Can warming-up or stretching be dispensed with before performing physical power or aerobic exercises?

https://doi.org/10.11606/issn.1981-4690.2023e37206267

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Abstract

The activities in preparation for physical exercise and/or sporting competitions are performed with a view to improving performance and preventing lesions. Traditional Warm-up (TW), such as jogging and Proprioceptive Neuromuscular Facilitation (PNF) stretching, are two examples of activities used for this purpose. However, there is no consensus in the literature about their efficacy, and which of them is the best. The aim is to compare the effects of TW and PNF on anaerobic power (AnP) and Aerobic Power (AP) and on physiological variables. This study evaluated 10 (ten) men between the ages of 18 and 30 years, physically active, non-athletes, in an outdoor environment with a mean temperature of 34º C, at 04 different time intervals, performing TW (M1), PNF (M2), TW (M3) and PNF (M4) before the long jump and 20m back and forth tests, with an interval of one week between them. The AnP and AP values were calculated; the post-test lactate level, cardiac frequency were measured, and the volunteers were asked about late pain 24h the tests. One-way ANOVA was used for the 04 time intervals, with significance established at 5%. There were no differences between the variables in the different time intervals. There was no difference in physical performance in any of the types of pre-exercise preparation activities. Furthermore, TW with elevation of body temperature and PNF appeared to be dispensable for active youngsters in a warm environment.

Keywords: Warm-up; Anaerobic power; Aerobic power.

Introduction

Physical exercise demands greater production of work per unit of time from the body, thereby overloading all the organic systems to a greater or lesser extent; and causes global functional and structural changes to express what is happening at cellular level. These participations are defined by the intensity and duration of exercise, which normally has an inverse proportion between them[1]. Sports and physical activities normally have previous, acute or chronic preparation. Acute preparation stimulates the body for the more intense main activity, and is normally composed of general or specific, active or passive warming-up or stretching[2]. Chronic preparation consists of sequential planning of the physical exercise programs, with specificities determined by the purpose of training[1]. The purpose of the present study was to discuss the first situation.

Warming-up is performed with a view to increasing body temperature, diminishing muscle

and blood viscosity, increasing neuromuscular transmissions, activating the peripheral proprioceptors, signaling the CNS to increase the metabolic production of energy[2]. Active warming-up mainly modulates metabolic changes, while the passive type increases the temperature of the body nucleus without spending important energy. Studies have demonstrated that warming-up in hot water at 40° C was as beneficial as intermittent high intensity physical activity[3], while an elevated ambient temperature reduced the performance of football players[4].

Warming-up also seeks to improve performance and reduce lesions in physical exercises. In those of short duration and high intensity, it potentiates the rapid production of energy, producing more intense contractions; and in those of long duration, previously activates the energy production of the aerobic component; reduces the slow aerobic component and toxic metabolites, such as lactic acid. However, the is no definition as regards the combination of intensity, duration and interval for each type of exercise[3]; and the environmental interferences combined with physiological factors stimulated by physical exercise. There is little evidence of improvement in sporting capacity, commonly verified in studies with few participants, focused on physiological changes and not on physical performance, therefore studies are necessary to demonstrate these different conditions[2].

Normally, stretching is performed as a means of warming-up, but for this an increase in body temperature is necessary; however, stretching does not meet the requirements of this condition. Stretching is performed with a view to maintaining or increasing articular mobility, and may indirectly potentiate physical performance by the increase in articular amplitude and elastic potential of the musculature, favoring activities that demand greater muscle strength and power, reducing lesions, especially in eccentric contractions[5].

Stretching exercises are divided into the following categories: passive, ballistic or active stretching; forced and Proprioceptive Neuromuscular Facilitation (PNF). Studies have demonstrated that passive and ballistic stretching diminish the muscle capacity for generating tension and to exert force against resistance[6]; the ballistic type was superior to these in activities involving balance and agility[7]; or made no difference in the production of force and prevention of lesions[8]; PNF increased articular amplitude and kicking velocity of young football players[9], but little has been investigated about long duration performance. Moreover, PNF stretching showed no difference in maximum voluntary contraction in electromyography of the vastus lateralis and rectus femoris[10], and worsened the maximum isometric when compared with the static strength[11], however, it has not been studied with regard to being performed before anaerobic power exercises (AnP) and aerobic power (AP) exercises.

The effects of stretching on preventing lesions and performance are contradictory in the literature, mainly due to the possible variations among techniques and sports involved[12,13]. In a systematic review, Hebert et al.[14], concluded that stretching before, after; or before and after physical training did not produce clinically important reduction in exercise-induced late pain or muscle soreness. The authors of the present study obtained a similar result in their group when young women were induced to maximum eccentric elbow-flexor exercise, divided into groups, and receiving massage, passive stretching, PNF stretching, or rest (control), in which at the time intervals of 24, 48, 72, 96 and 120 hours post-test, the greatest reduction obtained was shown for massage and the worst result was obtained with passive stretching, and without difference between PNF and rest[15]. It has also been pointed out that stretching performed with a view to increasing the amplitude of movement worsened strength and power performance, without interference for ballistic stretching, but increased the amplitude of movement and are beneficial in the long term in sports that require this condition[13].

Therefore, in this study the authors sought to investigate the effects of traditional warming-up x PNF performed before an activity of short duration for AnP and of medium duration for AP.

Methods

Sample

The project was approved by the Research Ethics Committee of Hospital Universitário Júlio Muller, Protocol No. 658/CEP/HUJM/09. All the volunteers signed the term of free and informed consent to participating in the research study. Therefore, the authors declare that there was no conflict of interests. For inclusion, the volunteers had to be active, contemplating physical activities practiced two to three times per week, in addition to participating in practical lessons of the Physical Education Course, but not being athletes. The study was divulged among the students of the course by direct contact and posters. For the study, 180 students of the male sex were contacted, and those excluded were under 18 or older than 30 years of age; who had any type of bone or muscle lesion in the knees, and athletes. Thus 10 (ten) remained, who fulfilled the requisites and responded to the call of the study. The authors conducted this study in Cuiabá, Mato Grosso, Brazil, one of the hottest regions in the country. The mean annual temperature is 27ºC and between October and March, a temperature of 40ºC is frequently attained. The mean in the month of October, when the tests were performed was 34º C[16].

Study Design

The volunteers performed the treatments in the following order: Traditional warming-up TW (M1), PNF (M2), TW (M3) and PNF (M4) followed by the high jump test (HJ), measuring anaerobic (AnP) and the 20 m back and forth test, to obtain aerobic power (AP); collection of Lactic (Lac) and cardiac frequency (CF) data, with an interval of one week between the tests (FIGURE 1). In the twenty-four hours preceding the tests, the volunteers had to avoid vigorous physical activities, use of alcoholic beverages or exaggerated caffeine consumption.

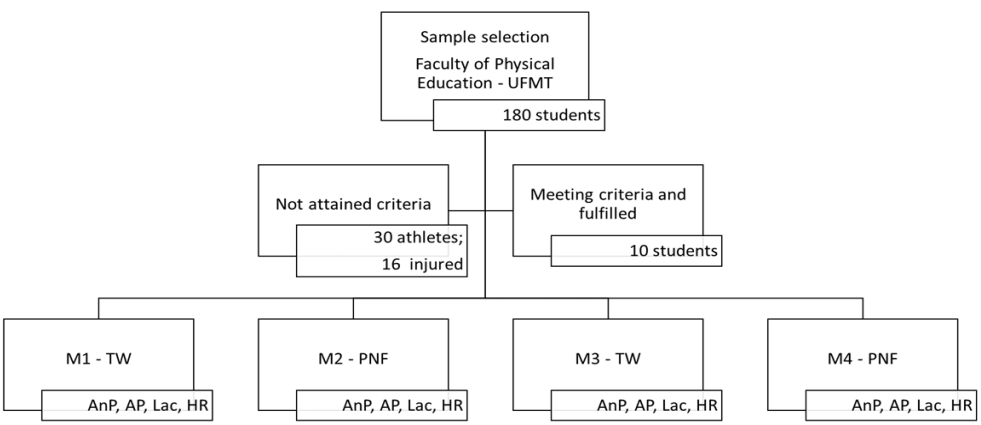


FIGURE 1 - Experimental Design.

The authors invited 180 students of the male sex; 46 did not meet the inclusion criteria, and only 10 who did meet these conditions volunteered. There was a one-week interval between each time interval: (M1, M2, M3 and M4).
TW was traditional warming-up, light trotting (Borg de 3-5) and PNF was proprioceptive neuromuscular facilitation stretching, each with a duration of 7 min, before the anaerobic power tests (AnP) and aerobic power (AP) tests, capillary lactate (Lac) and cardiac frequency (CF) data collection.

Anthropometric Evaluation

The authors evaluated body weight in kilograms and height in meters (scale: Soehnle Professional (Germany), with precision of 0.1 kg and 0.5 cm respectively, volunteers dressed in shorts only[17].

Traditional Warming-UP

We performed 07 mins., of trotting with intensity between light and moderate (3 to 5) on the modified Borg scale of 0-10.

PNF Stretching

The target muscle group was stretched by moving the joint/articulation up to is maximum amplitude of movement for 10 seconds; being pre-elongated, it was isometrically contracted against the resistance of a helper for 10 seconds maintaining the same position,

and lastly the muscle was relaxed, performing another stretch in a static manner up to the greatest point of limitation for another 10 seconds. The isometric contraction intensity was approximately 60% of the maximum, being in agreement with contemporary recommendations[18]. PNF stretching was performed for 07 min., with 02 series of 30 seconds for each muscle group, in which:

Pectoral: Performed with the volunteer standing up, shoulders in horizontal extension at approximately 90º, palms of the hands facing outwards.

Back: With the volunteer in the orthostatic position, feet slightly apart, knees semi-flexioned and arms crossed over the chest, performing scapular abduction. The helper supported the volunteer's back with his own weight, holding onto the elbows, performing stretching.

Lumbar: The volunteer seated on a mat, legs extended, performing flexure of the hip and trunk over the legs, trying to reach his limit of flexibility in the direction of the feet.

Quadriceps: Volunteer was lying on his stomach, on a mat. With the aid of a helper supported on the front part of the ankles, inducing knee flexion so that the foot, in plantar flexion would approximate the gluteal muscles.

Posterior portion of the thigh: The volunteer was lying with the back completed supported on the mat, legs extended on the ground, performing unilateral flexion of the hip, with the aid of the helper, one of the leg, without flexing the knee, until the articular limit was reached. The helper held the heel, applying a force, in order to approximate the lower member to the thorax. The other leg remained extended on the ground, where the helper supported the foot on the volunteer's thigh, avoiding flexure of the hip and knee.

Calf: In the same position as that of the previous exercise, with one leg extended until the articular angle of the hip was equal to 90º, inducing dorsiflexion of the foot.

Abductors: With the volunteer lying down, back on the mat, performing a 90º flexion of the hip, elevating the lower limbs. With help, being held by the internal and distal surface of the thigh, the volunteer performed abduction of the hip.

Anaerobic Power Test

The authors used the Sargent Jump test, indirectly measuring the muscle power of the lower limbs[19]. The test was performed with the individual placed beside a wall where he performed the high jump starting from the static position, being allowed to move his arms, and the highest jump obtained in three attempts was measured. The power of the lower limbs was calculated by means of the following equation:

$$Pkgm.s = 2.21 \times kg \times \sqrt{D}$$

Where:

Pkgm.s = power in kg per meters per seconds;
Kg = body mass
D = difference between marks in meters.

Aerobic Power Test

The 20 m back and forth run test was used, composed of 21 stages, starting with a speed of 8.5 km/h, with 0.5 km/h per stage being added, with the frequency being marked by a sound recording. Each stage lasted approximately 1 minute, performing between 7 and 15 back and forth runs, with adjustment of velocity after every 2 or 3 runs. The space was demarcated by two lines on the ground, where the volunteer was warned to increase his rhythm if he did not attain this distance, and the test was stopped if he was not able to accompany the rhythm. To predict the VO_2 max, the following equation was used:

$$Y = -24,4 + 6,0X$$

Where:

Y = VO_2 max predicted ($ml.kg^{-1}.min^{-1}$);
X = Velocity attained (km/h) in the final stage of the test.

Lactate and Cardiac Frequency Data

Lactate and cardiac frequency data were measured immediately after the AP test. Lactate was measured with a portable appliance (Accutrend® Lactate; Accusport Bm-Lactate; Manufacturer: Roche 2007), after piercing (Accucheck Softclix) the forefinger, and using reagent tapes of the same brand. CF was measured with a portable frequency meter of the POLAR® brand.

Delayed onset muscle soreness (DOMS)

The numerical pain scale was used 24h after the tests.

Statistical Analysis

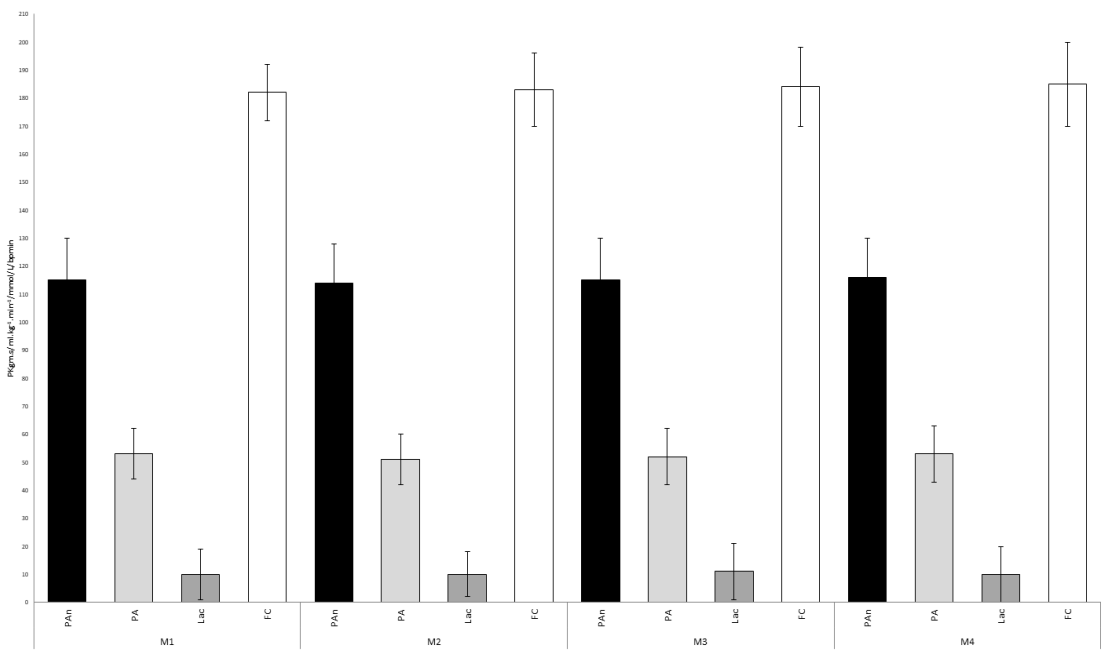
One-way ANOVA was used to compare the group in the 04 time intervals, followed by the Tukey-Kramer post-test for paired and parametric measurements. Significant difference was considered $P<0.05$ with an interval of confidence of 95%. The results were presented as mean and standard deviation.

Results

There was no report of joint/articular problems or use of medications that would affect cardiac frequency and energy metabolism The sample was homogeneous, composed of eutrophic young men (TABLE 1). There was no significant increase in delayed onset of muscle soreness evaluated in the hours subsequent to the tests and in 24 hours. No significant difference was observed among the variables measured in the four time intervals (FIGURE 2).

TABLE 1 - Mean and standard deviation (SD), of age, body mass, stature and BMI of volunteers.

Variables	Mean SD
Age (years)	23.2±2.85
Body mass (Kg)	70.7±2.27
Stature (cm)	1.73 ± 0.04
BMI (kg/m²)	23.44±7.27



Tests preceded by traditional warm-up (M1 and M3), or proprioceptive neuromuscular facilitation stretching (PNF) (M2 and M4), with an interval of 1 week between them. N=10; ANOVA; One-way Analysis of Variance, followed by Tukey-Kramer post-test; there was no significant difference for any comparison ($p>0.05$). Y-axis units are respective to the order of the variables.

FIGURE 2 - Results of anaerobic power tests (AnP-long jump) and aerobic (AP-back and forth run test), Lactate (Lac) and cardiac frequency (CF) post-tests.

Discussion

The main finding of this study was that there were no difference in performance of an AnP and AP activity, and physiological variables with regard to performing TW or PNF. Differently from the above-mentioned observation, there are demonstrations in which warming-up with elevation in body temperature favored performance[3,20]. Pre-exercise stretching exercises have presented controversies, such as no interference of stretching in performance[8]; effect of worsening on strength and power exercises6and improvement of performance in tests[5,8]. Different protocols, types of stretching, publics investigated, level of performance and sex may justify these differences In the following paragraphs the authors of this study discuss different factors related to the pre-exercise activities performed.

Warming-up

Warming-up exercises might potentiate muscle efficiency for energy production and intense muscle contraction with possible reduction in metabolites such as lactate[3]. Thus, the authors investigated the changes in these variables by comparing TW and PNF, however, none of them changed significantly. Apparently, warming-up the body, a concept defended in sports, in physical education and in the gymnastic academies, seemed to have no influence on performance in the present study, because PNF did not elevate the body temperature, and did not differ from the performance obtained by TW. However, differently from that which we observed, in a study of performance of a specific professional ballet exercise, it was concluded that when warming-up was performed, there was greater participation of the aerobic system and less by the anaerobic system in the production of this exercise[20]. This justified the economy of movement in ballet, differently from ours, in which general sporting movements were used.

Stretching

Apparently activities that need a higher degree of flexibility, such as fighting, dances, gymnastics benefit from previously performing stretching exercises, however, activities such as jogging or cycling show no evidences of this improvement[12], similar to the findings observed in the present study. In the following paragraphs the authors present studies that investigated the performance of strength/power, aerobic exercises, or delayed onset of muscle soreness.

Performance of Strength

Loss

A difference in isometric contraction of the posterior muscle of the thigh at different angles (90°, 70°, 50°, 30°) was observed, after PNF and static stretching. PNF stretching led to greater loss of strength when compared with static stretching, with the latter being recommended[11]. We observed no loss of power with PNF, which has a direct relationship with the production of strength. The total time of stretching may partly explain these differences. In the study of de Balle et al.[11], they used 60 s repeated 6 times with an interval of 1 s with sub maximum isometric contraction of 10 s, while we used a total of 30 s, being 10 s at 60% of maximum isometric contraction. Furthermore, a review of 43 articles concluded that passive stretching reduced strength, but the ballistic type did not[13].

Neutral

We expected that stretching would reduce the tension in the posterior muscles of the thigh, and would increase the elastic potential of the muscles in the AnP test, as was observed by passive stretching performed by football players[5]. However, we did not observe this, which was reinforced by the finding of 49 active adult individuals who presented no difference in torque and strength of extension of the knees, compared with pre-exercise activity between not stretching, passive stretching and active stretching[21].

Gain

Variations among the possible types of stretching may differentiate the effects. In a study with 100 men, they compared three types of stretching before the exercise of high jump against movement, with 5 minutes being jogging for the three groups, followed by: a) ballistic stretching of 5 s for each exercise; b) PNF + ballistic stretching (same performance as the previous one); and c) PNF plus 30 s of static stretching. The researchers observed that ballistic

stretching alone produced better effects on the performance of high jump[22], confirming that PNF did not potentiate performance. As a possible justification, the dynamics of this exercise also allow the increase in body temperature as it is closer to the dynamics of the movement used in the AnP test.

Moreover, the types of stretching presented other conflicting results. Sekir et al.[23] observed that although passive stretching did not prejudice the ratio of strength of the posterior regions of the thigh/quadriceps, it reduced the strength in both groups measured, and in the isokinetic evaluation at 60º/s and 180º/s pre- and post-stretching sessions. However, the cited authors concluded that in dynamic activities such as collective games, passive stretching did not harm the performance, differently from Akbulut and Agopyan[9], in which PNF stretching improved the kicking velocity performance of football players. The differentiated training and effects chronic adaptation to training and acute effect of each protocol must be considered. Therefore, we did not use athletes, but active individuals, to minimize interferences of the sporting peculiarities. In any event, the results observed were similar to those of ballistic stretching in other studies[9].

Aerobics

Few studies were found using pre-aerobic activity warming-up. Similarly to the present study, Belkhiria-Turki et al.[24], observed no difference with combinations of passive and active stretching and aerobic exercise in the performance of the stair climbing test.

Delayed onset of muscle soreness

Stretching exercises are also linked to prevention, reduction in lesions and delayed onset of muscle soreness after exercise. Hebert et al.[14] concluded that they are not effective for this purpose. In our study there was no report of delayed onset of soreness, and it is important to consider that this is more associated with high intensity eccentric exercise than power activities of short duration and aerobic activities of medium duration, as performed in our study. Moreover, the volunteers of the present study were active and delayed pain is natural in non-routine activities[14].

Duration of Exercise

Variables such as total time and number of series may influence the results of stretching exercises. Studies have investigated different series and times of static stretching (20, 30, 40, 60 s) in a single series (Group 1) or divided into series of 10 s each (Group 2), and found no difference between the groups, observing that the stretching exercises of up to 30 s improved the performance of velocity when compared with the control without stretching. Stretching for longer than 30 s did not improve performance[25]. Thus, our protocol was similar to that found in the cited study, because two series of 10 s of static stretching were performed, interspersed with 10 s of isometric exercises, however they did not interfere in the power of the test applied. Although the tests performed were different, speed and power are related with regard to performance.

Warming-up x Stretching

Three studies compared different combinations of stretching and specific pre-physical exercise warming-up exercises. They compared ballistic stretching, intermittent isometric exercises, specific warming up in resistance exercises, running and jumping, and found distinct results:

a) One study, with 21 school football players of 20.14 ± 1.65 compared rest (control), ballistic stretching, prolonged intermittent isometric exercise of low intensity and the same exercise in addition to 30% of body weight, before they performed the Counter Movement jump test (AnP), 15 m running test and agility test (modified agility T-test). Better general performance was observed when pre-test stretching was done, however, without difference in agility, and it was concluded that intermittent isometric exercise of low intensity could be used as an alternative to dynamic stretching before power activities[19]. Performing TW and PNF in our study did not interfere in the tests and physiological markers. Not having a control group without exercise limited our conclusion, but the favorable fact is that TW had no effect on increasing articular and muscular amplitude, and PNF did not increase body temperature, suggesting that neither of these conditions changed the performance in the tests. It was also limiting to directly compare PNF with ballistic stretching due to the dynamic nature of

the latter, and of TW with intermittent isometric contraction, due to stimulation of contraction differing between them. Moreover, there was no randomization in the order of the tests among the volunteers in the study of Pojskić et al.[19], which was a limitation. As a solution, we performed cross-over in 4 time intervals, avoiding superimposition of learning on the results obtained.

b) With regard to the performance of exerting force against resistance, researchers investigated the effect of ballistic stretching, passive stretching and specific pre-training warming-up for resistance exercises in nine men, performing a maximum number of repetitions in three series of 12 RM for the leg press, knee extension, knee flexion and plantar flexion exercises. Six sessions were performed with an interval of 48 h between them. Although the knee extension exercises obtained the highest number of repetitions, in the general score of the exercises, the specific warming up was significantly better than the stretching exercises. The cited authors concluded by suggesting that stretching exercises must be avoided before strength exercises[6]. In our study, the power exercises did not differ between TW and PNF, and this performance was not harmed.

c) Young and Elliott[26] compared the effects of running (4 min), static stretching of knee extensor muscles and performing jumps before an AnP test. The authors showed that static stretching as warm-up produced the lowest values, while the combination of running or running and static stretching and the performance of jumps produced higher values for the production of explosive strength. The cited study obtained results differing from those we observed, because warming-up *per se* improved the performance, and was potentiated by the jumping exercises.

Warming-up and Ambient Temperature

The hotter the environment, the faster physiological warm-up is achieved. The researchers investigated 10 football players submitted to a test of 10 high intensity intermittent series of 6 s with 34 s of rest, and previously submitted to warming up by 10 minutes of running; or submersion in water at 40º C. They observed that both presented better performance than the control group without warming-up, but without differences between them[3]. In our study, as the volunteers were submitted to tests in a hot climate, the advantage that there would be of elevating body temperature in an exercise with aerobic warming-up could have equalized TW and PNF neutralized possible differences. One the one hand, this limited comparisons, but on the other, this was one of the few studies conducted under these conditions, suggesting that in hot environments at least, warming-up is not necessary. However, when the individual is submitted to a submaximum exercise in a relatively hot environment, this diminishes his capacity to perform certain work. Apart from the possible effects on the circulatory system, blood volume and rate of transpiration, exercise performed at high temperatures may also influence cellular metabolism. Studies have observed the reduction in the performance of football players submitted to high temperature (34º C) and humidity[4]. In spite of the ambient temperature in our tests having been higher (35-37º C), the TW does not seem to have been superimposed.

Sex

In a comparative study with 31 schoolchildren of the female sex aged 17.3±0.5 years the protocols of a) 3 min of jogging plus 7 min of static stretching; b) 3 min of jogging plus 7 min of dynamic stretching; and c) 3 min of jogging plus 7 min of rest, the researchers observed that dynamic stretching favored balance and agility when compared with the other treatments[7]. However, Chatzopoulos et al.[8] repeated the procedures of the previously cited study, with 27 male schoolchildren aged 17.3±0.2 years, establishing 5 min as the time of stretching and resting, and observed no improvement in the same tests as those applied to the group of girls. However, PNF has different dynamics of performance from the dynamics of stretching or static only, limiting this direct comparison. Contrary to that observed for girls, in our volunteers we observed no difference in favor of stretching. Avoiding differentiation due to gender, we opted to study young men, compared with the greater portion of studies. Additional warming-up in the cited studies may have influenced in favor of performance, however, all received the same treatment. To avoid this superimposition, we performed interventions in distinct time intervals in crossover format. Nevertheless, all the volunteers performed the same time of jogging, and this difference could be attributed to the type of stretching used[7].

Limitations of this study and researches with pre-exercise activities

There are an infinite number of possible variables in pre-exercise activities that prevent them from being joined in a single category. Results may be conflicting when these variables are altered among the studies. Comparison between studies with warming-up only, or warming-up associated with stretching present different results and may depend on many variables, such as; duration of exercise, ambient temperature[3]; sex[7,8]; order of pre-exercise activities and physical tests[11]. In the present study the temperature may have minimized the effect of warm-up and to resolve the problem, the order of the exercises was performed in the cross-over system in four time intervals, alternating the pre-exercise protocols and using active, but non-athlete individuals thereby reducing the interference of the particularities of each modality.

Conclusion

Traditional warming up with increase in body temperature and without increase in muscle amplitude did not differ from PNF stretching that does not increase the body temperature, but increases the articular amplitude in both anaerobic and aerobic physical performance. The data suggested that warming-up or stretching at temperatures of over 30ºC did not change the performance of anaerobic an aerobic power in active young men.

Acknowledgments and conflicts of interest

We thank all authors for their contribution to the preparation of the scientific article. The work was financed by the authors' own resources. There is no conflict of interest between the authors, collaborators and institution.

Resumo

O aquecimento ou alongamento podem ser dispensados antes da realização de exercícios de força física ou aeróbicos?

As atividades de preparação para exercícios físicos e/ou competições esportivas são realizadas com o objetivo de melhorar o desempenho e prevenir lesões. O aquecimento tradicional (TW), como o jogging e o alongamento de Facilitação Neuromuscular Proprioceptiva (FNP), são dois exemplos de atividades utilizadas para esse fim. No entanto, não há consenso na literatura sobre sua eficácia e qual deles é o melhor. O objetivo é comparar os efeitos de TW e PNF na potência anaeróbica (AnP) e na potência aeróbica (PA) e em variáveis fisiológicas. Este estudo avaliou 10 (dez) homens entre 18 e 30 anos, fisicamente ativos, não atletas, em ambiente externo com temperatura média de 34º C, em 04 intervalos de tempo distintos, realizando TW (M1), PNF (M2), TW (M3) e PNF (M4) antes dos testes de salto em distância e ida e volta de 20m, com intervalo de uma semana entre eles. Foram calculados os valores de AnP e AP; o nível de lactato pós-teste, a frequência cardíaca foram medidos e os voluntários foram questionados sobre dor tardia 24h os testes. ANOVA one-way foi utilizada para os 04 intervalos de tempo, com significância estabelecida em 5%. Não houve diferenças entre as variáveis nos diferentes intervalos de tempo. Não houve diferença no desempenho físico em nenhum dos tipos de atividades de preparação pré-exercício. Além disso, TW com elevação da temperatura corporal e PNF parece ser dispensável para jovens ativos em um ambiente quente.

Palavras-chave: Aquecimento; Potência anaeróbica; Potência aeróbica.

References

1. Hartmann H, Wirth K, Keiner M, Mickel C, Sander A, Szilvas E. Short-term periodization models: effects on strength and speed-strength performance. Sports Med. 2015;45(10):1373-86. doi: 10.1007/s40279-015-0355-2.
2. McGowan CJ, Pyne DB, Thompson KG, Rattray B. Warm-up strategies for sport and exercise: mechanisms and applications. Sports Med. 2015;45(11):1523-46. doi: 10.1007/s40279-015-0376-x.
3. Brown PI, Hughes MG, Tong RJ. The effect of warm-up on high-intensity, intermitente running using nonmotorized treadmill ergometry. J Strength Cond Res. 2008;22(3):801-8. doi: 10.1519/JSC.0b013e31816a5775
4. Ozgünen KT, Kurdak SS, Maughan RJ, Zeren C, Korkmaz S, Yazici Z, Ersöz G, Shirreffs SM, Binnet MS, Dvorak J. Effect of hot environmental conditions on physical activity patterns and temperature response of football players. Scand J Med Sci Sports. 2010;20(Suppl 3):140-7. doi: 10.1111/j.1600-0838.2010.01219.x
5. Marshall PW, Lovell R, Siegler JC. Changes in passive tension of the hamstring muscle during a simulated soccer match. Int. J Sports Physiol Perform. 2015;9.
6. Sá MA, Neto GR, Costa PB, Gomes TM, Bentes CM, Brown AF, Novaes JS. Acute effects of different stretching techniques on the number of repetitions in a single lower body resistance training session. J Human Kinetics. 2015;45:177-185. doi: 10.1515/hukin-2015-0018.
7. Chatzopoulos D, Galazoulas C, Patikas D, Kotzamanidis C. Acute effects of static and dynamic stretching on balance, agility, reaction time and movement time. J Sports Sci Med. 2014;13:403-409.
8. Chatzopoulos DE, Yiannakos A, Kotzamanidou M, Bassa E. Warm-up protocols for High School students. Perceptual Motor Skills Exerc Sport. 2015;121(1):1-13.
9. Akbulut T, Agopyan A.Effects of an eight-week proprioceptive neuromuscular facilitation stretching program on kicking speed and range of motion in young male soccer players. J Strength Cond Res. 2015;21.
10. Reis EF, Pereira GB, Sousa NM, Tibana RA, Silva MF, Araujo M, Gomes I, Prestes J. Acute effects of proprioceptive neuromuscular facilitation and static stretching on maximal voluntary contraction and muscle electromyographical activity in indoor soccer players. Clin Physiol Funct Imaging. 2013;33(6):418-22. doi: 10.1111/cpf.12047.
11. Balle SS, Magnusson SP, McHugh MP. Effects of contract-relax vs static stretching on stretch-induced strength loss and length–tension relationship. Scand J Med Sci Sports. 2015: doi: 10.1111/sms.12399.
12. Gremion G. Is stretching for sports performance still useful? A review of the literature. Rev Med Suisse. 2005;27;1(28):1830-4.
13. Kallerud H, Gleeson N. Effects of stretching on performances involving stretch-shortening cycles. Sports Med. 2013;43(8):733-50. doi: 10.1007/s40279-013-0053-x.
14. Herbert RD, de Noronha M, Kamper SJ. Stretching to prevent or reduce muscle soreness after exercise. Cochrane Database Syst Rev. 2011; (7):CD004577. doi: 10.1002/14651858.
15. Silveira LC, Fett CA. Comparison of four methods in recovery delayed onset muscle soreness [monograph]. Physical Education Course. Federal University of Mato Grosso, 2011.
16. Instituto Nacional de Pesquisas Espaciais, 2016. Disponível em: http://sonda.ccst.inpe.br/estacoes/cuiaba_clima.html. Acesso em: 01 mar 2016.
17. Vannucchi H, Marchini JS, Santos JE, Dutra de Oliveira JE. Avaliação antropométrica e bioquímica do estado nutricional. Medicina Ribeirão Preto. 1984;17:17-28.
18. Kwak DH, Ryu YU. Applying proprioceptive neuromuscular facilitation stretching: optimal contraction intensity to attain the maximum increase in range of motion in young males. J Phys Ther Sci. 2015; 27(7):2129-32. doi: 10.1589/jpts.27.2129. Epub 2015 Jul 22.
19. Pojskić H, Pagaduan JC, Babajić F, Užičanin E, Muratović M, Tomljanović M.Acute effects of prolonged intermittent low-intensity isometric warm-up schemes on jump, sprint, and agility performance in collegiate soccer players. Biol Sport 2015;32:129-134.doi: 10.5604/20831862.1140427.
20. Guidetti L, Emerenziani GP, Gallotta MC, Baldari C. Effect of warm up on energy cost and energy sources of a ballet dance exercise. Eur J Appl Physiol. 2007;99:275-281.
21. Ayala F, De SteCroix M, Sainz De Baranda P, Santonja F. Acuteeffects of static and dynamic stretching on hamstring eccentric isokinetic strength and unilateral hamstring to quadriceps strength ratios. J Sports Sci. 2013;31(8):831-9. doi: 10.1080/02640414.2012.751119.
22. Kirmizigil B, Ozcaldiran B, Colakoglu M. Effects of three different stretching techniques on vertical jumping performance. J Strength Cond Res. 2014;28(5):1263-71. doi: 10.1519/JSC.0000000000000268.

23. Sekir U, Arabaci R, Akova B.Acuteeffects of staticstretching on peak and end-range hamstring-to-quadriceps functional ratios. World J Orthop. 2015;6(9):719-26. doi: 10.5312/wjo.v6.i9.719.
24. Belkhiria-Turki L, Chaouachi A, Turki O, Hammami R, Chtara M, Amri M, Drinkwater EJ, Behm DG. Greater volumes of static and dynamic stretching within a warm-up do not impair star excursion balance performance. J Sports Med Phys Fitness. 2014;54(3):279-88.
25. Avloniti A, Chatzinikolaou A, Fatouros IG, Protopapa M, Athanailidis I, Avloniti C, Leontsini D, Mavropalias G, Jamurtas AZ. The effects of static stretching on speed and agility: one or multiple repetition protocols? Eur J Sport Sci. 2015;7:1-7.
26. Young W, Elliott S. Acute effects of static stretching, proprioceptive neuromuscular facilitation stretching, and maximum voluntary contractions on explosive force production and jumping performance. Res Q Exerc Sport. 2001;72.

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Submitted: 2022/23/12
Revised: 2023/11/10
Acepted: 2023/12/20