

Does aerobic interval training induce a decrease in body weight in pencak silat elite athletes?

by Sri Sumartiningsih

Submission date: 03-May-2023 01:44PM (UTC+0700)

Submission ID: 2082858582

File name: Art_318.pdf (307.83K)

Word count: 6071

Character count: 34025

2

Does aerobic interval training induce a decrease in body weight in pencak silat elite athletes?

JOHANSYAH LUBIS¹, EKO JULI FITRIANTO², SUKIRI³, ARIDHOTUL HAQIYAH⁴, YASEP SETIAKARNAWIJAYA⁵, AGUNG ROBIANTO⁶, SLAMET SUKRIADI⁷, RIZKY NURULFA⁸, ASTRI AYU IRAWAN⁹, SRI SUMARTININGSIH¹⁰

^{1,2,3,5,6,7,8}Universitas Negeri Jakarta Jl. Rawamangun Muka Raya, Jakarta 13220, INDONESIA

⁹Universitas Singaperbangsa Karawang Jl. HS. Ronggo Waluyo, Karawang 41361, INDONESIA

⁴Universitas Islam 45 Jl. Cut Meutia No. 83, Bekasi 17113, INDONESIA

¹⁰Universitas Negeri Semarang, Jalan Raya Sekaran-Gunungpati Semarang 50229, INDONESIA

Published online: August 31, 2021

(Accepted for publication August 15, 2021)

DOI:10.7752/jpes.2021.s4318

Abstract:

Competition in martial art sports depends on body weight of the athletes so they can compete in the right weight class. The purpose of this study was to determine the effect of aerobic interval training on overweight national elite athletes based on their body mass index (BMI), VO₂max, and basal pulse rate. This study used purposive sampling of eight national Pencak Silat elite athletes (6 males and 2 females who were 23.75±4.55 years old with heights of 171.63±6.32 cm), who were in the sub phase of special preparation, as the subjects. The athletes lived in the athlete village, and the food was the exact condition. The Aerobic Interval (AI) training was 67-77 min per session twice a week for 5 weeks and with warm-up and cool down for 10-15 min for each session. AI training was performed for 5 min with 80–85% intensity of HRmax (controlled by Polar) and a rest interval of 1 min or with a 5:1 ratio of training to rest. Polar produces a series of heart rate monitoring devices and accessories for sports training and fitness, as well as measuring heart rate variability. The weight, BMI, body fat percentage, muscle mass, basal metabolic rate, and VO₂max showed significant differences ($p < 0.05$) after five weeks of AI training. However, the AI training did not produce significant differences in the measured variables, i.e. the percentage of water, protein, visceral fat, bone density, biological age, and basal pulse, in the overweight Pencak Silat elite athletes. The AI training for five weeks improved VO₂max and decreased body weight and fat percentage.

Key Words: Aerobic interval training, overweight, body composition, heart rate, VO₂Max, pencak silat

Introduction

Pencak Silat is a martial arts sport that consists of several categories, and one of them is Match. It is categorized based on the athlete's body weight, which is further categorized into several numbers/classes. An athlete will be disqualified if their body weight is not compliant with the class they compete in whether because of being overweight or underweight. However, in measuring an athlete's body weight using Body Mass Index (BMI), they will be categorized as underweight if the BMI is below 18.5 kg/m², normal weight if they are between 18.5 and 24.9 kg/m², and overweight if they are between 25 and 30 kg/m² (Cesare et al., 2016; DiFrancisco-Donoghue, Werner, Douris, & Zwibel, 2020). Thus, when a competition nears, athletes will try to lose their weight without taking care of their diet with a combination of training and behaviour modification. The process of losing and gaining repeatedly can affect athletes negatively (Yen, 1992). Being overweight, according to WHO reports, is a part of society's health agenda and is a health risk factor, which is often associated with lifestyle ("WHO. 916," 2003). Obesity is often related to the depression risk (Malmir et al., 2019). Overweight female athletes will most likely become more aggressive and more expressive in conveying their feelings when upset (Urzealã, Popescu, & Predoiu, 2014). Disorders, such as musculoskeletal dysfunction, in athletes could limit their movements (Naderi, Goli, Shephard, & Degens, 2021). Aging is also one of the reasons for an increase in BMI, body fat, visceral fat, waist size, and the muscle mass of males and females (Liang, Chen, Li, Yan, & Yang, 2018).

Body composition, especially body fat and lean mass, may change significantly through physical training (Campos et al., 2013), which is the main factor in regulating and maintaining body mass (Ubago-Guisado et al., 2017)). One of the methods of physical training is aerobic activity, where the right aerobic training will not produce any risks of toxicity. It even reduces obesity or overweight status, improves the lipid profile, and improves quality of life (Bortolozzo et al., 2020). Another effect of aerobic training for six weeks is a decrease in weight, waist size, body mass index, total cholesterol, HDL cholesterol, LDL, triglycerides, and increase VO₂max (Farsani & Rezaeimaneh, 2011; Romanchuk & Dolgier, 2017). Aerobic training can be conducted with "Aerobic Interval" (AI) methods, which are effective for increasing aerobic capacity, HR recovery, and heart function (Molmen-Hansen et al., 2012). AI also has an impact on psychosocial factors

2372-----

Corresponding Author: JOHANSYAH LUBIS, E-mail: johansyah.sport@unj.ac.id

(Hannan et al., 2018) The heart function and body composition of overweight athletes can be improved through AI training (França et al., 2020) Not only can overweight athletes benefit from AI training but also people who suffer from Coronary Artery Disease (CAD), where it is used as cardiac rehabilitation (CR) as an alternative to psychology and physical health (Terada et al., 2019) Through AI training, BMI and body fat mass may decrease, and VO₂max may increase, but the body weight will remain the same (Tjønnå et al., 2009). A study reported that HIIT training could decrease total fat mass by 28.5% more than moderate-intensity continuous training, which is also effective for weight loss for young males who suffer from obesity (Nafar, Fathei, & Ziaaldini, 2020; Viana et al., 2019) and effective training protocol to increase the maximal aerobic capacity with a minimum of 4 weeks of exercise duration of 18-30 minutes per session (Syamsudin, Dyah, Wungu, & Qurnianingsih, 2021).

The system energy requirements in Pencak Silat martial arts for the match category during a competition of 2 min in 3 rounds with 1-min rest are mostly aerobic (Lubis et al., 2021; Lubis & Wardoyo, 2014); however, resistance training is a key foundation for the preparation phase (Bompa & Buzzichelli, 2018). In AI training, intensity training is the main factor in which AI training should meet the lactate threshold or higher (Baquet, Van Praagh, & Berthoin, 2003; Tjønnå et al., 2009). AI activity reaches 'almost maximum' when the heart rate (HR) is 80% of the HR_{max}; thus, AI training done in high volume and low intensity (90% VO₂max) is called 'threshold' training or velocity or pace training (Seiler, Jøranson, Olesen, & Hetlelid, 2013; Weston, Wisløff, & Coombes, 2014). Regardless of the methods, AI training should trigger physiological adaptation while stimulating athletic performance, which can be twice a week for 4 weeks (Laursen, Shing, Peake, Coombes, & Jenkins, 2002) The recommended duration for AI training is 20–40 min, depending on the total duration, with 80–100% heart rate intensity of HR_{max} or 70–100% (VO₂max) 1-2 times a week (Bompa & Buzzichelli, 2018) When it comes to designing AI training, it is recommended to gradually increase the intensity to determine the athlete's maximum heart rate, maximum speed, or strength output in terms of VO₂max and lactate threshold. The resting interval is set to reach 65% of the athlete's maximum heart rate or a decrease in intensity that is lower (Laursen et al., 2002). AI training is appropriate to use to increase the intensity of Pencak silat movements because there is a change in the intensity of the movement every certain time interval that is repeated during training. This exercise program can have a positive effect on the body, functional, and motor changes such as providing significant benefits to physical fitness (Rýzková, Labudová, Grznár, & Šmída, 2018), overcoming the lack of mastery of attack techniques and fatigue in Pencak silat. Physiological and psychological pressure will appear because of AI training, and the athlete's performance will be affected by the better BMI. Physical training is considered a potential clinical intervention treatment for public health regulations (Porrás-Segovia et al., 2019). The purpose of this study was to determine the AI training effect on the body composition, BMI, VO₂max, and basal pulse rate of overweight Pencak Silat athletes.

Material and methods

Participants

This study involved 30 national elite Pencak Silat athletes who are prepared multi-events in the SEA Games 2021 as participants. They were then selected purposively; 22 participants in the normal BMI category (18.5–24.9 kg/m²) and 8 participants in the overweight category (25 kg/m²) were used as the sample for this study. The average age of those 8 participants (6 males and 2 females) was 23.75 ± 4.55 years old with an average height of 171.63 ± 6.32 cm, and a baseline body weight of 80.4 ± 11 kg. Before the experiment, athletes were gathered and provided an explanation about the study implementation and the process of data collection. After knowing and understanding that this study will not affect national team selection as part of their agreement to participate in this study, they signed an informed consent form.

Preliminary procedure

All participants in this study lived in the same dorm, and the food types provided to them were the same (the amount of food consumed was uncontrolled). The following health examinations were conducted by the medical team: antigen SWAB for COVID-19, ECG, complete blood count (CBC), respiratory examination, and osteoarthritis examination. For initial data, BMI was measured, and VO₂max was tested on all athletes. All participants were asked to use Polar and not allowed to smoke or drink alcohol. The AI experiment was conducted for 67–77 min twice a week for five weeks. Polar was used to measure AI training activity. Athletes had to wear sports shoes and apparel. Inclusion criteria: the BMI was overweight, healthy, and tested negative for COVID-19. Exclusion criteria included tested positive for COVID-19. Participants that did not meet the requirements or were not compliant with this instruction were excluded from the experiment.

Experimental protocol

Before and after AI training

The VO₂max of participants was measured with a multistage fitness test (MFT), and their body compositions were measured using a Mi Xiaomi Body Scale 2/BIA (bioimpedance analysis) that was connected to a smartphone with each athlete's height and date of birth data provided. The following data were collected: body weight, BMI, body fat percentage, bone mass, protein percentage, body water percentage, visceral fat, body age, muscle mass, and BMR (basal metabolic rate). The basal heart rate and resting heart rate were measured with Polar.

AI training program protocol

All participants that took part in the AI training selected for this study with a duration of 67-77 min per session twice a week for 5 weeks and with warm-up and cool down for 10-15 min for each session. AI training was performed for 5 min with 80–85% intensity of HRmax (controlled by Polar) and a rest interval of 1 min or with a 5:1 ratio of training to rest (adapted from (Laursen et al., 2002)) (Weston et al., 2014)

Instrumentation and measured parameters

Measurement was conducted on all national elite athletes selected whose BMI showed they were overweight. Before training, their temperatures were checked using an infrared thermo gun on the forehead at a 10 cm distance. Body composition was measured with BIA (bioimpedance analysis) (Mi Body 15, Mi Body Composition 2, Xiaomi) (Walter-Kroker, Kroker, Mattiucci-Guehlke, & Glaab, 2011) which is believed to be one of the most efficient methods to estimate body composition for its easy accessibility, portability, cost-efficiency, quick assessment procedure, and high validity of DXA (Huang et al., 2018) (Pulse was measured using a Polar (OH1 heart rate monitor). The Polar monitor was attached to the upper arm and monitored through an iPad (Apple) for team Polar data. Polar produces a series of heart rate monitoring devices and accessories for sports training and fitness, as well as measuring heart rate variability. Polar Fitness Test is a non-exercise fitness test that measures your aerobic (cardiovascular) fitness. It estimates your maximal oxygen uptake, VO2max, in millilitres per kilogram of body mass per minute. The VO2max was measured using MFT at a distance of 20 m by running with rhythm.

Statistical analysis

The statistical analysis was performed using SPSS v26.0 for Windows (SPSS Inc., Chicago, USA). The paired sample t-test was used to determine the training effect by comparing the average and testing the significance of all study variables. Variables of body weight, BMI, fat percentage, bone mass, protein percentage, body water percentage, visceral fat, body age, muscle mass, and BMR (basal metabolic rate) were analysed using a paired sample t-test to determine the effect of aerobic interval training. The acceptable level (2-tailed) of statistical significance was <0.05.

Table 1. Descriptive statistics

Variable	Group	
	Pre-test (n=8)	Post-test (n=8)
Weight (Kg)	80.4± 11	79.6± 11
BMI (Kg/m ²)	27.1±2.1	26.8±2.1
Fat Mass (%)	28.4±5.1	28±5
Muscle Mass (Kg)	54.5±8.1	54.3±8.3
Total Body Water	50.1±2.7	50.1±2.7
Protein Profile	17.8±2.4	18.1±2.4
Basal Metabolic Rate	1675.4±224.9	1686.1±226.7
Visceral Fat (%)	9.4±2.7	9±2.3
Bone Density (%)	3±0.3	3±0.3
Body Age (y)	28.9±13.1	24.5±15.9
VO2max (mL.kg.min)	42.3±3.6	46.5±3.2
Basal Pulse (per min)	58.4±4.5	57.3±4.1

Table 2. Hypothesis test results

		Paired Sample Test					t	df	Sig. (2-tailed)
		Paired Differences							
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
			Lower	Upper					
Pair 1	Weight (Kg)	-.79875	.46707	.16513	-1.18923	-.40827	-4.837	7	.002*
Pair 2	BMI (Kg/m ²)	-.27750	.15691	.05548	-.40868	-.14632	-5.002	7	.002*
Pair 3	Fat Mass (%)	-.40000	.37033	.13093	-.70960	-.09040	-3.055	7	.018*
Pair 4	Muscle Mass (Kg)	-.21000	.22590	.07987	-.39885	-.02115	-2.629	7	.034*
Pair 5	Total Body Water	.02500	.50639	.17904	-.39835	.44835	.140	7	.893
Pair 6	Protein Profile	.37500	.77965	.27565	-.27681	1.02681	1.360	7	.216
Pair 7	Basal Metabolic Rate	10.75000	5.65054	1.99777	6.02603	15.47397	5.381	7	.001*
Pair 8	Visceral Fat (%)	-.37500	.51755	.18298	-.80768	.05768	-2.049	7	.080
Pair 9	Bone Density (%)	.01125	.01458	.00515	-.00094	.02344	2.183	7	.065
Pair 10	Body Age (y)	-4.33875	9.18715	3.24815	-12.01940	3.34190	-1.336	7	.223
Pair 11	VO2max (mL.kg.min)	4.21250	3.41671	1.20799	1.35606	7.06894	3.487	7	.010
Pair 12	Basal Pulse (per min)	-1.12500	5.71808	2.02165	-5.90543	3.65543	-.556	7	.595

*significant

Results

Bodyweight data was taken before training with average body weights for the pre- and post-test of 74.4 ± 11 and 79.6 ± 11 , respectively, and the significance of the body weight analysis (2-tailed) was $0.002 < 0.05$; thus, there was a significant decrease. For the average BMI for the pre- and post-tests ($27.1 \text{ kg/m}^2 \pm 2.1$; $26.8 \text{ kg/m}^2 \pm 2.1$), the significance of the BMI analysis (2-tailed) was $0.002 < 0.05$; thus, there was a significant decrease. There was a decrease in the athletes' fat mass according to the pre- and post-test averages ($28.4 \pm 5.1\%$; $28 \pm 5\%$), and the significance of the fat mass analysis (2-tailed) was $0.018 < 0.05$; thus, there was a significant decrease in fat mass. For the average muscle mass in the pre- and post-tests (54.5 ± 8.1 ; 54.3 ± 8.3), the significance of the muscle mass analysis (2-tailed) was $0.034 < 0.05$; thus, there was a significant decrease in muscle mass. For average body water in the pre- and post-tests (50.1 ± 2.7 ; 50.1 ± 2.7), the significance of the body water analysis (2-tailed) was $0.893 > 0.05$; thus, it was not significant. For the average protein profile in the pre- and post-tests ($17.8\% \pm 2.4$; 18.1 ± 2.4), the significance of the body water analysis (2-tailed) was $0.216 > 0.05$; thus, the increase in the protein profile was not significant. For the basal metabolic rate for the pre- and post-tests ($1675.4 \pm 224.9 \text{ kcal}$; 1686.1 ± 226.7), the significance of the basal metabolic rate (2-tailed) was $0.001 < 0.05$; thus, the increase in the basal metabolic rate was significant. For the average visceral fat during the pre- and post-tests (9.4 ± 2.7 ; 9 ± 2.3), the significance of the visceral fat analysis (2-tailed) was $0.080 > 0.05$; thus, the decrease in the visceral fat was not significant. For the average bone density during the pre- and post-tests ($3 \text{ kg} \pm 0.3$; $3 \text{ kg} \pm 0.3$), the significance of the bone density analysis (2-tailed) was $0.065 > 0.05$; thus, the increase in bone density was not significant. For the average body age during the pre- and post-tests ($28.9 \text{ years} \pm 13.1$; $24.5 \text{ years} \pm 15.9$), the significance of the body age analysis (2-tailed) was $0.223 > 0.05$; thus, the decrease in body age was not significant. For the average VO₂max during the pre- and post-tests ($42.3 \pm 3.6 \text{ mL/kg/min}$; $46.5 \pm 3.2 \text{ mL/kg/min}$), the significance of the VO₂max analysis (2-tailed) was $0.010 < 0.05$; thus, there was a significant increase in VO₂max during the 5 weeks of aerobic interval training. Their basal pulse was checked on the next day after training before they did activities after each treatment. For the average initial basal pulse rate (58.4 ± 4.5 ; 57.3 ± 4.1), the significance of the basal pulse rate analysis (2-tailed) was $0.595 > 0.05$; thus, the decrease in basal pulse rate was not significant.

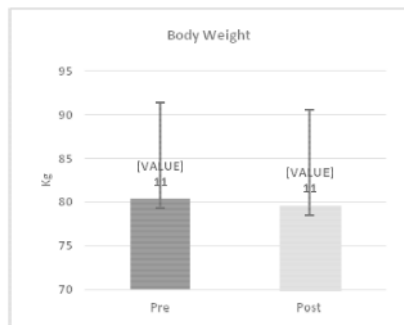


Fig.1. Body weight diagram

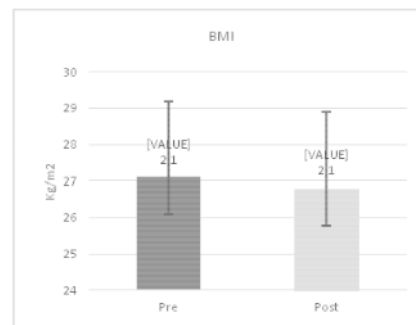


Fig.2. BMI diagram

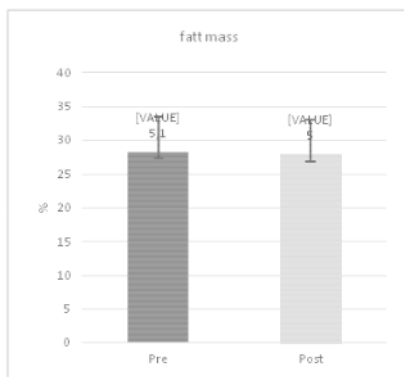


Fig.3. Fat mass diagram

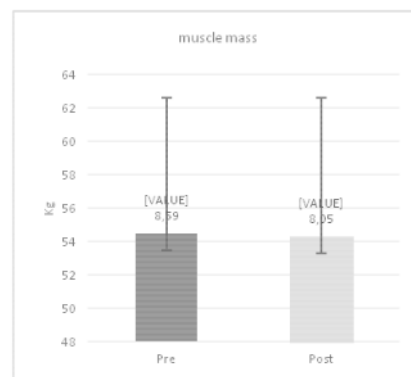


Fig.4. Muscle mass diagram

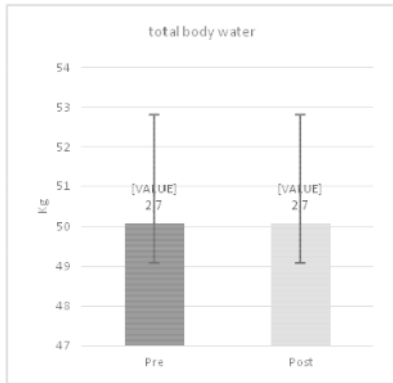


Fig.5. Total body water diagram

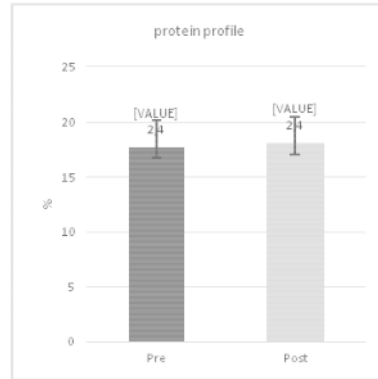


Fig.6. Protein profile diagram

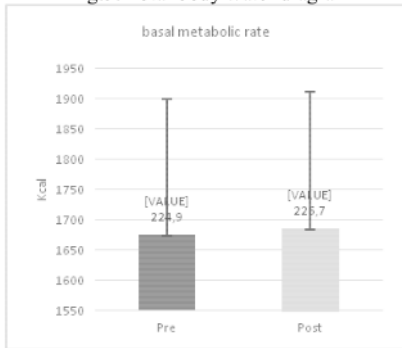


Fig.7. Basal metabolic rate diagram

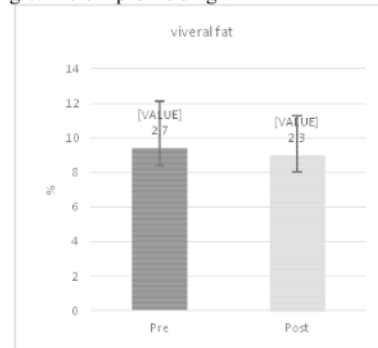


Fig.8. Visceral fat diagram

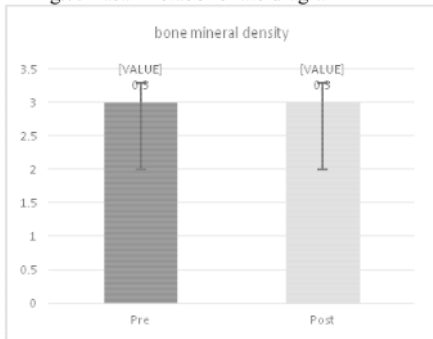


Fig.9. Bone mineral density (BMD) diagram

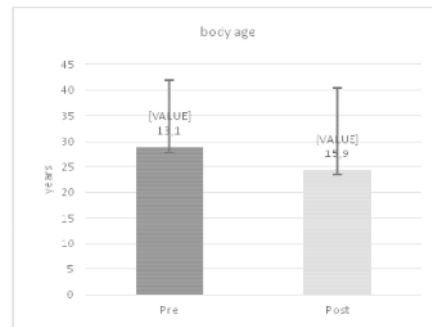


Fig.10. Body age diagram

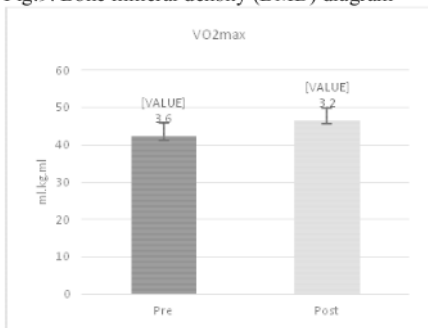


Fig.11. VO2max diagram

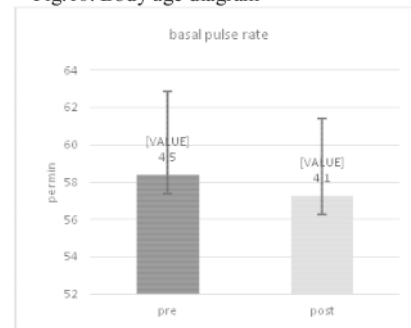


Fig.12. Basal pulse rate diagram

Discussion

The athletes who were overweight when given AI training for 5 weeks showed a significant weight loss (see Figure 1), and the training also resulted in changes in BMI even though they were still categorized as overweight (see Figure 2). In this study, AI training reduced body weight and fat mass, especially in athletes who were overweight, as in prior study referenced (Feo, 2013). This also applied to the management of body weight and overall health, which can be carried out for a long time and continuously, including the requirement of oxygen from activities (Berg, 2008). The findings showed that the body fat of the overweight elite athletes also decreased significantly. This is in accordance with HIIT research indicating that HIIT can reduce the accumulation of abdominal fat mass and visceral fat, although there was no explanation regarding the HIIT protocol that was carried out (Maillard et al., 2018). Similarly, the effect of training will result in a reduction in body fat and abdominal fat in overweight individuals (Boutcher, 2011) (The findings of this study indicated that muscle mass was significantly decreased in overweight athletes (see Figure 3). In accordance with research reports, the muscle mass size of individuals who were overweight or obese under 12 at significant changes (Blue Malia N et al., 2020). However, this differs from other research reports that showed that there was no evidence of a significant increase in muscle mass, though AI training is considered the training type that is relevant for reducing body fat and weight significantly. However, in that report, there were difficulties in the level of sample readiness that had to be considered by the researchers (Juránková, Bílý, & Hrazdíra, 2015).

In this study, the significant increase in BMR in the overweight athletes (see Figure 7) was in accordance with a research report, which stated that lifestyle among other things, such as physical activity intensity, dietary aspects, and smoking habits, could affect BMR (Porras-Segovia et al., 2019)). The national training athletes were required to live in dormitories had the same diet, even though the portions eaten by each individual were different and adjusted to their needs; thus, in this case, we did not control it. However, the sleeping schedule for athletes was controlled, and athletes were not allowed to smoke. Our results are supported by research reports that showed that BMI is closely related to BMR. In one study, it was stated that the increase in BMI that recovered to a normal level would be in line with 20 process of recovering BMR to a healthy level for 3 to 4-year-old children suffering from narcolepsy (Wang et al., 2016). The findings of this study showed that VO₂max had a significant increase in overweight athletes after AI training for 5 weeks (see Figure 11). Thus, HIIT training for 2 weeks could increase VO₂max, and the average and peak strength output but did not affect resting heart rate or muscle strength production (Astorino, Allen, Roberson, & Jurancich, 2012)). However, we were concerned by the significant increase in low baseline increase, i.e., 42.3 mL/kg/min, in the overweight athletes; thus, the increase was quite significant.

The total body water of the athletes who were overweight in this study was not significant (see Figure 5). These findings differ from the findings of researchers who stated that "the lower the body fat percentage, the higher the total body water" (Mastria & Adyaksa, 2014). Physiologically, the need for fluids and electrolytes is a basic human need. Although the percentage of human body fluids and electrolytes vary depending on age, body fat, and sex, researchers need to suggest further research on total body water because the number of participants in the study was small, and there was no gender classification. Another finding was the insignificant decrease in visceral fat after 5 weeks of performing AI training (see Figure 8), even though the athletes in this study showed significant body weight loss.

This finding was in contrast to the finding that visceral fat and liver fat could be reduced along with weight 24 (Tiikkainen et al., 2003). One research report showed that HIIT did not show a decrease in visceral fat, but there was a significant decrease in visceral fat after MICT training for 12 weeks, especially in young women who were obese (Zhang et al., 2017) According to another study, the degree of visceral fat in obese people was higher than in adults who were not obese. In addition, total cholesterol, triglycerides, LDL cholesterol and the TG/HDL ratio were correlated with the amount of visceral fat (Sumami, 2019) AI training for 5 weeks in our study did not decrease the visceral fat in overweight athletes; thus, further research with a longer study period and more participants is needed.

This study showed 21 no significant increase in bone mineral density (BMD) (see Figure 9), although AI training for 5 weeks resulted in a decrease in fat mass and muscle mass (see Figures 3 and 4). In contrast to research reports that showed that BMD was positively related to lean mass in the female population in Korea, it was found that fat mass did not show a consistent correlation with BMD (Kim et al., 2009). Other research reports showed that for strength athletes, such as weightlifting or judo athletes (judo is a martial arts sport similar to Pencak Silat), they had better bone density than endurance athletes, such as long-distance running, cycling, and swimming athletes (Hinrichs, Chae, Lehmann, Allolio, & Platen, 2010). Bone density can be affected by a weight lifting process focused on the bones; thus, training activities that involved weight affected bone density in contrast to endurance sports, which did not require athletes to lift weights (Bellew & Gehrig, 2006) (We hope that there will be further research on functional AI training that focuses on weight lifting to determine the bone density increase. However, for the findings in research related to basal pulse rate, AI training in overweight athletes had a decreasing effect but was not significant (see Figure 12), which is in contrast to research reports that showed that AI training decreases basal pulse rate (Beijer et al., 2018).

Conclusions

Aerobic interval training for 5 weeks had effects on overweight athletes, i.e., weight loss, a decrease in body mass index, body fat, muscle mass, and an increase in basal metabolic rate and VO₂max. The insignificant results were for total body water, protein profile, visceral fat, bone density, body age, and basal pulse. So, through aerobic interval training, body composition (body mass index, body fat, muscle mass), basal metabolic rate, and VO₂max of Pencak silat athletes can be controlled.

Acknowledgments

Our sincere thanks go to PB IPSI (Indonesian Pencak Silat Sports Association), Physiology Lab, Sport Science Faculty of Universitas Negeri Jakarta, the National coach pencak silat for the 2021 SEA Games, and Lembaga Pengelola dana Pendidikan (LPDP).

Ethics

Ethics Committee for Higher Education in this study No. B/349/UN39.14/PT/202

References

- Astorino, T. A., Allen, R. P., Roberson, D. W., & Jurancich, M. (2012). Effect of High-intensity Interval Training on Cardiovascular Function, VO₂max, and Muscular Force. *Journal of Strength and Conditioning Research*, 26(1), 138–145. <https://doi.org/10.1519/jsc.0b013e318218dd77>
- Baquet, G., Van Praagh, E., & Berthoin, S. (2003). Endurance Training and Aerobic Fitness in Young People. *Sports Medicine*, 33(15), 1127–1143. <https://doi.org/10.2165/00007256-200333150-00004>
- Beijer, K., Lampa, E., Sundström, J., Nilsson, P. M., Elmståhl, S., Pedersen, N. L., & Lind, L. (2018). Physical Activity May Compensate for Prolonged TV Time Regarding Pulse Rate—a cross-sectional Study. *Upsala Journal of Medical Sciences*, 123(4), 247–254. <https://doi.org/10.1080/03009734.2018.1540505>
- Bellew, J. W., & Gehrig, L. (2006). A Comparison of Bone Mineral Density in Adolescent Female Swimmers, Soccer Players, and Weight Lifters. *Pediatric Physical Therapy*, 18(1), 19–22. <https://doi.org/10.1097/01.ppt.0000200952.63544.16>
- Berg, K. (2008). Are Sports and Games Effective for Fitness and Weight Control? *Journal of Physical Education, Recreation & Dance*, 79(5), 13–17. <https://doi.org/10.1080/07303084.2008.10598177>
- Bompa, T. O., & Buzzichelli, C. (2018). *Periodization: Theory and Methodology of Training Sixth Edition*. United States of America: Human Kinetics.
- Bortolozzo, H. I., Derchain, S., Vechin, F. C., Maginador, G. F., Santos, I. S., Torresan, R., ... Conceicao, M. S. (2020). Aerobic Fitness is a Predictor of Body Composition in Women With Breast Cancer at Diagnosis. *Clinical Breast Cancer*, 21(3).
- Boutcher, S. H. (2011). High-intensity intermittent exercise and fat loss. *Journal of Obesity*, 2011. <https://doi.org/10.1155/2011/868305>
- Campos, L. F. C. C. de, Silva, A. de A. C. e, Santos, L. G. T. F. dos, Costa, L. T., A, Montagner, P. C., ... Gorla, J. I. (2013). Effects of Training in Physical Fitness and Body Composition of the Brazilian 5-a-side Football Team. *Revista Andaluza de Medicina Del Deporte*, 6(3), 91–95.
- Cesare, M. Di, Bentham, J., Stevens, G. A., Zhou, B., Danaei, G., Lu, Y., ... Hobbs, M. (2016). Trends in Adult Body-mass Index in 200 Countries from 1975 to 2014: A Pooled Analysis of 1698 Population-based Measurement Studies with 19.2 Million Participants. *The Lancet*, 387(10026).
- DiFrancisco-Donoghue, J., Werner, W. G., Douris, P. C., & Zwibel, H. (2020). Esports Players, Got Muscle? Competitive Video Game Players' Physical Activity, Body Fat, Bone Mineral Content, and Muscle Mass in Comparison to Matched Controls. *Journal of Sport and Health Science*, 00, 1–6. <https://doi.org/10.1016/j.jshs.2020.07.006>
- Farsani, P. A., & Rezaeimaneh, D. (2011). The Effect of Six-week Aerobic Interval Training on Some Blood Lipids and VO₂max in Female Athlete Students. *Procedia - Social and Behavioral Sciences*, 30(2011), 2144–2148. <https://doi.org/10.1016/j.sbspro.2011.10.416>
- Feo, P. De. (2013). Is High-intensity Exercise Better Than Moderate-intensity Exercise for Weight Loss? *Nutrition, Metabolism, and Cardiovascular Diseases*, 23(11), 1037–1042.
- França, G. de O., Frantz, E. D. C., Magliano, D. C., Bargut, T. C. L., Sepúlveda-Fragoso, V., Silveiras, R. R., ... Borges, J. P. (2020). Effects of Short-term high-intensity Interval and Continuous Exercise Training on Body Composition and Cardiac Function in Obese Sarcopenic Rats. *Life Sciences*, 256(March), 117920. <https://doi.org/10.1016/j.lfs.2020.117920>
- Hannan, A., Hing, W., Simas, V., Climstein, M., Coombes, J., Jayasinghe, R., ... Furness, J. (2018). High-intensity Interval Training Versus Moderate-intensity Continuous Training Within Cardiac Rehabilitation: A Systematic Review and Meta-analysis. *Open Access Journal of Sports Medicine*, 9, 1–17. <https://doi.org/10.2147/oajsm.s150596>
- Hinrichs, T., Chae, E.-H., Lehmann, R., Allolio, B., & Platen, P. (2010). Bone Mineral Density in Athletes of Different Disciplines: a Cross-Sectional Study. *The Open Sports Sciences Journal*, 3(1), 129–133. <https://doi.org/10.2174/1875399x01003010129>
- Huang, S. W., Hsieh, F. C., Lin, L. F., Liao, C. De, Ku, J. W., Hsiao, D. J., & Liou, T. H. (2018). Correlation between Body Composition and Physical Performance in Aged People. *International Journal of*

- Gerontology*, 12(3), 186–190. <https://doi.org/10.1016/j.ijge.2018.02.011>
- Juránková, M., Bily, J., & Hrazdira, E. (2015). Effects of High-intensity Strength Interval Training Program on Body Composition. *Journal of Human Sport and Exercise*, 10(Procl), <https://doi.org/10.14198/jhse.2015.10.procl.20>
- Laursen, P. B., Shing, C. M., Peake, J. M., Coombes, J. S., & Jenkins, D. G. (2002). Interval Training Program Optimization in Highly Trained Endurance Cyclists. *Medicine and Science in Sports and Exercise*, 34(11), 1801–1807. <https://doi.org/10.1097/00005768-200211000-00017>
- Liang, X., Chen, X., Li, J., Yan, M., & Yang, Y. (2018). Study on Body Composition and Its Correlation with Obesity A Cohort Study in 5121 Chinese Han Participants. *Medicine*, 97(21). <https://doi.org/10.1097/MD.00000000000010722>
- Lubis, J., Sukur, A., Fitrianto, E. J., Suliyanthini, D., Irawan, A. A., Robianto, A., ... Oktafiranda, N. D. (2021). Wearing a fibrous protein (cv-f) cooling vest to reduce fatigue among indonesian pencak silat athletes: Is it effective? *Journal of Engineering Science and Technology*.
- Lubis, J., & Wardoyo, H. (2014). *Pencak silat*. Jakarta: PT. Rajawali Sport
- Malmir, H., Mirzababaei, A., Moradi, S., Rezaei, S., Mirzaei, K., & Dadfarma, A. (2019). Metabolically Healthy Status and BMI in Relation to Depression: A Systematic Review of Observational Studies. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 13(2).
- Molmen-Hansen, H. E., Stølen, T., Tjønnå, A. E., Aamot, I. L., Ekeberg, I. S., Tyldum, G. A., ... Støylene, A. (2012). Aerobic Interval Training Reduces Blood Pressure and Improves Myocardial Function in Hypertensive Patients. *European Journal of Preventive Cardiology*, 19(2).
- Naderi, A., Goli, S., Shephard, R. J., & Degens, H. (2021). Six-month table tennis training improves body composition, bone health and physical performance in untrained older men; a randomized controlled trial. *Science and Sports*, 36(1), 72.e1-72.e9. <https://doi.org/10.1016/j.scispo.2020.02.008>
- Nafar, A. H., Fathei, M., & Ziaaldini, M. M. (2020). Effect of 8 Weeks of HIIT on Hepatic Enzyme Levels, Lipid Profile and Body Composition in Overweight Young Men. *Obesity Medicine*, 18.
- Porrás-Segovia, A., Rivera, M., Molina, E., López-Chaves, D., Gutiérrez, B., & Cervilla, J. (2019). Physical Exercise and Body Mass Index as Correlates of Major Depressive Disorder in Community-dwelling Adults: Results from the PISMA-ep Study. *Journal of Affective Disorders*, 251(8).
- Romanchuk, A., & Dolgier, Y. (2017). Original Article Effects of long-term training experience of aerobic exercises on middle-aged women. *Journal of Physical Education and Sport*, 17(2), 680–687. <https://doi.org/10.7752/jpes.2017.02102>
- Rýzková, E. V. A., Labudová, J., Grznár, L., & Šmída, M. (2018). Original Article Effects of aquafitness with high intensity interval training on physical fitness. *Journal of Physical Education and Sport*, (1), 373–381. <https://doi.org/10.7752/jpes.2018.s151>
- Seiler, S., Jørganson, K., Olesen, B. V., & Hetlelid, K. J. (2013). Adaptations to aerobic interval training: Interactive effects of exercise intensity and total work duration. *Scandinavian Journal of Medicine and Science in Sports*, 23(1), 74–83. <https://doi.org/10.1111/j.1600-0838.2011.01351.x>
- Sumarni. (2019). Hubungan antara Derajat Lemak Visceral dengan Profil Lipid Pada Dewasa Obesitas. *Jurnal Ilmiah Kedokteran*, 6(1), 45–54.
- Syamsudin, F., Dyah, C., Wungu, K., & Qumianingsih, E. M. A. (2021). Original Article 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(June), 1788–1797. <https://doi.org/10.7752/jpes.2021.04226>
- Terada, T., Beanlands, R. A., Tulloch, H. E., Pipe, A. L., Chirico, D., & Reed, J. L. (2019). Aerobic Interval Training and Moderate-to-vigorous Intensity Continuous Training are Associated with sex-specific Improvements in Psychological Health in Patients with Heart Disease. *European Journal of Preventive Cardiology*, 26(8).
- Tjønnå, A. E., Stølen, T. O., Bye, A., Volden, M., Slørdahl, S. A., Odegård, R., ... Wisløff, U. (2009). Aerobic Interval Training Reduces Cardiovascular Risk Factors more than a Multitreatment Approach in Overweight Adolescents. *Clinical Science*, 116(4).
- Ubago-Guisado, E., Mata, E., Sánchez-Sánchez, J., Plaza-Carmona, M., Martín-García, M., & Gallardo, L. (2017). Influence of Different Sports on Fat Mass and Lean Mass in Growing Girls. *Journal of Sport and Health Science*, 6(2), 213–218. <https://doi.org/10.1016/j.jshs.2015.06.001>
- Urzeală, C., Popescu, V., & Predoiu, R. (2014). Dimensions of the Personality of Athlete and Non-athlete Normal Weight and Overweight Female Students. *Procedia - Social and Behavioral Sciences*, 117, 395–401. <https://doi.org/10.1016/j.sbspro.2014.02.234>
- Viana, R. B., Naves, J. P. A., Coswig, V. S., De Lira, C. A. B., Steele, J., Fisher, J. P., & Gentil, P. (2019). Is Interval Training the Magic Bullet for Fat Loss? A Systematic Review and Meta-analysis Comparing Moderate-intensity Continuous Training with High-intensity Interval Training (HIIT). *British Journal of Sports Medicine*, 53(10), 655–664. <https://doi.org/10.1136/bjsports-2018-099928>
- Walter-Kroker, A., Kroker, A., Mattiucci-Guehlke, M., & Glaab, T. (2011). A practical guide to bioelectrical impedance analysis using the example of chronic obstructive pulmonary disease. *Nutrition Journal*, 10(1),

2–9. <https://doi.org/10.1186/1475-2891-10-35>

- Wang, Z., Wu, H., Stone, W. S., Zhuang, J., Qiu, L., Xu, X., ... Zhao, Z. (2016). Body Weight and Basal Metabolic Rate in Childhood Narcolepsy: A Longitudinal Study. *Sleep Medicine*, 25. <https://doi.org/10.1016/j.sleep.2016.06.019>
- Weston, K. S., Wisløff, U., & Coombes, J. S. (2014). High-intensity Interval Training in Patients with Lifestyle-induced Cardiometabolic Disease: A Systematic Review and Meta-analysis. *British Journal of Sports Medicine*, 48.
- Yen, P. K. (1992). Losing Weight Realistically. *Geriatric Nursing*, 13(4). [https://doi.org/10.1016/S0197-4572\(05\)80405-7](https://doi.org/10.1016/S0197-4572(05)80405-7)
- Zhang, H., Tong, T. K., Qiu, W., Zhang, X., Zhou, S., Liu, Y., & He, Y. (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(January). <https://doi.org/10.1155/2017/5071740>

Does aerobic interval training induce a decrease in body weight in pencak silat elite athletes?

ORIGINALITY REPORT

14%

SIMILARITY INDEX

12%

INTERNET SOURCES

3%

PUBLICATIONS

5%

STUDENT PAPERS

PRIMARY SOURCES

1	sipeg.unj.ac.id Internet Source	3%
2	www.efsupit.ro Internet Source	1%
3	jestec.taylors.edu.my Internet Source	1%
4	Submitted to University of Glasgow Student Paper	1%
5	Submitted to Universitas Muhammadiyah Surakarta Student Paper	1%
6	www.polar.com Internet Source	1%
7	Submitted to Universitas Airlangga Student Paper	1%
8	www.science.gov Internet Source	1%

9	Parisa Amiri Farsani, Davar Rezaeimanesh. "The Effect of Six-Week Aerobic Interval Training on Some Blood Lipids and VO 2 max in Female Athlete Students", Procedia - Social and Behavioral Sciences, 2011 Publication	1 %
10	seminar.uad.ac.id Internet Source	1 %
11	www.karger.com Internet Source	<1 %
12	tmfv.com.ua Internet Source	<1 %
13	academic.oup.com Internet Source	<1 %
14	www.ijramr.com Internet Source	<1 %
15	Shih-Wei Huang, Feng-Chi Hsieh, Li-Fong Lin, Chun-De Liao, Jan-Wen Ku, Dun-Jen Hsiao, Tsan-Hon Liou. "Correlation between Body Composition and Physical Performance in Aged People", International Journal of Gerontology, 2018 Publication	<1 %
16	www.hrpub.org Internet Source	<1 %

theses.gla.ac.uk

17	Internet Source	<1 %
18	www.koreascience.or.kr Internet Source	<1 %
19	coek.info Internet Source	<1 %
20	dergipark.org.tr Internet Source	<1 %
21	Antonia Giacco, Elena Silvestri, Rosalba Senese, Federica Cioffi et al. "Exercise with Energy Restriction as a Means of Losing Body Mass while Preserving Muscle Quality and Ameliorating Co-morbidities: Towards a Therapy for Obesity?", <i>Translational Medicine and Exercise Prescription</i> , 2021 Publication	<1 %
22	barbend.com Internet Source	<1 %
23	dokumen.pub Internet Source	<1 %
24	open.library.ubc.ca Internet Source	<1 %
25	rdw.rowan.edu Internet Source	<1 %
26	www.elsevier.es Internet Source	<1 %

<1 %

Exclude quotes Off

Exclude matches Off

Exclude bibliography On