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Original Article

High-intensity interval training for undergraduate students: Study protocols for randomized controlled trials

IYAKRUS[1], MEIRIZAL USRA[1], WAHYU INDRA BAYU[2,*], SOLEH SOLAHUDDIN[3], HERRI YUSFI[4]
[1,2,3,5]Sport Education, Faculty of Teacher Training and Education, Sriwijaya University, INDONESIA
[4]Physical Education and Health, Faculty of Teacher Training and Education , Sriwijaya University, INDONESIA
[4]Doctoral Program of Physical Education, Universitas Negeri Jakarta, INDONESIA

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Abstract:
This study aims to evaluate the benefit of the HIIT training program for college students, as a strategy to improve the physical fitness of undergraduate students, physical activity levels, and motivation to exercise. This study was a randomized controlled trial design with two groups of third and fifth semester undergraduate students (19-21 years). The trial will involve 150 students from the Physical Education and Health study program, FKIP, Sriwijaya University. The HIIT training sessions will be applied in the first 10-15 minutes of each sessions, twice a week for 16 weeks, ranging from 14-20 all-out bout intervals, adopting 2:1 work-to-rest ratio. A cyt point of ≥ 90% of maximal heart rate will be the criterion for satisfactory compliance with high-intensity training. The control group will continue with the programmed lecture as usual. The results of this study show that there was an increase on maximal oxygen capacity (VO2Max) in each group before and after the training treatment using the HIIT method, but there was a significant difference between the experimental and control group.
Key words: **HIIT, student athlete, physical fitness, physical activity**

Introduction

Sports achievement basically depends on 4 (four) main components, namely physical, technical, tactical and mental. Training is known to improve the energy status of the working muscles, which generate the ability to mantain muscle strength for longer periods of time. To increase the athlete's ability to achieve peak performance, high intensity and high volume training are important components of the training program. Sport scientists reveal how this combination of training can be utilized to optimize the development of the aerobic muscle phenotype and improve performance with intense training. McMilan, et. al. (2005) indicated that a high VO2Max value allows athletes to cover the total distance traveled. Furthermore, Durandt, et. al. (2006) revealed that maximal aerobic capacity in football affects the ability to repeat sprints and perform high intensity movement, both with and without the ball.

There are several methods used to increase endurance such as continuous training, interval training, fartlek, and cross country. This study uses the interval training method, because in basketball, futsal, football, volleyball, athletics, swimming, and others, there are movements at intervals, besides that both methods are the right method to increase VO2Max so that in competition athletes will not lack of VO2 max. The coach must understand the match situation, field conditions, athlete needs and abilities, etc., in order to achieve the objectives of the planned training program. In addition, the motivation of athletes in carrying out training programs will greatly affect the achievement. Competitive athletes undertake rigorous training to produce the stimulus needed for physiological adaptation and increased performance (Grove et al., 2014).

Low intensity (high volume) and high intensity (short duration) training are important components of a training program for athletes who want to be able to maximize performance and compete at a high level on various sporting events. An intense training is considered as one that last between 1-8 minutes, during which there is mixture of adenosine triphosphate (ATP) energy from both anaerobic and aerobic energy systems (Laursen, 2010). Athletes need to slow the process of breaking down regardless of volume, intensity, or load, and maintain the ability to explode when necessary, and, not to lose form once fatigue sets in (Mackenzie and Cordoza, 2012).

Talanian, et.al. (2007), show the impact of high intensity interval training (HIIT) which increased VO2Max from 7% to 12%. Meanwhile Burgomaster, et.al. (2000), show that aerobic capacity or Vo2Max depends on the fitness level of the subject and the duration and with an increase ranging from 4% -46%. The results of the research were supported by Kuno (2012), who shows that high intensity training as well as continuous endurance training brought significant improvements in body composition, heart rate, and aerobic strength with less than 2 hours and 30 minutes of weekly training. Furthermore, high-intensity training has been

Corresponding Author: WAHYU INDRA BAYU, E-mail: wahyu.indra@fkip.unsri.ac.id

shown to be more effective in increasing maximal oxygen capacity. Andrew, et.al., (2013), analyzed several research articles and stated that training intervals of 3-5 minutes were very effective in generating increased exercise capacity. In line with this study, nine other studies described the greatest increase in VO2Max (0.85/min). Martin, et.al. (2012) show evidence that HIIT can be utilized as an effective alternative to traditional resistance-based training, stimulating equal or even better physiological adaptations than conventional training in both healthy and diseased populations.

Materials and methods

This study was a randomized controlled trial design with two groups of third and fifth semester undergraduate students (19-21 years). The trial will involve 150 students from the Physical Education and Health study program, FKIP, Sriwijaya University. The HIIT sessions will be applied on the experimental group in the first 10-15 minutes of each sessions, twice a week, for 16 weeks, with the range from14 to 20 all-out bout intervals, adopting 2:1 work-to-rest ratio. A cut-point of ≥ 90% of maximal heart rate will be the standard for satisfactory compliance with high-intensity training. The control group will follow the programmed lecture as usual. The results of this study will be measured before and after the implementation of HIIT program. The progressive Aerobic Cardiovascular Endurance Run (PACER) was administered following standardized procedures. 4 participants ran from one marker to another, which set 20m apart, while keeping pace with a pre-recorded cadence. The cadence was an audio signal for the participants which connected to a speaker and the cadance was getting shorter every minute. Participants were instructed to keep up with the cadance for as long as possible. The participants were terminated when they failed twice to reach the appropriate marker in the alloted time or could no longer maintain the pace. The number of laps that the participants completed was recorded. The PACER is the recommended assessment of aerobic fitness in the FitnessGram® battery as well as by the National Academy of Medicine (formerly the Institute of Medicine [IOM]) to be used in youth fitness surveillance (Institute of Medicine, 2012). The data will be analyzed using IBM SPSS 26.0 (SPSS Inc., Chicago, IL, USA). An exploratory analysis will be performed to determine the frequency, range, variability, and distribution type of each variable, to use the most appropriate statistical test when comparisons is necessary.

Results

A summary of descriptive statistics of the VO2Max test results displayed in table 3. From these results it can be seen that although both groups experienced an increase in VO2Max, it can be seen that the treatment group (HIIT method) experienced a greater increase compared to the control group (conventional training).

Table 3. Statistical Descriptive Research Data

Group	Deskripsi	*Vo2max*	
		Pretest	***Posttest***
Control (conventional training)	Average	36.51	37.38
	Max	37.90	38.70
	Min	34.90	35.50
	Standard Deviation	0.76	0.77
	%	2.41%	
Experiment (HIIT method)	Average	36.32	39.32
	Max	38.70	42.40
	Min	33.40	36.40
	Standard Deviation	1.26	1.37
	%	8.26%	

To find out the difference between the experimental and the control group, the independent sample t-test (test was used as the data analysis for similarity of variance using Levene's Test, p>0.05 in all cases). Overall, from the posttest results, there was a significant difference between the experimental and the control group [t = 5.396; p = 0.000 (<0.05)]. While the pretest results did not show a significant difference between the experimental and the control group [t = -0.553; p = 0.584 (> 0.05)], which shows that the initial abilities between the two groups were at the same level.

Table 4. Independent Sample t-test

	Experiment - Control Grup	*T*	*P-Value*
Max Oxygen Capacity (*VO_2Max*)	*Pretest*	-0.553	0.584
	Posttest	5.396	0.000

Statistical differences in the pretest and posttest for the experimental group in table 5 were analyzed using paired sample t-test for the total total maximal oxygen capacity score (VO2Max); the calculation results show that there is a significant difference in VO2Max before and after the training treatment using the HIIT method [t = 13.932; p = 0.000 (<0.05)], with an increase of 8.26%.

Table 5. Paired Sample t-test

	Experiment - Control Group	*T*	*P-Value*
Max Oxygen Capacity (VO_2Max)	*Posttest*	13.932	0.000

Discussion

HIIT is a training which characterized by repeated sessions of relatively short, intermittent training, often performed with all out effort or at an intensity which close to the elicits peak oxygen uptake (i.e., ≥ 90% of VO2Max). In one of the previous studies, it was found that high-intensity training has been suggested to elicit greater aerobic and cardiovascular adaptation than low-and-moderate level training (Gibala, 2007). HIIT, especially interval running training, usually consist of reduced all out running, leads to the improvement of muscle oxidative enzymes, namely the maximal increase in citrate synthase activity and pyrubate dehydrogenase (PDH) activity, in a relatively short time (i.e., 1-2 weeks) (Gibala, 2006). Depending on the intensity of the training, single attempts may last from a few seconds to several minutes, with multiple attempts separated by specified mimum rest or low-intensity training. Unlike strength training, which is brief and usually performed intense effort against heavy resistance to increase skeletal muscle mass, HIIT usually associated with activities such as cycling or walking and does not cause any hypertrophy effect (Gibala, 2007).

HIIT has been proven to be effective to improve performance over relatively short training periods (Sperlich,2010). Ancient (2012), shows that high-intensity training as well as continuous endurance training leads to significant improvementsin body composition, heart rate, and aerobic strength with less than 2 hours and 30 minutes of weekly training. In addition, high-intensity training has been shown to be more effective in increasing maximal oxygen capacity. The results of this study show that the athletes who participated in this study experienced an increase in VO2Max, but there was a significant difference between HIIT and conventional training effect. This shows that HIIT is more effective for increasing VO2max than the conventional training,

HIIT is a form of training that alternates between short repeated sessions of intense exercise and periods of active rest, improving several clinically relevant results. HIIT improves VO2Max, exercise performance, cardiovascular function, and markers of oxidative capacity in skeletal muscle in healthy and clinical populations. Recently HIIT has also been reported to reduce systemic inflammation in coronary intervention patients and individuals with metabolic syndrome. These physiological benefits can be achieved in a short period of time and with less total exercise energy expenditure (i.e., training volume) than endurance training. However, some evidences suggest that HIIT is more pleasurable that endurance training. HIIT usually closely related to maximal intensity or supramaximal intensity. This intensity represents a potential threat to the adoption of HIIT by the general public as a high-intensity exercis, which is usually associated with overweight individuals who are fearful and only engage in light or low-volume exercise activities. Safety protocols are required for training at higher intensity (i.e., supramaximal intervals) for the populations at risk of cardiovascular disease (Boy, et.al., 2013).

Sikiru & Okoye (2013), suggest that giving an interval training program should be carried out for 8 weeks, with an intensity ranging from 60-79% of maximum capacity (maximum heart rate) and a duration of 45-60 minutes exercise. Haskell, et.al. (2007), recommends aerobic training for individuals at ages of 18-65 years old. For moderate-intensity aerobic exercise, a minimum of 30 minutes of exercise with a frequency of 5 times a week, is required, while the intensity of aerobic physical exercise should be carried out with a minimum heavy intensity duration, for about 20 minutes with a frequency of 3 times a week. In contrast with the results of Gibala's (2007), six sessions of HIIT over two weeks, or a total of only about 15 minutes of intense exercise (cumulative energy expenditure of ~600 kJ or ~143 kcal), can increase oxidative capacity of skeletal muscle and also performance.

Shephard (1990), analyzed VO2Max with research on senior athletes comparing training time in 8-10 weeks, 12-18 weeks and 24-52 weeks. The analysis of the study shows that 12.9% increase in VO2Max could be realized within 8-10 weeks of aerobic exercise compared to an increase of 14.1% at 12-18 weeks and 16.9% at 24-52 weeks with an improvement in the aerobic system. Furthermore, training according to personal professional fitness can help preventing or even reversing age and functional independence decline with progressive aerobic conditioning in the senior population. Shephard (2008) showed that gradual aerobictraining can increase the aerobic strength of the ederly by at least 10 ml/kg/min, potentially delaying the aging by 20 years. Shephard contnues that higher intensity training for seniors leads to greater gains. A 25% increase in VO2Max (about 6 ml/kg/min) is equivalent to regaining about 12 years of vigor for one's lifestyle.

Conclusions

HIIT has been proven to be an effective alternative to traditional resistance-based training, stimulating equal or even better physiological adaptations than conventional training in both in healthy and diseased population. The results of this study show that there was significant difference between the effect of HIIT and conventional training. While high-intensity training has been shown to be more effective in increasing maximal oxygen capacity, there are some requirements to train at higher intensity for populations at risk of cardiovascular disease.

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