

# 18. Effect of High Intensity Circuit Training in Peak Expiratory Flow

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## EFFECT OF HIGH INTENSITY CIRCUIT TRAINING IN PEAK EXPIRATORY FLOW RATE VALUE AMONG YOUNG MALE ADULTS

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### ABSTRACT

**Background:** Lung function has a mutual correlation with exercise. Abnormal lung function can affect the physical ability to exercise. Otherwise, exercise can increase lung function. Peak expiratory flow rate (PEFR) is a parameter to observe lung function. High Intensity Circuit Training (HICT) is a combination of aerobic and endurance exercise, which has a total duration of only 7-minutes long. High Intensity Circuit Training can be a good choice for young adults because it does not need much time, easy to be practiced, and beneficial for physical health as well. **Objective:** To analyze a significant increase in PEFR value after High Intensity Circuit Training for eight weeks. **Methods:** This study was quasi-experimental with a pre-test and post-test comparison group method. Samples were taken purposively from medical student of Diponegoro University (n=56, age=18-21 years old), divided into two groups, the control and training groups. A peak flow meter was used to measure PEFR value before and after the intervention. The data were analyzed using Paired t-test and Independent t-test. **Results:** A significant increase in PEFR value was found after High Intensity Circuit Training for eight weeks ( $p=0.000$ ). The mean difference between pre-test and post-test PEFR value was found increased significantly ( $p=0.001$ ), that training group had higher score as compared to control group. **Conclusion:** Regular High Intensity Circuit Training can improve lung function, particularly PEFR value in young male adults.

**Keywords:** *High Intensity Circuit Training, Peak expiratory flow rate*

### INTRODUCTION

Exercise is a form of physical activity that is carried out regularly, which will improve the development of the function of the organs of the human body. When exercising regularly, the body's muscles work together to increase muscle strength, muscle flexibility, agility, movement coordination, and cardiorespiratory system endurance.<sup>1,2</sup> Pulmonary function and exercise have a reciprocal relationship. Impaired lung function can affect the physical ability to exercise, on the other hand, physical exercise can improve lung function. One of the parameters used to assess lung function is the peak expiratory flow rate (PEFR). PEFR is an important parameter to measure how strong the maximum airflow can be expelled when performing a maximum expiration. The peak expiratory current value can be measured using a simple tool in the form of a small tube that is practical and easy to carry, namely the Peak Flow Meter.<sup>3</sup>

A study by Chaitra B (2011) proved that there is a relationship between aerobic exercise and increased lung function, an increase in PEFR value of 17% was found in 40 healthy people aged 17-20 years who were given a running intervention.<sup>4</sup> Similar results were also obtained study by (2017) with a skipping intervention for 8 weeks in the 18 – 22 -year age group.<sup>5</sup>

Circuit training is a form of exercise that combines aerobic exercise with resistance training by performing a series of movements performed one at a time.<sup>6</sup> Several researchers have investigated how to increase the intensity of this type of exercise, which became known as High Intensity Circuit Training (HICT). HICT consists of 12 kinds of movements, with a duration of 30 seconds for each movement, so overall, HICT only takes about 7 minutes. With a relatively short training duration, it can be done anywhere and only requires a simple tool in the form of a chair. This form of exercise can be the sport of choice for individuals with a busy schedule. HICT has also been known to have various significant benefits for the body.<sup>7, 8, 9, 10</sup> One of them is Bill's research (2017) conducted on obese women with HICT intervention for nine weeks, this type of exercise has been shown to reduce fat mass, increase  $VO_2$  max, strength, and quality of life.<sup>11</sup> However, no studies prove the effect of HICT on increasing peak expiratory flow, especially in male young adults.

This study's objective is to investigate the effect of HICT in peak expiratory flow rate value among young male adults.



## METHODS

This research method was quasi-experimental with pre-and post-test comparison groups. The subject was taken by purposive sampling method among male medical students of Diponegoro University with an age range from 18 to 20 years old, normal body mass index (BMI) range of 18.5-24.9 kg/m<sup>2</sup>, no impaired function of the superior and inferior extremities, willing to be a study subject for eight weeks, did not participate in sports other than HICT for eight weeks, and did not do high-intensity exercise 1 day before the initial PEFR measurement. The exclusion criteria for this study were having a history of cardiovascular or pulmonary disease and being an active smoker.

There were 62 subjects, divided into two groups: control and intervention. The subjects were not allowed to smoke and had not previously performed HICT regularly. Subjects signed informed consent after being informed about the study's concept, which was to perform HICT only during the study and to measure PEFR before and after HICT. Subjects with a history of pulmonary or cardiovascular disease were excluded. Six subjects dropped out because they did not attend less than 75% of the total HICT exercise or only followed less than 75% of the movement; thus, 56 subjects were analyzed for PEFR value measurement.

From April to June 2018, HICT exercises were held indoors at the Faculty of Medicine Diponegoro University. The exercise consisted of a simple, vigorous-intensity exercise that combined aerobic and resistance exercise into 12 movements in 7 minutes using one chair, three times per week for eight weeks.

The PEFR value of both groups was measured by Peak Flow Meter at the beginning and end of 8 weeks of HICT performing.

The normality of the data's distribution was determined using the Kolmogorov-Smirnov test ( $n > 50$ ). The data that normally distributed were analyzed using the paired and independent t-test, and other data used the Wilcoxon and Mann-Whitney test. The data were analyzed using SPSS v.23.0, and the significant difference was determined when the  $p$ -value  $< 0.05$ .

## RESULTS

### Characteristics of the Subject

All subjects were young male adults between 18 and 20, with an average age of  $19.75 \pm 1.14$ . The subjects' average height was  $167.68 \pm 5.68$  cm, and the average weight was  $61.82 \pm 6.88$  kg. All subjects had normal BMIs, with the average being  $21.95 \pm 2.03$  kg/m<sup>2</sup>. Table 1 shows the characteristics of the subject.

Table 1. Characteristics of the research subjects

Variable	Control (n=28) Mean (SD)	Intervention 20 (n=28) Mean (SD)
Age (year)	19.75 (1.143)	18.93 (0.716)
Height (cm)	167.68 (5.677)	170.71 (6.710)
Weight (kg)	61.82 (6.875)	63.64 (8.795)
BMI (kg/m <sup>2</sup> )	21.953 (2.031)	21.897 (2.132)

### Measurement of PEFR value before and after 8-week HICT

After being tested using paired t-test, the treatment group showed a significant difference in PEFR mean with a significance value of 0.00 ( $p < 0.05$ ). The mean PEFR pre-test value was 531.79 and the mean PEFR post-test value was 558.21 (Table 2). Thus, it can be concluded that there was a significant increase in the mean PEFR in the intervention group after eight weeks of High Intensity Circuit Training. Paired t-test was also used in the control group, the results showed that the mean difference between the pretest and post-test PEFR values was not significant because the  $p$ -value was 0.304 ( $p > 0.05$ ).

Table 2. PEFR value differences before and after HICT exercise

Group	Pretest (Mean±SD)	Posttest (Mean±SD)	p*
Control	522.14 ± 50.137	558.21 ± 56.375	0.000*
Intervention	531.79 ± 63.190	513.93 ± 50.136	0.304

\* $p < 0.05$  was considered as significant



After the normality test with Kolmogorov-Smirnov was carried out, it was found that the difference in the PEFR (posttest - pretest) value was normally distributed. Therefore, the difference in PEFR values was tested by unpaired t-test, with the result that the p-value was 0.001 ( $p < 0.05$ ). From these results, it can be concluded that there is a significant difference in the increase in PEFR in the treatment group compared to the control group, where the mean difference in PEFR after HICT exercise in the treatment group is greater than the control group (Table 3).

**Table 3.** Comparison of Difference in PEFR Value of Intervention and Control Group

Group	Mean (SD)	p*
Control	26.43 (31.176)	0.001*
Intervention	0.71 (25.666)	

\* $p < 0.05$  was considered as significant

## DISCUSSION

This study shows the effect of High Intensity Circuit Training (HICT) exercise for eight weeks on the peak expiratory flow rate (PEFR). Based on the results of statistical tests, the treatment group that was given an intervention of HICT exercise for eight weeks showed a significant increase in the PEFR value. Meanwhile, in the control group who were not given the HICT exercise intervention and only carried out their usual daily activities, there was no significant difference in their PEFR values. The increase in PEFR between the intervention group and the control group showed a significant difference where the difference in PEFR value in the treatment group was greater than the control group.

High Intensity Circuit Training (HICT) is a type of high-intensity exercise that combines aerobic exercise and endurance training, consisting of 12 movements and are performed for approximately 7 minutes.<sup>10</sup> In this study, HICT exercise with a frequency of 3 times a week for eight weeks can have a good long-term effect on several organ systems in young adults due to the adaptation mechanisms of the musculoskeletal, cardiovascular and respiratory systems.

In the musculoskeletal system, HICT exercise will cause an increase in muscle strength through the mechanism of increasing protein synthesis in muscle contractile when the muscles contract.<sup>12</sup> Actin and myosin filaments will increase progressively, then myofibrils will become hypertrophied. The

hypertrophied fibers will increase the components of the phosphagen metabolism system, namely ATP and creatine phosphate. This increase in creatine phosphate reserves increases the ability of the aerobic and anaerobic metabolic systems that affect muscle strength.<sup>13</sup> Research by Solanki, et al. (2015) has proven that there is a significant positive increase in muscle strength and endurance in twelve students with the HICT intervention for 6 weeks.<sup>14</sup>

In the cardiovascular system, HICT exercise increases cardiorespiratory endurance by increasing plasma volume and blood flow mechanisms as well as better central adaptation. HICT can increase maximal heart stroke volume. This increase in stroke volume causes an increase in cardiac output. This then increases the value of  $\text{VO}_2\text{max}$ , which is one of the important parameters in assessing cardiorespiratory function.<sup>11</sup> An increase in oxygen capacity makes the heart work more effectively, and blood flow to muscles increases when exercising.<sup>15</sup>

In terms of function, the respiratory muscles can be grouped into three, namely the diaphragm muscle, the muscles of the chest cavity, and the abdominal muscles. These three muscle groups will coordinate in such a way as to prevent the chest cavity and lungs from collapsing during the process of inspiration and expiration. The ventilation mechanism will be different when we are exercising. While exercising, the need to increase ventilation will increase so that the body sends signals to the respiratory muscles to increase ventilation. In addition, when exercising, the intercostal muscles and abdominal muscles will play an active role.<sup>16</sup>

Peak Expiratory Flow Rate (PEFR) is the maximum airflow achieved during expiration with maximum force and can be used as a parameter to assess lung function.<sup>17</sup> The amount of individual PEFR value is influenced by several factors, one of which is physical activity. High Intensity Circuit Training has an effect on increasing respiratory function by optimizing the increase in the strength of the chest, abdominal, and intercostal muscles, which will then increase the PEFR value.

When exercising HICT, demands of the ventilation will increase, so there are signals sent to the respiratory muscles to increase ventilation. This will then increase the power of the respiratory muscles. The intercostal and abdominal muscles will play an active role, namely as a pressure generator



or in generating pressure. This will then lead to a decrease in end-expiratory lung volume.<sup>12</sup>

Based on the results of this study, according to the hypothesis, the mean PEFR value of the group of men aged 18-21 years who were treated with HICT exercise for 7 minutes for eight weeks, with a frequency of 3 times a week, gave a significant increase in PEFR values. This increase in PEFR is related to the adaptive mechanisms of the musculoskeletal, cardiovascular, and respiratory systems, as previously described. The results of this study are in line with previous research by Haningtyas (2017), which stated that there was a significant increase in PEFR in the young adult age group by giving skipping exercise interventions for eight weeks and a frequency of 3 times a week.<sup>5</sup> In addition, there are other studies by Sperlich et al. (2017) who have proven an increase in VO<sub>2</sub>max and muscle strength with a 20-minute HICT intervention in a group of adult women for nine weeks.<sup>11</sup>

Before the study, all subjects were given a verbal explanation not to do sports other than HICT during the eight weeks of the study. However, there are limitations indirectly monitoring what activities are carried out by research subjects, where sports other than HICT and different types of physical exercise can affect the PEFR value. In addition, there are also limitations in monitoring what foods are consumed during the study. Foods with a high-fat content that are consumed in large quantities can affect the PEFR value because fat accumulation in body parts such as the chest and abdominal walls can interfere with lung expansion. To ensure that the study's validity is not jeopardized, an oral explanation of the situation has been provided to each research subject.

## CONCLUSION

Regular exercise of High Intensity Circuit Training can improve lung function, particularly PEFR value in young male adults.

## ETHICAL APPROVAL

Prior to data collection, ethical approval was obtained from the Medical Research Ethical Committee, Faculty of Medicine Diponegoro University and Kariadi Hospital, Indonesia. The Ethical Clearance of this research was No. 196/EC/KEPK/FK-RSDK/IV/2018.

## CONFLICTS OF INTEREST

The authors declare that they have no competing interests. that may be perceived as inappropriately influencing the representation or interpretation of reported research results.

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