Static Stretching and Performance in Multiple Sets in the Bench Press Exercise

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Abstract

Ribeiro, AS, Romanzini, M, Dias, DF, Ohara, D, da Silva, DRP, Achour, A Jr, Avelar, A, and Cyrino, ES. Static stretching and performance in multiple sets in the bench press exercise. *J Strength Cond Res* 28(4): 1158–1163, 2014—The purpose of this study was to analyze the acute effect of static stretching on the performance of multiple sets in the bench press (BP) exercise. Fifteen men (26.2 ± 0.7 years, 72.4 ± 1.3 kg, 1.78 ± 0.1 m, 22.8 ± 0.3 $kg \cdot m^{-2}$) performed 4 sets of the BP exercise at 80% of 1 repetition maximum until concentric failure, both in the stretching condition (SC) and control condition (CC). The rate of force decline between the first and the fourth set was used as fatigue index. A randomized, counterbalanced, crossover design was performed with 48 hours between each session. Two static stretching exercises (pectoral and triceps brachii muscles) were performed in a single set before BP in SC, whereas in CC, subjects remained at rest for 150 seconds. For each stretching exercise, the muscle was held at the maximal stretched position for 30 seconds. No significant difference ($p > 0.05$) was identified for total repetitions performed in 4 sets (SC, 21.3 ± 0.7% vs. CC, 20.5 ± 0.7%) and in the fatigue index (SC, 75.5 ± 1.3% vs. CC, 73.2 ± 1.9%). The results suggest that the performance of multiple sets in the BP exercise does not seem to be influenced by previous static stretching.

Key Words muscle stretching, physical performance, endurance, resistance training

Introduction

Stretching exercises before physical and sports activities have been widely used by practitioners of physical exercise and athletes (34). Among the different stretching techniques, the static method has been often used as part of warm-up routines before resistance training exercises (24). The wide popularity of this strategy is probably related to the belief of a possible ergogenic and prophylactic effect of stretching in avoiding muscle injury and improving muscular performance (18,30) because this recommendation is usually found in textbooks aimed at health professionals and sports coaches (6).

In fact, recent studies have reported that preexercise static stretching might reduce the performance in events related to muscle performance (2–4,7,9,10,18,20,21,24,31,32). This decrease in performance may be related to changes in the viscoelastic properties of the musculotendinous unit (16,35) and neurologic factors, such as decreased motor unit activation (8). However, the greatest evidence is seen in maximal and explosive strength (14,32). That is, so far, only few studies have investigated the acute effects of static stretching exercises on fatigue, and they reported conflicting results (4,9,10,20). For example, Franco et al. (9) and Gomes et al. (10) have not observed an effect of static stretching on fatigue, whereas other researchers have shown that static stretching performed before resistance exercise reduces the number of repetitions (2,4,7,20). These conflicting results may be related to important methodological differences between the studies such as the duration of stretching, where protocols with a larger static stretching volume exert a negative influence on muscular endurance (7,9,17,24). Furthermore, some of previous studies that have investigated the acute effect of static stretching on fatigue used a single set of resistance exercises, which is not the habitual method used in most resistance training centers because of its lower efficiency in promoting muscular strength and muscle growth compared with multiple sets (15), thus leading to a gap in the specific literature.

Considering that the duration of stretching used in some previous studies was too long and they do not seem to represent the practical duration for warm-up, exceeding the usual number of sets, exercises, and the duration of stretching used in field, and that recommended by the literature (i.e., 15 to 30 seconds per muscle) (1,24,32), studies with a more practical approach may be useful. To optimize the practical application of outcomes, the purpose of this study was to investigate the acute effect of static stretching on the performance of multiple sets in the bench press (BP) exercise. We hypothesized that a short time of static stretching may not influence the performance.

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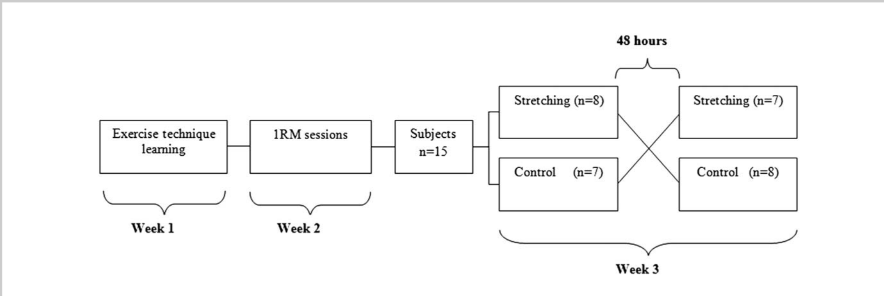

Figure 1. Experimental design.

Methods

Experimental Approach to the Problem

Fifteen subjects were asked to visit the laboratory on 8 occasions separated by an interval between 48 and 72 hours, for 3 orientation sessions, 3 one repetition maximum (1RM) test sessions, and 2 experimental protocols. During the first week (sessions 1–3), each participant was familiarized with the testing equipment and the lifting techniques of the BP exercise. This consisted of 3 sets of 10–15 repetitions, with a light load on the specific exercise used in this study, with 2-minute rest intervals between the sets. In the second week (sessions 4–6), the subjects performed the 1RM tests. A randomized, counterbalanced, crossover design was applied in the third week (sessions 7–8), and the subjects performed 4 sets of BP exercise at 80% of 1RM until concentric failure, both in the stretching condition (SC) and control condition (CC), with 48 hours of interval between the sessions. The subjects were oriented to avoid strenuous physical activity during the period of the study. All testing sessions were conducted during autumn at the same time of the day. The preliminary screening (medical history and physical activity form) and anthropometric measurements were obtained in the first visit. The experimental design is shown in Figure 1.

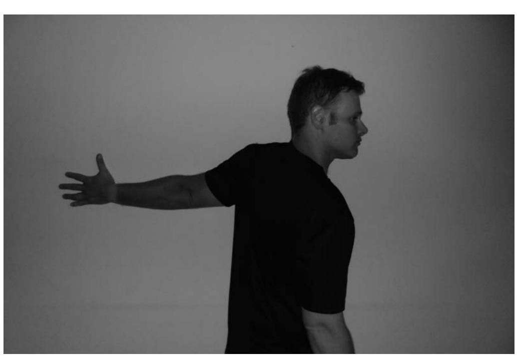

Figure 2. Static stretching to the pectorals.

Subjects

Fifteen men (26.2 ± 0.7 years, 72.4 ± 1.3 kg, 1.78 ± 0.1 m, 22.8 ± 0.3 $kg \cdot m^{-2}$) were selected for participation in this study. All subjects completed a detailed health history questionnaire and were included in the study, if they had no orthopedic injuries that precluded or hindered the execution of the movements to be performed, were nonathlete, inactive, or moderately active individuals (physical activity less than twice a week), and had not performed resistance training for at least 6 months before the beginning of the study. Written informed consent was obtained from the subjects after a detailed description of all procedures was provided. This investigation was conducted according to the Declaration of Helsinki and was approved by the local University Ethics Committee.

Bench Press 1 Repetition Maximum

Maximal dynamic strength was evaluated using a 1RM test in the BP exercise. The 1RM was performed with free weights. The grip was such that the thumbs were at shoulder width when the bar was resting on the support props. The complete range of motion consisted of lowering the bar until it touched the chest and pressing it upward until locking the elbows at the top of the press. The test was preceded by a warm-up set (6–10 repetitions) with 50% of the estimated load used in the first attempt of the 1RM test. The testing procedure was initiated 2 minutes after warm-up. The subjects were oriented to try to accomplish 2 repetitions with the imposed load in 3 attempts. If the subject was successful in the first attempt, weight was added (3–10% of the first attempted load), a 3- to 5-minute rest was given, and a second attempt was made. If this attempt was successful, a third attempt was given with an increased load (3–10% of the second attempted load), after a 3- to 5-minute rest. If the subject was not successful in the first or second attempt, weight was removed (3–10% of the previous attempted load) and another attempt was given. The 1RM was recorded as the last resistance lifted in which the subject was able to complete 1 single maximum execution (22). Execution technique and form of each exercise were standardized and continuously monitored to guarantee reliability in the maximum strength assessment. All sessions were supervised by 3 experienced researchers for greater safety and integrity of the subjects during tests. Verbal encouragement was given throughout the entire test. Three 1RM sessions were performed separated by 48 hours showing high intraclass correlation coefficient (≥0.98), small coefficient of variation between sessions (≤0.06), and low standard error of measurement (*SEM* = 3.3 kg), demonstrating homogeneity and

Figure 3. Static stretching to the triceps brachii.

reliability of data. The highest load among the 3 sessions was used for analysis. During all sessions, subjects were allowed to drink water whenever necessary and were encouraged to remain hydrated throughout testing.

Static Stretching

Two static stretching exercises were performed (1 aimed to the pectoral and 1 aimed to the triceps brachii). In the first exercise, the subjects stayed on a standing position and performed an abduction of the upper limb at the shoulder line and then with the thumbs upward the participants supported their palms on the wall, performing a trunk rotation (Figure 2). In the second exercise, the subjects remained standing with the upper limb flexed (shoulder and elbow) and with their palms resting on the back; the subjects held the elbow with the opposite hand forcing it down (Figure 3).

The exercises were performed with both the sides, always following the same order (right pectoral, left pectoral, right triceps, and left triceps). Each static stretching exercise was performed in a single set lasting 30 seconds and a rest interval of 10 seconds between the movements. The subjects executed the stretching until the muscular discomfort point. In the CC, the subjects remained at rest for 150 seconds on a chair.

Fatiguing Task Protocol

The subjects arrived at the laboratory 2 hours after having a light meal and were instructed to avoid any caffeine- and alcohol-containing beverages 48 hours before the tests. Thirty seconds after the SC or CC, the subjects performed the fatigue protocol. The protocol consisted of 4 sets of BP at 80% of 1RM until voluntary exhaustion, with a rest interval of 2 minutes between the sets. The subjects were asked to perform the maximum number of repetitions in each set. The rate of force decline between the first and the fourth sets was used as fatigue index (FI) as proposed by Sforzo and Touey (29):

$$FI = [(TF(set\ 1) - TF(set\ 4))/ (TF(set\ 1))] \times 100\%,$$

where FI is fatigue index and TF is total force (load lifted up × number of repetitions performed).

Statistical Analyses

The data are presented as mean ± standard error. Normality was checked using Shapiro-Wilk's test, the homogeneity of variances was verified using Levene's test, and the sphericity was assessed by Mauchly's test. The total number of repetitions and the FI between conditions and across days were compared using the dependent Student's *t*-test. Two-way analysis of variance for repeated measures with main effects for conditions (SC and CC) and sets (1–4) was used to compare changes in repetitions during sets between the groups. When the *F* ratio was significant, Tukey's post hoc test was applied to identify the differences. The data were stored and analyzed using the statistical package for the social sciences (SPSS for Windows Version 17.0; SPSS, Inc., Chicago, IL, USA). Statistical significance was set at $p \leq 0.05$.

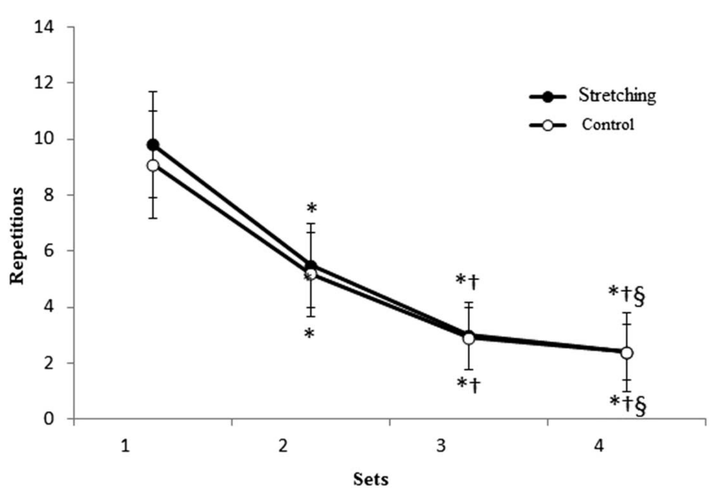

Figure 4. Number of repetitions performed in bench press in 4 sets at 80% of 1 repetition maximum until concentric failure after stretching and control conditions ($n = 15$). *$p < 0.001$ vs. set 1; †$p < 0.001$ vs. set 2; §$p < 0.001$ vs. set 3. Data are presented as means and ± *SE*.

Results

No significant difference was found between the 2 experimental sessions (fatigue protocol) for

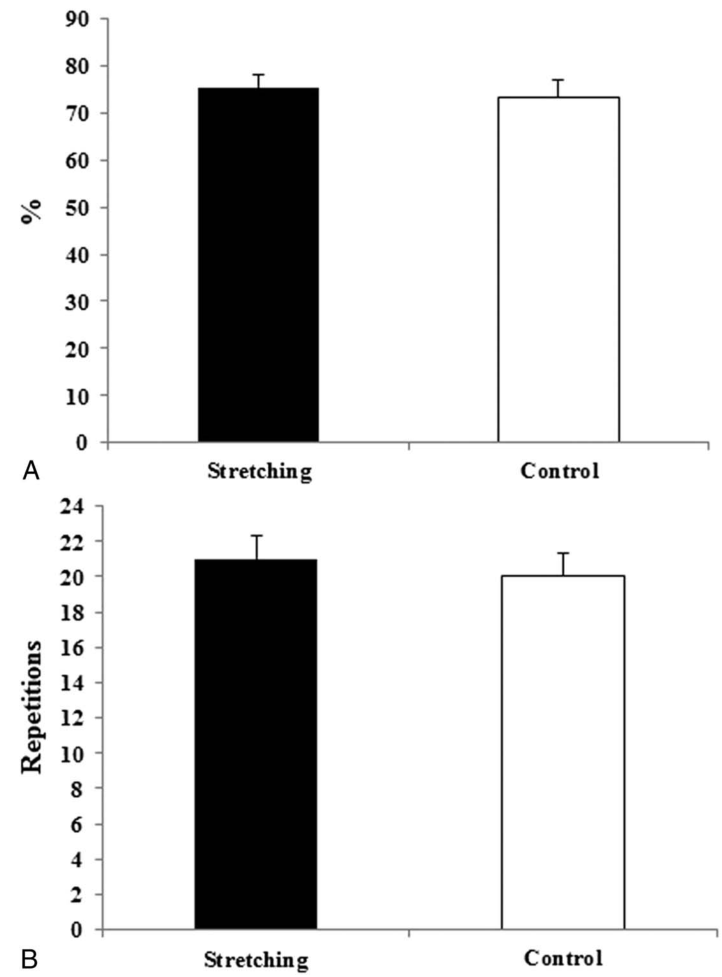

Figure 5. Fatigue index (A) and total of repetitions (B) performed in bench press in 4 sets at 80% of 1 repetition maximum until concentric failure after stretching and control conditions ($n = 15$). Data are presented as mean and ± *SE*.

the total number of repetitions (day 1, 20.5 ± 0.9; day 2, 20.3 ± 1.1; $p = 0.982$) and FI (day 1, 75.5 ± 3.3; day 2, 80.7 ± 3.2; $p = 0.145$).

Figure 4 shows the number of repetitions performed in each set in both conditions during the fatigue protocol. There was no significant set vs. time interaction ($F = 0.62$; $p = 0.541$). However, the main effect of set was identified ($F = 312.16$; $p < 0.001$), with a significant decrease in the number of repetitions performed between sets in both conditions (SC and CC).

The FI and the sum of repetitions are presented in Figure 5. No significant difference was identified for total repetitions performed in 4 sets (SC, 21.3 ± 0.7 vs. CC, 20.5 ± 0.7; $p = 0.620$) and in the FI (SC, 75.5 ± 1.3% vs. CC, 73.2 ± 1.9%; $p = 0.527$).

Discussion

The main finding of our study was that the short-duration static stretching performed before resistance exercise does not affect the FI and the total number of repetitions performed in multiple sets of BP.

Investigations about the acute effects of static stretching on fatigue and the number of repetitions performed in multiple sets in resistance exercises are limited, unlike the great evidence observed in maximal and explosive strength (14,32). Our results are in agreement with some of these few previous investigations that have not found a negative effect of static stretching on strength endurance (9,10). In this sense, the novel and most significant feature of our study was the inclusion of multiple sets in a very popular exercise (BP). Nevertheless, other researches have shown that static stretching performed before resistance exercise reduces the number of repetitions in a single and multiple set (2,4,7,20). This difference in results may be related to some important methodological procedures, mainly, the duration of stretching, in which the negative influence on muscular endurance was observed in protocols with a larger static stretching volume (7,9,17,24). It is worth noting that these investigations, which have observed a decrease in performance, applied a stretching protocol with a larger volume than what is commonly used in practice (24). In this regard, we chose 30 seconds of stretch duration for each movement because this short time is sufficient to exert influence on the structural properties of soft tissues (12) and negatively influence muscle performance (5,36). Taken together, these results highlight that longer stretch times may negatively affect the structural properties of soft tissues, muscle fiber length-tension relationship, and a decrease in the activation of motors unit, which may explain, at least partially, the effect of static stretching on performance decrements (8,16,35).

The type of exercise used in studies also could contribute to the conflicting results among investigations because fatigue is dependent on the task (13). Another possibility may be associated to the difference in subject training status among studies. The movement velocity in which the resistance exercise was performed also may affect the results (19).

In our investigation, the participants were oriented to perform the exercise at a fast velocity, although the movement velocity has not been controlled. Additionally, other variables, such as the test used to evaluate fatigue and the lack of standardization of the muscle groups stretched, make difficult a more detailed comparison between the studies. Another critical point observed in previous studies that focus on static stretching is the intensity standardization. The relative subjectivity to the articular discomfort adopted in most studies may bias the comparisons.

Resistance to fatigue is a capacity that plays an important role on resistance training adaptations (27,28). Considering that most resistance training practitioners perform their training in multiple sets, our investigation also allowed analyzing the acute effect of static stretching on the repetition sustainability capacity in BP, which in both experimental conditions, the individuals were not able to sustain the number of repetitions throughout the sets. This inability to sustain the number of repetitions is in agreement with previous findings from our laboratory (25,26).

The present study analyzed the outcomes in detrained subjects. Considering that the status of resistance training plays an important role in motor units recruitment (11), and one of the potential mechanisms suggested to performance decrements is the depression of motor neuron excitability particularly in high-threshold motor units (8), it would be reasonable to expect the absence of effects in subjects who were detrained in resistance training exercise because detrained individuals might not be able to recruit their fastest motor units efficiently. However, this hypothesis may be not suitable because previous investigation have found no static stretching effect even in trained subjects. For example, Franco et al. (9) studied 19 men who were performing resistance training for at least 6 months and observed that previous static stretching (1×20 seconds, 2×20 seconds, and 3×30 seconds) did not influence the number of repetitions performed in BP. Gomes et al. (10) investigated 15 men who had at least 2 years of resistance training practice, thus highly familiarized with the exercises performed in their study (BP and knee extension), and yet they did not find influence of previous static stretching (3×30 seconds) on the number of repetitions. Our findings extend these reports to detrained subjects. Taking into account that in practical and research settings, the subjects who have practiced resistance training in the past may be interested in restarting their exercise program, our results may be useful to understand how previous static stretching exerts influence in detrained subjects.

Recently, previous studies have shown that for adequate evaluation of maximal strength, familiarization sessions for the 1RM test should be conducted until the stabilization of the load lifted is achieved (23,33). Otherwise, there might be a strong possibility of underestimating maximal strength. Given that we believe that the three 1RM trial applied in our experiment is a strong point of our study.

The present investigation has some important limitations such as these data cannot be generalized neither to other exercises and populations such as more trained subjects nor for complete resistance training sessions. Furthermore, we did not perform a direct measurement of flexibility after the static stretching exercises. However, to our knowledge, this was the first study to investigate the effect of prior static stretching that uses a more practical approach, such as the duration of applied stretching, and the number of sets used in a very popular exercise (BP), chiefly, in men.

Practical Applications

The previous findings of a decrease in muscle performance have led a number of coaches and exercise professionals to recommend the avoidance of stretching before strength activities. However, these recommendations may be questioned, as these protocols are prolonged and do not represent the common routines applied in the field. Our results may be useful for those individuals who are afraid of practicing stretching during warm-up procedures. Thus, we do not recommend against static stretching during warm-up before resistance training exercise because such conduct does not seem to influence positively or negatively the performance in multiple sets at least in the BP exercise.

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