

Impact of Resistance Training on Functional Capacity and Muscle Performance in Postmenopausal Women

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ABSTRACT

The objective is to investigate the impact of 12 weeks of high-speed resistance training (RT) compared to low-speed RT on muscle strength, measured by one repetition maximum leg press (1RMLP) and bench press (1RMBP), as well as dominant (HGd) and non-dominant maximum isometric handgrip strength, power, ball throwing (BT) ability, functional performance assessed through the 8-foot up-and-go test (UG) and sit-to-stand test (STS), and perceived quality of life in older women. Methods: Ninety elderly women were categorized into a high-speed resistance training group [EG, n = 30], a low-speed resistance training group [SG, n = 30], and a control group [CG, n = 30]. The SG and EG participated in an analogous 12-week resistance training program [3 sets of 10 repetitions at 40–75% of the one-repetition maximum (1 < RM) and BT], employing slow, controlled (3 seconds) concentric muscle actions for the SG and rapid, explosive (< 1 second) concentric muscle actions for the EG (20% reduced workload per exercise without BT). Results: The dependent variable exhibited enhancement in both RT groups throughout the 12-week training duration in clinically significant measures ranging from small to large; however, a notable difference was observed between the EG and SG regarding performance alterations in BT and UG (28% vs 23%, 21% vs 13%, $p < 0.01$, respectively). No significant alterations were seen for the CG. Conclusion: Although a high-speed resistance training program yields greater enhancements in muscular power and functional task performance, both low-speed and high-speed resistance training therapies effectively increase functional capacity, muscle performance, and quality of life in older women.

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INTRODUCTION

The extent to which elderly individuals experience difficulties with daily activities and age-associated impairments is linked to their peak strength. Muscle power may be more closely associated with daily functional performance and life-threatening risks, such as falls, which are especially prevalent among women, than muscle strength. The study aimed to assess the effects of high-resistance-resistance training vs low-speed resistance training on functional capacity and muscle performance in postmenopausal women [1]. especially within this cohort. Moreover, in comparison to muscle strength, muscle power diminishes more rapidly with advancing age, and elderly women exhibit lower muscle power levels than their male counterparts. These data suggest that interventions influencing muscle strength should be considered, especially for elderly women. The impact of normal low-speed resistance training therapy on muscle power, especially for functional tasks, has been scrutinized.

It has been proposed that older individuals should engage in resistance training (RT) programs that prioritize muscle power rather than peak strength. An innovative technique for assisting older women in developing muscle power may involve high-velocity resistance training. However, certain studies have expressed apprehensions over the impact of this training methodology on the functional task performance, muscle strength, and power of this age demographic [2]. Moreover, although it is widely recognized that exercise enhances the quality of life for menopausal women, there is insufficient research to reach definitive conclusions. A comprehensive understanding of the muscular, functional, and quality-of-life adaptations in older women subjected to diverse resistance training regimens is thus necessary, as little research has examined the effects and efficacy of these various strategies on these parameters. Some studies have reported analogous outcomes between low-speed and high-speed resistance training, whilst others have demonstrated greater training-related adaptations with high-speed resistance training. High-speed resistance training may surpass conventional low-speed resistance training in enhancing muscle strength, functional capacity, and quality of life, as posited by our hypothesis [3].

RESEARCH ELABORATIONS

Ninety elderly women of Hispanic descent initially satisfied the criteria for inclusion in the study. We chose participants with similar levels of physical activity. Older women met the following inclusion criteria: (a) self-reported health status, confirmed by the updated physical activity readiness questionnaire for older adults; (b) absence of a history of heart disease, osteoarthritis, severe visual impairment, neurological disorders, pulmonary conditions necessitating oxygen, uncontrolled hypertension, hip fractures, or lower extremity joint replacement within the past six months; and (c) either current participation in structured exercise or prior engagement in resistance training within the last six months. A physician conducted a thorough screening of all applicants prior to their inclusion in the trial, which involved assessing the number of daily prescriptions taken by the women for EG, SG, and CG, respectively [4].

Three groups were randomly selected among the women: a high-speed resistance training group, a low-speed resistance training group, and a control group. To be included in the final analysis, participants were required to complete all training sessions, familiarization sessions, and assessments, resulting in a cohort of 60 older women integrated into the conclusive analyses. Alongside their normal responsibilities, the EG and SG engaged in a tri-weekly RT program for a duration of 12 weeks. The CG did not participate in any specific form of exercise. Prior to the commencement of any testing, all participants signed an informed consent form after receiving a comprehensive briefing about the experimental protocols, potential risks, and benefits of their involvement in the study. The ethics committee of the pertinent department granted consent for the study conducted at Mahatma Gandhi Medical Hospital. The alterations in peak muscle power performance among a cohort of older adults who participated in the same high-speed resistance training program utilized in this investigation were employed to determine the sample size [5]. A group size of eight persons would yield a power of 80% with an alpha level of 0.05, as determined by a statistical power analysis.

RESULTS AND DISCUSSIONS

Both groups completed all assessment procedures before the experimental period (T1) and after a 12-week training period (T2). Prior to testing, the subjects participated in a 90-minute familiarization session to mitigate the effects of any learning discrepancies. The standardized examinations were conducted over two sessions, each separated by a 48-hour interval. The examinations were conducted concurrently under supervision at the same location, both before and immediately following the 12-week intervention period, executed by the same researchers. The subjects' body mass was assessed on the initial day. Standing height, resting heart rate, and rate and quality of life throughout menopause, as well as the sit-to-stand and functional 8-foot up-and-go assessments. The subjects were assessed for maximum isometric strength during the second session. Muscle power (maximum walking speed, vertical leap, and medicine ball throwing capacity), handgrip strength, and maximum dynamic strength (maximum repetitions for leg and bench press) were assessed. Prior to this, all tests were administered in a consistent sequence and following exercise, with subjects attired in sports clothing. During performance reviews, each individual was urged to exert their utmost effort.

Cardiovascular and anthropometric measurements were conducted following global norms for anthropometric evaluation, with body mass (kg) and standing height (m) recorded. A stadiometer and mechanical scale were employed to measure height and body mass, with an accuracy of 0.1 cm and 0.1 kg, respectively. Prior to any actual performance assessment, these criteria were analyzed. The participants donned lightweight attire for the examination (footwear was removed). The body mass index (BMI) was calculated in kilograms per square meter. In accordance with an established protocol for older women, the subjects were allotted ten minutes of tranquil repose in a supine position before obtaining two readings with an automatic heart rate monitor, separated by one minute.

Participants were evaluated for maximal bilateral concentric one-repetition leg press (1RMLP) and bench press (1RMBP) using a previously established technique. In summary, the 1RMLP machine made contact with the patients' shoulders. The initial knee angle was 100°. Upon instruction, the participant executed a concentric extension of the leg muscles (knee, hip), along with the extensor muscles of the ankle, as swiftly as possible, commencing from a flexed posture to achieve a full 180° extension against the resistance determined by the weight plates. The bar was situated 1 cm above the 1RMBP. The subject's chest was supported by the lower

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stops of the measurement instrument. The subject was instructed to perform a purely concentric movement as swiftly as possible from the initial position. The warm-up consisted of five repetitions at 40–60% of the perceived maximum load. Subsequently, four to five independent, singular attempts were conducted until the individual was unable to extend her arms or legs to the requisite length. The one-repetition maximum (1RM) was determined to be the ultimate permissible extension with the maximal weight.

An adjustable digital hand dynamometer was employed to assess the maximum isometric strength of the forearm muscles through a handgrip test in both hands, following a previously established methodology. In summary, female participants were instructed to exert maximal grip while seated upright in a chair, with the hip, knee, and elbow flexed at 90°, the shoulder adducted and in a neutral rotation, the forearm in a neutral position, and the wrist slightly extended (0°—30°). Three grip-strength measures were obtained for each hand, and the optimal result was chosen for analysis. POWER TEST Medicine Ball Throwing A 2 kg medicine ball was utilized to assess ball throwing performance (BT) in accordance with established norms. In summary, women positioned themselves in a chair with their backs against the backrest, utilizing both hands to grasp the medicine ball in front of them, and were subsequently instructed to throw the ball as swiftly and as far as possible. Three attempts were allowed, with one-minute rest intervals between each attempt. Only the utmost effort was employed in the subsequent steps.

The examination comprised traversing 2.44 meters, rising from a chair, altering direction, and subsequently sitting down once more. The examination was administered in compliance with the aforementioned rules. Six-Minute Sit-to-Stand Test (STS). The examination necessitated rising from a chair and returning to the starting position while remaining seated, doing as many repetitions as possible within a 30-second timeframe. The assessment was conducted in compliance with the aforementioned guidelines. The Quality of Life Questionnaire designed for menopause (MENQOL) is administered during a structured interview, wherein participants complete the MENQOL. The Spanish translation of the questionnaire has been authorized for use with Chilean women. The MENQOL comprises 29 questions categorized into four domains: vasomotor, psychological, physical, and sexual well-being. The inquiry assesses the severity of a felt symptom, measured using an integer rating scale from 0 (no discomfort) to 6 (extreme discomfort). For scoring purposes, if the subject

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exhibited no symptoms for a question, her score was 1. If the subject exhibited a symptom rated at 1, her score was 2, continuing in this manner, with a maximum score of 8 for individuals reporting a symptom rated at 6. The average score for each area was utilized for analysis. STATISTICAL ANALYSIS The mean and standard deviation (SD) are utilized to report all values, while 90% confidence limits (CL) reflect the relative change in the dependent variable and effect sizes (ESs). The Shapiro-Wilk and Levene's tests were employed to assess the normality and homoscedasticity assumptions for all data before and after the intervention, respectively. The two-way ANOVA with repeated measures (Groups $\times$ Time) was employed to assess the training-related effect.

Table 1 Twelve-Week High-Speed Resistance Training Protocol versus Traditional Low-Speed Resistance Training Protocol

Exercises	EG	SG
	Bench press, standing row, leg press, and press, and leg extension.	
sets $\times$ Reps	3 $\times$ 10	3 $\times$ 10
Intensity (% 1RM)	35-45	45
Eccentric velocity(S)	5	5
Concentric velocity (S)	2 or less	5
Rest between sets (Min)	2-3	3-5

To calculate the pairwise difference from the mean value. Tukey's post hoc techniques were employed when a significant F statistic was seen across time or among groups. Tukey's post hoc methods were employed to ascertain the pairwise differences among the mean values, with a threshold established at $P < 0.05$ for statistical significance observed over time or between groups. In addition to null hypothesis testing, these data were assessed for clinical significance using a method based on the size of changes, with the threshold established at $P \leq P \leq 0.05$ for statistical significance. Threshold settings for assessing effect size magnitudes (changes represented as a multiple or proportion of the baseline standard deviation). For the diverse performance indicators, we observed a high intraclass correlation coefficient ranging from 0.87 to 0.99. No notable differences ($p > 0.05$) were detected among the groups for the descriptive and dependent variables at baseline. At baseline, no significant differences ($p > 0.05$) were observed between the groups for either the dependent or descriptive variables.

Between T1 and T2, there were no significant changes in height, body mass, or BMI for either group ($p > 0.05$). Similarly, the resting heart rate of neither group exhibited a significant shift ($p > 0.05$) between T1 and T2. Both the EG and SG exhibited a clinically significant increase ($p < 0.05$) in 1RMBP (63%, 2.1 ES), 1RMLP (45%, 1.7 ES), HGd (13%, 0.9 ES), and HGnd (23%, 0.9 ES) when comparing muscle performance from the pre- to post-training period (58%, 1.9 ES; 38%, 0.9 ES; 9%, 0.3 ES; 11%, 0.7 ES; respectively). However, there are no significant differences between the EG and SG regarding performance alterations in strength measurements. Both the Experimental Group (EG) and the Control Group (SG) (14%, 0.9 ES; 21%, 0.9 ES, respectively) exhibited a clinically significant improvement in Upper Grasp (UG) (-19%, -1.03 ES) and Sit-to-Stand (STS) (25%, 1.2 ES) performance in both functional tasks; the performance alterations in UG and STS for the EG and SG were statistically significant ($p < 0.05$). Their psychosocial (-39%, -1.3 ES) and physical (-29%, -1.1 ES) quality of life exhibited clinically significant improvement ($p < 0.05$) from T1 to T2, as did the SG (-36%, -0.7 ES; -32%, -0.8 ES). Conversely, the CG had no clinically significant alterations (Table 4). Table 4 indicates that the changes in the psychosocial and physical subscales for the EG were significantly ($p < 0.05$) larger than those for the CG, whilst the SG exhibited no such changes. Concerning the percentage changes in quality of life, no significant variations were seen between the EG and SG. Changes in psychosocial quality of life ($r = -0.49$, $p < 0.01$; $r = 0.37$, $p < 0.05$; $r = -0.39$, $p < 0.05$) and physical quality of life ($r = 0.37$, $p < 0.05$) were strongly linked with performance changes on the HGnd, UG, and STS tests.

This study evaluated the advantages of a 12-week high-velocity resistance training program against a low-velocity traditional resistance training program on the muscle strength, power, and quality of older women, as well as their ability to perform functional tasks. This study demonstrated that 12 weeks of high-speed and low-speed resistance training resulted in clinically significant enhancements in psychosocial and physical quality of life, as well as notable improvements in 1RMLP, 1RMBP, HGd, HGnd, BT, walking test duration, UG functional test, and STS performances, ranging from small to large in magnitude. Compared to the traditional low-speed RT protocol, the high-speed RT program resulted in significantly enhanced BT and UG functional test performance. These findings are unique and provide compelling evidence that high-speed resistance training improves muscular power and

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functional task performance in older women. Although the control group (CG) did not exhibit changes in their performance on these strength measures, the experimental group (EG) and the strength group (SG) showed comparable clinically significant enhancements in one-repetition maximum bench press (1RMBP) (63%, 2.1 effect size; 58%, 1.9 effect size, respectively), one-repetition maximum leg press (1RMLP) (45%, 1.7 effect size; 29%, 0.8 effect size, respectively), handgrip dominant (HGd) (9%, 0.4 effect size; 9%, 0.3 effect size, respectively), and handgrip non-dominant (HGnd) (23%, 0.9 effect size; 14%, 0.6 effect size, respectively). Our research indicates that both high-speed and low-speed resistance training significantly enhance maximal upper- and lower-body muscle strength in older women. The challenges faced by older individuals in executing daily activities and their overall quality of life correlate with maximal strength metrics; this observation reinforces the relationship between maximal strength and psychosocial quality of life. Moreover, maximal strength may serve as a significant predictor of age-related impairment and overall mortality. Maximal strength assessments, especially handgrip strength, are relatively straightforward to do, rendering them an effective predictive instrument for the elderly demographic. This trial was smaller following RT with an intervention of comparable length. This variation in training impact might be related to training specificity, given the aforementioned research employed analogous exercises as a training technique. The EG attains a training effect comparable to that previously found in women aged 60–70 and mixed-sex groups undergoing explosive strength training. EG demonstrated a much larger enhancement in BT performance (28%, 1.4 ES) compared to SG (14%, 0.9 ES), aligning with previous research on older women who participated in high-speed interventions. These data suggest that high-speed resistance training may exert a more significant influence on muscle power development in both upper and lower body muscles compared to traditional low-speed resistance training.

In older women, engaging in high-speed resistance training to enhance muscle power may be a more efficacious method for improving functional performance in daily activities, as muscle power is more closely associated with the execution of activities of daily living than muscle strength. The performance change in the experimental group was significantly ($p < 0.05$) correlated with the alteration in physical quality of life and the improvement in sit-to-stand test performance. This finding indicates that high-speed resistance training is a superior strategy for enhancing a fundamental functional activity, potentially leading to improvements

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in significant aspects of quality of life. Enhancements in walking performance can be maintained over prolonged durations. The advantages of resistance training, especially high-velocity resistance training, can persist for extended periods of detraining despite the cessation of resistance training. This is especially vital for older women participating in training programs that experience interruptions (due to illness or summer). The experimental group (EG) and the control group (SG) both exhibited substantial decreases in upper body (UG) test duration (-19% , -1.3 effect size, and -14% , -0.9 effect size, respectively); however, the performance improvement in the EG was significantly greater, akin to findings previously reported for older adults undergoing high-speed and traditional low-speed resistance training, respectively. This indicates that high-speed resistance training may be a more effective strategy for enhancing functional performance in older women.

The EG and SG exhibit similar improvements in maximum strength; however, the EG achieved enhanced performance in both lower-body and upper-body muscle power. These findings may elucidate the more pronounced decline in UG test performance observed in the EG, since muscular power is more closely associated with functional task performance and fall risk in older women than maximum strength. Aging-related neuromuscular atrophy may adversely affect the quality of life of the elderly, potentially associated with challenges in rising from a chair. Both the EG and SG exhibit a notable and comparable alteration in performance on the STS test, which assesses the functional status of older women (25% and 25% and 1.2 ES, respectively). Neuromuscular and morphological changes induced by ST in the lower limbs may correlate with differences in older women's performance on the STS test. Both high-speed and low-speed resistance training regimens can substantially improve lower limb neuromuscular and morphological responses.

While only muscular power is independently associated with the capacity to repeatedly stand and sit in a chair, variations in muscle strength and power may elucidate the performance enhancement observed in both resistance training groups. This indicates that muscular strength is more essential for the daily functioning activities of older women. This aligns with our findings, indicating that only the EG significantly ($p > 0.05$) enhances performance in the STS test relative to the CG. The examination of clinical significance indicates that the EG exhibits considerable clinical importance, whereas the SG demonstrates minimal significance. Given the advantages of high-speed resistance training (RT) yielding clinically significant outcomes,

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our findings may substantiate the notion that RT can aid in reversing neural and morphological aging-related atrophy and can markedly enhance crucial daily functional tasks, such as sitting and rising from a chair, in older women, thereby promoting their independence. The absence of additional physiological data to elucidate the underlying mechanisms of training-induced adaptations to both high-speed and low-speed resistance training was a notable limitation of the current investigation.

CONCLUSIONS

Although high-speed resistance training (RT) programs yield greater enhancements in muscular power and functional task performance, both low-speed and high-speed RT therapies effectively augment functional capacity, muscle performance, and quality of life in older women. A high-speed RT intervention is a safe, effective, and efficient method for improving the quality of life in older women, while also achieving significant and clinically relevant advancements in their neuromuscular and functional task performance associated with daily activities. When developing appropriate recreational therapy programs for senior persons, these findings must be considered. A conflict of interest: The authors declare no conflicts of interest.

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