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Original Research Article

The Efficacy of Cycle Ergometry in Improving Cardiac Behaviour and Reducing Dyspnoea in Asthmatic Persons

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ABSTRACT

Background and Objectives: The purpose of this study is to access the efficacy of cycle ergometry in reducing dyspnoea and improving cardiac behaviour in asthmatic patients.
Method: 50 asthmatic individuals were divided into two groups ie, experimental group consisted of 25 asthmatics and control group consisted of 25 asthmatics. The asthmatic patients in experimental group received cycle ergometry for 6 minutes whereas those in control group did not receive any exercise. Blood pressure, Heart rate, Rate pressure product, Borg's scale of perceived exertion was assessed prior and after the exercise.
Results: Greater significant reduction were seen in systolic blood pressure (P<0.001), diastolic blood pressure (P<0.001), heart rate (P<0.001) and rate pressure product (P<0.001) in experimental group as compared to control group. But significance was less in the case of reducing the ratings of perceived exertion.
Conclusion: Cycle ergometry proved to have a positive effect in improving the cardiovascular status of asthmatic patients but have minimal changes in dyspnoea.
Interpretation: Experimental group in whom cycle ergometery was given showed better improvement in the cardiovascular fitness and dyspnoea ratings than control group.
Key words: Cycle ergometry, dyspnoea, cardiac functions, Borg's scale

INTRODUCTION

Asthma is a chronic inflammatory disease of the airways, characterized by increased responsiveness of the tracheo-bronchial tree to variety of stimuli. [1] 300 million people worldwide currently have asthma with highest prevalence found in UK, New Zealand, Australia, China and India. It is a major cause of morbidity and mortality with an approximate of 180,000 deaths each year. [2] Asthma, one of the common disorders of the respiratory system has a prevalence of 2.38% with females having significantly higher odds in India. [3]

Asthma may be exaggerated by various stimuli like

- Allergens
- Infections
- Occupational stress
- Pharmacological stress

- Emotional stress
- Environmental stress. [2]

Typical signs associated with asthma include recurrent episodes of wheezing, chest tightness and dyspnoea, usually accompanied by cough and limited exercise tolerance.

Dyspnoea: It can be defined as the sensation of difficulty in breathing. It is difficult to quantitate because it is subjective and at times is normal. Usually dyspnoea occurs when the body's requirement for breathing exceeds the body's capacity to provide it. It is a symptom of cardiac and pulmonary diseases as well as of other conditions.

There are three basic causes of dyspnoea.

1) An increased awareness of normal breathing-related to anxiety, where the patients breathing pattern is irregular, with frequent sighs.

2) An increase in the work of breathing – greater inspiratory pressures must be generated by the respiratory muscles to move air in and out of the lungs as in small or large airway obstruction which may be due to broncho constriction, sputum and inflammation.

3) An abnormality in the ventilator system-ventilatory apparatus consists of the thoracic cage, respiratory muscles and nerves, any of these may become dysfunctional.

Grading of dyspnoea according to 5 grade (0-4) scale [4]

0: No dyspnoea
1: Mild noticeable
2: Some difficulty
3: Moderate difficulty but can continue activity
4: Severe difficulty, cannot continue activity

In asthma, intra-thoracic pressure increases during peak inspiration, resulting in a transient decrease in venous return and thereby causing a decrease in stroke volume output of the heart resulting in pulse pressure variation. [5] During an asthma attack, there is no sufficient air entering the lungs, which causes stress and releases adrenaline that speeds up heart beat, also the pressure in the lungs makes it difficult for the blood to pass by the capillaries and to be oxygenated. An elevation in systolic pressure may be a significant clinical sign as in the case of asthma. [6]

Physical therapy management includes;

1. Reduce the work of breathing
2. Maximise aerobic capacity and efficiency of oxygen transport
3. Optimise physical endurance and exercise capacity

The primary interventions for maximizing cardiopulmonary function and oxygen transport in patients with asthma include education, aerobic exercise, strengthening exercise, chest wall mobility exercise, range of motion, relaxation, activity pacing and stress management. Exercise training enables the patient to determine the balance between optimal aerobic capacity and medication and the optimal physical environment for exercise. The less aerobically fit an individual, the less physiological reserve capacity is available in the cardiovascular and pulmonary systems.

On the one hand, exercise can provoke an increase in airways resistance leading to exercise induced asthma; on the other hand, regular physical activity and participation in sports are considered to be useful in the management of asthma. An increase in regular physical activity of sufficient intensity to increase aerobic fitness will raise the ventilatory threshold, thereby lowering the minute ventilation during mild and moderate exercise. Exercise training may also reduce the perception of breathlessness through other mechanisms including strengthening of the respiratory muscle. [7]

A cycle ergometer is a stationary bicycle with saddle, pedals and handle bars along with an ergometer to measure the work done by the exerciser. It is used in physical therapy because of the low – impact, safe and effective cardiovascular exercise it provides. On a cycle ergometer upper body can remain relatively stable, allowing for more accurate determination of blood pressure. [8]

M Emtner conducted a study on 26 asthmatic patients by giving supervised rehabilitation programme and showed improvements in cardiovascular conditioning, breathlessness and anxiety. [9]

Ioannis Vogiatzis, Andrew Frederick Williamson also found that Submaximal aerobic exercise training of moderate intensity (50% of baseline peak work rate) performed twice weekly for 12 weeks in 60 patients with COPD showed significant reductions in minute ventilation, Co2 output and heart rate. [10]

A various study done by C J Clark, L M Cochrane and Sibel Basaran et al: also showed improvement in cardiac function and dyspnoea status for the patients having asthma following Submaximal exercise performed on bicycle ergometer. [11,12]

Many studies have been conducted on the efficacy of cycle ergometry in improving the cardiovascular functions but hardly few studies were done on the efficacy of cycle ergometry in improving dyspnoea and cardiac functions in asthmatic patients. . Hence the study was conducted to determining the efficacy of cycle ergometery in improving dyspnoea and cardiac functions in asthmatic patients and to compare the changes in cardiovascular and dyspnoea level with and without cycle ergometer in asthmatic individuals

METHODOLOGY

Study design: Comparative trial
Sample size: 50
Sampling technique: Simple Random Sampling
Population: Asthmatic Individuals
Study duration: 8 weeks

Inclusion criteria:

1. Asthmatic individuals within age group of 20-50 years.
2. Individuals having asthma with duration of 6 months to 1 year.
3. Individuals with mild to moderate asthma rated according to Borg dyspnoea scale, (0-4) grade.
4. Patients on bronchodilator excepts beta-2 agonist and anticholinergics which have a direct effect on heart

Exclusion criteria:

1. Individuals who have severe dyspnoea rated according to Borg's (0-4) grade dyspnoea scale.
2. Patients with exercise induced asthma.
3. Subjects with any cardiac diseases, pregnant women, any neurological disorders.
4. Persons with peripheral vascular diseases.
5. Obese individuals.

Method of data collection:

At the entry to the study, all the 50 participants were assessed and those who met with above mentioned inclusion criteria were selected for their respective groups. After explaining the purpose of the study, the subjects who were ready to participate in the study were asked to sign consent form.

Group A : Consist of 25 asthmatic individuals to whom 6 minutes of cycle ergometry were given.

Group B : Consist of 25 asthmatic individuals to whom no exercise were given.

Outcome Measures

- Heart rate
- Systolic & Diastolic blood pressure
- Rate pressure product (RPP)
- Rating of perceived exertion (RPE)

Tools:

1) Heart rate monitor
2) Sphygmomanometer
3) Borg's 15 point RPE scale
4) Cycle ergometer

Procedure:

Prior to procedure individuals who met the inclusion criteria were assessed and evaluated thoroughly by using the questionnaire (Annexure 1). After signing the consent form they were made to participate in study.

Individuals having asthma who were given cycle ergometry were kept under GROUP A and those individuals who were not given any treatment were distributed under GROUP B.

Group A: Consist of 25 asthmatic individuals to whom 6 minutes of cycle ergometry were given.

Group B: Consist of 25 asthmatic individuals to whom no exercise were given.

Following the above procedure the individuals belonging to both the groups were evaluated for above mentioned testing parameters and the data obtained were tabulated.

Experimental Group

On day1, the heart rate(radial pulse) measured by palpation method, BP using sphygmomanometer, RPE using Borg's scale and Rate Pressure product (RPP) of the individuals were noted before exercise. RPP was measured as the product of systolic BP and Heart rate. They were made to perform Astrand's Sub-maximal cycle ergometry for 6 minutes. The aim during the test was to raise the subject's heart rate above 120 beats per minute. If this is not achieved within first 2 minutes, the work rate should be increased by 50%. Usually a steady state is reached after 4-5 minutes if the work rate is not too heavy. The pulse rate averaged for the fifth and sixth minute is taken as the heart rate response to the exercise demand. If the heart rate goes beyond the maximum heart rate, exercise should be stopped.

Maximum heart rate is calculated using the formula

Max. HR = 220-Age

After 6 minutes of exercise, Blood pressure was recorded, also RPE and RPP were noted down. All patients in this group were trained for a period of 8 weeks, 4 times a week for 6 minutes.

All the parameters were noted each day before and after the exercise.

Fig- 1: Cycle ergometer

Control Group

The heart rate, blood pressure and RPE of the asthmatic individuals were monitored on day1 and end of each week

Ethical Consideration: Procedures followed were in accordance with the ethical standards of Helsinki Declaration of 1975, as revised in 2000. [13]

RESULTS

The study was conducted on 50 subjects who were divided into two groups, experimental group and control group, consisting of 25 subjects each. The subjects in experimental group were given cycle ergometry and in control group were not given any exercise. Blood pressure, heart rate, rate pressure product and rating of

perceived exertion were assessed as the outcome measures. Although the scores were taken on daily basis, for statistical analysis the values on the 1st day and 4th day of week 1, week 4 and week 8 were used. The comparison of pre and post values was done using students paired t test, and improvement between two groups was done using students un-paired t test and Mann-Whitney U test was used for inter group comparison.

Table 1: Descriptive Statistics of Age

	Group	Mean	Std. Deviation	t value	p value
Age	Experimental	23.56	3.229	.845	.402
	Control	22.92	1.977		NS

Table 1 shows the descriptive statistics of age distribution of the subjects in both Experimental and Control Group. The mean age and SD of the 25 individuals in Experimental Group is 23.56 ± 3.22 and the mean age and SD in Control Group is 22.92 ± 1.97. There is no significant difference between Experimental Group and Control Group with respect to age. (t = 0.84, p = 0.402, NS)

Table 2: Gender Wise Distribution of Subjects in Experimental and Control Group

		Group		
		Experimental	Control	Total
Sex	F	15	14	29
		60.0%	56.0%	58.0%
	M	10	11	21
		40.0%	44.0%	42.0%
Total		25	25	50
		100.0%	100.0%	100.0%

x2 = 0.082, p=0.774, NS

Table 2 shows the gender distribution among 50 individuals who participated in the study. Experimental Group had 15 females (60.0%) and 10 males (40.0%). Control Group had 14 females (56.0%) and 11 males (44.0%).

Table 3: SBP Values in Both the Groups

Group		N	Minimum	Maximum	Mean	Std. Deviation	Median	t value	d.f	p value
Experimental	SBP WEEK – 1 pre	25	100	140	123.20	12.819	120.00	38.648	24	p<0.001
	SBP WEEK – 1 end of 4th day	25	120	158	141.60	12.741	140.00			HS
	SBP WEEK – 4 pre	25	116	154	137.28	12.895	136.00	25.695	24	p<0.001
	SBP WEEK – 4 end of 4th day	25	112	150	132.80	12.987	132.00			HS
	SBP WEEK – 8 pre	25	106	146	128.96	12.899	128.00	18.000	24	p<0.001
	SBP WEEK – 8 end of 4th day	25	102	144	125.36	12.893	122.00			HS
Control	SBP WEEK – 1 pre	25	110	150	126.80	12.819	120.00	.00	24	1.000
	SBP WEEK – 1 end of 4th day	25	110	150	126.80	12.819	120.00			NS
	SBP WEEK – 4 pre	25	110	142	124.72	10.310	120.00	.00	24	1.000
	SBP WEEK – 4 end of 4th day	25	110	142	124.72	10.310	120.00			NS
	SBP WEEK – 8 pre	25	110	140	124.16	9.797	120.00	.00	24	1.000
	SBP WEEK – 8 end of 4th day	25	110	140	124.16	9.797	120.00			NS

TABLE 3 shows SBP values in both the groups, in first week ,Experimental Group mean value before the treatment was 123.2 ± 12.81,at the end of 4th day it was 141.60 ± 12.74 in 1st week,132.8 ± 12.98 in 4th week and 125.36 ± 12.89 in 8th week (p<0.001,HS).In Control Group mean value before the treatment was 126.8 ± 12.81,at the end of 4th day it was 126.81 ± 12.81 in 1st week,124.72 ± 10.31 in 4th week,124.16 ± 9.79 in 8th week (p=1.00,NS)

Table 4: SBP Difference in Both the Groups

	Group	N	Minimum	Maximum	Mean	Std. Deviation	Median	t value	d.f	p value
SBP diff. Week -1	Experimental	25	-24	-16	-18.40	2.380	-18.00	38.65	48	p<0.001
	Control	25	0	0	.00	.000	.00			HS
SBP diff. Week -4	Experimental	25	4	6	4.48	.872	4.00	25.69	48	p<0.001
	Control	25	0	0	.00	.000	.00			HS
SBP diff. Week -8	Experimental	25	2	6	3.60	1.000	4.00	18.00	48	p<0.001
	Control	25	0	0	.00	.000	.00			HS

TABLE 4 shows SBP difference between the groups. In Experimental Group, mean value was 18.4 ± 2.38 in week 1,4.48 ± 0.87 in week 4,3.6 ± 1.00 in week 8 compared to the Control Group in which the mean values were 0.Pre to Post comparison shows that there is significant decrease of SBP in the 4th and 8th week than from week 1 in the Experimental Group.

Table 5: DBP Value In Both The Groups

Group		N	Minimum	Maximum	Mean	Std. Deviation	Median	t value	d.f	p value
Experimental	DBP WEEK – 1 pre	25	68	90	83.44	6.746	80.00	24.000	24	p<0.001
	DBP WEEK – 1 end of 4th day	25	72	96	88.24	7.008	86.00			HS
	DBP WEEK – 4 pre	25	72	94	87.04	6.432	86.00	4.000	24	.001
	DBP WEEK – 4 end of 4th day	25	70	94	86.24	7.008	84.00			HS
	DBP WEEK – 8 pre	25	70	94	85.84	6.854	84.00	5.527	24	p<0.001
	DBP WEEK – 8 end of 4th day	25	68	92	84.72	6.997	82.00			HS
Control	DBP WEEK – 1 pre	25	80	90	86.40	4.899	90.00	.00	24	1.000
	DBP WEEK – 1 end of 4th day	25	80	90	86.40	4.899	90.00			NS
	DBP WEEK – 4 pre	25	80	90	86.40	4.899	90.00	.00	24	1.000
	DBP WEEK – 4 end of 4th day	25	80	90	86.40	4.899	90.00			NS
	DBP WEEK – 8 pre	25	80	90	86.40	4.899	90.00	.00	24	1.000
	DBP WEEK – 8 end of 4th day	25	80	90	86.40	4.899	90.00			NS

TABLE 5 shows DBP values in both the groups, in first week ,Experimental Group mean value before the treatment was 83.44 ± 6.74,at the end of 4th day it was 88.24 ± 7.0 in 1st week,86.24 ± 7.0 in 4th week and 84.72 ± 6.99 in 8th week (p<0.001,HS).In Control Group mean value before the treatment was 86.4 ± 4.89,at the end of 4th day it was 86.4 ± 4.89 in 1st week,4th week and 8th week(p=1.00,NS).

Table 6: DBP Difference in Both the Groups

	Group	N	Minimum	Maximum	Mean	Std. Deviation	Median	Mann-Whitney Test Z value	p value
DBP diff. Week -1	Experimental	25	-6	-4	-4.80	1.000	-4.00	24.00	p<0.001
	Control	25	0	0	.00	.000	.00		HS
DBP diff. Week -4	Experimental	25	0	2	.80	1.000	.00	4.00	p<0.001
	Control	25	0	0	.00	.000	.00		HS
DBP diff. Week -8	Experimental	25	0	2	1.12	1.013	2.00	5.53	p<0.001
	Control	25	0	0	.00	.000	.00		HS

TABLE 6 shows DBP difference between the groups. In Experimental Group, mean value was 4.8 ± 1.0 in week 1, 0.8 ± 1.0 in week 4, 1.12 ± 1.01 in week 8 compared to the Control Group in which the mean values were 0.Pre to Post comparison shows that there is significant decrease of SBP in the 4th and 8th week than from week 1 in the Experimental Group.

Table 7: RPP Values in Both the Groups

Group		N	Minimum	Maximum	Mean	Std. Deviation	Median	t value	d.f	p value
Experimental	RPP WEEK – 1 pre	25	6800	10360	8846.40	1015.032	8840.00	55.538	24	p<0.001
	RPP WEEK – 1 end of 4th day	25	15600	21560	19032.56	1806.322	19040.00			HS
	RPP WEEK – 4 pre	25	14616	20944	17964.32	1836.727	17952.00	29.614	24	p<0.001
	RPP WEEK – 4 end of 4th day	25	13664	19800	16874.56	1767.123	16836.00			HS
	RPP WEEK – 8 pre	25	12720	18688	15843.36	1710.378	15876.00	35.046	24	p<0.001
	RPP WEEK – 8 end of 4th day	25	11832	17608	14900.00	1654.925	14884.00			HS
Control	RPP WEEK – 1 pre	25	7480	10500	8928.00	927.254	8840.00	.00	24	1.000
	RPP WEEK – 1 end of 4th day	25	7480	10500	8928.00	927.254	8840.00			NS
	RPP WEEK – 4 pre	25	7700	10080	8809.60	749.334	8840.00	.00	24	1.000
	RPP WEEK – 4 end of 4th day	25	7700	10080	8809.60	749.334	8840.00			NS
	RPP WEEK – 8 pre	25	7700	9936	8749.28	706.434	8704.00	.00	24	1.000
	RPP WEEK – 8 end of 4th day	25	7700	9936	8749.28	706.434	8704.00			NS

TABLE 7 shows RPP values in both the groups, in first week ,Experimental Group mean value before the treatment was 8846.4 ± 1015.03,at the end of 4th day it was 19032.56 ± 1806.32 in 1st week,16874.56 ± 1767.12 in 4th week and 14900.0 ± 1654.9 in 8th week (p<0.001,HS).In Control Group mean value before the treatment was 8928.0 ± 927.25,at the end of 4th day it was 8928.0 ± 927.2 in 1st week,8809.6 ± 749.33 in 4th week,8749.28 ± 706.43 in 8th week (p=1.00,NS)

Table 8: RPP Difference in Both the Groups

	Group	N	Minimum	Maximum	Mean	Std. Deviation	Median	t value	d.f	p value
RPP diff. Week -1	Experimental	25	-11940	-8460	-10186.16	917.052	-10200.00	55.54	48	p<0.001
	Control	25	0	0	.00	.000	.00			HS
RPP diff. Week -4	Experimental	25	400	1380	1089.76	183.997	1096.00	29.61	48	p<0.001
	Control	25	0	0	.00	.000	.00			HS
RPP diff. Week -8	Experimental	25	692	1256	943.36	134.589	968.00	35.05	48	p<0.001
	Control	25	0	0	.00	.000	.00			HS

TABLE 8 shows RPP difference between the groups. In, Experimental Group mean value was 10186.16 ± 917.05 in week 1,1089.76 ± 183.99 in week 4,943.36 ± 134.5 in week 8 compared to the Control Group in which the mean values were 0.Pre to Post comparison shows that there is significant decrease of RPP in the 4th and 8th week than from week 1 in the Experimental Group.

Table 9: RPE Values In Both The Groups

Group		N	Minimum	Maximum	Mean	Std. Deviation	Median	t value	d.f	p value
Experimental	RPE WEEK – 1 pre	25	11	14	12.24	1.052	12.00	.00	24	1.000
	RPE WEEK – 1 end of 4th day	25	11	14	12.24	1.052	12.00			NS
	RPE WEEK – 4 pre	25	10	13	11.24	1.052	11.00	.00	24	1.000
	RPEWEEK – 4 end of 4th day	25	10	13	11.24	1.052	11.00			NS
	RPE WEEK – 8 pre	25	9	12	10.24	1.052	10.00	.00	24	1.000
	RPE WEEK – 8 end of 4th day	25	9	12	10.24	1.052	10.00			NS
Control	RPE WEEK – 1 pre	25	11	14	12.48	1.005	12.00	.00	24	1.000
	RPE WEEK – 1 end of 4th day	25	11	14	12.48	1.005	12.00			NS
	RPE WEEK – 4 pre	25	11	14	12.20	.957	12.00	.00	24	1.000
	RPEWEEK – 4 end of 4th day	25	11	14	12.20	.957	12.00			NS
	RPE WEEK – 8 pre	25	10	14	12.00	1.000	12.00	.00	24	1.000
	RPE WEEK – 8 end of 4th day	25	10	14	12.00	1.000	12.00			NS

TABLE 9 shows RPE values in both the groups, in first week ,Experimental Group mean value before the treatment was 12.24 ± 1.05,at the end of 4th day it was 12.24 ± 1.05 in 1st week,11.24 ± 1.05 in 4th week and 10.24 ± 1.05 in 8th week (p=1.00,NS).In Control Group mean value before the treatment was 12.48 ± 1.00,at the end of 4th day it was 12.48 ± 1.00 in 1st week,12.20 ± 0.95 in 4th week,12.00 ± 1.00 in 8th week (p=1.00,NS)

Table 10: RPE Difference in Both the Groups

	Group	N	Minimum	Maximum	Mean	Std. Deviation	Median
RPE diff. Week -1	Experimental	25	0	0	.00	.000	.00
	Control	25	0	0	.00	.000	.00
RPE diff. Week -4	Experimental	25	0	0	.00	.000	.00
	Control	25	0	0	.00	.000	.00
RPE diff. Week -8	Experimental	25	0	0	.00	.000	.00
	Control	25	0	0	.00	.000	.00

TABLE 10 shows RPE difference between the groups. In both Experimental and Control Group, mean value was 0.00 in week 1, week 4 and week 8.Pre to Post comparison shows that there is no significant improvement in dyspnoea in both the groups.

DISCUSSION

The study was conducted to examine the efficacy of cycle ergometry in reducing dyspnoea and improving cardiac functions in asthmatic patients. The numbers of subjects were sufficient for adequate statistical comparisons. The exercise was carefully controlled with supervision.

Results showed improvement in all cardiovascular parameters like systolic and diastolic blood pressure, heart rate, rate

pressure product except rating of perceived exertion with 8 weeks of cycle ergometry.

The result shows a significant reduction in blood pressure (P<0.001) and rate pressure product (P<0.001) in Experimental Group than in Control Group. The Heart rate values shows a higher significance in the 1st week (P<0.05) but then shows no significant difference (P=1.00) later in the 4th and the 8th week. Compared to the Control Group, in which there were no difference in the mean values from week 1 to week 8, Experimental Group shows greater reductions in heart rate.

The ratings of perceived exertion shows only a minute change from week 1 to week 8 in both Experimental and Control Group (P=1.00) ie, there no significant difference between the values.

In several studies, progressive cycle ergometry proved to be effective in improving cardiovascular fitness and reducing dyspnoea in asthmatic individuals. [9,11,14]

Thus we can say that cycle ergometry is a better choice of exercise for asthmatic individuals in improving cardiovascular fitness but this may not have greater influence on the dyspnoea reductions.

CONCLUSION

The study was done on asthmatic subjects who underwent cycle ergometry for a period of 8 weeks and found to be effective in improving cardiac parameters and reducing dyspnoea. Statistically experimental group showed better improvement in the cardiovascular fitness and dyspnoea ratings than control group. In conclusion, cycle ergometery showed a positive effect in improving cardiovascular status but had minimal changes in dyspnoea.

Limitation of the study:

- Study was limited to duration of 8 weeks.
- The duration and intensity of exercise was limited on dyspnoea.
- No follow up was done.

Scope of further study:

- Exercise at different intensities should be carried out to check for dyspnoea.
- Longer periods of exercise programme and follow up is required.

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Conflict of interest – None

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