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Acute effects of static stretching on muscle strength

Juliana Boscher Torres[1,2,3], Mario C.S.C.Conceição[2,4,7], Adriane de Oliveira Sampaio[2,4,6], Estélio H.M.Dantas[1,2,5]

[1] Master Degree Course of Human Kinetics, University Castelo Branco; [2] Laboratory of Human Kinetics Bioscience, Rio de Janeiro; [3] University of Itaperuna; [4] Euro-American Physiology Doctoral Program; [5] National Council of Research (CNPq); [6] Brazilian Air Force College; [7] University Augusto Motta, Brazil

Summary

Study aim: To assess the effects of static passive maximal stretching on muscle performance in order to clarify the existing controversies.
Material and methods: Two randomly selected groups of the Brazilian Air Force personnel were studied: experimental (n = 15), subjected to 3 bouts of static passive stretching exercises of wrist flexors and extensors (beyond a mild discomfort). Every bout lasted 10 s and was followed by a 30-s rest. The control group (n = 15) performed no exercises. Muscle strength was measured with a handgrip dynamometer before and 20 min after the test.
Results: Subjects from the experimental group had the pre-exercise handgrip strength significantly higher than post-exercise (by about 7%; $p<0.01$). No significant decrease was noted in the control group.
Conclusions: Static passive stretching induces decreases in muscle strength.

Key words: Stretching – Muscle strength – Flexibility

Introduction

An initial preparation of athletes prior to the period of intense training is of great importance for a safe sport practice [32], the specific components and techniques involved in the warm-up remain, however, not well known [14]. According to the traditional approach, the warm-up should include activities that increase muscle flexibility [32] in order to improve the joint ranges of motion (ROM). Acute and chronic changes in flexibility refer to the period before or after the practice of physical activity, respectively [1,5,18,31].

Flexibility training can be of maximum intensity (flexibilizing) or of a sub-maximum one (stretching); the first, conducted just under the pain threshold, leads to attaining maximum range of motion (ROM), the other form employs movements in the upper normal range of motion [35]. In practice, there are 4 different protocols for flexibility training – static, ballistic and dynamic stretching, and proprioceptive neuromuscular facilitation (PNF, [20]). Static stretching, or slow movements that gradually lengthen muscles to an elongated position, hold for 15 to 60 s, is the most widely used protocol [1].

Although a prolonged static stretching may increase muscle performance [30], a number of studies showed that acute stretching (maximum stretching preceding physical activity) may reduce it, particularly in terms of maximal and explosive muscle strength [31,33,37]. However, other authors did not observe that latter effect [14, 27]. The aim of this study was to assess the acute effects of static passive flexibilizing on muscle strength, with the hope to clarify that controversy.

Material and Methods

Subjects: From the cohort of air force recruits aged 18 – 20 years, 30 male subjects were randomly selected and randomly assigned into an experimental or control groups, n = 15 each. All subjects were found healthy; they submitted their written consents to participate. They were informed about study objective and protocol, all the procedures conforming to the ethical guidelines of the Declaration of Helsinki [28]. The study was approved by the local Human Research Ethics Committee.

Procedures: Body height was recorded with a stadiometer (SANNY, Brazil), body mass – with a digital

Author's address Juliana Boscher-Torres, M.S., Castelo Branco University, Laboratory of Human Kinetics Bioscience, Salvador Allende Avenue 6700, 22780-160 Rio de Janeiro, Brazil juliana.boscher@hotmail.com

balance (Filizola PL150, Brazil), and relative body fat content was computed from 3 skinfolds with a caliper (Lange, USA) according to Jackson and Pollock [21] set for a constant pressure of 10 g/mm^2. Measurement accuracies amounted to 0.1 cm, 0.1 kg and 1 mm, respectively. The subjects were randomly assigned into two groups, n = 15 each: experimental, subjected to standardised stretching exercises, and control, not engaged in any regular programme of physical exercises.

The stretching exercises consisted of handgrips, upper extremity straight along the trunk. According to the protocol of Dantas [8], subjects from the experimental group executed the exercise slowly until perceiving pain and then was sustained for 10 s; the exercise intensity was monitored by means of the Scale of Perceived Effort (PERFLEX) [13], mean intensity amounting to 71.5 ± 0.8. That bout of exercise was repeated twice more, the bouts being separated by 30-s intermissions and 20 min after the last bout the subject performed a single handgrip (post-test strength). No exercises that might affect the outcome of the test were allowed throughout all intermissions. Handgrip strength was measured in all subjects at the beginning (pre-test) and at the end (post-test) of the session. A hand dynamometer (Lafayette, model 78010, USA) was used [7], its accuracy amounting to 1 N.

Data analysis: Since the variability coefficients of strength measurements were very low (less than 5%), Student's *t*-test for dependent or independent data was used, the level of $p \leq 0.05$ being considered significant.

Results

Basic characteristics of subjects are presented in Table 1 and the results handgrip strength before and after the applied stretching exercise in Table 2. Subjects from the experimental group had the post-exercise handgrip strength significantly ($p<0.01$), by about 7% lower than pre-exercise. No significant decrease was noted in the control group (cf. Table 2).

Table 1. Mean values (±SD) and ranges of basic features of studied subjects

Group / Variable	Experimental (n = 15)	Control (n = 15)
Age (years)	18.5 ± 0.6 (18 – 20)	18.4 ± 4.4 (18 – 20)
Body height (cm)	174.6 ± 2.7 (166 – 184)	175.3 ± 5.7 (168 – 187)
Body mass (kg)	65.5 ± 8.1 (51.8 – 78.3)	67.8 ± 7.9 (56.8 – 83.3)
BMI	21.4 ± 2.0 (17.4 – 25.0)	22.0 ± 2.2 (19.6 – 26.6)
Body fat content (%)	10.4 ± 2.7 (5.0 – 16.1)	10.5 ± 4.4 (5.7 – 19.9)

Table 2. Mean values (±SD) of hand strength before and after a passive stretching exercise

Group / Variable	Experimental (n = 15)	Control (n = 15)
Pre-exercise	44.6 ± 1.8	40.0 ± 1.5 °°
Post-exercise	41.6 ± 1.9**	39.8 ± 1.5

** Significantly ($p<0.01$) different from the pre-exercise value; °° Significantly ($p<0.01$) different from the respective value in the experimental group

Discussion

Passive stretching exercise proved highly efficient in reducing muscle strength. Similar observations were made also by other authors. Cardozo *et al*. [7] reported a tendency towards strength reduction in healthy individuals aged 20 – 30 years, practicing weight exercises, soon after a handgrip (1 RM) session, despite a gradual increase throughout 90 min post-exercise. Also Arruda *et al*. [2] noted strength reduction in 22 male subjects aged 20 – 30 years who performed supine straight arm exercise (10 RM), and Galdino *et al*. [17] in 15 male and 6 female subjects aged about 22 years.

McMillian *et al.* [26] compared the effects of warm-ups consisting of dynamic or static stretching on power output and agility performance in 30 US Military Academy cadets aged 18 – 24 years. They were subjected to 3 kinds of warm-up on consecutive days: dynamic stretching (DWU), static stretching (SWU), or no warm-up (NWU). The flexibility session lasted 10 min and, after a 2-min recovery 3 tests of power or agility were conducted. The results showed improved performance following DWU in all three tests and following SWU in only one of them. Other studies [5,10,11], however, rendered results resembling those in the present work.

Woolstenhulme *et al.* [35] approached three questions: (*a*) What is the effect of 6-week warm-up exercise on flexibility and vertical jump height in basketball? (*b*) What are the acute effects of each type of warm-up on

the vertical jump height? and (*c*) What are the acute effects of each type of warm-up on vertical jump height following a 20-min play? They noted a significant ($p<0.0001$) increase in flexibility associated with sport performance after 6 weeks of warm-up in the ballistic, static, and sprint groups, and a significant ($p<0.05$), acute increase in vertical jump in the ballistic-stretching group after a 20 min basketball play. These data partially disagree with our results, since performance was improved in the ballistic-stretching group but not in the static-stretching group.

McBride *et al.* [26] studied acute effects of stretching on muscle activity (evaluated by electromyography) and muscle strength during isometric knee extension and squat in moderately active university students. Subjects in the stretching group significantly ($p\leq0.05$) differed in muscle strength compared to control subjects. The activity of the *biceps femoris* significantly ($p\leq0.05$) decreased in the stretching group during knee extension and during squat.

In a study on Division I basketball players, Egan et *al.* [14] reported that acute static stretching had no effect on muscle torque and power output during concentric isokinetic knee extension. The authors used a dynamometer, like in this study, but the results were different from ours. In most studies that investigate the association between acute stretching and a decrease in muscle performance, the evaluation considers isokinetic and isometric muscle contractions [6,9,11,12,16,24]. Few studies considered the isotonic assessment – dynamic constant external resistance [22]. Yamaguchi *et al.* [37], however, reported that even in an isotonic contraction, a significant ($p<0.05$) decrease in muscle power was observed after stretching, compared with a control group. Their results thus coincided with the our ones.

Whereas in the present study the assessment of the effects of acute stretching on muscle strength was performed with concentric exercise, Cramer *et al.* [10] used eccentric contraction. The analysis of peak torques and joint angles in active women who performed static stretching, indicated no significant from pre-/post-stretching changes. Papadopoulos *et al*. [29], however, reported different effects of static and dynamic stretching exercises on the maximal isokinetic strength of knee extensors and flexors. Their results were similar to ours in showing that static stretching resulted in decreased torques of both muscles ($p<0.01$).

A number of studies suggested that active subjects (but not athletes) were more responsive to acute stretching exercises in the reduction of muscle performance and muscle strength during physical activity. Other studies, involving basketball [14,34] and other athletes, disagreed with the presented results. For example, Little and Williams [23] examined acute effects of different modes of stretching (static and dynamic) on the high-speed motor capacity of soccer players. Their results showed that the static stretch protocol did not interfere with the analysed variables; dynamic stretching, however, produced significantly improved performance in vertical jumps and 10-m sprint time.

In conclusion, the present work showed that static passive stretching resulted in a decrease in muscle strength, supporting previous studies in which similar methods were employed. Other reports, however, showed different results in athletes to whom ballistic and dynamic stretching were applied. Further studies would be needed to compare acute and chronic effects following different stretching protocols.

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