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Original Article

Effect of Resistance Training Volume on Muscular Strength, Stability and Mobility in Sedentary Obese Elderly Women

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Introduction: There is limited knowledge regarding how different resistance training (RT) volumes affect musculoskeletal fitness adaptations. Hence, our study compared the efficacy of varied RT volumes in enhancing maximal strength, stability, and mobility among sedentary, obese older women.

Methods: Thirty sedentary, obese elderly women (mean age 64.57 ± 4.50 years; mean body mass index 32.34 ± 2.69 kg/m²) participated in this experimental design and were randomly assigned to control (C), low-volume RT (LVRT), and high-volume RT (HVRT) groups. Participants in the LVRT group performed one set of each exercise, while those in the HVRT group performed three sets. Both training groups trained twice weekly for 12 weeks. Assessments were conducted at baseline and post-intervention, including the Timed Up and Go (TUG) test, Sharpened Romberg test (SRT), walking and stepping up/down parameters, and whole-body maximal strength.

Results: Post-training, significant enhancements in maximal strength and SRT ($p = 0.001$ and $p = 0.019$, respectively) performance were observed in both the LVRT and HVRT groups when compared to the C. Notably, the magnitude of improvement in maximal strength was greater in the HVRT than in the LVRT. Furthermore, time of TUG ($p = 0.001$ and $p = 0.001$, respectively), walking ($p = 0.012$ and $p = 0.001$, respectively), stepping up ($p = 0.034$ and $p = 0.001$, respectively), and stepping down ($p = 0.016$ and $p = 0.001$, respectively) tests all showed significant reductions in the LVRT and HVRT groups relative to the C. In addition, the time of TUG ($p = 0.007$), stepping up ($p = 0.020$), and stepping down ($p = 0.001$) tests, demonstrated further significant reductions in the HVRT compared to the LVRT group.

Conclusion: RT improves strength, mobility in elderly obese women; higher volumes yield superior gains. These findings support HVRT incorporation to maximize functional benefits this population.

Keywords: Resistance Training, Postural Balance, Muscle Strength, Physical Fitness, Aging

Introduction

Physiological aging is characteristically marked by distinct shifts in body composition. These include a notable expansion of fat mass, especially concentrated in the central and visceral regions, alongside a reduction in fat-free mass. Such alterations are directly linked to an elevated susceptibility to both metabolic and cardiovascular diseases (1). A confluence of aging, sedentary lifestyles, and suboptimal dietary habits has driven a twofold increase in the prevalence of overweight and obesity within the general U.S. populace

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over the last decade. Specifically, recent estimates indicate obesity rates of 32.8% for non-Hispanic White women and 44.4% for Hispanic women aged over 60 years (2). Notably, overweight and obesity are more prevalent among older women compared to older men, with body composition changes accelerating in women during later life stages, often exacerbated by menopause (3). The convergence of aging and obesity significantly exacerbates the decline in muscle strength and physical functionality. This accelerated deterioration consequently impairs the ability to perform instrumental daily activities, diminishes independence, and reduces overall quality of life (4, 5). Ultimately, these factors contribute to an elevated risk of falls, increased morbidity, and higher mortality rates among older adults (2, 6-8). In reality, the age-associated decrement in skeletal muscle mass and muscular strength observed in older women detrimentally impacts their functional autonomy and survival (2, 8, 9).

Given these considerations, Resistance Training (RT) is widely acknowledged as a crucial element within exercise regimens tailored for older adults (2, 9). Nevertheless, the diverse methodologies and findings across studies concerning RT in the elderly present a challenge in determining the optimal parameters for exercise prescription (8). In light of these considerations, a comprehensive meta-analysis indicated that varied RT interventions, differing across parameters such as duration, volume, and intensity, have proven effective to some extent in counteracting the age-associated deterioration of lean body mass, muscle strength, and physical function among healthy elderly individuals (6).

One aspect that is frequently debated is exercise volume, specifically measured by the number of sets (4, 5). Nevertheless, consensus among experts on the optimal RT volume - defined as the total amount of work performed - a critical variable, has not yet been reached for healthy older adults. Radley et al., reported in their systematic review and network meta-analysis that while lower RT volumes yield considerable benefits for physical function, lean mass, and muscle size in healthy older adults across various program durations, greater volumes appear requisite for maximizing muscle strength gains (6). In a similar vein, Marques et al., through their systematic review and network meta-analysis, found that while single sets per exercise suffice for enhancing upper-limb strength, muscle size, and functional capacity in middle-aged and older adults, multiple sets per exercise yield superior gains in lower-limb strength and muscle quality within the same population (10). The research by de Souza Rocha et al., indicates a clear advantage for high-volume RT (HVRT) over low-volume RT (LVRT) in enhancing upper limb muscle strength, particularly in interventions exceeding twelve weeks; furthermore, HVRT consistently outperformed LVRT for lower limb strength regardless of the intervention's duration. This suggests a general trend where HVRT tends to yield superior improvements in functional fitness for older individuals, irrespective of how long the training lasts (11). In contrast, previous research by Barbalho et al., revealed comparable gains in muscle strength, endurance, and hypertrophy among older adults undertaking varied set protocols (8). Moreover, other studies did not observe differences in muscle size or quality (12-14) and functional gains (15, 16) when comparing single sets to multiple sets. This lack of distinction may be attributed to the untrained status of the participants, where even a minimal training stimulus seems adequate to enhance physical performance in older adults, particularly during the early stages of RT (10). However, it remains uncertain whether combining data from studies that investigate single versus multiple sets with different RT durations will ultimately favor one approach over the other in the long term. Recognizing time limitations as a common barrier to exercise adoption and adherence, the development of time-efficient programs is paramount (7, 8). If lower-volume training proves as effective as higher-volume training, its adoption could improve participation and adherence (17, 18). However, establishing whether increased sets offer enhanced results is necessary to properly assess the cost-benefit of reducing training volume. In light of escalating proportions of older adults within societal demographics and concurrent limitations in available resources, the pursuit of optimal time and cost-efficiency in physical activity programming becomes a critical imperative (7, 17, 18).

Functional fitness refers to the physical capacity required to perform the essential, everyday activities of life safely and independently (4, 5). It is not merely about strength or endurance in isolation, but rather the integrated capability of the musculoskeletal and neuromuscular systems working together. Key components include mobility, strength, endurance, and balance (2). Balance is understood as the ability to maintain an ideal posture, whether still or in motion. Achieving this optimal balance relies on intricate coordination between internal elements, such as proprioception and the auditory and visual systems, and muscular components (7). The aging process influences all elements involved in balance (19). Optimal balance serves as a crucial metric for assessing the functional independence of older adults. Consequently, researchers actively investigate and pinpoint the variables that influence balance, with the ultimate goals of enhancing mobility independence, promoting safety during both daily routines and athletic endeavors, and mitigating fall-related injuries (7). Despite these efforts, a review of existing literature reveals that while numerous exercise interventions have been tested on elderly populations to improve balance, the resulting outcomes have been inconsistent across different studies (19). Importantly, research is lacking that compares the effects of different RT volumes on balance and mobility in elderly obese women. Hence, this study was designed to compare the efficacy of varying RT volumes in enhancing maximal strength, stability, and mobility among sedentary, obese older women. Our hypothesis, based on the premise that differential loading elicits a superior training stimulus, posited that HVRT would yield greater improvements in muscular strength, stability and mobility compared to LVRT.

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Methods

Study design and participants

The required sample size was determined a priori using the G*Power statistical software, version 3.0.10 (Heinrich Heine University Düsseldorf, Düsseldorf, Germany). The parameters selected for the analysis were as follows: a significance level (α) of 0.05, a statistical power (1−β) of 0.80, a medium effect size (f) of 0.30, three groups, and two measurements. A total of thirty sedentary obese women from Mashhad City, northeastern Iran, were recruited to participate in this three-group pretest-posttest experimental design. Recruitment was conducted through word of mouth, social media advertisements, and fliers distributed to nursing homes. All participants completed the Baecke Physical Activity Questionnaire and the Physical Activity Readiness Questionnaire. Inclusion criteria for all participants were: (1) age over 60 years, (2) menopause status, (3) obesity (body mass index > 30 kg/m²), (4) physician-confirmed absence of musculoskeletal limitations or diseases preventing participation in physical activities, (5) no prior experience with RT or regular exercise for at least one year preceding the study, and (6) no current specialized dietary interventions or use of ergogenic supplements. Exclusion criteria were: (1) absence from more than three protocol sessions, or (2) development of any musculoskeletal injury that limited RT during the research period. Two weeks prior to the commencement of the research protocol, participants were familiarized with the techniques for RT (4, 5). Using simple randomization, participants were allocated to Control (C, n = 10), LVRT (n = 10), or HVRT (n = 10) groups. The characteristics of the study participants are presented in Table 1.

Measurements

Before the whole-body maximal strength assessments (One-Repetition Maximum, 1RM), participants completed two familiarization sessions. During the first session, subjects received detailed instruction on correct lifting techniques and equipment use, supervised by an experienced strength and conditioning coach. The second session ensured that all participants applied proper techniques. The main test session commenced with a standardized dynamic general warm-up, including 5 minutes on a cycle ergometer at light resistance. This was followed by a specific warm-up involving lifting light weights (10 repetitions at 40-60% of perceived 1RM) and light stretching exercises (4, 17). Subsequently, the load was progressively increased across 3 to 5 attempts to determine the 1RM, with a 3-minute rest period between each attempt (5, 18). 1RM was determined for all lifts included in the protocol both before the experimental intervention and after the completion of the LVRT and HVRT protocols (specifically, 3 sessions post-intervention). All 1RM assessments were conducted by the same coach.

Static balance was evaluated using the Sharpened Romberg test (SRT), wherein participants held a heel-to-toe stance with arms crossed on their chest in a quiet room. Three consecutive trials measured the duration of this static posture with eyes open (19). Mobility was assessed using the Timed Up and Go (TUG) test, a step test, and a walking test. For the TUG, participants stood up from a chair, walked to a cone 10 feet away, returned to the chair, and sat down. The walking test involved participants walking 25 feet at a comfortable yet quick pace, turning, and returning to the starting line. The step test required participants to walk up and down a flight of 8 stairs while carrying a 2.3 kg weight. For all mobility tests, participants were instructed to complete the tasks as quickly as safely possible. The time taken for each task was recorded as the score for each subject (20). The same researcher administered the stork test and all mobility assessments.

To evaluate the impact of fatigue, a Persian version of the Fatigue Severity Scale (FSS) was administered. The FSS comprises nine items, each rated on a 7-point Likert scale ranging from 1 (strong disagreement) to 7 (strong agreement). Participants were instructed to rate the severity of their fatigue. The total FSS score was calculated as the mean value across all nine items (21).

Table 1. Participant characteristics

Variables	Unit	Whole group
Age	(year)	64.57 ± 4.50
Weight	kg	79.17 ± 8.04
Body mass index	(kg/m2)	32.34 ± 2.69
Body fat	(%)	40.93 ± 2.11
Education		
Primary school	N (% of total)	18 (60)
High school	N (% of total)	9 (30)
University	N (% of total)	3 (10)
Marital status		
Married	N (% of total)	27 (90)
Widowed	N (% of total)	3 (10)

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Intervention

Subjects in the experimental groups underwent a 12-week RT program, performing two sessions per week on non-consecutive days. One group engaged in LVRT, completing one set per exercise, while the other performed HVRT, with three sets per exercise (4, 5, 17, 18). Participants executed the following exercises in sequential order: leg extension, lat pull-down, leg press, arm curl, leg curls, bench press, triceps extension, calf raises, low back extension, and crunch abdomen. A minimum 48-hour rest period was mandated between sessions. For both groups, training intensity was meticulously monitored using the repetition maximum (RM) method, ensuring that the heaviest possible load was utilized for the prescribed number of repetitions. The training intensity progressively increased throughout the 12-week intervention. During the initial four weeks (weeks 1-4), subjects trained at an intensity of 15-20 RM. This was advanced to 12-15 RM for weeks 5-8, and finally to 10-12 RM for weeks 9-12. If participants could perform more repetitions than prescribed for a given RM range, the load for that exercise was increased by 2.5 to 5.0 kg for the subsequent training session (18, 22, 23). For the HVRT group, a 2-minute rest interval was appropriated between sets. Repetitions were performed with a controlled cadence, lasting 6 to 9 seconds in total, consisting of a 2-3 second concentric phase, a 2-3 second isometric pause, and a 2-3 second eccentric phase (4, 5, 20). Each training session was preceded by a 10-15 minute warm-up that included cycling, stretching, and exercises with light weights. A similar 10-15 minute cool-down period, incorporating the same modalities, followed each session. Participants committed to consistent adherence to the prescribed program and were instructed to abstain from any other forms of exercise training (4, 5, 18, 22, 23]. Subjects in the control group did not engage in any structured exercise training. All supervised training sessions were carried out at the gymnasium of the Health Monitoring Center (Mashhad, Iran). Fidelity to the protocol was ensured through the continuous, direct supervision of a qualified professional in strength and conditioning.

Statistical analyses

All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) software (version 16.0; SPSS Inc., Chicago, IL, USA). Initially, data normality was assessed via the Shapiro-Wilk test. As all variables demonstrated a normal distribution, an Analysis of Covariance (ANCOVA) was employed to compare differences across the groups. Where significant F-values were observed, Bonferroni's post-hoc test facilitated pairwise comparisons. Furthermore, within-group changes were evaluated using paired t-tests. Statistical significance was set at $p < 0.05$. Data are presented as mean ± standard deviation.

Ethical considerations

Following a thorough explanation of the experimental procedures and potential risks, participants and their husbands provided written informed consent. This consent process was approved by the Ethics Committee for Human Use of the Islamic Azad University, Bojnourd Branch (IR.IAU.BOJNOURD.REC.1398.012). The study adhered to the principles of the 1975 Declaration of Helsinki and its subsequent 1996 revision. Participants were informed that they could withdraw from the protocol at any time without penalty or prejudice.

Results

Table 2 presents the results for upper- and lower-body maximal strength following the RT protocols. Regarding upper-body maximal strength, the study revealed significant increases in the 1RM for arm curl (p = 0.008 and p = 0.001), triceps extension (p = 0.005 and p = 0.001), lat pull-down (p = 0.013 and p = 0.001), and bench press (p = 0.004 and p = 0.001) in both the LVRT and HVRT groups compared to the C group at the end of the protocol. Furthermore, the HVRT group demonstrated significantly greater 1RM in arm curl (p = 0.033) and triceps extension (p = 0.021) compared to the LVRT group. However, no significant differences were observed between the HVRT and LVRT groups for lat pull-down (p = 0.182) and bench press (p = 0.130) 1RMs. The observed power for all parameters was greater than 0.99.

Regarding lower-body maximal strength, Table 2 indicates that the 1RM for leg extension (p =0.016 and p = 0.001), leg curl (p = 0.001 and p = 0.001), and calf raise (p = 0.014 and p = 0.001) were significantly higher in both the LVRT and HVRT groups compared to the C group post-intervention. The HVRT group also demonstrated a significantly higher 1RM for leg press than the C group (p = 0.018). Furthermore, the HVRT group exhibited significantly greater 1RMs in leg extension (p = 0.015), leg curl (p = 0.040), and calf raise (p = 0.001) compared to the LVRT group. However, no significant differences were observed between the HVRT and LVRT groups for leg press 1RM (p = 0.173). The observed power for all parameters was greater than 0.99.

Table 3 presents mobility measurement differences. Post-intervention, both the LVRT and HVRT groups showed significantly higher SRT times compared to the C group (p = 0.001 and p = 0.019, respectively), with no significant difference between LVRT and HVRT (p = 0.153). Conversely, the LVRT and HVRT groups exhibited significantly lower times for the TUG, walking, stepping up, and stepping down tests than the C group (TUG: p = 0.001 & p = 0.001; Walking: p = 0.012 & p = 0.001; Stepping up: p = 0.034 & p = 0.001; Stepping down: p = 0.016 & p = 0.001). Notably, the HVRT group achieved significantly lower times than the LVRT group in TUG (p = 0.007), stepping up (p = 0.020), and stepping down (p = 0.001), but not in walking (p = 0.101). The observed power for all parameters was greater than 0.99.

Table 4 indicates improvements in the FSS following the intervention. Mean FSS scores were significantly lower in the LVRT (p = 0.031) and HVRT (p = 0.001) groups relative to the C group. The HVRT intervention resulted in the most substantial decrease, as evidenced by significantly lower mean FSS scores compared to the LVRT group (p = 0.001). The observed power for FSS parameter was greater than 0.99.

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Table 2. Maximal strength changes in RT and C groups post-intervention

Variables	Group	Baseline	After training	Inter-group	Intra-group
Arm curl	C	15.01 ± 5.23	14.87 ± 5.43	t = 0.174, p = 0.867	F = 16.773
	LVRT	16.70 ± 3.52	21.40 ± 4.08*#	t = 4.413, p = 0.002	p = 0.001
	HVRT	18.55 ± 7.69	27.01 ± 7.33*#†	t = 6.764, p = 0.001	η2 = 0.59
Triceps extension	C	10.87 ± 3.79	11.25 ± 4.36	t = 0.999, p = 0.351	F=19.321
	LVRT	10.40 ± 3.43	15.80 ± 4.46*#	t = 5.062, p = 0.001	p = 0.001
	HVRT	13.50 ± 4.95	23.01 ± 6.59*#†	t = 7.109, p = 0.001	η2 = 0.64
Lat pull-down	C	21.25 ± 5.80	20.62 ± 6.65	t = 0.676, p = 0.521	F = 12.159
	LVRT	22.20 ± 4.89	25.50 ± 4.94*#	t = 4.514, p = 0.001	p = 0.001
	HVRT	22.50 ± 6.65	28.25 ± 6.45*#	t = 5.578, p = 0.001	η2 = 0.53
Chest press	C	18.75 ± 4.43	19.37 ± 4.17	t = 0.999, p = 0.351	F = 17.532
	LVRT	16.30 ± 2.16	22.01 ± 2.58*#	t = 5.300, p = 0.001	p = 0.001
	HVRT	19.90 ± 4.22	28.01 ± 5.37*#	t = 10.37, p = 0.001	η2 = 0.55
Leg exetension	C	32.50 ± 4.47	33.37 ± 5.62	t = 1.219, p = 0.262	F = 17.602
	LVRT	31.60 ± 3.40	36.10 ± 4.53*#	t = 5.400, p = 0.001	P = 0.001
	HVRT	35.33 ± 5.19	44.55 ± 7.23*#†	t = 8.561, p = 0.001	η2 = 0.61
Leg curls	C	16.75 ± 8.22	16.37 ± 7.81	t = 0.336, p = 0.747	F =2 9.355
	LVRT	16.10 ± 5.50	22.30 ± 6.53*#	t = 10.46, p = 0.001	p = 0.001
	HVRT	18.22 ± 7.96	28.01 ± 10.35*#†	t = 9.302, p = 0.001	η2 = 0.72
Calf raises	C	24.37 ± 7.28	25.25 ± 6.67	t = 0.778, p = 0.462	F = 26.923
	LVRT	25.55 ± 9.50	29.66 ± 10.24*#	t = 11.700, p = 0.001	p = 0.001
	HVRT	25.55 ± 7.68	34.01 ± 7.01*#†	t = 14.559, p = 0.001	η2 = 0.71
Leg press	C	45.87 ± 10.58	47.87 ± 9.77	t = 0.861, p = 0.418	F = 4.727
	LVRT	44.50 ± 10.91	50.60 ± 8.26*	t = 2.762, p = 0.022	p = 0.020
	HVRT	52.57 ± 10.86	64.01 ± 15.01*#	t = 5.090, p = 0.002	η2 = 0.53

Abbreviations: C, Control group; HVRT, High-volume resistance training; LVRT, Low-volume resistance training. Symptoms denote significant differences: * from baseline, # from the C group, and † from the LVRT group.

Table 3. Mobility changes in RT and C groups post-intervention

Variables	Group	Baseline	After training	Inter-group	Between-group
SRT (s)	C	37.75±17.71	36.62±18.61	t = 0.358, p = 0.731	F=12.372
	LVRT	29.31±16.16	41.37±16.93*#	t=3.894, p = 0.004	P=0.001
	HVRT	35.39±17.53	55.25±18.31*#	t=9.259, p =0.001	η2=0.52
TUG (s)	C	9.31±1.64	9.52±1.52	t=1.676, p=0.138	F=28.852
	LVRT	8.99±1.10	8.61±1.12*#	t=5.531, p=0.001	P=0.001
	HVRT	8.91±1.07	8.09±1.02*#†	t=8.073, p=0.001	η2=0.72
Walking (s)	C	21.37±1.75	21.77±2.10	t=0.789, p=0.456	F=13.286
	LVRT	20.56±1.98	19.45±2.35*#	t=6.065, p=0.001	P=0.001
	HVRT	20.18±2.28	18.06±2.33*#	t=8.273, p=0.001	η2=0.54
Stepping up (s)	C	8.52±1.40	8.59±1.06	t=0.451, p=0.666	F=14.539
	LVRT	8.10±1.39	7.28±1.32*#	t=2.342, p=0.044	P=0.001
	HVRT	7.72±1.15	5.95±1.12*#†	t=6.511, p=0.001	η2=0.56
Stepping down (s)	C	8.01±1.03	8.15±1.06	t=1.536, p=0.168	F=39.196
	LVRT	7.11±1.52	6.65±1.35 *#	t=3.929, p=0.003	P=0.001
	HVRT	6.90±1.05	5.20±1.20*#†	t=8.398, p=0.001	η2=0.77

Abbreviations: C, Control group; HVRT, High-volume resistance training; LVRT, Low-volume resistance training; SRT, Sharpened Romberg test; TUG, timed up and go. Symptoms denote significant differences: * from baseline, # from the C group, and † from the LVRT group.

Table 4. FSS changes in RT and C groups post-intervention

Variables	Group	Baseline	After training	Inter-group	Intra-group
FSS	C	4.68 ± 0.96	4.59 ± 0.91	t = 0.681, p =0.518	F = 26.784
	LVRT	4.50 ± 1.08	3.86 ± 0.88 *#	t = 7.479, p = 0.001	p = 0.001
	HVRT	4.23 ± 0.64	2.69 ± 0.88 *#†	t = 7.917, p = 0.001	η2 = 0.70

Abbreviations: C, Control group; FSS, Fatigue severity scale; HVRT, High-volume resistance training; LVRT, Low-volume resistance training. Symptoms denote significant differences: * from baseline, # from the C group, and † from the LVRT group.

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Discussion

Physical functioning in older adults deteriorates in a non-linear fashion, accelerating with increasing age. Physical exercise remains the only intervention shown to effectively boost muscle strength in old age, with RT being essential for preventing age-related declines in muscle strength (7). The primary purpose of this study was to compare the efficacy of differential RT volume regimens in augmenting maximal strength, stability, and mobility in a cohort of sedentary, obese older women. According to the findings of this research, the enhancement of whole-body maximal strength, stability, and mobility in sedentary obese older women is contingent upon the volume of resistance training interventions undertaken.

The current study's findings reveal significant gains in both upper and lower body muscle strength across both RT volumes when contrasted with the C group. Notably, the HVRT protocol yielded significantly superior improvements compared to its LVRT counterpart. These observed increases in maximal muscle strength align with previously published data on older adults (6, 11), reinforcing the established principle that greater RT volumes generally confer a higher potential for maximal muscle strength enhancement. The superior muscle strength adaptations observed are underpinned by the integrated neuromuscular and skeletal muscle responses instigated by HVRT (6). This comprehensive adaptive process is vital for mitigating age-associated physiological decrements, such as reduced spinal excitability (24), increased variability in motor unit discharge rates (25), a diminished incidence of doublet discharges, and alterations in cortical plasticity (26). Consequently, a more substantial RT volume may be indispensable for eliciting the specific neuromuscular modifications that enhance mobility in healthy older adults. In contrast to the notion of strict volume-dependence, certain research indicates that RT may yield similar results regardless of volume, specifically when comparing LVRT and HVRT. A case in point is the earlier dose-response meta-analysis by Borde et al., which found no significant association between the total number of RT sets and enhancements in muscle strength or size within an older adult population (≥ 60 years) (27). Similarly, Marques et al.'s meta-analysis pointed to very slight, non-substantial differences between LVRT and HVRT concerning lower limb muscle strength and muscle size among adults aged 50 years or older (10). Discrepancies in research findings regarding the comparative efficacy of HVRT and LVRT - where some studies (4, 9) favor HVRT, while others (10, 12-16, 27) report similar effects - can be attributed to several methodological variations. These include significant differences in participant demographics (age, sex, health status) across studies, the limited number of studies often included in analyses, the application of diverse meta-analytic models (meta-analysis vs. meta-regression), an absence of research systematically comparing distinct RT volume ranges (e.g., low, moderate, high), and a general lack of standardized operational definitions for RT volume (e.g., whether to consider exercises × sets, or to further incorporate repetitions and tempo). Strength gains following RT result from both neural adaptations and muscle hypertrophy. Initial increases are primarily driven by neural factors, involving enhanced motor unit recruitment, synchronization, and modulation of inhibitory processes. Structural increases from hypertrophy, characterized by greater myofibrillar cross-bridges, contribute to maximal force capacity in later stages of prolonged training (15). Given the short duration of the current intervention, the observed strength improvements are predominantly attributed to these rapid neural adaptations and technical skill learning. Enhanced gains in maximal muscle strength are primarily attributable to greater training volume, as elevated volume facilitates superior motor unit recruitment and synchronization, coupled with the attenuation of inhibitory feedback from both the golgi tendon organ and antagonistic muscle groups (17).

The present study revealed that while both RT groups surpassed the C group in mobility and balance improvements, the HVRT group specifically yielded significantly greater gains than the LVRT group. Regarding exercise modality and volume, multimodal training encompassing activities like resistance, aerobic, functional, and balance exercises shows a comprehensive impact on muscle strength, balance, and overall physical functioning (28). However, RT specifically has demonstrated the most consistent improvements in functional tasks (29), notably by counteracting age-related declines in functional mobility, as evidenced by enhanced gait speed, improved static and dynamic balance, and a reduced risk of falls (29). Furthermore, RT is recognized as vital for enhancing and preserving muscle strength, psychological well-being, quality of life, and healthy life expectancy (30), with the magnitude of these benefits being contingent upon the specific RT protocol employed (31). Consistent with the findings of the present study, Ransdell et al.; established that the magnitude of improvements in muscle mass, muscle strength, and functional fitness following RT is contingent upon the prescribed exercise dosage (32). The present study also revealed enhanced balance in all RT participants, with a more pronounced improvement observed in the HVRT group. Multicomponent exercise interventions have been associated with significant reductions in fall rates, with documented decreases of 17% (33) and 21% (34), thereby mitigating disability, morbidity, and mortality in community-dwelling older adults. Concurrently, RT has been highlighted by multiple studies as crucial for diminishing fall risk and injury incidence (7, 30, 32). Aligning with our results, the most substantial relative reductions in fall rates were observed in programs incorporating higher exercise volumes and balance components (7, 30, 34). According to Leitão et al., various RT protocols yielded comparable benefits in balance and reduced the risk of falls (31). This improvement in balance may stem from augmented lower body strength and muscle mass, which provide a more stable base of support, thereby decreasing fall risk (35). Furthermore, RT has been shown to enhance bone density, improve the metabolic capacity of skeletal muscle, and increase gait speed, all of which contribute to better balance (30). Moreover, it has been revealed that RT significantly induces neuromuscular activation,

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which is purported to be a primary factor responsible for increases in balance. When a moment of imbalance occurs between an individual's center of gravity and base of support, the nervous system responds by increasing muscular recruitment through efferent signaling. Nevertheless, it warrants consideration that muscle strength enhancements observed through RT may be responsible for muscular recruitment improvement. Consequently, an elevated ability to activate motor units is proposed as a possible mechanism for improvements in balance through RT (36).

Conclusion

While both LVRT and HVRT interventions lead to improvements in maximal strength, overall mobility and balance, HVRT regimens appear to induce greater gains specifically in sedentary, older women with obesity. Consequently, healthcare professionals and specialists working with geriatric populations can integrate these evidence-based programs to enhance the muscle strength, mobility and balance of older adults.

Study limitations

Despite the significant insights garnered, the scope of this investigation is constrained by several inherent limitations. Foremost among these is the restricted external validity, attributable to the small sample size composed exclusively of elderly women, which necessitates caution when extrapolating results to the general public. Increasing the participant cohort is crucial for establishing greater statistical inference. Secondly, the mechanistic interpretation remains partially obscured by the omission of detailed physiological profiling and the necessary surrogate markers required to fully delineate the adaptive cascade in response to both HVRT and LVRT.

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Conflict of interest

No conflict of interest has been declared by the authors.

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Authors' contributions

All authors contributed to the design and implementation of the study, analysis and interpretation of data, and to draft or modify the article. Data collection was carried out by ZF. All authors have read and approved the final version of the article.

References

1. Rossi AP, Bianchi L, Volpato S, Bandinelli S, Guralnik J, Zamboni M, et al. Dynapenic abdominal obesity as a predictor of worsening disability, hospitalization, and mortality in older adults: results from the InCHIANTI study. Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences. 2017; 72(8): 1098-104.
2. Fritz NB, Juesas Á, Gargallo P, Calatayud J, Fernández-Garrido J, Rogers ME, et al. Positive effects of a short-term intense elastic resistance training program on body composition and physical functioning in overweight older women. Biological Research for Nursing. 2018; 20(3): 321-34.
3. Pucci G, Alcidi R, Tap L, Battista F, Mattace-Raso F, Schillaci G. Sex-and gender-related prevalence, cardiovascular risk and therapeutic approach in metabolic syndrome: A review of the literature. Pharmacological Research. 2017; 120: 34-42.
4. TaheriChadorneshin H, Fattahi Z, Rashidi E. The effect of high and low volume resistance training on quality of life and endurance in elderly women. The Iranian Journal of Obstetrics, Gynecology and Infertility. 2023; 26(4): 26-35. [Persian]
5. Fattahi Z, TaheriChadorneshin H, Rashidi E, Abtahi-Eivary S. Effect of two different volumes of resistance training on serum level of fibroblast growth factor-21, body fat percentage and mobility in obese elderly women. The Iranian Journal of Obstetrics, Gynecology and Infertility, 2020; 23(10): 61-71. [Persian]
6. Radaelli R, Rech A, Molinari T, Markarian AM, Petropoulou M, Granacher U, et al. Effects of resistance training volume on physical function, lean body mass and lower-body muscle hypertrophy and strength in older adults: a systematic review and network meta-analysis of 151 randomised trials. Sports Medicine. 2025; 55(1): 167-92.
7. Aartolahti E, Lönnroos E, Hartikainen S, Häkkinen A. Long-term strength and balance training in prevention of decline in muscle strength and mobility in older adults. Aging Clinical and Experimental Research. 2020; 32(1): 59-66.
8. Barbalho MD, Gentil P, Izquierdo M, Fisher J, Steele J, de Azevedo Raiol R. There are no no-responders to low or high resistance training volumes among older women. Experimental Gerontology. 2017; 99: 18-26.
9. Ribeiro AS, Aguiar AF, Schoenfeld BJ, Nunes JP, Cavalcante EF, Cadore EL, et al. Effects of different resistance training systems on muscular strength and hypertrophy in resistance-trained older women. Journal of Strength & Conditioning Research. 2018; 32(2): 545-53.
10. Marques DL, Neiva HP, Marinho DA, Marques MC. Manipulating the resistance training volume in middle-aged and older adults: a systematic review with meta-analysis of the effects on muscle strength and size, muscle quality, and functional capacity. Sports Medicine. 2023; 53(2): 503-18.
11. de Souza Rocha JN, Pereira-Monteiro MR, Vasconcelos AB, Pantoja-Cardoso A, Aragão-Santos JC, Da Silva-Grigoletto ME. Different resistance training volumes on strength, functional fitness, and body composition of older people: a systematic review with

meta-analysis. Archives of Gerontology and Geriatrics. 2024; 119: 105303.
12. Antunes M, Kassiano W, Silva AM, Schoenfeld BJ, Ribeiro AS, Costa B, et al. Volume reduction: which dose is sufficient to retain resistance training adaptations in older women?. International Journal of Sports Medicine. 2022; 43(01): 68-76.
13. Cunha PM, Nunes JP, Tomeleri CM, Nascimento MA, Schoenfeld BJ, Antunes M, et al. Resistance training performed with single and multiple sets induces similar improvements in muscular strength, muscle mass, muscle quality, and IGF-1 in older women: a randomized controlled trial. The Journal of Strength & Conditioning Research. 2020; 34(4): 1008-16.
14. Correa CS, Teixeira BC, Bittencourt A, Lemos L, Marques NR, Radaelli R, et al. Effects of high and low volume of strength training on muscle strength, muscle volume and lipid profile in postmenopausal women. Journal of Exercise Science & Fitness. 2014; 12(2): 62-7.
15. Radaelli R, Brusco CM, Lopez P, Rech A, Machado CL, Grazioli R, et al. Higher muscle power training volume is not determinant for the magnitude of neuromuscular improvements in elderly women. Experimental Gerontology. 2018; 110: 15-22.
16. Abrahin O, Rodrigues RP, Nascimento VC, Da Silva-Grigoletto ME, Sousa EC, Marçal AC. Single-and multiple-set resistance training improves skeletal and respiratory muscle strength in elderly women. Clinical Interventions in Aging. 2014; 9: 1775-82.
17. Radaelli R, Botton CE, Wilhelm EN, Bottaro M, Lacerda F, Gaya A, et al. Low-and high-volume strength training induces similar neuromuscular improvements in muscle quality in elderly women. Experimental Gerontology. 2013; 48(8): 710-6.
18. Radaelli R, Botton CE, Wilhelm EN, Bottaro M, Brown LE, Lacerda F, et al. Time course of low-and high-volume strength training on neuromuscular adaptations and muscle quality in older women. Age. 2014; 36(2): 881-92.
19. Barzegari M, Shojaedin SS, Bayat Tork M. The effect of 8-week strength training, balance training and combined training on the dynamic and static balance of the elderly inactive men. Physical Treatments Specific Physical Therapy Journal. 2019; 9(1): 15-22. [Persian]
20. Fatouros IG, Kambas A, Katrabasas I, Nikolaidis K, Chatzinikolaou A, Leontsini D, et al. Strength training and detraining effects on muscular strength, anaerobic power, and mobility of inactive older men are intensity dependent. British Journal of Sports Medicine. 2005; 39(10): 776-80.
21. Fereshtehnejad SM, Hadizadeh H, Farhadi F, Shahidi GA, Delbari A, Lökk J. Reliability and validity of the Persian version of the fatigue severity scale in idiopathic Parkinson’s disease patients. Parkinson’s Disease. 2013; 2013(1): 1-7.
22. Hanssen KE., Kvamme NH, Nilsen TS, Rønnestad B, Ambjørnsen IK, Norheim F, et al. The effect of strength training volume on satellite cells, myogenic regulatory factors, and growth factors. Scandinavian Journal of Medicine & Science in Sports. 2013; 23(6): 728-39.
23. Cadore EL, Izquierdo M, Alberton CL, Pinto RS, Conceição M, Cunha G, et al. Strength prior to endurance intra-session exercise sequence optimizes neuromuscular and cardiovascular gains in elderly men. Experimental Gerontology. 2012; 47(2): 164-9.
24. Kido A, Tanaka N, Stein RB. Spinal excitation and inhibition decrease as humans age. Canadian Journal of Physiology and Pharmacology. 2004; 82(4): 238-48.
25. Christie A, Kamen G. Doublet discharges in motoneurons of young and older adults. Journal of Neurophysiology. 2006; 95(5): 2787-95.
26. Curtin D, Cadwallader CJ, Taylor EM, Andrews SC, Stout JC, Hendrikse JJ, et al. Ageing attenuates exercisenhanced motor cortical plasticity. The Journal of Physiology. 2023; 601(24): 5733-50.
27. Borde R, Hortobágyi T, Granacher U. Dose–response relationships of resistance training in healthy old adults: a systematic review and meta-analysis. Sports Medicine. 2015; 45(12): 1693-720.
28. Liu CJ, Chang WP, de Carvalho IA, Savage KE, Radford LW, Thiyagarajan JA. Effects of physical exercise in older adults with reduced physical capacity: meta-analysis of resistance exercise and multimodal exercise. International Journal of Rehabilitation Research. 2017; 40(4): 303-14.
29. Papa EV, Dong X, Hassan M. Resistance training for activity limitations in older adults with skeletal muscle function deficits: a systematic review. Clinical Interventions in Aging. 2017; 12: 955-61.
30. Fragala MS, Cadore EL, Dorgo S, Izquierdo M, Kraemer WJ, Peterson MD, et al. Resistance training for older adults: position statement from the national strength and conditioning association. Journal of Strength & Conditioning Research. 2019; 33(8): 2019-52.
31. Leitão L, Venturini GR, Junior RP, Monteiro ER, Telles LG, Araújo G, et al. Impact of different resistance training protocols on balance, quality of life and physical activity level of older women. International Journal of Environmental Research and Public Health. 2022; 19(18): 1-9.
32. Ransdell LB, Wayment HA, Lopez N, Lorts C, Schwartz AL, Pugliesi K, et al. The impact of resistance training on body composition, muscle strength, and functional fitness in older women (45–80 years): a systematic review (2010–2020). Women. 2021; 1(3): 143-68.
33. Sherrington C, Whitney JC, Lord SR, Herbert RD, Cumming RG, Close JC. Effective exercise for the prevention of falls: a systematic review and meta-analysis. Journal of the American Geriatrics Society. 2008; 56(12): 2234-43.
34. Sherrington C, Michaleff ZA, Fairhall N, Paul SS, Tiedemann A, Whitney J, et al. Exercise to prevent falls in older adults: an updated systematic review and meta-analysis. British Journal of Sports Medicine. 2017; 51(24): 1750-8.
35. Zouita S, Zouhal H, Ferchichi H, Paillard T, Dziri C, Hackney AC, et al. Effects of combined balance and strength training on measures of balance and muscle strength in older women with a history of falls. Frontiers in Physiology. 2020; 11: 1-13.
36. Boiko Ferreira LH, Schoenfeld BJ, Smolarek AC, McAnulty SR, Mascarenhas LP, Souza Junior TP. Effect of 12 weeks of resistance training on motor coordination and dynamic balance of older woman. Rejuvenation Research. 2021; 24(3): 191-7.

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