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Linear and undulating resistance training programming induce similar outcomes on physical fitness in elderly women

Programações linear e ondulatória do treinamento de força induzem a mesmos resultados na aptidão física em mulheres idosas

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Abstract - The aim of the present study was to analyze the effect of two different types of resistance training programming (linear and daily undulating) on submaximal strength and functional capacity in elderly women. Twenty-two participants (64 ± 3 years) were randomly assigned to 2 training groups: linear programming (LP; n=12) and daily undulating programming (DUP; n =10). Functional capacity and submaximal strength (10RM) were analyzed before and after 12 weeks of resistance training. The results demonstrated improvement on strength and functional capacity after the resistance training period ($p \leq 0.05$), except for the Bench Press ($p = 0.30$), for both groups DUP and LP. The Effect Size was, respectively, high for DUP (timed up and go test = -2.07, and timed sit test= 4.69), and high for LP (horizontal leg press = 2.35). For all other results, the effect size was trivial or small. No statistical difference was observed between programming models. The LP and DUP trainnings have similar results in increasing submaximal muscle strength in elderly women inexperienced in RT after 12 weeks of intervention ($p \leq 0,05$). However, DUP appears to be more effective in increasing functional capacity. In practice, the professional can use both the LP and the DUP to improve the level of fitness in the early stages of training in this population. However, when the goal of programming is to increase functional capacity, DUP can be prioritized.

Key words: Aging; Exercise; Muscle strength; Physical functional performance; Resistance training.

Resumo - *O objetivo do presente estudo foi analisar o efeito de dois tipos diferentes de programação do treinamento de força (linear e ondulatório diário) na força submáxima e na capacidade funcional de mulheres idosas. Vinte e duas participantes (64 ± 3 anos) foram randomizados em 2 grupos experimentais: programação linear (PL; n=12) e programação ondulatória diária (POD; n=10). A capacidade funcional e a força submáxima (10RM) foram avaliadas antes e depois das 12 semanas de treinamento de força. Os resultados demonstraram melhora da força submáxima e da capacidade funcional após o período de treinamento ($p \leq 0,05$), exceto para o exercício supino ($p = 0,30$), para ambos os grupos POD e PL. Foi encontrado um tamanho de efeito grande para a POD nos testes de sentar e caminhar = -2,07 e teste de sentar e levantar = 4,69, bem como na PL para o exercício leg press horizontal = 2,35. Não foi observada diferença estatística entre os modelos de programação. As programações LP e DUP têm resultados semelhantes no aumento da força muscular submáxima em mulheres idosas inexperientes em TR após 12 semanas de intervenção ($p \leq 0,05$). No entanto, o DUP parece ser mais eficaz para aumentar a capacidade funcional. Na prática, o profissional pode usar tanto o LP quanto o DUP para melhorar o nível de condicionamento físico nos estágios iniciais do treinamento nessa população. Porém, quando o objetivo da programação é aumentar a capacidade funcional, o DUP pode ser priorizado.*

Palavras-chave: *Desempenho físico funcional; Envelhecimento; Exercício físico; Força muscular; Treinamento de resistência.*

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INTRODUCTION

The systematic organization of training is used to increase, acquire and realize the achievement of specific performance goals (e.g., endurance, strength-endurance, strength, power, speed)[1-5]. Scientific evidence demonstrates that the systematic organization of resistance training contributes more effectively to increased strength compared to non-organized training programs[6]. The strength is relevant due prevent loss of lean body mass associated with sarcopenia, and improve performance[2], both important to maintain or increase functional capacity while aging. For this, the manipulation of variables is used to produce the greatest increases in strength and functional ability, and this is used in the periodization of training.

Linear periodization (LP) has a primary characteristic the systematic increase of training intensity associated with a decrease in the number of reps (volume). The undulating periodization (UP) is characterized by more frequent changes in intensity and volume throughout the training period when compared to linear periodization[6-8]. Despite the multitude of studies that have utilized different forms of training periodization, there is still no consensus on which model is the most effective for improving strength and functional capacity. In the context of this study, it may be more appropriate to refer to this approach as "programming", which involves the micromanagement of specific training phases through the strategic manipulation of training variables[4,5], that includes a functional evaluation.

The evaluation of functional capacity in the elderly is of extreme importance, both to identify physical limitations and to follow the evolution provided by the training over time. In this sense, the Senior Fitness Test has been used to evaluate the functional capacity of the elderly[9]. Among the five tests that make up the battery are included the Timed Sit Test (TST), for its strong correlation with the test repetition maximum (1RM) and Timed Up and Go (TUG) for its combination of strength, agility, speed, and balance[10].

Even with the use of traditional tests for the elderly, other functional capacity assessment strategies can be used and adapted according to the physical characteristics of the population. About that, the shuttle run (SR) and the vertical jump test (VJT) are tests of easy application and analysis, and those can evaluate the agility, velocity, and power of lower limbs, respectively[11,12].

Although the previous research demonstrating the use of these tests in the elderly population[12-15], they did not have the objective of analyzing the programed training effect in the improvement of the individual's performance. Regarding this, it is still necessary to establish how the different types of programming and manipulation of resistance training variables influence functional capacity and strength level in elderly people. Therefore, the objective of the present study was to compare the effects of two types of programming (linear and daily undulating) on submaximal strength and functional capacity in this population.

METHODS

This is randomized controlled blinded research, with a casual sample and simple assigning, consisting of participants from 1) quality of life programs of the Federal University of Maranhão, 2) who presented themselves or by indication of other participants, or 3) learned about the search through linked ads on social media (radio, TV, and internet). The following eligibility criteria adopted were female gender, age from 60 to 70 years old, never having performed resistance training, and not having any limitation in the physical functionality and/or diseases that interfered in the exercises. All participants read and signed the Informed Consent Term following the Declaration of Helsinki. The research was approved by the Ethics Committee on Human Research of the Federal University of Maranhão (Protocol 1.301.113).

The International Physical Activity Questionnaire (IPAQ) short version was used to identify the level of physical activity[16]. The resistance training sessions was not included in the analyse of questionary. The 24-hour Food Recall (R24hs) was applied to establish the amount of macro and micronutrients ingested[17]. Participants were asked to maintain the routines of daily living and eating. To measure body mass and height, the WELMY ® (W300A, USA) coupled with a stadiometer was used.

Participants began the Timed Up and Go test (TUG) sitting on a standard bench with a height of 43 cm. At the evaluator's command, the participants moved for 3 m in front of the bench, where they were to pass with two feet the tape that marked the distance in the ground. Three attempts were made with chronometer and the value of the shortest time was used to evaluate the performance[18].

In the Timed sit test (TST – 30s), the participants started the test in the same chair as the TUG. At the evaluator's command, they should get up and sit as many times as possible for the 30s. Three attempts were made and the set with the highest number of correct repetitions was considered as a result[15]. For both TUG and TST tests, the hands were not allowed to assist in the body extension or to sit, and the evaluator maintained verbal motivation during the test.

In the Vertical Jump Test (VJT), the participants were positioned in the side to tape attached to the wall. The height was made in a static position using the value of dactyloid of the middle finger of the arm raised. Three consecutive jumps were performed with the dominant arm held high throughout the movement and the other side with the hand touching the thigh for non-compensatory movements. The highest jump was considered as a result[19].

For the Shuttle Run test (SR), the participants were instructed to move as fast as possible at 9.14 m demarcated on the floor. On the opposite side, two weights (250 ml plastic bottles filled with sand) were kept at 30 cm from each other. Participants had to pick up the weights, pass at least one foot over the line, and then return to the starting position. Three attempts were made with chronometer, and the shortest time was used as a result[13,15].

Before doing the Ten-Repetition Maximum Test (10RM), three familiarization sessions were performed, respecting the 24-hour rest between them. The exercises performed were horizontal leg press (HL), pulldown (PD), leg curl (LC), vertical bench press (BP), and leg extension (LE). This sequence was the same for all participants. The sessions were composed of 3 sets of 10 reps with 2 min rest between sets and 5 min between exercises. No load was used on the first day because the individuals trained had no experience in weight training and the movements in each equipment were taught as well as the execution speed. The metronome (Metronome Beats, Stonekick, Version 3.6.1) was used to control the execution speed due to all the phases of research (familiarization, 10RM, and training program), adopting the time of 3s for concentric and 3s for eccentric phases. On the second and third day, the Borg Rating of Perceived Exertion (6 to 20) was used to determine the intensity[20].

The values from 11 to 14 were adopted (light or somewhat hard) on the second day[21] and 15 to 16 (hard) on the third day. The choice to increase the intensity from day 2 to 3 was to approximate the values to be obtained in the 10RM test, both to minimize the chance of error in the load estimate on the day of the test, as to approach the real conditions to which the evaluated ones would be submitted.

The test of 10RM[2,21,22] occurred respecting the same order of the familiarization exercises. The localized warm-up was performed (one set of 15 reps, Borg scale of 11 to 14, and 1-min rest). The value of the 10RM test load was reached in a maximum of 5 attempts, with the rest of 5 min between the attempts and 10 min between the different exercises. The highest load found in the 10RM test/retest was considered as the submaximal muscle strength.

The same procedures were performed for the retest application, 72 hours after the test. The participants began the first attempt with the 10RM load obtained during the test period. The results found from the Intraclass Correlation Coefficient (ICC) calculation were classified as almost complete (ICC ≥ 0.80)[23] for all 10RM tests in HL (CCI = 0.88), PD (CCI = 0.94), LC (CCI = 0.94), BP (ICC = 0.98), LE (ICC = 0.98), with $p < 0.01$ in the F test.

The exercises and the order of execution for the training followed the same used in the 10RM test. The training protocols were applied during 12 weeks on Monday, Wednesday, and Friday. The specific warm-up was performed in each exercise, with one set of 15 reps and 1 min rest using 50% the intensity of the maximum load obtained in the 10RM test. In weeks 2 to 12, the warm-up was performed with 50% of the load used in the corresponding session of the previous week of each programming.

LP started with a more extensive training volume, decreasing each month. In the DUP the changes occur at each session. The total training volume was equalized for both groups. The groups were equalized in relation to the total training volume in the 12 weeks (sum of the 5 exercises: 3420 to 4500 reps; per exercise: 684 to 900 reps), recovery intervals (sum of the 5 exercises: 3240 min; interval per exercise: 648 min) and number of sessions (36 sessions). The loads were adjusted both concerning the ranges of reps predicted in each session, as well as the Borg perception scale (17 to 20, very hard to exhaust)[20]. LP and DUP are shown in Figure 1.

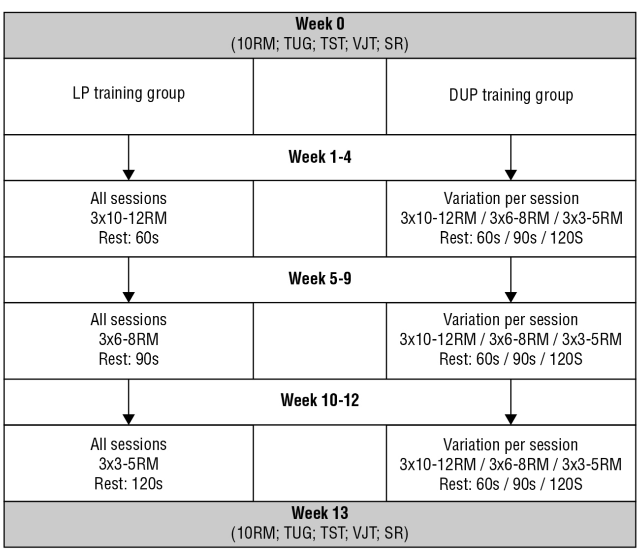

Figure 1. Training program. RM = maximum repetition; LP = linear programming; DUP = daily undulating programming; TST = Timed sit test; TUG = timed up & go; VJT = vertical jump test; SR= shuttle run.

The statistical power was performed posteriori in the GPower software (3.1.7) considering the ANOVA of repeated measures over time. The mean between all variables was performed and the following values were included in the program: Effect size = 0.41; alpha error = 0.05; total sample = 22; number of groups = 2; number of measures = 2; correlation between repeated measures = 0.33 and non-sphericity correction = 1, thus obtaining a statistical power of 0.88. All data are presented as mean and standard deviation. For normality analysis, the Shapiro Wilk test was used, and the Levene test was used to analyze the homogeneity of the sample. The Student's t-test was used to analyze the characteristics of the sample in the pre-training period (age, body mass, height, and body mass index (BMI)) and the values Δ (post minus the pre-training value). Intraclass Correlation Coefficient (ICC) was used to analyze the reliability of the test-retest in the 10RM test. For the comparison of baseline and post (12 weeks) between the two training models (DUP and LP), the ANOVA two-way (time X programming) was used with measures repeated in time. The variables measured were the IPAQ, R24hs, the 10RM tests (HL, PD, LC, BP, and LE), and functional capacity (TUG, TST, SR, and SJT). The Tukey post hoc was used when necessary ($p \leq 0.05$). The effect size calculation (post minus the pre-training value means divided by the standard deviation of pre-training) was performed in the variables 10RM and functional capacity. The classification adopted was relative to untrained individuals (Trivial: <0.50; Small: 0.50-1.25; Moderate: 1.25-1.9; Large: >2.0)[24]. For the statistical analysis, version 18 of the SPSS statistical package was used ($p \leq 0.05$).

RESULTS

The 47 participants performed the clinical evaluation with the physician. Thus, 35 participants finished the initial evaluation and were allocated into groups: linear programming (LP, n = 18) or daily undulating programming (DUP, n = 17). Just 22 participants (LP, n = 10 and DUP, n = 12) completed all stages of the research. The reasons for the sample loss were gave up the research (n = 12), and health issues (zika virus n = 11, cancer n = 1, and hypertension n = 1).

Table 1. Baseline groups characteristics.

Groups	Age (years)	Body mass (Kg)	Height (cm)	BMI (Kg/cm2)
LP (n = 12)	64.66 ± 2.60	69.99 ± 11.57	1.47 ± .03	32.28 ± 5.41
DUP (n = 10)	63 ± 3.16	58.34 ± 9.23*	1.49 ± .05	26.23 ± 3.91*

LP = linear programming; DUP = daily undulating programming; BMI = body mass index. Values are given as mean ± SD. *Significant difference in each group.

Statistical differences were found between groups (LP vs. DUP) in the variables weight (p = 0.01) and BMI (p = 0.01), with no difference for age (p = 0.19) and height (p = 0.38) in the baseline (Table 1).

After 12 weeks of training, both groups were classified as Active or Very Active (LP = 11 (91.6%) and DUP = 10 (100%)), with only one woman in the LP group (8.3%) classified as Irregularly Active (Table 2). No statistical differences were observed between groups when the time per week of physical activity was analyzed (p = 0.94). The same occurred with total energy (p = 0.60), protein (p = 0.38), carbohydrate (p = 0.49) and total fat (p = 0.78) intake, when comparing groups (Table 2).

Table 2. Level of physical activity and dietary intake baseline and after intervention.

Physical activity	LP (n = 12)		DUP (n = 10)	
	Baseline	12wk	Baseline	12wk
Sedentary	-	-	-	-
Irreg Active B	3 (25%)	1 (8.3%)	4 (40%)	-
Irreg Active A	7 (58.3%)	-	2 (20%)	-
Active	-	10 (83.3%)	3 (30%)	8 (80%)
High Active	2 (26.7%)	1 (8.3%)	1 (10%)	2 (20%)
Total time/week (min)	335 ± 375.56	478.75 ± 494.91	406.5 ± 625.73	572.50 ± 460.95
Dietary intake				
Energy (kcal)	1228.80 ± 656.99	1134.49 ± 503.83	1142.75 ± 350.70	1223.53 ± 590.25
Protein (g)	54.72 ± 33.86	54.89 ± 41.47	38.76 ± 10.22	55.99 ± 32.29
Carbohydrate (g)	171.22 ± 102.87	134.51 ± 59.59	185.84 ± 63.48	184.52 ± 75.36
Total Fat (g)	36.94 ± 21.66	34.62 ± 23.00	32.37 ± 15.90	33.46 ± 26.47

LP = linear programming; DUP = daily undulating programming; Irreg Active A = Irregularly Active A; Irreg Active B = Irregularly Active B. Values are given as mean ± SD.

There was a significant difference in the exercises between post and pre training period, except for the BP exercise (p = 0.30), with no difference for Δ between groups (LP vs. DUP). In the analysis between the groups, only the HL exercise was different between them in the post test (LP > DUP; p = 0.03). Most of the RM tests showed trivial or small effect (ES < 1.25), except the HL exercise of the LP group, which demonstrated a high effect size (Table 3).

Table 3. 10RM loads, Δ (delta), % change and effect size at baseline and after 12 weeks of training.

Exercises	Groups	Baseline (Kg)	12wk (Kg)	Δ (Kg)	Change (%)	effect size (magnitude)
HL	LP	76.23 ± 14.38	110.06 ± 20.88†	33.83 ± 18.20	44.37	2.35 (high)
	DUP	64.12 ± 18.56	83.54 ± 28.75†	19.42 ± 13.77	30.28	1.05 (small)
PD	LP	37.50 ± 4.49	39.94 ± 3.32†	2.43 ± 2.58	6.48	0.54 (small)
	DUP	33.46 ± 7.13	36.27 ± 7.02†	2.81 ± 4.59	8.39	0.39 (trivial)
LC	LP	21.32 ± 4.53	24.18 ± 3.81†	2.85 ± 4.87	13.36	0.63 (small)
	DUP	19.24 ± 4.16	23.61 ± 6.59†	4.37 ± 4.65	22.71	1.05 (small)
BP	LP	23.10 ± 5.54	24.33 ± 3.20	1.23 ± 5.21	5.32	0.22 (small)
	DUP	21.76 ± 6.49	22.66 ± 7.12	0.09 ± 3.92	0.41	0.14 (trivial)
LE	LP	29.99 ± 9.61	35.53 ± 7.54†	5.54 ± 5.25	18.47	0.58 (small)
	DUP	28.95 ± 8.84	33.06 ± 7.94†	4.11 ± 8.34	14.19	0.46 (trivial)

RM = maximum repetition; LP = linear programming; DUP = daily undulating programming; HL = horizontal leg press; PD = pulldown; LC = leg curl; BP = vertical bench press; LE = leg extension; Δ = delta difference between 12 weeks of training and baseline values. †Significant difference to baseline.

All participants increased performance for the TUG, TST, VJT, and SR (p = 0.01) in the post test, with no difference for Δ between groups (LP vs. DUP). Most of the tests presented the magnitude of the effect as trivial or small (ES < 1.25), except for the TUG and TST tests for the DUP group, being classified as high magnitude (Table 4).

Table 4. Functional tests values, Δ (delta), % change, and effect size at baseline and after 12 weeks of training.

Exercises	Groups	Baseline	12wk	Δ	Change (%)	Effect Size (magnitude)
TUG (s)	LP	5.75 ± 1.65	4.66 ± 0.65†	-1.08 ± 1.44	-18.78	-0.66 (small)
	DUP	6.30 ± 0.82	4.60 ± 0.84†	-1.70 ± 1,15	-26.98	-2.07 (high)
TST (reps)	LP	16.75 ± 4.37	21.25 ± 3.41†	4.5 ± 5.26	26.86	1.03 (small)
	DUP	14.20 ± 1.47	21.10 ± 5.43†	6.90 ± 2.37	48.59	4.69 (high)
VJT (cm)	LP	17.29 ± 4.46	19.50 ± 3.96†	2.20 ± 3.42	12.72	0.50 (small)
	DUP	19.30 ± 4.38	22.10 ± 3.44†	3.10 ± 1.62	16.06	0.64 (small)
SR (s)	LP	16.75 ± 0.96	15.75 ± 1.05†	-1.00 ± 0,85	-5.97	-1.04 (small)
	DUP	16.90 ± 1.44	15.80 ± 1.75†	-1.10 ± 0,99	-6.50	-0.76 (small)

LP = linear programming; DUP = daily undulating programming; TST = timed sit test; TUG = timed up & go; VJT = vertical jump test; SR = shuttle run; Δ = delta difference between 12 weeks of training and baseline values. †Significant difference to baseline.

DISCUSSION

The purpose of this study was to compare the effects of LP and DUP resistance training programming on submaximal strength and functional capacity in elderly women. To our knowledge, this is the first study that has compared the effect of two types of resistance programming training in an elderly woman as using the submaximal strength as evaluation. Both programming provided a significant increase of the submaximal strength and functional capacity in elderly women inexperienced in RT after 12 weeks of intervention. However, DUP appears to be more effective in increasing functional capacity when analyzed the ES.

Even though research has shown improvement in submaximal strength in both groups, it is not possible to observe a difference between them. When volumes and training intensities are equalized in a short training period, no differences were observed in muscle strength levels in individuals trained in strength[7,25]. Despite the studies using different populations (trained in resistance vs. elderly without experience in resistance training), this research used the equalization of programming, which may explain the fact that submaximal strength does not show statistically significant differences when comparing groups. On the other hand, the lack of exercise variations could explain the absence of difference between groups. Both groups maintained the same exercises for all the period of training, changing only intensity over time. According to Fonseca et al.[26], the variation of exercises is an important component to increase muscle strength and hypertrophy in the initial stages of training, just like the characteristic of the participants who presented lower to the middle level of physical activity. Other researchers[8,27] demonstrated that there was no increase in strength for upper limbs, corroborating the results observed in the BP for both trained groups. Because it is a muscle group with a smaller volume when compared to the lower limbs[28], it may be necessary longer training time to promote more significant muscular adaptations such as muscular hypertrophy[3]. On the opposite side, the HL involves a multi-joint lower extremity with a huge group of muscles such as the gluteal complex, hip extensors and flexors, and triceps surae[29], which may explain the better performance presented in that exercise.

Both programming were effective in improving the results for TUG, even though no statistical difference was observed between the groups. The results of the TUG test showed initial values for the LP group of 5.75 ± 1.65s and DUP of 6.30 ± 0.82s, corresponding to the age groups of 75-79 years (5.60 ± 0.87s) and 80-84 years (6.42 ± 1.01 s), respectively[30]. However, after the 12 weeks of training, the LP group (4.66 ± 0.65s) and the DUP group (4.60 ± 0.84s) were between the ages of 60 to 64 (4.70 ± 0.52s), indicating that decrease by 10 to 20 years functional decline over just 12 weeks of programmed resistance training who apparently was never observed before in other investigations. There was a large magnitude of effect size in the DUP group, probably due to the frequency of changes in the training stimulus in that group[26].

For the TST, both programming showed improvement with the resistance training without statistical difference between groups. In research by Latorre-Rojas et al.[30], a group of women aged 60-64 years old obtained a mean of 17.42 ± 4.08 reps, agreeing with this research for the LP group (16.75 ± 4.37 reps.) in the initial phase, but not for the DUP (14.20 ± 1.47 reps).

Both the LP group (21.25 ± 3.41 reps) and the DUP group (21.10 ± 5.43 reps) improved their performance after intervention corresponding to the ages of 50 to 54 years (20.78 ± 4.90 reps). In the Prestes et al.[2] research, the participants presented better initial conditioning to the TST test (LP = 19.75 ± 4.12 reps and UP = 21.76 ± 4.55 reps), corresponding to the ages of 55-59 years (19.08 ± 4.00 reps), and no difference between groups. When analyzing the Effect Size, both programmed groups were classified as a small effect (LP = 0.93 and UP = 0.61), in agreement with what was presented in this research for the LP group (ES = 1.03), but not for DUP group (ES = 4.69). Could it be the same explanation given in the TUG on the highest frequency of stimulus changes in the DUP group seems to influence the better test performance[26].

The results of this research showed statistical improvement in the VJT with no difference between training groups. Despite the body mass in the LP group being higher than in the DUP group, these remained unchanged after the training time, which leads us to believe that the improvement obtained in the VJT was due to RT. In studies that investigated the effect of LP and UP for 12 weeks in active young women[11] and men[25], with or without experience in resistance training, there was an improvement in VJT, but no difference was observed between the periods, corroborating the results of this research. A longitudinal study[12] was analyzed the evolution of the neuromotor profile and the functional capacity of active elderly women (5.4 ± 3.0 years of training) during one year of training. They obtained results for the VJT test in the 60 to 69 age group as 15.5 ± 3.7 cm (baseline), 16.0 ± 4.7 cm (6 months), and 16.5 ± 3.9 cm (12 months). Although the women in the present study presented mean values for the initial period in both groups like those found in the above research (LP = 17.29 ± 4.46 cm and DUP = 19.30 ± 4.38 cm), 12 weeks were sufficient to improve performance (LP = 19.50 ± 3.96 cm and DUP = 22.10 ± 3.44 cm) in the impulse. One factor that may explain the increase in strength performance is the initial stage in which the participants were (Irregularly Active) compared to the study by Matsudo et al.[12] (Active), thus having a greater capacity for training in the participants of this research. On the other hand, the manipulation of variables strength and training intensity[1] seems to be a relevant variable for long-term improvement, thus avoiding the stagnation in the physical capacities. However, this hypothesis must be carefully analyzed, considering that we do not have a no programmed group to compare with the results obtained by the programmed groups.

When the SR test was analyzed, both programming was able to decrease the execution time by 5.97% and 6.50% for LP and DUP, respectively. The same was obtained in another research with resistance training over 8 weeks that reduced the time in the 10-meter walk test for elderly women by 3.67%[29]. To decrease 1.2s and 1.5s, it took 6 to 12 months of intervention in a Matsudo et al.[12] research. Our programmed groups decreased 1.00 ± 0.85s for the LP group, and 1.10 ± 0.99 for the DUP in 3 months. This difference may have occurred due to the characteristics of the groups, trained for more than 2 years[12] vs. without RT in our research since for untrained individuals there is a greater capacity for increased performance. On the other hand, the programmed training used by us and Santos et al.[29] compared to the non- programmed training[12] presents an advantage in the increment of muscular strength and power[6] physical abilities that influence the walking speed and are essential physical capabilities for the manifestation of functional abilities.

The difference presented in the BMI and bodyweight of the groups in the initial phase is a potential limitation of this study. It is important to emphasize that the randomization was respected. Regarding the level of physical activity of the participants, they came mostly Irregularly Active to Active - Very Active. Besides this, they do not show a difference between groups after a trained period when the time expended with physical activities was analyzed. In the fact that RT can improve muscle strength, many elderly women could improve their performance in daily activities. Furthermore, no bodyweight nor intake ingestion changed after the period of intervention. For the future, it is important to investigate the increase in training time and other programming models to improve muscle strength and functional capacities in the elderly population.

CONCLUSION

The LP and DUP trainings have similar results in increasing submaximal muscle strength in elderly women inexperienced in RT after 12 weeks of intervention. However, DUP appears to be more effective in increasing functional capacity. In practice, the professional can use both the LP and the DUP to improve the level of fitness in the early stages of training in this population. However, when the goal of programming is to increase functional capacity, DUP can be prioritized.

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COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the Ethics Committee on Human Research of the Federal University of Maranhão (Protocol: 1.301.113), and the protocol was written following the standards established by the Declaration of Helsinki.

Conflict of interest statement

The authors declare no conflicts of interest.

Author Contributions

Conception and design of the experiment: SCSS, FOP, CETC, RDL; Realization of the experiments: SCSS, MTBJ, LLPS, CBFR, LPA; Data analysis: SCSS, LLPS, PTVTP, CETC, RDL; Article Writing: SCSS, CETC, RDL. All authors read and approved the final version of the manuscript.

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