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Effects of Tabata High Intensity Interval Training and Isometric Exercise on Blood Pressure of Overweight-Obese Female Students

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ABSTRACT

Overweight and obesity are health challenges for Indonesian society. One effective way to prevent and manage the impact of overweight and obesity on health is through physical exercise, including Tabata High Intensity Interval Training (HIIT) and Isometric exercise. This study aimed to analyze the effects of Tabata HIIT and Isometric exercise on blood pressure of overweight and obese female students. This study used a quasi-experimental quantitative method with a two-group pre-post design. The research samples were divided into two treatment groups, namely the Tabata HIIT group and the Isometric exercise group. The study involved 30 respondents, with each group consisting of 15 participants. The training sessions were conducted three times a week for four weeks. The findings indicate that both Tabata HIIT and Isometric exercise had significant effects on blood pressure reduction in overweight and obese female students ($p<0.05$). Both exercise methods also contributed to lowering blood pressure. There was no statistically significant difference between the two approaches ($p>0.05$). It suggests that both Tabata HIIT and Isometric exercise can be effective in managing blood pressure in overweight-obese individuals.

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INTRODUCTION

One of the public health challenges in developing countries is overweight and obesity. Indonesia has recorded a drastic increase in overweight and obesity cases across all age groups. The prevalence of overweight among children aged 5–12 years increased significantly from 2013 to 2018 (Sulistiadi et al., 2023). Indonesian women have a greater prevalence of overweight and obesity (Izhar, 2020). Women are more likely to experience body dissatisfaction, which can lead to eating disorders such as binge-eating disorder or night-eating syndrome. Social and cultural pressures that emphasize certain beauty standards contribute to this phenomenon (Koceva et al., 2024).

According to WHO Asia Pacific, a person is classified as overweight if the BMI (Body Mass Index) value ranges from 23-24.9 kg/m2 and categorized in obesity category if the BMI value ≥ 25 kg/m2 (Bolang et al., 2021). Hypertension can occur in people whose BMI and waist size exceed normal limits. According to a study, the percentage of hypertension in overweight patients was 24.5% and the percentage in patients with obesity was 27.5% (Te'ne & Karjadidjaja, 2020). If a person diastolic and systolic blood pressure readings are more than 80 and 120 mmHg respectively, the diagnosis is hypertension (Wulandari et al., 2023). To prevent hypertension caused by being overweight, preventive measures are needed. One of the most effective ways is by regularly doing physical activity.

Regular physical exercise can prevent excessive weight gain or help maintain weight loss, as it burns calories. Regular physical exercise is able to reduce body fat and can control blood pressure (Elmagd, 2016). Overweight is mostly caused by a lack of physical exercise. Many aspects, both inside and outside a person, contribute to a lack of physical exercise. Internal factors include laziness, shyness, feelings of discomfort, and the assumption that sports are boring. Meanwhile, external factors include time constraints, lack of facilities, disruptions to social or family activities, required costs, disruptions to work, lack of access to transportation, and unfavorable weather conditions (Haditya & Griadhi, 2017). Doing basic physical exercises that do not require specific space or equipment will help address this issue. Physical exercises that can be done are Tabata High Intensity Interval Training (HIIT) and Isometric exercise.

Tabata is a type of popular HIIT that is carried out according to the HIIT principle, a combination of high-intensity physical exercise with recovery or rest time (Munandar et al., 2023;Herlan & Komarudin, 2020). High Intensity Interval Training (HIIT) has various benefits, one of which is to help lower blood pressure and prevent an increase in blood pressure. Tabata could be an effective exercise method for lowering blood pressure (Dewi et al., 2022). Another physical exercise that is effective in lowering blood pressure is Isometric exercise. Isometric exercises involve muscle contractions against resistance without causing a change in length in the muscles being trained. As long as there is enough space, Isometric exercises can be performed anytime and anywhere. The average session time for this type of exercise is only twenty minutes (Susiladewi et al., 2017).

The two exercises described above differ in rest distances, movement levels, and training durations. HIIT involves rapid full-body movements per second, whereas Isometric exercise focuses on holding positions to maintain body strengths (Ugelta et al., 2022; Fajrin et al., 2018). Both Isometric exercise and Tabata HIIT have been shown to have impacts on blood pressure (de Oliveira Teles et al., 2022; Lu et al., 2023). However, previous studies had primarily examined their effects separately. There has no research specifically explored a direct comparison between these two training methods, particularly in overweight-obese

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female students. Given the rising prevalence of obesity-related health risks, including hypertension, this study aimed to investigate how these two-training methods impact blood pressure in overweight-obese female students at the Faculty of Medicine, University of Palangka Raya.

METHODS

Participants and Samples

This study selected subjects using a purposive sampling methodology, a way to select samples according to predetermined criteria, to collect data. Data collection is carried out through the observation method, where researchers select samples based on observation and measurement results that meet the inclusion and exclusion criteria. The inclusion criteria of this study were women aged 18-25 years who had a body mass index of ≥23, did not have a history of chronic diseases, and were willing to be respondents. The assessment of chronic disease history was conducted through an observation sheet provided before the study began. This sheet included information of several chronic diseases, such as diabetes mellitus, asthma, cardiovascular disease, history of surgery, and other chronic illnesses, with an option for respondents to specify any other conditions they had experienced. Exclusion criteria included smoking, performing regular physical activity, following a diet program, taking hypertension medications, and having upper and lower extremity injuries. All of the information was obtained during the initial anamnesis interview before the study began as the part of the sample selection process. Blood pressure measurements in this study were conducted by following the standard protocols established by the World Health Organization (WHO) to ensure the accuracy and validity. The subjects involved 30 people who were then divided into two groups, namely Tabata High Intensity Interval Training for the first group and Isometric exercise for the second group.

Materials and Apparatus

In this study, weight and height were measured using digital scales and staturemeters to ensure that the subject BMI was in accordance with the criteria. Blood pressure measurement used an aneroid sphygmomanometer.

Procedures

This research was approved by the Ethics Commission of the Faculty of Medicine, University of Palangka Raya, with reference number 69/UN24.9/LL/2024. Recruitment was carried out among students of the Faculty of Medicine, University of Palangka Raya, who met the inclusion criteria. The researchers provided an explanation to the subjects regarding the research objectives, research benefits, procedures, and procedures for performing Tabata HIIT and Isometric exercise. The researchers then gave the subjects an informed consent sheet as a form of consent to participate and carry out the research. After the subjects agreed, the researchers made insurance to all subjects as a form of anticipation. The researchers divided the total number of subjects into two groups, namely the Tabata HIIT group and the Isometric exercise group. The sample in this study was allocated using a randomized sampling method. The researchers measured blood pressure of all subjects in the Tabata HIIT group and the Isometric exercise group the day before carrying out physical exercises. After measuring and recording blood pressure of all subjects, the researchers gave treatments to the subjects in the form of Tabata and Isometric exercises guided by a personal trainer by following the Tabata HIIT and Isometric exercise videos. Tabata HIIT and Isometric exercise were carried out for 4 weeks each, with a frequency of 3 times a week. The exercise was carried out at one of the fitness center studios in Palangka Raya. During the exercise, the subjects were supervised by a doctor to anticipate any injury. After completing the entire physical exercise schedule, blood pressure measurements were taken following the last

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intervention to observe the effects of Tabata HIIT and Isometric exercise on blood pressure in overweight-obese female students. The measurements followed WHO standard protocols, which include ensuring the participant is seated in a quiet environment for at least 5 minutes before the measurement, using a properly calibrated sphygmomanometer with an appropriately sized cuff, placing the cuff at heart level on the upper arm, and taking at least two measurements one minute apart. The average of these readings was used to determine the final blood pressure value.

Design or Data Analysis

This research is included in the quantitative research type with a pre-experimental design using the two-group pre-test post-test design. The study involved two groups, where observations were made before the experiment as the pre-test and after the experiment as the post-test. This study used the IBM SPSS Statistic 27 statistical program to analyze the obtained data and displayed the findings in tables. This study intended to use bivariate analysis for the data analysis. To ensure that the data followed the normal distribution, the researchers ran a Shapiro-Wilk normality test before going into the analysis. This study used Paired T-Test and Independent T-Test when the data followed the normal distribution. The study used the Wilcoxon test and the Mann Whitney test when the data did not follow the normal distribution. In addition, a difference mean test was used to observe the difference in mean changes before and after the intervention to determine the physical exercise that had the best effect on blood pressure.

The results of the study were interpreted by comparing the data analysis with hypotheses. When a p< value of 0.05 found in the unpaired mean difference test (Independent T-test or Mann-Whitney Test), a difference in the effect between each physical exercise on blood pressure was indicated according to the hypothesis. Furthermore, when a p-value of < 0.05 found in a mean difference test of one group (Paired T-test or Wilxocon test), a difference in the effect between each physical exercise on blood pressure was indicated.

RESULTS

According to Table 1, the average value of the post-test was lower than the pre-test, showing a decrease in results after the interventions. Based on the Saphiro-Wilk test, the p value of systolic blood pressure before the intervention was 0.112 (p > 0.05), so the data were normally distributed. Systolic blood pressure after the intervention was 0.001 (p < 0.05), so the data were not normally distributed. Because the results of the normality test on systolic blood pressure were not eligible for the parametric test, it was necessary to continue using a non-parametric test, namely the Wilcoxon Signed Rank Test.

Table 1. Results of Systolic Blood Pressure Measurements Before and After Tabata HIIT

No.	Sbp	N	*Mean*	*Std. Deviation*	*P Value*
1.	*Pre-test*	15	112.7	8.42332	0.112
2.	*Post-test*	15	107.3	9.42388	0.001

Table 2. The Effect of Tabata HIIT on Systolic Blood Pressure

	P value
Systolic Blood Pressure Tabata HIIT	.023

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The results of Wilcoxon test presented in Table 2 showed that there was a significant difference between pre-test and post-test on systolic blood pressure with a p value of 0.023 (p < 0.05). Based on the data depicted in Table 3, the mean in the post-test was lower than in the pre-test, indicating a decrease in results after the intervention. Furthermore, the result of Saphiro-Wilk test on diastolic blood pressure before the intervention was 0.100 (p > 0.05), while the test result on the diastolic blood pressure after the intervention was 0.117 (p > 0.05). The data were normally distributed so that the Paired T-Test could be continued.

Table 3. Diastolic Blood Pressure Measurement Results Before and After Tabata HIIT

No.	Dbp	N	*Mean*	*Std. Deviation*	*P Value*
1.	*Pre-test*	15	77.7	9.03696	0.100
2.	*Post-test*	15	73.0	9.41124	0.117

Table 4. The Effect of Tabata HIIT on Diastolic Blood Pressure

	P value
Diastolic Blood Pressure Tabata HIIT	.004

Table 5. Results of Systolic Blood Pressure Measurement Before and After Isometric Exercise

No.	Sbp	N	*Mean*	*Std. Deviation*	*P value*
1.	*Pre-test*	15	110.3	9.15475	0.053
2.	*Post-test*	15	105.7	7.28665	0.001

Table 6. The Effect of Isometric Exercise on Systolic Blood Pressure

	P value
Systolic Blood Pressure Isometric Exercise	.008

Table 7. Results of Diastolic Blood Pressure Measurement Before and After Isometric Exercise

No	Dbp	N	*Mean*	*Std. Deviation*	*P value*
1.	*Pre-test*	15	75.0	10.17700	0.100
2.	*Post-test*	15	70.7	8.83715	0.042

According to the results of the Paired T-Test in Table 4, there was a significant difference between pre-test and post-test on diastolic blood pressure with a p value of 0.004 (p < 0.05). Table 5 shows that the average in the post-test was lower than in the pre-test, implying a decrease in results after the intervention. Based on the Saphiro-Wilk test, the p value of systolic blood pressure before the intervention was 0.053 (p > 0.05), meaning that the data were normally distributed. Meanwhile, the systolic blood pressure after the intervention was 0.001 (p < 0.05), indicating that the data were not normally distributed. Because the results of the normality test on systolic blood pressure were not eligible for parametric tests, a non-parametric test using the Wilcoxon Signed Rank Test was taken.

Based on the results of the wilcoxon test in Table 6, there was a significant difference between pre-test and post-test on systolic blood pressure with a p value of 0.008 (p < 0.05). Table 7 shows that the mean in the post-test was lower than the mean in the pre-test, showing a decrease in results after the intervention. Based on the Saphiro-Wilk test on

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diastolic blood pressure before the intervention, which was 0.100 (p > 0.05), the data were normally distributed. Meanwhile, the diastolic blood pressure after the intervention was 0.042 (p < 0.05), indicating that the data were not normally distributed. Because the results of the normality test on diastolic blood pressure were not eligible for parametric tests, a non-parametric test using the Wilcoxon Signed Rank Test was performed.

Table 8. The Effect of Isometric Exercise on Diastolic Blood Pressure

	P value
Diastolic Blood Pressure Isometric Exercise	.031

Table 9. Difference Analysis of The Effects of Tabata HIIT and Isometric Exercise on Systolic and Diastolic Blood Pressure

	P Value
Systolic Blood Pressure	.698
Diastolic Blood Pressure	.501

Based on the results of the Wilcoxon test, there was a significant difference between pre-test and post-test on diastolic blood pressure with a p value of 0.031 (p < 0.05). According to the results of the normality test, the p value of the difference in systolic blood pressure in the Tabata HIIT group was 0.095 (p > 0.05) so that the data were distributed normally. Furthermore, the p values of the difference in systolic blood pressure in Isometric exercise, the difference in diastolic blood pressure in Tabata HIIT, and the difference in diastolic blood pressure in Isometric exercise were 0.000, 0.010, and 0.003 (p < 0.05) respectively, showing that the data were not normally distributed. Therefore, the analysis continued with the Mann Whitney test.

Significant results for systolic and diastolic blood pressure in both Tabata HIIT and Isometric Exercise interventions indicated that both methods could effectively lower the blood pressure. However, the comparative analysis on the effects of the two methods (Table 9) showed no significant difference (p > 0.05). This suggests that both methods may have similar efficacy. To illustrate the effects of Isometric exercise and Tabata HIIT on blood pressure, graphical representations are provided in Figure1 and Figure 2.

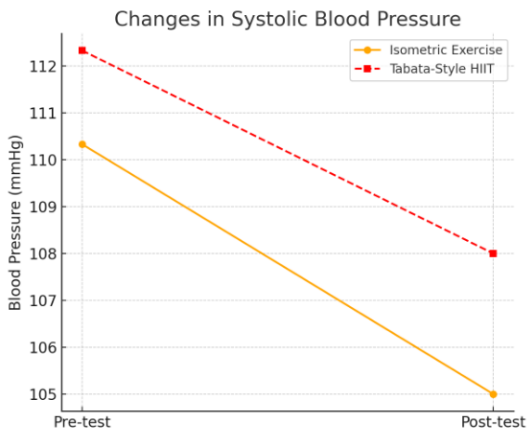

Fig 1. Changes in Systolic Blood Pressure Before and After Exercise

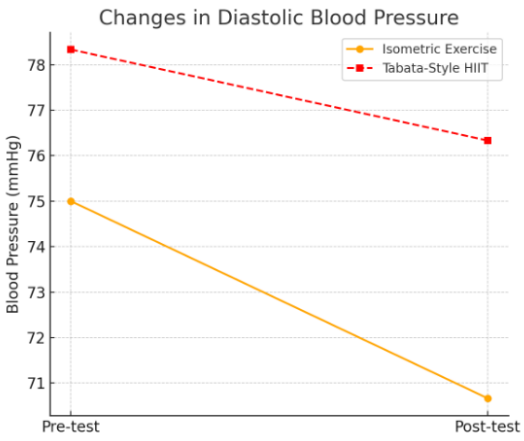

Fig 2. Changes in Diastolic Blood Pressure Before and After Exercise

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The graphs illustrate changes in systolic and diastolic blood pressures before and after the intervention for both Isometric exercise and Tabata HIIT groups. In the systolic blood pressure graph, both exercise groups showed a decrease in systolic blood pressure after the intervention. The Isometric exercise group experienced a greater decrease compared to the Tabata HIIT group. Similarly, in the diastolic blood pressure graph, both exercise types led to a decline in diastolic blood pressure. The Isometric exercise group demonstrated a more pronounced reduction in diastolic pressure than the Tabata HIIT group. These results suggested that both Isometric exercise and Tabata HIIT contributed to the decrease on blood pressure.

DISCUSSION

There were significant differences in systolic blood pressure and diastolic blood pressure of respondents in Tabata HIIT group in the pre-test and post-test. This might be due to the ability of HIIT to trigger a thickening of the myocardial left ventricle of the heart, increasing the cardiac output and making the heart works more efficient, leading to lower blood pressure (Herlan & Komarudin, 2020). This increased cardiac output enhances vascular shear stress, promoting endothelial adaptations such as improved nitric oxide production, which facilitates vasodilatation and blood pressure reduction (Sakellariou et al., 2021). This is relevant to the research of Lu et al. showing that systolic blood pressure experienced a significant decrease in the Tabata group (Lu et al., 2023). In addition, research conducted by Soltani et al. (2019) also showed a significant decrease in systolic blood pressure, blood viscosity, and plasma. HIIT training can lower systolic blood pressure and blood fluidity markers in patients with stage 1 hypertension regardless of the intensity and duration of HIIT, thus HIIT can have a very high influence on lowering blood pressure in hypertensive patients (Soltani et al., 2019).

People with normal or high blood pressure and excess body fat can improve their cardiorespiratory fitness and lower their blood pressure with 16 weeks of HIIT training (Delgado-Floody et al., 2020). A study found that high-intensity interval training (HIIT) also successfully lowered blood pressure in people who were obese, especially those who already had a previous diagnosis of hypertension (Clark et al., 2020). Twelve weeks of high-intensity interval training (HIIT) could lower the risk of cardiovascular disease and increase arterial stiffness in women with hypertension and obesity (Taha et al., 2016). This is because, in response to a series of physiological signals, the Hormone-Sensitive Lipase (HSL) enzyme regulates adipocytes during exercise. Adipocytes internalize phosphorylated HSL, which is then translocated to the surface of the fat droplets. Phosphorylation of perilipine surface proteins is necessary for HSL to catalyze the breakdown of triglycerides within fat droplets. Phosphorylation of perilipin modifies the surface of fat droplets, which in turn allows HSL to access triglycerides. Adipocytes release breakdown products into the circulation, which carries them to the muscles. Hormones including thyroid, growth hormone, and cortisol can reduce the number of adipocytes by accelerating the lipolysis process. The decrease in the number of adipocytes can lower the risk of hypertension caused by obesity (Utami & Balumbi, 2019). Therefore, HIIT can be said to be effective in lowering blood pressure and it is recommended to use this exercise as a non-pharmacological treatment for hypertension control with respect to time and facility (Shakoor et al., 2020).

Systolic and diastolic blood pressure readings from isometric exercise participants before and after the test showed statistically significant changes. Hence, it is reasonable to assume that isometric exercise could lower blood pressure. Ischemic stimulus physiologically

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increases blood flow in the distal arteries through the mechanism of shear stress. This process encourages the release of vasodilators which play a role in lowering peripheral resistance. In addition, isometric exercise is able to improve the body ability to regulate the neuro-cardiac system that affects sympathetic nerve activities. As the result, there is a vagal response that decreases heart contractility. The mechanical compression during Isometric exercise temporarily restricts blood flow. When the muscle relaxes, there is a surge in blood flow known as reactive hyperemia. The increased blood flow improves endothelial function and stimulates the release of nitric oxide, which promotes vasodilation and enhances vascular health (Lauber et al., 2021).

The results of the study of duPlessis et al., (2023), which found that the systolic and diastolic blood pressure of the isometric group decreased after the intervention, corroborate these findings. Furthermore, hypertension patients in the Pohjarak Kediri Health Center area showed a statistically significant decrease in systolic and diastolic blood pressure on the post-test evaluation of the isometric handgrip training group. According to the research of Rahmawati et al. (2018), this is possible because the dominant type of muscle contraction determines the systemic cardiovascular response to exercise. During isometric contractions, the frequency of the heart rate increases even though the muscle contractions are stopped by a neuromuscular inhibitor. Even just by thinking about performing muscle contractions, the heart rate can also increase. It also shows the influence of psychological factors, which are processed by the medulla oblongata, as the part of the brain that regulates vital functions including heart rate. It only takes a few seconds for diastolic and systolic blood pressure to rise once the isometric contractions begin. The amount of blood that the heart pumps (the number of heartbeats) remains relatively constant, but the amount of blood reaching the contracting muscles decreases. This happens because the narrowing of blood arteries during muscle contraction reduces blood flows. Muscle contractions have physiological and psychological effects on heart rate, blood pressure, and blood flow (Rahmawati et al., 2018). Another study showed a significant difference in the mean of the respondent systolic blood pressure between before and after the intervention, with an average difference of 12.5 mmHg and a p-value = 0.005. In addition, there was a significant difference in the mean of diastolic blood pressure before and after the intervention, with a mean difference of 9 mmHg and a p-value = 0.024, indicating a decrease in blood pressure after the intervention. These results conclude that isometric exercise has a significant effect on lowering blood pressure in hypertensive patients (Naldi et al., 2022).

There was no visible change in systolic and diastolic blood pressures in the Isometric exercise and Tabata HIIT groups. Although there was no statistically significant difference between Tabata HIIT and Isometric exercise groups, the results of tests comparing blood pressure before and after exercise showed significant differences for both types of exercise. Isometric exercise resulted in lower average of systolic blood pressure readings than Tabata HIIT. The difference mean value of blood pressure in the Tabata HIIT group was higher, namely 5.33 mmHg for systolic blood pressure and 4.67 mmHg for diastolic blood pressure. Meanwhile, the differences in blood pressure gained by the Isometric exercise group were 4.67 mmHg for systolic blood pressure and 4.33 mmHg for diastolic blood pressure.

The result of this study was not in line with Shakoor et al. research which showed that HIIT training and IHG (Isometric Hand Grip) exercises lowered blood pressure, but HIIT significantly caused more PEH (post-exercise hypotension) than IHG. The decrease was observed after IHG workouts for 15 minutes and after HIIT for 30 minutes (Shakoor et al., 2020). In addition, the study of Edwards et al. stated that Isometric exercise resulted in a much greater reduction in resting blood pressure compared to HIIT (Edwards et al., 2022). Expanding on these

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methodological differences, Shakoor et al. examined the acute effects of a single session of HIIT and IHG in hypertensive woman, whereas the present study involved four-week intervention exercises in overweight-obese women. Additionally, Edwards et al. conducted a systematic review and meta-analysis, which included multiple studies with varying protocols, specifically comparing the effects of Isometric exercise and Tabata HIIT over a standardized duration. These variations in study design could explain the different conclusions regarding the impact of each exercise type on blood pressure regulations.

The result of this study showed no significant difference between the effects of Isometric exercise and Tabata HIIT on blood pressure. One possible explanation is that both exercise protocols were performed for the same duration, 30 minutes per session, which may have influenced the magnitude of the physiological response. While high-intensity dynamic movements in Tabata HIIT and static muscle contractions in Isometric exercise induce different cardiovascular adaptations, the total exercise duration plays a crucial role in determining their effectiveness in reducing blood pressure. Studies have suggested that exercise duration, intensity, and frequency all contribute to blood pressure regulations. Research by Kobayashi et al. indicated that exercise for least 15 minutes per session could reduce arterial stiffness, a key factor influencing blood pressure (Kobayashi et al., 2020). However, significant reductions in blood pressure are often observed in interventions lasting longer than four weeks or with higher training volume (Lopes et al., 2018).

In this study, the training frequency was three times per week for four weeks, totaling 12 sessions. Meanwhile, the duration aligned with recommendations for structured physical activity. Previous research suggested that a longer intervention period or an increased session frequency could enhance the effects on blood pressure. Additionally, individual variability in blood pressure responses to exercise may require a longer period to observe significant changes (Lopes et al., 2018). It is generally recommended to engage in 20-60 minutes of exercise at an appropriate intensity to improve overall fitness. Even short but consistent physical activity has been shown to provide significant health benefits, including reducing the risk of cardiovascular disease and mortality (Sarastuti & Widyantoro, 2018). Despite relatively short duration of the interventions in this study, both exercise modalities still offer potential benefits as non-pharmacological strategies for blood pressure managements.

Extensive research has shown that maintaining an active lifestyle can lower blood pressure and train the heart to work harder by reducing peripheral resistance. In addition, exercising regularly triggers the production of endorphins, which help relax the heart muscle and keep blood pressure from rising (Rahmawati et al., 2018). Although no significant difference was found between two exercise types in this study, both Tabata HIIT and Isometric exercise can still be recommended as non-pharmacological options for blood pressure managements. Tabata HIIT, characterized by short bursts of high-intensity exercise followed by brief rest periods, can improve cardiovascular fitness, enhance endothelial function, and promote vasodilation, contributing to better blood pressure regulation. On the other hand, Isometric exercise, which involves sustained muscle contractions without joint movement, have been shown to reduce resting blood pressure by improving vascular functions and reducing sympathetic nervous system activity (Izadi et al., 2017; Rodrigues et al., 2018). Given these benefits, both exercise modalities may serve as practical alternatives for hypertensive patients or individuals at risk of hypertension, offering accessible and adaptable strategies for blood pressure control that can be incorporated into daily routines.

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CONCLUSION

Based on the results of this research on the effect differences of Tabata high intensity interval training and Isometric exercise on blood pressure in overweight-obese female students, it concludes that both Tabata high intensity interval training and Isometric exercise have an effect on blood pressure in overweight-obese female students. However, the two exercises did not have a significant difference to determine which exercise was better for regulating blood pressure of overweight-obese female students.

AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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