Interval Training is better than Endurance Training for Improving VO2max

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Abstract: This study aims to find out which is better between Interval Training and Endurance Training for increasing VO2max capacity in non-athlete men and women. The method used is a literature review, searching for articles from Electronic Data Based in the form of PubMed, and ProQuest that have been published and accredited. A total of 3 articles were selected for deeper review. The research results show that Interval Training is better than Endurance Training for increasing VO2max, besides that Interval training is more popular because it is effective in training duration.
Keywords: Interval Training, Endurance Training, VO2max, Maximum Aerobic Capacity

INTRODUCTION

Maximum Oxygen Volume (VO2Max) is the body's ability to use oxygen, being an indicator of the level of cardiovascular health, the higher the VO2max, the higher the level of cardiovascular health, and vice versa. (Syamsudin, Wungu, et al. 2021). Apart from that, VO2max is also important for the body when doing physical activity, the higher the physical activity carried out, the higher the oxygen capacity required, the body's oxygen capacity needs to be large in order to be able to fulfill the strenuous activities carried out (Hoeger et al. 2019). VO2max is important, because with a high VO2max capacity, the body can carry out heavy portions of physical activity (Alonso-Fernández et al. 2019). Although generally heavy physical activity is only carried out by athletes, VO2max is also an indicator of the level of cardiovascular health of people 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, (Su et al. 2019; Zhang et al. 2017) state that Interval Training 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 which is also recommended by WHO (Russomando et al. 2020; Syamsudin, Herawati, et al. 2021).

Interval training such as HIIT (High Intensity Interval Training) is a type of exercise that combines high intensity with breaks or intervals, and uses short periods of time, generally carried out by achieving a minimum intensity of 75-95% Heart Rate Maximum (HRM) (Little et al. 2019), while Endurance Training such as MICT (Moderate Intensity Continuous Training) is exercise of moderate intensity with a continuous duration without any breaks, generally carried out with an intensity of around 60-75% HRM (Nie et al. 2018). These two types of training have differences in intensity and duration, and in general Interval Training does not require more time compared to Endurance Training.

Many studies have compared Interval Training and Endurance Training, 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 sufferers. Ramos et al. (2015) stated that HIIT was better than MICT in improving vascular function, and research by Wewege et al. (2017) also stated that interval training is more effective for reducing fat in obese people, and in a review article conducted by De Nardi et al. (2018) in prediabetes and diabetes subjects, HIIT and MICT can both 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 carry out an in-depth review of this matter.

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

METHOD

This study is a literature review article, meaning that this study is a study that takes several published studies, the studies obtained come from the electronic databases PubMed and ProQuest. The search for studies to be reviewed in this research used the period 2014-2024, with the following PICOS eligibility criteria:

- *Population* : Men or women healty non-atlhete
- *Intervention* : Every type interval training and endurance training
- *Comparison* : nothing boundaries in research, but must have two type intervention
- *Outcomes* : VO2max (Volume Oxygen Maximum)
- *Study Design* : RCT (Randomization Control Trial), paper study published.

RESULTS

After searching for articles that fit your needs, three articles were selected for deeper review. The following table displays the selected articles.

Tabel hasil review

No	Author	Protocol & Training Duration	Intervention	Subject	Volume & Intensity	Pre VO2Max ($mL \cdot kg^{-1} \cdot min^{-1}$)	Post VO2Max ($mL \cdot kg^{-1} \cdot min^{-1}$)	Result
1.	Matsuo et al. (2014)	• Ergocycle • 8 weeks, 5x per week	SIT	C : 14 men B : 21.3 ± 1.2 U : 26.4 ± 6.5	• 10 minute • 2 minute warm up • 30 seconds sprint active, 15 pasive, 7x reps • 3 minute cooling down	43.9 ± 6.7	50.7 ± 4.4	SIT is better than CAT
			CAT	C : 14 men B : 21.2 ± 2.4 U : 25.9 ± 6.0	• 40 minute continuous • 40 minute (60%–65% VO2max, 60 rpm)	42.0 ± 6.8	45.8 ± 2.9	
2.	Heisz et al. (2016)	• Ergocycle • 6 weeks, 3x per week	HIT	C : 5 men, 12 women B : 21.1 ± 0.5 U : 21.4 ± 2.9	• 20 minute • 1 minute 90 – 95% HRM, 1 minute recovery, 10x reps	31.8 ± 1.6	35.8 ± 1.8	HIT is better than MCT
			MCT	C : 6 men, 13	• 27,5 minute	30.2 ± 1.5	33.1 ± 1.7	

				women B : 23.0 ± 1.0 U : 20.4 ± 1.3	continuous • 70-75% HRM			
3.	Vella et al. (2017)	• Ergocycle dan Treadmill • 8 weeks, 4x per week	HIIT	C : Sedentary, 2 men 7 women B : 29.9 ± 3.3 U : 23.1 ± 6.6	• 20 minute • 1 minute sprint active, 1 minute passive, 10x reps	34.8 ± 2.9	37.4 ± 0.8	HIIT is better than MICT
			MICT	C : Sedentary, 6 men 4 women B : 33.1 ± 6.0 U : 28.9 ± 8.1	• 30 minute continuous • 5 minute warm up 35-40% HRM • 20 minute inti 55-59% HRM • 5 minute cooling down 35-40% HRM	34.5 ± 2.1	34.9 ± 0.8	

Note: **Intervention** : HIIT, High Intensity Interval Training; SIT, Sprint Interval Training; HIT, High-Intensity Interval Training; MICT, Moderate Intensity Continuous Training; CAT, Continuous Aerobic Training; MCT, Moderate Continuous Training. **Interval Training** = HIIT, HIT, SIT; **Endurance Training** = MICT, MCT, CAT; **Subject** : C, Subject Character ; B, BMI; U, Age

Interval training is the same as HIIT (High Intensity Interval Training), HIT (High Intensity-Interval Training and SIT (Sprint Interval Training) (Matsuo et al. 2014). In the basic concept, what is meant by interval training is a type of exercise that uses pauses or time intervals from high intensity to moderate intensity. High intensity 85-95% HRM (Heart Rate Maximum) is carried out for a short duration, but maximally or full of energy. Meanwhile, there is a break in the form of a moderate intensity interval of 50-65% HRM (recovery) which is carried out for a longer duration compared to High Intensity, this aims to restore the heart rate so that you can do High Intensity again (Arboleda-Serna et al. 2019).

Endurance training is the same as continuous training, MICT (Moderate Intensity Continuous Training), CAT (Continuous Aerobic Training), and MCT (Moderate Continuous Training) (Heisz et al. 2016). n basic concept, what is meant by endurance training is a type of exercise that is carried out with moderate intensity of 50-75% HRM continuously without any pause at all for a set time (Vella, Taylor, and Drummer 2017)

A total of three 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 there were differences of opinion regarding the increase in VO2max, some proved that Interval Training was superior, others stated that it was superior Endurance training, more details can be seen in **Table 1.**

DISCUSSION

From third article prove that every training has a good effect on increasing VO2max. 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 Interval Traning is better than Endurance Training. The highher and more training, the highher the results obtained on increasing VO2max, but if the amount of training is the same, the training duration is not too far apart, and the intensity given is in accordance with the type of training, then the author supports that Interval Training is better than Endurance Training to increase VO2max capacity.

From here authors can take the basic concept, that basically Interval Training is better in increasing VO2max if compared to Endurance Training with the same number of meetings and in the same time period. Relatedly, Interval Training is more popular than Endurance Training in a study conducted by (Kong et al. 2016) which is 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. in 3rd place and has always been in the top 5 since 2015. Interval Training has become popular because this sport is challenging and does

not require a long time to do, apart from that the benefits obtained are similar or even more so than Endurance Training type sports in general (Alansare et al. 2018; Syamsudin et al. 2021). Interval Training can be a solution for people who complain about lack of time, low motivation, and non-compliance with the guidelines that have been given (Hoare et al. 2017; Rech et al. 2016).

Tabel 2. Category of VO2max (mL·kg-1 ·min-1)

Gender	Age	Very Poor	Poor	Currently	Good	Very Good
Men	≤ 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

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

CONCLUSION

Interval Training and Endurance Training have a good effect on increasing VO2max capacity, but Interval Training is more efficient, effective and in demand than Endurance Training. This article is a reference that interval training is better for increasing VO2max, but for practice in the field and to be imitated by the public, it needs to be modified further, meaning without using equipment such as ergocycles and treadmills, this is also a recommendation for future research on how to model easy training implemented by society.

Conflict of Interest

The authors declare that they have no conflict of interest.

REFERENCES

Alonso-Fernández, D., R. Fernández-Rodríguez, Y. Taboada-Iglesias, and Gutiérrez-Sánchez. 2019. "Impact of a HIIT Protocol on Body Composition and VO2max in Adolescents." *Science and Sports* 34(5):341–47. doi: 10.1016/j.scispo.2019.04.001.

Costa, Eduardo Caldas, Jacqueline L. Hay, Dustin S. Kehler, Kevin F. Boreskie, Rakesh C. Arora, Daniel Umpierre, Andrea Szwajcer, and Todd A. Duhamel. 2018. "Effects of High-Intensity Interval Training Versus Moderate-Intensity Continuous Training On Blood Pressure in Adults with Pre- to Established Hypertension: A Systematic Review and Meta-Analysis of Randomized Trials." *Sports Medicine* 48(9):2127–42. doi: 10.1007/s40279-018-0944-y.

Heisz, Jennifer J., Mary Grace M. Tejada, Emily M. Paolucci, and Cameron Muir. 2016. "Enjoyment for High-Intensity Interval Exercise Increases during the First Six Weeks of Training: Implications for Promoting Exercise Adherence in Sedentary Adults." *PLoS One* 11(12). doi: http://dx.doi.org/10.1371/journal.pone.0168534.

Hoeger, Werner W. K., Sharon A. Hoeger, Amber L. Fawson, and Cherie I. Hoeger. 2019. "Principles and Labs for Fitness and Wellness." 606.

Little, Jonathan P., Jodi Langley, Michael Lee, Etienne Myette-Côté, Garett Jackson, Cody Durrer, Martin J. Gibala, and Mary E. Jung. 2019. "Sprint Exercise Snacks: A Novel Approach to Increase Aerobic Fitness." *European Journal of Applied Physiology* 119(5):1203–12. doi: 10.1007/s00421-019-04110-z.

Matsuo, Tomoaki, Kousaku Saotome, Satoshi Seino, Nobutake Shimojo, Akira Matsushita, Motoyuki Iemitsu, Hiroshi Ohshima, Kiyoji Tanaka, and Chiaki Mukai. 2014. "Effects of a Low-Volume Aerobic-Type Interval Exercise on V̇O 2max and Cardiac Mass." *Medicine and Science in Sports and Exercise* 46(1):42–50. doi: 10.1249/MSS.0b013e3182a38da8.

De Nardi, Angélica Trevisan, Tainara Tolves, Thatiane Larissa Lenzi, Luis Ulisses Signori, and Antônio Marcos Vargas da Silva. 2018. "High-Intensity Interval Training versus Continuous Training on Physiological and Metabolic Variables in Prediabetes and Type 2 Diabetes: A Meta-Analysis." *Diabetes Research and Clinical Practice* 137:149–59. doi: 10.1016/j.diabres.2017.12.017.

Nie, Jinlei, Haifeng Zhang, Zhaowei Kong, Keith George, Jonathan P. Little, Tomas K. Tong, Feifei Li, and Qingde Shi. 2018. "Impact of High-Intensity Interval Training and Moderate-Intensity Continuous Training on Resting and Postexercise Cardiac Troponin T Concentration." *Experimental Physiology* 103(3):370–80. doi: 10.1113/EP086767.

Ramos, Joyce S., Lance C. Dalleck, Arnt Erik Tjonna, Kassia S. Beetham, and Jeff S. Coombes. 2015. "The Impact of High-Intensity Interval Training Versus Moderate-Intensity Continuous Training on Vascular Function: A Systematic Review and Meta-Analysis." *Sports Medicine* 45(5):679–92. doi: 10.1007/s40279-015-0321-z.

Russomando, Luca, Vincenzo Bono, Annamaria Mancini, Alessia Terracciano,

Francesca Cozzolino, Esther Imperlini, Stefania Orrù, Andreina Alfieri, and Pasqualina Buono. 2020. "The Effects of Short-Term High-Intensity Interval Training and Moderate Intensity Continuous Training on Body Fat Percentage, Abdominal Circumference, BMI and VO 2max in Overweight Subjects." *Journal of Functional Morphology and Kinesiology Article*. doi: 10.3390/jfmk5020041.

Su, Li Qiang, Jin Mei Fu, Shun Li Sun, Guang Gao Zhao, Wei Cheng, Chuan Chuan Dou, and Ming Hui Quan. 2019. "Effects of HIIT and MICT on Cardiovascular Risk Factors in Adults with Overweight and/or Obesity: A Meta-Analysis." *PLoS ONE* 14(1):1–21. doi: 10.1371/journal.pone.0210644.

Syamsudin, Fajar, Lilik Herawati, Ema Qurnianingsih, and Dyah Citrawati Kencono Wungu. 2021. "HIIT for Improving Maximal Aerobic Capacity in Adults Sedentary Lifestyle : Review Article." *Halaman Olahraga Nusantara (Jurnal Ilmu Keolahragaan)* 4(I):1–11. doi: 10.31851/hon.v4i1.5139.

Syamsudin, Fajar, Citrawati Dyah Kencono Wungu, Ema Qurnianingsih, and Lilik Herawati. 2021. "High-Intensity Interval Training for Improving Maximum Aerobic Capacity in Women with Sedentary Lifestyle: A Systematic Review and Meta-Analysis." *Journal of Physical Education and Sport* 21(4):1788–97. doi: 10.7752/jpes.2021.04226.

Vella, Chantal A., Katrina Taylor, and Devin Drummer. 2017. "High-Intensity Interval and Moderate-Intensity Continuous Training Elicit Similar Enjoyment and Adherence Levels in Overweight and Obese Adults." *European Journal of Sport Science* 17(9):1203–11. doi: 10.1080/17461391.2017.1359679.

Wewege, M., R. van den Berg, R. E. Ward, and A. Keech. 2017. "The Effects of High-Intensity Interval Training vs. Moderate-Intensity Continuous Training on Body Composition in Overweight and Obese Adults: A Systematic Review and Meta-Analysis." *Obesity Reviews* 18(6):635-646.

World Health Organization. 2020. *WHO Guidelines on Physical Activity, Sedentary Behaviour*.

Zhang, Haifeng, Tom K. Tong, Weifeng Qiu, Xu Zhang, Shi Zhou, Yang Liu, and Yuxiu He. 2017. "Comparable Effects of High-Intensity Interval Training and Prolonged Continuous Exercise Training on Abdominal Visceral Fat Reduction in Obese Young Women." *Journal of Diabetes Research* 2017. doi: 10.1155/2017/5071740.