Research Article

The effect of aerobic exercises on peak expiratory flow rate and physical fitness index in female subjects

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Received July 21, 2015. Accepted July 31, 2015

Abstract

Background: A widely acknowledged fact is that people with more physical activity inclined to possess greater degree of fitness and physical activity can enhance cardiorespiratory health. **Aims and Objective:** To study the effect of aerobic exercises on peak expiratory flow rate (PEFR), body mass index (BMI), and physical fitness index (PFI) in apparently healthy female subjects. **Materials and Methods:** This study was conducted after a clearance from institutional ethical committee on 25 apparently healthy female subjects in the age group of 19–35 years who had voluntarily enrolled in a local health club, under the supervision of an expert trainer. The subjects were divided into two groups depending upon the aerobic exercise regimen they followed. They were assessed for height, weight, BMI, body surface area (BSA), PEFR, and PFI by Harvard step test at three different time intervals: 0 week, 6 weeks, and 10 weeks. The mean values of all the parameters were compared and evaluated. **Result:** There were significant changes ($p < 0.001$) in all the parameters while comparing with the baseline values at the three time intervals; an increase in PEFR, fall in BMI, and rise in PFI was seen. While comparing the values between the two groups, no significant difference could be found. **Conclusion:** Any form of aerobic exercise proves to be beneficial if followed consistently. Both the groups experienced an improvement in PEFR, BMI, and PFI, but labeling as which aerobic regimen was better could not be done.

KEY WORDS: PEFR; BMI; PFI; Aerobic Exercise; females

Introduction

Exercises in the form of sports, aerobics, or workouts, if performed regularly, have a beneficial effect on the various systems of the body. The major advantage of such exercises is that the increase in blood flow to the various organs results in distribution of more nutrients, thereby enhancing their functioning. Special attention is being given to the vital organs of the body such as the heart, brain, and lungs to know the effect of exercise on these organs.[1]

Access this article online	
Website: http://www.njppp.com	Quick Response Code:
DOI: 10.5455/njppp.2015.5.2107201560	

The physical ability and physiological reactions of an individual can be studied by means of exercise. As pulmonary function is a long-term indicator of overall survival rates in both the sexes, it forms a vital tool in general health assessment.[2] Exercise gives rise to remarkable changes in bodily conditions owing to its stressful nature, and lungs are not excluded. On the contrary, inactive lifestyles could result in lesser effective pulmonary functions. Many studies have shown that effect of exercise exerts noteworthy enhancements in pulmonary functions.[3–5]

Metabolic activities is on the rise during exercising; therefore, both the pulmonary and the cardiac systems exert greater efforts to make available an elevated level of ventilation and cardiac output, respectively.[6]

Table 1: Baseline mean values at 0 week

	Group 1 (n = 12), mean ± SD	Group 2 (n = 13), mean ± SD
Age (years)	24.75 ± 5.11	26.69 ± 6.38
Height (cm)	155.33 ± 4.29	154.84 ± 5.52
Weight (kg)	76.41 ± 9.02	81.15 ± 8.28
BMI (kg/m^2)	31.73 ± 4.15	33.95 ± 4.14
BSA (m^2)	1.81 ± 0.11	1.86 ± 0.10
PEFR (L/min)		
Pretest	420 ± 36.43	412.30 ± 33.20
Posttest	445 ± 36.80	436.15 ± 32.28
PFI (%)	53.0 ± 4.12	52.56 ± 4.39

Peak expiratory flow rate (PEFR) is the maximal expiratory flow rate achieved, and this occurs very early in the forced expiratory maneuver. As PEFR analyzes how quick a person can breathe out (exhale) air, it is one of the many tests that measure how well your airways work.[7] A widely acknowledged fact is that people with more physical activity inclined to possess greater degree of fitness and that physical activity can enhance cardiorespiratory health and pulmonary function in healthy sedentary people.[8,9] The American College of Sports Medicine (ACSM) defines aerobic exercise as "any activity that uses large muscle groups, can be maintained continuously, and is rhythmic in nature." Aerobic is a form of exercise that increases the burden of the heart and lungs, making them to exert greater efforts than at rest[10] (e.g., walking, jogging, running, skipping, dancing, swimming, bicycling, etc.).

It is possible that better lung function is related to activity-induced bronchodilation. Such dilatory effects predominate at brief episodes and at reasonable levels of physical activity in everyday life.[11–15] Regular exercise leads to numerous and varied physiological changes, which improves the quality of life. In general, pulmonary functions are estimated by the strength of the respiratory muscles, amenability of the thoracic cavity, airway resistance, and elastic recoil of the lungs.[16]

In this study, exploration of the relation between the type of aerobic exercise and PEFR was done where young female subjects performed different types of aerobic exercises. Their PEFR and physical fitness index (PFI) were assessed at three different time intervals.

Materials and Methods

This study was conducted on 25 apparently healthy female subjects in the age group of 19–35 years who had voluntarily enrolled in a local health club, under the supervision of an expert trainer. A routine health examination was performed on all the subjects before the study. All the subjects were assessed for the following parameters: height, weight, body mass index (BMI), body surface area (BSA), PEFR, and PFI.

The subjects were divided into two groups depending upon the type of exercise regimen they followed. The recording of the various parameters was done at three intervals. The readings taken at the start of the training were regarded as 0 week; then, subsequent readings were taken at 6 weeks; and the final readings were taken at 10 weeks. The groups were divided as follows:

Group 1: Warmup for 10 min; treadmill for 20 min; cycling for 10 min; and step test for 5 min.

Group 2: Warmup for 10 min; aerobics for 30 min; and step test for 5 min.

The subjects followed the regimen for at least 5 days in a week. The values were recorded into two phases. Phase 1 consisted of recording of PEFR before the exercise session (pretest values), and phase 2 was recording PEFR, 8–10 min after the exercise session (posttest values). All the subjects were briefed about the procedures before the commencement of the study, and an informed consent was obtained. No controls were taken as the values at the start of the study served as control values.

During the initial week, they were allowed to run on the treadmill at their comfortable speed and, then, increase the intensity slowly. Subjects were asked to refrain from tea, coffee, chocolates, and caffeinated soft-drinks on the day of recording.

Table 2: Variations in parameters in group over a period of 10 weeks

	0 Week, Mean ± SD	6 Weeks, Mean ± SD	Paired t test, p	0 Week, Mean ± SD	10 Weeks, Mean ± SD	Paired t test, p
Weight (kg)	76.41 ± 9.02	73.79 ± 8.79	0.000	76.41 ± 9.02	71.20 ± 8.50	0.000
BMI (kg/m^2)	31.73 ± 4.15	30.65 ± 4.07	0.000	31.73 ± 4.15	29.57 ± 3.93	0.000
BSA (m^2)	1.81 ± 0.11	1.78 ± 0.10	0.000	1.81 ± 0.11	1.75 ± 0.107	0.000
PEFR (L/min)						
Pretest	420 ± 36.43	450 ± 30.74	0.000	420 ± 36.43	488.33 ± 32.42	0.000
Posttest	445 ± 36.80	475 ± 31.76	0.000	445 ± 36.80	505.83 ± 32.32	0.000
PFI (%)	53.0 ± 4.12	57.34 ± 3.46	0.000	53.0 ± 4.12	60.66 ± 3.43	0.000

$p > 0.05$, not significant;
$p < 0.05$, significant;
$p < 0.001$, highly significant.

Table 3: Variations in parameters in group 2 over a period of 10 weeks

	0 Week, Mean ± SD	6 Weeks, Mean ± SD	Paired *t* test, *p*	0 Week, Mean ± SD	10 Weeks, Mean ± SD	Paired *t* test, *p*
Weight (kg)	81.15 ± 8.28	78.69 ± 8.13	0.000	81.15 ± 8.28	75.61 ± 8.24	0.000
BMI (kg/m^2)	33.95 ± 4.14	32.91 ± 4.03	0.000	33.95 ± 4.14	31.63 ± 4.07	0.000
BSA (m^2)	1.86 ± 0.10	1.83 ± 0.10	0.000	1.86 ± 0.10	1.80 ± 0.103	0.000
PEFR (L/min)						
Pretest	412.30 ± 33.20	448.46 ± 35.08	0.000	412.30 ± 33.20	482.33 ± 32.42	0.000
Posttest	436.15 ± 32.28	462.30 ± 32.69	0.000	436.15 ± 32.28	500.00 ± 28.28	0.000
PFI (%)	52.56 ± 4.39	57.18 ± 3.09	0.000	52.56 ± 4.39	61.48 ± 2.54	0.000

$p > 0.05$, not significant;
$p < 0.05$, significant;
$p < 0.001$, highly significant.

PEFR Measurement

It was done with the help of a Mini-Wright Peak Flow Meter. The graduations are for every 10 L/min. The values for PEFR recorded at the start of the study were counted as 0 week, next readings were taken at an interval of 6 weeks, and the third set of readings was taken at 10 weeks. The procedure was practiced by the study participants. After adequate amount of practice, the study subjects were asked to take full inspiration and blow into mouthpiece as quickly, powerfully, and fully as possible. It was checked that a tight closure was sustained between the lips and the mouth piece of the flow meter. Each subject was given three trials, and the best of three was taken for the study.

PFI (Harvard step test) was calculated by the formula:

$$\text{PFI} = \frac{\text{Duration of exercise in seconds} \times 100}{5.5 \times \text{pulserate}(1 - 1.30 \text{ min after exercise})}$$

PFI score was calculated and represented as: excellent (>90), good (80–90), high average (65–79), low average (55–64), and poor (<55).

Exclusion criteria

The subjects who took part in this study were not doing any type of exercise or yoga before volunteering for the study. A complete history was collected, and the study subjects were subjected to clinical examination to exclude any noticeable cardiopulmonary compromise. Subjects with the history of smoking, history of severe chest trauma, with obvious chest and spinal deformity, and with personal/family history of asthma, chronic obstructive pulmonary diseases, and other cardiorespiratory diseases were excluded from the study.

At the end of the study, we compared the two groups with respect to the various parameters studied and tried to look for any significant difference in the findings in the types of aerobic regimen followed by the two groups. The data collected was analyzed by one-way ANOVA test and Student's *t* test. The difference was considered significant if the *p*-value was <0.05 and highly significant if the *p*-value was <0.001.

Results

The baseline mean values for all the parameters in the subjects in both groups 1 and 2 were recorded [Table 1]. The variations in these parameters in group 1 subjects (*n* = 12) over a period

Table 4: Comparison of parameters between groups 1 and 2

	0 Week			6 Weeks			10 Weeks		
	Group 1	Group 2	*p*[a]	Group 1	Group 2	*p*[a]	Group 1	Group 2	*p*[a]
Weight (kg)	76.41 ± 9.02	81.15 ± 8.28	0.814	73.79 ± 8.79	78.69 ± 8.13	0.161	71.20 ± 8.50	75.61 ± 8.24	0.201
BMI (kg/m^2)	31.73 ± 4.15	33.95 ± 4.14	0.197	30.65 ± 4.07	32.91 ± 4.03	0.176	29.57 ± 3.93	31.63 ± 4.07	0.213
BSA (m^2)	1.81 ± 0.11	1.86 ± 0.10	0.200	1.78 ± 0.10	1.83 ± 0.10	0.175	1.75 ± 0.107	1.80 ± 0.103	0.216
PEFR (L/min)									
Pretest	420 ± 36.43	412.30 ± 33.20	0.586	450 ± 30.74	448.46 ± 35.08	0.909	488.33 ± 32.42	482.33 ± 32.42	0.625
Posttest	445 ± 36.80	436.15 ± 32.28	0.528	475 ± 31.76	462.30 ± 32.69	0.336	505.83 ± 32.32	500.00 ± 28.28	0.635
PFI (%)	53.0 ± 4.12	52.56 ± 4.39	0.799	57.34 ± 3.46	57.18 ± 3.09	0.905	60.66 ± 3.43	61.48 ± 2.54	0.501

[a]Unpaired *t* test.

Table 5: Correlation of parameters in group 1

	0 week			6 week			10 week		
	PEFR, Pretest	PEFR, Posttest	PFI	PEFR, Pretest	PEFR, Posttest	PFI	PEFR, Pretest	PEFR, Posttest	PFI
BMI									
r	-0.698	-0.678	-0.725	-0.643	-0.551	-0.644	-0.511	-0.514	-0.628
p	0.012*	0.015*	0.008**	0.003**	0.063	0.024*	0.089	0.087	0.029*
BSA									
r	-0.719	-0.716	-0.899	-0.583	-0.474	-0.85	-0.444	-0.386	-0.386
p	0.008**	0.009**	<0.001**	0.047*	0.119	0.000**	0.148	0.216	0.004*
PEFR (L/min)									
Pretest									
r	—	0.942	0.64	—	0.94	0.562	—	0.982	0.652
p		<0.001**	0.025*		0.000**	0.057		0.000**	0.022*
Posttest									
r	0.942	—	0.617	0.949	—	0.51	0.982	—	0.618
p	<0.001**		0.033*	0.000**		0.09	0.000**		0.032*

*$p < 0.05$, significant;
**$p < 0.01$, significant.

of 10 weeks [Table 2] when compared using a paired *t* test showed that the mean value for weight dropped significantly. Mean values for BMI also showed a highly significant improvement when compared between 0 week and 6 weeks and between 6 and 10 weeks. Following BMI, BSA also decreased significantly. The change in PEFR was recorded before and after the aerobic session. The pretest values increased significantly when compared with the posttest values between 0 week and 6 weeks and between 6 and 10 weeks. The PFI estimated after the Harvard step test increased significantly from 0 week to 6 weeks and from 6 to 10 weeks. Table 3 shows the findings in group 2 subjects (n = 13).

The comparison between the groups at various time intervals was done using the unpaired *t* test [Table 4]. All the said parameters were compared. None of the parameter showed any statistical significance.

The correlation values for group 1 are depicted in Table 5. At 0 week (baseline), BMI was negatively correlated with PFI and PEFR (both pre- and posttest). This correlation was statistically significant. BSA was negatively correlated with PFI and PEFR (both pre- and posttest). This correlation was also statistically significant. PEFR (pretest) was positively correlated with PEFR (posttest) and PFI. At 6 weeks, BMI revealed a negative correlation with PEFR (pretest) and PFI, which was

Table 6: Correlation of parameters in group 2

	0 week			6 week			10 week		
	PEFR, Pretest	PEFR, Posttest	PFI	PEFR, Pretest	PEFR, Posttest	PFI	PEFR, Pretest	PEFR, Posttest	PFI
BMI									
r	-0.773	-0.784	-0.238	-0.773	-0.719	-0.352	-0.789	-0.749	-0.278
p	0.002**	0.002**	0.435	0.002**	0.006**	0.238	0.001**	0.003**	0.357
BSA									
r	-0.035	-0.077	0.237	-0.071	0.022	0.02	-0.114	-0.011	0.157
p	0.911	0.803	0.435	0.818	0.944	0.948	0.711	0.97	0.608
PEFR (L/min)									
Pretest									
r	—	0.973	0.348	—	0.991	0.34	—	0.967	0.4
p		0.000**	0.244		0.000**	0.256		0.000**	0.176
Posttest									
r	0.973		0.355	0.991		0.332	0.967		0.343
p	0.000**	—	0.263	0.000**	—	0.267	0.000**	—	0.251

*$p < 0.05$, significant;
**$p < 0.01$, significant.

statistically significant. Pre- and posttest PEFR values showed a positive correlation, which was statistically significant.

Table 6 shows correlation values for group 2. At 0 week, there was a negative correlation between BMI and PEFR (pretest and posttest), which was statistically significant. Pretest PEFR values also showed a statistically significant positive correlation with posttest PEFR values. At 6 and 10 weeks, a similar statistically significant negative correlation was found between BMI and PEFR (pretest and posttest). Pretest and posttest PEFR values also showed a statistically significant positive correlation. At 10 weeks, a positive correlation was also seen between BMI and PFI and BSA and PFI, which was statistically significant. Both pretest and posttest PEFR values also showed a significant positive correlation.

Discussion

On the basis of the theoretical model proposed by Bouchard et al.,[17] health-related physical fitness is classified as follows: morphological, muscular, motor, cardiorespiratory, and metabolic fitness. Aerobic fitness estimates the amount of exhaustion that is mostly experienced by all in everyday life. The higher the aerobic fitness, the less fatigue one experiences. Aerobic fitness is the capacity to sustain work for extended sessions.[18]

Inactive lifestyles could result in lesser effective pulmonary functions and a positive effect on the lungs by elevating pulmonary capacity, and hence enhancing the lung functioning, could be achieved by regular running exercises.[19] A few studies on aerobic exercise and pulmonary function in general population are available.[20]

PEFR, being an easy test for quick assessment of improvement of an overall pulmonary function, has been used in our study. In our study, over a period of 10 weeks, the subjects in both the groups showed a significant fall in BMI and a highly significant increase in PEFR and PFI. This finding is supported by the fact that people with higher levels of physical activity tend to have higher levels of fitness and that physical activity can improve cardiorespiratory fitness.[8] Cheng et al. also concluded in their study that the physical activity improved pulmonary function in healthy sedentary people, as is seen in our findings.[9]

The fall in BMI values over the duration of our study is also supported by a study wherein BMI was inversely correlated with most of the pulmonary function abnormalities.[21] In addition, a moderate weight loss by 12-week diet and exercise program significantly improve the breathing mechanics during exercise for obese men.[22] The cause of improvement in PEFR values can be because of aerobic exercises, which are known to enhance the breathing efficiency and decrease pulmonary resistance and, on the other hand, decrease the fat percentage.[23]

The improvement in aerobic exercises may have occurred because the regular exercises strengthen the respiratory muscles (diaphragm and intercostals). This may have further helped in better chest expansion and, therefore, improving the chest cavity. Thus, larger chest cavity means more air could be inspired, therefore increasing the vital capacity and enabling more capillaries to be formed around the alveoli so that more gaseous exchange can take place. During aerobic exercise, minute ventilation increases and an increased load is placed on the respiratory muscles.[24]

The correlation between physical fitness and BMI in urban American youth was reported[25] in which a reduction in physical fitness with increase BMI was observed, which is very similar to our findings of a significant correlation of BMI and PFI in group 1 and a less significant correlation in group 2. Higher BMIs were generally associated with lower fitness.[26] In another study, the efficiency fitness index of the subjects differed significantly from one another in the various BMI categories, with the subjects of normal weight possessing a higher fitness than the overweight or obese subjects. Fitness capacity, therefore, decreased progressively as the BMI increased.[27]

The intergroup comparisons showed no significant difference in any of the parameters, indicating that the exercise regimen followed by both the groups was no doubt beneficial to the subjects but no specific aerobic exercise regimen could be labeled as having a better effect on PEFR, PFI, and BMI.

Many noncommunicable diseases that occur as a result of unfavorable lifestyle can be prevented in the early stages by assessing the aerobic fitness and by making necessary changes in lifestyle.[18] Exercise, in any form, if followed regularly, can bring benefits in otherwise sedentary individuals. Aerobic fitness indicates one's capacity to undergo strenuous work. Hence, it can be used to assess one's lifestyle, indirectly.

Conclusion

Involvement in certain types of physical activities such as aerobic exercises can help in improvement in pulmonary function and one's physical fitness. It can also inculcate a healthier lifestyle. From our study groups, we conclude that different types of aerobic exercises can bring an improvement in PEFR and PFI and a fall in BMI, if followed consistently. We were not able to pinpoint as to which type of aerobic exercise regimen can bring about more prominent results as the difference between our study groups at the end of the study was not significant.

The limited number of subjects taken and conducting the study exclusively on female subjects can be a few of the limitations of our study. Moreover, the results could have been refined by estimation of VO_2 Max values and other cardiorespiratory parameters.

Acknowledgments

We are extremely thankful to the subjects for their cooperation. We are also grateful to the Ethical Committee for allowing us to undertake this study.

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How to cite this article: Bassi R, Sharma S, Sharma A, Kaur D, Kaur H. The effect of aerobic exercises on peak expiratory flow rate and physical fitness index in female subjects . Natl J Physiol Pharm Pharmacol 2015;5:376-381.

Source of Support: Nil, **Conflict of Interest:** None declared.