motricidade

ORIGINAL ARTICLE

https://doi.org/10.6063/motricidade.44051

Acute effects of different antagonist muscle stretching methods on agonist muscle strength performance in trained men

Fabio Henrique de Freitas[1,2*], Caio Vinicius dos Santos Bendito[1,3], Darlan Tavares dos Santos[2], Abdallah Achour Júnior[4], Humberto Lameira Miranda[1,3], Charles Ricardo Lopes[5], Maria do Socorro Cirilo Sousa[6,7], Marckson da Silva Paula[2], Estélio Henrique Martin Dantas[2,8]

ABSTRACT

In the scientific literature, the most commonly used stretching methods are: static, dynamic, and proprioceptive neuromuscular facilitation. Some studies show that stretching can have deleterious effects on strength performance. However, some evidence suggests that stretching, when applied to antagonist muscles, can positively influence strength performance. Therefore, the aim of this study was to investigate the acute effects of different stretching methods for antagonist muscles on the total training volume in a strength training session in trained men. The sample consisted of 22 trained men. Entry into the experimental protocols was random, through a draw, and performed on four different days: 1) proprioceptive neuromuscular facilitation stretching protocol for antagonists followed by an strength training session; 2) static protocol for antagonists followed by an strength training session; 3) dynamic protocol for antagonists followed by an strength training session; 4) protocol without stretching followed by an strength training session. As a result, no significant differences were observed in total training volume when comparing the different experimental protocols. In conclusion, stretching exercises, when applied acutely to antagonist muscles, regardless of the method, do not promote deleterious effects on the total training volume of agonist muscles.

KEYWORDS: muscle stretching exercises; muscle strength; resistance training; hamstring muscles.

INTRODUCTION

Flexibility is defined as the ability to bring a given joint to its maximum range of motion (American College of Sports Medicine [ACSM], 2018). Some physical capacities such as strength, muscle power, and flexibility play a very important role in maintaining or increasing functional capacity and improving physical performance (Araújo et al., 2023; Leite et al., 2015). Therefore, stretching exercises have been commonly used with the aim of preventing injuries, increasing functional capacity, and improving physical performance (Alves et al., 2021; Behm et al., 2021).

In the scientific literature, the most commonly used stretching methods are: static (SS), ballistic (BS), dynamic (DS), and proprioceptive neuromuscular facilitation (PNF) (Behm et al., 2021; Miranda et al., 2022), with the PNF method being the most used when the goal is to increase flexibility

[1]Universidade Federal do Rio de Janeiro, Postgraduate Lato sensu in Strength Training – Rio de Janeiro (RJ), Brazil.
[2]Universidade Federal do Estado do Rio de Janeiro, Postgraduate Program in Nursing and Biosciences – Rio de Janeiro (RJ), Brazil.
[3]Universidade Federal do Rio de Janeiro, School of Physical Education and Sports – Rio de Janeiro (RJ), Brazil.
[4]Universidade Estadual de Londrina – Londrina (PR), Brazil.
[5]Universidade Católica de Campinas – Campinas (SP), Brazil.
[6]Universidade Regional do Cariri, Department of Physical Education – Crato (CE), Brazil.
[7]Universidade Federal da Paraíba, Department of Physical Education – João Pessoa (PB), Brazil.
[8]Universidade Tiradentes, Postgraduate Program in Biosciences and Health – Aracaju (SE), Brazil.
*Corresponding author: Avenida Pasteur, 296, Urca – CEP: 22290-240 – Rio de Janeiro (RJ), Brazil. E-mail: freitash2004@gmail.com

Conflict of interests: nothing to declare. Funding: This work was carried out with the support of the Coordination for the Improvement of Higher Education Personnel – Brazil (CAPES) – Funding Code 001.
Received: 10th November 2025. Accepted: 4th April 2026.
Edited by: Luís Branquinho – Instituto Politécnico de Portalegre – Portalegre, Portugal.

(Miranda et al., 2022; Nascimento et al., 2020; Silva et al., 2023). In a given joint, antagonist and agonist muscles are recruited simultaneously, in a synchronised and coordinated manner, with the aim of improving the precision and efficiency of a given movement (Busse et al., 2006; Higginson et al., 2006). Thus, it has been suggested that stretching antagonist muscles, through mechanisms of reciprocal inhibition, stress relaxation, and reduction of muscle-tendon unit stiffness, may induce an increase in the strength performance of agonist muscle (Longo et al., 2025; Miranda et al., 2022).

Indeed, some studies show that acute stretching can have deleterious effects on repetition performance, total training volume (TTV), and load performance (Barbosa-Netto et al., 2018; Longo et al., 2025; Marchetti et al., 2015; Moreira et al., 2022). However, some evidence suggests that stretching exercises may not interfere with strength performance (Freitas et al., 2020; Gomes et al., 2021; Pessoa et al., 2023). Nevertheless, some contemporary studies determine that stretching, when applied acutely to antagonist muscles, can positively influence repetition performance, TTV and load performance (Gomes et al., 2014; Miranda et al., 2022).

In a study conducted by Miranda et al. (2014), it was observed that an SS protocol consisting of two 40-second sets applied to antagonist muscles promoted improvements in load performance in the 10 RM test for the leg curl and scott curl exercises in strength-trained men and women. However, a study by Nascimento et al. (2019) showed that a PNF stretching session consisting of a 30-second set applied to antagonist muscles did not influence repetition performance in the leg extension exercise in strength-trained men.

Additionally, Freitas et al. (2020) determined that a PNF stretching session consisting of three 30-second sets applied to antagonist muscles did not interfere with repetition performance in the CE exercise in strength-trained men. Furthermore, Pessoa et al. (2023) elucidated that an SS protocol consisting of two 20-second sets, applied to antagonist muscles, did not interfere with TTV in the leg extension exercise in trained men. However, Montalvo et al. (2025) determined that a DS protocol, applied chronically to antagonist muscles, promoted improvements in vertical jump performance and isokinetic strength in trained and sedentary men.

Therefore, it seems that the use of different stretching volumes, intensity, training level, sex, stretching methods and measured variables related to strength performance can influence, in a distinct way, the effects of stretching antagonist muscles on the strength performance of agonists, with the TTV an important variable that is not very well elucidated in the scientific literature. In parallel, recent bibliometric evidence has demonstrated a sustained growth in scientific production addressing strength training variables and performance-related outcomes in different sports contexts, highlighting increasing methodological refinement and interest in neuromuscular performance mechanisms (Venâncio et al., 2025). Thus, the objective of the present study was to investigate the acute effects of different stretching methods of antagonist muscles on the TTV in the leg extension exercise in trained men.

METHODS

Participants

The sample consisted of 22 trained men (27.85 ± 7.79 years old; 72.38 ± 18.56 kg body mass; 167.00 ± 10.90 cm height) and were selected by convenience. The sample size was calculated using the G*Power software (G*Power 3.1.9.7, Heinrich Heine-Universität, Düsseldorf, Germany). Assuming the values of effect size = 0.56; α-error = 0.05; Power = 0.8, the total sample size was 22 participants. The inclusion criteria were: a) being between 18 and 45 years old; b) having at least six months of strength training (ST) practice, with a minimum frequency of three sessions per week, and having prior experience in the leg extension exercise; c) a negative Physical Fitness Readiness Questionnaire (PAR-Q). Similarly, the following exclusion criteria were established: a) having musculoskeletal injuries that compromise the performance of the experimental protocols; b) using ergogenic aids or medications for performance or health purposes; c) having any disease.

All subjects signed a free and informed consent form before participating in the study, which was conducted in accordance with the ethical standards set forth in Law No. 14,874, of May 28, 2024 (Brazil, 2024). This study was approved by the Research Ethics Committee with Human Beings of the Clementino Fraga Filho University Hospital, Federal University of Rio de Janeiro, CAEE No. 27779119.2.0000.5257, with the approved registration number 3,904,690.

Procedures

Six visits were conducted with 48-hour intervals between them. During the first two visits, the following procedures were performed: a) completion of the informed consent form and the PAR-Q; b) anthropometric measurements; c) familiarisation with the experimental protocols; d) 10-RM test (first visit); e) 10-RM retest (second visit). During the remaining visits, the experimental protocols were performed.

Furthermore, all individuals were instructed to maintain their respective routines of eating, hydration, and physical exercise, and to avoid alcohol consumption at least 24 hours prior to testing and training sessions.

This study had a randomised, crossover design with simple randomisation. Entry into the experimental protocols was random, through a lottery, and performed on four different days: 1) PNF stretching protocol of antagonists (hamstrings) followed by resistance training (GPNF); 2) SS protocol of antagonists (hamstrings) followed by resistance training (GSS); 3) DS protocol of antagonists (hamstrings) followed by resistance training (GDS); 4) protocol without stretching and resistance training (GCON).

Furthermore, in all experimental conditions, the resistance training session consisted of the following exercise: leg extension; three sets, performed to concentric failure; loads of 100% of 10RM; and 90-second intervals between sets. Additionally, in order to increase the ecological validity of this study, the cadence was not controlled.

Additionally, in all experimental protocols, the total number of repetitions performed at the end of each of the three series was recorded, and the TTV was subsequently calculated. Furthermore, in all experimental protocols, except for GCON, the ST session was performed immediately after the end of the intervention protocol. Furthermore, it should be noted that not controlling for cadence is a limitation of the present study; therefore, future studies that control for cadence are suggested.

Additionally, all experimental protocols were performed at the same time of day (12:00 to 17:00 hour) in order to reduce the effects of circadian variation (Pazetti-Baccili et al., 2024); the ambient temperature was controlled, using a thermometer, so that all experimental conditions were performed under the same temperature conditions (between 20° and 25°C); and height and body mass were measured using a scale (Welmy, W200a) and a stadiometer (Welmy, W200a).

In the PNF stretching protocol, the subject was initially positioned as follows: lying in a supine position, hips and knees extended, and ankles in dorsiflexion. Then, with the heel resting on the evaluator's shoulder, the subject passively performed hip flexion with the knee fully extended, to the greatest possible range of motion (ROM), at an intensity between levels 61 and 80 (maximum intensity) of the PERFLEX scale (0–110) (Dantas et al., 2008). Upon reaching ROM, the subject, with resistance applied by the evaluator, performed a maximum voluntary isometric action (MVIA) of the hip extensor muscles for six seconds. Subsequently, the subject, with their heel resting on the evaluator's shoulder, performed a passive hip flexion with the knee fully extended, at the maximum possible ROM, at an intensity between levels 61 and 80 (maximum intensity) of the PERFLEX scale (0–110), and upon reaching that ROM, maintained it for 30 seconds (Dantas et al., 2008; Gama et al., 2007). Additionally, it is important to emphasise that a single series of 30 seconds was performed for each lower limb, without any interval between limbs (Gama et al., 2007).

In the static stretching protocol, the subject was initially positioned as follows: lying in a supine position, hips and knees extended, and ankles in dorsiflexion. Then, with the heel resting on the evaluator's shoulder, the subject performed a passive hip flexion, with the knee fully extended, to the greatest possible ROM, at an intensity between levels 61 and 80 (maximum intensity) of the PERFLEX scale (0–110), and upon reaching this ROM, it was maintained for 30 seconds. (Dantas et al., 2008; Gama et al., 2007). Additionally, a single series lasting 30 seconds was performed for each lower limb, without any interval between limbs (Gama et al., 2007).

In the dynamic stretching protocol, the subject was initially positioned as follows: lying in a supine position, hips and knees extended, and ankles in dorsiflexion. Then, the subject actively performed a hip flexion with the knee fully extended, at the maximum possible ROM, at an intensity between levels 61 and 80 (maximum intensity) of the PERFLEX scale (0–110) (Dantas et al., 2008). Upon reaching this ROM, the subject actively performed hip extension with the knee fully extended, returning to the initial position. These motor movements were repeated for 30 seconds (Gama et al., 2007; Pereira et al., 2022). Furthermore, a single series lasting 30 seconds was performed for each lower limb, without any interval between limbs (Gama et al., 2007).

Regarding the 10-RM test, initially, a warm-up session was performed consisting of one set of 20 repetitions with a load of 50% of the 10RM usually used by each individual (Miranda et al., 2022). Then, after a five-minute interval, up to five attempts were performed with five-minute intervals between them, and if the load was not found by the fifth attempt, a new test was performed 48 hours later. The test was interrupted under the following conditions: a) when more than ten repetitions were performed; b) when a given individual reached concentric failure on the tenth repetition. Furthermore, in order to guarantee the reproducibility of the load, a new test session was performed 48 hours later, considering the highest load found on the two days of testing (Valério et al., 2022); and the same evaluator supervised all testing sessions.

Statistical analysis

Statistical analysis was performed using SPSS software (version 22.0; SPSS, Inc., Chicago, IL, USA). Initially, to test the normality of the data, the Shapiro-Wilk normality test and analysis of skewness and kurtosis were performed (Chan, 2003). With the normality of the data not rejected, a one-way ANOVA followed by a Bonferroni post-hoc test was performed to determine if there were significant differences between the experimental groups in relation to TTV. For all inferential analyses, a $p < .05$ was adopted.

RESULTS

Table 1 presents the mean and standard deviation values of TTV in each of the experimental conditions. As a result, no significant differences were observed in TTV when comparing the different experimental protocols ($p = .320$; $df = 3$).

DISCUSSION

The main finding of the present study was that stretching exercises, when volume and intensity are equalised and when applied to antagonist muscles, regardless of the method, in an acute manner, do not promote deleterious effects on the TTV of agonist muscles in strength-trained men. Therefore, these findings corroborate some previous evidence that elucidated that stretching antagonist muscles does not negatively interfere with the performance of agonist muscles (Cè et al., 2021; Freitas et al., 2020; Souza et al., 2020; Valério et al., 2022).

In a similar study, Freitas et al. (2020) investigated the acute effect of different volumes of PNF stretching of antagonist muscles on the strength performance of agonist muscles in trained men. The PNF stretching protocol consisted of one or two 30-second sets, depending on the experimental condition, applied to the hamstring muscles of both limbs. Furthermore, the PNF stretching session was performed immediately before the start of the resistance training session, and the intensity of the stretch was not controlled. As a result, the authors observed that PNF stretching, regardless of volume, when applied to antagonist muscles, did not interfere with repetition performance in the controlled exercise in strength-trained men.

Table 1. Mean and standard deviation values of total training volume in each of the experimental conditions.

Experimental protocols	TTV (kg)
GPNF	3513.00 + 707.10
GSS	4011.00 + 1675.46
GDS	3366.00 + 720.74
GCON	2658.00 + 1055.63

TTV: total training volume; GPNF: proprioceptive neuromuscular facilitation antagonist protocol; GSS: static stretching antagonist protocol; GDS: dynamic stretching antagonist protocol; GCON: protocol without stretching; kg: kilogram; $p < .05$.

Additionally, a study by Souza et al. (2020) investigated the effects of intra-set SS of antagonist muscles on the strength performance of agonist muscles in strength-trained men. The SS protocol consisted of two 30-second sets, without intervals between them, applied to the hamstring muscles of both limbs. Furthermore, the SS exercises were performed immediately before the start of each set, and the intensity of the stretch was not controlled. It was then determined that intra-set SS of antagonist muscles did not influence the total volume of repetitions in the leg extension exercise.

Furthermore, a study conducted by Cè et al. (2021) investigated the acute effects of SS of antagonist muscles on the strength performance of agonist muscles in sedentary men. The SS session consisted of five sets of 45 seconds, with 15-second intervals between them, applied to the plantar flexor muscles of the dominant limb. Moreover, the SS session was applied immediately before the start of the resistance training session. In conclusion, it was found that SS did not interfere with the electromyographic activity and the force production capacity of the agonist muscles.

However, in a subsequent study, Miranda et al. (2022) investigated the acute effects of different volumes of intra-set PNF stretching of antagonist muscles on the strength performance of agonist muscles in physically active men. The PNF stretching session consisted of three sets of 20 or 30 seconds, depending on the experimental condition, without intervals between them, applied to the hamstring muscles of the dominant limb. Furthermore, the stretching session was performed immediately before the start of each set, and the intensity of the stretch was not controlled. As a result, it was observed that the higher volume PNF stretching protocol (3 sets of 30 seconds) promoted improvements in the total volume of repetitions in the unilateral leg extension exercise.

However, it is important to highlight the different volumes and intensity of stretching, the timing of the stretching exercises, the exercises and the training levels used in the present study and in the study conducted by Miranda et al. (2022), which may possibly support the findings of Miranda et al. (2022).

This conservative effect profile appears consistent with broader trends identified in recent bibliometric analyses, which highlight an increasing emphasis on methodological control, volume manipulation, and specific interpretations of results within strength training research (Venâncio et al., 2025).

In the scientific literature, several neuromuscular mechanisms are elucidated as potentially responsible for acute changes in strength performance after a stretching session (Trajano et al., 2017). Among these mechanisms, alterations in afferent feedback from type I, II, III, and IV fibres, changes in the viscoelastic properties of the muscle-tendon unit, and reductions in muscle stiffness (Cè et al., 2021; Warneke et al., 2024) can be considered the most relevant mechanisms. Furthermore, it should be noted that the volume of stretching may be associated with the magnitude of the deleterious effects on strength performance (Behm et al., 2021). Therefore, it is speculated that the reduced volume of stretching used in the present study, in each of the experimental protocols, was not sufficient to promote acute neuromuscular changes in antagonist muscles and, consequently, to promote improvements in the strength performance of agonist muscles.

Furthermore, it is important to highlight that the present study presents some important methodological limitations, such as: a) sample size; b) using a resistance training session composed of a single exercise; c) using only strength-trained individuals; d) using only male individuals. Therefore, it is suggested that future studies be conducted with a larger sample size, using resistance training sessions composed of multiple exercises, using other populations in their respective samples and using female subjects.

CONCLUSIONS

Stretching exercises, when applied to antagonist muscles and when volume and intensity are equalised, regardless of the method, do not promote deleterious effects in the performance of agonist muscle strength in trained men. Therefore, based on these findings, it is suggested that trainers, resistance training practitioners, and physical conditioning professionals use stretching of antagonist muscles as a warm-up when the intention is to prepare the neuromuscular system for a resistance training session, since stretching antagonist muscles does not promote deleterious effects on the strength performance of agonist muscles. However, it should be noted that, in the present study, only one exercise, one intensity, and one stretching exercise were tested. Furthermore, only trained men were used, and only the acute effects were analysed.

REFERENCES

Alves, F. R. O., Lima, A. M. F., Andrade, T. M., & Andrade, C. M. S. A. (2021). Impact of muscle stretching in active individual engine performance. *Research, Society and Development, 10*(4), Artcicle e35810414325. https://doi.org/10.33448/rsd-v10i4.14325

American College of Sports Medicine. (2018). *ACSM's Guidelines for Exercise Testing and Prescription* (10th ed.). Lippincott Williams & Wilkins.

Araújo, C. G. (2023). Flexibility exercises are often recommended but flexibility is rarely evaluated: a misconnection. *The Journal of Sports Medicine and Physical Fitness*, *63*(11), 1135–1137. https://doi.org/10.23736/S0022-4707.23.15237-6

Barbosa-Netto, S., Veloso, L. G., D'Acelino-e-Porto, O. S., & Almeida, M. B. (2018). Effect of unilateral stretching on contralateral strength performance. *Revista Andaluza de Medicina del Deporte*, *11*(2), 89–92. https://doi.org/10.1016/j.ramd.2016.05.001

Behm, D. G., Kay, A. D., Trajano, G. S., Alizadeh, S., & Blazevich, A. J. (2021). Effects of Acute and Chronic Stretching on Pain Control. *Journal of Clinical Exercise Physiology*, *10*(4), 150–159. https://doi.org/10.31189/2165-6193-10.4.150

Brazil. (2024). *Lei nº 14.874, de 28 de maio de 2024*. Provides for research with human beings and establishes the National System of Ethics in Research with Human Beings. Diário Oficial da União. https://legislacao.presidencia.gov.br/atos/?tipo=LEI&numero=14874&ano=2024&ato=677Izaq1ENZpWT381

Busse, M. E., Wiles, C. M., & Van, D. R.W.M. (2006). Co-activation: its association with weakness and specific neurological pathology. *Journal of NeuroEngineering and Rehabilitation*, *3*(26). https://doi.org/10.1186/1743-0003-3-26

Cè, E., Coratella, G., Doria, C., Rampichini, S., Borrelli, M., Longo, S., & Esposito, F. (2021). No effect of passive stretching on neuromuscular function and maximum force-generating capacity in the antagonist muscle. *European Journal of Applied Physiology*, *121*(7), 1955–1965. https://doi.org/10.1007/s00421-021-04646-z

Chan, Y. H. (2003). Biostatistics 101: Data Presentation. *Singapore Medicine Journal*, *44*(6), 280–285.

Dantas, E. H. M., Salomão, P. T., Vale, R. G. S., Achour Júnior, A., Simão, R., & Figueiredo, N. M. A. (2008). Scale of perceived exertion in the flexibility (PERFLEX): a dimensionless tool to evaluate the intensity? *Fitness & Performance Journal*, *7*(5), 289–294. https://doi.org/10.3900/fpj.7.5.289.e

Freitas, F. H., Carelli Junior, C. A., Fernandes, R. M. S., Corrêa Neto, V., & Miranda, H. L. (2020). Influence of different volumes of the proprioceptive neuromuscular facilitation stretching method of antagonists on the maximum repetition performance of agonists. *Brazilian Journal of Exercise Prescription and Physiology*, *14*(92), 588–596. https://www.rbpfex.com.br/index.php/rbpfex/article/view/2100

Gama, Z. A. S., Medeiros, C. A. S., Dantas, A. V. R., & Souza, T. O. (2007). Influence of stretching frequency using proprioceptive neuromuscular facilitation on hamstring muscle flexibility. *Brazilian Journal of Sports Medicine*, *13*(1), 27e–31e. https://doi.org/10.1590/S1517-86922007000100008

Gomes, F. D., Souza, F. R. O., Casseres, S. M., Jesus, M. A., Lima, V. P., Miranda, H. L., & Paz, G. A. (2021). Acute effect of antagonist stretching on myoelectric activity and agonist performance in the extensor chair. *Brazilian Journal of Exercise Prescription and Physiology*, *15*(100), 670–680. https://www.rbpfex.com.br/index.php/rbpfex/article/view/2173

Gomes, F. D., Vieira, W., Souza, L. M., Paz, G. A., & Lima, V. P. (2014). Maximum repetition performance after proprioceptive neuromuscular facilitation applied to agonist and antagonist muscles. *ConScientiae Saúde*, *13*(2), 252–258. https://doi.org/10.5585/ConsSaude.v13n2.4816

Higginson, J. S., Zajac, F. E., Neptune, R. R., Kautz, S. A., & Delp, S. L. (2006). Muscle contributions to support during gait in na individual with post-stroke hemiparesis. *Journal of Biomechanics*, *39*(10), 1769–1777. https://doi.org/10.1016/j.jbiomech.2005.05.032

Leite, T., Teixeira, A. S., Saavedra, F., Leite, R. D., Rhea, M. R., & Simão, R. (2015). Influence of strength and flexibility training, combined or isolated, on strength and flexibility gains. *Journal of Strength and Conditioning Research*, *29*(4), 1083–1088. https://doi.org/10.1519/JSC.0000000000000719

Longo, S., Cè, E., Toninelli, N., Esposito, F., & Coratella, G. (2025). Muscle stretching: exploring the impact of different modalities on maximal range of motion and strength with practical recommendations. *Sports Medicine*, *11*(1), Article 126. https://doi.org/10.1186/s40798-025-00925-7

Marchetti, P. H., Mattos, V. J., Silva, J. J., Soares, E. G., Paulodeto, A. N., Correa, D. A., Vilela Junior, G. B., & Gomes, W. A. (2015). Intermittent and continuous stretching increase range of motion and decrease force on wrist flexors. *Brazilian Journal of Sports Medicine*, *21*(6), 416–420. https://doi.org/10.1590/1517-869220152106152116

Miranda, H., Oliveira, A. A., Ribeiro, J. S. S., Freitas, F. H., Castro, J. B. P., Alvarenga, R. L., & Willardson, J. M. (2022). Effect of different numbers of interset antagonist proprioceptive neuromuscular facilitation stretching on the total number of repetitions for the agonists. *International Journal of Exercise Science*, *15*(4), 498–506. https://doi.org/10.70252/SJQH8101

Miranda, H., Paz, G. A., Antunes, H., Maia, M. D. F., & Novaes, J. (2014). Acute effect of static stretching in antagonists on agonist repetition performance. *Brazilian Journal of Science and Movement*, *22*(2), 19–26.

Montalvo, S., Gonzales, M. P., Dietze-Hermosa, M. S., Martinez, A., Rodríguez, S., Gomez, M., Cubillos, N., Ibarra-Meija, G., Tan, E., & Dorgo, S. (2025). Effects of different stretching modalities on the antagonist and agonist muscles on isokinetic strength and vertical jump performance in young men. *Journal of Strength and Conditioning Research*, *39*(2), 173–183. https://doi. Org/10.1519/JSC.0000000000004937.

Moreira, O. C., Mendes, P. H. V., Santos, L. V., Marins, J. C. B., & Oliveira, C. E. P. (2022). Effect of stretching on muscle strength in healthy people: a systematic review. *Motricidade*, *18*(2), 330–338. https://doi.org/10.6063/motricidade.27118

Nascimento, C. E. R., Guapyassú, R. M., Silva, J. B., Paz, G. A., Gomes, F. D. D., Vale, R. G. S., Nunes, R. A. L., & Lima, V. P. (2019). Subsequent response of the proprioceptive neuromuscular facilitation training on antagonists in the strength of agonists in multiple sets. *Brazilian Journal of Exercise Prescription and Physiology*, *13*(83), 383–388. https://www.rbpfex.com.br/index.php/rbpfex/article/view/1662

Nascimento, R., Desiree, M., Monteiro, E. R., Ribeiro, A., Reis, N., Sant'Ana, L., Vianna, J., Novaes, J., & Brown, A. (2020). Acute effect of different stretching methods in classical dancer children. *Brazilian Journal of Exercise Physiology*, *19*(2), 14–123. https://doi.org/10.33233/rbfe.v19i2.3266

Pazetti-Baccili, G., Borges-Marchini, K., Mayara-Nunhes, K., Ardengue, M., & Lopes-Nunes, H. (2024). Influencia de la hora del día en el rendimiento en una batería de pruebas de aptitud física en jóvenes universitarios. *Revista Ciencias de la Actividad Física*, *25*(1), 1–11. https://doi.org/10.29035/rcaf.25.1.1

Pereira, B. M., Silveira, C. M. C., Menzel, H. J., Lemos, K. L. M., & Araújo, S. R. S. (2022). Acute effect of passive static stretching and active dynamic stretching on dorsiflexion range of motion in aerobic gymnastics athletes . *Research Collection in Physical Education, Várzea Paulista*, *21*(4), 15–23. https://rcpef.org/cpef/article/view/1634

Pessoa, D., Penfold, H., Pegado, S., Gonçalves, Castro, M., Brandão-Pinto, J., Willardson, J., & Miranda, H. (2023). Effect of static stretching on agonists, antagonists, and agonist-antagonist combination on total training volume. *International Journal of Exercise Science, 16*(4), 665–675. https://doi.org/10.70252/AKGR8444

Silva, D. S., Andrade, A. T., & Pereira, F. B. (2023). Analysis of stretching methods for hamstrings: a systematic review. *Electronic Journal Health Archive*, *23*(1), Article e11536. https://doi.org/10.25248/reas.e11536.2023

Souza, P. A., Teixeira, D. R., Corte, J. D., Batista, C. A. S., Miranda, H. L., & Paz, G. A. (2020). Acute effect of intra-set static stretching on antagonists versus passive interval on the performance of maximum repetitions of agonists in leg extension machine. *Brazilian Journal of Kinanthropometry and Human Performance*, *22*, Article e60225. https://doi.org/10.1590/1980-0037.2020v22e60225

Trajano, G. S., Nosaka, K., & Blazevich, A. J. (2017). Neurophysiological Mechanisms Underpinning Stretch-Induced Force Loss. *Sports Medicine*, *47*(8), 1531–1541. https://doi.org/10.1007/s40279-017-0682-6

Valério, A. B., Silva, F. B., Patusco, H. C. V. M., Patusco, J. M. A., Freitas, F. H., & Miranda, H. L. (2022). Acute effects of different methods of antagonist muscles stretching on total agonist training volume. *Brazilian Journal of Exercise Prescription and Physiology*, *16*(102), 192–199. https://www.rbpfex.com.br/index.php/rbpfex/article/view/2550

Venâncio, T. F., Costa, M. J., Santos, C. C., Batalha, N., Hernández-Beltrán, V., Gamonales, J. M., & Espada, M. C. (2025). Evolution of documents related to strength training research on competitive swimmers: a bibliometric review. *Frontiers in Sports and Active Living*, *7*, Article 1603576. https://doi.org/10.3389/fspor.2025.1603576

Warneke, K., Behm, D. G., Alizadeh, S., Hillebrecht, M., Konrad, A., & Wirth, K. (2024). Discussing conflicting explanatory approaches in flexibility training under consideration of physiology: a narrative review. *Sports Medicine*, *54*(7), 1785–1799. https://doi.org/10.1007/s40279-024-02043-y

All content of Journal Motricidade is licensed under Creative Commons, except when otherwise specified and in content retrieved from other bibliographic sources