Original Article

Comparison of different flexibility training methods and specific warm-up on repetition maximum volume in lower limb exercises with female jazz dancers

DANIEL TINOCO NOVAES DOS SANTOS [1], LÍVIA TORRES MENDES [1], MARIA DE FÁTIMA DAS NEVES ALVES [1], AMANDA CALDAS DA COSTA BONELA [1], GABRIEL ANDRADE PAZ [1,2,3], JURANDIR BAPTISTA DA SILVA [2,3,4], JULIANA BRANDÃO PINTO DE CASTRO [4] ✉, CAMILA APARECIDA DE SOUZA BATISTA[1], HAROLDO GUALTER SANT'ANA [1,2,3], VICENTE PINHEIRO LIMA [2,3,4], HUMBERTO LAMEIRA MIRANDA[1]

[1]*School of Physical Education and Sports, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil*
[2]*Biodynamic Laboratory of Exercise, Health & Performance, Castelo Branco University, Rio de Janeiro, Brazil*
[3]*Biodesp Institute, Kinesiology Center of Performance, Rio de Janeiro, Brazil*
[4]*Institute of Physical Education and Sports, Rio de Janeiro State University, Rio de Janeiro, Brazil*

ABSTRACT

Introduction: Some evidences show that stretching exercises prior to a strength training session can result in decrease of performance. Therefore, the aim of this study was to compare the acute effect of different stretching protocols in the lower limbs using the sum of repetition maximum (RM) performed before a strength training session. Material and methods: The sample consisted of ten female jazz dancers (age: 24.7 ± 7.84 years), with no experience in strength training. Six visits were conducted in which participants were subjected to 10-RM test, 10-RM retest and four different warm-up protocols: specific warm-up, static stretching, proprioceptive neuromuscular facilitation and ballistic stretching. Results: The results obtained in this study showed that in the squat exercise in the Smith machine, the ballistic stretching protocol had a significantly higher volume compared to all other protocols, while the PNF had a significantly higher volume in comparison

✉ **Corresponding author.** *Postgraduate Program in Exercise and Sport Sciences, Rio de Janeiro State University, RJ, Brazil.*
http://orcid.org/0000-0002-5656-0782
E-mail: julianabrandaoflp@hotmail.com
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with the specific warm-up protocol and static stretching protocol ($p < 0.05$). However, in the leg extension, there were no significant differences in the total volume of maximum repetitions between protocols. Conclusion: Ballistic stretching was the most effective protocol to increase the levels of muscle strength in female jazz dancers. **Key words:** MUSCLE STRETCHING EXERCISES; RESISTANCE TRAINING; WARM-UP EXERCISE; LOWER EXTREMITY; DANCING.

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INTRODUCTION

Jazz is a dance with origin in the fusion of African and American cultures. The jazz is based on natural movements of the human body. It requires actions involving strength and flexibility, jumps and supports.[1] Thus, the physical valences flexibility and strength are seen as important components of physical training to obtain and maintain health, quality of life and sports performance.[2]

Dance practitioners have adopted stretching exercises – more formally known as flexibility training[3] – not only to increase flexibility in the preparation and completion of training and activities. It is also used as a complement to physical preparation because it develops active flexibility, improves blood supply, avoids compensation that can lead to destabilization of posture and prevents potential injuries.[4]

Strength training (ST) is very important for joint stability compromised by excessive range of motion.[5] However, the benefits of the muscle stretching before ST is still controversial in respect to strength production.[6-8] Previous studies which applied stretching exercises for the antagonist muscles before the ST showed positive results, with improvement in repetition performance.[9,10] However, some studies have shown reduction in the repetition performance when the stretching exercises were performed in agonist muscles before the ST.[11,12]

Among the different flexibility training methods used before sports activity, it can be mentioned static stretching (SS), ballistic stretching (BS) and proprioceptive neuromuscular facilitation (PNF).[13] However, previous studies that analyzed the responses in muscle power performance immediately after these protocols of flexibility training have presented controversial results. These studies showed reduction in strength production after SS[6] and after PNF,[14,15] no difference after the PNF protocol[16] and after the three protocols.[17] Thus, the most efficient method to use before the ST is still controversial in the literature.

As stated, studies present different effects on strength production in certain protocols of flexibility training executed pre-training, leaving questions about the acute effects of different protocols, as well as their influence on strength production in the practice of jazz. Thus, there is a need for studies that allow knowing the best method to use in the physical preparation of jazz dancers, as well as verify the influence of stretching in strength production. Therefore, the aim of this study was to compare different flexibility training methods (SS, BS and PNF) and specific warm-up (SW) on the volume of maximum repetitions in exercises for the lower limbs in women who practice jazz.

MATERIAL AND METHODS

Subjects

The sample was composed of ten women (age: 24.7 ± 7.84 years; weight: 59.08 ± 7.34 kg; height: 1.63 ± 0.05 m) selected by convenience and not probabilistically. To be included in the study, a subject had to meet the following inclusion criteria: a) practice jazz; b) do not practice ST. We excluded women: a) with some type of muscular-skeletal anomalies or some kind of pathology that would undermine the tests; b) who used some ergogenic substance; c) with positive Physical Activity Readiness Questionnaire (PAR-Q).[18] Before undergoing the tests, all participants were informed about the study and were invited to participate. Those who agreed to participate signed an informed consent form in accordance with the guidelines regarding human research delineated in the Helsinki Declaration[19] and the resolution 466/2012 of the National Health Council.[20]

The subjects were randomly divided into four groups. Each group was submitted to the proposed protocols randomly and alternatively, in a way that all participants made all protocols. The participants did six training sessions with at least 48 hours between each session. The first and the second sessions were for test and re-test of ten-repetition maximum (10-RM). The others sessions were for the implementation of the protocols.

Ten-repetition maximum (10-RM) testing

The participants performed an initially familiarization with the proposed exercises and the correct positioning. A professional and experienced researcher was responsible for guidance. To obtain the maximum load, the participants underwent the realization of the proposed exercises with load mobilization that enabled the realization of a maximum of 10 repetitions in a voluntary concentric muscle failure regime.[21] Three attempts were made with intervals of 3 to 5 minutes between them. The maximum load was determined through the load in which the individual performed the 10 full repetitions. In order to minimize the margin of error in the results, we adopted the following strategies:[22] a) standardized instructions were provided before the test, so the individual was aware of the whole routine that involved collecting data; b) the individual was instructed on the correct technical execution of each exercise; c) the researcher was alert to the position adopted by the time of testing, because small variations in positioning of the joints involved in the movement could activate other muscles, leading to interpretations of erroneous scores; d) fixed position was set at each equipment: using as reference in the squat exercise in the Smith machine, knee flexion to the angle of 90°, and in leg extension, the full extension of the knee joint, starting from 90° flexion position, during the extension.

Procedures

The visits were divided into six sessions (Figure 1). In the first session, the participants signed an informed consent form, held an anthropometric assessment, did the exercises familiarization and were held the calculation of the load for 10-RM. In the next session, was held retesting to check the reproducibility of the maximum load obtained in the previous session. In the following four sessions, tests were performed preceded by the protocols of SW, SS, PNF and BS. All subjects were submitted to all experimental conditions randomly and alternately.

Training sessions

The exercises were performed in the following order: squat exercise in the Smith machine and leg extension. The tests consisted in performing three sets until concentric failure, using the load obtained in 10-RM test. It was calculated the maximum number of repetitions performed until concentric failure with an interval of two minutes between sets, in each exercise. At the end of the session, it was determined the sum of repetitions for each exercise after the different protocols. In all test sessions, there were no interval between the warm-up protocol and the proposed exercises.

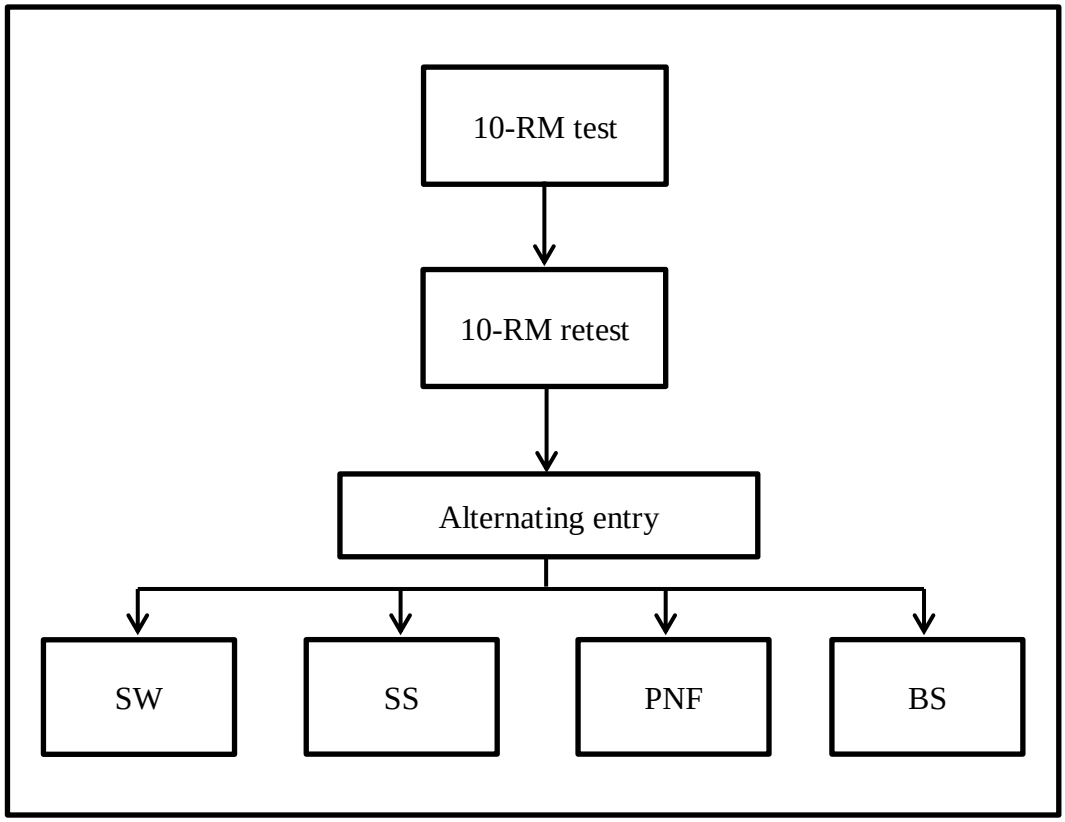
Specific warm-up (SW) protocol

The SW protocol consisted of two sets of 15 repetitions of squat exercise in the Smith machine with 50% of the maximum load obtained in 10-RM test and interval of 60 seconds between sets.

Proprioceptive neuromuscular facilitation (PNF) protocol

The PNF protocol consisted of stretching the quadriceps through unilateral knee flexion with the individual in the prone position and parallel legs.[23] To stretch the hamstrings, the subject was positioned in supine position with straight leg raising towards the trunk. In both movements, the muscles involved were stretched until the position of discomfort, followed by maximum voluntary contraction for 20 seconds. The researcher, with

subsequent attempts to reach a greater range of extension than previously achieved, retained this movement. The procedure was repeated twice for each muscular group.[21]



SW: specific warm-up; SS: static stretching; PNF: proprioceptive neuromuscular facilitation; BS: ballistic stretching.

Figure 1. Experimental study design.

Static stretching (SS) protocol

The SS protocol consisted of unilateral stretching of the quadriceps in the prone position, stretching the knee to the maximum discomfort position and hold for 40 seconds.[24] This movement was performed twice, alternately between members, with no interval in the total realization. Similarly for hamstrings, the individual was positioned in supine position with straight leg raising towards the trunk, stretching until the maximum discomfort position, holding the position for 40 seconds, alternating between members without intermission. The procedure was repeated twice for each muscular group.

Ballistic stretching (BS) protocol

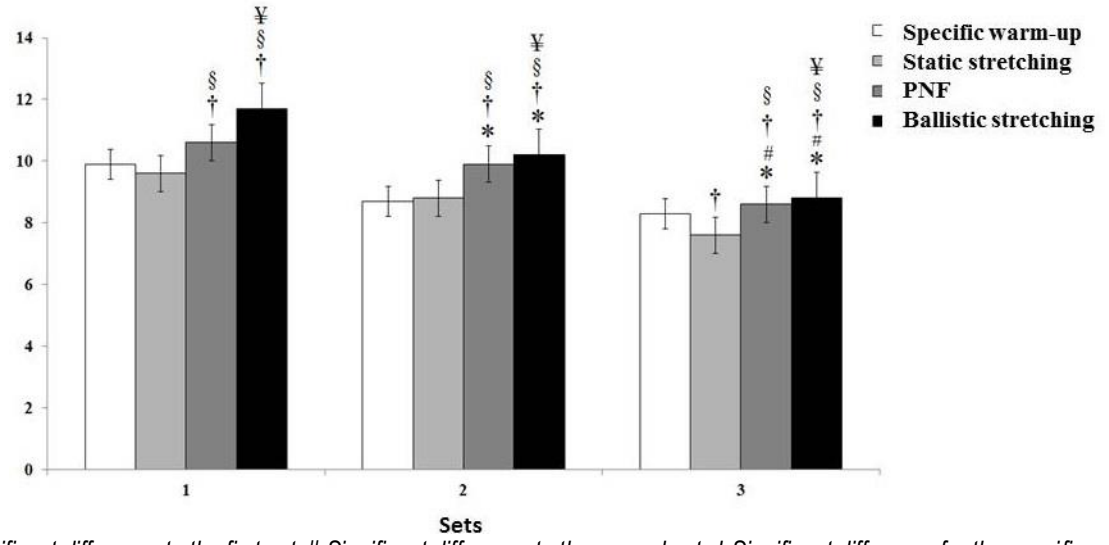
The BS protocol consisted of stretching the hamstrings in standing position, both feet facing forward and straight knees. It was underwent hip flexion through the contraction of its flexor muscles. Forty repetitions were performed with intervals of 40 second. Individuals were encouraged to realize the maximum possible stretching during the movement. Two cycles of stretching were performed with an interval of 40 seconds between each cycle.[25] For the quadriceps stretch, there were 40 unilateral knee push-ups, with the individual in standing position and with intervals of 40 seconds, alternating between members without intermission. This procedure was repeated twice for each muscular group.

Statistical analysis

The statistical analysis was done by the software SPSS version 20.0 (Chicago, IL, USA). Statistical analysis was initially done by the Shapiro-Wilk normality test and by the homoscedasticity test (Bartlett criterion). All variables showed normal distribution and homoscedasticity. The two-way ANOVA [protocols (4) x sets (3)] for repeated measures followed by Bonferroni post hoc was applied to determine whether there was a significant difference or interaction between the protocol and between sets (1-3) related to leg extension. The value of $p<0.05$ was adopted for all inferential analyzes.

RESULTS

In the squat exercise in the Smith machine, comparing the protocols among each other (Figure 2), PNF protocol showed a significantly larger volume in comparison with SW and SS protocols ($p<0.05$). Ballistic stretching protocol had a significantly larger volume in comparison with all other protocols performed ($p < 0.05$).



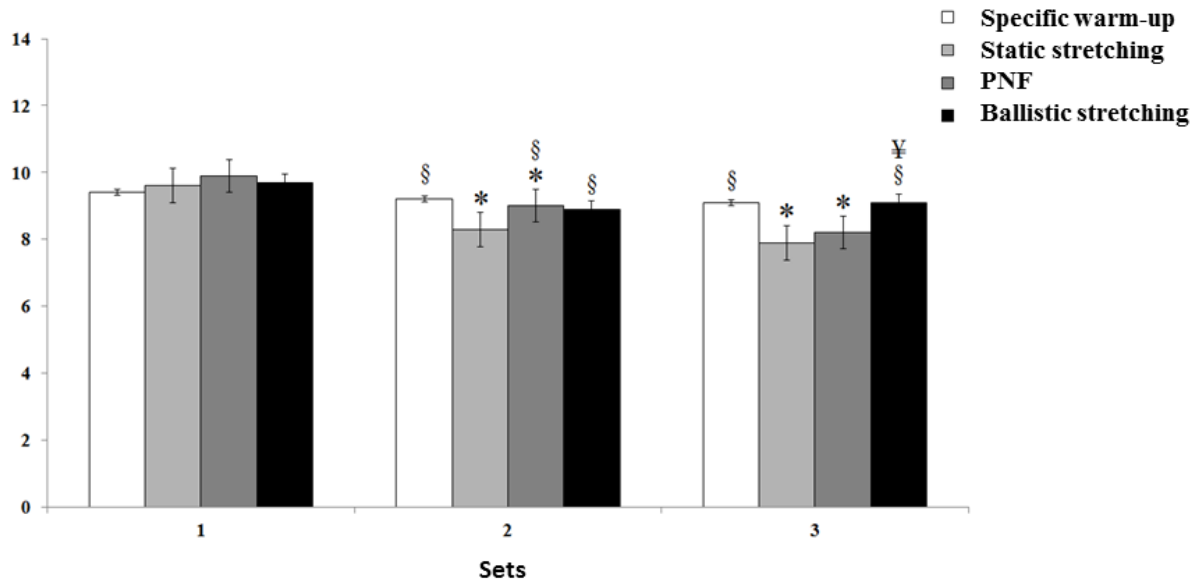
** Significant difference to the first set; # Significant difference to the second set; † Significant difference for the specific warm-up protocol; § Significant difference to the static stretching protocol; ¥ Significant difference to the PNF protocol.*

Figure 2. Repetition maximum performance held in the squat exercise in the Smith machine.

Analyzing the series performed, we found that the BS and PNF protocols showed significant decrease in the volume of maximum repetitions in the second set in relation to the first and in the third set in relation to the second ($p < 0.05$). It suggests a decrease of strength production in both protocols. The third set of SS protocol showed a significantly larger volume in comparison with the third set of SW protocol ($p < 0.05$). There was no significant difference between the sets of SW protocol.

In the leg extension, there were no significant differences in the total volume of maximum repetitions comparing the protocols between themselves ($p > 0.05$) (Figure 3). When analyzed the sets performed, there was a significant decrease in the volume of maximum repetitions in the second and third sets in relation to the first set in the SS and PNF protocols ($p < 0.05$), and also significantly lower results in the same sets when compared to sets of the SW protocol ($p < 0.05$). We also identified that the second set performed in the PNF

protocol showed volume of maximum repetitions significantly greater than the second set in the SS protocol ($p < 0.05$).



** Significant difference to the first set; # Significant difference to the second set; † Significant difference for the specific warm-up protocol; § Significant difference to the static stretching protocol; ¥ Significant difference to the PNF protocol.*

Figure 3. Repetition maximum performance held in the leg extension.

Ballistic stretching protocol showed significant differences in the volume of maximum repetitions of the second and third sets in comparison with the SS protocol ($p < 0.05$) and significant difference in the volume of maximum repetitions in the third set compared to the third set held in the PNF protocol ($p < 0.05$). There were no significant differences when comparing the three sets of this protocol with each other.

DISCUSSION

The aim of the present study was to compare the acute effect of three different flexibility training methods (SS, BS and PNF) and SW applied prior to ST session on the volume of maximum repetitions performed in the squat exercise in the Smith machine and leg extension. Participated in this study ten women who practice jazz and with no previous experience in ST. The results obtained in the present study showed that the squat exercise in the Smith machine, the BS protocol had a significantly higher volume compared to all other protocols, while the PNF protocol had a significantly higher volume in comparison with the SW and SS protocols. However, in the leg extension there were no significant differences in the total volume of maximum repetitions between protocols. Fermino et al.[26] analyzed the influence of SW and SS on the performance of muscle strength in 10-RM in leg curl in 12 male subjects, experienced in SF, randomly divided into two groups. The first group performed the SW before exercise, while the second held SS as warm-up. After 48 hours, the protocols were inverted. The authors concluded that there were no significant differences between the types of warming-up, both in the number of repetitions of each sets individually and in total volume performed. These results corroborate the findings of this study, which found no significant difference in exercises performed after flexibility training passively.

However, the results of the flexibility protocols influence on the number of repetitions in squat exercise in the Smith machine in the present study differ from Simão et al.[27] These authors did not identify significant differences in strength performance in 1RM test using three different warming-up protocols. The specific protocol consisted of 20 repetitions with comfortable load. The flexibility warming-up consisted of six stretching exercises adapted from Flextest and staying in uncomfortable position for 10 seconds each. The aerobic warm-up consisted of reaching the target zone training in a bike, remained at this stage for 10 minutes. However, the results for the leg extension are similar to the findings of Simão et al.[27] In relation to SS, Noel et al.[28] compared the influence of static stretching and specific stretching in the maximum number of repetitions performed in multiple sets of strength training in bench press and leg press. Twelve men with, at least, six months of experience in strength training, performed three sets of the exercises in bench press and leg press until fatigue with load to 10-RM, after the static stretching and the specific stretching. The results showed that there was no significant difference in the number of repetitions performed between static stretching and specific stretching. This corroborates with the findings of the present study, where there was no significant difference in the total volume of repetitions in the squat exercise and leg extension to this protocol. The results obtained in the present article corroborates the mentioned studies, since it was not identified significant difference between these two protocols, but does not confirm the result found by Tricoli e Paulo.[29] These authors investigated the acute effect of static stretching on strength performance. They found decrease in maximum strength performance when held a stretching session immediately before training. It is important to note that the volume of stretching session proposed by the authors, with an approximate duration of 20 minutes, may have been determinant in reducing the strength performance. This decrease in performance was not observed in our study.

Comparing PNF protocol with SW protocol, we did not verify the same results found by Gomes et al.,[14] who analyzed the effect of two different stretching methods (SS and PNF), and Sá et al.,[30] who compared the acute effect of SS and PNF on the performance of maximum repetitions in a strength training session. Gomes et al.[14] evaluated 15 men, not athletes, with previous experience in strength training, which made the maximum possible repetitions with loads of 40%, 60% and 80% of 1RM in leg extension and bench press. The volunteers performed the exercises without stretching, with SS and PNF. The results indicated significant loss of muscle strength when used PNF before training, being verified higher strength loss in higher loads.

Sá et al.[30] also compared SS, SW and the PNF in the leg press, leg extension, leg curl, and calf. They compared the performance using the sum of the number of maximum repetitions of three sets of each exercise. The authors found a significant decrease in performance in three of the four evaluated exercises (leg press, leg extension and leg curl) when applied the PNF and SS before training. The authors suggested as a hypothesis for the performance reduction a possible overload of the hamstring and quadriceps muscles, already loaded by the others exercises, may be a reflection of muscle fatigue and neural fatigue occurred in these muscles.

The results found in the present article showed no significant reduction in performance comparing PNF with SW, which corroborates with the results obtained by Simão et al.[16] They evaluated the effects of SW and PNF methods in the 1RM test in the bench press. In general, the authors found no significant influence in the type of stretching method in the maximum loads obtained. At the end of the study, the authors propose that when stretching has a low volume, it seems that there is no significant difference in the tests and maximum loads. In the present study, however, the authors did not highlight what is the low levels of volume and intensity, not establishing benchmarks that can be used in other experiments.

As for BS, squat exercise in the Smith machine showed better performance than the other protocols, presenting significant difference in the volume of maximum repetitions. This result corroborates with the study of Bacurau et al.,[31] which compared the acute effect of BS and SS. They found that BS showed no reduction in maximum strength. Despite the significant difference in the amount of stretching employed, since the stretching sessions lasted 20 minutes, the results indicate that BS did not result in decreased ability of strength generation by the individual. Despite the significant result of BS checked in performed the squat exercise in the Smith machine, we did not identify the same result when performing the leg extension. The possible explanation may be the eventual fatigue of the quadriceps, also used in the squat exercise. Comparing the protocols of the present study with each other, we observe that only the squat exercise in the Smith machine showed significant differences in the total volume of maximum repetitions. In this exercise, the BS protocol showed the best result, with better performance of individuals in the total volume of maximum repetitions. It was also possible to note a significant decrease in the volume of repetitions when comparing the series performed with each other in the different protocols. This shows a decrease in the capacity of strength generation from one series to another. Such evidence can be explained by an insufficient rest interval between sets and by the inexperience of the participants in ST.

This study presents some limitations, such as small sample and lack of familiarization with ST. However, the evidence obtained in this study have significant practical relevance and the procedures can be reproduced in a simple and objective way with jazz dancers, promoting contributions to optimize ST sessions. In addition, we can say, in general, that low volume and low intensity of the proposed protocols may not have caused acute significant changes in the total volume of repetitions in all exercises. The fact of the presented studies and this article evaluated a low number of exercises does not allow the achieved results to be replicated in a full training session.

CONCLUSION

In conclusion, there was no modification in repetition performance with different flexibility training protocols prior to knee extension exercises performed separately. However, for the multi-joint exercises, such as squat, the BS provided significant increases in repetition performance. Therefore, in jazz universe, whose activity requires a large number of jumps, this type of stretching appears to be more effective for increasing acute repetition performance.

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