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THE EFFECTS OF FIVE -WEEK AEROBIC INTERVAL TRAINING ON THE BODY COMPOSITION OF PENCAK SILAT ELITE ATHLETES

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ABSTRACT

This study aims to examine the effect of Aerobic Interval (AI) training performed for five weeks on the body mass index (BMI), basal heart rate, and Vo_{2max} of elite athletes. The study used an experimental study design with purposive sampling. Thirty National Pencak silat elite athletes (17 males, 13 females, aged 23.67 $\pm$ 4.10 years old) who were in the phase of preparation were involved as participants. The athletes lived in the dormitory where the food, type of training and exercise, and sleeping time were controlled to be in the exact condition. The AI training was 67–77 minutes per session, twice a week for five weeks, with vigorous-intensity at 80–85% of maximal heart rate, 5 minutes per interval, and 1 minute of the rest interval. The weight, BMI, body Fat %, basal heart rate, and Vo_{2max} showed significant differences ($p < 0.05$) after five weeks of AI training. However, the effect of AI training was not significantly different on the variables measured, muscle mass, percentage of water, percentage of protein, bone mineral density, and biological age. The AI training performed for five weeks improved Vo_{2max} and decreased basal heart rate, body weight, and fat percentage.

Keywords: *Aerobic interval training, Vigorous intensity, Body composition, Heart rate, Maximal oxygen consumption*

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INTRODUCTION

Competition in martial arts always depends on body weight, so athletes whose weights are not within a certain body weight range are not eligible to compete. Classifying an athlete as underweight, normal weight, overweight, or obese can be done by using BMI (DiFrancisco-Donoghue et al., 2020). According to BMI, underweight is below 18,5 kg/m^2; normal weight is between 18,5 and 24,9 kg/m^2; overweight is between 25 and 30 kg/m^2 (Di Cesare et al., 2016). BMI is associated with the risk of depression, especially in unhealthy obesity (Malmir et al., 2019). It is also reported that aging has an impact on the increase of BMI, waist circumference, body fat, visceral fat, and muscle loss in both men and women (Liang et al., 2018). In female athletes, overweight has an impact on higher aggressiveness and overweight female athletes tend to not hesitate to express feelings of irritation (Urzeală et al., 2014). Overweight athletes are predicted to experience musculoskeletal dysfunction which results in the individual's mobility limitations (Naderi et al., 2021)

Since athletes should match to a certain body weight range, the attempt in losing weight is frequently done. Some experts suggest that the best method to lose weight is combining a healthy diet, regular exercise and behavior modification. However, it should be performed with caution that there are negative consequences to repeated rapid weight gain and loss (Yen, 1992). Physical training can cause significant changes in body composition parameters, especially body fat and lean mass which are the important factors in the regulation and maintenance of body mass (Castelli Correia De Campos et al., 2013) (Ubago-Guisado et al., 2017).

One of the physical exercises that affect body composition is aerobic activity. Aerobic exercise is not only associated with obesity, overweight, poor quality of life and fat profile, but if done properly, aerobic exercise is effective to treat toxicity and it also has no other risks (Bortolozo et al., 2020). Aerobic interval training is assessed to be an effective method in increasing aerobic capacity, recovery of HR, as well as improving cardiac function and psychosocial (Molmen-Hansen et al., 2012)(Hannan et al., 2018). Furthermore, interval aerobic exercise for pencak silat athletes is needed in the preparation phase, because this type of exercise reduces BMI and body fat, but does not significantly change lean mass. It even increases Vo2max (Arnt E. Tjønna et al., 2009). In addition, after six weeks of Aerobic Interval training, there was an effect on body weight, waist circumference, body mass index, triglycerides, total cholesterol, HDL cholesterol, LDL and Vo2max (Farsani & Rezaeimanesh, 2011).

The exercise intensity is an important factor in the implementation of interval aerobic programs (Tjønna et al., 2008), where the intensity needs to be at the lactate threshold or slightly above (Baquet et al., 2003). In performing interval aerobic exercise, it is also recommended to gradually determine the maximum heart rate, maximal power output (VO2max) and lactate threshold (Laursen & Jenkins, 2002). It is recommended that the interval aerobic exercise is performed for 20 - 40 minutes of the total training duration at the 80 - 100% heart rate max (Tudor O Bompa & Buzzichelli, 2019) as this type of training requires to be performed at the near maximal or >80% of HRmax (Weston et al., 2014). Aerobic interval training is also called threshold training or speed or tempo training, with a high intensity (100% HRmax) or with higher volume than low intensity interval training (90% VO2max) (Seiler et al., 2013). A meta-analysis study suggests that High-Intensity Interval Training (HIIT) results in 28.5% greater reduction in total fat mass than Moderate-Intensity Continuous Training

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(MICT) (Viana et al., 2019). Interval aerobic exercise is also able to restore heart function in overweight athletes and improve body composition (França et al., 2020). HIIT is effective for weight loss and reducing body fat in obese young men (Hemmatinafar et al., 2020). Aerobic interval is also used in cardiac rehabilitation (CR) training as an alternative to improve psychological and physical health of patients with coronary artery disease (CAD). (Terada et al., 2019).

In the preparatory phase in the periodization of the exercise program, endurance training is an important foundation (Tudor O Bompa & Buzzichelli, 2019). Aerobic interval training is an alternative exercise for the needs of pencak silat martial arts athletes who are predominantly anaerobic (Lubis et al., 2021). Better BMI will affect athlete performance, and there is a relationship between BMI and decreased physical activity. Physical exercise should be considered as a potential intervention for clinical treatment and prevention and public health regulation (Porras-Segovia et al., 2019). The absence of studies discussing the effects of exercise on BMI, especially in athletes, is the significance of this study, considering that match category athletes are very dependent on body weight and body weight maintenance.

MATERIALS AND METHODS

Participants

This study used purposive sampling method involving 30 elite national pencak silat athletes who were prepared for the 2021 SEA Games multi-event as participants; 17 men and 13 women, with normal BMI (18.5 – 24.9 kg/m2) as many as 23 participants and BMI above 25 kg/m2 (overweight) as many as 7 participants. Their average age was (23.67+ 4.10) years with average height (166.03+7.15) cm and average initial weight (64.84+12.65) kg. Before the experiment started, the participants were briefed and explained the research implementation protocol and the data collection process. Then, they were required to sign the informed consent to participate in the research process.

Preliminary procedure

Participants underwent several health examinations, including the nasal swab for Covid-19 antigen test, EKG, complete blood, lung, and joint checks. In addition, participants' body composition was screened to determine their BMI and VO2max. During this study, participants were not allowed to smoke and drink alcoholic beverages. They were also required to perform aerobic interval training for 67 - 77 minutes, twice a week for 5 weeks, 2 hours per-session. wearing sportswear and shoes. During each training, polar was employed to monitor their pulse. Inclusion criteria: healthy, tested negative for Covid-19, and willing to live in the dormitory. Exclusion criteria: Tested positive for COVID-19, didn't follow the agreed research procedures, and uncontrolled food intake.

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Experimental protocol (Before and after AI training)

The participants' body composition was measured using Mi Xiaomi Body Scale 2/BIA (Bioimpedance analysis), including body weight, BMI, body fat percentage, bone mass, protein percentage, total water body percentage, visceral fat, body age, muscle mass, and BMR (basal

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metabolic rate). BMR and resting heart rate was measured by Polar. VO2Max measurement is acquired by using a multistage fitness test (MFT).

AI Training program protocol

The participants followed the AI training sessions, twice a week, for five weeks. Each training session was performed for 67 - 77 minutes duration. The duration included 10 - 15 minutes warming up, eight intervals, 5 minutes exercise with 80% intensity, peak power of VO2max, at 80 - 85% maximum heart rate, 1 minute of rest interval, 5:1 ratio of work to rest interval, and 10-15 minutes of cooling down (Weston et al., 2014).

Instrumentation and measured parameter.

Measurements were done for all participants. Body temperature was taken at the forehead point which was 10 cm away using an infrared thermogun. Body composition was measured by BIA (Bio Impedance Analysis) using Mi Body Scale composition 2, Xiaomi (Walter-Kroker et al., 2011) which is considered as one of the most practical methods for estimating body composition as it is accessible, portable, affordable, practicable for rapid assessment procedure, and high validity against DXA (Huang et al., 2018). Pulse rate was measured using Polar (OH1 heart rate monitor). Polar was tied on the upper arm and monitored using an iPad (Apple) Polar team data.

Statistical Analysis

The statistical analysis was performed with SPSS v26.0 for Windows (SPSS Inc., Chicago, USA). Paired sample t-test was used to compare the mean and test the significance of all study variables. Measurements of body weight, BMI, fat percentage, bone mass, protein percentage, total water body percentage, visceral fat, body age, muscle mass, BMR (Basal Metabolic Rate) were performed using paired sample t-test analysis to see the effect of interval aerobic exercise. Statistical significance was accepted at the level (2-tailed) < 0.05.

Table 1. Descriptive statistic

Variable	Pre-test		Post-test	
	Men (n=17)	Woman (n=13)	Men (n=17)	Woman (n=13)
Weight (Kg)	70.6± 12.7	57.3± 8.7	69.8± 12.7	56.9±8.3
BMI (Kg/m2)	24.3±3	21.9±2.4	24±3	21.7±2.3
Fat Mass (%)	20.1±5.8	27.9±5.1	19.6±5.8	27.7±5.1
Muscle Mass (Kg)	52.9±5.7	38.5±3.8	52.6±5.7	40±4.5
Total Body Water	55±3.6	50.2±2.7	55.3±3.8	47.8±8.8
Protein Profile	20.8±2	17.7±2.3	21±1.8	18.6±4.1
Basal Metabolic Rate	1479.1±424.7	1245.3±91.8	1589.6±192.1	1250.9±96.6
Visceral Fat (%)	8.1±2.8	3.4±1.7	7.7±2.6	3.5±2

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Bone Density (%)	2.8±0.3	2.4±0.3	2.8±0.3	2.4±0.3
Body Age (y)	24.6±7.5	21.5±9.4	22±9	20.9±9.2
VO2max (ml.kg.min)	48.8±6.6	40.6±6.9	53.5±5.9	44.9±4.6
Basal Pulse (permin)	59.9±4.8	58±4.5	55.4±5.4	56.6±5.7

Table 2. Hypothesis test result

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	Weight (Kg)	-.73967	.74609	.13622	-1.01826	-.46107	-5.430	29	.000
Pair 2	BMI (Kg/m2)	-.24733	.30247	.05522	-.36028	-.13439	-4.479	29	.000
Pair 3	Fat Mass (%)	-.36667	.58800	.10735	-.58623	-.14710	-3.415	29	.002
Pair 4	Muscle Mass (Kg)	.45933	4.15887	.75930	-1.09362	2.01228	.605	29	.550
Pair 5	Total Body Water	-.89333	6.00609	1.09656	-3.13604	1.34938	-.815	29	.422
Pair 6	Protein Profile	.51533	1.90817	.34838	-.19719	1.22786	1.479	29	.150
Pair 7	Basal Metabolic Rate	65.07723	305.78231	55.82796	-49.10376	179.25822	1.166	29	.253
Pair 8	Visceral Fat (%)	-.16667	.91287	.16667	-.50754	.17420	-1.000	29	.326
Pair 9	Bone Density (%)	.00333	.05047	.00921	-.01551	.02218	.362	29	.720

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Pair 10	Body Age (y)	-1.72367	4.85405	.88622	-3.53620	.08887	-1.945	29	.062
Pair 11	VO2max (ml.kg.min)	4.50500	3.79515	.69290	3.08787	5.92213	6.502	29	.000
Pair 12	Basal Pulse (permin)	-3.16667	5.90198	1.07755	-5.37050	-.96283	-2.939	29	.006

RESULT AND DISCUSSIONS

Results

Bodyweight data was taken before training. The average body weight of pre and post-test (64.84 ± 12.65; 64.10 ± 12.47), the sig. body weight analysis was (2-tailed) 0.000 < 0.05, so there was a significant body weight loss. The average BMI of pre and post-test was (23.27 kg/m2 ± 2.93; 23.01 kg/m2 ± 2.91). The sig. BMI analysis was (2-tailed) 0.000 < 0.05, so, there was a significant BMI decrease. The average fat mass of pre and post-test was (24.04 % ± 5.96; 23.12 % ± 6.67). The sig. fat mass analysis was (2-tailed) 0.002 < 0.05, so there was a significant fat loss. The average muscle mass of pre- and post-test was (46.67kg ± 8.59; 47.13kg ± 8.05). The sig. muscle mass was (2-tailed) 0.550 > 0.05. There were not any significant changes despite the fact that descriptively there was an increase in muscle mass. The average body water of pre- and post-test was (52.07 % ± 3.95; 52.04 % ± 7.26). The sig. body water analysis was (2-tailed) 0.422 > 0.05, and there was not significant change. The average protein percentage of pre-and post-test was (19.45 % ± 2.54; 19.97 % ± 3.15). The sig. body water was (2-tailed) 0.150 > 0.05, so, there was not a significant increase of body water. The average BMR of pre- and post-test was (1377.79 Kcal ± 336.15; 1442.87 % ± 227.14). The sig. BMR analysis was (2-tailed) 0.253 > 0.05, so, there was not a significant BMR change. The average visceral fat of pre- and post-test was (6.07 % ± 3.28; 5.90 % ± 3.09). The sig. visceral fat analysis was (2-tailed) 0.326 > 0.05, so there was an insignificant visceral fat loss. The average bone density of pre- and post-test was (2.64 kg ± 0.36: 2.69 Kg ± 0.33). The sig bone density analysis was (2-tailed) 0.720 > 0.05, so, there was an insignificant increase of bone density. The average body age of pre- and post-test was (24.03 years ± 7.12: 22.25 years ± 7.94). The sig. body age analysis was (2-tailed) 0.062 > 0.05, so there was an insignificant body age decrease. The average VO2max of pre- and post-test was (45.28 ml/kg/mnt ± 7.68: 49.79 ml/kg/mnt ± 6.72). The sig VO2Max analysis was (2-tailed) 0.000 < 0.05, so there was a significant VO2 Max increase after the five weeks aerobic training. Athletes' basal pulse was checked on the next day after training, before doing activities after each treatment. The average initial basal pulse was (59.07 ± 4.61; 55.90 ± 5.39). The sig. basal pulse analysis was (2-tailed) 0.006 < 0.05, so there was a significant basal rate decrease.

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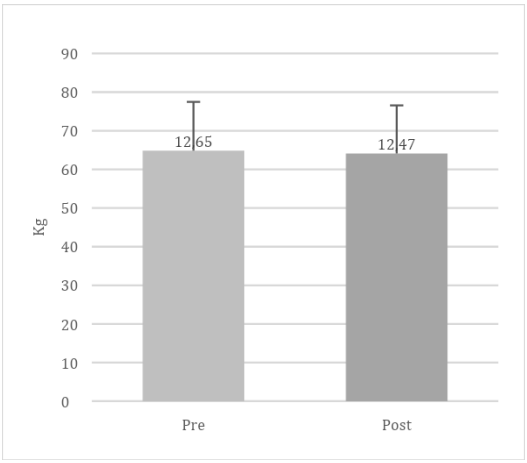

Figure 1. Body weight Diagram.

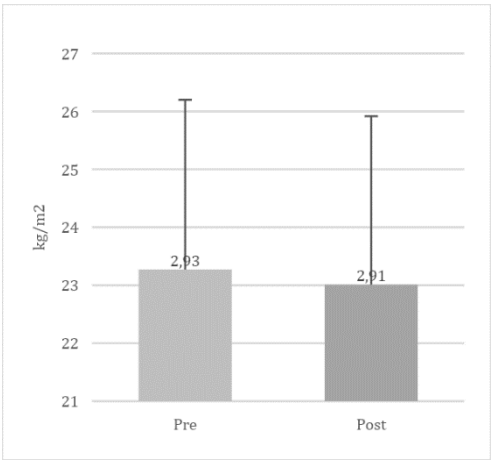

Figure 2. BMI Diagram

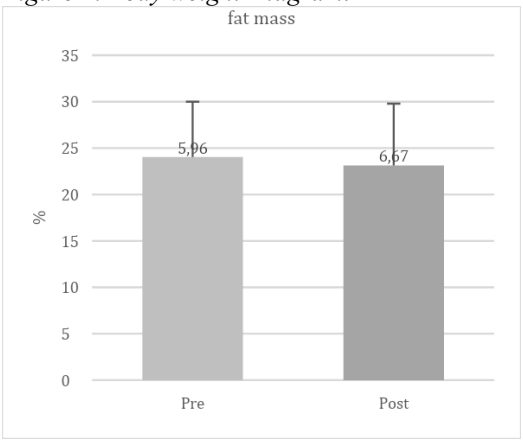

Figure 3. Fat mass Diagram.

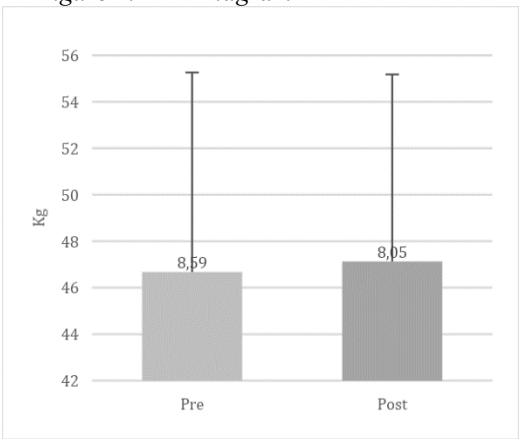

Figure 4. Muscle mass Diagram

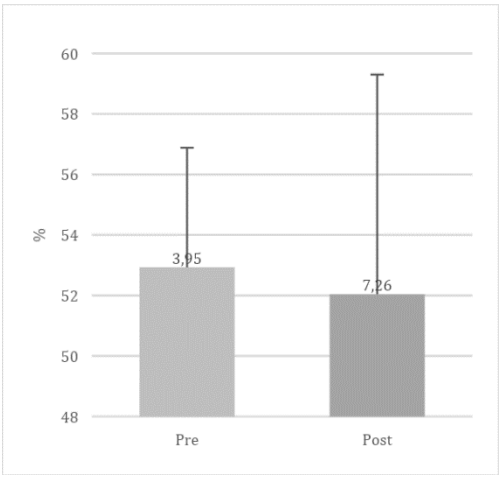

Figure 5. Total body water diagram

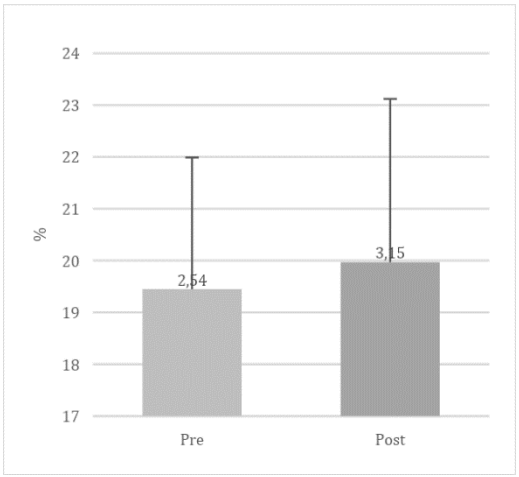

Figure 6. Protein profile diagram

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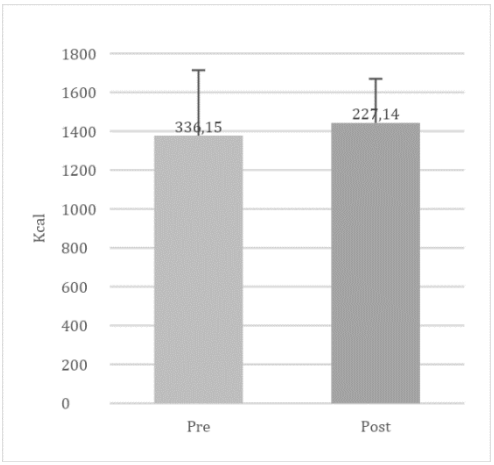

Figure 7. Basal metabolic rate diagram.

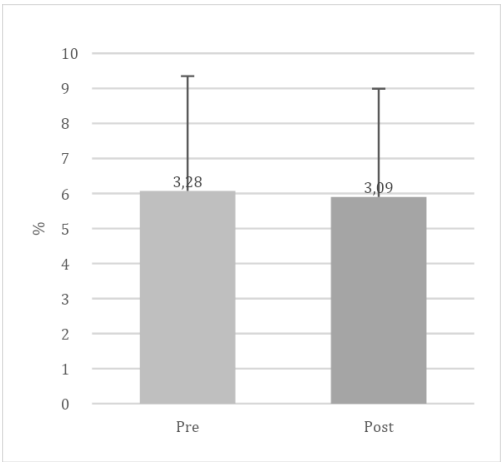

Figure 8. Visceral fat diagram

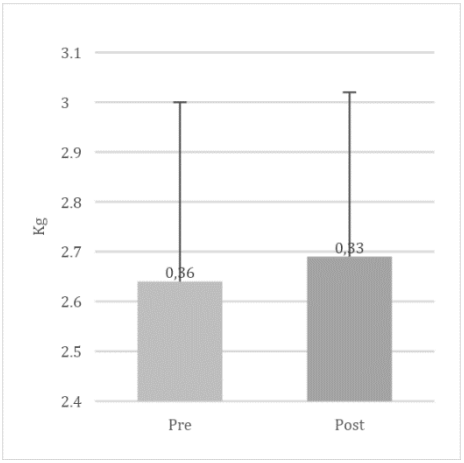

Figure 9. Bone density diagram.

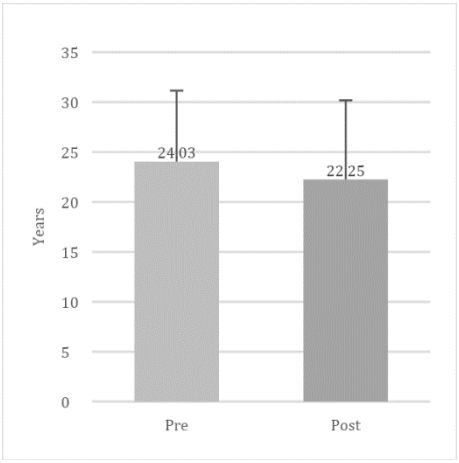

Figure 10. Body age diagram.

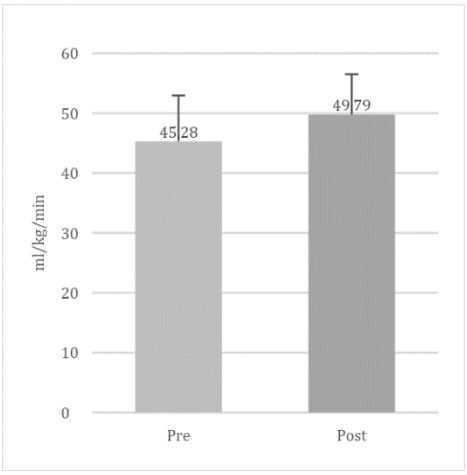

Figure 11. Vo2max diagram.

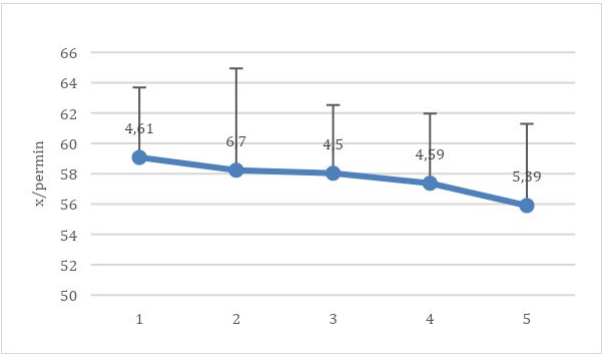

Figure 12. Basal pulse rate diagram

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DISCUSSION

This study revealed that there were significant decreases in body weight, BMI, and body fat. This result is similar to one study on HIIT suggesting that aerobic interval training can reduce body weight and fat mass, especially on overweight athletes (De Feo, 2013). The oxygen intake from the activity can contribute to long-term body weight maintenance and general health, and body weight loss is possible to achieve if the training is done in a continuous and consistent manner (Berg, 2008). AI training was also considered effective in significantly reducing fat mass and secondary body weight, but it was not helpful in making significant muscle gain, though the training difficulty needs to be taken into consideration (Juránková et al., 2015). The interval aerobic exercise given was a high-intensity exercise which was supposed to decrease the pulse rate (Beijer et al., 2018). However, this study showed that the basal pulse rate was in a stable graphic. In a similar study which involved overweight individuals, AI training results in reduced body fat and visceral fat (Boutcher, 2011), although direct comparison cannot be made since this study only involved 30% overweight participants and moreover, the main concern of this study is not specifically on body weight loss. This study also revealed that the participants experienced an increase in VO2Max after participating in the AI training for 5 weeks. Meanwhile, HIIT training for 2 weeks could increase VO2max and the average and peak strength output but cannot affect resting heart rate or muscle strength production (Astorino et al., 2012). However, in this study, aerobic interval training for 5 weeks had an effect on VO2max and basal pulse rate, but not on muscle mass. A progressive increase was also seen in the dominance of VO2max whose baseline was below 45 ml.kg.min.

This experiment also found out that there were no significant changes in muscle mass, in contrast with a study showing that there was a significant change in muscle mass of overweight and obese individuals (Blue Malia N et al., 2020). It is because the study involved only 30% overweight participants. Further research is needed by considering the muscle characteristics and characteristics of the overweight population. This study also found that there was not a significant change in visceral fat. It is similar to a study revealing that there was not a significant change in visceral fat after participants underwent HIIT, but there was significant change in visceral fat in obese young females after participating in MICT for 12 weeks (Zhang et al., 2017). This leads to a suggestion that further study is needed to examine visceral fat loss in a more intense volume and longer period of AI training. The ineffectiveness of reducing visceral fat is in line with one study reporting that the degree of visceral fat in obese adults 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 degree of visceral fat (Sumarni, 2019). This study also revealed that there was no significant change in bone density as aerobic interval training is an endurance training. This is in line with a study suggesting that endurance athletes such as marathon runners, 800m runners, cyclists and swimmers have lower bone density than weightlifting or judo athletes (Hinrichs et al., 2010). Bone density can be effected through the weight lifting process focused on the bones, so that training activities that used weight affected bone density, in contrast to endurance sports which did not require athletes to lift weights (Bellew & Gehrig, 2006). Thus, to increase bone density it is suggested to incorporate strength training or weightlifting into the aerobic interval training program.

During the 5 weeks study, the participants also underwent a national training program, especially Pencak Silat training. They lived in the same dormitory and had the same meal, although the portion for each participant was not controlled. During this period, the participants experienced an increase in BMR, but not significant, as BMR is strongly affected by lifestyle,

including physical activity, diet, and smoking habit (López-Sánchez et al., 2020). This finding is different from one study involving children suffering from narcolepsy suggesting that BMR is heavily correlated with BMI. In 3 to 4 years, the increase in BMI to normal level would be in line with the process of recovering BMR to a healthy level (Wang et al., 2016). In this study, there was a significant increase in BMI but not in BMR. This can be assumed that the duration of study is not adequate to examine the increase of BMR.

CONCLUSION

This study concluded that a five-week aerobic interval training resulted in a significant decrease of body weight, BMI, fat mass, basal pulse, and an increase in VO2max. Since there was no control in the participants' caloric intake, muscle mass, total body water, protein profile, basal metabolic rate, and bone density did not show significant changes. It also revealed that overweight participants experienced more significant changes compared to participants whose BMI was normal. AI training for duration 67-77 minutes twice a week for five weeks significantly decreased body weight, BMI, Body fat, and basal heart rate and increased VO2max.

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Ethics
The study was approved by the local ethic Committee Universitas Negeri Jakarta No. B/349/UN39.14/PT/202, and written consent was obtained from all participants prior to any testing.

Declaration of Interest
No conflict of interest.

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