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Effect of different intensity of circuit training and detraining on peak expiratory flow rate

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Abstract
The purpose of the study was to find out the effect of different intensity circuit training and detraining on Peak Expiratory Flow Rate. To achieve the purpose of the study, 45 untrained male students from the Department of Physical Education and Sports Sciences, Annamalai University were selected at random as subjects from volunteers, in the age group of 18 to 20 years. The selected subjects neither have the experience of organised fitness training nor participating in any other special coaching programme.
The chosen subjects were randomly assigned into three groups of 15 each. Group I underwent moderate intensity circuit training, group II followed high intensity circuit training and group III acted as control subjects.
A qualified physician examined the subjects medically and declared that they were fit to undergo the circuit training programme. All the subjects had a similar academic work and regular activities in accordance with the requirements of the university curriculum. The subjects in the control group were not engaged in any activity other than the regular curriculum during the training period. The subjects were free to withdraw their consent to participate in the training programme, in case they felt any discomfort during the period of training. But there were no dropouts in the study. After the completion of ten weeks of moderate and high intensity circuit training periods, the subjects of both experimental groups were physically detrained for 40 days. Both experimental groups have significantly increased the peak expiratory flow rate as compared to control group. Further, the improvement of peak expiratory flow rate is significantly higher for high intensity group than moderate intensity circuit training group. During detraining period the decline on peak expiratory flow rate for high intensity circuit training group was significant during second and third cessation. The maximum rate of deterioration has occurred during second cessation.

Keywords: circuit training, flow rate

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.

Table 1: Tests used for Criterion Variables

S. No	Criterion Variables	Instrument/ Test/ Method/ Formula	Unit of Measurement
1.	Peak Expiratory Flow Rate	Wright's Peak Flow Meter	Litres/Minute

Experimental Protocols
The experimental groups I and II were subjected to ten weeks of moderate intensity and high intensity circuit training programmes respectively. Training was given during alternative days for three days a week for both experimental groups. The circuit training programme was scheduled for one session per day in the morning between 6.30 and 8.00 am. During every session the workout lasted approximately for 90 minutes inclusive of warming up, training and warm down process. Circuit training was given under the direct supervision of the investigator. The control group did not participated in any of the circuit training programme. All the criterion variables were tested for three groups prior and after the training period.

Detraining Period
After the completion of ten weeks of moderate and high intensity circuit training periods, the subjects of both experimental groups were physically detrained for 40 days.

Peak Expiratory Flow Rate
Purpose: To measure the peak expiratory flow rate.
Equipment used: Mini Wright's Peak Flow Meter and Dettol were used.

Procedure
The Mini Wright's peak flow meter consists of a mouthpiece, a marker and a calibrated air tube. When the air is "Puffed" into the mouthpiece, the marker moves along the calibrated air tube and measures the peak expiratory flow rate. The subject stood and grabbed the instrument in one hand in such a way that the fingers do not obstruct the slot. The instrument was held in hand tightly with the slot facing away from the hand with the flattered part of the plastic mouthpiece in horizontal position. Then, the subject inhaled through his mouth to the maximum capacity. He then expelled the maximum possible amount of air by blowing out into the mouthpiece with a hard blow. The expelled air caused the marker to move up the scale. The values were the marker came to rest was recorded as the peak flow rates in liters

per minute. Thereafter, the marker was gently pushed back. Three chances were given. The mouthpiece was disinfected with Dettol after use by each subject.

Scoring

The reading indicated by the marker was taken as the score in liters per minute. The best of three trials was taken into account (Wright, 1990).

Analysis of Peak Expiratory Flow Rate Training Effect

The mean and standard deviation values on peak expiratory flow rate 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 Peak Expiratory Flow Rate 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	469.33	526.00	521.33	512.00	503.33	497.33
	SD	8.83	21.64	20.30	18.59	16.76	15.79
High Intensity Circuit Training Group	Mean	461.33	540.66	534.67	520.66	509.33	504.00
	SD	13.55	12.79	13.56	12.79	13.34	11.21
Control Group	Mean	464.00	464.67	466.00	467.33	467.33	468.00
	SD	15.94	9.90	13.52	14.86	13.34	16.56

The details of peak expiratory flow rate during six testing periods among three groups are graphically illustrated in figure 1.

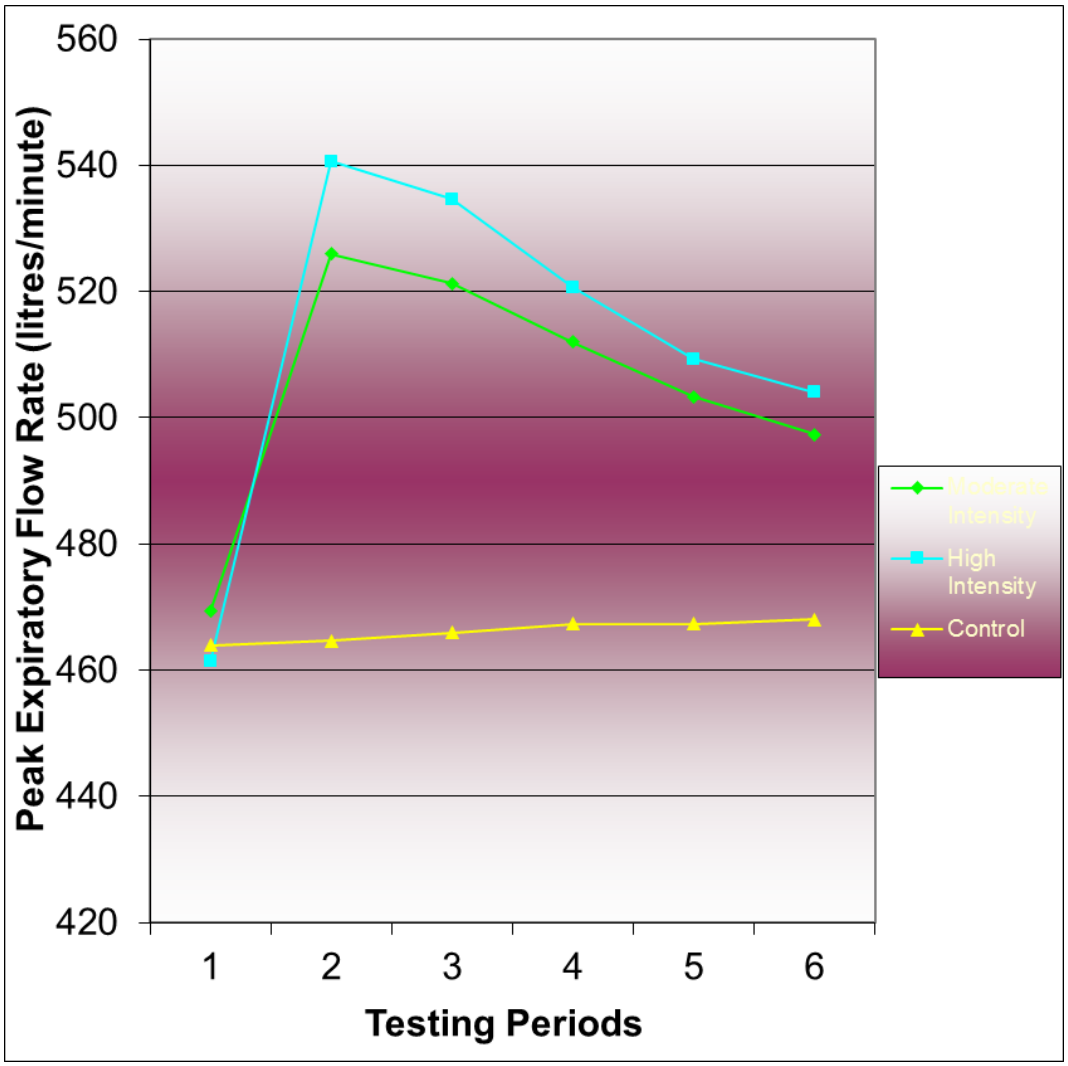

Fig 1: Graphical Representation of Pretest, Posttest and Four Cessations Data of Moderate Intensity, High Intensity and Control Groups on Peak Expiratory Flow Rate

The analysis of covariance for the pre and post-tests data on peak expiratory flow rate of experimental and control groups have been analysed and presented in table 3.

Table 3: Analysis of Covariance for Pre and Post Tests Data on Peak Expiratory Flow Rate of Experimental and Control Groups

Group / Test	Moderate Intensity Circuit Training	High Intensity Circuit Training	Control Group	Source of Variance	Sum of Squares	df	Mean Squares	'F' Ratio
Pretest Mean	469.33	461.33	464.00	Between	497.77	2	248.88	1.44
SD	8.83	13.55	15.94	Within	7226.66	42	172.06	
Posttest Mean	526.00	540.67	464.66	Between	48764.4	2	24382.2	100.14*
SD	21.64	12.79	9.90	Within	10226.7	42	243.49	
Adjusted Posttest Mean	523.31	542.82	465.20	Between	48894.1	2	24447.1	132.09*
				Within	7588.14	41	185.07	

* 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 3 shows that the obtained 'F' ratio value of 1.44 for pretest mean on peak expiratory flow rate is not significant at 0.05 level. It reveals that there is statistically no significant difference among experimental and control groups on muscular endurance before the commencement of circuit training.

The 'F' ratio value of 100.14 for post-test data on peak expiratory flow rate is significant at 0.05 level.

The 'F' ratio value of 132.09 for adjusted post-test on peak expiratory flow rate is significant at 0.05 level. It reveals that there is significant difference among the groups on peak expiratory flow rate as a result of circuit training.

The result of Scheffe's post-hoc test is presented in table 4.

Table 4: Scheffe's Test for the Differences between the Adjusted Post Test Paired Means on Peak Expiratory Flow Rate 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		
523.31	542.82		19.51	0.05
523.31		465.20	58.11	0.05
	542.82	465.20	77.62	0.05

The confidence interval required for 0.05 level of significance is 12.62.

Table 4 shows that all the three paired means are significant at 0.05 level. It reveals that both experimental groups have significantly increased the peak expiratory flow rate as compared to control group. Further, the improvement of peak expiratory flow rate is significantly higher for high intensity group than moderate intensity circuit training group.

Influence of Detraining

The data on peak expiratory flow rate have been analysed by two-way factorial ANOVA (3 x 5) with repeated measures on last factor and the results are presented in table 5.

Table 5: Analysis of Variance on Peak Expiratory Flow Rate of Experimental and Control Groups at Five Different Testing Periods

Source of Variance	Sum of Squares	df	Mean Squares	"F" Ratio
Rows (Groups)	129987.6	2	64993.7	63.06*
Error	43285.33	42	1030.603	
Columns (Testing Periods)	14024.00	4	3506.00	96.75*
Interaction (Groups X Testing Periods)	9608.00	8	1201.00	33.14*
Error	6088.00	168	36.24	

*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 6 it is clear that the obtained 'F' ratio for groups, 63.06 is significant at 0.05 level. It is evident that the influence of detraining on peak expiratory flow rate among moderate intensity, high intensity and control groups differ significantly.

Table 6 also shows that the obtained 'F' ratio for testing periods, 96.75 is significant at 0.05 level. It is found that the declines of peak expiratory flow rate during different testing periods differ significantly.

From the table 6 it is evident that the obtained 'F' ratio for the interaction between groups and testing periods is 33.14 is also significant at 0.05 level. The finding of the study implies that significant differences exist for the reduction on peak expiratory flow rate 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 7.

Table 7: Simple Effect Scores on Peak Expiratory Flow Rate 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	48753.82	2	24376.91	672.652*
Groups and First Cessation	39774.67	2	19887.33	548.767*
Groups and Second Cessation	24572.47	2	12286.23	339.024*
Groups and Third Cessation	15480	2	7740	213.576*
Groups and Fourth Cessation	11003.69	2	5501.84	151.817*
Testing Periods and Group I	8601.4	4	2150.35	59.336*
Testing Periods and Group II	14924.35	4	3731.09	102.955*
Testing Periods and Group III	106.33	4	26.58	0.733
Error	6088.00	168	36.24	

*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 7 shows that the changes on peak expiratory flow rate during all the five testing periods differ significantly at 0.05 level.

Table 12d also reveals that the changes on peak expiratory flow rate for both experimental groups differ significantly at 0.05 level, during different testing periods.

Since, the changes on peak expiratory flow rate 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 8.

Table 8: Scheffe's Test for the differences between the Paired Means of Post Test and Cessation Periods for Different Groups on Peak Expiratory Flow Rate

Testing Periods	Moderate Intensity Circuit Training Group	High Intensity Circuit Training Group	Control Group	Mean Difference
Post Test	526.00	540.66		14.66*
	526.00		464.67	61.33*
		540.66	464.67	75.99*
First Cessation	521.33	534.67		13.34*
	521.33		466.00	55.33*
		534.67	466.00	68.67*
Second Cessation	512.00	520.66		8.66*
	512.00		467.33	44.67*
		520.66	467.33	53.33*
Third Cessation	503.33	509.33		6.00*
	503.33		467.33	36.00*
		509.33	467.33	42.00*
Fourth Cessation	497.33	504.00		6.67*
	497.33		468.00	29.33*
		504.00	468.00	36.00*

* Significant at 0.05 level.
The confidence interval required for significance at 0.05 level is 5.43.

It is clear from table 8 that the changes on peak expiratory flow rate during each testing periods differ significantly at 0.05 level. The result of the study reveals that during detraining period, the gradual decline of peak expiratory flow rate for moderate intensity group is similar to that of high intensity group.
The results of Scheffe's test for the moderate intensity circuit training group is presented in table 9.

Table 9: Scheffe's Test for the differences among Paired Means of Moderate Intensity Circuit Training Group during different Testing Periods on Peak Expiratory Flow Rate

Post Test	First Cessation	Second Cessation	Third Cessation	Fourth Cessation	Mean Difference
526.00	521.33				4.67
526.00		512.00			14.00*
526.00			503.33		22.67*
526.00				497.33	28.67*
	521.33	512.00			9.33*
	521.33		503.33		18.00*
	521.33			497.33	24.00*
		512.00	503.33		8.67*
		512.00		497.33	14.67*
			503.33	497.33	6.00

* Significant at .05 level.
The confidence interval required for significance at 0.05 level is 6.84.

Table 9 shows that the changes on peak expiratory flow rate 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 second, third and fourth cessations; & second cessation with third and fourth cessations. Rest of the paired means didn't differ significantly.
The peak expiratory flow rate of moderate intensity circuit training group declined significantly during second and third cessation. The maximum rate of deterioration has occurred during second cessation.
The results of Scheffe's test for the high intensity circuit training group is presented in table 10.

Table 10: Scheffe's Test for the differences among Paired Means of High Intensity Circuit Training Group during different Testing Periods on Peak Expiratory Flow Rate

Post Test	First Cessation	Second Cessation	Third Cessation	Fourth Cessation	Mean Difference
540.67	534.67				6.00
540.67		520.67			20.00*
540.67			509.33		31.34*
540.67				504.00	36.67*
	534.67	520.67			14.00*
	534.67		509.33		25.34*
	534.67			504.00	30.67*
		520.67	509.33		11.34*
		520.67		504.00	16.67*
			509.33	504.00	5.33

* Significant at .05 level.

The confidence interval required for significance at 0.05 level is 6.84.
with regard to the changes on peak expiratory flow rate, the trend observed for the moderate intensity group is also reflected for the high intensity group.

During detraining period the decline on peak expiratory flow rate for high intensity circuit training group was significant during second and third cessation. The maximum rate of deterioration has occurred during second cessation.

Discussion

1. Both experimental groups have significantly increased the peak expiratory flow rate as compared to control group. Further, the improvement of peak expiratory flow rate is significantly higher for high intensity group than moderate intensity circuit training group.
2. The peak expiratory flow rate of moderate intensity circuit training group declined significantly during second and third cessation. The maximum rate of deterioration has occurred during second cessation.
3. During detraining period the decline on peak expiratory flow rate for high intensity circuit training group was significant during second and third cessation. The maximum rate of deterioration has occurred during second cessation.
4. During detraining period, the gradual decline of peak expiratory flow rate for moderate intensity group is similar to that of high intensity group.

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