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# Age-defying fitness: How can combining resistance and aerobic exercise help elderly adults increase muscle strength?

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**ABSTRACT**

The population of elderly individuals in the village of Tinggede, Indonesia, continues to increase. It is crucial for the ageing population to maintain good fitness throughout the ageing process. Ageing in the elderly encompasses a range of issues, from declining motor function to muscle strength loss. Therefore, it is important for the elderly to preserve muscle strength through physical exercise to ensure independent functioning. This research aimed to investigate the effects of a combination of resistance and aerobic exercises on muscle strength in healthy elderly individuals. The study involved a sample of 30 male elderly individuals aged 60 years and older. The treatment group was given a combination of resistance exercise and aerobic exercise, while the control group was given aerobic exercise. Resistance exercise is given three times per week with a progressive increase in sets and reps. While aerobic exercise is given seven times per week for 40 minutes per session. Participants were examined for muscle strength before and after the intervention using a digital hand grip dynamometer (DHD). The analysis performed included paired t-test and independent t-test with $p < 0.05$. The results demonstrated a significant increase in hand grip strength among the participants who underwent the exercise programme compared to the control group. These findings suggest that a progressive increase in sets and repetitions for each exercise activity can effectively enhance muscle strength in the elderly. However, it is pivotal to note that this study was limited to a single village. Nonetheless, the exercise combination proposed in this study provides valuable insights for sports medicine research and can be utilised as a reference for designing exercise programmes targeting healthy elderly individuals.

**Keywords:** Resistance exercise; aerobic exercise; elderly; muscle strength

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## INTRODUCTION

In the 21st century, both developed and developing nations face the issue of population aging. Indonesia's population is also getting older. According to projections made by the Indonesian Central Bureau of Statistics in 2020, the elderly in Indonesia will account for nearly one fifth of the country's total population in 2045 (Bungsu et al., 2019; Statistik, 2021). Elderly people make up almost three out of every ten households (29.52%), and almost three out of every five elderly people act as the head of the household

that is, the person who is in charge of providing for the needs of the household on a daily basis (Mizukami et al., 2023). One in ten (9.99%) of the elderly live alone, according to the status of living together, and the health of the elderly can show how well they are doing (Chen et al., 2023; Oliveira et al., 2022). A person is in good health when they are physically, mentally, spiritually, and socially healthy, allowing them to be socially and economically productive (Huiwen et al., 2023; Martínez & González, 2023). The term "potential elderly" refers to locals who are over the age of 65 but are still able to engage in work or other activities that can generate goods or services. One in two older people, or 49.46%, will still be employed (Bungsu et al., 2019; Statistik, 2021).

There is a quantitative loss of muscle mass as a result of aging, as well as a decline in muscle strength and power (Martínez & González, 2023; Oliveira et al., 2022). All of the body's organs degenerate over time in the elderly, one of which is a decline in muscle strength. Poor nutrition, inactivity, and a lack of interaction between the central nervous system, the peripheral nervous system, and hormones can all contribute to weaker muscles (Leite et al., 2022; Martínez & González, 2023; Oliveira et al., 2022; Zhang et al., 2021). Morbidity in the elderly can be linked to diminished muscle strength. Self-efficacy, or the capacity to carry out day-to-day activities without becoming exhausted, is one definition of functionality (Leite et al., 2022; Shah et al., 2022; Taul-Madsen et al., 2021; Thojampa et al., 2020). This has a direct bearing on the muscle's potential and strength (Bicer et al., 2022; Marcos-Pardo et al., 2022; Singh et al., 2022; Thomsen et al., 2022; Waterval et al., 2022; Yeon et al., 2022). There is also a qualitative decrease in muscle strength, with atrophy of the fast fibers (type II fibers), decreased elasticity of the tendons, and lower activation of the higher agonist and antagonist muscles (Haddara et al., 2020; Sun et al., 2018). Within a range or muscle group, strength loss occurs at different rates. Lower extremity proximal muscles are more affected than upper extremity proximal muscles (Farrell et al., 2021; Kanmaniraja et al., 2021).

Between the second and third decades of one's life, muscle strength reaches its peak. Muscle strength decreases slightly between the ages of 50 and 65, then decreases by 12 to 15 percent per decade thereafter (Oliveira et al., 2022; Roma et al., 2013). The atrophy of fasting fibers (type II fibers), reduced elasticity of tendons, and lower activation of the muscles by higher agonists and antagonists all result in a qualitative decline in muscle strength (Oliveira et al., 2022; Roma et al., 2013). Maintaining moderate physical activity is one way to maintain health, muscle strength and physical fitness, because the body's negative feedback system becomes active during physical activity, which has a beneficial effect on homeostasis (Bungsu et al., 2019; Zhang et al., 2021). In the elderly, physical activity improves health, muscle strength and physical fitness and supports healthy relationships (Felix, 2022; Taylor, 2014; Zhang et al., 2021). Aerobic, resistance, and flexibility exercises are recommended forms of exercise for the elderly to prevent a decrease in body function, although many forms of exercise can improve physical abilities and fitness (Yamamoto et al., 2016). One of them is physical activity that lasts at least 30 minutes per session and includes moderate-intensity aerobic exercise at least 3-5 times per week for a total of 150 minutes per week, accompanied by resistance, flexibilit,y and balance exercises (Bungsu et al., 2019; Wiyaka, 2014; Zhang et al., 2021).

Exercise that is aerobic in nature, such as jogging, gymnastics, swimming, and cycling, utilizes the body's large muscles (Ohta et al., 2017; Thojampa et al., 2020). Aerobic exercise helps people lose weight and prevents persistent conditions like diabetes, heart disease, and blood vessel disease (Thojampa et al., 2020; Wang et al., 2019). Resistance exercise aims to prevent degenerative diseases like osteoporosis and sarcopenia (Jeon et al., 2017; Oliveira et al., 2022). An exercise program that is effective will produce the intended results. As a result, aerobic activity must be done at the right dose, which should be between 70 and 85 percent DNM for 20 to 30 minutes, three times per week (Oliveira et al., 2022; Thojampa et al., 2020; Yamamoto et al., 2016). According to the DeLorme method, resistance exercises are performed correctly, with biceps curl, triceps extension, leg press, knee extension, and knee flexion being the forms of movement. The volume of exercises is three times per week (Bungsu et al., 2019; Ohta et al., 2017; Portal et al., 2022; Wiyaka, 2014; Yamamoto et al., 2016).

Various findings or research on the effect of resistance exercise and aerobic exercise on increasing strength in children, adolescents, and the elderly include: a combination of locomotor exercise and aerobic exercise in the elderly with locomotive syndrome (Nayasista et al., 2022; Ohta et al., 2017), aerobic exercise

combined with resistance exercise physical conditioning on adolescent health (Mendonça et al., 2022), a combination of resistance exercise and aerobic exercise klotho serum secretion in healthy young men (Morishima & Ochi, 2022) and resistance exercise is associated with differential blood pressure flow restriction on bone remodeling biomarkers in the elderly (Copatti et al., 2022; Ohta et al., 2017).

There is extensive research highlighting the benefits of resistance exercise for increasing muscle mass and strength, as well as aerobic exercise for preventing cardiovascular disease (Al-khersan et al., 2021; Huifen et al., 2022; Lim et al., 2017; Mendonça et al., 2022; Morishima & Ochi, 2022; Wen et al., 2022). However, elderly individuals can experience the progression of locomotive syndrome due to factors like inactivity and inadequate nutrition (Ishibashi, 2018). Resistance exercise, which includes muscle strengthening and balance components, has been recommended as an exercise therapy to improve mobility and function, thereby enhancing independence in the elderly (Ikemoto & Arai, 2018; Nakamura & Ogata, 2016). Meanwhile, aerobic exercise can improve cardiorespiratory tone (Nayasista et al., 2022; Sbardelotto et al., 2019; Kokic et al., 2018). Combining various exercises, such as resistance exercise and aerobic exercise, can provide elderly individuals with a range of beneficial exercises that can improve muscle strengthening, balance, flexibility, and cardiorespiratory function, thereby leading to an overall improved quality of life (Haraldstad et al., 2017; Nayasista et al., 2022; Roma et al., 2013).

Based on data from the National Statistics Center (BDS), the number and proportion of the elderly population continue to increase (Statistik, 2021). However, government facilities and programmes related to the physical health service programme for the elderly have not had a significant impact on the physical health condition of the elderly (Cho et al., 2021; Kariya et al., 2018; Sbardelotto et al., 2019), in order for the elderly population to maintain their physical health and be productive, it is necessary to provide various models of exercise to maintain their physical health. The combined effects of resistance exercise and aerobic exercise on increasing muscle strength in productive, healthy elderly populations (subjects) in Indonesia, especially in eastern Indonesia, have not been studied until now. The research that has been done before is on resistance exercise or aerobic exercise in elderly populations (subjects) who experience various health problems (Copatti et al., 2022; Ikemoto & Arai, 2018; Nakamura & Ogata, 2016; Nayasista et al., 2022).

Meanwhile, this study aims to analyse the effect of a combination of resistance exercise and aerobic exercise on muscle strength in healthy and productive elderly people who have not participated in regular exercise in the last 6 months, which is important to do considering the number and proportion of the elderly population (elderly) continues to increase, which is not directly proportional to the facilities and physical health service programmes prepared by the government (Cho et al., 2021; Kariya et al., 2018; Sbardelotto et al., 2019). There are also concerns that the physical disabilities of the elderly will cause dependence on others. However, there is a lack of research on the effectiveness of combined resistance exercise and aerobic exercise specifically for healthy and productive elderly populations in Indonesia, particularly in eastern Indonesia, where the elderly population is growing rapidly but access to exercise programmes may be limited (Cho et al., 2021; Kariya et al., 2018; Sbardelotto et al., 2019; Statistik, 2021). Thus, the lack of research on the effectiveness of a combined exercise programme for healthy and productive elderly populations in Indonesia makes this study novel and urgent.

## METHOD

Resistance exercise is safe resistance exercise that can be done by anyone, from young adults to the elderly, as long as they can stand on their own (Ishizawa et al., 2001; Mendonça et al., 2022; Morishima & Ochi, 2022; Taul-Madsen et al., 2021; Wen et al., 2022). Lifting and weight systems, two types of equipment made for older people, are used in the exercises. The load is gradually increased in sets of 12, 10, and 8 repetitions for each exercise. Chest presses, leg presses, calf presses, and crunches are some of the exercises.

Aerobic exercise for the elderly includes exercises with a moderate to high intensity (maximum heart rate of 40-70%) to improve cardiorespiration, muscle endurance, and joint flexibility. According to various studies, aerobic exercise for the elderly should be done for 30 minutes (Bouaziz et al., 2018; Luo et al., 2017; Roma et al., 2013; Tabara et al., 2007). The workout consists of a 5 minute warm-up, 20 minutes of

aerobic activity (walking exercise for the arms and legs), and 5 minutes of recovery (Picorelli et al., 2014). Every five minutes, the heart rate (HR) is checked to make sure and it stays between 60% and 70% of maximum HR (220-Age). If HR is lower than expected, participants are encouraged to work harder, in contrary if HR is higher than expected, they should work harder.

**Study Design**

This study utilized a pre-test and post-test group design with 15 participants in each treatment and control group, division of groups by ordinal pairing (Fraenkel et al., 2012). The control group only received aerobic exercise, whereas the treatment group received a combination of resistance exercise and aerobic exercise. For eight weeks, resistance exercise and aerobic exercise would each take 40 minutes per session. Additionally, aerobic exercise was done three times per week and resistance exercise was done three times per week. Aerobic exercise focuses on endurance and flexibility, while resistance exercise focuses on strengthening and strength. Multiple modal exercises are the exercises that can be combined and can then complement one another. By comparing the participants' muscle strength before and after the activity, strength exercise, and aerobic exercise were evaluated.

**Subject Retrieval Techniques**

This study involved participants aged 60 years and over who lived in Sigi District, Marawola District, Tinggede Village, had no contraindications to exercise, and were in good health but had not participated in regular exercise in the last 6 months. Arteries (systolic blood pressure > 170 mmHg and diastolic blood pressure > 105 mmHg). The population in this study were all elderly people living in the Tinggede sub-district area, with a total sample of 30 elderly people using a purposive sampling technique.

**Instruments**

An electronic hand dynamometer was used to measure the muscle strength of the participants' hands. Method for determining extraordinary handgrip strength on the elbow and non-dominant hand up to 90. Three times, participants were instructed to grip the handlebars as hard as they could for three seconds. The measurement results are taken from the trial with the best value, and the distance between trials is approximately one minute (Franchini et al., 2015; Pastuszak et al., 2016).

**Data Analysis**

Data were analyzed using SPSS version 21.0. Descriptive presentation of data was carried out to determine the characteristics of all data. The data normality test was measured using the Shapiro-Wilk test. Statistical tests used in this study included paired t-tests and independent t-tests. Statistical test results were declared significant if the p-value < 0.05 (Creswell, 2012).

## RESULTS AND DISCUSSION

**Characteristics of participants**

The mean age of the participants was 62.13 years, with a median of 60.50 years. The youngest and oldest participants were 60 years and 70 years old respectively. There was no significant difference in the age of the participants between the treatment group (62.53 years) and the control group (61.73 years). From the research results in table 1, descriptive analysis data was obtained.

**Table 1. Descriptive Analysis**

| Group | N | Minimum | Maximum | Means | SD |
|---|---|---|---|---|---|
| Pre Test Experimer | 15 | 21 | 31 | 27.80 | 2.908 |
| Post Test Experime | 15 | 28 | 40 | 33,73 | 3.770 |
| Pre Test Control | 15 | 20 | 30 | 24.53 | 2.669 |
| Post Test Control | 15 | 24 | 34 | 27.80 | 2.981 |

Based on the descriptive analysis data in Table 1 above, it can be explained that the experimental group's initial test consisted of a minimum score of 21, a maximum of 31 with a average of 27.80 while for the control group a minimum score of 20, a maximum of 30 with a average of 24.53. Both the experimental group and the control group experienced an increase after being given treatment, where the final test for the experimental group was for a minimum score of 28, a maximum of 40 with a average of 33.73 while the control group had a minimum score of 24, a maximum of 34 with a average of 27.80. The results of the research in Table 2 obtained the test valuenormality and in Table 3 the homogeneity test value of the research data was obtained.

**Table 2. Data Normality Test**

| Experiment Group | Sig. | Control Group | Sig. | Information |
|---|---|---|---|---|
| Pre Test Experiment | 0.133 | Pre Test Control | 0.156 | Normally |
| Post Test Experiment | 0.200 | Post Test Control | 0.160 | Normally |

Based on the normality test in Table 2 above, it is known that the significance value of the initial test for the experimental group is 0.133 > 0.05 and the control group is 0.156 > 0.05, while the significance value for the final test for the experimental group is 0.22 > 0.05 and the control group is 0.160 > 0 .05, it can be concluded that the residual values are normally distributed.

**Table 3. Data Homogeneity Test**

| Experimental and Control Group | Sig. | Information |
|---|---|---|
| Based On Means | 0.444 | Homogeneous |

After showing normal and homogeneous data test results, the paired sample t test will be tested. The paired sample test is used to find out whether there is a difference in the mean of the two paired samples while the independent sample t test is used to find out whether there is a difference in the mean. the mean of two unpaired samples.

**Table 4. Paired Sample t Test**

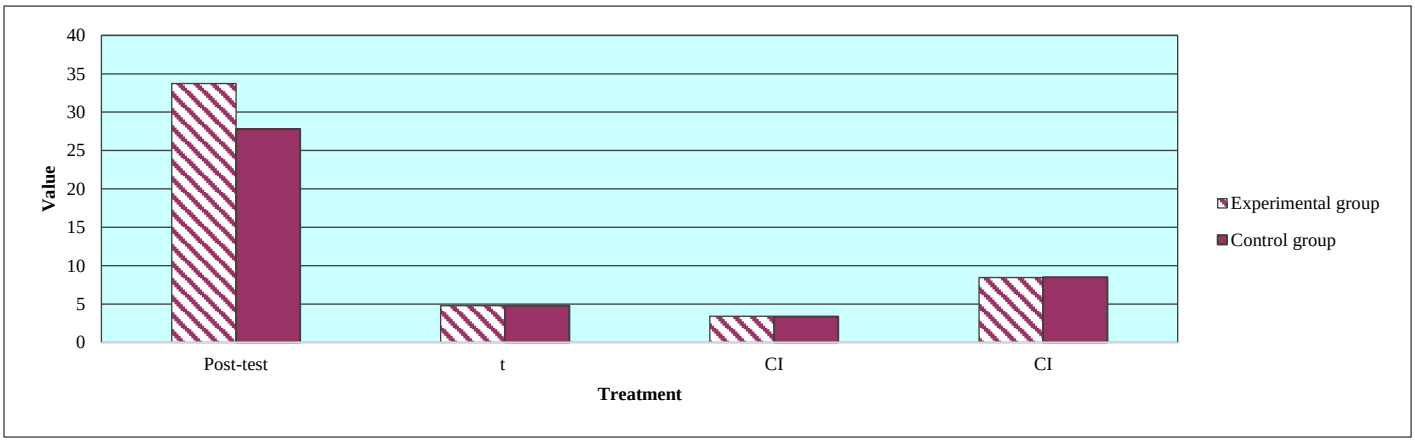
| Paired | Sig. (2-Tailed) |
|---|---|
| Pair 1: Pre Test Experimental and Post Test Experimental | 0.000 < 0.05 |
| Pair 2: Pre Test Control and Post Test Control | 0.000 < 0.05 |

Based on Table 4 of the paired sample t test where Pair 1, it is obtained a value of Sig. (2-Tailed 0.000 < 0.05), it can be concluded that there is a difference in the average results of the combination of resistance exercise and aerobic exercise for the elderly for the pre-test of the experimental group and the post-test of the group experiment. While, Pair 2, it is obtained a Sig. value (2-Tailed 0.000 < 0.05) so it can be concluded that there is a difference in the average results of elderly aerobic exercise for the pre-test of the control group and the post-test of the control group. Once it is known that the two exercise models have a significant effect, then to answer the next hypothesis is to do a parametric test as shown in Table 5 (independent sample t-test).

**Table 5. Independent Sample t Test**

| Post Test Experiment and Control Group | Sig. (2-Tailed) |
|---|---|
| Equal variances Assumed | 0.000 < 0.05 |

Based on Table 5 above, it is Sig. (2-Tailed 0.000 < 0.05). There is a significant difference in the average between the combination of resistance exercise and aerobic exercise where the digital hand grip dynamometer (DHD) in the experimental group is 33.73 (post-test); t = 4.782; 95% CI = 3.392 to 8.475. Meanwhile, the DHD value in the control group at the post-test was 27.80; t = 4.782; 95% CI = 3.385 to 8.481.




**Graph 1: Independent Sample t Test**

The findings of this study are in line with those of previous studies, which indicated that eight weeks of consistent exercise could result in an increase in muscle mass and strength (Dolezal, 2013). Other studies demonstrate that elderly people can begin resistance exercise at week 8 (Romero-García et al., 2021). Other studies have shown that elderly people can maintain their muscle mass and prevent atrophy by exercising for eight weeks (Ogawa et al., 2020). According to a different study, eight weeks of exercise significantly increased muscle fiber diameter and strength (Ogawa et al., 2020). According to the existing literature, combined resistance exercise and aerobic exercise are performed for eight weeks in the field for the elderly due to their weakness. To achieve maximum results (Losa-Reyna et al., 2019), the elderly requires a prolonged period of movement (> six weeks). The three times a week of resistance exercise are a reference to previous studies that recommended three times a week of gymnastics for elderly people who are weak (Losa-Reyna et al., 2019).

The activity that is provided stimulates the production of brain-derived neurotrophic factor (BDNF), which plays an important role in energy metabolism (Gonçalves et al., 2022; Anthea et al., 2022). The combination of resistance exercise and aerobic exercise increases muscle strength (Martínez & González, 2023). The metabolic process by which the body converts fat into energy is influenced by BDNF. In addition, it has been reported that BDNF triggers muscle contraction by stimulating acetylcholine release at myocyte neuromuscular synapses (Huiwen et al., 2023; Martínez & González, 2023; Oliveira et al., 2022). According (Oliveira et al., 2022), BDNF production rises 3–7 days after exercise, so eight weeks of combined resistance exercise and aerobic exercise can improve muscle strength. Muscle satellite cells have also been shown to be regulated by BDNF. BDNF is interested in increasing the diameter of muscle fibers in addition to its roles in fat burning and muscle contraction.

In healthy and productive elderly people, resistance exercise and aerobic exercise can increase muscle strength more effectively than aerobic exercise alone. Additionally, there are exercises in resistance exercise that can be used to build muscle mass in older people (Matsumoto et al., 2016). Similar to aerobic exercise, it can also improve muscle strength and endurance (Roma et al., 2013). According to previous studies, participants' physical functioning improved significantly following resistance exercise and other exercise interventions (Ikemoto & Arai, 2018). The study concludes that a combination of resistance exercise and aerobic exercise with a progressive increase in sets and repetitions for each exercise activity can increase the muscle strength of the elderly as evidenced by an increase in hand grip strength. However, this study was limited to one village, it is hoped that additional studies can be compared to other treatments like flexibility exercise and aerobic exercise to lend a hand to our investigation. This study provides a combination of exercises for healthy elderly men and can be used as a reference for sports medicine research.

## CONCLUSION

The study's findings show that a combination of resistance exercise and aerobic exercise with a gradual increase in sets and repetitions for each exercise activity can increase the muscle strength of the elderly.

However, this study was limited to one village. Future research should consider expanding the study to multiple villages or even different regions to enhance the generalizability of the findings. Additionally, it would be valuable to include a larger and more diverse sample size to obtain a more representative population. Further investigations should also explore the long-term effects of this exercise combination on other aspects of physical health, such as balance, flexibility, and cardiovascular fitness. Overall, this study provides a promising foundation for future sports medicine research aimed at developing effective exercise programmes for maintaining and improving the muscle strength of healthy elderly individuals.

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**CONFLICT OF INTEREST**

There are no conflicts of interest in this study

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