STAR
Research Journal

Available online at www.starresearchjournal.com (Star International Journal)
PHYSICAL EDUCATION
UGC Journal No: 63023

INTERVENTION OF MODERATE AND HIGH INTENSITY CIRCUIT TRAINING AND DETRAINING ON PEAK EXPIRATORY FLOW RATE

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Abstract:

In the present 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 physiological variables used was peak expiratory flow rate and it was quantified by using standard test and equipments. The chosen subjects were divided into three equal groups of 15 each and designated as moderate intensity group, high intensity group and controlee group. Moderate and high intensity circuit training was given to concerned group for ten weeks. Controle group did not participated in any of the training. After the completion of ten weeks of training both experimental groups were physically detrained and became inactive for 40 days. In addition to pre test, data were collected for the variable once in ten days for four detraining periods for all the three groups. Analysis of Covariance (ANCOVA) and Scheffer's (ANCORA) Post Hoc tests were computed to examine the training effect. Further, two way 3x5 factorial ANOVA with last factor repeated measures, simple effect test and Scheffe's tests were used to analyse the influence of detraining. It was concluded that both experimental groups have significantly increased the peak expiratory flow rate and the improvement is significantly higher for high intensity group than moderate intensity group. It was also concluded that during detraining period the gradual decline of peak expiratory flow rate for moderate intensity group is similar to that of high intensity group.

Keywords: Moderate and high intensity circuit training – Detraining - peak expiratory flow rate.

INTRODUCTION

Circuit training was developed by R.E.Morgan and G.T.Anderson in 1953 at the University of Leeds in England (Sorani,1996). The term circuit refers to a number of carefully selected exercises arranged consecutively. Each participant moves from one station to the next with little or no rest, performing a 15 to 45 seconds work bout of 8 to 20 repetitions at each station. Circuit training may be performed with exercise machines, hand held weights, elastic resistance, calisthenics or any other combination. The circuit is split into different exercises which are known as work station. As the circuit progresses the trainer moves form one exercise to another in a pre-determined sequence completing a prescribed amount of work (sets / repetitions) at each station. Once the trainer has completed the prescribed work on each station they move on to the next work station. The trainee work different muscle groups on each work station. While one major muscle group is subject to exercise others are actively recovering (Sorani,1996). Circuit training is an excellent choice for developing all round physical and cardiovascular fitness. It involves a series of exercises carefully selected to simultaneously train all the major muscle groups of the body. As the trainee moves from one exercise to another the stimulus on major muscle groups changes. Generally a good circuit training programme involve each muscle group getting worked by several different exercises. The number of exercises per muscle group depends on the training effect to be achieved, the desired volume of work to be completed during a training session, the desired intensity of effort and the structure of the programme. Circuit weight training is a form of exercise that uses a number of weight exercise sets separated by short intervals.

Detraining refers to the cessation of regulars physical training. In general greater the gains during training the greater the losses during detraining simply because the well trained person has more to lose than the untrained person. In elite athletes many training improvements are lost within several weeks if an athlete stop training (Zatsior sky, 1995). Detraining causes muscle atrophy which is accompanied by losses in muscular strength and power. Detraining losses in speed and agility are less but flexibility seems to be lost quickly. With detraining losses of cardio-respiratory endurance are much greater than losses of muscular strength and power over the same time period. Many organic and cellular adaptation benefits are degraded. The decrease in the muscle fiber cross-sectional area is quite apparent after several weeks of inactivity. These changes are the result of protein breakdown, as well as a reduction in the recruitment pattern of the working muscle (Bompa,1999) . Exercise physiology is one of the most important areas of research in physical education

and sports.

METHODOLOGY

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 chosen subjects have not participated in organized circuit training programme earlier. A quailed Physician examined the subjects medically and declared that they were fit to undergo the circuit training. There were no dropouts in the study. The experimental variables used in the present study were moderate intensity and high intensity circuit training and which was finalized based on the pilot study. The criterion variable chosen was peak expiratory flow rate. It is a measure of how fast and forcefully a person can flow the air out. This shows how well the lungs are functioning. Peak expiratory flow rate was measured by using Mini Wright's peak flow meter and the data was recorded in liters per minute **(Subrahmanyam and Madhavam kutty,2001)**.

TRAINING PERIOD

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 direct supervision of the investigator. The control group did not participated in any of the circuit training programme. Peak expiratory flow rate was 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. During the detraining period both the experimental groups were ceased the circuit training and became inactive. They have not participated in circuit training or in any other strenuous physical exercise throughout the detraining period and they were under the control of the investigator. During the 40 days of detraining period, peak expiratory flow rate was tested once in ten days for four detraining periods for both experimental groups and control group.

CIRCUIT TRAINING REGIMENS

In both the circuit training regimens, the subjects moved from one station to another, which was alternated by unloaded and loaded exercise for 10 stations. The details of circuit exercises are furnished in table I. The subjects performed the prescribed exercises for the fixed duration at each station. The duration of unloaded and loaded exercise for moderate intensity circuit training group varied between 25 to 40 seconds and for high intensity circuit training group it varied between 30 to 45 seconds. The percentage for 1 RM for loaded exercise for moderate intensity and high intensity circuit training groups ranged between 40 to 50 and 50 to 60 respectively. The number of circuits for both the groups varied between two and three for ten weeks. The recovery interval between circuits for moderate intensity group is two to four minutes and for high intensity group is three to five minutes. The recovery interval between exercise for moderate intensity circuit training and high intensity circuit training groups ranged between 10 to 20 seconds and 15 to 25 seconds respectively. The intensity of exercise was progressively increased once in two weeks. The moderate and high intensity circuit training regimens are presented in tables II and III respectively.

TABLE - I
SEQUENTIAL ORDER OF CIRCUIT TRAINING EXERCISES FOLLOWED IN THE PRESENT STUDY

Order of Exercise	Name of the Exercise	Body Regions Involved	Major Muscles Involved	Body Position	Equipments Used
1	Burpee	Whole Body	Hamstring, rectus abdominis, biceps, triceps, quadriceps and erector spinae	Combined	
2	Barbell Preacher Curl	Upper Limbs	Biceps, brachialis and forearm flexors	Standing	Barbell & Weight Plates
3	Sit –ups	Abdomen	Rectus abdominis and intercostals	Supine lying	
4	Bench Press	Chest & Upper Limbs	Pectorals, anterior & medial deltoids, triceps and latissimus dorsi	Supine lying	Barbell & Weight Plates
5	Hyper Extension	Back & Lower Limbs	Spinal erector, gluteus and hamstring	Prone lying	
6	Bent over Lateral Raise	Shoulders & Upper Back	Posterior & medial deltoid and upper back	Standing	Iron Dumbbells

7	Squat Jumps	Whole Body	Hamstring rectus abdominis quadriceps gastrocnemius and erector spinae	Combined	
8	Seated Pulley Rows	Back & Upper Limbs	Trapezius, lattisimus dorsi erector spinae posterior deltoids biceps brachialis and forearm flexors	Sitting	Rowing Machine
9	Push –ups	Upper Limbs	Biceps brachialis triceps and forearm extensors	Prone lying	
10	Calf Raise	Lower Limbs	Gastrocnemius	Standing	Calf Raise Machine

TABLE-II
MODERATE INTENSITY CIRCUIT TRAINING REGIMENS

Week	No. of Station	Duration for Unloaded & Loaded Exercise (seconds)	Percentage of 1 RM for Loaded Excise	No. of Circuit	Recovery between Circuit (minutes)	Recovery between Exercise (seconds)
I & II	10	25	40	2	2	10
III&IV	10	30	45	2	2 1/2	12
V&VI	10	30	45	3	3	15
VII&VIII	10	35	50	3	3 1/2	18
IX & X	10	40	50	3	4	20

TABLE -III
HIGH INTENSITY CIRCUIT TRAINING REGIMENS

Week	No. of Station	Duration for Unloaded & Loaded Exercise (seconds)	Percentage of 1 RM for Loaded Excise	No. of Circuit	Recovery between Circuit (minutes)	Recovery between Exercise (seconds)
I & II	10	30	50	2	3	15
III&IV	10	35	55	2	31/2	17
V&VI	10	35	55	3	4	20
VII&VIII	10	40	60	3	4 1/2	23
IX & X	10	45	60	3	5	25

EXPERIMENTAL DESIGN

The experimental design used for the present study was random group design involving 45 volunteers as subjects. For the detraining effects 3 x 5 factorial design with the last factor repeated measures was used. The first factor denotes two experimental groups and control group, and the second factor indicates five testing periods namely post- test and four tests during detraining period.

STATISTICAL TECHNIQUE

To examine the effect of moderate and high intensity circuit training on peak expiratory flow rate Analysis of Covariance (ANCOVA) was computed (Clarke & Clarke, 1972) for the data collected from moderate intensity high intensity, and control groups during pretest and posttest . Further, since three groups were involved whenever the F ratio was significant Scheffe's Post Hoc test was used to determine which of the paired mean differ significantly.

In order to explore the influence of detraining on chosen variable, the data collected from both experimental groups and control groups during four stages of detraining were analysed by calculating two way 3 x 5 factorial ANOVA with last factor repeated measures.

When the interaction (groups and testing periods) was significant, the simple effect test (Rothstein,1985) was used as a follow up test. Whenever simple effect test showed significant difference, Scheffe's test was applied as Post Hoc test to find out which of the paired means showed significant difference. In determining the level of significance 0.05 was fixed. The data was analysed in computer by using standard statistical packages.

ANALYSIS OF PEAK EXPIRATORY FLOW RATE TRAINING EFFECT

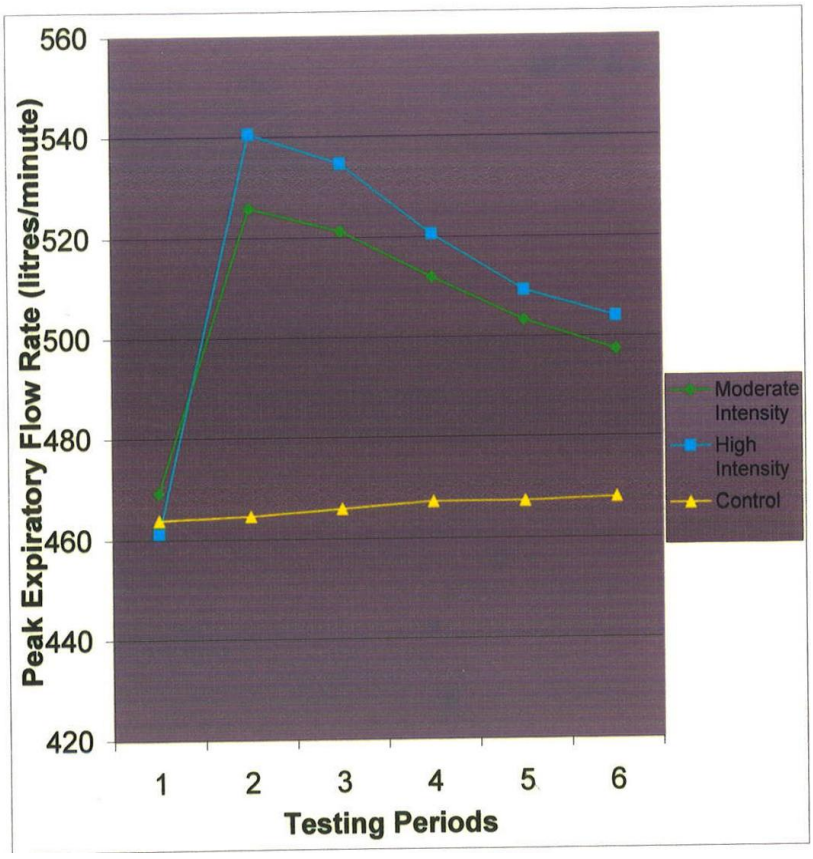
The mean and standard deviation values on peak expiratory flow rate of moderate intensity circuit training group, high intensity circuit training group and control group during six different testing periods have been presented in table IV.

TABLE - IV
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	16.79	15.79
High Intensity Circuit Training Group	Mena	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.

FIGURE - I
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 posttests data on peak expiratory flow rate of experimental and control groups have been analysed and presented in table V.

TABLE -V
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 degrees of freedom 2, 24 is 3.22. Table V 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 peak expiratory flow rate 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-VI.

TABLE – VI
SCHEFFE'S TEST FOR THE DIFFERENCE 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 -VI 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-VII.

TABLE -VII
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' Ration
Rows (Groups) Error	129987.6 43285.33	2 42	64993.7 1030.603	63.06*
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 VII 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 VII 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 VII 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 VIII.

TABLE - VIII
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' Ration
Groups and Post Test	48753.82	2	24376.91	672.652*
Group and First Cessation	39774.67	2	19887.33	548.767*
Group and Second Cessation	24572.47	2	12286.23	339.024*
Group 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 VIII shows that the changes on peak expiratory flow rate during all the five testing periods differ significantly at 0.05 level. Table VIII 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-IX.

TABLE -IX
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 IX 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 periods, 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 X.

TABLE - X
SCHEFFE'S TEST FOR THE DIFFERENCE 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	503.00		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 X 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 XI

TABLE - XI.
SCHEFFE'S TEST FOR THE DIFFERENCE 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 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. Based on findings it is concluded that:

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.

REFERENCES

1. Bompa Tudor O.(1999). Periodization Theory and Methodology of Training (4th ed.) Champaign, Illinois Human: kinetics.
2. Barrow, Harold M.& McG, Rosemary (1996). A Practical Approach to Measurement of Physical Education, Philadelphia: Lea and Febiger.
3. Clarke, Harrison H. and David H. Clarke(1972). Advanced Statistics with Application to Physical Education, Englewood Cliffs, New jersey : Prentice Hall.
4. Cromwell,L, Weibell, Fred J. & Pfeiffer, Erich A. (2002). Biomedical Instrumentation and Measurements (2nd ed.) New Delhi: Prentice Hall of India Pvt. Ltd.
5. Fox, Edward L., Richard W. Bowers & Merle L. Foss (1993). The Physiological Basis for Exercise and Sports (5th ed.) Dubugue, Iowa: WMC Brown and Benchamane Publishers.
6. Gautrin D.et. al., (1994). Comparison between peak expiratory flow rates (PEFR) and FEVI in the monitoring of Asthmatic subjects at an outpatients clinic. Chest , Vol.106 .
7. Gettman L.R., & Pollock , M.L. (1981). Circuit weight Training: A critical review of its physiological benefits. The Physician and Sports Medicine, 9.
8. Gossard, D.et.al., (1986). Effects of low and high intensity home based exercise training on functional capacity in healthy middle aged men. Am J Cardiol , 57 (6).
9. Haennel, R. et. al., (1989). Effects of hydraulic circuit training on cardiovascular function. Medisci Sports Exerc. 21 (5).
10. Harris, K.A.& Holly R.G.(1987). Physiological responses to circuit weight training in borderline hypertensive subjects. Medicine and Science in Sports and Exercise,19.
11. Sharver, Larry G. (1982). Essentials of Exercise Physiology, Delhi : Surjeet Publications.
12. Sorani , R.(1966). Circuit Training. Dubuque , IA: WM. C. Brown.
13. Subrahmanyam Sarada & Madhavan Kutty K. (2001). Text Book of Human Physiology, New Delhi: Chand and Company.
14. Wilmore J.H. & Costill, D.L. (1994). Physiology of Sport and Exercise. Champaign: Human kinetics.
15.