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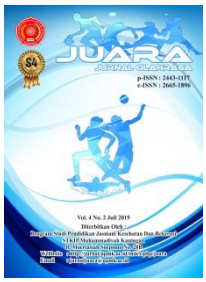

Interval Training and Endurance Training to Increase VO2max: Article Review

Fajar Syamsudin[1], Rony Syaifullah[2], Muhammad Bakhtiar Subardi[3], Sayid Fariz[4]
[1] Faculty of Medicine, Universitas Airlangga, Street. Airlangga No.4 - 6, Airlangga, Surabaya City, East Java, 60115, Indonesia
[2,4] Faculty of Sports, Unviversitas Sebelas Maret, Street. Ir. Sutami No.36, Kentingan, Surakarta City, Central Java, 57126, Indonesia
[3] Faculty of Sports, Universitas Negeri Semarang, Street. Sekaran, Semarang City, Central Java 50229, Indonesia
*e-mail: fajarsyamsudin96@gmail.com[1], ronysyaifullah@staff.uns.ac.id[2], muhammadbahtiar61@gmail.com[3], sayid_fariz76@yahoo.com[4]

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Abstract

This study aims to determine better between Interval Training and Endurance Training to increase VO2max capacity in healthy adult men and women. The method used is a literature review, looking for articles from Electronic DataBased in PubMed, ScienceDirect, Eric. Journal, Google Scholar, and ProQuest that have been published and accredited. A total of 8 papers were selected for in-depth review. The results show that Interval Training is better than Endurance Training, even though both can increase VO2max.

✉ Alamat korespondensi: Street. Airlangga No.4 - 6, Airlangga, Surabay City
E-mail : fajarsyamsudin96@gmail.com

INTRODUCTION

Volume Oxygen Maximum (VO2Max) is the body's ability to use oxygen, an indicator of cardiovascular health. The higher the VO2max, the higher the level of cardiovascular health, and vice versa (Palar, Wongkar, and Ticoalu 2015). In addition, VO2max is also essential for the body when carrying out physical activities. The higher the physical activity carried out, the higher the oxygen capacity is needed; it is necessary to have a large oxygen capacity in the body to meet the strenuous activities carried out (Hoeger et al., 2019). VO2max is essential because, with a high VO2max degree, the body can carry out heavy physical activities (Alonso-Fernández et al., 2019). Although, in general, strenuous physical activity is only

done by athletes, VO2max is also an indicator of the level of cardiovascular health in general.

WHO (World Health Organization 2020) recommends at least 150-300 minutes of moderate-intensity physical activity or 75-150 minutes of high-intensity physical activity per week to maintain and improve the fitness of healthy adults. Many studies conducted by foreign researchers (Arboleda Serna et al. 2016; Su et al. 2019; Zhang et al. 2017) mention that Interval Exercise or HIIT (High-Intensity Interval Training) is included in the high-intensity category as recommended by WHO, while Endurance Training or MICT (Moderate Intensity Continuous Training) is included in the moderate-intensity category recommended by WHO (Russomando et al. 2020; Syamsudin et al. 2021).

Interval training such as HIIT (High-Intensity Interval Training) is a type of exercise that combines High Intensity with giving pauses or intervals. It uses a short time, generally done by reaching a minimum intensity of 75-95% Heart Rate Maximum (HRM) (Little et al. 2019), while Endurance Training such as MICT (Moderate Intensity Continous Training) are moderate-intensity training of continuous duration without any breaks, generally performed at an intensity of around 60-75% HRM (Nie et al. 2018). These two types of exercise have different intensity and duration, and generally, Interval Training does not require more time than Endurance Training.

Many studies have compared HIIT and MICT; in a previous review article, Costa et al. (2018) HIIT and MICT in subjects with hypertension, it is proven that HIIT and MICT can reduce blood pressure in hypertensive patients. Ramos et al. (2015) stated that HIIT is better than MICT in improving vascular function, and the study of Wewege et al. (2017) also noted that interval training was more effective for reducing fat in obese people, and in a review article conducted by De Nardi et al. (2018) in prediabetic and diabetic subjects, HIIT and MICT both can improve cardiovascular function. However, a review of the impact of Interval training and Endurance training on VO2max in adult subjects is still unknown, so it is necessary to conduct an in-depth study of this.

This article helps increase literacy about the world of Sport Science, especially understanding the form of interval training and endurance training. This review aims to review and compare which is better between interval training and endurance training to increase VO2max in healthy adult subjects.

METHODS

This study is a literature review article, meaning that this study is a study that takes several published studies, the lessons obtained from the electronic databases PubMed, Science Direct, Eric. Journal, Google Scholar, and ProQuest.

The search for studies to be reviewed in this study uses the 2014-2020 range, with the PICOS eligibility criteria as follows:

- Population: Male or female aged 18-35 years old, healthy, with no history of

cardiovascular disease, and no injuries that could interfere with the performance of the training.

- Intervention: Interval Training and Endurance training.
- Comparison: There is no comparison limitation in the study, as long as it has the two types of Interventions above.
- Outcomes: VO2max (Volume Oxygen Maximum)
- Study Design: RCT (Randomization Control Trial) studies are research articles that have been published and indexed by Scopus.

A key Word is accompanied by MeSH Term, Title/Abstract, and an asterisk (*) for words that may have different types of subsequent comments. The keywords or search terms used are "(Interval Training) OR (HIIT) OR (High-Intensity Interval Training)" AND "(Endurance Training) OR (Continuous Training) OR (MICT) OR (Moderate Intensity Continuous Training)" AND "(VO2max) OR (VO2 Max) OR (Maximum Aerobic Capacity) OR (Maximal Oxygen Uptake)".

The search and collection of articles started from November 2020; then, an analysis was carried out according to the inclusion and exclusion criteria in December 2020, beginning the preparation of this article in early January 2021. It was done online using a Laptop and Internet Network.

FINDINGS AND DISCUSSION

The results of the research used in this literature review use secondary data from eight Scopus-indexed international journals, and the following steps are carried out before choosing a journal:

1. Identification (study collection): 285
    1. PubMed : 100
    2. ScienceDirect : 50
    3. Eric.ed.gov : 4
    4. Google Scholar : 81
    5. ProQuest : 50
2. Duplicates (check for duplicate articles to avoid the same paper using Mendeley desktop): 230
3. Screening (checking the study by reading the title/abstract): 25
4. Eligibility (feasibility of study by reviewing full text): 8
5. Included (selected studies and according to the criteria): 8

Findings

Interval Training is synonymous with HIIT (High-Intensity Interval Training) and SIT (Sprint Interval Training) (Matsuo et al. 2014). In the basic concept, interval training is a type of exercise that uses a pause or time interval from high intensity to moderate intensity. High power 85-95% HRM (Heart Rate Maximum) performed with a short duration, but maximal or total energy. While there are intervals of moderate intensity of 50-65% HRM (recovery) carried out with a more extended period than High Intensity, this aims to restore the heart rate to perform High Intensity again (Arboleda-Serna et al. 2019).

Endurance Training is synonymous with Continuous Training, MICT (Moderate

Intensity Continuous Training) (Heisz et al. 2016). What is meant by endurance training is a type of exercise that is carried out with moderate intensity 65-75% HRM continuously without any pause at a set time (Vella, Taylor, and Drummer 2017).

A total of eight selected studies were reviewed in-depth, all studies used modern tools in the form of a Heart Rate Monitor to monitor HRM (Heart Rate Maximum), in several studies showing differences of opinion regarding the increase in VO2max, some proved to be superior to interval training, some stated it was excellent. Endurance training, more details can be seen in Table 1.

Table 1. Article Review Results

No	Author	Protocol & Training Duration	Intervention	Subject	Volume & Intensity	Pre VO2Max ($mL \cdot kg^{-1} \cdot min^{-1}$)	Post VO2Max ($mL \cdot kg^{-1} \cdot min^{-1}$)	Results
1.	(Kong et al. 2016) Cina	• Ergocycle • 5 weeks, 4x per week	HIIT (13)	K : Sedentary healthy woman B : 25.8 ± 2.6 U : 21.5 ± 4.0	• 20 minute • 8 seconds max sprint, 12 seconds passive, 60 reps	32.0 ± 6.6	34.3 ± 7.5	MVCT is superiorl
			MVCT (13)	K : Sedentary healthy woman B : 26.0 ± 2.5 U : 20.5 ± 1.9	• 40 continuous minutes • 60 – 80% VO2max	32.0 ± 5.0	35.8 ± 6.9	
2.	(Zhang et al. 2015) Cina	• Treadmill • 12 weeks, 4x per week	HIIT (14)	K : 14 Sedentary healthy woman B : 25.8 ± 2.7 U : 21.0 ± 1.0	• 15 minute • 4 minutes 85-95% HRM, 4 minutes 50-60% HRM, and 7 minutes of active rest	33.1 ± 3.0	37.7 ± 3.0	There is no difference in the results that are much adrift.
			MICT (15)	K : 15 Sedentary healthy woman B : 26.0 ± 1.6 U : 20.6 ± 1.2	• 33 continuous minutes • 60-70% HRM	33.0 ± 3.3	37.6 ± 3.7	
3.	(Matsuo et al. 2014) Jepang	• Ergocycle • 8 weeks, 5x per week	SIT (14)	K : 14 healthy man B : 21.3 ± 1.2 U : 26.4 ± 6.5	• 10 minute • 2 minutes warm up • 30 seconds active sprint, 15 passive, 7 reps • 3 minutes cooling down	43.9 ± 6.7	50.7 ± 4.4	SIT is superior to CAT
			CAT (14)	K : 14 healthy man B : 21.2 ± 2.4 U : 25.9 ± 6.0	• 40 continuous minutes • 40 minute (60%–65% VO2max, 60 rpm)	42.0 ± 6.8	45.8 ± 2.9	
4.	(Arboleda-Serna et al. 2019)	• Treadmill • 4 weeks, 3x per week	HIIT (22)	K : 22 healthy man B : 26.2	• 37 minute • 30 seconds 90-95% HRM, 60	42.7 ± 6.0	44.0 ± 5.8	There is no difference in the

	Kolombia			U : 29.5	seconds 50-55% HRM, 15 Reps • 90% VO2max			results that are much adrift.
			MICT (7)	K : 22 healthy man B : 23.5 U : 23.5	• 40 continuous minutes • 65 – 75% HRM	44.1 ± 8.7	45.1 ± 8.9	
5.	(Heisz et al. 2016) Canada	• Ergocycle • 6 weeks, 3x per week	HIT (17)	K : 5 man, 12 women B : 21.1 ± 0.5 U : 21.4 ± 2.9	• 20 minute • 1 minute 90 – 95% HRM, 1 minute recovery, 10 reps	31.8 ± 1.6	35.8 ± 1.8	HIT is superior to MCT
			MCT (19)	K : 6 man, 13 women B : 23.0 ± 1.0 U : 20.4 ± 1.3	• 27,5 continuous minutes • 70-75% HRM	30.2 ± 1.5	33.1 ± 1.7	
6.	(Fisher et al. 2015) Amerika	• Ergocycle • 6 weeks, 5/3x per week	HIIT (13) 3x per week	K : Sedentary healthy man B : 29.0 ± 3.4 U : 20 ± 1.5	• 20 minute • 30 seconds of active sprint, 4 minutes of passive, 4x reps • Active : 178 ± 9 HRM • Passive : 140 ± 13 HRM	35.7 ± 6.2	36.54 ± 3.5	MICT is superior to HIIT
			MICT (10) 5x per week	K : Sedentary healthy man B : 30.0 ± 3.1 U : 20 ± 1.5	• 45–60 continuous minutes • 158 ± 11 HRM	34.95 ± 6.46	38.35 ± 3.36	
7.	(Vella et al. 2017) Amerika	• Ergocycle dan Treadmill • 8 weeks, 4x per week	HIIT (8) 2 Man 7 woman	K : Healthy sedentary B : 29.9 ± 3.3 U : 23.1 ± 6.6	• 20 minute • 1 minute active sprint, 1 minute passive, 10 reps	34.8 ± 2.9	37.4 ± 0.8	HIIT is superior to MICT
			MICT (9) 6 Man 4 woman	K : Healthy sedentary B : 33.1 ± 6.0 U : 28.9 ± 8.1	• 30 continuous minutes • 5 minutes warm-up 35-40% HRM • 20 minutes core 55-59% HRM • 5 minutes cooling down 35-40% HRM	34.5 ± 2.1	34.9 ± 0.8	
8.	(Cocks et al. 2013) Inggris	• Ergocycle • 6 weeks, 3/5x per week	SIT (8) 3x per week	K : Sedentary Men B : 24.8 ± 0.8 U : 22 ± 1	• 20 – 30 minute • 30 seconds max sprint, 4.5 minutes passive, 4-6 reps • Reps increase progressively	41.9 ± 1.8	45.1 ± 2.3	ET is superior to SIT
			ET (8) 5x per week	K : Sedentary Men	• 40–60 continuous	41.7 ± 4.1	48.2 ± 5.0	

	B : 22.6 ± 1.6 U : 21 ± 1	minutes • Duration increases progressively • 65% VO2max

Interventions: HIIT, High-Intensity Interval Training; SIT, Sprint Interval Training; HIT, High-Intensity Interval Training; MVCT, Moderate to Vigorous Continuous Training; MICT, Moderate Intensity Continuous Training; CAT, Continuous Aerobic Training; ET, Endurance Training; MCT, Moderate Continuous Training. **Interval Training** = HIIT, HIT, SIT; **Endurance Training** = MICT, MCT, MVCT, CAT, ET. Subject: K, Subject Character; B, BMI; U, Age

Discussion

From all articles proving that each training has a good effect on increasing VO2max capacity, training studies (Heisz et al. 2016; Kong et al. 2016; Zhang et al. 2015) show success in increasing the level of the VO2max category Table 2., which was initially the subject feels in the less category, managed to increase significantly to the excellent category. In another study (Arboleda-Serna et al. 2019; Cocks et al. 2013; Matsuo et al. 2014) showed that in harmony, subjects in the moderate level category managed to move up to the excellent level category. In addition, some studies do not experience an increase in the level of the type, the subjects used are already in the fairly low-range category, and the results after being given training the issues are still in the excellent category but have risen to the middle or upper range enough type (Fisher et al. al. 2015; Vella et al. 2017).

Table 2. VO2max category (mL kg-1 min-1)

Gender	Age	Very less	Less	Enough	Good	Very good
Man	≤ 29	24.9	25 - 33.9	34 - 43.9	44 - 52.9	≥ 53
	30 - 39	22.9	23 - 30.9	31 - 41.9	42 - 49.9	≥ 50
	40 - 49	19.9	20 - 26.9	27 - 38.9	39 - 44.9	≥ 45
	50 - 59	17.9	18 - 24.9	25 - 37.9	38 - 42.9	≥ 43
	60 - 69	15.9	16 - 22.9	23 - 35.9	36 - 40.9	≥ 41
	≥70	12.9	13 - 20.9	21 - 32.9	33 - 37.9	≥ 38
Women	≤ 29	23.9	24 - 30.9	31 - 38.9	39 - 48.9	≥ 49
	30 - 39	19.9	20 - 27.9	28 - 36.9	37 - 44.9	≥ 45
	40 - 49	16.9	17 - 24.9	25 - 34.9	35 - 41.9	≥ 42
	50 - 59	14.9	15 - 21.9	22 - 33.9	34 - 39.9	≥ 40
	60 - 69	12.9	13 - 20.9	21 - 31.9	33 - 36.9	≥ 37
	≥ 70	11.9	12 - 19.9	20 - 30.9	31 - 34.9	≥ 35

Nominal : General fitness standards Nominal : High standard of fitness

Source: Ebook Principles and labs for fitness and wellness Hoeger et al., (2019)

The study (Kong et al. 2016) applied an intensity that was above moderate. That's what made his MICT different from the others. In general, MICT had a power of 60-75% of VO2max, but his study applied intensity of 60-80%. In line with the previous statement, studies

(Fisher et al. 2015) and (Cocks et al. 2013) also state that MICT is better than HIIT, but this is reasonable because MICT performs more training than HIIT, where HIIT is only 3 times a week, MICT 5x a week, so the amount of exercise also affects the increase in VO2max.

The study conducted (Matsuo et al. 2014) proved that HIIT is the best solution in increasing VO2max, where SIT only takes 10 minutes, compared to CAT, which takes 40 minutes in training carried out for 8 weeks with the same number of meetings. In line with a study conducted by Dunham and Harms (2012) that 20-minute HIIT results can be higher than 45-minute ET. In line with the survey conducted by (Vella et al. 2017) that 20-minute HIIT is better than 30-minute MICT.

Which is better between Interval Training and Endurance Training? Studies conducted by (Heisz et al. 2016; Matsuo et al. 2014; Vella et al. 2017) prove that HIIT is better than MICT. However, there are 3 studies (Cocks et al. 2013; Fisher et al. 2015; Kong et al. 2016) which state that MICT is better than HIIT; this difference in results shows that VO2max effects do not only affect interval training or continuous training but are influenced by duration, volume and intensity of exercise used (Fisher et al. 2015; Kong et al. 2016). The higher and the amount of training, the higher the results obtained in increasing VO2max, but if the amount of training is the same, the duration of the training is not too far apart, and the intensity given is by the type of training, the authors support that interval training is better than training Endurance in increasing VO2max capacity.

The author can take the basic concept that Interval Training is indeed better in increasing VO2max if compared to Endurance training with the same number of meetings and in the same period. Also related to HIIT being more attractive than MVCT in a study conducted by (Kong et al. 2016) is indeed a natural thing because this is also in line with survey research conducted by Thompson (2019) that HIIT is the most popular type of sport in the world on the order of 3rd, and has always been in the top 5 since 2015. HIIT has become in demand because this sport is challenging and doesn't take long to do; besides that, the benefits are similar and even more so than Endurance sports in general (Alansare et al. 2018; Syamsudin et al. 2021). HIIT can be a solution for people who complain about lack of time, low motivation, and non-adherence to guidelines (Hoare et al., 2017; Rech et al., 2016).

CONCLUSION

Interval Training and Endurance training have a good effect on increasing VO2max capacity, but Interval Training is more efficient, effective, and attractive than Endurance Training. Although it is clear how the procedure for doing Interval Training and Endurance Training is in the review above, a study is needed that discusses HIIT or MICT that does not use modern tools such as ergocycles and treadmills, so that later they can be easily practiced and imitated directly by the community.

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