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Effects of an exercise programme on strength, balance and endurance in the elderly population: a pilot study.

Efectos de un programa de ejercicios sobre la fuerza, el equilibrio y la resistencia en la población de edad avanzada: un estudio piloto.

Gaetano Altavilla[13]; Giuseppe Di Lascio[23]; Manuele Taleb[23]; Giuseppe Giardullo[23]; Pompilio Cusano[13]

[1] Department of Education and Sports Sciences, Pegaso University of Naples, Italy
[2] Department of Neuroscience, Biomedicine and Movement, University of Verona, Italy
[3] Research Center of Physical Education and Exercise, Pegaso University, Centro Direzionale Isola F2, 80143, Naples, Italy

*Corresponding author: Gaetano Altavilla, gaetano.altavilla@unipegaso.it

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Abstract

Population ageing leads to a progressive decline in functional abilities, with significant impacts on the independence and quality of life of older people. Structured physical activity is an effective tool for counteracting these processes; however, there is still limited evidence regarding possible differences in response to exercise between older men and women. The aim of this pilot study is to evaluate the effects of a structured physical activity program on muscle strength, cardiorespiratory endurance and balance in the elderly population, analysing any gender differences. Twenty-five functionally independent elderly subjects participated in the study. The experimental protocol, lasting six months with twice-weekly sessions, included progressive strength, endurance and balance exercises. Functional abilities were assessed before and after the intervention using validated tests. Statistical analysis was performed using a paired t-test, with a significance level set at $p < 0.05$. Both men and women showed significant improvements in all variables analysed. In particular, increases in upper and lower limb strength, cardiorespiratory endurance and improvements in static and dynamic balance were observed, with a reduction in execution times and number of errors. Men performing better in strength tests and women in balance tests. The results confirm the effectiveness of a structured physical activity program in improving the functional physical abilities of older adults, regardless of gender. The intervention proves to be a valid tool for promoting active ageing and functional autonomy, highlighting the importance of exercise programs that are adapted and sensitive to gender differences.

Keywords: active ageing; functional assessment; physical exercise; gender differences.

Resumen

El envejecimiento de la población conduce a un deterioro progresivo de las capacidades funcionales, lo que tiene un impacto significativo en la independencia y la calidad de vida de las personas mayores. La actividad física estructurada es una herramienta eficaz para contrarrestar estos procesos; sin embargo, aún hay pocas pruebas sobre las posibles diferencias en la respuesta al ejercicio entre hombres y mujeres mayores. El objetivo de este estudio piloto es evaluar los efectos de un programa de actividad física estructurada sobre la fuerza muscular, la resistencia cardiorrespiratoria y el equilibrio en la población de edad avanzada, analizando las posibles diferencias entre sexos. Veinticinco sujetos mayores funcionalmente independientes participaron en el estudio. El protocolo experimental, con una duración de seis meses y sesiones dos veces por semana, incluyó ejercicios progresivos de fuerza, resistencia y equilibrio. Las capacidades funcionales se evaluaron antes y después de la intervención mediante pruebas validadas. El análisis estadístico se realizó mediante una prueba t pareada, con un nivel de significación establecido en $p < 0,05$. Tanto los hombres como las mujeres mostraron mejoras significativas en todas las variables analizadas. En particular, se observaron aumentos en la fuerza de las extremidades superiores e inferiores, la resistencia cardiorrespiratoria y mejoras en el equilibrio estático y dinámico, con una reducción en los tiempos de ejecución y el número de errores. Los hombres obtuvieron mejores resultados en las pruebas de fuerza y las mujeres en las pruebas de equilibrio. Los resultados confirman la eficacia de un programa de actividad física estructurado para mejorar las capacidades físicas funcionales de las personas mayores, independientemente de su sexo. La

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intervención demuestra ser una herramienta válida para promover el envejecimiento activo y la autonomía funcional, lo que pone de relieve la importancia de los programas de ejercicio adaptados y sensibles a las diferencias de género.

Palabras clave: envejecimiento activo, evaluación funcional, ejercicio físico, diferencias de género.

Introduction

The ageing population is one of the main health and social challenges facing industrialised countries. In Europe, the percentage of individuals aged 65 and over increased from 16% in 2001 to 21% in 2020, while the number of people aged 80 and over almost doubled during the same period, outlining a demographic scenario characterised by a progressive increase in longevity and the structural dependency ratio (Eurostat, 2020). This demographic change calls for in-depth reflection on the quality of life in old age and the adoption of effective strategies for maintaining the functional autonomy and overall health of the elderly population (Bauman et al., 2012; Altavilla, 2016). Ageing is a complex and non-homogeneous process, characterised by a progressive reduction in functional reserves and the ability to adapt to physical and environmental stress. Although these differences may not be apparent at rest, they become evident during complex motor tasks or physical activities, increasing the risk of disability, falls and loss of independence (Esposito et al., 2025a; Cascone et al., 2020). Among the main mechanisms responsible for functional decline are sarcopenia and dynapenia, both strongly associated with frailty and limitations in activities of daily living (Mitchell et al., 2012).

Regular physical activity is widely recognised as a fundamental tool for counteracting these processes, improving strength, cardiorespiratory endurance and balance, and reducing the risk of falls and disability (Naseer et al., 2022; Latorella et al., 2020; Altavilla et al., 2018). International guidelines emphasise the role of structured physical exercise in promoting active ageing and preserving functional autonomy in the elderly population (WHO, 2020; Ceruso et al., 2024). However, ageing does not affect men and women equally. In fact, there are significant differences between the sexes in levels of physical activity, daily movement patterns, decline in muscle strength, aerobic

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capacity and risk of falling, suggesting the need for personalised and gender-sensitive interventions (Cruz-Jentoft et al., 2019; Guthold et al., 2020**).** In particular, older men tend to have higher levels of moderate-vigorous physical activity, while women more frequently perform domestic activities as their main form of daily movement (Lee, 2005). Furthermore, socio-demographic factors such as educational level, social isolation and previous lifestyle habits have a different impact on physical function in the two sexes, reinforcing the hypothesis that programmes promoting physical activity should be adapted to gender-specific characteristics (Esposito et al., 2025b; Teraoka et al., 2025; Raiola et al., 2015). Recent studies also show that, at the same levels of physical activity, the benefits on health-related quality of life may manifest differently between men and women (Liao et al., 2021; Martínez-Moreno et al., 2020). Declines in muscle strength and changes in muscle and adipose tissue also follow sex-specific trajectories, suggesting different biological mechanisms underlying functional loss with advancing age (Chang et al., 2024). Similarly, the cardiorespiratory system undergoes a progressive reduction in aerobic capacity and VO_2max, with higher average values in men but similar decline patterns in both sexes; however, targeted training programmes can mitigate these functional losses even in old age (Fleg et al., 2005; Hawkins & Wiswell, 2003). The assessment of motor skills in the elderly population plays a crucial role in identifying specific deficits, monitoring the level of functional autonomy and planning personalised prevention and rehabilitation interventions. In this context, balance is a key factor in the prevention of falls (Choudhary et al, 2026), which are particularly relevant in the elderly female population, who are at greater risk due to differences in muscle strength, bone density and posture (Ambrose et al., 2013; Rubenstein, 2006). Despite ample evidence supporting the benefits of physical activity in older age, it remains unclear to what extent structured exercise programmes focusing on strength, endurance and balance and carried out over a defined period of time differentially influence the functional physical abilities of men and women over 65 (Aliberti et al., 2023; D'Elia et al., 2023). This knowledge gap limits the possibility of developing truly effective and personalised interventions. Based on these considerations, the aim of this study is to investigate the effects of a structured physical activity programme on the functional physical abilities of the elderly population, with particular reference to strength, endurance and balance, through a

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comparative analysis between male and female subjects. This approach is part of the broader framework of European policies and recommendations aimed at promoting active, multidimensional and gender-sensitive ageing (European Commission, 2021).

Materials & Methods

Study Participants

The sample involved in the study consisted of 25 elderly subjects. The group was composed of 10 men and 15 women, all aged between 65 and 84, representative of the age group commonly investigated in gerontological studies dedicated to maintaining and enhancing motor skills in old age. Participants were recruited on a voluntary basis within the context of organised physical activity aimed at the elderly population, after verification of inclusion and exclusion criteria and suitability for adapted physical activity. The distribution by age and gender reflects a heterogeneous but functionally autonomous population, suitable for participation in a motor protocol aimed at improving strength, endurance and balance. The participants are in good general health and are suitable for adapted physical activity. Although most report age-related disorders such as neck pain, low back pain, knee pain and reduced scapula-humeral mobility, these conditions do not significantly compromise daily functioning or represent an obstacle to participation in the exercise programme.

This study is part of the research project entitled 'Psychophysical perception and body awareness in school and sports contexts through observational and non-invasive tools', approved by the Ethics Committee of Pegaso University (Prot./E 004726 of 15/07/2025). The research was conducted in accordance with the ethical principles established by the Declaration of Helsinki. All participants were adequately informed about the purposes and procedures of the study and provided their written informed consent before the start of the activities. The confidentiality of the data and the anonymity of the participants were guaranteed at all stages of the research.

Inclusion and exclusion criteria

The inclusion and exclusion criteria were defined to ensure the selection of a functionally homogeneous sample suitable for safely following the planned physical

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activity programme. The aim is to ensure that participants are able to sustain moderate-intensity group physical activity without health risks and with adequate participation skills.

Inclusion criteria:

- aged 65 or over; functional autonomy in activities of daily living; ability to walk independently; suitability for physical activity; absence of acute pathologies in the active phase; sufficient cognitive ability.

Subjects with one or more of the following conditions were excluded from the study:

- uncontrolled cardiovascular, respiratory or metabolic diseases; severe neurological disorders or advanced neurodegenerative diseases; severe musculoskeletal limitations (marked stiffness, severe pain, poor joint mobility) that would prevent them from performing the planned exercises; significant cognitive deficits.

Description of the Physical Performance Tests

The functional assessment of participants was conducted using a structured set of motor tests recognised in international scientific literature for assessing the physical efficiency of the elderly population. These tests were selected based on their validity, reliability and sensitivity to change following adapted physical exercise programmes. The primary outcomes of the study were indicators of lower and upper limb muscle strength and cardiorespiratory endurance, while secondary outcomes included measures of static and dynamic balance, agility, and speed of movement execution.

The procedures were identical in the pre- and post-intervention phases, allowing for a direct comparison between the initial measurements and those collected at the end of the six months of activity. Before the tests began, the participants were given a clear explanation of how the tests would be conducted; in addition, a demonstration was given and a short time was allowed for questions.

All operators involved in the intervention (graduates in motor sciences, researchers and kinesiologists) received instructions on the procedure and administration of the physical performance tests.

The following tests were used:

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1. The Chair Stand Test was used to assess lower limb strength. To ensure standardisation, a stable chair with a height of 43 cm and no armrests was used. The participant, sitting on the edge of the seat with their back straight, arms crossed over their chest and feet flat on the floor, performed as many lifts as possible in 30 seconds. Each valid repetition corresponded to a complete extension of the body in a standing position and a return to a sitting position without support from the upper limbs.

2. The Arm Curl Test was used to assess upper limb strength. The load specified in the original protocol was used: 2.3 kg dumbbells for women and 3.6 kg for men. The subject, sitting with their torso upright and the dumbbell in their dominant hand, performed as many curls as possible in 30 seconds, bringing the weight towards their shoulder and returning to the starting position, always maintaining control of the movement.

3. The 6 Minute Walk Test, which measures cardiorespiratory endurance, was conducted around the perimeter of a gym. Participants were instructed to walk around the track for 6 minutes, maintaining the maximum sustainable speed without running. At the end of the time, the total distance covered in metres was recorded.

4. The Tandem Walk Test, which assesses dynamic balance, was performed on a 2-metre straight path. Participants had to walk with the heel of one foot immediately in front of the other, maintaining an alignment similar to "walking on a beam". Both the time taken to complete the course and the number of errors (loss of balance, foot misalignment, extra steps) were recorded.

5. The Unipedal Stance Test assessed static balance through three tests: first with the dominant leg, then with the non-dominant leg, and finally with the dominant leg again. Participants had to maintain a single-leg stance while the observer recorded any errors made during the 30-second test.

6. The 8-Foot Up-and-Go test measures speed, agility and the ability to change direction. Participants must get up from a chair, walk across an eight-foot path and return to the chair as quickly as possible. The time taken to complete the test was recorded.

Study design

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The study is configured as a quasi-experimental longitudinal pilot study with a pre- and post-intervention design, without a control group, aimed at evaluating the effects of a structured physical activity programme on the functional physical abilities of elderly subjects. This approach allows significant changes over time to be detected within the same sample, which can be attributed with a high degree of probability to the intervention carried out. The objective is to analyse the effect of training on the functional abilities of the elderly population, in particular muscle strength, cardiorespiratory endurance and balance, through validated and sensitive tests for this population. The protocol is divided into successive phases: collection of informed consent and initial medical history, administration of pre-intervention tests under standardised conditions, implementation of the exercise programme with direct supervision and constant monitoring of participation and safety, and finally administration of post-intervention tests under the same initial conditions to ensure data comparability. All subjects initially enrolled completed the intervention programme and the pre- and post-assessments required by the protocol; there were no dropouts during the study period.

Procedures

The physical activity programme used in the study was designed to specifically meet the functional needs of the elderly population involved. Its overall aim was to promote active ageing by improving essential motor skills, reducing the risk of falls, enhancing independence and improving quality of life. The intervention was structured according to a progressive path, adapted to individual abilities and divided into three phases (adaptation, consolidation and enhancement), each characterised by specific objectives and operating methods. The sessions, held twice a week for a total duration of six months, consisted of a warm-up phase, a central phase dedicated to the actual motor work, and a final cool-down and stretching phase. The intensity of the exercise was progressively adapted to the individual abilities of the participants, favouring a moderate and sustainable workload, in line with international recommendations for physical activity in the elderly population.

The programme progression was modulated by gradually increasing the complexity of the exercises, the duration of the activities and the resistance of the

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equipment used, with particular attention to safety and movement control. The subjective perception of effort was monitored during the sessions in order to maintain the intensity of the exercise within levels compatible with the functional characteristics of the participants. During the intervention period, no specific controls were applied to any physical activities carried out by the participants outside the proposed programme; however, the subjects were asked to maintain their motor and lifestyle habits unchanged for the duration of the study.

Programme phases

Phase 1 – Adaptation (first 4 weeks)

The initial phase was aimed at familiarising participants with the motor environment, reactivating basic coordination skills and performing initial general joint mobilisation. The warm-up consisted mainly of slow, controlled movements to mobilise the spine, shoulders and lower limbs, accompanied by light walking. The central part of the programme consisted of bodyweight exercises and activities using simple equipment (sticks, low-resistance elastic bands, soft balls) with the aim of reactivating the muscles without overloading them. Balance exercises included assisted support, short walks and slight variations in stride. The cool-down consisted of stretching and controlled breathing exercises (Table 1).

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Table 1 – Exercise sheet Phase 1 (Adaptation)

Objective	Exercise	Equipment	Duration/Repetitions	Execution notes
Joint mobilisation	Spinal rotations with stick	Stick	2×10 per side	Slow, controlled movement
Shoulder mobility	Arm flexions/abductions	Stick or free body	2×12	Avoid compensating with the torso
Lower limb activation	Assisted standing	Chair	2×8–10	Use of hands
Light upper limb strengthening	Forward thrusts with light elastic band	Low resistance elastic band	2×12	permitted during the first few sessions
Static balance	Assisted single-leg stance	_____	3×20–30 s	Posture control
Walking	Walking at natural pace	_____	5–7 min	Support yourself on the chair for safety
Flexibility	Stretching of quadriceps, calves, deltoids	_____	20–30 s per muscle group	With slight variations in stride

Phase 2 – Consolidation (from the 2nd to the 4th month)

This phase represented the core of the programme and involved a gradual increase in muscular and cardiorespiratory effort. Strength exercises were performed with higher resistance bands, small weights and more complex movements than in the previous phase. The aerobic component was stimulated through brisk walking, dynamic exercises and continuous sequences. Circuit training sessions were also introduced, combining strength, balance and endurance exercises in a station-based format (Table 2).

Table 2 – Exercise sheet Phase 2 (Consolidation)

Objective	Exercise	Equipment	Duration/Repetitions	Execution notes

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Lower limb strength	Unassisted chair squats	Chair	3×10	Control downward movement
Upper limb and back strength	Rowing with elastic band	Medium elastic band	3×12	Activate shoulder blades
Cardiorespiratory endurance	Fast walking	____	8–10 min	Gradually increase speed
Shoulder and trunk strengthening	Side/front lifts	Light weights (0.5–1 kg)	3×10–12	Avoid lifting shoulders
Dynamic balance	Walking in a straight line	____	4–5 passes	Look forward, controlled stride
Coordination	Paths with changes of direction	Cones or markers	3–4 sets of 1 min	Modulated stride length
Functional circuit training	6 stations (core, strength, balance, mobility, elastic bands, walking)	Various	2–3 rounds of 30–40 s for station	1-minute break between laps
Mobility and cool-down	Full-body stretching	____	10 min	Focus on lower limbs and spine

Phase 3 – Strengthening and stabilisation (last 2 months)

In this final phase, the goal was to consolidate the improvements achieved, optimising movement quality and further strengthening strength and dynamic balance. Mat exercises were used more frequently to strengthen the core and improve spinal mobility, while circuit training sessions became more structured. Aerobic activities took on a more continuous form, with sustained walking for longer periods (Table 3). The focus was on movement control, precision of execution and the ability to manage more complex stimuli, always with full respect for individual limits and safety.

Table 3 – Exercise sheet Phase 3 (Strengthening/Stabilisation)

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Objective	Exercise	Equipment	Duration/Repetitions	Execution notes
Advanced lower body strength	Controlled squats with greater range of motion	Chair or floor exercises	3×12–15	Increase depth according to tolerance
Upper body strength	Wall push-ups and pull-ups with	Wall + elastic band	3×12 each	Control of the trunk during
Core stability	Elastic band	Mat	3×20–30 s	Execution
Proprioceptive balance	Easy plank and variations on mat	Proprioceptive cushions or thick mat	3×30 s	Avoid lumbar hyperlordosis
Cardiovascular endurance	Exercises with centre of gravity variation	_____	6–8 min	Individual progression in safety
Advanced coordination	Continuous walking at a steady pace	_____	4×1 min	RPE (rate of perceived exertion) 3–5 out of 10
Advanced circuit training	Combined strength–balance–endurance stations	Sticks, elastic bands, weights, mat	3 round × 40–45 s	Promote fluidity and precision
Cool down	Specific stretching + guided breathing	____	8–10 min	Reduction of breaks and continuity of work

Statistical Analysis

Statistical analysis was conducted in order to objectively quantify the effects of the exercise programme on the functional performance of participants, comparing the values recorded in the pre-intervention and post-intervention tests. The data, reported in descriptive form, are expressed as mean and standard deviation (mean +/- SD). After verifying the normality of the data distribution with the Shapiro-Wilk test ($p > 0.05$) and the homogeneity of variances with the Levene test ($p > 0.05$), a paired t-test was used to compare the initial and final physical performance on the different variables measured in the male and female groups. In addition to statistical significance, the effect size was estimated in order to quantify the extent of the changes observed between pre- and post-intervention assessments. The effect size was calculated using Cohen's d for paired samples, interpreted according to conventional criteria (0.2 = small; 0.5 = medium; 0.8 = large). The level of significance was set at $p < 0.05$. All statistical tests were performed using IBM SPSS (version 22; IBM, Armonk, NY, USA).

Results

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Table 4 - Average results in the various tests for the two groups

Gender	N.	Action (Pre-Post)	Chair Stand Test (repetitions)	Arm Curl Test (repetitions)	6 Minute Walk Test (m)	Tandem Walk Test (sec)	Unipedal Stance Test (errors)	8-Foot Up-and-Go Test (sec)
Males	10	Pre	13.8 ± 1.87	13.5 ± 1.96	512.3 ± 71.9	8,47 ± 2.88	9.90 ± 7.01	5,09 ± 0,35
		Post	15.8 ± 2.30	16.0 ± 1.76	534.5 ± 72.8	7.98 ± 2.71	7.30 ± 6.54	4.69 ± 1.20
Females	15	Pre	14.9 ± 3.94	14.5 ± 2.72	491.1±33,5	8.76 ± 2.35	9.66 ± 5,02	5.18 ± 1.39
		Post	16.9 ± 3.51	16.6 ± 2.38	506.8±34.7	7.93 ± 2.49	7.40 ± 4.56	4.96 ± 1.41

In the Chair Stand Test, men showed an increase in the average score from 13.8 ± 1.87 pre-intervention to 15.8 ± 2.30 post-intervention, with an average percentage improvement of +14.5%. Similarly, women went from 14.9 ± 3.94 to 16.9 ± 3.51, recording an average percentage improvement of +13.4. In the Arm Curl Test, the average score for men increased from 13.5 ± 1.96 to 16.0 ± 1.76, corresponding to an average percentage increase of +18.5%. Women showed an improvement from 14.5 ± 2.72 to 16.6 ± 2.38, equal to an average percentage increase of +14.5%. In the 6-Minute Walk Test, men increased the distance covered from 512.3 ± 71.9 m to 534.5 ± 72.8 m, with an average percentage improvement of +4.3%. For women, the average distance increased from 491.1 ± 33.5 m to 506.8 ± 34.7 m, with an average percentage increase of +3.2%. As for the Tandem Walk Test, the average time for men decreased from 8.47 ± 2.88 sec to 7.98 ± 2.71 sec, with an average percentage improvement of –5.8%. Women reduced their average time from 8.76 ± 2.35 sec to 7.93 ± 2.49 sec, with an average percentage improvement of –9.5%. In the Unipedal Stance Test, the average number of errors in men decreased from 9.90 ± 7.01 to 7.30 ± 6.54, with an absolute reduction of –2.60 errors and an average percentage reduction of –26.3%. In women, errors decreased from 9.66 ± 5.02 to 7.40 ± 4.56, with an absolute reduction of –2.53 errors and an average percentage reduction of –23.4%. In the 8 Foot Up and Go Test, the average execution time for men decreased from 5.09 ± 0.35 sec to 4.69 ± 1.20 sec, with an absolute improvement of –0.40 sec and a percentage change of –7.85%. Women showed a reduction in average time from 5.18 ± 1.39 sec to 4.96 ± 1.41 sec, with an absolute improvement of –0.22 sec and a performance increase of –4.25. Finally, the effect size analysis showed that, although the improvements observed in all functional tests were statistically significant, their

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practical significance was generally low in both men and women. In both groups, Cohen's d values fell mainly into the small or very small effect category, suggesting that the pre-post changes, although consistent and systematic, had a limited functional impact. The relatively higher effects were found in the Arm Curl Test, particularly in men (d = 0.35), indicating a more marked improvement in upper limb strength compared to the other functional domains assessed (Table 5 and 6).

Table 5 - Paired sample t-test results for males

Males (Pre and Post)	t	Df	p-value	Cohen's d
Chair Stand Test	-5.477	9	< .001	0.26
Arm Curl Test	-7.319	9	< .001	0.35
6 Minute Walk Test	-3.540	9	0.006	0.11
Tandem Walk Test	6.619	9	< .001	0.03
Unipedal Stance Test	8.510	9	<.001	0.09
8 Foot Up and Go Test	5.379	9	< .001	0.10

*p-value < .05 considered significant

Table 6 - Paired sample t-test results for females

Female (Pre and Post)	t	Df	p-value	Cohen's d
Chair Stand Test	-5.477	14	< .001	0.13
Arm Curl Test	-6.959	14	< .001	0.19
6 Minute Walk Test	-15.927	14	< .001	0.09
Tandem Walk Test	5.138	14	< .001	0.03
Unipedal Stance Test	10.990	14	<.001	0.08
8 Foot Up and Go Test	8.508	14	< .001	0.04

*p-value < .05 considered significant

Discussion

The results show a significant improvement in functional performance after the intervention, consistent with previous studies that have identified positive effects of combined exercise (aerobic + strength) on muscle strength, balance and mobility in the elderly population (Sousa et al., 2014). In the male-female comparison, in terms of muscle strength, men showed slightly higher percentage increases in the Arm Curl than women, while the progression in the Chair Stand was similar between the sexes. This may reflect biological differences in response to muscle resistance or variations in initial load capacity. However, the literature indicates that both sexes derive significant benefits from counter-resistance training in old age, thanks to widely shared neuromuscular adaptation mechanisms (Jones et al., 2021). With regard to cardiorespiratory endurance, the improvement in the 6-Minute Walk Test was more evident in women in terms of

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statistical significance. This difference could be attributed to factors such as body composition or specific cardiovascular responses to exercise, which have already been observed in studies conducted on elderly populations (Dimech et al., 2019). Both groups achieved significant reductions in agility test times and in the number of errors in the balance test. Both groups achieved significant reductions in agility test times and in the number of errors in the balance test. Similar percentage changes between the sexes suggest that the intervention has cross-sectional effects on neuromuscular abilities. Finally, the use of these performance tests is also supported as a predictor of fall risk and disability in the elderly populations. For example, poorer performance in balance and agility tests has been associated with an increased risk of falls in the elderly population (Ho et al., 2021). Analysis of the results shows that the six-month exercise programme produced significant improvements in all dimensions of physical function assessed. Muscle strength, in both the lower and upper limbs, increased consistently, indicating improved support for daily activities and a potential reduction in the risk of disability. The cardiorespiratory test (6MWT) showed an increase in endurance, with a more marked improvement in rhythmic and dynamic exercises, consistent with the characteristics of the protocol performed. Static and dynamic balance also showed significant progress, as indicated by the reduction in times and errors in the Tandem Walk Test and the improvement in single-leg stability in the Unipedal Stance Test. This suggests an improvement in proprioception and postural control, key elements in fall prevention, as highlighted by previous systematic reviews on physical exercise in the elderly populations (Sherrington et al., 2020). Finally, the 8-Foot Up-and-Go Test confirms an increase in agility and the ability to coordinate rapid and complex movements, which are essential for motor safety in everyday life. One element that deserves attention is individual variability: women tend to have wider dispersion intervals than men, suggesting greater heterogeneity in baseline conditions and response to training. Despite these differences, the overall trend in results shows that all participants, regardless of age, gender or initial level of physical ability, benefited from the exercise programme. The improvements observed in strength, balance and agility can be interpreted as the result of neuromuscular and coordinative adaptations induced by regular functional and multimodal exercise, in line with theoretical models of active ageing. They are also

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particularly relevant in relation to maintaining independence in daily activities and potentially reducing the risk of falls in the elderly population. The effectiveness of the intervention therefore seems attributable to the combination of functional exercises, progressive load, variety of activities and regular weekly frequency, factors recognised as central to the promotion of active ageing.

Practical implications and limitations of the study

Given the pilot nature of the study, the results obtained should be interpreted as exploratory and useful primarily for guiding future controlled research on larger samples. They clearly show that a structured, progressive physical activity programme adapted to the characteristics of the elderly population can produce significant improvements in various areas of physical function. This evidence has important practical implications, especially in residential, semi-residential or associative contexts dedicated to active ageing. From an operational point of view, the protocol used is easily reproducible: it requires limited space and minimal equipment and can be carried out in heterogeneous groups thanks to the possibility of modulating the intensity, duration and complexity of the exercises. Despite the encouraging results of the study, further investigation is still needed. It will be important to expand the sample, include elderly population with more diverse levels of autonomy, and introduce a control group to increase the statistical robustness of the results. In addition, future work should investigate the long-term duration of the effects and assess whether more intensive or longer-lasting protocols can produce even greater benefits. Looking ahead, it will be useful to integrate motor programmes such as the one proposed with multidisciplinary interventions that include health education, psychological support, social activities and environmental fall prevention strategies. This integrated approach could represent a fundamental step towards building a truly sustainable model of active ageing. The absence of a control group represents a further methodological limitation of the study, as it does not allow the improvements observed to be attributed with causal certainty exclusively to the proposed intervention. However, the pre- and post-intervention design adopted is consistent with the exploratory nature of the study and the reference application context. Finally, a further limitation of the study concerns the absence of a direct statistical analysis between the

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male and female groups. Although the pre- and post-intervention improvements were analysed separately within each group, no statistical comparison was made between the changes observed in the two sexes. Therefore, the gender differences that emerged should be interpreted with caution and considered mainly in descriptive terms.

Conclusions

This pilot study provides preliminary evidence supporting the effectiveness of structured physical activity programmes in the elderly population in terms of key functional physical abilities. The improvements observed in strength, balance, endurance and agility confirm that the neuromuscular system remains plastically responsive even in old age, provided it is adequately stimulated. From a social point of view, these results help to counteract the perception of old age as a mere phase of loss, restoring dignity and value to it. The work carried out also demonstrates that physical activity programmes are not only rehabilitation tools but can also become central elements in the promotion of public health. Investing in the physical functionality of older people means reducing healthcare costs, preventing frailty and strengthening social ties within the community. In conclusion, the results obtained confirm not only the effectiveness of the physical activity programme, but also the need to fundamentally rethink the way we view old age. It is not just biological decline: it is a time that, if supported appropriately, can become an opportunity for personal growth, relationships and participation. Active ageing is therefore not an unattainable goal, but a real possibility that can and must be cultivated so that older people continue to be a living, recognised and central part of our community.

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