periods among three groups are graphically illustrated in figure II.

The analysis of covariance for the pre and post-tests data on leg strength of experimental and control groups have been analysed and presented in table 7a.

Table 2a: Analysis of Covariance for Pre and Post Tests Data on Leg Strength (kg) of Experimental and Control Groups

	Moderate Intensity Circuit Training	High Intensity Circuit Training	Control Group	Source of Variance	Sum of Squares	df	Mean Squares	‘F’ Ratio
Pretest Mean SD	92.33	91.53	92.26	Between	5.91	2	2.95	0.12
	5.47	4.43	4.87	Within	1028.00	42	24.47	
Posttest Mean SD	99.27	103.86	94.13	Between	711.24	2	355.62	21.51*
	5.19	3.02	3.68	Within	694.40	42	16.53	
Adjusted Posttest Mean	99.04	104.26	93.96	Between	792.89	2	396.45	213.36*
				Within	76.18	41	1.86	

* Significant at 0.05 level.

The table value required for significance at 0.05 level of confidence with degrees of freedom 2, 41 is 3.23 and degree of freedom 2, 42 is 3.22.

Table 2a shows that the obtained 'F' ratio value of 0.12 for pretest mean on leg strength is not significant. It reveals that there is statistically no significant difference among experimental and control groups on leg strength before the commencement of circuit training.

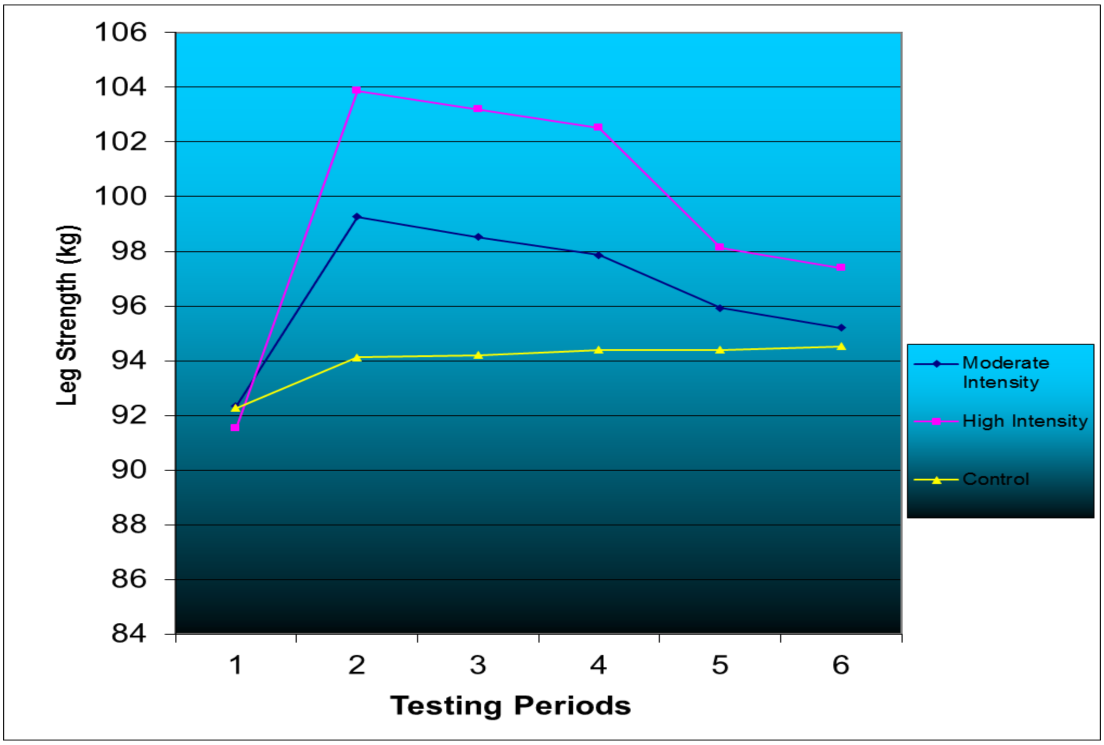

Fig I: Graphical Representation of Pretest, Posttest and Four Cessations Data of Moderate Intensity, High Intensity and Control Groups on Leg Strength

The 'F' ratio value of 21.51 for post-test data on leg strength is significant at 0.05 level.

The 'F' ratio value of 213.36 for adjusted post-test on leg strength is significant at 0.05 level. It reveals that there is significant difference among the groups on leg strength as a result of circuit training.

The results of Scheffe's post-hoc test is presented in table 7b.

Table 2b: Scheffe's Test for the Differences between the Adjusted Post Test Paired Means on Leg Strength (kg) of Experimental and Control Groups

Adjusted Post Test Mean			Mean Differences	Level of Significance
Moderate Intensity Circuit Training Group	**High Intensity Circuit Training Group**	**Control Group**		
99.04	104.26		5.22	0.05
99.04		93.96	5.08	0.05
	104.26	93.96	10.30	0.05

The confidence interval required for 0.05 level of significance is 1.26.

Table 2b shows that all the three-paired means are significant at 0.05 level. It reveals that both experimental groups have significantly increased the leg strength as compared to control group. Further, the improvement of leg strength is significantly higher for high intensity group than moderate intensity circuit training group. Influence of Detraining

The data on leg strength have been analysed by two-way factorial ANOVA (3 x 5) with repeated measures on last factor and the results are presented in table 2c.

Table 2c: Analysis of Variance on Leg Strength of Experimental and Control Groups at Five Different Testing Periods

Source of Variance	Sum of Squares	df	Mean Squares	"F" Ratio
Rows (Groups)	1685.15	2	842.57	12.30*
Error	2876.29	42	68.48	
Columns (Testing Periods)	423.13	4	105.78	148.36*
Interaction (Groups X Testing Periods)	306.76	8	38.35	53.78*
Error	119.71	168	0.713	

*Significant at.05 level

Table values required for significance at 0.05 level with df 2, 42; 4, 168 and 8, 168 are 3.22, 2.42 and 1.99 respectively.

From the table 7c it is clear that the obtained 'F' ratio for groups, 12.30 is significant at 0.05 level. It is evident that the influence of detraining on leg strength among moderate intensity, high intensity and control groups differ significantly.
Table 2c also shows that the obtained 'F' ratio for testing periods, 148.36 is significant at 0.05 level. It is found that the declines of leg strength during different testing periods differ significantly.
From the table 2c it is evident that the obtained 'F' ratio for the interaction between groups and testing periods is 53.78 is also significant at 0.05 level. The finding of the study implies that significant differences exist for the reduction on leg strength among three groups and five testing periods.
Since, the interaction is significant, the simple effect test was applied as follow-up test and which is presented in table 2d.

Table 2d: Simple Effect Scores on Leg Strength for the Interaction among Three Groups during Five Testing Periods

Source of Variance	Sum of Squares	df	Mean Squares	"F" Ratio
Groups and Post Test	712.24	2	356.12	499.47*
Groups and First Cessation	607.79	2	303.89	426.21*
Groups and Second Cessation	499.267	2	249.634	350.12*
Groups and Third Cessation	105.47	2	52.73	73.96*
Groups and Fourth Cessation	67.63	2	33.81	47.42*
Testing Periods and Group I	179.814	4	44.954	63.05*
Testing Periods and Group II	549.170	4	137.293	192.56*
Testing Periods and Group III	1.60	4	0.40	0.56
Error	119.71	168	0.713	

*Significant at 0.05 level.
Table values required for significance at 0.05 level with df 2, 168 and 4, 168 are 3.05 and 2.42 respectively.

Table 2d shows that the changes on leg strength during all the five testing periods differ significantly at 0.05 level.
Table 2d also reveals that the changes on leg strength for both experimental groups differ significantly at 0.05 level, during different testing periods.
Since, the changes on leg strength is significant during testing periods and among groups, Scheffe's post-hoc test was applied separately to find out the paired mean differences, if any. The results of Scheffe's test for testing period is given in table 7e.

Table 2e: Scheffe's Test for the differences between the Paired Means of Post Test and Cessation Periods for Different Groups on Leg Strength

Testing Periods	Moderate Intensity Circuit Training Group	High Intensity Circuit Training Group	Control Group	Mean Difference
Post Test	99.27	103.87		4.60*
	99.27		94.13	5.14*
		103.87	94.13	9.74*
First Cessation	98.53	103.20		4.67*
	98.53		94.20	4.33*
		103.20	94.20	9.00*
Second Cessation	97.87	102.53		4.66*
	97.87		94.40	3.47*
		102.53	94.40	8.13*
Third Cessation	95.93	98.13		2.20*
	95.93		94.40	1.53*
		98.13	94.40	3.73*
Fourth Cessation	95.20	97.40		2.20*
	95.20		94.53	0.67
		97.40	94.53	2.87*

* Significant at 0.05 level.
The confidence interval required for significant at 0.05 level is 0.76.

It is clear from table 2e that the changes on leg strength during each testing periods differ significantly at 0.05 level, except during fourth cessation period between moderate intensity group and control group.
The result of the study reveals that during detraining period, the gradual decline of leg strength for moderate intensity group is similar to high intensity group up to 40 days.
The results of Scheffe's test for the moderate intensity circuit training group is presented in table 7f.

Table 2f: Scheffe's Test for the differences among Paired Means of Moderate Intensity Circuit Training Group during different Testing Periods on Leg Strength

Post Test	First Cessation	Second Cessation	Third Cessation	Fourth Cessation	Mean Difference
99.27	98.53				0.74
99.27		97.87			1.40*
99.27			95.93		3.34*
99.27				95.20	4.07*

	98.53	97.87			0.66
	98.53		95.93		2.60*
	98.53			95.20	3.33*
		97.87	95.93		1.94*
		97.87		95.20	2.67*
			95.93	95.20	0.73

* Significant at.05 level.
The confidence interval required for significance at 0.05 level is 0.96.

Table 7f shows that the changes on leg strength of moderate intensity circuit training group differ significantly at 0.05 level for the paired means of post-test with second, third and fourth cessations; first cessation with third and fourth cessations; & second cessation with third and fourth cessations. Rest of the paired means didn't differ significantly.

Table 2g: Scheffe's Test for the differences among Paired Means of High Intensity Circuit Training Group during different Testing Periods on Leg Strength

Post Test	First Cessation	Second Cessation	Third Cessation	Fourth Cessation	Mean Difference
103.87	103.20				0.67
103.87		102.53			1.34*
103.87			98.13		5.74*
103.87				97.40	6.47*
	103.20	102.53			0.67
	103.20		98.13		5.07*
	103.20			97.40	5.80*
		102.53	98.13		4.40*
		102.53		97.40	5.13*
			98.13	97.40	0.73

* Significant at.05 level.
The confidence interval required for significance at 0.05 level is 0.96.

With regard to the changes on leg strength, the trend observed for the moderate intensity group is also reflected for the high intensity group.
During detraining period the decline on leg strength for high intensity circuit training group was significant during third cessation.

5. Discussion
The leg strength of moderate intensity circuit training group declined significantly during third cessation.
The results of Scheffe's test for the high intensity circuit training group is presented in table2g.
1. Both experimental groups have significantly increased the leg strength as compared to control group. Further, the improvement of leg strength is significantly higher for high intensity group than moderate intensity circuit training group.
2. The leg strength of moderate intensity circuit training group declined significantly during third cessation.
3. During detraining period the decline on leg strength for high intensity circuit training group was significant during third cessation.
4. During detraining period, the gradual decline of leg strength for moderate intensity group is similar to high intensity group up to 40 days.

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