

Effectiveness of strength training on handgrip strength in overweight and obese older women in Indonesia: A quasi-experimental study

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ABSTRACT

Obesity remains the predominant comorbid condition, particularly among the elderly population in Indonesia. It is a degenerative condition that leads to physiological and morphological dysfunction. Consequently, there is a decline in muscular strength, flexibility, and functional capacity, which impairs daily activities and increases the risk of cardiovascular disease. Strength training is effective in increasing muscle strength, especially hand grip strength (HGS). The evaluation of overall body strength in aged individuals often involves the use of handgrip strength as a key indicator. Therefore, this study investigated the effect of strength training on dominant and non-dominant handgrip strength (HGS) among overweight and obese female participants aged 60 to 69 years. A pretest-posttest control group design was employed in this quasi-experimental study to compare the control group, which received no treatment with the intervention group, which underwent strength training (60 minutes per session, two sets, twice a week). The statistical test results indicate a tendency for increased average grip strength in both the dominant and non-dominant hands in the treatment group, although it is not significant. In contrast, the control group shows a significant decrease in average grip strength in both hands. When compared between groups, the average grip strength of both the dominant and non-dominant hands in the treatment group increased statistically following the strength training intervention compared to the control group ($p < .05$). The eight-week strength training program was effective in maintaining and increasing handgrip strength in overweight and obese older adults. Such programs have the potential to improve physical health and can be implemented effectively at home or in healthcare facilities (integrated health care posts) with support from family members and qualified fitness trainers.

Keywords:

handgrip strength, obesity, older women, strength training, quasi-experimental study

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INTRODUCTION

Obesity remains the dominant comorbid condition, especially for the elderly population in Indonesia¹. RISKESDAS data indicate an increasing trend in the prevalence of overweight and obesity in the geriatric population (aged ≥ 60 years).² The prevalence of overweight was 13.6% in 2018 and is projected to increase to 14.4% in 2023. Similarly, there was a rise in obesity prevalence from 21.8% in 2018 to 23.4% in 2023.^{2,3} Indonesia is also projected to have 20% of its population aged 60 years and older—approximately 50 million people—by 2045.⁴ This demographic shift is likely to be accompanied by a rise in comorbid conditions, including overweight and obesity. Common risk factors for obesity in the elderly include physical inactivity, low appendicular skeletal muscle mass index (ASMI), smoking history, and alcohol consumption.^{5–8}

Obesity in the elderly, especially sarcopenic obesity, characterized by obesity accompanied by a decrease in muscle mass, contributes to decreased flexibility, reduced muscle strength, functional ability, and limitations in performing daily activities that can lead to the development of cardiovascular disease.^{9,10} Muscle strength positively correlated with the muscle mass. As muscle mass decreases, muscle strength also decreases, even after adjusting for body weight and gender.¹¹ However, case-control studies indicate that muscle strength has a greater impact on the physical performance of the elderly than muscle mass.¹² Despite a meta-analysis showing a significant correlation between muscle strength and physical performance, the relationship between muscle mass and physical performance in older adults remains inconsistent.¹³ Therefore, further research is required to provide pertinent

evidence to explain the relationship between physical performance, muscle mass, and muscle strength.

One of the simple indicators for measuring muscle strength in the elderly population is hand grip strength (HGS). Hand grip strength (HGS) is a quick, easy, affordable, and highly accurate method to measure muscle strength in both epidemiological research and clinical settings.¹⁴ It has been proposed as a helpful indicator for vital signs, health status biomarkers, and health assessment, as recommended by the Asian Working Group for Sarcopenia (AWGS).^{15,16} Additionally, HGS can indicate overall muscle strength because it positively correlates with the strength of other muscle groups, especially in the legs.¹⁷

Strength training is one of the physical exercises highly recommended for the elderly by the World Health Organization (WHO). It is performed at moderate to high intensity and engages all muscle components.¹⁸ Strength training involves working against resistance to strengthen and build muscle mass. Systematic reviews and meta-analyses have shown that strength training, especially when combined with calorie restriction, is effective in reducing both the percentage of body fat and total fat mass in overweight or obese individuals. Additionally, strength training is the most effective method for increasing muscle mass compared to a control group with no exercise.¹⁹ Beyond building strength and muscle mass, it also induces various psychological adaptations that benefit overall health.^{20,21}

This study develops a simple and friendly strength training program to be implemented at home and in the elderly communities. Therefore, this study aimed to evaluate the effect of eight weeks of strength training on the grip strength of both dominant and non-dominant hands in

overweight and obese older women aged 60-69 with certain comorbidities.

METHODS

Research Design

This research was a quasi-experimental study using a pre-posttest design with a control group, conducted from November 2024 to January 2025.

Population and Sample

The population in this study consisted of 154 overweight and obese women aged 60-69 years with comorbidities, who were registered in the integrated health posts (Posyandu) under the Public Health Center of three urban villages (Gunung Batu, Loji, and Pasir Mulya) in West Bogor District, Bogor City, West Java Province, Indonesia. The sample was selected purposively according to the inclusion criteria: 1) BMI ≥ 25.0 kg/m² (overweight and obese). Subjects were selected with a BMI ≥ 25 kg/m² based on Indonesian Ministry of Health guidelines for Asian populations, where these cut-offs are correlated with elevated metabolic syndrome risk.² Our preliminary data indicated that high obesity prevalence (42.2%) and overweight (18.2%) in the target elderly population;⁸ 2) No history of CVD (congestive heart failure, coronary heart disease, angina, myocardial infarction, or stroke), kidney disease, cancer, uncontrolled asthma, or musculoskeletal disorders, such as osteoporosis or other physical injuries that limit movement, based on the subject's report and the doctor's diagnosis from the latest medical routine visit; 3) Not smoking

or consuming alcohol; 4) Not doing structured sports activities that increase muscle mass more than once a week for the last 6 months; and 5) Willing to participate in the study and sign the informed consent. The sample was calculated based on the difference in the average formula²², with an expected change of 6.8, a standard deviation of 4.6 (referring to the research conducted by Tomeleri et al., 2016),²³ degrees of significance ($\alpha=0.05$), 90% power test, and an estimated 20% dropout rate, resulting in a total sample size of 24 subjects (12 per group). Subjects were excluded if they meet these criterias: 1) Type 2 diabetes (fasting blood glucose level ≥ 126 mg/dL) with insulin therapy and diabetes complications; 2) Use of medications other than antidiabetic drugs (sulfonylureas, metformin, DPP-4) and antihypertensives known to affect metabolism or body water levels (e.g., insulin, antidepressants, etc.), or changes in the type of antidiabetic or antihypertensive medication from what is usually consumed during the study period; 3) developed one or more chronic diseases during the study (doctor-diagnosed); 4) Relocation from the study area, making them unreachable; 5) Withdrawal from the study and/or failure to follow the study protocol to completion. If subjects manifested at least one of the medical conditions during the study, they were referred for medical treatment. However, post-intervention, one subject within the control group withdrew because they could not complete the final data collection, as they were outside the research location for an indefinite period, as determined by the subject.

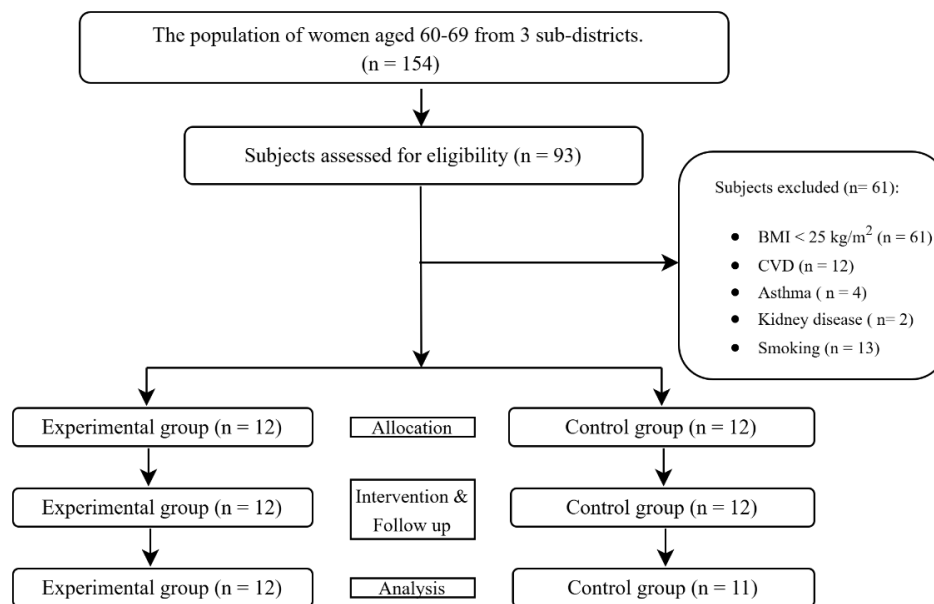


Figure 1. The flow chart illustrates the selection of participants into the experimental and control groups at baseline and the end of the eight-week intervention.

Procedure

Screening Stage

A total of 154 potential subjects, contacted via telephone or WhatsApp by integrated health post cadres were screened through door to door visits. Screening included an interview to assess inclusion criteria, blood pressure measurement, total cholesterol, fasting blood glucose (after 10-12 hours fasting), and anthropometric measurements. The research procedures were explained before the blood testing, and informed consent was obtained. Subjects who met the inclusion criteria were then allocated to the control and treatment groups, with 12 subjects in each group. The control group was assigned to Gunung Batu village, while the treatment group was assigned to Loji village. One village was excluded from the next stage because no participants met the inclusion criteria during the screening stage. Since this study was designed to evaluate programs and interventions under real-world field conditions, logistical factors such as resource distribution, facility

availability, and subject compliance at each location determine group allocation. While we acknowledge that this approach may introduce selection bias, it was crucial to ensure the feasibility of field implementation. To address this concern, we confirmed that both groups were homogenous at baseline, with no significant differences in demographics, BMI, or comorbidities ($p > 0.05$, as shown in Table 2).

Treatment of the Control Group

The control group did not receive strength training but only received education about a healthy lifestyle and balanced nutrition for the control of degenerative diseases through *booklets*, which were given once during the initial data collection. Subjects were also asked to maintain their usual physical activity and consumption patterns, including the consumption of medications that had been reported at the screening stage, throughout the study. We monitored eating habits, daily activities, and medication usage

regularly every week for eight consecutive weeks through a WhatsApp group chat to ensure our subjects adhered to our research protocol. All variable data will be collected before and after the intervention, except for exercise readiness data, exercise intensity scale data, and compliance level data. Subjects will be provided with transportation costs during the research process and a gift at the end of the study. The initial data collection is conducted in the same week as the socialization, but the implementation is carried out on different days.

Treatment of the Intervention Group

Pre-intervention stage

The intervention group participated in strength training exercises that were specifically designed to suit the physical conditions of elderly individuals. Prior to intervention, subjects received detailed instructions on the exercise procedures and were introduced to the Borg Rating of Perceived Exertion (RPE) measure to determine exercise intensity.²⁴ During the first visit, data on the dependent variable (HGS) and anthropometry measurements were collected using bioelectric impedance (BIA). Baseline venous blood samples were also obtained at this time. Functional capacity was evaluated through the Physical Activity Readiness Questionnaire (PAR-Q) during the socialization session. The evaluation was conducted before the start of the physical exercise program to identify subjects at potential health risk. Subjects who responded 'yes' to one or more questions were advised to consult a medical professional before proceeding with physical exercise.²⁵

The functional capacity assessment was conducted during a second visit by a team consisting of an experienced researcher, enumerator, and fitness trainer. This stage included the following tests: 1) the Eight-foot up-and-go test to measure speed, agility, and dynamic balance; 2) the Thirty-second chair stand test to assess

lower limb strength and endurance; 3) the Thirty-second arm curl test to evaluate upper limb strength and endurance.²⁶ Following the functional test, participants underwent an adaptation phase involving seven strength training exercises without external load (2 sets of 10 repetitions) to familiarize themselves with proper movement and breathing techniques. The adaptation session lasts 2-4 sessions over a span of two weeks. Upon completion of the adaptation phase, to determine the initial training load and evaluate the training's effectiveness, a 3-repetition maximum (RM) test was performed. The 3-RM test was defined as the maximum load that can be lifted for 3 repetitions with a full range of motion. It is measured by starting with a moderate weight (2 kg) and increasing the weight in 1 kg increments until the subject cannot complete 3 repetitions.²⁷

Intervention Stage

The strength training interventions were conducted over eight weeks, with two sessions per week.^{23,28} Each 60-minute session consisted of a dynamic warm-up (5 minutes), strength training (50 minutes), and a static cool-down (5 minutes). The strength training program included seven movements targeting major muscle groups, using body weight and external weights (dumbbells), as presented in Table 1. The training intensity was set at 70% of one-repetition maximum (1RM), with 8–12 repetitions per exercise, 2–3 minutes of rest between exercises, and 1–2 minutes between sets. Intensity was progressively increased: during weeks 1–4, participants trained at 70% 1RM (10–12 repetitions), and in weeks 5–8, the load was increased by 15% from the initial load. Participants were instructed to avoid performing Valsalva maneuvers during exercises. The level of perceived exertion was measured using the Borg Rating of Perceived Exertion (RPE) scale (range: 1-10).²⁴

All subjects were instructed to maintain their usual diet, refrain from

consuming alcohol and caffeinated beverages, continue their regular medication use, and avoid engaging in moderate to heavy physical activity on days outside the scheduled sessions. Compliance with training session attendance was measured using a checklist completed by the fitness trainer. Overall, participant attendance reached 80% of the total training sessions conducted over the eight-week intervention period.

Handgrip strength (HGS) data were collected at baseline (week 1) and endline (week 8). HGS was measured using a standardized protocol with an electronic hand dynamometer (model EH101;

Zhongshan Camry Electronic Co. Ltd., Zhongshan, China), which was a reliable and valid low-cost alternative tool. Measurements were taken for both the dominant and non-dominant hands with the elbow flexed at a 90° angle, which is considered optimal for HGS assessment. Participants were instructed to grip the handlebar as firmly as possible for 3–5 seconds during each of three trials, with approximately one minute of rest between attempts. According to the Asian Working Group for Sarcopenia (AWGS), handgrip strength values below 18.6 kg in women indicate low muscle strength.¹⁶

Table 1. Strength training formulation for elderly participants and the target muscles trained for eight weeks

Exercise	Target Muscles
Shoulder press with dumbbells	Shoulder Muscles
Overhead tricep extension with dumbbell	Back Arm Muscles
Bicep curl with dumbbell	Front Arm Muscles
Chest press with dumbbells	Chest Muscles
Chair assisted squat	Thigh and Buttock Muscles (<i>Gluteus</i>)
Calf raises with a chair-assisted	Calf and Foot Muscles
Leg raise	Core/Abdominal Muscles

Statistical Analysis

Quantitative data were analyzed both descriptively and inferentially using Microsoft Excel and SPSS version 26, with a significance level set at $p < 0.05$. Univariate analysis was conducted to describe the frequency distribution of the independent and dependent variables, presented as frequency (percentage), mean $\pm$ SD (for normally distributed data), or median and interquartile range (IQR) (for non-normally distributed data). Between-group differences in blood pressure, lipid profile, fasting blood glucose, BMI, body

composition, grip strength, intake, and physical activity were analyzed using the independent t-test for normally distributed data or the Mann-Whitney U test for non-normally distributed data. Within-group differences were assessed using the paired t-test (normal data) or the Wilcoxon signed-rank test (non-normal data).

Ethical Clearance

This study complied with the Declaration of Helsinki (2013 version, last updated in Finland, 2024)²⁹, with respect to research involving human subjects, ethical

approval was secured from the Research Ethics Committee of Semarang State Health Polytechnic, which provided authorization for the study on July 30, 2024 (1062/EA/KEPK/2024). All participants gave written informed consent before data collection.

RESULTS

This study involved 24 female participants aged 60-69 years with comorbidities. However, one subject was excluded, resulting in a final analysis on baseline and endline data from 23 participants. Table 2 presents the sociodemographic, anthropometric, and

clinical characteristics of the participants in the control group and the treatment group. The analysis showed that the control group had a higher proportion of participants aged 65-69 years (66.7%), while the treatment group had more participants aged 60-64 years (64.3%). The distribution of employment status (working/not working) was nearly equal between the two groups. Regarding comorbidity status, the treatment group had a higher proportion of participants with more than one comorbidity (75.0%) than the control group (25.0%). Both groups had a similar BMI distribution, with the majority of participants being obese (BMI ≥ 27.0 kg/m²).

Table 2. Sociodemographic, anthropometric, and clinical profiles of the participants

Variable	Control (n=11)	Experimental (n=12)	P ¹⁾
Age (year)			
60-64	5 (35.7) ^a	9 (64.3) ^a	.154 ¹⁾
65-69	6 (66.7) ^a	3 (33.3) ^a	
Total	11 (47.8)	12 (52.2)	
Employment Status			
Employed	1 (50.0) ^a	1 (50.0) ^a	.739 ¹⁾
Unemployed	10 (47.6) ^a	11 (52.4) ^a	
Total	11 (47.8)	12 (52.2)	
Comorbid			
1 comorbid	9 (60.0) ^a	6 (40.0) ^a	.122
>1 comorbid	2 (25.0) ^a	6 (75.0) ^a	
Total	11 (47.8)	12 (52.2)	
BMI (kg/m ²)			
Overweight (BMI ≥ 25.0 - <27.0)	4 (36.4)	4 (33.3)	.388 ²⁾
Obese (BMI ≥ 27.0)	7 (63.6)	8 (66.7)	
Total	11 (100)	12 (100)	
Median (IQR)	27.0 (3.2)	27.5 (7.5)	
Physical Activity (Mets-mins/week)			
Mild-Moderate <1500	10 (47.6) ^a	11 (52.4) ^a	.739 ¹⁾
High: ≥ 1500	1 (50.0) ^a	1 (50.0) ^a	
Total n (%)	11 (47.8)	12 (52.2)	
Exercise Habits			
Yes	5 (71.4) ^a	2 (28.6) ^a	.148 ¹⁾
No	6 (37.5) ^a	10 (62.5) ^a	
Total n (%)	11 (47.8)	12 (52.2)	
Dominant Hand Grip Strength (DHGS) (kg)			
Low (< 18.6)	4 (36.4)	4 (33.3)	.436 ³⁾
Normal (≥ 18.6)	7 (63.6)	8 (66.7)	
Total	11 (100)	12 (100)	

Variable	Control (n=11)	Experimental (n=12)	P ¹⁾
Mean (SD)	18.8 (4.8)	20.3 (3.7)	
Non-dominant Hand Grip Strength (NDHGS) (kg)			
Low (< 18.6)	8 (50.0)	8 (50.0)	.556 ³⁾
Normal (≥ 18.6)	3 (42.9)	4 (57.1)	
Total	11 (47.8)	12 (52.2)	
Mean (SD)	17.04 (4.3)	20.28 (3.6)	

¹⁾Fisher's Exact; The same subscript letters indicate no significant differences between groups in $p < .05$; ²⁾Mann-Whitney, Median (IQR): Inter Quartile Range; ³⁾T-Independent, Mean (SD); significant in $p < .05$.

Table 2 also presents the distribution of physical activity, showing that the level of physical activity (light-moderate and high) was similar in both groups. Regarding exercise habits, the control group had more respondents with regular exercise habits (71.4%) than the treatment group (28.6%). Based on the distribution of hand grip strength, both hands showed similar patterns within the

two groups. Dominant and non-dominant handgrip strength showed slightly higher mean (SD) values in the treatment group (20.3 ± 3.7 ; 20.28 ± 3.6) compared to the control group (18.8 ± 4.8 ; 17.04 ± 4.3). The groups did not differ significantly in any measured variable ($p > 0.05$), indicating that the subject characteristics in both groups were comparable.

Table 3. Change in average handgrip strength before and after intervention in the control and treatment groups

Variable	Control n=11 (Mean ± SD)		Experimental n=12 (Mean ± SD)	
	DHGS (kg)	NDHGS (kg)	DHGS (kg)	NDHGS (kg)
Before	18.87 ± 4.82	17.04 ± 4.38	20.28 ± 3.67	17.25 ± 4.20
After	13.34 ± 3.73	12.86 ± 4.07	21.46 ± 3.38	17.47 ± 3.49
Δ	-5.53 ± 5.42	-4.18 ± 4.68	1.18 ± 2.94	$.22 \pm 3.24$
P	.007*	.014*	.192	.815

Values are presented as Mean ± standard deviation (SD); Paired T-test, *statistical significance for $P < .05$; DHGS: Dominant Hand Grip Strength; NDHGS: Non-Dominant Hand Grip Strength; Δ: the average difference in HGS before and after the intervention

Table 3 presents the changes in average handgrip strength (HGS) before and after intervention in the control group and treatment group. Paired t-test analysis showed that the average dominant hand grip strength (DHGS) in the control group decreased significantly from 18.87 ± 4.82 to 13.34 ± 3.73 ($\Delta = -5.53 \pm 5.42$, $p < .05$). Similarly, the average grip strength of the nondominant hand (NDHGS) also decreased significantly from 17.04 ± 4.38 to 12.86 ± 4.07 ($\Delta = -4.18 \pm 4.68$, $p < .05$). This decrease indicates that without a

strength training intervention, both dominant and nondominant hand grip strength decreased significantly in the control group. Meanwhile, in the treatment group, the average DHGS increased from 20.28 ± 3.67 to 21.46 ± 3.38 ($\Delta = 1.18 \pm 2.94$), and the average NDHGS also increased from 17.25 ± 4.20 to 17.47 ± 3.49 ($\Delta = 0.22 \pm 3.24$). Statistically, there was no significant difference in the average grip strength of both hands before and after the 8-week strength training intervention ($p > 0.05$); however, there was an increasing

trend in hand grip strength in the treatment group after following the intervention. This shows that strength training positively

contributed to increasing muscle strength in the subject.

Table 4. The difference in average handgrip strength before and after intervention between the control and treatment groups

Variable	Control n=11 (Mean $\pm$ SD)	Experimental n=12 (Mean $\pm$ SD)	P
DHGS (kg)			
Before	18.87 $\pm$ 4.82	20.28 $\pm$ 3.67	
After	13.34 $\pm$ 3.73	21.46 $\pm$ 3.38	< .001*
NDHGS (kg)			
Before	17.04 $\pm$ 4.38	17.25 $\pm$ 4.20	
After	12.86 $\pm$ 4.07	17.47 $\pm$ 3.49	.008*

Values are presented as Mean $\pm$ standard deviation (SD); Independent T-test, *statistical significance for $P < .05$; DHGS: Dominant Hand Grip Strength; NDHGS: Non-Dominant Hand Grip Strength

Table 4 presents the difference in average handgrip strength (HGS) before and after the 8-week strength training intervention between the control group and the treatment groups. The table emphasized the difference in average handgrip strength between the two groups following the intervention. The treatment group showed an increase in hand grip strength, while the control group experienced a decrease. This indicates that an 8-week strength training is effective in increasing hand grip strength.

DISCUSSION

This study focuses on providing eight weeks of strength training through a pragmatic approach in the elderly community. The results of this study align with previous research, stating that physical exercise for at least eight weeks with 2-3 sets and 10-12 repetitions regularly can increase muscle strength,³⁰ particularly hand grip strength.^{31,32} This strength training program uses minimal loads (dumbbells and body weight) and incorporates a chair for support, making it suitable for the elderly. The distribution of grip strength in both dominant and non-dominant hands was similar in both groups at baseline. The difference test showed no significant difference ($p > .556$) in non-dominant hand grip strength between the

two groups before the intervention. Although the average grip strength of the subjects' hands in both groups was considered normal (≥ 18.6 kg) before the intervention, the control group experienced a significant decrease in strength after 8 weeks, while the treatment group (undergoing strength training) showed an increase. While the increase in the treatment group was not statistically significant, the 8-week strength training intervention appeared effective in maintaining or improving handgrip strength.

The decrease in grip strength in the control group shows the negative effect of the absence of muscle-stimulating physical activity, as they continued their daily activities without strength training. Initially, research suggests that diminished muscle strength in older individuals is primarily a consequence of impaired muscle quality—the capacity of muscle fibers to generate force—rather than a reduction in muscle mass.¹³ Second, muscle mass declines with age, supported by comorbidities and physical inactivity. These results are supported by research by Phillips et al. (2014) and Davies et al (2019), which shows that physical inactivity (evidenced by a decrease in daily steps) is a dominant factor leading to muscle atrophy due to disuse for more than 10 days.^{33,34} Physical inactivity also

increases the risk of developing diseases such as type 2 diabetes, cardiovascular disease, colon cancer, post-menopausal breast cancer, dementia, and depression.³⁵

The primary discovery of this research is a trend of increasing average grip strength of both dominant and non-dominant hands in the treatment group after eight weeks of strength training, though the change was not statistically significant. This finding aligns with previous research showing that eight weeks of combined locomotor strength and aerobic exercise can enhance muscle strength, especially hand grip strength, in elderly people with grade one locomotor syndrome.³¹ Other research also reveals that an eight-week strength training program can increase muscle strength even with chronic disease.^{30,36,37} The increase in average grip strength observed in this study could be influenced by the activity of holding dumbbells with multicomponent movements, involving various muscle groups, especially the muscles in the hand-to-foot areas. The strength training applied in this study utilized dumbbells with weights adjusted to the participants' abilities before the training was administered. Gripping the dumbbells activates satellite cells, which stimulate muscle growth, enhancing both size and strength. This is supported by various studies evaluating the effect of exercise on increasing muscle strength. Resistance training stimulates the release of myokines, marker proteins derived from the muscle that play an important role in increasing muscle strength and promoting muscle adaptation, such as Decorin and Brain-derived neurotrophic factor (BDNF).^{38,39} Decorin inhibits myostatin, promoting muscle growth,⁴⁰ while BDNF increases muscle strength and neuron survival.³⁸ Muscle adaptation occurs through microdamage, repair, and metabolic changes, triggering protein synthesis and

satellite cells.^{20,41} BDNF also contributes to muscle injury response and contraction via acetylcholine, indicating its involvement in the control of injured muscles.⁴²⁻⁴⁵ Delayed muscle adaptation in this group is expected due to reduced satellite cell activation and slower myokine (BDNF) responses, and mitochondrial dysfunction that impedes protein synthesis.^{46,47} Obesity's pro-inflammatory environment (e.g., IL-6 inhibiting BDNF) likely further diminished the response, unlike the small but significant gains observed in healthier elderly individuals with longer training and heavier loads.⁴⁸⁻⁵⁰

We acknowledge that this study has limitations that may affect the significance of the outcomes in the treatment group, particularly in the allocation group process. The relatively small sample size (n=12 per group) may affect the level of statistical power and the generalizability of the observed results. Considering our subjects, who come from a population of elderly individuals with comorbidities, the intervention was designed as an 8-week program, with a training volume of twice per week and two sets each movement, as the minimum period considered sufficient to improve exercise efficacy.⁵¹ However, this duration was likely insufficient for this population, as compared to a previous study by Urzi et al. (2019), which reported significant changes after 12 weeks.⁴⁷ Another limitation is that this program only included strength training interventions, without a combination of diet and/or aerobic exercise. Combined interventions usually produce greater increases in muscle mass and strength compared to strength training interventions alone.³¹ A similar approach has been applied in other community intervention studies that also encountered logistical constraints.^{52,53} Although this study has limitations in internal validity, the findings highlight the real-world conditions in the elderly

community, which, despite having adequate access to healthcare services, continues to face gaps in program implementation aimed at maintaining health, especially among the elderly individuals in our area. Therefore, the findings and operational obstacles of this study may serve as initial evidence to support the implementation of future health programs for the elderly.

RECOMMENDATION

Robust future research utilizing a randomized controlled design, multi-site recruitment, and a larger sample size is necessary to enhance internal validity, compare diverse groups (normal and comorbidity-free), and evaluate the effectiveness of interventions across various muscle strength variables. Given the injury risks associated with unsupervised multi-component movements, supervised strength training conducted by family at home or trainers at health posts is essential for the elderly. Elderly individuals with comorbidities could potentially maintain or improve their handgrip strength through an 8-week home-based regimen of 2 sets of 10-12 repetitions with minimal load.

AUTHOR CONTRIBUTIONS

INM: Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing, Methodology, Formal analysis and Validation. HR: Methodology, Formal analysis, Validation, Writing - Original Draft and Writing - Review & Editing. AK: Methodology, Formal analysis, Validation, Writing - Original Draft and Writing - Review & Editing. MJ: Methodology, Formal analysis, Validation, Writing - Original Draft and Writing - Review & Editing.

ETHICAL CONSIDERATION

This research obtained ethical approval from the Research Ethics Committee of Semarang State Health Polytechnic, with protocol/approval number 1062/EA/KEPK/2024, which was approved on July 30, 2024.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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