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# Differences in the Effect of *Aerobic Exercise* and *Resistance Exercise* on *Cardiovascular Endurance* in Metabolic Syndrome

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**ABSTRACT**

**Introduction:** individuals with metabolic syndrome have a three times greater chance of experiencing heart disease and stroke, twice as likely to experience death, and the risk of type 2 diabetes.Metabolic syndrome is characterized by a collection of metabolic disorders caused by obesity, in the form of a combination of dyslipidemia, hypertension, hyperglycemia, and central obesity.Objective to find out how *aerobic exercise* and *resistance exercise* differ on *cardiovascular endurance.* **Methods:** the research is quantitative with *quasi experimental* method*,* using *pretest and posttest two group design*. Sampling using *purposive sampling* by selecting samples from the population that meets the inclusion criteria. **Results:** most respondents were >70 years old (40%), female (65%), normal BMI (52.5%), and physical activity 2 times a week (47.5%).The results of the *paired sample t-test* in group 1 increased from 3.34 ± 0.57 to 6.00 ± 1.8. in group 2 increased from 3.38 ± 0.67 to 5.46 ± 1.14. the results of the *independent sample t-test* sig value (p = 0.025). **Conclusion:** there is an effect of *aerobic exercise* and *resistance exercise*, and there are differences in the effect on increasing *cardiovascular endurance* in metabolic syndrome.

***Keywords****: metabolic syndrome, cardiovascular endurance, aerobic exercise, resistance exercise*

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## INTRODUCTION

Metabolic syndrome is considered a major health hazard, due to its contribution to disability and mortality (Nguyen *et al*., 2021). The chance of individuals with metabolic syndrome to experience heart disease and stroke is three times greater, the chance of death is twice as great, and the risk of developing type 2 diabetes is five times greater than individuals without metabolic syndrome (Amriani *et al.,* 2023).

There is an increase in waist circumference, blood pressure, blood sugar, triglycerides and cholesterol if one has metabolic syndrome (Codazzi et al., 2024). It is characterized by a number of risk factors that increase the risk of cardiovascular disease and type 2 diabetes. Unhealthy diet, physical inactivity, sedentary lifestyle, and vitamin D deficiency are some of the factors that increase the likelihood of these problems (Nurzakiah et al., 2021).

Prevalence shows that metabolic syndrome is associated with future cardiovascular morbidity and mortality with different populations around the world, which ranges from 5-45% depending on the age of the population (Lind et al., 2021). In Indonesia, Riskesdas data shows that in 2018, the prevalence of metabolic syndrome reached 18.3%. According to Herningtyas & Ng, (2019) the prevalence rate is 21.66% in Indonesia, and is higher in older people as well as those who are inactive and do not have good cardiovascular fitness.

Physical activity levels in Daerah Istimewa Yogyakarta show that only 14.9% of the population is physically active, while 85.1% are less active (Ghozi et al., 2024). This figure is in line with the prevalence of metabolic syndrome which reaches 20% and has a direct impact on reducing cardiovascular endurance (Jian et al., 2017). Sleman is one of the districts with the highest prevalence, with 79.5% (Avisena &

Perdana, 2020). Based on preliminary studies conducted, the highest rate is found in Posyandu Mawar Ngebong under the auspices of the Puskesmas Tempel, Kabupaten Sleman, which is 100%.

People increasingly realize the importance of physical activity in maintaining health, especially for people with metabolic syndrome. In order to get health and fitness that is fulfilled, WHO recommends doing physical exercise with moderate intensity for at least 150 minutes per week (Sudibjo et al.,2021). Physiotherapists can assist patients in choosing the right type of exercise, both aerobic and resistance adapted to their abilities and physical conditions in controlling metabolic syndrome (Natalia et al., 2022).

The cardiovascular system undergoes physiological changes in the elderly, including decreased heart function, aerobic capacity, and vascular elasticity. Cardiovascular disease is the leading cause of death in the elderly, due to changes in the cardiovascular system. Metabolic syndrome, with insulin resistance, dyslipidemia, and hypertension can exacerbate these conditions. Thus, managing metabolic syndrome in the elderly requires efforts to increase cardiovascular endurance. The effectiveness of the circulatory system in delivering oxygen and nutrients is measured by cardiovascular endurance (Prananda et al., 2022).

The Indonesian government through the Ministry of Health has issued various policies to deal with the problem of metabolic syndrome, including promotive and preventive programs aimed at increasing physical activity in the community. Aerobic exercise is a movement performed to music within a certain period of time by increasing heart rate and respiratory volume in meeting oxygen demand.

This type of exercise can lower blood pressure and improve cardiovascular endurance for people with metabolic syndrome, exercise can be done at least 3 times a week for 30 minutes (Chomiuk et al.,2024). Resistance exercise such as using dumbbells, is an exercise that can be done to overcome cardiac endurance problems in metabolic syndrome. this exercise is an excellent type of exercise to improve fitness and prevent loss of muscle mass when entering old age (Gifari & Yahya, 2023).

Previous research has revealed that aerobic exercise and resistance exercise both provide benefits in improving cardiac endurance in individuals with metabolic syndrome (Priatna & Barat, 2015). However, no study has specifically compared the effect of each type of exercise on cardiac endurance. Metabolic syndrome represents a collection of risk factors with insulin resistance associated with increased cardiovascular disease. This increase in incidence is associated with lifestyle changes due to population growth and globalization (Angria & Sugiarti, 2023).

The purpose of this study is to comparatively analyze the effects of aerobic and resistance exercise interventions on improving cardiovascular endurance in individuals with metabolic syndrome. The hypothesis of this study is that there is a significant difference in improving cardiovascular endurance between the two types of intervention. The results of this study are expected to provide empirical evidence regarding the most effective exercise modalities in improving cardiovascular functional capacity and physical fitness in the population with metabolic syndrome, so that it can be a foundation for the development of evidence-based and personalized physiotherapy intervention protocols.

## METHODS

Quantitative research with quasi experimental method. The study used a pretest and posttest two group design. Before treatment, both groups were measured using the 6minute walking test to determine cardiovascular endurance. The population in this study amounted to 60 elderly people who experienced metabolic syndrome and did not experience metabolic syndrome. The provision of both interventions was carried out within 1 month (4 weeks). Aerobic exercise with a dose of 3 times in 1 week, intensity of 30 minutes and the provision of resistance exercise with a dose of 2 times in 1 week, the frequency of training 3 sets. Sampling using purposive sampling technique by selecting samples among the population in accordance with



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the inclusion and exclusion criteria. The inclusion criteria in this study are as follows: respondents who are willing, respondents who have a history of metabolic syndrome with decreased cardiovascular endurance, respondents aged ≥40. Exclusion criteria are as follows: respondents are pregnant women, respondents are athletes, respondents who have a history of angina and myocardial infarction in the last 1 month, chest pain, blood pressure >180/100mmHg, resting heart rate >120×/minute. The sample amounted to 40 which were divided into 2 groups by the researcher. The sample was determined through a series of assessment processes and measurement of cardiac endurance using the 6minute walking test so as to represent the population.

In this study, aerobic exercise and resistance exercise are independent variables, and cardiovascular endurance is the dependent variable.

The data processing method is univariate analysis in the form of age, gender, body composition, and physical activity. Bivariate analysis was used to determine the differences and relationships between two variables, namely aerobic exercise and resistance exercise on cardiovascular endurance. Normality test to determine the independent and dependent variables are normally distributed using the Saphiro Wilk Test. Homogeneity test using Lavene's test. Test group 1 and group 2 using Paired sample t-test. Test the difference in post-test with Independent Sample t-test. This data analysis uses the SPSS computer program.

This research was conducted after the issuance of an Ethical Certificate from Universitas 'Aisyiyah Yogyakarta Number: 4070/KEP-UNISA/XII/2024.

## RESULTS

At Posyandu Mawar Ngebong, which is under the auspices of Puskesmas Tempel 1, in Kecamatan Tempel, Kabupaten Sleman, Daerah Istimewa Yogyakarta, there were two groups involved in this study. The first group did aerobic exercise and the second group did resistance exercise. The study was conducted by giving exercises to each group that had been determined after an initial examination, which included checking vital signs, cholesterol, and blood sugar, as well as a six-minute walking test. The first group consisted of 20 members and the second group consisted of 20 members. The total number of members with metabolic syndrome with reduced cardiovascular endurance was 40.

The results of the test Characteristics of respondents in this study using univariate analysis include age, gender, body composition (BMI), and physical activity.

Table 1 . Respondent Characteristics

| Characteristics | Category | Frequency (n) | Percentage(%) |
|---|---|---|---|
| **Age** | 45-59 th | 11 | 27,5 |
| | 60-69 th | 13 | 32,5 |
| | >70 years old | 16 | 40,0 |
| | Total | 40 | 100,0 |
| **JK** | LK | 14 | 35 |
| | PR | 26 | 65 |
| | Total | 40 | 100 |
| **IMT** | Skinny | 1 | 2,5 |
| | Normal | 21 | 52,5 |
| | Obesity | 18 | 45 |
| | Total | 40 | 100 |
| **AF** | 1 time | 18 | 45 |
| | 2 times | 19 | 47,5 |
| | 3 times | 3 | 7,5 |
| | Total | 40 | 100 |
| **Mets** | Low | 28 | 70 |
| | Medium | 12 | 30 |
| | Total | 40 | 100 |

Notes: JK (gender), BMI (body mass index), AF (physical activity), METs (*metabolic equivalents*).

Table 1 presents the characteristics of respondents based on age, gender (JK), body mass index (BMI), physical activity (AF), and metabolic equivalents (METs). The majority of respondents were over 70 years old (seniors) (40.0%), followed by the age groups 60-69 years (32.5%) and 45-59 years (27.5%). There were more female respondents (65%) than male



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respondents (35%). The data results illustrate the larger elderly population in the study area

Based on BMI, most respondents had normal BMI (52.5%), while 45% were obese and only 2.5% were lean. Respondents' physical activity was dominated by 2 times a week activity (47.5%), followed by 1 time a week (45%) and only a small proportion did 3 times a week activity (7.5%).

The low level of physical activity in most respondents indicates the need for efforts to increase awareness of the importance of physical activity for health and cardiovascular endurance in the elderly. Based on METs, the majority of respondents had low METs levels (70%) and the rest had moderate METs levels (30%).

Bivariate analysis was used to analyze the difference between two variables on the effect of aerobic exercise and resistance exercise on cardiovascular endurance.

Table 2 . *Paired Sample t-test* results of groups 1 and 2

| ***Paired Sample t-test*** | | | |
|---|---|---|---|
| | **Mean±SD** | | **P-Value** |
| | **Ex. 1** | **Exhibit 2** | |
| ***Pre*** | 3,34±0,57 | 3,38±0,67 | 0,000 |
| ***The post*** | 6,00±1,18 | 5,46±1,14 | |

Source: researcher's primary data, (2025)

Table 3 . *Independent Sample t-test* Results

| ***Independent Sample t-test*** | | | |
|---|---|---|---|
| | **Mean±SD** | | **P-Value** |
| | **Ex. 1** | **Exhibit 2** | |
| ***The post*** | 6,00±1,18 | 5,46±1,14 | 0,025 |

Source: researcher's primary data, (2025)

The results of paired sample t-test and independent sample t-test are presented in tables 2 and 3. A normality test was conducted to determine the distribution of data in groups 1 and 2 before and after the intervention.

The normality test results showed that the data were normally distributed in both groups, both pre-test and post-test (p>0.05). The homogeneity test results showed that the data variance was homogeneous in the pre-test (p= 0.503) and post-test (p = 0.161). Paired sample t-test was conducted using paired sample t-test.

The results of the paired sample test proved that both groups experienced a significant increase in cardiovascular endurance after the intervention. In group 1 (aerobic exercise), the average cardiovascular endurance increased from 3.34±0.57 to 6.00±1.18. In class 2 (resistance exercise), the average cardiovascular endurance increased from 3.38±0.67 to 5.46±1.14 with a value of (p < 0.000). These results indicate that both aerobic exercise and resistance exercise are effective in increasing cardiovascular endurance

The results of the independent sample test proved that there was a significant difference in post-test cardiovascular endurance between the two groups (p = 0.025). The average post-test of group 1 (6.00±1.18) was higher than group 2 (5.46±1.14). The findings of this study indicate that aerobic exercise provides a greater effect in improving cardiovascular endurance than resistance exercise.

Based on the results of the analysis, it can be concluded that both aerobic exercise and resistance exercise are effective in increasing cardiovascular endurance. However, aerobic exercise provides a greater effect than resistance exercise.

## DISCUSSION

Table 1 test results of respondent characteristics based on age show that of the 40 respondents with age ranges based on the Ministry of Health pralansia 45-59 years, elderly 60-69 years, Seniors over 70 years, the most respondents were over 70 years old, namely 16 respondents (40.0%). This age is the average age of the exercise group at Posyandu Mawar Ngebong.

Age also affects heart-lung endurance. VO2Max values are affected by age. VO2Max will gradually decrease after the age of 20 years and above. At 55 years of age, VO2Max drops by about 27% compared to 25 years of age (Utamayasa, 2021). These results are in accordance with the author's research. Respondent 1 with an age of 45 years has a higher cardiovascular endurance value of 4.4 METs compared to respondent 2 with an age of 82 years



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with a cardiovascular endurance value of 2.4 METs.

This research is supported by Nugraha et al., (2021) that a decrease in cardiovascular endurance often occurs at the age of over 40-60 years. Cardiovascular endurance is the ability of the lungs, heart, and blood vessels to transport oxygen to active tissues for optimal body metabolism. The decline occurs due to decreased respiratory capacity, heavier breathing, decreased lung elasticity, and decreased heart ability to pump blood which results in changes in volume and contraction.

Characteristics of respondents based on gender were divided into 2 in 40 respondents from both groups, with the most respondents being female with a frequency of 26 respondents and (65%).

The findings of this study prove that the decline in cardiovascular endurance is more prevalent in women. Compared to women, men have greater cardiovascular endurance. This is due to variations in lung capacity, hemoglobin count, muscle strength and body composition. After adolescence, females use less oxygen than males. Therefore, males have better cardiovascular endurance, with balanced physical activity (Nuarti et al., 2019). These results are in accordance with the author's research. Respondent 1 with female gender has a cardiovascular endurance value of 2.1 METs and respondent 2 with male gender has a cardiovascular endurance value of 4.7 METs.

The characteristics of respondents based on body composition (BMI) in the results of this study showed that of the 40 respondents, most had normal values with a frequency of 21 and a representative percentage was (52.5%). Body composition, is one of the factors that play a role in physical fitness, in addition to cardiopulmonary endurance.

Body mass index is one of the important factors in determining cardiorespiratory endurance. Cardiac and pulmonary endurance in someone who has a normal BMI (<25 kg/m2) is better than those who are obese (BMI ≥30 kg/m2). Body mass index and cardiorespiratory fitness have a significant influence on the risk of metabolic syndrome and a high BMI has a 1.746 times greater tendency to have metabolic syndrome than individuals who have a normal BMI (Prananda et al., 2022).

These results are in accordance with the research conducted. Respondent 1 who has a normal BMI value (22.9 kg/m2) has a better cardiovascular endurance value of 3.7 METs compared to respondent 2 who has an obese BMI (34.5 kg/m2) with a cardiovascular endurance value of 2.1 METs.

Characteristics of respondents based on physical activity carried out in a week by respondents based on the results of the study, most of the activities 2 times a week, with a frequency of 19 and a representative percentage is (47.5%). Physical activity greatly affects the quality of cardiovascular endurance. These results are in accordance with the author's research. Respondents with physical activity 2 times a week have a cardiovascular endurance value of 2.4 METs and respondents with physical activity 3 times a week have a value of 3.4 METs

According to some sports experts, VO2Max is the body's mechanism of transporting oxygen through the blood pumped from the lungs to the muscle tissue. Individuals who practice or exercise 3-4 times a week have good stamina by having a higher VO2Max value. According to MRizky, (2020) physical fitness that a person has is influenced by maximum aerobic capacity (VO2Max).

According to Dobrowolski et al., (2022) said that from the point of view of metabolic syndrome, important effects of physical activity include increased HDL-C levels, decreased triglyceride levels, improved glycemic control due to increased tissue sensitivity to insulin, and lower blood pressure. To reduce all-cause mortality, cardiovascular mortality, and morbidity, adults should engage in physical activity per week. Exercise engagement is associated with good metabolic health outcomes, while sedentary behavior is associated with greater risk of cardiovascular disease (Rus et al., 2023).

Table 2 shows that there is an effect on the test results of group 1 aerobic exercise. Metabolic



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syndrome is a combination of metabolic risk factors directly associated with non-communicable diseases, especially arterosclerotic cardiovascular disease. However, it is not a disease (Nguyen et al., 2021).

In an effort to improve cardiovascular endurance, physiotherapy is an important component of an appropriate exercise program. There are several physiotherapy exercise programs that are effective in improving cardiovascular endurance. One of them is aerobic exercise. This is supported in research Said, (2022) that one type of endurance exercise that increases a person's heart rate and breathing rate over a long period of time is aerobic exercise. This type of exercise is beneficial in heart health and weight loss. Aerobic exercise is an activity that relies on the availability of oxygen to support energy burning. This happens because the exercise affects how the heart, lungs and blood vessels operate to deliver oxygen so that the burning of energy sources can take place

Aerobic exercise has various forms of exercise, namely aerobics with low impact¸moderate, and high impact (Rubiyatno et al., 2023). The aerobic exercise movement given in this study is aerobic exercise. Hammami et al., (2022) stated that aerobic exercise and audiovisual guided gymnastics help maintain cardiovascular health, musculoskeletal, and metabolic fitness. Aerobic exercise is one type of exercise from aerobic exercise where physical fitness is gradual, regular and meets the dose or dose of exercise (Fatmala et al., 2022).

According to Denyut et al., (2023) mentioned that this type of exercise has a balanced exercise design in covering both upper and lower body activities. In aerobic exercise, low impact refers to exercising specific muscles in turn. The training session lasts at least 10 minutes, during which participants can perform a variety of movements as well as one type of movement that is frequently performed. An important element in determining maximum oxygen intake (VO2Max) is intensity (Muhammad, 2020).

In this study, the dose used, namely training is carried out 3 times per week, with a training time of 15-30 minutes (Fuadi et al., 2023). By using the benchmark of increasing heart rate (Training Heart Rate = THR), the intensity is moderate (low impact). 60% to 90% of an individual's maximal heart rate is a good exercise in improving fitness (Ninzar, 2018). Warm up, core, and cool down are a series of movements in aerobic exercise.

The results of the group 2 test, namely resistance exercise, showed that there was an effect. Decreased physical activity is caused by changes in the musculoskeletal and cardiovascular systems. Cardiovascular changes such as work capacity, low oxygen consumption, and low hemoglobin levels. One form of treatment that can be done by physiotherapy is to provide an exercise or exercise that is regular and directed to be able to reduce the pulse rate after exercise. Resistance exercise can reduce the pulse rate after exercise by increasing the strength of the heart muscle obtained from the chronic adaptation response to exercise (Tambing et al., 2020).

Resistance exercise can increase cardiovascular endurance in metabolic syndrome. Resistance exercise (weight training) in this study can be done using external loads, namely free weights such as dumbbells. Dumbbell exercise is a form of exercise aimed at increasing the strength and power of arm muscles, especially, biceps, radial flexor, barchio radialis (Hidayat et al., 2019). The weight of the dumbbell used is 1 kg which consists of warm-up, main exercise, and cooling movements. Exercises are performed 2 times per week for 4 weeks with moderate intensity, frequency of 3 sets, 1-2 multi joint exercises per main group, with an intensity of 70-85% of 1 repetition maximum (1RM) which is 10-12 repetitions per set.

These results indicate that both types of interventions were effective in changing the participants' cardiovascular scores. The positive changes in both groups were indicated by the mean values increasing after the intervention. The greater improvement in group 1, aerobic exercise, indicates that the intervention provided to this group had a better impact on improving cardiovascular compared to the intervention in group 2, resistance exercise

Differences in the effect of aerobic exercise and resistance exercise on improving cardiovascular endurance can be influenced by



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differences in respondent characteristics. Group 1 with aerobic exercise had a higher proportion of participants with obese BMI (12 people) compared to group 2 with resistance exercise which was dominated by participants with normal BMI (14 people). This difference is thought to contribute to differences in cardiovascular outcomes post intervention.

Physical fitness is higher among individuals with normal or lower body mass index (BMI) than individuals who are obese or high BMI. One of the main determinants of cardiorespiratory endurance is body mass index. Compared to individuals who are obese (BMI ≥30 kg/m2), individuals with normal BMI (<25 kg/m2) have better heart and lung endurance (Prananda et al., 2022).

Based on the results of the difference test, there is a significant difference between cardiovascular post in groups 1 and 2. From the results of the difference data analysis that group 1 aerobic exercise showed a mean cardiovascular post greater than group 2 resistance exercise. This difference in mean value indicates that aerobic exercise has a greater effect on increasing cardiovascular endurance post compared to resistance exercise.

Different types of exercise affect the cardiovascular system in different ways, there are significant differences in the cardiovascular system after exercise, as indicated by post-exercise observations. This occurs due to variations in the dose, intensity and duration of exercise. One type of aerobic exercise with aerobic exercise is known to help lose weight and maintain cardiovascular endurance. Exercises performed regularly and consistently can improve cardiovascular endurance by increasing oxygen consumption capacity (Fuadi et al., 2023).

The difference in effect also lies in the different physiological mechanisms. Aerobic exercise can improve cardiovascular and respiratory capacity, and burn calories effectively. Meanwhile, resistance exercise, such as weight lifting, focuses more on increasing muscle mass strength, as it is based on a movement pattern that is only one position without any displacement.

## CONCLUSION

In this study, there was an effect of aerobic exercise and resistance exercise, and there were differences in the effect of the two interventions on increasing cardiovascular endurance in metabolic syndrome.

## ADVICE

In an effort to understand the mechanism of the different impact of the two exercises on improving *cardiovascular endurance*, further research is needed. A more thorough research design using a control group and assessment of additional physiological variables may provide a deeper understanding of this.

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