

The influence of exercise order on strength performance in post menopause women

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OBJECTIVE: Verify the influence of different exercise orders on the performance of the number of maximal repetitions in older women.

METHODS: Twelve older women (65.7 ± 5.6 years, 66.9 ± 9.5 kg, 1.56 ± 0.67 m, 27.4 ± 3.6 kg/m²) underwent four nonconsecutive visits and two different orders of Resistance Training. At the first visit, the volunteers were submitted to anamnesis, anthropometric evaluation and a 10RM test. On the second visit, a re-test of 10RM was performed. On the third and fourth visits, the volunteers performed two exercise sequences: sequence A: bench press, latissimus pulldown close grip, biceps curl, triceps extension; for sequence B the order was inverted. Performance was measured by the number of repetitions in each exercise. To determine differences in performance for sequence A vs. sequence B, repeated measures were performed by two-way ANOVA followed by the Tuckey post-hoc test.

RESULTS: The number of repetitions of each exercise varied significantly for the bench press, biceps curl and triceps extension between the exercise sequences.

CONCLUSIONS: The order of the exercises performed in a resistance training session can affect the performance in the number of repetitions in older women.

KEYWORDS: Muscle Strength, Weight Lifting, Older People, Physical Fitness.

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INTRODUCTION

Aging is a dynamic, progressive and irreversible process, characterized by biological, psychological and social manifestations that, together, can negatively impact functional capacity and health.^{1,2,3} Some of physiological alterations promoted by aging are the loss of strength, muscle and bone mass, which are directly related to the reduction of the ability of older people to perform daily living activities.^{1,4} On the other hand, the literature suggests that physical activity can increase life expectancy, preventing the beginning of chronic diseases and associated comorbidities, and preventing the loss of functional capacity in older people.^{1,3,5,6,7}

In this context, resistance training (RT) seems to be beneficial to this population because of its efficiency for development and/or maintenance of physical fitness and health of apparently healthy people.^{1,2,4} In older people RT can promote an increase in strength, muscular power, improve body composition, bone mineral density, development and recovery of functional abilities, reductions of blood pressure and plasma glucose, thus preventing arterial hypertension, type II diabetes and obesity.^{1,2,4} However, to execute these exercises safely, it is necessary to know how to manipulate RT variables correctly and prescription should consider the number of repetitions per sets, speed of execution, rest interval between sets and exercises, number of sets, weekly frequency and order of exercises.^{1,4}

Among the variables of RT, the order of the exercises is a variable of great importance, since its

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manipulation influences the volume of training, strength gains and muscular thickness.⁸⁻¹⁴ The American College of Sports Medicine (ACSM) recommends that the exercises should be initiated from the largest muscle groups, however, these statements are not supported by the scientific literature.⁸⁻¹⁴

In a review Simão et al.¹⁵ reported that, in acute effect studies, the order of the exercises may affect performance indicating that the total number of repetitions is greater when an exercise is performed in the beginning of a RT session, regardless of the amount of muscle mass involved. Thus, the authors suggested that RT sessions should be initiated by the muscle groups considered as a priority. However, it is not known whether this occurs in the older population. According to literature, the evidence is insufficient to support the recommendation in the prescription and manipulation of exercise order in older people. Although there is evidence that recommends resistance training for older people, there is still a lack of information referring to manipulation of this variables as applied to the elderly. Therefore, the objective of the present study was to determine the influence of different exercise orders on the performance of the number of maximal repetitions in older women in post menopause.

■ MATERIALS AND METHODS

Samples

Twelve older women (65.7 ± 5.6 years, 66.9 ± 9.5 kg, 1.56 ± 6.7 cm, 27.4 ± 3.6 kg/m²) participated in the study. The inclusion criteria were: a) female, b) between 65 and 75 years old, and c) practitioners of RT for at least six months, with a minimum frequency of three sessions per week. The following subjects were excluded from the sample: a) presented some report of muscle, bone or articulation disease and b) presented a diagnosis of chronic degenerative disease, transmissible or not. All the volunteers were previously informed about the purposes of the research and procedures to which they would be submitted and signed an informed consent form, elaborated according to the Helsinki Declaration. This study was approved by an Ethics Committee in Research of Faculdade de Ciências Médicas da Universidade Federal do Rio de Janeiro (case # 847.611).

Experimental Procedures

The study was developed in four visits on non-consecutive days.

The first visit was used to perform an anamnesis, which included measurements of weight, height and of the 10RM test. The 10RM test was performed following the protocol recommended by Simão et al.,⁸ for the following

exercises: Bench press (BP), lateral pulldown close grip (LPD), biceps curl (BC) and triceps extension (TE). Prior to the start of the test, participants performed a warm-up consisting 1 set of 15 repetitions with 50% of 1RM of the maximum predicted load. To obtain the load in the 10RM test, up to five trials were performed in each exercise, with a 3-minute interval between trials and 5 minutes between exercises. Standardized instructions were provided and subjects were encouraged through verbal stimuli during the 10RM test.

The second visit, after 48 hours, was destined to perform a retest of 10RM. The highest load between the two days of testing was considered as the 10RM load.

On the third and fourth visit, the participants performed the experimental protocol consisting of an RT session with two different orders of exercise execution. The first sequence (SEQ A) was composed by the exercises: BP, LPD, BC and TE; in the second sequence (SEQ B), the exercises were performed in reverse order: TE, BC, LPD and BP. Both exercise sessions (SEQ A and SEQ B) consisted of three maximum sets for 10RM with two minute intervals between sets and exercises. The number of maximum repetitions was counted for each series of exercises performed (table 1).

Statistical Analysis

To verify the statistical differences in the number of repetitions between the different sequences and series performed, repeated measures two-way ANOVA was performed, followed by the Tukey post-hoc test. The determination of the reproducibility in the loads for 10RM was performed through the intraclass correlation coefficient, added to the paired Student's t-test. In all treatments, a significance level of $p < 0.05$ was considered. The software Statistic was used for analysis (version 6.0, Statsoft, Tulsa, USA).

■ RESULTS

The mean number of repetition of each exercise in the three sets varied significantly between the sequences, except for the LPD exercise. The BP repetitions were larger in the A sequence, while the total repetitions of BC and TC were significantly higher in the B sequence, as shown in figure 1.

The intraclass correlation coefficient showed high reproducibility (BP, $r = 0.85$, LPD, $r = 0.97$, BC, $r = 0.90$, TE, $r = 0.98$) between the mean values in the 10RM tests. These results also show that the performance of each exercise for 3 sets varied significantly between the sequences: for BP ($p \leq 0.05$), BC ($p \leq 0.05$) and TE ($p \leq 0.05$), as shown in Table 1.

Table 1. Number of repetitions per set on the sequences. (mean ± SD).

		BP	LPD	BC	TE
SEQ A	1 ^a set	10.00 ± 0.00	9.18 ± 0.98	8.00 ± 1.00	8.27 ± 0.47
	2 ^a set	8.91 ± 0.94*	8.18 ± 1.25	7.64 ± 1.21	7.00 ± 0.77*
	3 ^a set	7.91 ± 1.22*#	7.64 ± 1.03*	7.09 ± 0.70	6.55 ± 0.93*
SEQ B	1 ^a set	7.55 ± 0.52	8.82 ± 0.40	10.00 ± 0.00	10.00 ± 0.00
	2 ^a set	7.45 ± 0.93	8.27 ± 0.79	8.55 ± 0.69*	8.45 ± 1.37*
	3 ^a set	7.00 ± 0.63	7.36 ± 0.81*#	7.91 ± 0.94*	8.18 ± 0.87*

SEQ A - sequence A; SEQ B-sequence B; BP – bench press; LPD– lat pull down with triangle; BC- biceps curl; TE - triceps extension *Significant difference for the first set of the same sequence, #Significant difference for the second set of the same sequence. p <0.05.

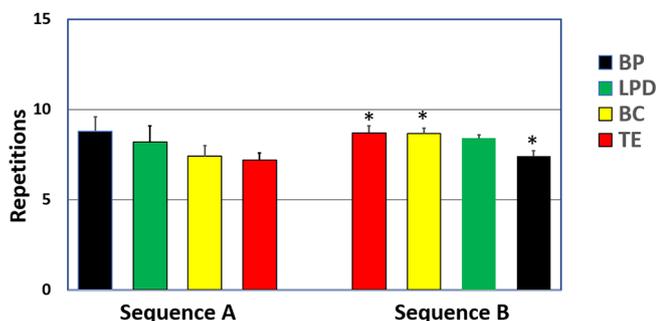


Figure 1. Mean number of repetitions per exercise during the two sequences. All data shown as mean ± std dev. In Sequence B the exercises were performed in an inverted order. BP - bench press; LPD – lateral pull down close grip; BC- biceps curl; TE - triceps extension. *: significant difference for sequence B vs. A, *: p <0.05.

DISCUSSION

The objective of the present study was to verify the influence of different exercise orders on the performance of the number of maximal repetitions in older women. Our results demonstrate that the order of the exercises influenced the volume of repetitions in the RT sessions: when an exercise was performed at the end of the training session, regardless of the size of the muscle group involved, there was a significant reduction in the performance of the number of repetitions for BP, BC and TE exercises.

These findings corroborate previous studies. For example, Simão et al.^{8,9} observed in these two studies that the exercises that initiate the training sessions, regardless of the size of the muscle groups, present a better performance in terms of the number of maximal repetitions when compared to the same exercises performed in the end of the training sessions.

Spreuwemberg et al.¹⁶ found that the manipulation of the order of squat exercise may favor the performance of muscular power output. In a review of the literature, Simão et al.¹⁵ verified that for both acute and chronic adaptations, the prioritized exercises should be inserted at the beginning of the training sessions. In this sense, Dias et al.¹¹ and Spinetti et al.¹² demonstrated that when a muscular group is trained at the beginning of the session, it presents higher strength levels regardless of its size.

With regard to older people, the literature is still insufficient concerning the manipulation of the variable order of the exercises. However, Silva et al.¹⁷ compared the influence of the exercise order on the number of repetitions and effort perception in 12 young and 8 older females with experience in RT. Participants performed three sets of exercises with loads of 10RM; three minute-recovery intervals were allowed between sets and exercises. Two exercise sequences were performed: (A) bench, shoulder press and triceps extension; and (B) the same exercises in reverse order. The results found were similar to those described in this study, showing that for the group of young women, there was a decrease in the number of repetitions regardless of the group of muscles involved, whereas in the group of the older women this decrease occurred only in the B sequence (group that started the exercises with smaller muscle groups). In this experiment it seemed to be more advantageous to start the exercises involving multiple joint followed by the single joint exercises.

However, apart from the study of Silva et al.¹⁷ there are few studies that investigated these responses among the elderly. For this reason, the present study can be considered of important practical applicability, since these responses were observed throughout a complete upper limb exercise session and in a specific sample of older women.

It is interesting to notice in our study the decrease of the performance of repetitions throughout the series, independently of the exercise. It is true that in aging there is a decline of muscle function that may manifest in less potential of force production and a smaller tolerance to fatigue.^{18,19} A number of studies show that the number of repetitions tends to be gradually reduced regardless of the adopted interval and/or number of joints involved.²⁰⁻²³ However, we can observe that during the exercise sequence, when the movement pattern (muscle group) and the sequence of exercises were modified, the number of repetitions tended to be higher throughout the three sets in the exercises positioned at the beginning of the training sessions (Table 1). For this reason, the choice of the order of the exercises should be taken into account when the focus is to optimize the results of some muscle group in the older population. Additionally, RT can contribute to the

improvement of muscle strength levels, which can impact on daily activities, such as climbing stairs, standing up from a chair, carrying heavy objects and especially maintaining an autonomous life throughout aging, which is very important for the population in question.

It is important to highlight one limitation of this study, which was the lack of verification of the subjective perception of effort (Borg scale) to measure the intensity perceived during the execution of RT session. However, this limitation is attenuated by the fact that exercises were continued until the concentric failure of the execution and until the interruption of execution when it was beginning to be performed incorrectly. Other possible limitations include the reduced number of participants and the non-control of the food consumption of the sample.

■ CONCLUSIONS

Based on our findings, it is possible to conclude that the musculature requested in the first exercise of a RT session shows better performance, through the number of repetitions. On the other hand, this same exercise, when performed at the end of the session, shows a decline in repetitions. Thus, in the elaboration of an RT session for older women, the first exercise of the sequence should be the one to be prioritized.

We recommend that further studies be conducted to determine the influence of exercise order manipulation on strength and hypertrophy responses in older people.

■ CONFLICT OF INTERESTS

The authors declare no conflict of interest.

■ AUTHOR PARTICIPATION

Jéssica Cid Jesus: project preparation, data collection, writing and article revision. Amanda Brown: data collection, methodological review. Diogo Cardozo: methodological review, general review of the article. Luiz Gustavo Dias dos Santos: data collection, literature review. Ingrid Dias: statistical analysis, article revision. Fábio Cahuê: literature review, methodological review. Verônica Salerno: methodological review, statistical analysis. Roberto Simão: methodological review, general review of the article.

A INFLUÊNCIA DA ORDEM DOS EXERCÍCIOS SOBRE O DESEMPENHO DA FORÇA MUSCULAR EM MULHERES NA PÓS-MENOPAUSA

OBJETIVO: Verificar a influência de diferentes sequências de exercícios no desempenho do número de repetições máximas em mulheres idosas.

MÉTODOS: Doze mulheres idosas (65,7 ± 5,6 anos, 66,9 ± 9,5 kg, 1,56 ± 0,67 m; 27,4 ± 3,6 kg/m²) foram

submetidas a diferentes sequências de exercícios no Treinamento Resistido. Na primeira visita, as voluntárias foram submetidas à anamnese, avaliação antropométrica e teste de 10 RM. Na segunda visita, foi feito um re-teste de 10RM. Na terceira e quarta visita, as voluntárias realizaram as duas sequências: SEQ A - supino horizontal, puxador alto fechado, rosca bíceps e rosca tríceps e, SEQ B - a ordem foi inversa. O desempenho foi medido pelo número de repetições em cada exercício.

A fim de verificar as diferenças nos dados obtidos no desempenho em diferentes sequências e séries, foram realizadas medidas repetidas pela ANOVA two-way seguido do teste post-hoc de Tuckey.

RESULTADOS: Os resultados demonstraram que o número de repetições de cada exercício variou significativamente entre as sequências nos exercícios de supino horizontal, rosca bíceps e rosca tríceps.

CONCLUSÕES: A ordem dos exercícios realizada em uma sessão de treinamento resistido pode afetar o desempenho no número de repetições em mulheres idosas.

PALAVRAS-CHAVE: Força Muscular, Levantamento de Peso, Pessoas Idosas, Aptidão Física.

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