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Effect of circuit weight training on aerobic fitness, body fat percentage, muscle mass percentage, and hand grip strength in the elderly

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Abstract*:* As individuals age, there is a natural decline in physical activity and aerobic capacity, which can have profound effects on their overall health and well-being. The purpose of this study was to determine the effect of weight training using circuit methods on aerobic fitness, body fat percentage, muscle mass percentage, and hand grip strength. This study is a one-group pretest-posttest quasi-experimental study with a sample of the elderly gymnastics group Sehat Bugar Ceria in Karanganyar Regency, Indonesia. Twenty-seven study subjects aged 60–75 participated in the exercise for 12 meetings. All research subjects can take all pretests and posttests in the form of a six-minute walk test, a hand grip strength test using a handgrip dynamometer, and body composition testing using bioelectrical impedance analysis. Changes that occurred before and after exercise were analyzed using paired t-tests. This study showed that aerobic fitness increased significantly ($p = 0.001$), body fat percentage decreased significantly ($p = 0.008$), but there was no significant change in the percentage of muscle mass ($p > 0.05$) or hand grip strength ($p > 0.05$). The results of this study showed that weight training using circuit methods can improve aerobic fitness and reduce body fat percentage in the elderly group.

Keywords: aerobic fitness, fat body mass, weight training, circuit training, elderly

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INTRODUCTION

The number of elderly people has increased around the world, including in Indonesia. The number of elderly residents increased by at least 3 percent over more than a decade (2010–2020) to 10.82 percent. Life expectancy also increased from 69.81 years in 2020 to 71.57 years in 2021(BPS, 2022). This condition is a challenge; the increasing number of elderly people should be followed by a good, active, and productive elderly health status.

As individuals age, there is a natural decline in physical activity and aerobic capacity, which can have profound effects on their overall health and well-being. In the elderly group, there is an accelerated loss of muscle mass and movement function, causing an increased risk of falls, decreased functional capacity, weakness, and death (Greco et al., 2019). As people grow older, they may experience a reduction in their energy levels, muscle mass, and joint flexibility, making it challenging to engage in regular physical activities (Kang et al., 2021). Sedentary lifestyles become more prevalent, leading to a decrease in aerobic capacity, the ability of the body to utilize oxygen efficiently during exercise. This decline in aerobic capacity can lead to decreased endurance, fatigue, and a reduced ability to perform daily tasks independently (McPhee et al., 2016). Moreover, a lack of physical activity in the elderly population increases the risk of various health conditions, including cardiovascular diseases, obesity, and metabolic disorders. To counteract this decline, it is crucial to promote and encourage regular physical activity tailored to the individual's capabilities (Langhammer et al., 2018). Regular physical activity not only contributes to a healthier and more active lifestyle but also helps preserve independence and quality of life as individuals age.

According to World Health Organization (WHO) recommendations, the elderly, in addition to aerobic physical exercise, also do muscle-strengthening exercises in the form of weight training carried out two days a week (WHO, 2020). So far, the elderly group knows more and does aerobic physical exercise. Not many elderly groups know and are able to do weight training independently. Even older adults also tend to experience musculoskeletal degenerative diseases in the form of osteoporosis, arthritis, and sarcopenia (Minetto et al., 2020). This will certainly inhibit the age group from doing physical activities such as walking or doing daily activities. Weight training for the elderly needs to be developed because it has many advantages, namely that in addition to training muscles, it will also increase bone density and train joints. With weight training, the elderly will get more benefits in addition to reducing the risk of cardiovascular disease and preventing sarcopenia (Sasaki & Fukumoto, 2022). The elderly also have a high prevalence, namely 1 in 10 elderly people experience sarcopenic obesity (SO), this condition can cause disability, morbidity, and mortality (Gao et al., 2021). In previous studies, it was found that fat mass will increase with age and reach a peak age of 60–75 years, while muscle mass and strength begin to decrease progressively starting at the age of 30 years and increasing faster after the age of 60 years (Scott et al., 2023).

Therefore, efforts are needed to prevent conditions related to the aging process. Various types of exercises for the elderly have been widely practiced and developed. According to the results of research conducted by (Vikberg et al., 2019), weight training is effective in maintaining aerobic fitness and increasing muscle mass in the elderly with pre-sarcopenia. In addition, research by Biben et al., (2019) showed that the addition of strength training with elastic bands to the elderly gymnastics group program increased muscle strength and physical performance in the elderly. Lately, weight training using both self-weight weights and without or minimal equipment is gaining popularity because it offers more variety during exercise. The circuit training method combines aerobic and strength training; therefore, it is considered less boring than classical strength training (Menz et al., 2021).

This study was to determine the effect of weight training using circuit training methods on aerobic capacity, body composition, and hand grip strength in the elderly. The results of this study can be used as an additional type of strength training for the elderly group that can be done routinely.

METHODS

This research is quasi-experimental. The study design is a group pretest-posttest design. The population of this study was members of the Sehat Bugar Ceria elderly gymnastics group in Karanganyar Regency, Central Java, Indonesia. Inclusion criteria (1) men and women aged 60–75 years; (2) can walk normally without assistance; and (3) do not do weight training 1 month before. Exclusion criteria: (1) have a serious degenerative disease; (2) have a risk of falling; and (3) have a serious degenerative disease such as uncontrolled hypertension, stroke, or heart disease. Study subjects who were absent three or more times or refused to continue were excluded from the research group.

In this study, treatment was in the form of weight training with a circuit method consisting of six movements designed by researchers according to the condition of the elderly. The exercise begins with the determination of the initial load for each participant. The exercise intensity was 70%–80% of one maximum repetition (1RM). Each workout begins with warm-ups, core exercises, and cool-downs. The exercise movements are: (1) good morning exercise movement with a curve-long bar; (2) toe stand with a curve-long bar; (3) biceps curl; (4) pull-up; (5) squat with a sit position on a chair; and (6) performed standing position holding the dumbbell, focusing on the abdominal muscle. The evaluation of maximal-intensity exercise is done every two weeks.

Preliminary data was obtained from subjects including name, gender, age, height, weight, and body mass index. This exercise lasts for six weeks, with a frequency of twice a week. Data collection was carried out twice: pretests and posttests, data on percent body fat and percent muscle mass using portable bioelectrical impedance (body composition monitor Karada Scan model HBF-375 Omron), muscle strength measured using a hand dynamometer, and a 6-minute walk test used to measure distance traveled. The norms of the 6-minute walk test can be seen in Table 1.

This research has received approval from the Health Research Ethics Committee of Dr. Moewardi Hospital with ethical clearance number 1.381/VII/HREC/2023.

Table 1. 6-Minute Walk Test Norms

Gender	Mileage (meter)	Categories Aerobic Fitness
Man	≥ 483	Normal
	434 -483	Low
	<434	Very low
Woman	≥ 442	Normal
	405 – 442	Low
	< 405	Very low

Source : Nusdwinuringtyas, (2018)

As for the norm for the percentage of body fat and skeletal muscle mass can be seen in tables 2 and 3.

Table 2. Interpretation of Body Fat Percentage

Man	Classification	Woman
≥ 25	Very high	≥ 35
20 - < 25	High	30 - < 35
10 - < 20	Normal	20 - < 30
< 10	Low	< 20

Source : Omron, (n.d.)

Table 3. Skeletal Muscle Percentage Norms

Gender	Age	Low	Normal	High	Very High
Woman	18-39	<24.3%	24.3 - 30.3%	30.4 - 35.3%	≥35.4%
	40-59	< 24.1 %	24.1 - 30.1%	30.2 - 35.1%	≥35.2%
	60-80	<23.9%	23.9 - 29.9%	30.0 - 34.9%	≥35%
Man	18-39	< 33.3%	33.3 - 39.3%	39.4 - 44%	≥44.1%
	40-59	< 33.1%	33.1 - 39.1%	39.2 - 43.8%	≥43.9%
	60-80	< 32.9%	32.9 - 38.9%	39.0 - 43.6%	≥43.7%

Sumber : Omron, (n.d.)

RESULT AND DISCUSSION

The total number of samples that participated in this study amounted to 27 (23 women and 4 men). All participants can follow all activities until the final measurement. The normality of the data was calculated using Kolmogorov-Smirnov on pre-test and post-test. The results of the analysis can be seen in Table 4.

Table 4. Normality Test Results

Variable		*p*	Interpretation
Hand grip strenght	Pre-test	0,172	Normal
	Post-test	0,022	Not normally distributed
Muscle mass percentage	Pre-test	0,314	Normal
	Post-test	0,375	Normal
Body fat percentage	Pre-test	0,139	Normal
	Post-test	0,578	Normal
6-minute walk test	Pre-test	0,505	Normal
	Post-test	0,150	Normal

Note :*significant if p<0.05

The homogeneity test of variance is not necessary because the test used is the average test of two groups of paired data.

Paired t-tests were performed to compare pre- and post-treatment subjects. Test results showed significant improvements in aerobic fitness (p = 0.001) and body fat percentage (p = 0.008) and no significant changes in the percentage of muscle mass or muscle strength. The results of the analysis can be seen in Table 5.

Table 5. Changes in Aerobic Fitness, Percent Body Fat, Percent Muscle Mass, and Muscle Strength, Pre- and Post-Intervention

Components	Subjects (n=27)		
	Pre test (mean±SD	Post test (mean±SD)	*p*
Hand grip strenght	21,15±3,94	21,52±4,79	0.631
Muscle mass percentage	22,63%±2,38	23,12%±3,31	0.521
Body fat percentage	34,87%±5,15	32,55%±5,03	0.008
6-minute walk test	399,64±46,66	446,63±65,01	0.001

Note :*significant if p<0.05

Based on data analysis, it is known that there is an effect of weight training with circuit training methods on aerobic fitness, body fat percentage, muscle mass percentage, and hand grip strength. The magnitude of the influence is: (1) Aerobic fitness experienced an increase in the average score from pre-test to post-test of 46.99; (2) Body fat percentage decreased the average score from pre-test to post-test by 2.31%. (3) The percentage of muscle mass increased by 0.49% but not significantly; (4) Hand grip strength increased by an average score of 0.37 but was not significant. Descriptive analysis showed that 12 sessions of weight training with the circuit method improved aerobic fitness and decreased percent body fat, but there was no change in muscle mass percentage or muscle strength.

Based on the results of this study, it was found that weight training in the elderly with the circuit method obtained results of increasing aerobic fitness. This proves that weight training with the circuit method can improve aerobic fitness in the elderly. Aerobic fitness plays an important role because it is a powerful predictor of health and is considered a reflection of total body health (Mendelson et al., 2018). High aerobic fitness can prevent insulin-resistant conditions related to insulin sensitivity; in addition, aerobic fitness has an effect on blood lipid profiles, total body fat, and inflammatory conditions in blood vessel walls that can cause atherosclerosis (Fernström et al., 2017). Antunes et al., (2020) state that individuals with high aerobic fitness exhibit higher concentrations of peripheral IL-6 and lower concentrations of IL-10 upon recovery, suggesting that aerobic fitness has a direct impact on the inflammatory response.

Circuit training has been shown to prevent a decrease in aerobic fitness in the elderly, such as research conducted by Menz et al., (2021), in this study, even though exercise is only done once per week, it can prevent a decrease in aerobic fitness in the elderly. Aerobic fitness provides many benefits for the elderly group, namely reducing the risk of cardiovascular death (Fardman et al., 2021). In addition, physical exercise in the elderly is very necessary to prevent metabolic syndrome conditions that tend to result in weakened leg muscle strength and decreased balance (Rismayanthi et al., 2022).

Circuit training consisting of several posts turned out to have a positive effect on the elderly. The elderly did not experience boredom in training because there were variations in movement in each post. In addition, circuit training can be done in one place without doing exercises remotely and can be done at home. Weight training using the circuit method in this study found a significant reduction in the percentage of body fat; this is in line with what was conveyed by Yachsie et al., (2022): circuit training is the most frequently used method to burn fat. In research conducted by Kolahdouzi et al., (2019), progressive resistance circuit training can improve the cardiovascular system and decrease fat mass in the elderly. This decrease in fat mass has a good impact considering that increasing age will increase body total fat mass and is in line with the decrease in muscle mass and bone density. Changes in body composition will cause a chronic inflammatory condition called inflammaging (Ponti et al., 2020).

The older population benefits from the study's lower body fat percentage. Obesity is more common among older adults. Body composition changes are related to aging. Aging causes the total amount of fat in the body to reset, as well as the risk of ectopic fat deposition in the liver, skeletal muscles, and belly, and visceral fat deposition. Numerous studies have shown that decreased energy expenditure is a significant factor in the aging process's rise in fat accumulation (Ahmed et al., 2021). Insulin resistance and low-grade systemic inflammation are brought on by long-term obesity. Because of this, it's important to stop these illnesses before they get severe or before they cause old age.

Obesity is linked to a number of physiological and morphological alterations in adipose tissue, including an increase in adipocyte trophic, an infiltration of pro-inflammatory macrophages, and a reduction in insulin sensitivity (Garg et al., 2023). Adipose tissue is now recognized as a crucial endocrine and immune organ, and it is hypothesized that pro-inflammatory secretion from this tissue in

obesity has a profound impact on the body's endocrine system and is a key factor in the development of metabolic disorders linked to obesity. Adipose tissue was once only thought of as a storage area for energy (Kunz et al., 2021).

Weight training for the elderly provides benefits for maintaining muscle mass Nasrulloh et al., (2020) and muscle strength (Yuniana et al., 2023). In addition, weight training can prevent the occurrence of sarcopenia. Increasing age is a major cause of decreased muscle structure and function (Han et al., 2018). Sarcopenia not only causes impaired movement function or muscle strength but can also result in decreased brain and cognitive function in the elderly (Scisciola et al., 2021). Decreased cognitive function can be caused by sarcopenia, which is an imbalance in myokine secretion due to decreased muscle mass (Jo et al., 2022). Muscles produce myokines, and decreased muscle mass will affect the condition of the body (Ellingsgaard et al., 2019). Myokine is an anti-inflammatory cytokine or peptide produced by striated muscle. Physical activity will spur myokine secretion and can reduce inflammation (Aryana et al., 2018). Decreased myokine levels can increase the risk of diabetes and cardiovascular disease (Pedersen, 2017). One myokine that is widely studied and influenced by physical activity is interleukin-6 (IL-6). This myokine level increases after physical exercise and has anti-inflammatory effects (Lee & Jun, 2019). Therefore, physical exercise in the elderly, especially weight training, needs to be socialized to the community, and specific exercise models are arranged according to the condition of the elderly.

One effort to increase muscle mass is weight training. Although in this study there was no change in the percentage of muscle mass and muscle strength, it had a positive effect on the elderly related to improved aerobic fitness. Endurance training and short-term weight training are appropriate methods to improve mucosal immune function, reduce markers of systemic inflammation, and improve anti-inflammatory processes in the elderly (Sellami et al., 2021). Research conducted by Oliveira et al., (2020)and Bao et al., (2020) also found no increase in muscle mass in the elderly who did weight training. No increase in muscle mass or grip can occur because the intensity carried out has not been maximized considering the adjustment to the condition of the elderly, namely the risk of injury if the intensity is high. In addition, it can also be affected by short training times. The shortcomings in this study are expected to be corrected in further research, namely designing a program for the elderly to do weight training that can increase muscle mass and muscle strength so that the benefits of weight training can be more tangible.

CONCLUSSION

Overall, weight training using the circuit method for the elderly provides benefits for the elderly group. Regular, programmed, and measurable physical exercise is essential for maintaining aerobic fitness, reducing fat mass concentration, preventing metabolic diseases, and reducing the risk of sarcopenic obesity in the elderly.

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