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Effect of Chair-Based Cloth-Assisted Exercise on Coordination and Grip Strength in Older Adults: A Quasi-Experimental Study

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Abstract

Background: Aging is associated with progressive declines in motor coordination and muscle strength, increasing the risk of falls and functional limitations. Chair-based exercise offers a safer alternative for older adults who are unable to perform standing exercises due to balance and mobility impairments.

Objective: This study aimed to evaluate the effects of chair-based exercise using a non-elastic cloth on upper-extremity coordination and handgrip strength in older adults.

Methods: A quasi-experimental one-group pretest–posttest study was conducted among 20 female older adults aged 60–85 years selected through purposive sampling. The intervention consisted of chair-based aerobic exercise using a 2-meter non-elastic cloth, performed once weekly for 10 weeks (60 minutes per session). Upper-extremity coordination was assessed using the Finger-to-Nose Test (completion time and errors), and muscle strength was measured using a handgrip dynamometer. Data were analyzed using the Shapiro–Wilk test and Wilcoxon signed-rank test ($p < 0.05$).

Results: Significant improvements were observed in all outcomes. Finger-to-Nose completion time decreased from 20.0 to 9.5 seconds ($p < 0.001$; $r = 0.62$), and errors decreased from 2 to 1 ($p < 0.001$; $r = 0.58$). Right- and left-hand grip strength increased significantly ($p < 0.001$; $r = 0.62$).

Conclusion: Chair-based exercise using a non-elastic cloth significantly improved coordination and handgrip strength, indicating a safe and effective approach to support functional capacity in older adults.

Keywords
Aged; Exercise Therapy; Motor Coordination; Muscle Strength; Hand Strength; Quasi-Experimental Study

Introduction

The global population of adults aged 60 years and older is increasing rapidly, with the proportion expected to double from 11% in 2000 to 22% by 2050, reaching approximately 2 billion older adults worldwide. In Indonesia, the older population is projected to grow from 27 million to nearly 38 million, representing 11.8% of the national population.[1] This demographic transition is accompanied by heightened vulnerability to health problems that arise from physiological aging processes.[2] Among the most prominent age-related changes are cognitive decline and deterioration of motor functions, including reductions in muscle strength, flexibility, proprioceptive sensitivity, vestibular function, movement speed, and overall coordination.[3] These deficits substantially increase the risk of falls, which affect 28–35% of adults aged ≥65 years annually and represent a major public health concern due to their association with disability and mortality.[4]

Age-related loss of muscle mass and strength begins as early as 40 years and is attributed to reductions in muscle fiber number, motor unit counts, and fiber size.[5] In Indonesia, older adults are classified by the Ministry of Health into the categories of elderly (60–69 years) and high-risk elderly (>70 years or older adults with comorbidities).[6] Maintaining physical capacity through safe and appropriate exercise is therefore essential for promoting independence and preventing functional decline in this population. Elderly exercise programs consist of structured rhythmic movements designed to enhance functional abilities and overall physical fitness.[7] Declines in upper-extremity strength further contribute to limitations in daily activities, given that muscle strength is fundamental to generating adequate force to overcome resistance during functional tasks.[8]

Exercise stimulates coordinated activation of postural and synergistic muscles, producing adaptive physiological responses within the musculoskeletal and sensorimotor systems. Rhythmic motions supported by visual, auditory, vestibular, and somatosensory cues enhance coordinated movement patterns.[9] However, many older adults are unable to participate in standing exercises due to poor balance, reduced mobility, or impaired coordination, which increases fall risk during training.[3] Consequently, chair-based exercise (CBE) has emerged as a safe alternative for frail or mobility-limited older adults. CBE consists of structured, progressive exercise performed in a seated position, providing additional postural stability and allowing participation among those who cannot stand for prolonged periods.[10]

The use of a cloth or strap as an assistive tool in chair-based exercise may further promote improvements in motor control, flexibility, muscular endurance, and coordination.[11] Prior studies have demonstrated that seated resistance training using elastic bands or cloth-based tools for several weeks can improve pulmonary function, handgrip strength, and muscular endurance in older adults, including those using wheelchairs.[12] Chair-based exercise programs have also shown benefits across a variety of older adult populations—including healthy older adults, those with dementia, and individuals undergoing rehabilitation—demonstrating positive effects on upper- and lower-limb strength, balance, mobility, and performance of activities of daily living.[11] Despite these findings, research on chair-based programs using a non-elastic cloth is limited, and the long-term benefits remain unclear. Many previous studies implemented interventions lasting only 2–12 weeks, with inconsistent dosing and insufficient standardization of exercise

progression.[11] Given the heightened vulnerability of older adults to muscle loss, reduced mobility, and increased fall risk, high-quality evidence regarding effective, low-risk exercise modalities is urgently needed.

The present study aims to address this gap by evaluating whether a 10-week chair-based exercise program using a non-elastic cloth can improve upper-extremity coordination and handgrip strength in older adults. We hypothesized that the intervention would yield significant improvements in both coordination and muscle strength. Findings from this study may provide foundational evidence to inform future trials and expand practical exercise strategies for older adults with mobility limitations.

Methods

This study employed a quantitative quasi-experimental design using a one-group pretest–posttest approach to evaluate changes in upper-extremity coordination and handgrip strength following a 10-week chair-based exercise program using a non-elastic cloth. This design was selected because field conditions did not allow for random allocation or inclusion of a control group; however, repeated measurements before and after the intervention permitted objective assessment of intervention-related changes within the same participants.

Participants were older adults residing in Mantren Village, Klodran, Colomadu District, Karanganyar Regency, Central Java. A purposive sampling technique was applied. From an initial pool of 25 older adults, 20 individuals met the inclusion criteria and completed the study. All participants were female and recruited through a local community group (PKK).

Participants were eligible for inclusion if they were aged 60 years or older, able to ambulate without assistive devices, had controlled comorbidities such as hypertension or diabetes verified through pre-exercise screening, and were willing to participate by providing written informed consent. Participants were excluded if they had severe medical conditions, including uncontrolled cardiovascular disease or a recent stroke, active infections or medical conditions requiring treatment, or cognitive or communication impairments that limited their ability to follow instructions. Participants were considered dropouts if they missed three or more intervention sessions or developed medical limitations that prevented continued participation. In addition, seven individuals were excluded due to age-related criteria that did not meet the study requirements.

Intervention Protocol

The intervention consisted of a structured chair-based aerobic exercise program incorporating a non-elastic cloth as a training tool. Sessions were performed once weekly for 10 consecutive weeks, each lasting approximately 60 minutes, comprising 15 minutes of warm-up, 30 minutes of main exercise, and 15 minutes of cool-down. Training intensity followed recommendations for older adults: 65–80% of age-predicted maximum heart rate, accompanied by music at 110–120 beats per minute. The number of sets and repetitions followed established guidelines for resistance training in older adults (1–3 sets, 8–15 repetitions). The cloth used for training measured 2 meters in length and 5 cm in width, made of a thin, lightweight, non-elastic material. Exercise progression was based on physiotherapy principles for developing strength, flexibility, and coordination.

The intervention followed a standardized sequence, beginning with baseline screening of vital signs and blood glucose, followed by pretest assessments using the Finger-to-Nose Test and handgrip dynamometry. Participants were then seated individually and provided with a non-elastic cloth. Each session began with a warm-up consisting of deep breathing and rhythmic arm elevation synchronized with inhalation and exhalation. The main exercise phase included bilateral arm elevation coordinated with cervical extension and flexion, cloth-anchored lower-limb movements designed to enhance strength and coordination, and alternating upper- and contralateral lower-limb lifts to promote neuromuscular integration. Sessions concluded with a cool-down phase involving slow breathing, scapular retraction, and upper-extremity stretching, after which vital signs were reassessed. Following ten weeks of training, posttest assessments were conducted using the same procedures as at baseline. All sessions were supervised to ensure participant safety and consistency in exercise execution.

Coordination was assessed using the Finger-to-Nose Test, a validated clinical measure of upper-extremity motor control. Participants were instructed to alternately touch their nose and the examiner's moving finger as rapidly and accurately as possible. Performance was evaluated based on completion time and number of movement errors. This test demonstrates strong convergent validity with upper-extremity dexterity, functional independence, and global motor performance ($r = 0.74–0.84$), and excellent test–retest reliability (ICC 0.97–0.99).

Handgrip strength was measured using a Camry EH101 dynamometer, certified by SGS and calibrated in kilograms. Participants were seated with the elbows flexed at 90°, forearms in a neutral position, and handles adjusted for comfort. They were instructed to produce a maximal grip for 3–5 seconds. Measurements were performed three times for each hand, with one-minute rest intervals, and the highest value was recorded. Normal reference values for women were based on previous studies.

Data were analyzed using SPSS version 22. The Shapiro–Wilk test was used to evaluate data normality. Non-normally distributed variables (Finger-to-Nose time and error count) were analyzed using the Wilcoxon Signed-Rank Test, whereas normally distributed variables (right and left handgrip strength) were also analyzed using Wilcoxon to maintain consistency across outcomes. A significance level of $p < 0.05$ was applied. Median values were reported for non-normal variables, while mean ± standard deviation was used for normally distributed variables.

This study received ethical approval from the Health Research Ethics Committee (KEPK), Faculty of Health Sciences, Universitas Muhammadiyah Surakarta (No. 1580/KEPK-FIK/X/2025). All participants provided written informed consent after receiving detailed explanations regarding study procedures, benefits, and potential risks. Confidentiality was strictly maintained throughout the research process.

Results

A total of 20 older adults aged 60–85 years completed the study. Table 1 presents the distribution of participant age. The largest age groups were 68 years (20%) and 67 and 71 years (each 15%). Most participants were categorized as early to mid-stage older adults.

Table 1. Age Distribution of Participants (N = 20)

Age group (years)	n	%
60–64	4	20.0
65–69	8	40.0
70–74	5	25.0
≥75	3	15.0
Total	20	100.0

The sample exhibited a broad age range, representing a typical older adult community profile. No adverse events occurred during the intervention. Descriptive statistics for all outcome variables are summarized in Table 2. Finger-to-Nose completion time decreased substantially following the intervention (median 20.0 to 9.5 seconds), and the number of errors decreased from a median of 2 to 1. Right-hand grip strength increased from an average of 13.15 ± 5.23 kg to 17.01 ± 6.93 kg, whereas left-hand grip strength improved from 10.93 ± 5.37 kg to 13.87 ± 7.28 kg.

Table 2. Descriptive Statistics of Pretest and Posttest Measures (N = 20)

Variable	Pretest	Posttest
Finger-to-Nose Time (sec)	Median 20.0 (10–30)	Median 9.5 (6–18)
Number of Errors	Median 2 (1–3)	Median 1 (0–2)
Handgrip Strength—Right (kg)	13.15 ± 5.23	17.01 ± 6.93
Handgrip Strength—Left (kg)	10.93 ± 5.37	13.87 ± 7.28

The descriptive findings indicated consistent improvement across coordination and strength measures. The Shapiro–Wilk test results are shown in Table 3. Both Finger-to-Nose variables (time and number of errors) demonstrated non-normal distributions at pretest and posttest ($p < 0.05$). Conversely, both handgrip strength measures (right and left) showed normal distributions ($p > 0.05$). Based on these results, nonparametric analyses were used for all outcomes to preserve consistency.

Table 3. Shapiro–Wilk Normality Test Results (N = 20)

Variable	Pretest p-value	Posttest p-value	Distribution
Finger-to-Nose Time	0.012*	0.004*	Not normal
Number of Errors	0.020*	0.000*	Not normal
Handgrip Strength—Right	0.200	0.164	Normal
Handgrip Strength—Left	0.143	0.086	Normal

*$p < 0.05$ indicates non-normal distribution.

Wilcoxon Signed-Rank testing revealed significant improvements across all outcome variables. Table 4 summarizes the results, including effect sizes (r). Finger-to-Nose time showed a significant reduction ($Z = –3.923$; $p < 0.001$; $r = 0.62$), as did the number of errors ($Z = –3.640$; $p < 0.001$; $r = 0.58$). Both right and left handgrip strength increased significantly, each with large effect sizes ($r = 0.62$).

Table 4. Wilcoxon Signed-Rank Test Results (N = 20)

Variable	Median Pretest	Median Posttest	Z	p-value	Effect Size (r)
Finger-to-Nose Time (sec)	20.0	9.5	–3.923	<0.001	0.62
Number of Errors	2	1	–3.640	<0.001	0.58
Handgrip Strength—Right (kg)*	12.65	18.65	–3.921	<0.001	0.62
Handgrip Strength—Left (kg)*	10.20	13.05	–3.921	<0.001	0.62

*Although handgrip variables were normally distributed, Wilcoxon tests were applied for analytic consistency.

All coordination and strength outcomes improved significantly following the 10-week chair-based cloth-assisted exercise program. Improvements in the Finger-to-Nose Test included a 52.5% reduction in median completion time and a 50% reduction in movement errors, indicating enhanced motor control and accuracy. The large effect size ($r = 0.62$) suggests a meaningful impact on upper-extremity coordination.

Similarly, right-hand grip strength increased by approximately 6.0 kg (46% improvement), while left-hand strength increased by approximately 2.9 kg (28% improvement). These changes represent substantial gains in functional muscle strength among older adults, with effect sizes indicating strong benefits from the intervention. No adverse effects were reported during any session, and participant adherence was high. The collective data demonstrate that chair-based exercise using a non-elastic cloth produced statistically significant and clinically relevant improvements across coordination and strength parameters in this older adult population.

Discussion

This study investigated the effects of a 10-week chair-based exercise program using a non-elastic cloth on upper-extremity coordination and handgrip strength in older adults. The results demonstrated significant improvements across all measured outcomes, indicating that the intervention effectively enhanced neuromuscular performance despite a relatively low training frequency of once per week. These findings support growing evidence that structured chair-based exercise can be a feasible and beneficial modality for older adults who experience mobility limitations, balance impairments, or fear of falling.[9]

The marked reduction in Finger-to-Nose completion time and movement errors suggests substantial enhancement in upper-extremity coordination. These improvements align with prior studies reporting that rhythmic, repetitive, and task-oriented movements stimulate multisensory integration—visual, auditory, vestibular, and somatosensory—leading to more refined motor output.[13,14] Repeated practice of coordinated arm and trunk movements while seated may facilitate motor learning processes, improving both feedforward and feedback control mechanisms.[14]

Neurophysiological evidence indicates that aging is associated with cortical overactivation and compensatory recruitment of additional neural resources during motor tasks.[14] Exercise-based motor training may optimize these compensatory patterns, reduce neural noise, and improve signal precision, ultimately enhancing movement accuracy. Moreover, the Finger-to-Nose Test has demonstrated strong validity and reliability as an indicator of upper-limb motor control, reinforcing the relevance of the observed improvements.[15–17]

The significant improvements observed in this study are consistent with systematic reviews reporting that chair-based exercise enhances balance, coordination, and functional performance in older adults, particularly those unable to tolerate standing tasks.[18] The structured use of a cloth may impose additional proprioceptive and motor-control demands, requiring a higher level of concentration and accuracy. This aligns with previous findings suggesting that fine motor tasks involving targeted resistance or guided limb movement can refine coordination through enhanced somatosensory feedback.

Handgrip strength improved significantly in both hands, with large effect sizes, indicating robust neuromuscular adaptations despite minimal exercise frequency. These gains are clinically meaningful, particularly because handgrip strength is recognized as a biomarker of physical function, prognosis, and mortality in older adults.[19,20]

Physiologically, strength improvements in older adults occur through neural adaptations such as increased motor-unit recruitment, improved firing frequency, and better synchronization of remaining motor units. Age-related denervation leads to reduced muscle fiber numbers, yet surviving motor neurons may undergo collateral reinnervation, forming larger but fewer motor units. Exercise may enhance the efficiency of this remodeled system by improving rate coding and intramuscular coordination. Given that the intervention relied on low-load, repetitive resistance using a non-elastic cloth, the improvements likely reflect neuromotor rather than hypertrophic adaptations, which typically require higher training intensities.[21]

The magnitude of improvement in handgrip strength parallels findings from resistance training programs using cloths or resistance bands, where older adults demonstrated increases in strength after 8–12 weeks of training.[22] The current study adds to this literature by demonstrating comparable benefits using a very low-tech tool—a simple non-elastic cloth—suggesting that effective strength training does not necessarily require specialized equipment.

Furthermore, based on published minimal detectable change (MDC) values for handgrip strength in older adults, the increase observed in the right hand clearly exceeded typical MDC thresholds (approximately 2.4–3.2 kg), confirming that the change is unlikely to be due to measurement variability.[23] The increase in the left hand approached these thresholds, suggesting a likely meaningful change.

The findings of this study carry important clinical and practical implications for community-based exercise programs targeting older adults. Chair-based cloth-assisted exercise represents a low-cost and accessible intervention, as it requires only a simple non-elastic cloth rather than specialized resistance equipment. Its seated format makes it particularly safe for frail individuals or those with mobility limitations and heightened fall risk. The intervention is also easy to implement in group-based environments, making it suitable for community centers, eldercare facilities, and public health programs. Moreover, the exercises are readily adaptable, allowing gradual progression by modifying movement speed, the number of repetitions, or range of motion, thereby accommodating varying levels of functional capacity among older adults.

Improved coordination may translate into better performance of activities requiring precision and control, such as reaching, grasping, or manipulating objects. On the other hand, greater handgrip strength is associated with improved independence in activities of daily living, enhanced functional mobility, and reduced fall risk.[23–25] Together, these outcomes support the integration of chair-based training into routine exercise prescriptions for older adults.

The present findings align with a systematic review demonstrating that chair-based exercise improves muscle strength, balance, and functional capacity in older adults across varied health conditions.[9] Additionally, studies using resistance bands or cloths have shown improvements in strength and endurance among institutionalized older adults, consistent with the present results.[9]

Unlike many prior investigations that implemented higher frequency training (2–3 sessions per week), this study employed only one session per week, yet still demonstrated strong effects.[26] This suggests that even minimal but structured exposure can elicit meaningful neuromuscular adaptations when the exercises are well-designed and properly supervised.

This study possesses several notable strengths that enhance its contribution to the field. The intervention was implemented in a real-world community setting, thereby increasing its ecological validity and demonstrating the feasibility of conducting chair-based exercise programs in typical older-adult environments. Participant adherence was high, with no reported adverse events, underscoring the safety and acceptability of the protocol. In addition, all outcome assessments were conducted using standardized and validated measures with strong reliability, particularly for coordination and handgrip strength.[9] Despite the simplicity and low-tech nature of the intervention, the study yielded large effect sizes, indicating substantial and clinically meaningful improvements.

Nevertheless, several limitations must be acknowledged. The absence of a control group limits causal interpretation and introduces susceptibility to confounding factors such as learning effects or natural recovery. The sample size was relatively small (n = 20), reducing statistical power and limiting generalizability. The low training frequency of once per week may not align with optimal recommendations for older adults and may underestimate the interventional potential of the exercise program. Furthermore, the study was conducted at a single site using purposive sampling, potentially limiting external validity. The study also did not include additional functional outcomes—such as gait speed, balance assessments, or activities of daily living—that could have provided a more comprehensive understanding of functional implications.

Considering these limitations, several directions for future research are recommended. Subsequent studies should employ randomized controlled trial designs to strengthen causal inference and confirm the intervention's efficacy. Increasing exercise frequency to two or three sessions per week, in accordance with WHO physical activity guidelines, may help determine dose–response effects. Future investigations should incorporate functional clinical outcomes such as the Timed Up and Go test or the Berg Balance Scale to capture broader functional changes. Incorporating neurophysiological measures, including electromyography or functional imaging, may also clarify the mechanisms underlying neuromuscular adaptations. Additionally, applying frameworks such as minimal detectable change (MDC) and minimal clinically important difference (MCID) would facilitate interpretation of clinically meaningful improvements beyond statistical significance.

Conclusion

This study demonstrated that a 10-week chair-based exercise program using a non-elastic cloth produced significant improvements in upper-extremity coordination and handgrip strength among older adults. The reductions in Finger-to-Nose completion time and movement errors indicate enhanced sensorimotor integration and motor control, while the increases in handgrip strength reflect meaningful neuromuscular adaptations associated with improved functional capacity. These findings align with existing literature supporting the effectiveness of chair-based exercise as a safe, accessible, and low-cost modality for older adults with mobility limitations.

However, given the absence of a control group, modest sample size, and low training frequency, the results should be interpreted as associative rather than causative. Future randomized controlled trials with higher exercise dosage, broader functional outcomes, and neuromuscular assessments are needed to validate these findings and explore the mechanisms underlying the observed improvements. Nevertheless, the intervention holds promise as a practical strategy for enhancing physical function in community-dwelling older adults.

Author Contribution

- Conceptualization: Arin Supriyadi
- Methodology: Vikaenza Goldlian Brivilliany
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- Writing – Review & Editing: Vikaenza Goldlian Brivilliany
- Visualization: Vikaenza Goldlian Brivilliany
- Supervision: Arin Supriyadi

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Conflict of Interest Statement

The authors declare no conflict of interest.

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Ethics Statement

This study was approved by the Health Research Ethics Committee (KEPK), Faculty of Health Sciences, Universitas Muhammadiyah Surakarta (Approval No. 1580/KEPK-FIK/X/2025). All participants provided written informed consent, and confidentiality was maintained throughout the study.

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