



Original article

## Number of repetition after different rest intervals between static stretching and resistance training

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### ABSTRACT

**Objective:** The purpose of this study was to investigate the effects of different intervals between static stretching for hip adductor, quadriceps and hamstring muscles and resistance training in repetition performance.

**Method:** Twenty-two trained men were submitted to the 10 repetition maximum test and retest for leg extension, leg curl and hip adduction exercises. Three protocols were conducted in a randomized design – PWI: resistance training immediately after static stretching; P15: fifteen-minute rest interval between static stretching and resistance training; P30: thirty-minute rest interval between static stretching and resistance training.

**Results:** The total number of repetition [(sets \* repetitions) + exercises] performed under P30 ( $84.55 \pm 1.68$ ) was significantly higher than P15 ( $79.73 \pm 1.89$ ) and PWI ( $68.09 \pm 2.03$ ), respectively. Significant differences were also found between P15 and P30.

**Conclusions:** Therefore, 30-minute interval between static stretching and resistance exercises was needed to achieve greater repetition performance. Thus, static stretching for lower limbs may be avoided before a resistance training session.

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## Número de repeticiones tras diferentes secuencias de descanso entre estiramiento estático y entrenamiento de fuerza

### RESUMEN

**Objetivo:** El objetivo de ese estudio fue investigar los efectos de distintas secuencias de estiramiento estático, en los músculos aductores de la cadera, cuádriceps e isquiotibiales y el entrenamiento de resistencia, en el rendimiento en repeticiones.

**Método:** Veintidós hombres entrenados fueron sometidos a la prueba de 10 repeticiones máximas para ejercicios de extensión de piernas, flexión de piernas y aducción de cadera. Tres protocolos fueron realizados utilizando un diseño aleatorio: PSI: entrenamiento de resistencia realizado inmediatamente después del estiramiento estático; P15: intervalo de descanso de 15 minutos entre estiramiento estático y entrenamiento de resistencia; P30: intervalo de descanso de 30 minutos entre estiramiento estático y entrenamiento de resistencia.

**Resultados:** El número total de repeticiones [(sets \* repetición) + ejercicio], realizadas en P30 ( $84.55 \pm 1.68$ ) fue significativamente mayor que P15 ( $79.73 \pm 1.89$ ) y PSI ( $68.09 \pm 2.03$ ), respectivamente. También se observaron grandes diferencias entre P15 y P30.

*Palabras clave:*

Estiramiento estático

Entrenamiento de resistencia

Rendimiento de fuerza

Intervalo de recuperación

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**Conclusiones:** Por lo tanto, se necesitó un intervalo de 30 minutos entre el estiramiento estático y los ejercicios de resistencia para lograr un mayor rendimiento en repeticiones. En este sentido, el estiramiento estático para miembros inferiores puede ser evitado antes de una sesión de entrenamiento de resistencia.

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## Número de repetição após diferentes intervalos de recuperação entre alongamento estático e treinamento resistido

### R E S U M O

#### Palavras-chave:

Alongamento estático  
Treinamento resistido  
Desempenho de força  
Intervalo de recuperação

**Objetivo:** O objetivo deste estudo foi investigar os efeitos de diferentes intervalos entre alongamento estático para os músculos adutores do quadril, quadríceps e isquiotibiais e o treinamento resistido no desempenho de repetições.

**Método:** Vinte e dois homens treinados foram submetidos ao teste de 10 repetições máximas e reteste para os exercícios de extensão, e flexão de joelhos, e de adução do quadril. Três protocolos foram conduzidos em um desenho randomizado: PWI – treinamento resistido imediatamente após o alongamento estático; P15 – intervalo de descanso de 15 minutos entre alongamento estático e o treinamento resistido; P30 – intervalo de descanso de 30 minutos entre alongamento estático e o treinamento resistido.

**Resultados:** O número total de repetição ([séries \* repetições] + exercícios) realizada em P30 ( $84.55 \pm 1.68$ ) foi significativamente maior do que o P15 ( $79.73 \pm 1.89$ ) e PWI ( $68.09 \pm 2.03$ ), respectivamente. Diferenças significativas também foram encontradas entre P15 e P30.

**Conclusões:** O intervalo de 30 minutos entre o alongamento estático e o exercício resistido foi necessário para alcançar maior desempenho no número de repetição. Assim, os alongamentos estáticos para membros inferiores podem ser evitados antes de uma sessão treinamento resistido.

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## Introduction

Flexibility training is a key component in exercise programs with the goal to develop quality of life and health.<sup>1,2</sup> Static stretching (SS) is one of the methods often adopted to improve the range of motion temporarily.<sup>3</sup> However, several studies have shown that pre-exercise stretching induces significant reductions on force production when compared to resistance exercises performed isolated.<sup>4-7</sup> This phenomenon has been named the stretching-induced force deficit.<sup>8</sup>

Adequate biomechanical performance of lower-body resistance exercises in health and/or sport conditioning programs requires a high level of range of motion.<sup>9</sup> Appropriate joint flexibility not only permits proper form, but also allows the trainee the ability to work against resistance through a full range of motion.<sup>10</sup> However, SS adopted prior to resistance training (RT) can induce significant decreases on muscle endurance,<sup>2,4</sup> torque<sup>10,11</sup> and power performance.<sup>7</sup> Two primary hypotheses have been proposed to explain the stretching-induced force deficit. The first hypothesis is associated to a neural factor, causing a decrease in muscle activation and reflex sensitivity.<sup>12</sup> The second hypothesis involves a mechanical factor, promoting a decrease in stiffness of the muscle-tendon unit (MTU) that may affect the muscle's length-tension relationship.<sup>13</sup> On the other hand, there are limited evidences about the time course of the stretching-induced force deficit between SS and resistance exercises.

Fowles et al.<sup>14</sup> observed decreases of 28% on maximal voluntary isometric contraction (MVIC) of triceps surae after SS, and they also found a reduction of 9% after 1 h. McBride et al.<sup>15</sup> observed significant reduction in MVIC, 1, 2, 8 and 16 min after SS. This data indicated that negative effect induced by SS on strength performance has a time course relationship, and it is probably associated to the volume (duration and number of sets) of stretching and the target muscle group. On the other hand, there is a lack of evidences about the effect of different intervals between SS and resistance exercises on repetition performance.

Furthermore, previous evidences suggested that pre-exercise stretching may not prevent injuries or improve athletic and/or stretching performance.<sup>10,16</sup> However, coaches and practitioners usually adopted stretching exercises before RT with the goal optimize the training sessions durations. For this reason, evidences about exercise models which SS and resistance exercises could be applied in the same exercise session, may be positive and also helps conditioning professionals and practitioners to improve the outcomes without compromising the strength performance.

Therefore, the purpose of this study was to investigate the effect of different intervals between passive SS for hip adductors, quadriceps and hamstring muscles and the repetition performance of resistance exercises for lower body muscles over multiples sets.

## Method

### Subjects

The study subjects consisted of twenty-two recreationally trained men ( $25 \pm 7$  years,  $74 \pm 30$  kg and  $175 \pm 20$  cm). They indicated they were not currently using medical drugs, dietary supplements, or anabolic steroids, and were without joint, muscular or cardiovascular diseases. The experimental conditions were conducted in accordance with the norms of the Brazilian National Health Council, under Resolution No. 466/2012, referring to scientific research on human subjects and Helsinki Declaration. The study was submitted and approved by the Ethics Committee of Federal University of Rio de Janeiro.

### Experimental design

The participants initially performed the 10 repetition maximum (RM) test (10-RM) for leg extension (LE), leg curl (LC) and hip adduction (HA).<sup>17</sup> 10-RM retest were applied after a 48-hour to evaluate the test-retest reliability. The testing was carried out until the

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