Effects of High-Intensity Interval Training and Moderate-Intensity Continuous Training on Cardiorespiratory Capacity in Adolescents Girls

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Abstract. Cardiorespiratory capacity is inversely related to the risk of cardiovascular disease (CVD), and this can be improved through the classical type of continuous physical exercise and interval training with different intensity and duration. This study aims to compare the high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) on the cardiorespiratory capacity of physically active adolescent girls. Data were collected from twenty-six participants, divided into two groups of 16±0.5 years for HIIT and 15.7±0.4 years for the MICT. All training sessions were monitored by a qualified trainer using a heart rate monitor (PolarRS800CX GPS), while VO_2max was evaluated using the multistage fitness test (MFT) for 6 weeks. The results showed significant differences in the cardiorespiratory capacity (p=0.000) of HIIT and MICT with an increase of 26,7% and 37,6%, respectively. In conclusion, MICT produces higher CRF than HIIT in physically active adolescent girls.

Keyword : Interval training, Continous training.

1. Introduction

The recommended physical exercise for adolescents between the ages of 18-64 is 150 minutes per week. However, with aerobic exercise, the duration can be increased to 300 minutes per week for optimal health benefits called High-Intensity Interval Training (HIIT) [1]. According to previous studies, this is also effective in increasing cardiorespiratory fitness and repetitively interspersed with a resting phase [2]. The training intensity is 85-95% maximum heart rate (MHR) with a recovery intensity of 70% [3]. HIIT is different from classical or aerobic exercises that are continuous, long-lasting, and low in intensity called Moderate-Intensity Continuous Training (MICT) [4].

Although the intensity, duration, and energy system differ between HIIT and MICT, both encourage similar physiological adaptation [2]. These include improvements in cardiorespiratory capacity, skeletal muscle capillarization, fat metabolism, and insulin sensitivity, which tend to improve the overall health status of people.

There is also evidence that HIIT is also beneficial for young and adolescent, with the ability to reduce body fat [5], increase cardiorespiratory fitness, and body composition effectively [6]. Therefore, further research needs to be conducted on complex interval training variables with modifications on the work, rest, and type of exercise utilized.

The purpose of this study is to compare the differing effect of HIIT and MICT training methods on the VO_2max cardiorespiratory capacity in adolescent girls. The intensity, work,

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relief ratio, and different duration is used as a reference in developing the most effective training program in increasing cardiorespiratory capacity.

2. Methodology

2.1 Participants

Twenty-six physically active female students participated in the study in ratios of 1:1 for both HIIT and MICT. All subjects stayed in the school dormitory and actively exercised three times a week. The research subjects fulfilled the exclusion criteria, such as smoking, musculoskeletal disorders, and routine consumption of vitamin supplements, with the PAR-Q sheet filled to ensure the research subjects have the ability to conduct the physical exercises.

Table 1. Characteristics of the Participants

	HIIT				MICT			
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**min**	**max**
Age (years)	16	0,55	15	17	15,79	0,43	15	16
Height (cm)	160,4	0,05	153	168	156	0,30	152	161
Weight (Kg)	51,5	8,79	36,4	67	48,89	4,64	42,1	57,8
BMI (kg/m^2)	19,93	2,98	15,5	25,8	20,05	1,95	17,2	24,3
Body Fat(%)	25,37	6,04	15,3	37,2	26,61	5,56	11	14,5

2.2 Research design

This is a quasi-experimental research with pretest and posttest design. This study was conducted at Pradita Dirgantara High School Boyolali, from November to December 2019.

2.3 Measurement of Anthropometric

Two days before the exercise, the anthropometric measurements of the subjects, such as their body mass index, were obtained by dividing weight (kg) by square of height (m^2).

2.4 Measurement of Cardiorespiratory Fitness

The cardiorespiratory capacity was conducted using a multistage fitness test (MFT) at the beginning and the end of the training program. In addition, Maximum oxygen consumption (VO_2max) was the main indicator used to evaluate the cardiorespiratory capacity [7]

2.5 Exercise Training

HIIT was conducted three times a week with a break of 1-2 days before the next exercise. After every two sets with 4 x 30 seconds, and intensity of 80-95% maximum heart rate (MHR), using a 1:1 work/recovery ratio of 60-70% MHR breaks between sets. MHR is calculated using measurements of 208-0.7 participants [8]. All training sessions are monitored by a qualified trainer using PolarRS800CX GPS. The exercise applies the principle of progression by increasing repetition from 4 times in the first and second weeks, 5 times in the

third and fourth weeks, and 6 times in the fifth and sixth weeks. The subject warmed up before training for 5 minutes and rested for another 5 minutes after training. Two days after the completion of the exercise, the MFT test was conducted to measure the cardiorespiratory capacity.

Table 2. Description of 6 weeks of HIIT and MICT

	HIIT	**MICT**
Frequency	3 times/week	3 times/week
Duration	20-25 min	40-60 min
Intensity	Work : Recovery Ratio = 1:1 Work = 80-95%HRmax Relief = 60-70%HRmax	60-75%HRmax
Type of activity	Interval running	Continuous running

2.6 Statistical analysis

The normality of the data distribution and homogeneity of the variance was verified with the Shapiro-Wilk Levene tests, before proceeding with the statistical analysis. The paired test-t for dependent samples was used to identify the pre-post work out differences within each group. Meanwhile, the test-t was performed for independent samples for the pre-post workout comparison between two groups. Furthermore, the data was reported as an average of SD, and the statistical significance was set to $p<0.05$, with an SPSS 23.0 software used for data analysis.

2.7 Ethical Clearance

The subjects filled out informed consent known by parents and the principal before participating in the study. Dr. Moewardi General Hospital Health Research Ethics Committee approved the study protocol in letter No.1.131/X/HREC/2019 dated October 4, 2019.

3. Result and Discussion

This analysis was conducted to describe the characteristics of the variables presented in the form of descriptive statistics, which include the mean, minimum-maximum, and standard deviation.

Table 3. Data Analysis of VO_2max ($ml.min^{-1}.kg^{-1}$) HIIT and MICT groups

Variable		**Mean**	**SD**	**Min**	**Max**
VO_2max of HIIT	Pretest	26,77	3,19	22,8	33.9
	Posttest	30,39	4,03	24,4	40,2
VO_2max of MICT	Pretest	27,22	3,18	23,2	33,9
	Posttest	32,52	3,08	28,3	38,5

Table 4. T test analysis of VO_2max of pretest and posttest

	% change	p
VO_2max of HIIT	26,57	0,000
VO_2max of MICT	37,61	0,000

The results show that both training significantly increased the VO_2max with each p = 0,000 with the MICT group higher than HIIT.

MICT is known as a classic type of exercise, with the ability to increase cardiorespiratory capacity. Almost all age groups can conduct this training due to its low to moderate intensity, such as brisk walking, jogging, and cycling. [9] The training intensity is between 60-70% MHR, and in the low category in contrast to HIIT training which reaches 85-95% [10]

This low intensity causes changes or adaptations of the body to stimulate mitochondrial biogenesis in skeletal muscle, which increases the overall capacity for oxidative metabolic substrates [11]. HIIT is included in interval training, characterized by several exercises interspersed with periods of rest [12]. According to [3], the HIIT intensity is close to the maximum or "near maximal" between 85-95%. Interval training causes physiological adaptation in the skeletal muscle and cardiovascular system due to MICT training [12].

This study found that HIIT training significantly increases VO_2max, in accordance with the results of a meta-analysis [3]. An increase in cardiorespiratory capacity in HIIT training is due to a rise in the oxidative capacity of skeletal muscle, cardiac output, and a decrease in arterial stiffness [13]. This condition increases the aerobic energy metabolism throughout the body. [2] In untrained people, HIIT improves performance with lower training volume and less time. [2]. The training intensity also plays a role in increasing VO_2max due to the interval rest periods [14]. Some previous studies conducted found an increase in VO2max [5] [15]. However, there are significant differences between both exercises, with a rise in MICT over a prolonged time. One of the constraints experienced by the community during exercises is time limitations [16]. Previous researches showed that HIIT training also improves cardiorespiratory capacity at a shorter time [6] and [17].

4. Conclusion

In conclusion, HIIT and MICT increase cardiorespiratory capacity in adolescents. However, one of the benefits of HIIT is the ability to act as an alternative choice in increasing CRF for physical exercises within a short time in accordance with MICT.

Conflict of Interest

The authors declared that there was no conflict of interest in this study.

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