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Original Article

THE EFFECT OF SPECIFIC STRETCHING VERSUS GENERAL STATIC STRETCHING ON MUSCLE STRENGTH PERFORMANCE

EFEITO DO ALONGAMENTO ESTÁTICO ESPECÍFICO VERSUS GERAL SOBRE O DESEMPENHO DA FORÇA MUSCULAR

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ABSTRACT

The present study aimed at comparing the effect of general and specific stretching on the immediate ability to generate muscle strength with a self-selected load in strength training practitioners. Fourteen healthy and physically active men (25 ± 4 years, 75 ± 8 kg, 173 ± 6 cm) were on non-consecutive days at the study site. At visits 1 and 2 (Control), after a standardized warm-up, the participants performed the maximum repetitions with a self-selected load for 10 repetitions (RM_{C10R}) on the free-weight bench press. At visits 3 and 4, after standardized warm-up followed by stretching exercises (Specific Stretching vs. General Stretching), the subjects were invited to perform RM_{C10R}. Considering RM_{C10R} there was no difference between test and retest (15.1±3.2 vs. 15.5±2.9 RM_{C10R}; p=0.096); Pearson's correlation showed a high and significant correlation (r=0.975; p<0.001). There was no significant difference among the three conditions tested (Control: 15.5 ± 3.1; Specific Stretching: 15.4 ± 3.5, General Stretching: 15 ± 3.3, p = 0.874). The effect size (ES) of the differences among the conditions was trivial for all comparisons (Control x Specific Stretching, ES = 0.09, Control x General Stretching, ES = 0.21, Specific Stretching x General Stretching, ES = 0.10). Based on the results it can be concluded that general stretching has no deleterious effect on the immediate ability of generating strength when compared to specific stretching.

Keywords: Muscle strength. Self-selected load. Free-weight bench press. Stretching exercises.

RESUMO

O objetivo do estudo foi comparar o efeito dos alongamentos geral e específico sobre a capacidade imediata de gerar força muscular com a carga autosselecionada em praticantes de treinamento de força. Quatorze homens saudáveis e fisicamente ativos (25 ± 4 anos, 75 ± 8 kg, 173 ± 6 cm) compareceram quatro dias não consecutivos ao local do estudo. Nas visitas 1 e 2 (Controle), após um aquecimento padronizado, os participantes executaram o máximo de repetições com a carga autosselecionada para 10 repetições (RM_{C10R}) no supino reto. Nas visitas 3 e 4 após a realização de um aquecimento padronizado, seguido de exercícios de alongamento (Alongamento Específico versus Geral), os indivíduos foram convidados a executar as RM_{C10R}. Não houve diferença entre teste e reteste nas RM_{C10R} (15,1±3,2 vs. 15,5±2,9 RM_{C10R}; p=0,096), e a correlação de Pearson apresentou alta e significativa correlação (r=0,975; p<0,001). Não houve diferença significativa entre as três condições testadas (Controle: 15,5±3,1; Alongamento Específico: 15,4±3,5; Alongamento Geral: 15±3,3; p=0,874). O tamanho do efeito (ES) das diferenças entre as condições foi trivial para todas as comparações (Controle x Alongamento Específico, ES = 0,09; Controle x Alongamento Geral, ES = 0,21; Alongamento Específico x Alongamento Geral, ES = 0,10). Conclui-se com base em nossos resultados que o alongamento geral não produz efeito deletério sobre a capacidade imediata de gerar força quando comparado ao alongamento específico.

Palavras-chave: Contração muscular. Carga autosselecionada. Supino reto. Exercícios de alongamento.

Introduction

The use of static stretching before strength exercises has generated controversy in the scientific literature. Behm et al.[1] showed a moderate reduction in strength performance (-4.8%), and Kay and Blazevich[2] concluded that static stretching only decreases the immediate capacity of expressively generating strength when the sustaining stretching exceeds 60s. Therefore, short-term static stretching would unlikely cause damage in the sense of generating strength.

In fact, Silveira et al.[3] did not show differences in bench press performance regardless of the previous stretching lasting between 10 and 40s. However, whereas Barbosa-Netto et al.[4] identified a decrease in manual prehension strength after 3 x 20s of static stretching of the forearms, Barbosa-Netto and Almeida[5] found no differences in bench press after a similar

stretching protocol for the pectorals. In spite of the methodological differences, all the studies had in common that only the muscles responsible for the movement in the strength test[4-8] were stretched. This is a frequent approach in research laboratories; however it does not meet representation in professional practice, since individuals tend to stretch the whole body before the main activities, i.e., a general stretching.

The method used to assess strength is another difficulty to transfer research data to daily exercise prescription. Although being almost mandatory in the studies, the determination of maximum strength tends to overestimate the loads usually used at fitness centers[9], and the use of maximum load percentages has been shown to be inaccurate to support the training prescription[10,11]. Finally, the maximum strength test requires human resources and large-scale time to be performed[12].

In this sense, in order to represent the trends and magnitudes of the responses expected in professional practice, the exercises should be conducted according to daily routines. However, no studies were found about the difference between performing general and specific stretching on the immediate ability to generate strength with a self-selected load. Hypothetically, the general stretching should produce greater loss of strength than the specific one, based on the principle of the muscular chains, which states that the muscle tissue acts as an inseparable functional entity[13]. Therefore, the present study aimed at comparing the effect of general and specific stretching on the immediate ability to generate muscle strength with a self-selected load in strength training practitioners.

Methods

Study Design

Each participant was asked to attend the study site during four nonconsecutive days (48-72 hours). The main procedure was to perform a standardized warm-up, followed by stretching exercises. After that, individuals were asked to perform the maximum number of repetitions with the self-selected load for 10 repetitions (RM_{C10R}). None of the subjects were participating in the stretching program. All of them were instructed not to perform exercises before these procedures. The study protocol was previously approved by the Standing Committee on Ethical Research with Human Beings of the Federal University of Sergipe state under opinion nº 949.586.

Participants

The sample was selected by directly inviting university students of Physical Education. It comprised 14 asymptomatic men who used to practice strength training (25 ± 4 years, 75 ± 8 kg, 173 ± 6 cm). All the participants had experience with the exercise tested (bench press), since it was part of their training programs. The inclusion criteria were as it follows: (a) having experience in strength training for at least six months and a minimum frequency of three times a week; and (b) being able to perform the full range of movement on bench press. All the participants were previously advised and oriented on the procedure, and they read and signed the Free Informed Consent Form.

Procedures

In order to minimize errors, the following strategies were adopted: (a) the individuals did not perform exercises before the procedures; (b) prior to the procedures, the participants were advised on what they would do; (c) the participants received guidance on the bench press[14], (d) the position of the body was kept constant; and (e) the participants were motivated while doing bench press so that they could obtain the maximum effort of the exercise.

The participants were assessed during four days:

Visit 1: the procedure consisted in performing a single series of bench press. The individual was asked the following question: 'what load do you perform 10 repetitions in the bench press with?' After answering it, the subject performed a specific warm-up of the exercise tested, which consisted of a series of 10 repetitions with 50% of the self-selected load to perform 10 repetitions (C10R), and a second series, one minute later, of five repetitions with 70% of C10R[15]. Then, he rested for two minutes, and performed the most repetitions with the C10R (RM_{C10R})[9].

A repetition was only considered as such when the bar touched the chest and the participant stretched his elbows completely. The bar speed was not controlled in order to simulate what actually occurs during daily training routines. All the procedures were monitored by a single experienced evaluator.

Visit 2: the procedure performed on the first day was repeated with the purpose of confirming RM_{C10R} reliability.

Visits 3 and 4: the sequence of these visits was randomized.

At this stage, the procedure followed the previously described protocol. The difference was the inclusion of stretching exercises (general stretching and specific stretching) between warm-up and RM_{C10R} execution (Figure 1). The active static stretching technique was used, that is, the participants held the position up to the amplitude that signaled with a slight discomfort.

The bench press exercise was chosen for being the first exercise performed in the training session by 82% of the individuals[9]. Therefore, the bench press tends to better represent the stretching-strength relationship in training programs.

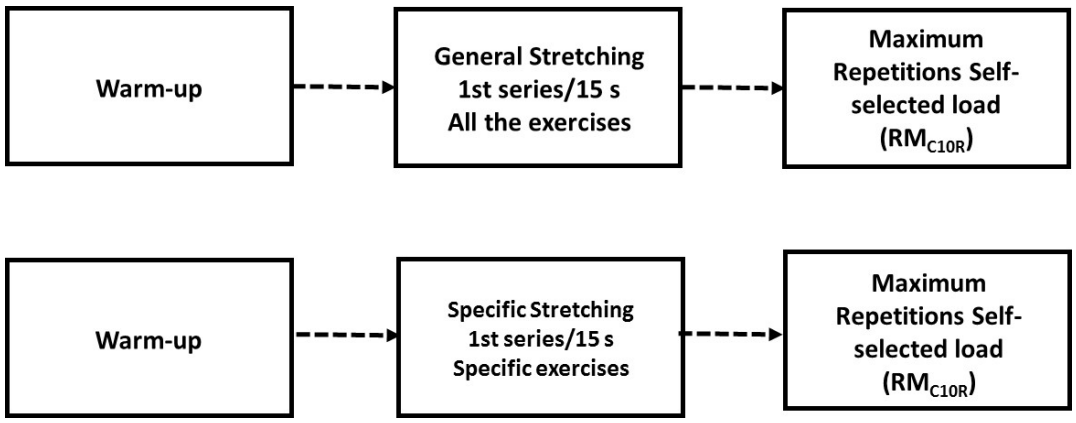

Figure 1. Study design in relation to visits 3 and 4 defined at random
Source: The authors

General Stretching

The subjects underwent a routine of general stretching exercises, contemplating the several muscle groups frequently mobilized during this type of activity: calf, quadriceps, posterior thigh, hip adductors and abductors, gluteal muscles, lumbar; exercises for the vertebral, dorsal and pectoral regions, in addition to shoulders, arms, forearms and neck (Figure 2). A series of 15 seconds was performed in all exercises. The general stretching session lasted approximately 8 minutes.

Specific Stretching

The specific stretching comprised exercises involving the agonist and antagonistic muscles of the movement tested (Figure 2: Movements II, III and IV). In this sense, the muscles of the pectoralis major, biceps, triceps brachial and the largest circular muscles were

stretched. A series of 15 seconds was performed in all exercises. The series of specific stretching lasted approximately 3 minutes.

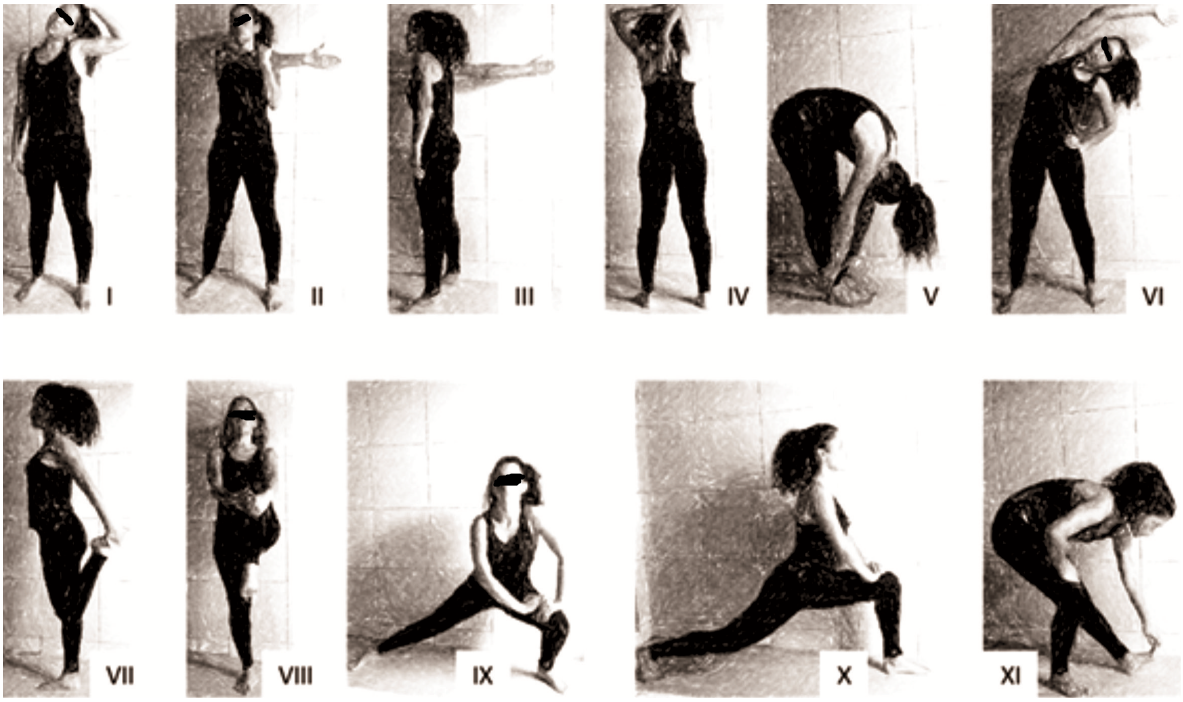

Figure 2. Static stretching exercises performed before the strength exercise
Source: the authors

The duration of 15s for both specific stretching and general stretching was adopted for being the type of stretching most practiced at fitness centers[16].

Statistical analysis

The distribution normality was confirmed by using Kolmogorov-Smirnov test ($p > 0.05$). The variances showed homogeneity according to Levene's test ($p = 0.749$). RM_{C10R} reproducibility was measured by Student's paired t-test, and the intraclass correlation coefficient (ICC). RM_{C10R} comparison among the conditions referred to as control, general stretching and specific stretching was carried out by using One-Way ANOVA for repeated measurements with Bonferroni *post hoc* test, if appropriate. SPSS software 20.0 (IBM, USA) was adopted for all calculations. The effect size (ES) was identified by using Cohen's d strategy, following the Rhea[22] reference values: trivial (<0.35), small (0.35-0.80), mean (0.80-1.50), and high (> 1.50). Finally, the inference analysis based on the magnitude proposed by Batterham and Hopkins[23] was carried out. The 95% confidence interval and significance level of 5% were defined for all the analyses.

Results

There was no difference between test and retest in the RM_{C10R} (15.1 ± 3.2 vs. 15.5 ± 2.9 RM_{C10R}; $t = -1.794$ $p = 0.096$; 95% CI = -0.787 to 0.073; ES = -0.11), and ICC showed high significant reproducibility ($r = 0.971$, $p < 0.001$). There was no statistical difference among the three conditions tested ($F = 0.269$, $p = 0.298$, Figure 3). The differences among the conditions were as it follows: 0.29 repetitions for Control x Specific Stretching (95% IC = -2.81 to 3.38); 0.64 repetitions for Control x General Stretching (95% IC = -2.45 to 3.74); and 0.36 repetitions for Specific Stretching x General Stretching (95% IC = -2.74 to 3.75). The effect size of the differences among the conditions was trivial for all comparisons (Control x

Specific Stretching, ES = 0.09, Control x General Stretching, ES = 0.21, Specific Stretching x General Stretching, ES = 0.10).

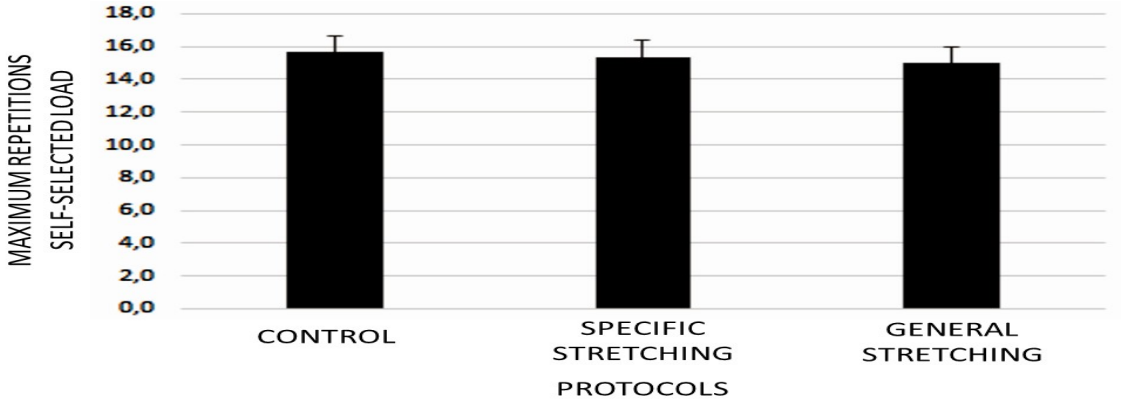

Figure 3. Number of maximum repetitions with a self-selected load for 10 repetitions on controlled bench press (rm_{c10r}), and after the two types of stretching (general and specific). Data expressed as mean and standard deviation.
Source: the authors

The inference analysis based on magnitude suggested a low probability of both general and specific stretching to cause a beneficial effect in terms of performance in the number of maximal repetitions; however the possibility of identifying a detrimental effect was suggested. Nevertheless, the mean performance reduction was less than 4% (Table 1).

Table 1. Reference analysis based on the effect magnitude of general and specific staticstretching on the number of maximum repetitions with a self-selected load for10 repetitions

	Reduction Mean of the Repetitions	Clinical interference	Estimate of Stretching effect		
			Positive	Trivial	Negative
Specific stretching	-1,56%	Possibly deleterious/Unlikely Beneficial	10,5%	59,7%	29,9%
General Stretching	-3,85%	Possibly deleterious/Very unlikely Beneficial	5,0%	28,3%	66,7%

Source: the authors

Discussion

This study aimed at comparing the effect of general and specific stretching on the immediate ability to generate muscle strength in strength training practitioners. Differently than expected, there was no difference in muscle strength performance, even after the series of general stretching. This finding has important implications for the prescription of exercises, since it supports the use of stretching at the beginning of the training session without causing damage to the subsequent strength performance.

In the present study, the general and specific stretching conditions had total duration, considering the intervals for changing the posture and restarting the exercises at 480 and 180 seconds, respectively. When considering only the act of stretching itself, the general stretching had 315 seconds, and the specific one had 90 seconds. This information is relevant, since the results of this study can be compared with those of the scientific literature. Kay and Blazevich[2] mentioned that the total stretching time might influence the performance of muscle

strength, as evidenced in studies that assessed the dose-response relationship between the volume of stretching exercises and muscle strength deficit[17,18].

Under this perspective, Tricoli and Paulo[19] showed a 14% strength decrease after a sequence of six stretching exercises specific for the lower limbs (3 x 30s). The total stretching length was of 540s, which does not only far exceeds what was shown in the present study, but also exceeds both what is proposed in the guidelines for prescribing stretching exercises[20] and the time usually taken in the fitness centers[16]. The number of stretching exercises used for the same muscle group was also higher than that of this study, which may have greatly contributed to reduce muscle strength.

The stretching duration seems to be a preponderant factor to affect strength performance, however without exerting a noticeable effect up to the limit of 60s, both continuous[5] and fractionated[4,21] ones. Thus, it is not surprising that this study failed to show effects after 15s of specific stretching. This had already been recorded by Beedle et al.[22] Nevertheless, the main focus of the present study was to verify the possible effect of general stretching on strength, respecting the way stretching[16] and strength training[9] are daily performed, which gives greater ecological validity to the study.

In this sense, it is worth mentioning that most of the studies that assess the relationship between muscle strength and stretching use specific stretching prior to strength exercises[4-6], which meets daily practice. In general it is not only the specific musculature that will be trained that is strengthened, but the body as a whole. The fact that the results of the present study do not point to the absence of a deleterious effect of stretching on strength in ecological conditions does not only ratifies the habits daily practiced, but it also increases the possibility of elaborating exercise programs for non-athletes. Even with the suspicion of a possible deleterious effect indicated by the inference analysis based on magnitude, the reduction in the number of repetitions performed after stretching was less than 4%, which in practice means that the individual would initiate the movement of the last repetition, but without being able to complete it. In addition, it should be taken into account that individuals were tested with the load usually used to perform 10 repetitions, but they were able to move the bar at least 15 times, regardless of the condition tested. This result suggests that losing the ability to perform the last maximum repetition would not affect the performance of daily training.

On the other hand, the hypothesis herein raised was based on the expectation that stretching a larger number of muscle groups (general stretching) would potentiate strength reduction through the summation of small deleterious effects along the several muscular chains. The muscle chains represent the functional influence of each muscle on its adjacent ones, and it is unlikely that a muscle acts as an independent unit in detriment of an integrated functional action[13]. In addition, Krause et al.[23] indicated the existence of contraction fibers in the muscular fascia with the capacity of changing the muscle mechanical properties, which is directly related to the dynamics of the muscular chain[13]. Barbosa-Netto et al.[4] showed that the physiological mechanisms responsible for the reduction of the post-stretching strength are not exclusively intramuscular, which suggests the participation of other factors, possibly related to a neural inhibition reflex. As a result of this study it was expected that this effect multiplied by the strengthened muscle region throughout the functional chain would increase the activation of the factors responsible for the decrease in strength performance. However, Krause et al.[23] did not find studies that investigated the tension transference between the rectus abdominis and pectoralis major muscles, which comprise the chain referred to as functional front line, thus, this keeps the debate open.

A possible limitation occurred in the dose-response of the stretching exercises because subjectivity (feeling of mild discomfort) was used to determine the stretching intensity. However, this is also a recommendation of the studies that have assessed the intensity of

stretching exercises, besides being a strategy widely used in daily practice. Another possible limitation of the present study was the performance of a single series of free-weight bench press after the stretching exercises. Although it is not consistent with daily practice, in which strength training practitioners perform several series, the protocol seemed to be appropriate with respect to the purpose of this study. The inclusion of other series of exercises after stretching could partially mistake the results, since there would be interference of the fatigue variable during data collection.

The stretching deleterious effect on muscle strength does not seem to exist in daily practice, since it is not usually practiced with maximal repetitions. Therefore, when training with submaximal intensities a loss related to the stretching exercises seems not to occur when the loads usually adopted in the training routine are used to perform 10 repetitions of general or specific stretching.

Conclusions

Based on the results herein shown, it can be concluded that general stretching does not produce a deleterious effect on the immediate ability of generating strength when compared to specific stretching. It should also be highlighted that there was no statistical difference among the conditions, that is, control, specific stretching and general stretching, which suggests that the duration (15 seconds) can be applied in the prescription of stretching exercises.

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