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Original Research

Similar Effects of 24 Weeks of Resistance Training Performed with Different Frequencies on Muscle Strength, Muscle Mass, and Muscle Quality in Older Women

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ABSTRACT

International Journal of Exercise Science 12(6): 623-635, 2019. The purpose of this study was to analyze the effects of 24 weeks of resistance training (RT) performed 2 vs. 3 times per week on muscle strength, muscle mass, and muscle quality in older women. Thirty-nine older women (≥ 60 years old) were randomly assigned to two groups according to RT frequency (G2x = two sessions per week, n=19; and G3x = three sessions per week, n=20) and were submitted to 24 weeks of whole-body RT, divided into two stages of 12 weeks. In the first stage, participants performed 1 set of 10 to 15 repetitions in each of eight exercise, whereas in the second stage, they performed 2 sets of 10 to 15 repetitions. Muscle strength was assessed by one repetition maximum (1RM) tests in chest press, knee extension, and biceps preacher curl, while the lean soft tissue was estimated by DXA. The muscle quality index was determined by the ratio between strength and lean soft tissue. There were observed similar increases between groups for muscle strength (G2x=19.5%; G3x=22.2%), lean soft tissue (G2x=3.0%; G3x=1.6%), and muscle quality index (G2x=16.0%; G3x=21.1%). These results indicate that RT-induced muscular adaptation occurs regardless of training twice or thrice a week in older women. Instructors, coaches and practitioners can choose their training frequency preference, since both frequencies provided similar adaptations.

KEY WORDS: Aging, elderly, strength training, weight training, muscle hypertrophy, volume

INTRODUCTION

The aging process is accompanied by several negative changes in the human body. Noteworthy are two phenomena observed in the neuromuscular system called dynapenia and sarcopenia. These conditions are characterized by marked reductions in muscle strength and muscle mass, respectively (17,23). In addition, reduction in muscle quality index (MQI; ratio of muscular strength to muscle mass) can be accomplished by a greater loss in muscle mass compared to strength with ageing. This ratio provides a valid indicator of muscle health and function as well as the general health status for this population (15,28). In order to reverse or attenuate these phenomena, resistance training (RT) has gained prominence due to its well-established efficiency in improving muscle morpho-functionality (1). In addition, having a higher level of muscle strength and quality is associated with higher functional fitness (22), life quality and expectancy in the elderly (10,21).

To maximally achieve RT-induced benefits, proper manipulation of the variables that compose the training program is deemed necessary, such as intensity (e.g. external load) (18,38), and volume (e.g. number of sets) (8,32,36). Regarding training volume specific to the number of RT sessions to be performed per week (i.e. weekly frequency), recent meta-analyzes indicate that the higher the frequency, the greater are the gains on strength (16) and hypertrophy (35). While there seems to be a dose-response in young adults until a certain point (16,35), for the elderly this does not seem to be the case (3,37). Discrepancies in study designs, training protocols, methods of assessing changes at muscular level, and initial training status of the participants are confounding factors that make interpretation of results somewhat ambiguous. Therefore, more homogeneous research is needed to answer the question of the effects of RT frequency on muscle performance and quality in the elderly (16). There is especially a need for longer duration studies, in which differences in the effects induced by protocols with different volume-dosages are more apparent (31,37). Furthermore, when considering long-term intervention studies, the results are still equivocal (12,39,40).

When aiming to verify RT-induced effects on muscular function in the elderly, the (MQI) may be an important aspect to verify the interaction between strength and muscle mass (2,14,15). The literature concerning dose-response of RT frequency for promoting changes in MQI is limited. Turpela et al. (40) verified greater gains in MQI with 3 compared to 2 and 1 times per week of RT, while Lera-Orsatti et al. (20) indicated similar increase between different frequencies. In the same way, there was indication that the differences in MQI between low- and high-volume protocols (1 vs 3 sets, performed 2x per week) may became statistically apparent only at the twentieth week of RT in older women (31).

Additionally, since the lack of time is reported as a barrier to joining and continuing in a training program by older adults (6), it is important to identify the extent to which smaller doses may provide similar significant responses to higher doses in this population. Gradually increasing the dose seems to be an interesting strategy to keep subjects in an exercise program rather than starting them with high doses and having a high drop-out rate (13). In this sense, the aim of the present study was to analyze the effect of 24 weeks of progressive RT with two different weekly frequencies on muscle strength, lean soft tissue, and muscle quality in older women. It was hypothesized that higher frequency would lead to better RT-induced adaptations.

METHODS

The present study is part of a longitudinal research project named the "Active Aging Longitudinal Study”, whose purpose is to analyze the behavior of neuromuscular, morphological, physiological, metabolic and behavioral indicators in older women submitted to RT. The study was executed over a total period of 30 weeks, with 24 weeks directed to the RT program, and 6 weeks used for data acquisition. At weeks 1-2 (pre-training), 15-16 (12 weeks), and 29-30 (24 weeks), anthropometric, body composition, and muscle strength measurements were performed. All participants were asked not to engage any other type of physical exercise during the training period. All testing and training procedures were conducted according to the Declaration of Helsinki and approved by the local University Ethics Committee. Figure 1 displays a flowchart of the study design.

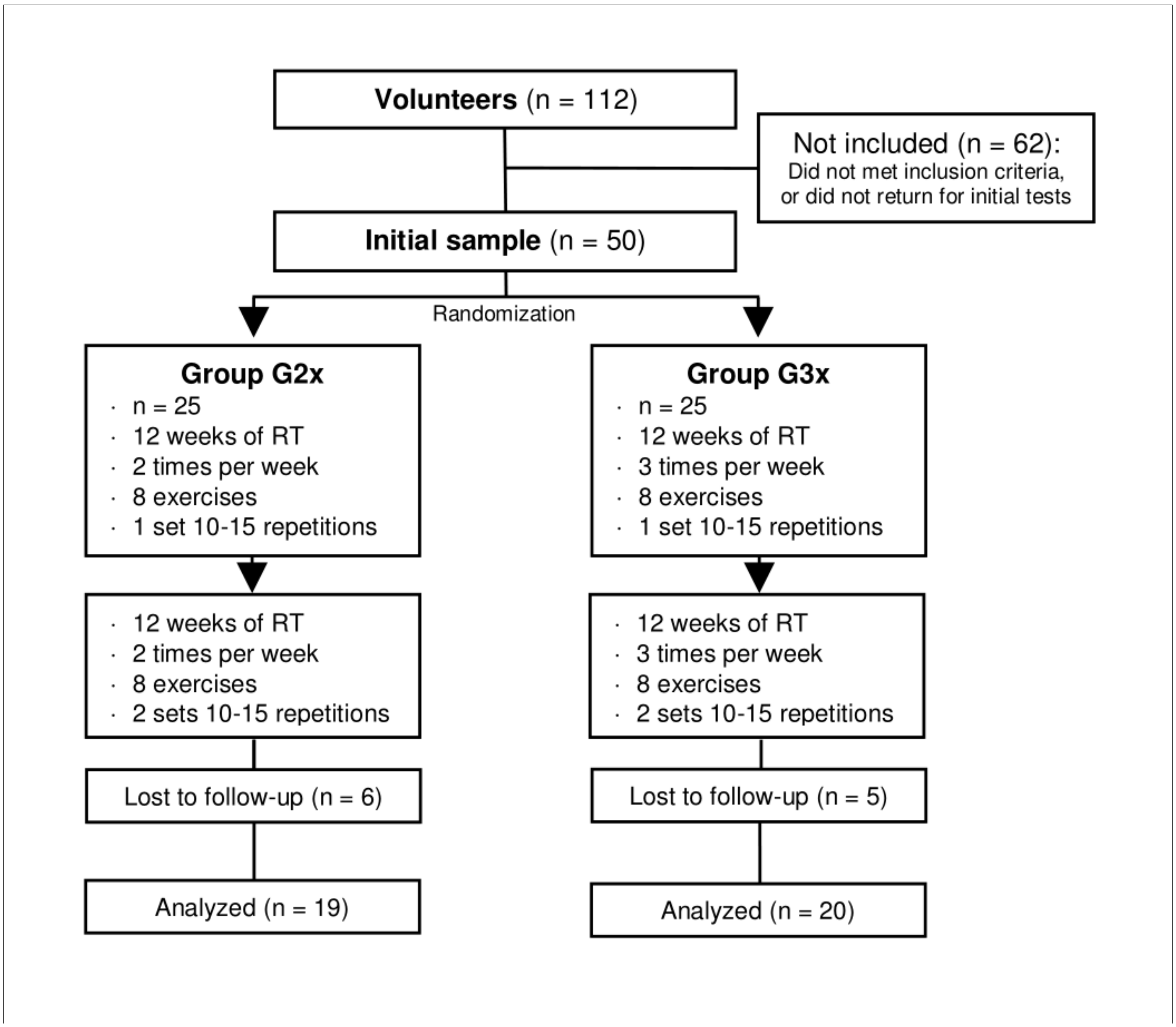

Figure 1. Experimental design (flow diagram).

Participants

For sample size calculation, type 1 error ($Z_{\square}$ = 1.96) and type 2 error ($Z_{\square}$ = 0.84) were assumed, with 95% confidence interval, with the ability to detect an increase of 10% in muscle strength

(34). Another 25% of subjects were added considering possible sample losses that could occur during the intervention (28). Recruitment was carried out through newspaper and radio advertisements, and home delivery of flyers in the central city area and residential neighborhoods. Interested participants completed detailed health history and physical activity questionnaires and were subsequently admitted to the study if they met the following previous inclusion criteria: female, ≥ 60 years old, physically independent, had no orthopedic conditions that would prevent them from performing the prescribed exercise or exercise testing associated with the study, and were not receiving hormonal replacement therapy.

Therefore, 112 elderly women spontaneously volunteered for the project and underwent personal interviews (which intervention was explained in detail) at the laboratory. Subsequently, 50 physically independent women who met all inclusion criteria and return to laboratory for initial analysis were evaluated by a cardiologist (resting 12-lead electrocardiogram test, personal interview, and treadmill stress test when deemed necessary) and released with no exclusions to exercise. Written informed consent was obtained from all participants. Regarding the participants' training background, they were members of the Active Aging Longitudinal Study and had a brief three-month introduction to RT, but had been untrained for 24 weeks prior to this study.

Subsequently, participants were randomly assigned to one of the two groups: one group performed RT 2 times/week (G2x) while the other group performed RT 3 times/week (G3x). As an exclusion criterion, at the end of the study, participants who did not obtain a training adherence of at least 80% during each stage of the study were not included in the analyses. Eleven women did not complete the study for personal reasons, travelling, health problems or surgeries not related to RT practice, and lack of time. Thirty-nine participants ultimately completed the study and were included for final analyses (G2x: n = 19; age = 68 ± 6 years; weight = 64.1 ± 13.8 kg; height = 155.9 ± 5.9 cm; BMI = 26.3 ± 5.0 kg/m^2. G3x: n = 20; age = 69 ± 7 years; weight = 66.4 ± 16.0 kg; height = 156.2 ± 7.0 cm; BMI = 27.1 ± 5.3 kg/m^2).

Protocol

Maximal dynamic strength was evaluated using 1RM tests assessed on chest press, knee extension, and preacher curl, performed in that order. Testing for each exercise was preceded by a warm-up set (6-10 repetitions) with approximately 50% of the estimated load used in the first attempt of the 1RM. This warm-up was also used to familiarize the subjects with the testing equipment and lifting technique. The testing procedure was initiated two minutes after warm-up. During the 1RM tests, participants were encouraged to attempt to accomplish two repetitions with the imposed load and given three attempts to reach a maximum in all exercises. The rest period was 3 to 5 min between each attempt and 5 min between exercises. Execution technique for each exercise was standardized and continuously monitored to ensure reliability. All 1RM testing sessions were supervised by experienced researchers for greater safety and integrity of the participants. Verbal encouragement was given throughout each test. Three 1RM sessions were performed separated by 48hrs (ICC ≥0.96), and the 1RM was recorded as the heaviest weight lifted in which the subject was able to complete one maximal execution among the three sessions (26).

Body composition was determined for trunk, lower- and upper-limb lean soft tissues (LST) by dual-energy X-ray absorptiometry (DXA) (Lunar Prodigy, model NRL 41990, General Electric Lunar, Madison, WI). Skeletal muscle mass (SMM) was estimated by the equation proposed by Kim et al. (19) as follows: SMM (kg) = (appendicular LST × 1.69) - 1.65. Prior to scanning, participants were instructed to remove all objects containing metal. Scans were performed with participants lying in the supine position along the table's longitudinal centerline axis. Feet were secured together at the toes to immobilize the legs while the hands were maintained in a pronated position within the scanning region. Both calibration and analysis were carried out by a skilled laboratory technician, following the manufacturer's recommendations. The software generated standard lines that set apart the limbs from the trunk and head. The same technician adjusted these lines using specific anatomical points determined by the manufacturer and performed analyses during the intervention. Previous test-retest scans resulted in a standard error of measurement (SEM) of 0.290 kg and intraclass correlation coefficient (ICC) of 0.997 for fat-free mass.

Muscle quality was expressed according to the recommendations of Fragala et al. (15) as the ratio of the muscle strength obtained in the 1RM tests (kg) to lean soft tissue of the trunk (TRMQ), lower limbs (LLMQ), and upper limbs (ULMQ), as follows:

TRMQ = Chest press 1RM (kg) / Trunk lean soft tissue (kg)
LLMQ = Knee extension 1RM (kg) / Lower limbs lean soft tissue (kg)
ULMQ = Preacher curl 1RM (kg) / Upper limbs lean soft tissue (kg)

The supervised RT was performed in the morning hours during the 24 weeks. The protocol was based on recommendations for RT in an older population to improve muscular endurance and muscular strength (1). Physical education professionals personally supervised all participants during the intervention to ensure consistent and safe performance. Participants performed RT using a combination of free weights for the preacher curl and machines for the other exercises. Both training groups underwent the same RT program composed of eight exercises performed in the following order: seated chest press, horizontal leg press, seated row, knee extension, preacher curl, leg curl, triceps pushdown, and seated calf raise. Each exercise was performed in 1 set of 10-15 repetitions maximum for the first 12 weeks, and then 2 sets of 10-15 repetitions maximum during the last 12 weeks. Participants were afforded 2 to 3 min of rest between each exercise. The G2x performed RT twice a week (Tuesdays and Thursdays), while G3x performed 3 sessions a week (Mondays, Wednesdays, and Fridays).

Initial training load was set at approximately 60% of 1RM for tested exercises (1). Adjustments in initial training load on these exercises and selection of initial load for the others non-tested exercises were done based on professional trainers' experience. Progression of training load (Figure 2) was planned so that when 15 repetitions were completed for two consecutive sessions in an exercise, weight was increased 2-5% for the upper limbs exercises and 5-10% for the lower limbs exercises (1). During the RT intervention, each individual's volume-load was calculated for each exercise as weight x repetitions. The volume-load for each session was determined as the sum of each exercise volume-load. Weekly (WVL) and total volume-loads (TVL) were also calculated in a similar manner.

Statistical Analysis

Normality was checked by the Shapiro-Wilk's test. Non-normal variables were analyzed with $\log_{10}$ adjustment. The data were expressed as means, standard deviations, and 95% confidence intervals. Levene's test was used to analyze the homogeneity of variances. Pre-training differences between groups were explored with an independent t-tests. Analysis of variance for repeated measures was used for within- and between-group comparisons. If the sphericity assumption was violated as indicated by Mauchly´s test, a Greenhouse-Geisser correction was used when epsilon was below 0.750, and Huynh-Feldt correction was used when epsilon was above 0.750. When an F-ratio was significant, Fisher´s post hoc test was employed to identify mean differences. Effects sizes (ES) were calculated as post-training (24 weeks) minus pre-training mean divided by the pre-training standard deviation (7). An ES of 0.00–0.19 was considered as trivial, 0.20–0.49 as small, 0.50–0.79 as moderate, and ≥ 0.80 as large (7). For all analyses, a $P < 0.05$ was accepted as statistically significant. The data were stored and analyzed using SPSS software version 23.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

There were no significant differences between groups at pre-training for any variable analyzed ($P > 0.05$). Figure 2 presents the WVL for the two groups. As expected, throughout 24 weeks of the program, WVL of G3x was greater ($P < 0.05$) than that of G2x. For the TVL, G3x performed 58% greater volume (150.9 ± 21.5 tons) comparing to G2x (95.4 ± 14.3 tons); however, percentage progression in VL from week 1 to week 24 were similar between groups (G2x = 199%, ES = 3.44; G3x = 193%, ES = 3.48; $P = 0.245$). Regarding training attendance, G2x (93 ± 5%) and G3x (92 ± 8%) were not significantly different between groups ($P = 0.645$).

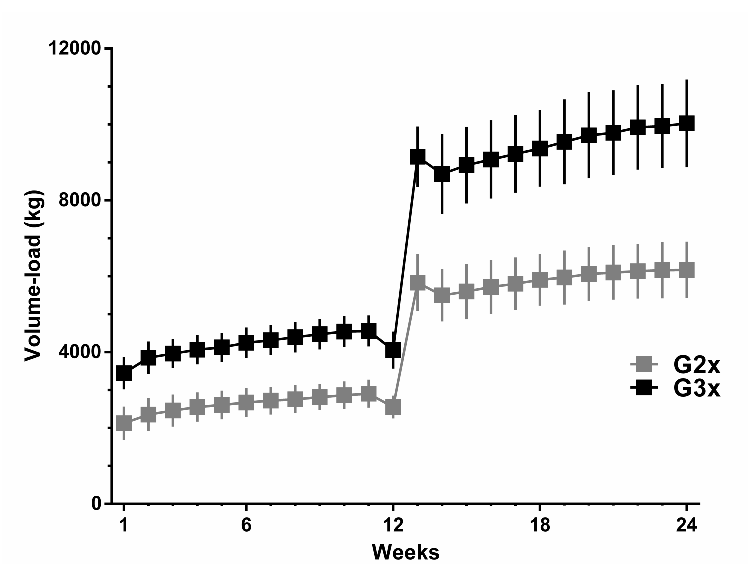

Figure 2. Weekly volume-load according to groups. During all the weeks, the training volume of the G3x was greater (P < 0.001) than that of the G2x. Data are presented as mean and standard deviation.

Changes in 1RM muscular strength and LST are presented in Table 1. After the first 12 weeks, both groups increased similarly the 1RM scores in the three tested exercises. Improvements were also similar for both groups after 24 weeks in chest press, knee extension, and preacher curl. The increase from 12 to 24 weeks was also similar between the groups. A main effect of time was observed for estimated skeletal muscle mass ($P < 0.001$) and all three regions for LST, in which there were no observed significant gains after the first 12 weeks, but only after 24 weeks of RT for both groups. There was no significant interaction effect for these variables. No significant difference between G2x and G3x was observed at either time point.

Values for MQI are presented in Table 2. Again, both groups increased similarly in all three measures after 12 weeks and further after 24 weeks. Only for the ULMQ, was there observed a significant interaction effect, wherein G3x improved better than G2x. The Figure 3 depicts the individual percentage changes between baseline and 24 weeks on MQI according to groups.

Table 1. Muscle strength and mass at pre-training, weeks 12 and 24, according to weekly frequency.

	G2x (n = 19)	G3x (n = 20)	ANOVA *P* values	
Chest press 1RM (kg)				
Pre-training	36.6 ± 6.5	41.2 ± 8.4	Time	< 0.001
12 weeks	40.5 ± 6.7*	45.3 ± 9.1*	Group	0.06
24 weeks	42.7 ± 6.8*†	48.2 ± 9.2*†	Interaction	0.38
Knee extension 1RM (kg)				
Pre-training	42.1 ± 8.6	45.1 ± 12.8	Time	< 0.001
12 weeks	46.7 ± 9.4*	51.1 ± 12.7*	Group	0.28
24 weeks	49.9 ± 10.5*†	54.5 ± 13.2*†	Interaction	0.21
Preacher curl 1RM (kg)				
Pre-training	18.5 ± 3.2	19.7 ± 3.2	Time	< 0.001
12 weeks	20.9 ± 3.8*	22.5 ± 3.9*	Group	0.13
24 weeks	22.8 ± 4.0*†	25.4 ± 4.0*†	Interaction	0.07
SMM (kg)				
Pre-training	19.3 ± 3.7	19.8 ± 3.5	Time	< 0.001
12 weeks	19.8 ± 3.7	20.0 ± 3.2	Group	0.79
24 weeks	20.1 ± 3.7*	20.1 ± 3.3*	Interaction	0.13
TRLST (kg)				
Pre-training	19.4 ± 2.9	19.8 ± 3.2	Time	0.01
12 weeks	19.6 ± 3.0	19.9 ± 3.1	Group	0.67
24 weeks	19.9 ± 3.1*	20.0 ± 2.9*	Interaction	0.11
LLLST (kg)				
Pre-training	13.4 ± 2.4	13.6 ± 2.3	Time	< 0.001
12 weeks	13.7 ± 2.4	13.8 ± 2.1	Group	0.85
24 weeks	13.8 ± 2.4*	13.8 ± 2.0*	Interaction	0.15
ULLST (kg)				
Pre-training	4.3 ± 0.8	4.4 ± 0.8	Time	0.01
12 weeks	4.3 ± 0.8	4.4 ± 0.8	Group	0.65
24 weeks	4.4 ± 0.8*	4.5 ± 0.8*	Interaction	0.21

Note. SMM = skeletal muscle mass. TRLST = trunk lean soft tissue. LLLST = lower limbs lean soft tissue. ULLST = upper limbs lean soft tissue. *$P < 0.05$ vs. Pre-training. †$P < 0.05$ vs. 12 weeks.

Table 2. Muscle quality of older women at pre-training, after 12 and 24 weeks of resistance training performed in different weekly frequencies.

	G2x (n = 19)	G3x (n = 20)	ANOVA *P* values	
TRMQ				
Pre-training	1.9 ± 0.3	2.1 ± 0.4	Time	< 0.001
12 weeks	2.1 ± 0.3*	2.3 ± 0.4*	Group	0.07
24 weeks	2.2 ± 0.3*†	2.4 ± 0.4*†	Interaction	0.43
LLMQ				
Pre-training	3.2 ± 0.5	3.3 ± 0.9	Time	< 0.001
12 weeks	3.4 ± 0.6*	3.7 ± 0.8*	Group	0.36
24 weeks	3.6 ± 0.8*†	4.0 ± 0.9*†	Interaction	0.10
ULMQ				
Pre-training	4.4 ± 0.6	4.5 ± 0.7	Time	< 0.001
12 weeks	4.9 ± 0.6*	5.1 ± 0.9*	Group	0.20
24 weeks	5.2 ± 0.5*†	5.8 ± 0.9*†§	Interaction	0.02

Note. TRMQ = trunk muscle quality. LLMQ = lower limbs muscle quality. ULMQ = upper limbs muscle quality. *P < 0.05 vs. Pre-training. †P < 0.05 vs. 12 weeks. §P < 0.05 vs. G2x.

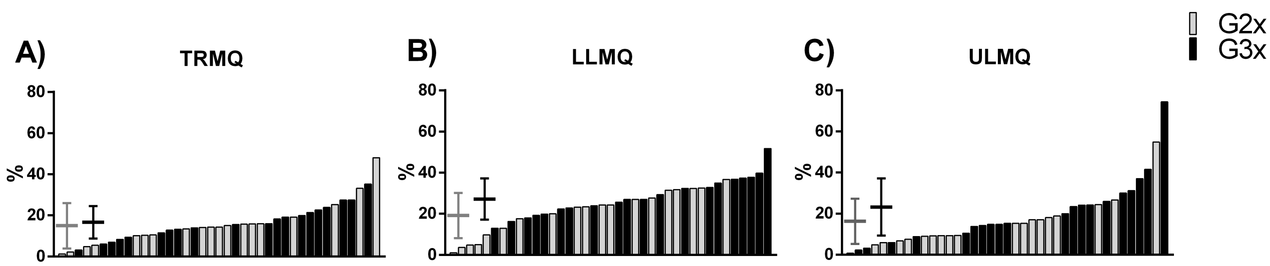

Figure 3. Individual values of percentage changes from baseline to 24 weeks in muscle quality index according to groups. Each bar represents a subject. Marks in the left of each panel represents mean and standard deviation of pre-to-post percentage changes according to groups. In Panel A, Panel B, and Panel C is respectively presented values of trunk muscle quality (TRMQ), lower limbs muscle quality (LLMQ), and upper limbs muscle quality (ULMQ).

Table 3 depicts the effect size values for groups as well as the difference between them. ES for 1RM and MQI were large for both groups while those for LST were trivial. The ES of the difference between groups were trivial-to-small (from 0.06 to 0.39) for analyzed variables.

DISCUSSION

The main finding of our study suggests that performing RT for 24 weeks promotes significant gains in 1RM strength, LST and MQI in older women, regardless of whether it is performed twice or three times a week. This was opposite to our initial hypothesis that greater frequency would produce greater changes. In particular, effect sizes (Table 3) did not show a regularity in either direction of magnitude of RT adaptations (favoring neither G2x or G3x), which would suggest a lack of a dose-response pattern for these frequencies in older women.

In regard to muscular strength, our results showed that both training frequencies produced similar gains for all three exercises tested (for both upper and lower body), corroborating the findings of other studies (3) but differing from a recent work (40) that presented a dose-response (i.e. 3 > 2 ≥ 1 $d \cdot w^{-1}$) for leg-press 1RM strength gain after 24 weeks of RT in older adults. Although other studies with shorter duration showed a potential advantage of higher frequencies to obtain better results (11), the findings of our study reinforce recent meta-analysis propositions indicated almost equal strength gains for 2 vs. 3 RT sessions per week (3,16). It has been suggested that training frequency should be increased beyond 2-3 $d \cdot w^{-1}$ after the initial stages of training in RT practitioners (1); in this sense, our results indicate that during the first 6 months after the start of a RT program, such an increase in volume (driven by increase in frequency) does not need to be performed, even if the subject is detrained. Similarly, previous studies demonstrate that greater training volume does not seem to be necessary during the initial stages of training for improving strength in elderly (9,31). Besides, considering the effect of the specificity principle on 1RM strength gain (5,24,27), it seems logical that increases in 1RM would be similar between groups once that they had similar increases in training VL (Figure 2). Previous work with older women also found similar strength gains comparing different RT volumes, and this was also attributed to the similar increases in training load (9).

Table 3. Effect sizes values calculated between measurements from baseline and 24 weeks according to groups for analyzed variables.

	G2x ES	G3x ES	Difference
Chest press 1RM	0.92	0.78	-0.14
Knee extension 1RM	0.82	0.73	-0.09
Preacher curl 1RM	1.19	1.58	0.39
SMM	0.20	0.08	-0.12
TRLST	0.17	0.06	-0.11
LLLST	0.21	0.11	-0.10
ULLST	0.16	0.09	-0.07
TRMQ	0.86	0.83	-0.06
LLMQ	0.81	0.67	-0.15
ULMQ	1.51	1.65	0.15

Note. ES = effect size. Relative ES = G3x ES minus G2x ES. SMM = skeletal muscle mass. TRLST = trunk lean soft tissue. LLLST = lower limbs lean soft tissue. ULLST = upper limbs lean soft tissue. TRMQ = trunk muscle quality. LLMQ = lower limbs muscle quality. ULMQ = upper limbs muscle quality.

Regarding the results on LST, although literature indicates that increases in muscle mass occurs in a volume-dependent and dose-response manner (29,35,42), our results were not in line with this. It is suggested that a low number of sets (< 5 weekly sets) per week, as we prescribed for the participants, is suboptimal for generating hypertrophic gains (36). However, in opposition to a previous study (40) that did not observe alterations on LST or CSA in trained muscles after 24 weeks of RT, we observed increases of trivial magnitudes. Improvements in LST were similar to previous studies in a similar sample (9,28), and in line with recent meta-analysis (36), but only when analyzing data from baseline to 24 weeks of training. That said, it is important to note that both groups had no changes in the subfractions of body LST in the first 12 weeks, but showed significant gains (although minor) only in the second phase of the study when the training volume was augmented. The lack of expressive gains might have diluted the potential differences between groups. Moreover, it should also be noted that, similar to previous studies (12,39,40), we did not obtain data referring to the subjects' dietary intake. Thus, since older individuals tends to present an insufficient habitual protein intake below the recommended and necessary level for optimal RT-adaptations (25), it is plausible that reduced protein intake would minimize the expected differences in LST gains between different RT protocol volumes. Differences between studies regarding gains on LST could be designated to the lack of assessment of dietary intake (12,30,33,39,40), as previously stated (30).

Similar adaptations between both groups were observed also for MQI; which is in agreement with a previous study (20). Increases in MQI scores represent greater strength gains per unit of LST. As there was observed significant difference between groups in ULMQ only after 24 weeks of RT, and in addition to previous findings (31), it seems that higher training volumes may be necessary to elicit significant greater adaptations on MQI only after longer intervention periods and/or when RT is performed with a moderate number of sets per week (> 5 sets) (36). Nevertheless, although there was a significant difference between the groups for the ULMQ, this was of trivial magnitude (effect size: 0.15) and likely not of practical meaningfulness. The mechanisms related to improvements in MQI may be related to other factors such as neural adaptations, muscle fiber re-innervation, alterations in muscle architecture, and/or a reduction in intramuscular fat deposits (15).

The current study has some limitations. First, although RT has been shown to be effective for improving the variables analyzed herein, a control group to determine a true effect size of the intervention would be required. Second, dietary intake, physical activity, and sedentary behavior were not monitored during the experiment, hindering our ability to determine whether these factors exerted an influence on changes in the measured variables across the study period. Third, the use of DXA, while a reference standard for measuring LST (4), may lack the sensitivity to detect subtle changes in muscle tissue compared to more direct imaging measures such as MRI and computed tomography. Regarding the MQI score, although it has been presented that it may confer a greater acute view of the aspect of the muscle (2,14), it is still questionable whether or not this score may provide a greater interpretation of the chronic adaptations on strength and LST. That is, if a training condition produced superior growth and similar strength adaptations compared to another condition, the group that had more growth would have lower MQI; this seems not to be more important than increases in strength and mass separately. Future studies directed at maximizing each component separately are warranted to determine the directionality of change in MQI and its impact on activities of daily living in the elderly. An additional consideration might be the tools used to measure these variables and the variability they provide in the parameters under investigation (41).

It appears that the functional capabilities of muscle in elderly women can be enhanced with minimal engagement in RT. Using low volume may require a longer period for meaningful changes to appear in muscle strength and MQI, but such an approach might enhance attendance and minimize dropouts. Further research contrasting higher dosages and greater volume with the current model seems warranted.

From a practical standpoint, these results further our understanding as to the manipulation of resistance exercise variables when developing programs for older women. A flexible approach to training frequency can be used according to individual preferences and still maintain a progressive responsiveness to the training program. Moreover, it is relevant to mention that two RT sessions per week is less time consuming compared to three sessions per week, which could aid in overcoming lack of time as a reason not to train. In summary, RT prescription should consider an individual's lifestyle and preferences when determining the volume of training, as this may improve motivation and adherence to exercise.

We conclude that 24 weeks of RT increases muscle strength, LST and MQI in older women with some experience in RT, regardless of training frequency. RT performed two times weekly promotes similar gains compared to three weekly sessions.

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