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Effects of aerobic interval training on heart rate recovery (HRR) and blood pressure in overweight young adults

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ABSTRACT

Introduction: Overweight in young adult women is a global health concern, including in Indonesia, as it increases the risk of cardiovascular disease. Heart Rate Recovery (HRR) is a key indicator of autonomic function and cardiovascular fitness, while blood pressure regulation plays a crucial role in preventing complications. Aerobic Interval Training (AIT) has the potential to improve HRR and stabilize blood pressure; however, its effectiveness in overweight individuals remains insufficiently studied.

Objective: To evaluate the effectiveness of AIT in improving HRR and stabilizing blood pressure in overweight young adult women.

Methods: A Randomized Controlled Trial (RCT) was conducted with 30 women, randomly assigned to either an intervention group (AIT for six weeks) or a control group (education program only). HRR was assessed using a pulse oximeter, while blood pressure was measured using a sphygmomanometer.

Results: The intervention group showed significant improvements in HRR1 and HRR2 (p<0.001), indicating enhanced autonomic nervous system function. Additionally, a significant reduction in systolic (p<0.001) and diastolic blood pressure ($p = 0.012$) was observed, whereas no significant changes occurred in the control group. These findings confirm that AIT promotes cardiovascular adaptation and improves blood pressure regulation.

Conclusion: AIT is an effective, non-pharmacological approach to improving HRR and stabilizing blood pressure in overweight young adult women. This intervention can be integrated into public health programs to prevent cardiovascular diseases and improve overall population health.

Keywords: aerobic exercise, heart rate, blood pressure, overweight, young adult

Conflict of interests: the authors declare no conflict of interest.

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Sports Medicine: research and practice

Влияние аэробных интервальных тренировок на восстановление частоты сердечных сокращений (ЧСС) и артериальное давление у молодых людей с избыточным весом

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РЕЗЮМЕ

Введение: Избыточный вес у молодых женщин является глобальной проблемой здравоохранения, включая Индонезию, поскольку он увеличивает риск сердечно-сосудистых заболеваний. Восстановление частоты сердечных сокращений (ЧСС) является ключевым показателем автономной функции и сердечно-сосудистой подготовки, в то время как регуляция артериального давления важна для предотвращения осложнений. Аэробные интервальные тренировки (АИТ) могут улучшить ЧСС и стабилизировать артериальное давление, однако их эффективность у людей с избыточным весом остается недостаточно изученной.

Цель: оценить эффективность АИТ для улучшения ЧСС и стабилизации артериального давления у молодых женщин с избыточным весом.

Методы: Проведено рандомизированное контролируемое исследование (РКИ) с участием 30 женщин, случайным образом разделенных на группу вмешательства (АИТ в течение шести недель) и контрольную группу (только образовательная программа). ЧСС оценивали с помощью пульсового оксиметра, а артериальное давление измеряли сфигмоманометром.

Результаты: В группе вмешательства наблюдались значительные улучшения ЧСС1 и ЧСС2 (p<0,001), что указывает на усиление функции автономной нервной системы. Кроме того, наблюдалось значительное снижение систолического (p<0,001) и диастолического давления (p = 0,012), тогда как в контрольной группе изменений не было. Это подтверждает, что АИТ способствует адаптации сердечно-сосудистой системы и улучшает регуляцию артериального давления.

Заключение: АИТ является эффективным, нефармакологическим подходом к улучшению ЧСС и стабилизации артериального давления у молодых женщин с избыточным весом. Этот метод можно интегрировать в программы общественного здравоохранения для профилактики сердечно-сосудистых заболеваний и улучшения здоровья населения.

Ключевые слова: аэробные тренировки, частота сердечных сокращений, артериальное давление, избыточный вес, молодой взрослый

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1. Introduction

In 2022, an estimated 880 million adults and 159 million children worldwide will be overweight, doubling since 1990. If this trend continues, the prevalence of overweight is expected to reach 18 % in men and more than 21 % in women by 2025. In Indonesia, the prevalence of overweight increased by 5 % and obesity by 11.3 % in the last ten years, with women having a higher prevalence than men in both categories. The main contributing factors to being overweight are unhealthy lifestyles, including consumption of foods high in carbohydrates and fat and lack of physical activity [1]. The WHO reported in 2016 that 26.5 % of the world's population was physically inactive, with higher rates in Southeast Asia (30.5 %) and Indonesia (22.6 %) [2].

Exercise, especially aerobic exercise, is essential for preventing overweight. The American Heart Association recommends 150 minutes of aerobics per week (30 minutes per day for five days) for overweight adults. Aerobic Interval Training (AIT) effectively improves aerobic capacity, cardiac function, psychosocial, and heart rate recovery after exercise [3, 4]. Aerobic Interval Training has various types of exercises based on their intensity. Some types of exercise are low intensity (low impact aerobic exercise), moderate intensity (Moderate Intensity Training (MIT), Moderate Intensity Continuous Training (MICT), and Moderate to Vigorous Continuous Training (MVCT), and high intensity (High Interval Intensity Training (HIIT) and High Interval Training (HIT), and High Impact Aerobic (HIA). The most commonly used AIT is the high-intensity interval training method and followed by the moderate-intensity continuous training method. In HIIT, the training intensity varies in each literature, but the average training intensity is 80–90 % VO2 max. While MICT, the training intensity varies from 55–59 % HRR, 65 % Maximum Adaptive Volume (MAV), and 65 % and 70 % VO2 peak. Exercise time also varies from 20–32 minutes [5].

Heart rate recovery is an essential indicator for assessing the effectiveness of exercise, showing how quickly the heart rate returns to normal after exercise. A slower HRR in overweight individuals may signal a higher risk of heart disease [6]. Several studies support the effectiveness of aerobic exercise in reducing body fat percentage and body weight [7, 8].

Some studies have shown significant improvements in HRR after vigorous-intensity aerobic exercise, but others have shown improvements after moderate-intensity exercise.

Being overweight is also associated with increased sympathetic nervous system (SNS) activity, which increases blood pressure. Excessive SNS activation increases heart rate, cardiac output, and sodium reabsorption in the kidneys, increasing intravascular volume and blood pressure. In addition, activation of the renin-angiotensin-aldosterone system (RAAS) produces angiotensin II and aldosterone, which cause vasoconstriction and water retention, triggering a rise in blood pressure [9].

HIIT training for 8 weeks can reduce Low Density Lipoprotein (LDL) cholesterol, although High Density Lipoprotein (HDL) cholesterol did not change significantly. MICT training improved aerobic fitness and decreased body fat percentage [10,11]. Nonetheless, the most effective intensity dose of AIT to improve HRR in overweight individuals remains unclear, and further research is needed to explore the effects of aerobic exercise on HRR and blood pressure, particularly in overweight populations.

2. Methods

2.1 Research design

The Strengthening conducted this research, using the Reporting of CONSORT 2010 checklist of information to include. This type of research includes quantitative research that uses a Randomized Clinical Trials (RCT) method to compare the treatment between the intervention and control groups. Participants in the intervention (A) group received *Aerobic Interval Training* treatment in the form of Aerobic Gymnastics, while the control (B) group received education only.

In Group B, an educational program was delivered using PowerPoint presentations and exercise videos on weight loss and fitness for overweight individuals. This program aimed to enhance understanding and engagement through visual and interactive methods. Both groups underwent the same exercise stimulation, and variables were measured at three time points: pretest, mid-test, and post-test, assessing changes from the beginning, middle, and end of the intervention.

2.2 Research variables

This study describes one independent variable, aerobic interval training, and two dependent variables: Heart Rate Recovery and Blood Pressure.

2.3 Sampling

The study population consisted of 42 overweight female students from the Faculty of Health Sciences, Muhammadiyah University of Surakarta. Participants were selected using non-probability quota sampling, and after screening, 30 met the eligibility criteria. They were then randomly assigned into two groups using a simple random sampling lottery system, where participants drawing numbers 1–15 were placed in the intervention group, and those drawing numbers 16–30 were assigned to the control group. This randomization process was facilitated by research assistants. The study was conducted at Muhammadiyah University of Surakarta (UMS), Sukoharjo, Central Java, Indonesia, with the intervention carried out three times per week for six weeks from October to December 2024.

2.4 Sample criteria

The participants of this study were students of the Faculty of Health Sciences at Universitas Muhammadiyah Surakarta who were overweight in the young adult age category. The inclusion criteria in this study are female gender, 18–25 years old, overweight or more with Asian BMI classification (> 23 kg/m^2). According to WHO, weight gain leads to an increase in Body Mass Index (BMI) which is calculated by body weight in kg divided by height squared in meters. BMI classification between 23 to 24.9 kg/m^2 is classified as overweight, BMI between 25 to 29.9 kg/m^2 is classified as obesity I, BMI above 30 is classified as obesity II [2]. Special requirements for the intervention group were no caffeine consumption up to 2 hours before the intervention, no respiratory problems, no history of injury to the upper and lower extremities that made it difficult to move, and commitment to the end of the intervention. The exclusion criteria for this study were cognitive impairment, pregnancy, physical stress, and fatigue. In addition, the dropout criteria were that during the training process, the respondents did not participate in the training twice in a row according to the set schedule and that the sample was suddenly sick.

2.5 Operational definition

AIT is an aerobic exercise method with low-to-high intensity that aims to improve Heart Rate Recovery and control blood pressure [3]. HRR measures the heart's ability to return to a regular resting rate after completion of exercise [12]. HRR was measured after the intervention in the first, second, and third minutes by a fingertip pulse oximeter in beat per minute (bpm). The instrument has the following interpretation: Normal: > 12 bpm; Abnormal: < 12 bpm [6, 13]. Blood pressure is the force exerted on artery walls during heartbeats, measured in mmHg using a sphygmomanometer before and after the intervention [14]. Normal blood pressure is when the systolic reading is < 120 and the diastolic reading is < 80. Pre-hypertension is defined as a systolic reading between 120–139 or a diastolic reading between 80–89. Grade 1 hypertension occurs when the systolic reading is between 140–159, or the diastolic reading is between 90–99. And then, Grade 2 hypertension is diagnosed when the systolic reading is > 160 or the diastolic reading is > 100 [15].

Table 1 indicates that the intervention group was given aerobic exercise for 6 weeks with a frequency of 3 times a week. The intensity increased every 2 weeks with a 5 % increase. Each movement has an interval to the next movement repeatedly. In weeks 1 and 2, the exercise intensity was 70 % Hrmax, interval 65 % HRReserve, and time 30 minutes (30' warm up, 45' movement, 15' interval, 30' cooling down). In weeks 3 and 4, exercise intensity is 75 % Hrmax, interval

Sports Medicine: research and practice

Table 1

Protocol of the AIT Program

Таблица 1

Протокол программы АИТ

Week	Frequency	Intensity		Time	Type	
		Exercise	Interval			
1st	3 times	70 % HRmax or talk test*	60 % HR Reserve	30 minutes	Aerobic Interval Training (AIT)	HIIT Aerobics
		Warm Up 30'	0'			
2nd	3 times	45' Practice	15'			
		Cooling Down 30'	0'			
3rd	3 times	75 % HRmax or talk test*	70 % HR Reserve	35 minutes	Aerobic Interval Training (AIT)	HIIT Aerobics
		Warm Up 30'	0'			
4th	3 times	45' Practice	15'			
		Cooling Down 30'	0'			
5th	3 times	80 % HRmax or talk test*	75 % HR Reserve	40 minutes	Aerobic Interval Training (AIT)	HIIT Aerobics
		Warm Up 30'	0'			
6th	3 times	45' Practice	15'			
		Cooling Down 30'	0'			

*Talk Test level vigorous/severe: When doing activities with heavy intensity, the respondent will not be able to say more than a few words without pausing to take a breath. Note: The sign (') indicates seconds.

70 % HRReserve time 35 minutes. In weeks 5 and 6, exercise intensity is 80 % Hrmax, interval 75 % HRReserve time 40 minutes.

2.6 Analysis data

Data analysis was processed using the IBM SPSS Statistic version 30 application. The respondent data distribution was homogeneous across groups. Mean differences were analyzed using the Independent T-test, while intervention effects were assessed using the Repeated Measures Test for normally distributed data and the Friedman test for non-normal data.

The sample size was calculated using G*Power 3.1.9.4 with an effect size of 1.6, $\alpha \leq 0.05$, 95 % power, and two-tailed analysis, resulting in 30 participants (15 per group) after accounting for a 20 % attrition rate. Eligible participants who consented were randomly assigned to Group A (AIT, $n = 15$) or Group B (education, $n = 15$) using a computer-generated random allocation method. The allocation sequence, concealed from participants and data analysts, was set before baseline assessment. Demographic data are presented in Table 2.

2.7 Ethical clearance

This research has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences, Muhammadiyah University of Surakarta, with No.626/KEPK-FIK/XI/2024.

3. Results

Table 2 indicates that the mean age of respondents in the intervention group (Group A) was 19.33 ± 0.976 years with a range of 18 to 21 years, while in the control group (Group B), the mean age reached 19.93 ± 0.704 years within the same age range.

Body Mass Index (BMI) parameters showed that the mean BMI in Group A was 28.587 ± 2.1742 kg/m², with a minimum value of 24.7 kg/m² and a maximum of 32.3 kg/m². Meanwhile, in Group B, the mean BMI value was 27.933 ± 2.7515 kg/m² with a range from 24.4 to 32.5 kg/m².

Based on the analysis of the two demographic variables, there were no notable differences between the two groups, indicating homogeneity of the respondents' basic characteristics. This homogeneity is essential in ensuring the internal validity of the study, so that the effects of Aerobic Interval Training intervention on cardiovascular variables can be evaluated more objectively without being influenced by demographic factors.

Table 3 indicates that there were significant differences in Heart Rate Recovery (HRR) and blood pressure between the intervention group (A) and control group (B). In HRR1, the intervention group increased from 6.53 ± 3.44 bpm to 18.33 ± 6.03 bpm ($p < 0.001$), while the control group increased from 6.07 ± 1.94 bpm to 9.13 ± 5.37 bpm ($p = 0.001$). Similar results were seen in HRR2, where the intervention group experienced a significant increase ($p < 0.001$), while the control group showed no significant change ($p = 0.093$).

On blood pressure variables, the intervention group experienced a decrease in systolic pressure from 125.80 ± 14.31 mmHg to 117.80 ± 8.91 mmHg ($p < 0.001$), while the control group did not experience significant changes ($p = 0.291$). Similarly, diastolic pressure decreased significantly in the

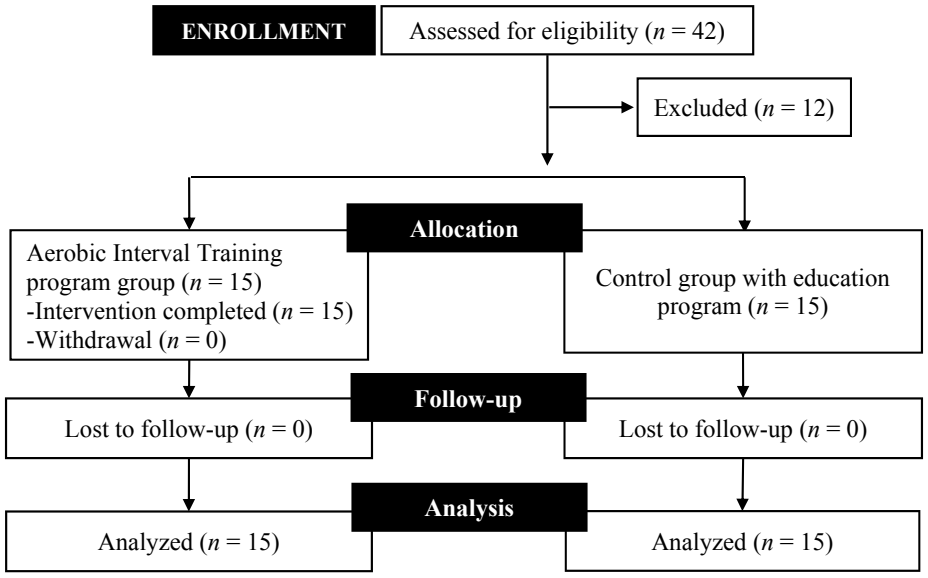

Fig. 1. Flow Chart Diagram for research sampling
Рис. 1. Блок-схема выборки для исследования

Table 2

Baseline Characteristics of Respondents in the Intervention and Control Groups

Таблица 2

Исходные характеристики респондентов в группах вмешательства и контроля

VARIABLES	Group A (*n* = 15)				Group B (*n* = 15)			
	Mean ± SD	Min	Max	Sig*	Mean ± SD	Min	Max	Sig*
DEMOGRAPHICS								
Age (years)	19.33 ± 0.976	18	21	–	19.93 ± 0.704	19	21	–
BMI (kg/m2)	28.587 ± 2.1742	24.7	32.3	–	27.933 ± 2.7515	24.4	32.5	–
Heart Rate Recovery (HRR)								
Heart Rate Recovery 1 minutes to 2 minutes**	6.53 ± 3.441	3	15	0.025	6.07 ± 1.944	3	9	<0.001
Heart Rate Recovery 2 minutes to 3 minutes***	5.67 ± 2.795	2	12	0.897	5.73 ± 2.187	2	9	0.019
Blood Pressure								
Systolic Blood Pressure	125.80 ± 14.309	105	153	0.077	123.53 ± 12.100	107	149	0.012
Diastolic blood Pressure	83.07 ± 10.096	72	106	0.681	82.33 ± 8.499	69	100	0.987

*Significancy Homogeneity > 0.05.
Note: Group A (Intervention with Aerobic Interval Training), Group B (Control with Education), **Difference between HRR of the first minute and the second minute after the exercise, ***Difference between HRR of the second minute and the third minute after the exercise, HRR (unit: bpm/beat per minute), Blood Pressure (unit: mmHg).

intervention group (p = 0.012), but not significantly in the control group (p = 0.648).

These results indicates that intervention with Aerobic Interval Training has a more significant effect on heart rate recovery and blood pressure reduction compared to education only.

4. Discussion

This study concerns the effectiveness of Aerobic Interval Training in increasing Heart Rate Recovery and lowering blood pressure in overweight young women. These findings are consistent with previous studies showing that HIIT can improve cardiorespiratory capacity and cardiac recovery efficiency.

Being overweight raises blood pressure through insulin resistance and hormone-induced sodium retention. Losing 5–10 % of body weight can significantly lower blood pressure. Overweight individuals often have slower Heart Rate Recovery, indicating lower cardiovascular fitness. Obesity affects heart rate response after exercise, and an HRR drop of less than 12 bpm within one-minute signals higher health risks [16]. Overweight individuals need reduced hunger

Sports Medicine: research and practice

Table 3

Analaysis of Effect and Mean Difference Between Intervention Group and Control Group

Таблица 3

Анализ эффекта и средней разницы между группой вмешательства и контрольной группой

	Effect								Mean Difference		
GROUP	A				B				A	B	Sig*
N	15				15				15	15	
	Mean ± SD		Sig*		Mean ± SD		Sig*		Mean ± SD		IT Test
	PRE	POST	RM Test	F Test	PRE	POST	RM Test	F Test			
Heart Rate Recovery (HRR)											
HRR1	6.53 ± 3.441	18.33 ± 6.032	–	<0.001	6.07 ± 1.944	9.13 ± 5.370	0.001	–	11.80 ± 7.073	3.07 ± 5.161	<0.001
HRR2	5.67 ± 2.795	13.67 ± 3.177	<0.001	–	5.73 ± 2.187	7.20 ± 3.764	–	0.093	8.00 ± 3.723	1.47 ± 3.701	<0.001
Blood Pressure											
SBP	125.80 ± 14.309	117.80 ± 8.914	<0.001	–	123.53 ± 12.100	122.93 ± 5.885	0.291	–	8.00 ± 9.688	0.60 ± 10.098	0.050
DBP	83.07 ± 10.096	77.60 ± 8.201	–	0.012	82.33 ± 8.499	82.07 ± 9.184	0.648	–	5.47 ± 9.448	0.27 ± 6.239	0.086

*Significancy <0.05.

Note: Group A (Intervention with Aerobic Interval Training), Group B (Control with Education), HRR1 (Difference between HRR of the first minute and the second minute after the exercise), HRR2 (difference between HRR of the second minute and the third minute after the exercise), SBP (Systolic Blood Pressure), DBP (Diastolic Blood Pressure), RM Test (Repeated Measure Test), F Test (Friedman Test), IT Test (Independent T-Test), HRR (unit: bpm/beat per minute), Blood Pressure (unit: mmHg).

behaviour, aided by better insulin performance. This requires dietary changes and exercise, as both improve insulin function [17].

In terms of physiological mechanisms, modulation of the autonomic nervous system plays an important role in the observed increase in HRR. HIIT is known to reduce sympathetic nerve activity and increase parasympathetic tone, which contributes to faster heart rate recovery post-exercise. Decreased sympathetic nerve activity during HIIT decreases norepinephrine production, increases blood vessel dilatation, and reduces vascular resistance [18].

Research shows that HIIT can improve HRR, reduce peripheral resistance, increase the heart's capacity to pump blood efficiently, and decrease heart rate per minute [19]. Parasympathetic activation and sympathetic deactivation enhance Heart Rate Recovery. During exercise, heart rate rises due to sympathetic activation and falls during recovery via parasympathetic activation, independent of age or intensity. Normal HRR drops below 120 bpm within 2–5 minutes, varying by fitness. Slow HRR may result from poor cooling, low fitness, illness, or overtraining. An abnormal HRR, defined as a decrease of ≤ 12 bpm, indicates impaired recovery and predicts cardiovascular disease risk. Heart rate recovery improves through parasympathetic activation and sympathetic deactivation, facilitating post-exercise heart rate reduction. A slow recovery may indicate cardiovascular dysfunction and increased heart disease risk.

In addition, the vascular adaptations resulting from HIIT contribute to the reduction in blood pressure after the intervention. Improved endothelial function and insulin sensitivity in response to exercise play a major role in lowering blood pressure, especially in individuals with hypertension or other cardiovascular risk factors [18, 20]. Something similar was found in the study of Delgado-Floody et al. (2020), which also showed the effectiveness of HIIT in lowering blood pressure [21] HIIT enhances stroke volume and cardiac contraction through adaptive increases in contraction force and cardiac output. It also stimulates mitochondrial biogenesis via PGC-1α activation, boosting mitochondrial protein production and oxygen metabolism, leading to higher maximal oxygen uptake [22]. Additionally, increased parasympathetic activity improves vascular elasticity through endothelial adaptations [22, 23].

Aerobic interval training improves heart rate recovery and blood pressure by modulating vasoactive substances. Increased blood flow during exercise enhances nitric oxide and prostacyclin release, promoting vasodilation and vascular function. High-intensity interval training also benefits blood pressure and resting heart rate in individuals with cardiovascular risks. These findings highlight AIT's role in cardiovascular health through vasoactive and autonomic regulation [24, 25].

Aerobic interval training enhances carbohydrate and glycogen regulation, lactic acid tolerance, and ammonia clearance via reactive oxygen species. It also boosts mitochondrial biogenesis, improving aerobic metabolism, oxygen efficiency, and maximal oxygen uptake [22]. Improved energy metabolism and mitochondrial function in skeletal muscle enhance

heart rate recovery and blood pressure regulation. High-intensity interval training increases oxygen uptake and haemoglobin-rich blood flow, boosting cardiorespiratory fitness [26].

In addition, HIIT has anti-inflammatory effects, which may help reduce levels of inflammatory markers and, ultimately, lower the risk of cardiovascular disease [18]. Decreased TNF-α levels after exercise may help reduce the risk of cardiovascular disease in overweight individuals [27]. Moreover, aerobic exercise can improve total antioxidant status without significant changes in body composition, suggesting that the benefits of exercise may occur regardless of weight loss [28].

These findings strengthen the understanding of the effectiveness of AIT in increasing HRR and lowering blood pressure in overweight individuals. HIIT has been shown to effectively improve cardiorespiratory and metabolic functions [29]. During exercise, the body experiences increased physical activity, increasing blood glucose consumption and making the heart work harder, ultimately increasing the heart's efficiency in pumping blood [30]. This suggests that HIIT can promote cardiovascular health and significantly improve cardiovascular performance. Tamayo Acosta et al. (2022) found that aerobic interval training reduces blood pressure and cardiovascular risk in obese adults. High-intensity interval training also lowers systolic and diastolic pressure, promoting long-term stability [31]. While other study reported a three-week program effectively reduced fat mass in obese women [16, 21].

In HIIT training, the aerobic and anaerobic energy systems work simultaneously, which increases the body's efficiency in processing oxygen and calories. The anaerobic system generates an oxygen debt repaid through the Excess Post-Exercise Oxygen Consumption (EPOC) process, accelerating HRR recovery. EPOC allows the body to continue burning calories and improves cardiovascular and central nervous system adaptations [11].

This study aligns with previous research demonstrating that aerobic interval training effectively reduces blood pressure in obese individuals. A review of 13 studies on high-intensity interval training showed a mean systolic pressure reduction of 5.85 mmHg (1–10 sessions), 6.84 mmHg (11–36 sessions), and 5.33 mmHg (37+ sessions). Diastolic pressure decreased by 3.30 mmHg, 3.56 mmHg, and 4.82 mmHg, respectively [31].

In overweight individuals, a reduction in hunger behaviour is required which can be addressed by improved insulin performance. This behaviour is related to dietary changes that affect the intake received by overweight individuals. In addition to dietary adjustments, overweight individuals must also compensate with exercise. Because exercise can improve insulin performance [17].

In addition to exercise factors, family history and physical fitness also influence HRR. Genetic factors can contribute to hypertensive conditions associated with increased blood pressure [32]. The better the level of physical fitness, the faster the recovery of HRR after exercise [33–35].

In terms of safety, the study also showed that the HIIT intervention could be safely performed by participants. During the intervention period, no participants reported any adverse events, emergencies or other health incidents. This suggests that HIIT conducted with supervision and in accordance with the developed Standard Operating Procedures (SOPs) can be implemented without significant risk to participants' safety or well-being.

HIIT is an effective non-pharmacologic approach to improving cardiovascular health in young overweight women and may help reduce cardiovascular risk factors. However, the small sample size, lack of diversity, and short intervention duration limit the study's generalizability and long-term evaluation. Future research should use a larger, more diverse sample, extend the intervention beyond six weeks, and include long-term follow-up.

5. Conclusions

This study shows that Aerobic Interval Training intervention positively affects Heart Rate Recovery and blood pressure variables. Based on existing scientific evidence, this study's results can be practically applied in health programs such as diet communities or fitness centers by integrating structured AIT to improve HRR and control blood pressure.

Authors' contribution:

Ajeng Adela Selandani — conceptualization, methodology, investigation, data collection and interpretation, writing — original draft, writing — editing, visualization, project administration, and formal analysis.

Farid Rahman — conceptualization, methodology, writing — original draft, writing — editing, visualization, and project administration.

Вклад авторов:

Адженг Адела Селандани — концептуализация, методология, исследование, сбор и интерпретация данных, написание — первоначальный проект, написание — редактирование, визуализация, администрирование проекта и формальный анализ.

Фарид Рахман — концептуализация, методология, написание — первоначальный проект, написание — редактирование, визуализация и администрирование проекта.

References / Литература

1. **Sugiatmi S., Rayhana R., Suryaalamsah I.I., Rahmini R., Akbar Z.A., Harisatunnasyitoh Z., et al.** Peningkatan pengetahuan tentang kegemukan dan obesitas pada pengasuh pondok pesantren igbs darul marhamah desa jatisari kecamatan cileungsi kabupaten bogor jawa barat. In: Prosiding Seminar Nasional Pengabdian Masyarakat LPPM UMJ; 2019. Available at: https://jurnal.umj.ac.id/index.php/semnaskat/article/view/5434

2. World Health Organization. Obesity and overweight [Internet]. Available at: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

3. **Hannan A., Hing W., Simas V., Climstein M., Coombes J., Jayasinghe R., et al.** High-intensity interval training versus moderate-intensity continuous training within cardiac rehabilitation: a systematic review and meta-analysis. Open Access J. Sports Med. 2018;9:1–17. https://doi.org/10.2147/oajsm.s150596

4. **Molmen-Hansen H.E., Stolen T., Tjonna A.E., Aamot I.L., Ekeberg I.S., Tyldum G.A., et al.** Aerobic interval training reduces blood pressure and improves myocardial function in hypertensive patients. Eur. J. Prev. Cardiol. 2012;19(2):151–160. https://doi.org/10.1177/1741826711400512

5. **Oroh P.J., Wungow H.I.S., Engka J.N.A.** Latihan Fisik Pada Pasien Obesitas. Jurnal Biomedik (JBM). 2021;13(1):34. https://doi.org/10.35790/jbm.13.1.2021.31773

6. **Dimkpa U., Godswill R.C., Okonudo P., Ikwuka D.** Heart Rate Responses at Rest, during Exercise and after Exercise Periods in Relation to Adiposity Levels among Young Nigerian Adults. J. Obes. Metab. Syndr. 2023;32(1):87–97. https://doi.org/10.7570/jomes22055

7. **Syukur M., Sitepu Z., Tangkudung J., Puspitorini W.** Pengaruh Latihan Senam Aerobik Dan Motivasi Berolahraga Terhadap Penurunan Persentase Lemak Tubuh. Jurnal Penjaskesrek. 2020;7(1):45. https://doi.org/10.46244/penjaskesrek.v7i1.1008

8. **Pratiwi I., Masriadi M., Basri M.** Pengaruh Senam Aerobik Terhadap Penurunan Berat Badan Remaja Obesitas di SMP Katolik Rajawali Makassar Tahun 2017. Window of Health : Jurnal Kesehatan. 2018;1(2). https://doi.org/10.33096/woh.v1i2.648

9. **Shariq O.A., Mckenzie T.J.** Obesity-related hypertension: A review of pathophysiology, management, and the role of metabolic surgery. Gland Surg. 2020;9(1):80–93. https://doi.org/10.21037/gs.2019.12.03

10. **Matsuo T., Saotome K., Seino S., Eto M., Shimojo N., Matsushita A., et al.** Low-volume, high-intensity, aerobic interval exercise for sedentary adults: V̇O2max, cardiac mass, and heart rate recovery. Eur. J. Appl. Physiol. 2014;114(9):1963–1972. https://doi.org/10.1007/s00421-014-2917-7

11. **Stöggl T.L., Björklund G.** High intensity interval training leads to greater improvements in acute heart rate recovery and anaerobic power as high volume low intensity training. Front. Physiol. 2017;8:562. https://doi.org/10.3389/fphys.2017.00562

12. **Cheng J.C., Chiu C.Y., Su T.J.** Training and evaluation of human cardiorespiratory endurance based on a fuzzy algorithm. Int. J. Environ. Res. Public Health. 2019;16(13):2390. https://doi.org/10.3390/ijerph16132390

13. **Cole C.R., Blackstone E.H., Pashkow F.J., Snader C.E., Lauer M.S.** Heart-Rate Recovery Immediately after Exercise as a Predictor of Mortality. N. Engl. J. Med. 1999;341(18):1351–1357. https://doi.org/10.1056/nejm199910283411804

14. World Health Organization. Hypertension [Internet]; 16 March 2023. Available at: https://www.who.int/news-room/fact-sheets/detail/hypertension

15. Joint National Committe on Prevention Detection E and T or HPV. Hypertension Classification [Internet]. Available at: https://p2ptm.kemkes.go.id/infographic-p2ptm/hipertensi-penyakit-jantung-dan-pembuluh-darah/page/28/klasifikasi-hipertensi

16. **Ho V., Ku-Goto M.H., Zhao H., Hoffman K.E., Smith B.D., Giordano S.H.** Regional differences in recommended cancer treatment for the elderly. BMC Health Serv. Res. 2016;16(1):262. https://doi.org/10.1186/s12913-016-1534-z

17. **Hall J.E.** Guyton dan Hall Buku Ajar Fisiologi Kedokteran. 13th ed. Elsevier Health Sciences; 2019.

18. **Diahputri N.M.N., Sundari L.P.R.** Respon Fisiologis Dan Biomolekuler Pada High Intensity Interval Training (HIIT). Jurnal Kesehatan Terpadu. 2022;6(2):79-84.

19. **Vlahoyiannis A., Aphamis G., Eddin D.A., Giannaki C.D.** The effect of evening cycling at different intensities on sleep in healthy young adults with intermediate chronobiological phenotype: A randomized, cross-over trial. J. Sports Sci. 2021;39(2):192–199. https://doi.org/10.1080/02640414.2020.1812194

20. **Dewi P.I.S., Putra M.M., Pratama A.A., Lestari P.I.W.** Latihan Fisik Intensitas Tinggi Menurunkan Tekanan Darah. Jurnal Ilmiah Keperawatan (Scientific Journal of Nursing). 2022;8(1):169–178. http://doi.org/10.33023/jikep.v8i1.971

21. **Delgado-Floody P., Izquierdo M., Ramírez-Vélez R., Caamaño-Navarrete F., Moris R., Jerez-Mayorga D., et al.** Effect of High-Intensity Interval Training on Body Composition, Cardiorespiratory Fitness, Blood Pressure, and Substrate Utilization During Exercise Among Prehypertensive and Hypertensive Patients With Excessive Adiposity. Front. Physiol. 2020;11. https://doi.org/10.3389/fphys.2020.558910

22. **Hernawan B., Putra R.A.A.A.** Effect of High Intensity Interval Training (HIIT) on VO2 Max in Young Adult: Literature Review. Jendela Olahraga. 2023;8(2):43–52. https://doi.org/10.26877/jo.v8i2.14015

23. **Fatikhawati A., Prahasanti K., Efendi C.** Perbandingan Pengaruh Latihan Fisik Interval Tinggi Dengan Kontinu Terhadap Heart Rate Istirahat, VO2Max Dan Heart Rate Recovery Pada Atlet Renang Pria POR SURYANAGA Surabaya. JOSSAE : Journal of Sport Science and Education. 2021;6(1):35. https://doi.org/10.26740/jossae.v6n1.p35-45

24. **Königstein K., Dipla K., Zafeiridis A.** Training the Vessels: Molecular and Clinical Effects of Exercise on Vascular Health—A Narrative Review. Cells. 2023;12(21):2544. https://doi.org/10.3390/cells12212544.

25. **Luo P., Wu R., Gao W., Yan W., Wang R., Ye Y.** Effects of high-intensity interval exercise on arterial stiffness in individuals at risk for cardiovascular disease: a meta-analysis. Front. Cardiovasc. Med. 2024;11:1376861 . https://doi.org/10.3389/fcvm.2024.1376861

26. **Taufikkurrachman T., Wardathi A.N., Rusdiawan A., Sari R.S., Kusumawardhana B.** Olahraga Kardio dan Tabata: Rekomendasi Untuk Menurunkan Lemak Tubuh Dan Berat Badan. Jendela Olahraga. 2021;6(1):197–212. https://doi.org/10.26877/jo.v6i1.7469

27. **Jin C.H., Rhyu H.S., Kim J.Y.** The effects of combined aerobic and resistance training on inflammatory markers in obese men. J. Exerc. Rehabil. 2018;14(4):660–665. https://doi.org/10.12965/jer.1836294.147

28. **Park K.S., Nickerson B.S.** Aerobic exercise is an independent determinant of levels of inflammation and oxidative stress in middle-aged obese females. J. Exerc. Rehabil. 2022;18(1):43–49. https://doi.org/10.12965/jer.2142724.352

29. **Alonso-Fernández D., Fernández-Rodríguez R., Taboada-Iglesias Y., Gutiérrez-Sánchez A.** Impact of a HIIT protocol

on body composition and VO2max in adolescents. Sci. Sports. 2019;34(5):341–347. https://doi.org/10.1016/j.scispo.2019.04.001

30. **Elshazly A., Khorshid H., Hanna H., Ali A.** Effect of exercise training on heart rate recovery in patients post anterior myocardial infarction. Egyptian Heart Journal. 2018;70(4):283–285. https://doi.org/10.1016/j.ehj.2018.04.007

31. **Tamayo Acosta J., Sosa Gomez A.E., Samuel S., Pelenyi S., Acosta R.E., Acosta M.** Effects of Aerobic Exercise Versus High-Intensity Interval Training on V̇O2max and Blood Pressure. Cureus. 2022;14(10):e30322 https://doi.org/10.7759/cureus.30322

32. **Angesti A.N., Triyanti T., Sartika R.A.D.** Riwayat Hipertensi Keluarga Sebagai Faktor Dominan Hipertensi pada Remaja Kelas XI SMA Sejahtera 1 Depok Tahun 2017. Buletin Penelitian Kesehatan. 2018;46(1):1–10. https://doi.org/10.22435/bpk.v46i1.41

33. **Wowor R., Wantania F., Pamolango F.** Perbandingan Pemulihan Laju Jantung antara Subjek Obes Sentral Terlatih dengan yang Non-obes Sentral Tak Terlatih. e-CliniC. 2017;5(2). https://doi.org/10.35790/ecl.5.2.2017.16878

34. **Sugiono, Muhammad Dzaky Maulana Nur Yudha, Nur Basuki.** Efektifitas antara Latihan High Intensity Interval Training dengan Moderate Intensity Continuous Training pada Prilaku Sedentary terhadap Perubahan Heart Rate recovery. Physiotherapy Health Science (PhysioHS). 2023;5(1):26–32. https://doi.org/10.22219/physiohs.v5i1.25882

35. **Astawan I.K.T., Widhiyanti K.A.T.** Pelatihan High Intensity Interval Training (HIIT) Meningkatkan VO2Max Atlet Basket. Jurnal Pendidikan Kesehatan Rekreasi. 2023;9(1):11–20. https://doi.org/10.5281/zenodo.7497766

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