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The Acute Effect of a Sport-Specific Stretching Routine on the Performance of Vertical Jumps in Rhythmic Gymnasts

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ABSTRACT

Silva GF, Almeida AR, Rodrigues SA, Szmuchrowski LA, Silva RAD, Drummond MDM. The Acute Effect of a Sport-Specific Stretching Routine on the Performance of Vertical Jumps in Rhythmic Gymnasts. **JEPonline** 2018;21(2):30-39. The purpose of this study was to investigate the acute effect of a specific flexibility training session on the height of a countermovement jump (CMJ) in Rhythmic Gymnastics (RG) Athletes. The subjects in this study were 13 female athletes with a mean age of 14.5 ± 2.43 yrs. After familiarization with the CMJ, the subjects performed the two evaluation sessions with a 48-hr interval between the two sessions. The athletes performed the CMJ tests without and with a predetermined stretch routine, which had pre-defined parameters specific to the modality. The results demonstrated a significant reduction in the height of the vertical jumps in the second session, compared to the first session (P=0.0001). Therefore, the modality-specific stretching protocol that was used generated an acute negative effect on the athletes' CMJ performance.

Key Words: Acute Effects, Flexibility, Rhythmic Gymnastics, Vertical Jump

INTRODUCTION

Rhythmic Gymnastics (RG) is a sport that presents the association between technique and the art of movement (12,20). The execution of technical gestures in RG demands high levels of flexibility and strength, besides a better than average aerobic capacity (11). According to Douda et al. (11), flexibility assumes a relevant role in RG performance because the movements in this modality require the execution of a great range of movement. Therefore, good flexibility becomes essential in the execution of great part of the bodily elements present in the RG code of points (10-12).

In fact, almost all the movements in RG are performed with a high degree of flexibility as well as strength, especially in the vertical and horizontal jumps (10,11). According to Di Cagno et al. (10), the vertical jumps in RG are very present in a series of movements and should reach the highest height possible to realize the intended technique with efficacy.

According to Richte and colleagues (22), the performance in the vertical jumps is directly related to the athletes' physical and motor capacities. Especially in the countermovement jump (CMJ), the elastic characteristic of the skeletal muscle is used to reach higher heights and longer airtime (22). The elastic components and, consequently, the performance in the vertical jump are affected by the velocity and range of motion (ROM), which in turn could be influenced by the rigidity of the muscle-tendon unit (MTU) (28).

Flexibility training can affect the ROM and the rigidity of the MTU (28), besides influencing the production of strength and power (25). In agreement, Rubini et al. (23) indicate that muscle strength is one of the most important factors in the vertical jump and the acute effect of the stretch interferes negatively in the performance of muscle strength. Thus, they conclude that a decrease in performance is to be expected with a decrease in the athlete's strength.

Some authors claim a stretch-induced transitory deficit in muscle strength occurs (21,29). According to these studies, the deficit is linked to two acute primary factors: neural and mechanic. In relation to the neural factors, the reduction in the activation of the motor units (MU) and the activation of the nociceptors occur, as well as the decrease in the sensibility of the muscle spindle and of the activation of the nociceptors, together with the inhibition generated by the Golgi Tendon (14).

Regarding the mechanical factors that involve the viscoelastic muscle properties, they would be connected to the effect over the muscle tension-length relationship. The stretches could alter in an acute manner the optimal position for myosin and actin coupling and of the consequent formation of the cross-bridges. Such a change in the myosin and actin coupling might have a negative effect in the production of muscle strength (4,30).

Investigating the acute effects of stretching over the performance of vertical jumps, some authors have pointed out a decrease (3,4) while others have not found any negative effects (5,7,22,27). The results in the literature suggest that the acute effect of a stretching session is determined by the relationship between the load of the stretching session, the tasks of the modality, and the characteristics of the subjects. It is important to emphasize that the duration and intensity of the stretching exercises play a determinant role in the magnitude of the

effects of a stretching session. That is, it appears a stretch with a long duration at a high intensity leads to a greater decrease in the capacity to generate strength and power (2).

The RG training routine includes dynamic and static stretches with high volume (duration and number of sets) and intensity (stretching to maximum ROM) (10,14). Therefore, it appears that the configuration of a RG flexibility training session can have a negatively influence the performance of athletes in an acute manner. However, only the study of Di Cagno et al. (10) investigated the acute effect of a stretching routine in RG athletes, and they did not find a deleterious effect in the performance. But, it is important to point out that the protocol used in their study investigated solely the effect of static stretches, which is not specific of this modality. Thus, the purpose of this study was to verify and compare the acute effect of a modality-specific, flexibility training session, over the height of vertical jumps in RG athletes.

METHODS

The present study is of the transverse type, in which the effect of a stretching session specific to Rhythmic Gymnastics over the performance of the vertical jump of athletes from this modality was evaluated. Initially, the CMJ familiarization session was performed, followed by two evaluation sessions, with a 48-hrs interval between the sessions. In the evaluation sessions, the athletes performed the CMJ tests without a prior stretch and with a prior stretch, which had pre-defined parameters specific to the modality. The evaluation sessions were performed randomly. All sessions were conducted in the same moment of the day for each subject. The data were collected in the city of Belo Horizonte, Brazil, in the athletes' training center. After initiating the evaluations, no changes in the protocol that might have had an influence on the results occurred.

Sample

The sample consisted of 13 RG female athletes from the city of Belo Horizonte, Brazil. Athletes with experience in international competitions in their respective categories were selected. The mean age of the subjects was of 14.5 ± 2.43 yrs. Their mean total body mass was 45.5 ± 11.9 kg, and their mean stature was 1.57 ± 0.12 m. None of the subjects presented any history of injury of the upper or lower limbs, trunk, or any type of limitation to the execution of the stretching routine or the CMJ test. All subjects received the same information about the study, the procedures, and signed an informed consent form (ICF). All the athletes under the age of 18 had their ICF signed by parents or tutor. This study was approved by the Committee on Ethics and Research of the Federal University of Minas Gerais (report number: 116.157).

Instruments

For the performance of the flexibility tests a manual goniometer, brand CARCI® (model 5205, São Paulo, Brazil) was used. For the collection of data related to the performance of the CMJ, a strength platform was used, model (PLA3-1D-7KN/JBA Zb, Staniak®, Poland). It is composed of two surfaces with 40 x 40 cm each. In each one of the surfaces, there are strength cells sensitive to pressure that were connected to an analogic-digital signal converter, amplifier (Amplifier WTM 005-2T/2P JP Jaroslaw® - Poland), and software (MVJ version 3.4 – ZB.Staniak® - Poland) to determine strength and time values. The strength cells

are composed of sensors sensitive to deformation. The execution of the stretching routine was performed under a specific flooring of the brand Tabacow® 12 mm (Campinas, São Paulo, Brazil), and Swedish stools of the brand Mataotramp® (São Paulo, São Paulo, Brazil) with 30 cm of height.

Procedures

Familiarization
The familiarization session was initiated by a standard preparation activity. The subjects performed sequence of 8 CMJs with an interval of 1 min between each jump. The performance was considered stabilized when the mean performance of the first sequence of 8 jumps did not show a significant difference in comparison to the mean of the second sequence with the same number of jumps (8).

Flexibility Test
For characterization of sample, the subjects passed an evaluation of initial flexibility and hip flexion level. The test consisted of the measurement of the passive ROM of the hip extensors using a manual goniometer. The subjects were positioned in the supine position on a stretcher, having the limb that was being evaluated taken passively by an examiner to the maximum hip flexion amplitude with knees extended from the beginning of movement. The point of maximum ROM was established by the sensation of stretching of subject, who stated to the examiner that he could not go past that angle. The contralateral member remained in anatomical position, fixated to the stretcher by a tape in the proximal femoral region, so there would not be any compensations of the hip (posterior tilt). The goniometer's fixed spindle was oriented parallel to the ground with its axis on top of the femur's greater trochanter of the side which was evaluated. The mobile spindle of the goniometer accompanied the hip flexion movement, having as reference the lateral epicondyle of femur on the side that was evaluated. The test was performed in both lower limbs of all subjects. Three measurements were performed up to the maximum ROM. The value for analysis was the average of the 3 measurements.

CMJ Test
In the CMJ test session that was not preceded by stretching to the jumps, the subjects engaged in 5 min of a specific preparatory physical activity. In CMJ test session preceded by stretches, the jumps were performed 6 min after the performance of the stretching routine (5) and after the preparatory activity. Each subject executed 4 CMJs with an interval of 1 min between each jump (26).

The CMJ was initiated with the subjects standing up and presented as its final phase the descendent movement with flexion of knees and hips. Shortly thereafter the ascending phase was performed, or impulsion phase, with the extension of knees and hips (22). The subjects performed a maximum effort, keeping their hands on their hips during the entire movement. The mean of the 4 jumps was used for the analysis of the data (26).

Stretching Routine Protocol
The stretching routine was initiated by a preparation activity that consisted of a low-intensity 5-min run (jog) followed by 5 min of walking with the ankle kept in plantar flexion. Then, the static stretching protocol was performed that was followed by the dynamic stretching protocol,

as described below. The static stretching protocol was: 1 set, duration of 90 sec with an interval of 30 sec between the exercises (refer to Figure 1, performed according to the sequence of letters). The intensity of the stretches was the maximum ROM of each exercise. The exercises with the bench (H and I) were performed after the dynamic stretching protocol, finishing the stretching routine.

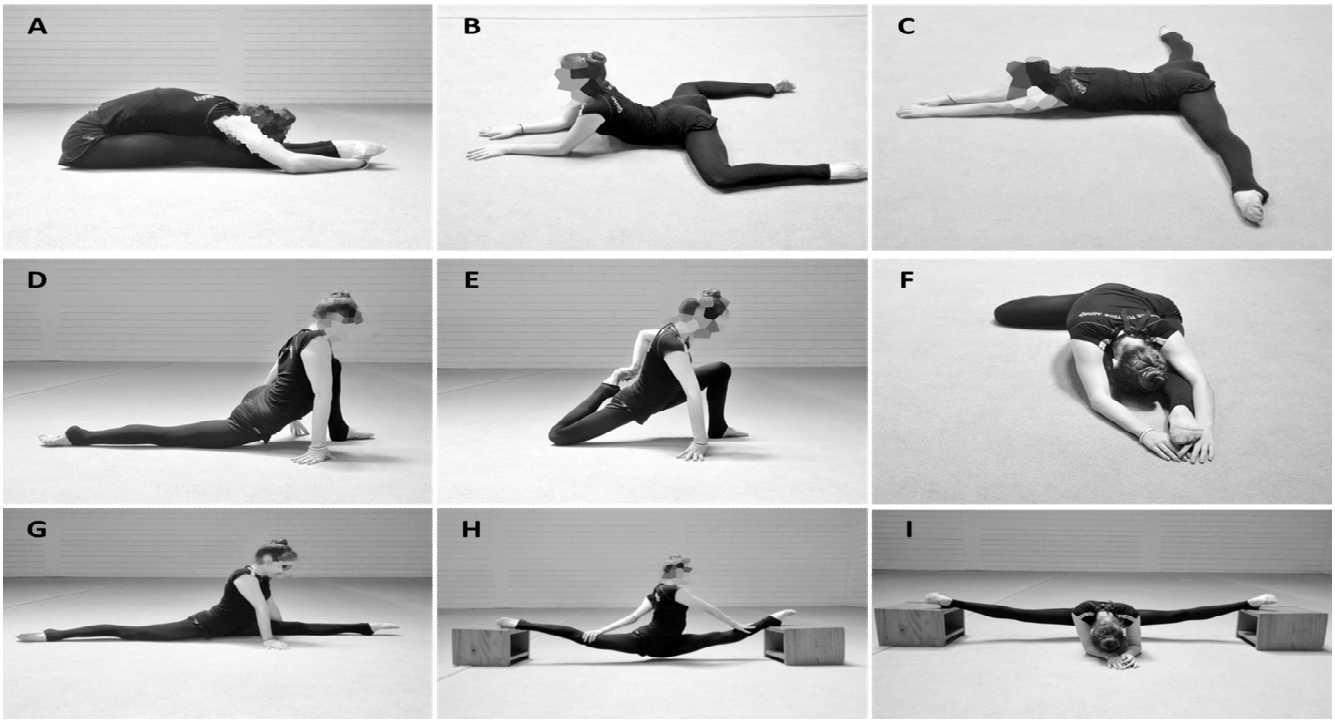

Figure 1. Static Stretches.

The dynamic stretching protocol consisted of the following: 1 set, 10 reps of each movement with a 30-sec interval between the exercises (as presented in Figure 2, performed according to the sequence of letters). The intensity of the stretches was the maximum ROM of each exercise.

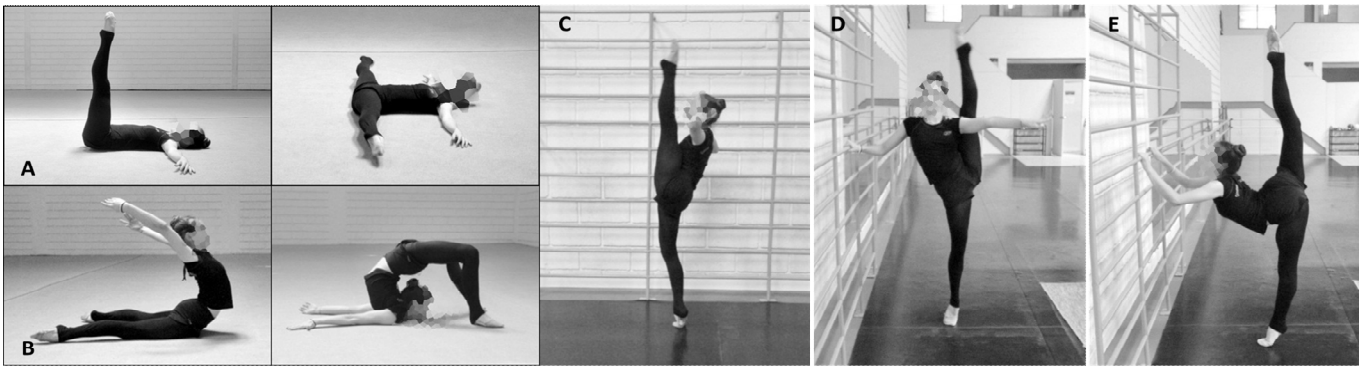

Figure 2. Dynamic Stretches.

These parameters make up the routine of stretching of the GR athletes, who were already familiar with the exercises, duration, and intensity. The stretching routine represented the specific routine of the modality similar to those used in other studies (10,14).

Statistical Analyses

The normality of data was verified by means of Shapiro-Wilk test. The paired *t*-test was utilized to verify the level of stabilization of performance in the jumps in the familiarization sessions, as well as to verify the effect of the stretches on the subjects' performance in CMJ in both groups. To verify the difference between the means of the stretches and effects between the groups, the unpaired *t*-test was used. The level of significance adopted was 5% ($P<0.05$). For all statistical analysis, the software Sigma plot was used (Version 12.0, Systat Software, San Jose, California, USA). In addition to the statistical inferential, a descriptive analysis of data was also performed.

RESULTS

The values obtained in the CMJs presented normal distribution. The subjects presented a maximum ROM of hip flexion of 142.15 ± 15.47º on the lower right limb and 138.69 ± 14.08º on the lower left limb. The results of the tests presented a significant reduction in the subjects' CMJ performance ($P=0.0001$) after the stretching routine. Table 1 presents the results of the CMJ heights (means ± standard deviation), "not preceded" (without a prior stretching warm-up) and "preceded" (i.e., with a prior stretching warm-up) by the specific stretching routines of the RG athletes.

Table 1. The CMJ Heights Not Preceded (NP) and Preceded (P) by Stretching Routine.

NP (cm)	P (cm)	Variation (%)
28.6 ± 3.5	26.1 ± 3.3*	- 8.1 ± 1.8

*Significant difference to the NP condition ($P<0.05$).

DISCUSSION

The purpose of this study was to determine the acute effect of a modality-specific flexibility training session on the height of vertical jumps in RG athletes. The results demonstrated that the performance of a stretching routine, specific and usually used in RG training, reduced the performance of the CMJ. Therefore, the hypothesis of this study was confirmed. The results of the present study are contrary to the findings of Di Cagno et al. (10) who did not find a negative effect on the CMJ and technical performance in RG after a routine of static stretches that included 4 exercises, 3 sets, and 30 sec each. The differences in stretching protocols may justify the divergence in the results, which is not likely due to the diversity of the sample

(given that the subjects of both studies were RG athletes). It is important to emphasize that in present study the effects of the session of stretches were not investigated directly in RG performance.

It appears that no other studies have investigated the acute effects of a flexibility training session on RG athletes, which makes the discussion of results somewhat difficult. The results of present study are similar to other studies (4,31,32) related to static stretching. Interestingly, these studies reported a decrease in the performance of the vertical jump when followed by the practice of this type of stretching in physically active subjects, but not in athletes. Also, it is apparent that the duration of stretching in these earlier studies is ~90 sec, of which according to Behm and colleagues (4), still is not very representative in relation to the time performed in the majority of sports activities. When the volume of each stretch is less than 90 sec, the effect on the performance is less perceivable, even in non-athletic subjects (13).

On the other hand, Chaouachi et al. (6) reported that the passive static stretch performed up to the first discomfort sensation did not have a negative influence on sprinting and the performance of the vertical jump of elite artistic gymnastic athletes. They attributed this finding to the high level of training of these athletes. The findings of the present study do not support their point of view, given that the stretching routine caused negative effects on the CMJ height in athletes. Possibly the differences in the results found in the studies occurred due to the different configurations of the loads of training and characteristics of the athletes, as well as the demands of modalities. Therefore, it is reasonable to state that there is a relation between these factors as a beginning point to determine the acute effect of a stretching session. This thinking also indicates the necessity of specific studies in regards to each modality and training load imposed.

Rubini et al. (23) indicated that ballistic stretching might be a flexibility training method to improve sports performance while it is a part of the warm-up prior to the power activities. In agreement, Perrier et al. (19) suggest that the dynamic stretching improves flexibility without causing significant loss in the performance of CMJ. Yet, it is clear that the present study refutes this affirmation, given that the addition of dynamic stretching to the stretching routine led to a decrease in performance of CMJ. But, here again, it is important to emphasize that the stretching routine applied in the RG training, as well as in the present study consists of a combination of static and dynamic stretching methods.

The acute effect of performance reduction in CMJ may be justified by the decrease in the production of strength of the muscles that received the stretch stimulus, as suggested by Simão et al. (25). According to Rubini et al. (23), the studies are controversial in relation to the deficit of strength induced by the stretch. According to these authors, this mainly occurs by the variation of methods applied in each work, the different time duration of stretches, the different muscle groups studied, and the types of stretches and methods used. The literature presents a diversity of mechanisms that could justify the negative effect of stretching on the development of muscle strength.

Evidences show reduction of electromyographic activity and of activation of the motor units (1,9,15), as well as the decrease of maximum torque (17,18). Recent research has also observed the acute deleterious effect of the stretching in the generation of muscle strength, with consequent loss of performance, including in CMJ, in non-athlete active subjects

(16,23,24). It is important to emphasize that the present study did not identify or analyze other parameters, that is, besides the height of the CMJ, which could justify the results from the reduction of muscle strength. Hence, this study cannot identify the decrease in strength as the factor in decreasing the subjects' performance.

CONCLUSIONS

In view of the present study, it is possible to conclude that the performance of a stretching routine, specific and commonplace in RG training, composed of static and dynamic exercises, significantly reduced the performance in CMJ. Therefore, the stretching session should not consist of similar parameters to those used in this study, be it for general training or modality-specific training for competitions. Additional studies are necessary to determine an ideal load of flexibility training in RG to reach the goals of flexibility improvement without loss in the vertical jump performance.

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