



Acute Effects of Stretching on Flexibility, Power and Sport Specific Performance in Fencers

by

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Elite athletes are eager to perform to the best of their ability, regardless of different warm-up stretching techniques used before training or competition which actually help or hinder specific performance variables. The aim of this study was to investigate the acute effects of static or ballistic stretching on flexibility and leg power characteristics of fencing performance in fencers of both genders. Ten male and ten female international level fencers participated in this study. Each subject performed static or ballistic stretching (3 sets of 20 sec) on three muscles of the lower limbs on separate days. Flexibility, squat jump, countermovement jump, drop jump, time and power of lunge and shuttle run test were measured before and after different stretching interventions. Neither static nor ballistic stretching exercises affected flexibility, jumping ability and leg functional fencing performance tests. Moreover, stretching conditions did not affect differently. The results of this study suggest that static or ballistic stretching in the later stages of a general warm-up normally used before training or competition does not hinder specific performance in fencing. Consequently, fencers can continue performing any type of stretching before training or competition at their preference.

Key words: fencing, warm-up, gender, stretching

Introduction

Stretching exercises have been widely used as a training or competition warm-up routine to prepare the musculoskeletal system before any sport performance (Holcomb, 2000). It has been suggested that stretching enhances subsequent performance and reduces the risk of injury by improving joints' mobility (Alter, 1997). Static stretching is commonly used during warm-up since it is the easiest and safest method. However, numerous recent studies have shown that static stretching before athletic performance may actually have a negative effect on a variety of performance variables as sprinting (Fletcher and Jones, 2004; Winchester et al., 2008) agility (Little and Williams, 2006; McMillian et al., 2006), vertical

jumping (Knudson et al., 2001; Koch et al., 2003; Unick et al., 2005;) kicking and striking movements (McMillian et al., 2006; Zakas, 2005) balance and reaction times (Behm et al., 2004; Costa et al., 2009). The mechanisms which cause loss of strength and power after static stretching have been presumed to involve both mechanical and neurophysiological changes (Avela et al., 1999; Magnusson et al., 1996; Stone et al., 2006). Although, some researchers do not recommend static stretching be used before athletic events or physical activities requiring high power outputs because of their negative effects (Bacureau et al., 2009; Manoel et al., 2008; McMillian et al., 2006), some others have observed no detrimental effects of static stretching on selected neuromuscular parameters (Dalrymple et al., 2010; Ogura et al., 2007; Samuel et al., 2008) while Egan et al. (2006) reported

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that trained athletes may be less susceptible to stretching in comparison to untrained individuals.

In contrast to static stretching, ballistic stretching may be an effective alternative warm-up procedure before athletic performance, given that it raises core body temperature (Bishop, 2003; Stein et al., 1982), stimulates the nervous system (Bishop, 2003), and increases post-activation potentiation (Hodson et al., 2005) while possibly reducing the risk of injury (Yamaguchi and Ishi, 2005). However, a clear consensus of the effect of ballistic stretching has not yet been achieved. Indeed, Yamaguchi and Ishi, (2005), and Jagers et al. (2008), suggest that muscular power is enhanced by dynamic activities. Recent studies have also indicated that dynamic stretching improved vertical jump results (Hough et al., 2009), sprinting time (Fletcher and Jones, 2004) and agility performance (Little and Williams, 2006). On the other hand, evidence has been provided by several researchers (Bacurau et al., 2009; Jagers et al., 2008; Samuel et al., 2008; Unick et al., 2005), suggesting that ballistic stretching did not affect maximal strength or vertical jump performance.

Although stretching is a beneficial component of all pre-participation athletic procedures, studies of its acute effects as a part of the warm-up in sport specific kinetic tasks have reported equivocal findings (Gergley, 2009; Haag et al., 2010; Knudson et al., 2004; Young et al., 2004). To our knowledge, only one of the existing studies investigated the effects of ballistic stretching in comparison to static stretching as a pre-participation warm up routine in sport specific activities. The results of this study showed that the effect of dynamic stretching produced significantly better golf swing kinematics enhancing the performance of elite golfers than both static and no stretching conditions did (Moran et al., 2009).

Based on the existing literature, it is clear that there is a lack of knowledge regarding the impact of different stretching protocols on athletic performance, concerning functional tasks performed in competition.

Fencing is an open skilled combat sport which is characterized by short, frequent bouts of high intensity actions. Consequently, muscle strength and power are crucial for fencers to perform specific dynamic movements as steps and bounces at different direction and lunges in order to strike the opponent (Barth and Beck, 2007). Power related jumping tests are correlated to specific fencing tests, indicating that concentric explosive strength and fast stretch shortening cycles qualities seem to be important in fencing

performance (Tsolakis et al., 2010). Moreover, the identical range of motion while learning and executing the lunge, as well as during the frequency of steps alteration, is related to muscle coordination, force production and has been of significant interest to fencing coaches (Szabo, 1982).

Stretching exercises before competition are still a common component of warm-up, although the relative information of the efficacy of such routines has mainly been derived from empirical aspects. Consequently, an understanding of the effect of both static and ballistic stretching is crucial in sports, where increased leg power is vital for successful athletic performance.

To date there has been no research on the effects of different warm-up protocols on fencing performance of well trained male and female subjects. It has been presumed that leg force and power, as well as functional fencing performance would be adversely affected after static stretching, whereas ballistic stretching may potentially enhance the same muscle performance variables parameters. Also, it has been postulated that flexibility would be increased as a result of either static or ballistic stretching respectively.

Thus, the aim of the present study was to compare the effects of a static and a ballistic stretching program, on significant variables in fencing performance as flexibility, leg power and functional kinetic tasks varied by gender.

Methods

Subjects

Ten male and ten female fencers with international experience volunteered to participate in this study. This study was approved by the Institutional ethical board of the Department of Physical Education and Sports Science, Athens University. The physical characteristics of the fencers are shown in Table 1. All fencers were informed of the procedures, potential risks and benefits before signing an informed consent form. The fencers were free of injury and the testing was performed during transitional training period.

Experimental design

Two different warm-up procedures with either static or ballistic stretching were executed by all participants in a within subjects experimental design. Two testing days separated by at least 48 hours, were required for subjects to be measured on the

| | Age (years) | Body Height (cm) | Body Mass (kg) | % body fat |
|-------------------------|----------------|------------------------|----------------------|------------------|
| Total, n= 20 | 21.7 \pm 3.4 | 175.5 \pm 8.1 | 68.3 \pm 11.7 | 15.9 \pm 5.2 |
| Men, n=10 | 20.9 \pm 4.2 | 180.5 \pm 6.2 | 76.7 \pm 9.5 | 13.2 \pm 6.1 |
| Women, n=10 | 22.5 \pm 2.3 | 170.5 \pm 6.6 | 59.9 \pm 6.6 | 18.6 \pm 1.9 |

selected parameters (sit and reach test, squat jump, counter-movement jump, drop jump, time and power of lunge and time of shuttle test) in a randomized order for each warm-up procedure. The participants were familiar with the stretching protocols and the exercise testing procedures, since they routinely performed these exercises in every day training and competition. Specifically, all subjects performed a 8 min low intensity jogging warm-up at their own pace and either a static or a ballistic stretching program afterwards. Before and after the static or the ballisting stretching mode of warming-up, the sit and reach test, squat jump, countermovement jump, drop jump, "time and power of lunge", and the "time in fencing specific shuttle test", were conducted.

For the static stretching mode each participant performed three different lower body stretching exercises: unilateral standing quadriceps stretch, unilateral sitting hamstring stretch, unilateral standing calf stretch without feeling pain or discomfort. Each stretch was performed three times on each limb and each repetition was held for 20 seconds giving to the non-stretched side adequate recovery before the next stretch repetition.

The ballistic stretching protocol incorporated three stretches of the same muscle groups as the static one. Each subject was instructed to perform three sets of ballistic stretching in a repetitive and alternative rapid fashion for 20 s with a 20-s rest period between repetitions. The ballistic stretching exercises were: butt-kick, standing knee raise, calf raise, all aimed to affect quadriceps, hamstrings and gastrocnemius muscles respectively. This protocol was designed to mimic athletes' stretching regimen followed before training or competitions. Fencing specific tests: The "time of lunge" (TL) and the time of the "shuttle test" (ST) were recorded by means of four photocells (Polifermo radio Light – Microgate

| Variables | pre | | post | |
|-----------------------------|-------|-------|-------|-------|
| | X | SD | X | SD |
| Sit and Reach (cm) | 9.55 | 10.4 | 11.2 | 9.2 |
| Squat jump (cm) | 29.7 | 5.53 | 28 | 6.0 |
| Counter jump (cm) | 35.8 | 7.9 | 33.7 | 8.1 |
| Elasticity | 6.2 | 4.5 | 5.1 | 5.4 |
| Drop jump (cm) | 27.6 | 5.6 | 26.1 | 4.9 |
| Contact time Drop jump (ms) | 200.8 | 52.2 | 201.7 | 32.8 |
| Reaction Strength Index | 0.14 | 0.03 | 0.13 | 0.02 |
| Time of lunge (s) | 0.27 | 0.06 | 0.26 | 0.08 |
| Power of lunge (Watt) | 602.4 | 251.4 | 568.6 | 243.1 |
| Shuttle test (s) | 13.1 | 1.8 | 12.8 | 1.7 |

Italy). For the "time of lunge" the photocells were placed at an adjustable lunge distance (2/3 leg length) according to Yiou and Do (2000) while the participants were asked to execute a fencing lunge at maximal speed. The height of the photocells was adjusted to be interrupted by the chest of the athletes. An Ergopower device (Ergotest Technology A.S. Langensud, Norway) was used to record the power of lunge (PL) based on a precise measurement of the load displacement. The displacement of the load was measured with a sensor which was interfaced to an electronic device. The electronic device with the software calculated velocity, acceleration, force power and work corresponding to the load displacement (Bosco et al 1995).

For the "shuttle test" which included three times "5m forward – 5m backward with fencing steps", the photocells were placed at the start and at the end of a 5 m distance. The participant had to take the on guard position behind the starting line and move with fencing steps forth and back between two parallel lines, as fast as possible, to cover a total distance of 30m (Iglesias and Rodrigez, 2008). Both fencing tests were performed by the participants wearing fencing shoes and the lower part of the fencing uniform, without holding any weapon. These tests were chosen on the basis of their relative simplicity and the close specificity to functional fencing performance as well as the easiness of full familiarization of the participants with the testing procedures. The test-retest reliability for the "time of lunge", "power of lunge" and the "shuttle test" estimated to be 0.93 0.92 and 0.98 ($p < .001$).

All other testing procedures, the derived indexes and the values of the reliability coefficients of each test were previously reported elsewhere (Tsolakis and Vagenas, 2010; Tsolakis et al, 2010).

Each test was performed twice, with a 30s rest between trials and the best was recorded for further processing with the exception for the procedures of the shuttle test. A rest of 2 minutes was set between trials to minimize the fatigue effects. The pause incorporated between two consecutive tests was approximately 5 min. A 5 -minute rest period was set between the stretching intervention and the post stretching tests.

Statistical Analyses

All parameters were normally distributed (Kolmogorov-Smirnov test). A mixed ANOVA model was performed with two within-subject factors [stretch type (static – ballistic stretching) and time (pre – post)] and a between –subject factor of gender. A significant level of $p < 0.05$ was considered statistically significant for this analysis. A Bonferroni post-hoc analysis was performed if any significant differences occurred. To prevent inflation of the experiment-wise type I error rate ($p < 0.05$) statistical significance for each test was accepted at the $p < 0.0038$ level. In addition, for statistical significant findings, the association (effect size) was estimated with the partial eta squared (η^2) statistic. All statistical analyses were performed using the Statistical Package for Social Sciences for Microsoft Windows (version 16, 2007; SPSS Inc. Chicago IL).

Results

ANOVA did not detect any significant interaction between stretching protocols (static or ballistic), time (pre-post) and gender for sit and reach ($p = 0.583$), squat jump ($p = 0.260$), counter-movement jump (0.954), drop jump ($p = 0.412$), elasticity ($p = 0.748$), contact time of drop jump ($p = 0.312$), reactive strength index ($p = 0.155$), time of lunge ($p = 0.640$), power of lunge ($p = 0.336$) and shuttle test ($p = 0.223$) respectively. There was a significant interaction between stretching protocols and time ($F = 4.564$, $p = 0.04$, $\eta^2 = 0.113$) for reactive stretch index. A significant main interaction was found for time (pre-post) on the sit and reach ($F = 12.406$, $p = 0.001$, $\eta^2 = 0.256$) and shuttle test ($F = 4,739$, $p = 0.036$, $\eta^2 = 0.116$). There was no gender difference by stretching interaction for any of the selected measurements, sug-

Table 3

Mean and standard deviations for strength power parameters and functional characteristics of fencing performance before and after ballistic stretching intervention in male and female fencers (N=20)

| Variables | pre | | post | |
|-------------------------------|-------|-------|-------|-------|
| | X | SD | X | SD |
| Sit and Reach | 9.9 | 9.0 | 11.6 | 8.2 |
| Squat jump (cm) | 29.2 | 6.5 | 29.4 | 6.4 |
| Counter jump (cm) | 34.8 | 8.0 | 34.7 | 7.9 |
| Elasticity | 5.6 | 4.0 | 5.3 | 4.0 |
| Drop jump (cm) | 27.1 | 4.4 | 27.3 | 5.0 |
| Contact time Drop jump (msec) | 195.3 | 24.7 | 195.2 | 29.5 |
| Reaction Strength Index | 0.14 | 0.03 | 0.14 | 0.03 |
| Time of lunge (sec) | 0.25 | 0.06 | 0.26 | 0.07 |
| Power of lunge (Watt) | 513.6 | 213.5 | 522.2 | 215.7 |
| Shuttle test (sec) | 12.7 | 1.6 | 12.5 | 1.6 |

gesting that the stretching conditions did not affect men and women differently. Finally, gender was found to have a significant main effect with men producing greater squat jump ($F = 55.692$, $p = 0.000$, $\eta^2 = 0.607$) counter-movement jump ($F = 49.995$, $p = 0.000$, $\eta^2 = 0.581$), drop jump ($F = 16.012$, $p = 0.000$, $\eta^2 = 0.308$), reactive strength index ($F = 10.086$, $p = 0.003$, $\eta^2 = 0.209$), power of lunge ($F = 30.635$, $p = 0.000$, $\eta^2 = 0.460$) and shuttle test results (18.880, $p = 0.000$, $\eta^2 = 0.344$) performance values compared to the women. There was also a between gender significant main effect on sit and reach with women having higher flexibility compared to men ($F = 12.216$, $p = 0.001$, $\eta^2 = 0.253$)

Due to severe Bonferroni accepted α level ($p < 0.0038$), no significant post hoc differences were observed. However, there was a consistent pattern for reduced performance values in squat jump (29.7 ± 5.53 to 28.3 ± 5.98), counter-movement jump (35.81 ± 7.92 to 33.77 ± 8.12) and drop jump (27.61 ± 5.62 to 26.09 ± 4.90) immediately after the static stretching program.

Discussion

The practice of stretching exercises is commonly recommended for recreational and professional athletes before the training programs and the pre-event warm-up activities (Fradkin et al., 2010, MacHugh and Cosgrave, 2010). Consequently, an understanding of the optimal pre-participation stretching protocols effects on athletic performance is crucial for sports with high level of strength and power re-

quirements. This study was the first to evaluate the acute effects of static and ballistic stretching exercises (3 x 20 sec) for the quadriceps, hamstring and gastrocnemius muscle on flexibility, jumping ability and leg functional power characteristics of fencing performance in male and female international fencers, to determine which method of warm-up is the best for this sport discipline.

In contrast to our hypotheses the results of the present study, revealed that neither static nor ballistic stretching exercises affected jumping ability and functional fencing performance and that these effects were independent of gender. Similarly, flexibility which was assessed by the sit and reach test seems to be unaltered after both static and ballistic stretching. However, with respect to jumping performance tests, there was a consistent tendency for lower values in squat jump, countermovement-jump and drop jump after the static stretching intervention.

Several studies have shown that muscular performance was not different after static (Christensen and Nordstrom, 2008; Darlymple et al., 2010; Egan et al., 2006; Samuel et al., 2008; Unick et al., 2005) or ballistic stretching (Bacureau et al., 2009; Jaegggers et al., 2008; Samuel et al., 2008; Unick et al., 2005) respectively. Most of these studies have evaluated multiple variations of stretching programs (modes, intensities, frequencies, durations of stretches, recovery prior to performance) on a variety of performance variables in recreational or relatively well trained athletes. Consequently, the results of our study are partially comparable to the above mentioned studies.

Also, limited amount of studies have examined the acute effects of pre-participation warm-up stretching in sport specific kinetic tasks with conflicting results. (Gergley, 2009; Haag et al., 2010; Knudson et al., 2004; Moran et al., 2009; Young et al., 2004). A number of methodological issues may have a significant impact upon the discrepancy between results of these studies showing that static stretching in different sports (tennis, golf, football, baseball), did not have any significant effect on specific sport kinetic patterns performance (Haag et al., 2010; Knudson et al., 2004; Young et al., 2004). In contrary, Gergley (2009), found significant decrements in a number of golf kinetic parameters after acute passive stretching exercises. It is interesting to note that only the study by Moran et al. (2009), compared static and dynamic stretching showing that the effect of dynamic stretching produced significantly better golf

swing kinematic results than both static and no stretching conditions in elite golfers.

Our findings will add to the growing volume of conflicting results providing further evidence that static or ballistic stretching does not impair leg power characteristics of fencing performance, confirming the results of others (Haag et al., 2010; Knudson et al., 2004; Young et al., 2004). The present study was designed to evaluate warming-up stretching programs that are usually recommended by experienced coaches, before fencing training or competition. The program characteristics included a relatively short stretching period of 3 sets x 20 s in three different muscle groups, which were involved in the specific kinetic patterns of fencing (Williams and Walmsley, 2000), with a total duration of 90 s per each target muscle group. Previous studies (Costa et al., 2009; Ogura et al., 2007; Sekir et al., 2010; Yamaguchi and Ishi, 2005) have suggested that the duration of the static stretching protocols influenced the subsequent muscular performance. Longer total stretching durations than those commonly applied in the field, tend to cause a greater decrement in performance making the viscoelastic properties of the musculotendinous units more compliant (Magnuson et al., 1996; Power et al., 2004). On the other hand, Little and Williams. (2006) found no detrimental effects after applying 30 s of stretching on performance outcome and suggest that shorter durations of stretching may minimize any detrimental effects on subsequent performance. The stretching time in the present study was brief, representing a usual duration of the warm-up regimen showing that this amount of stretching could not adversely affect the leg power characteristics of fencing performance. A number of studies reported similar results to this study after a stretching protocol which included 1 to 3 sets of 10 to 30 s duration on maximal handgrip (Knudson and Noffal, 2005), vertical jump kinematics (Knudson et al., 2001), tennis serve performance (Knudson et al., 2004) reaction time and explosive strength (Alpkaya et al., 2007) kicking speed (Young et al., 2004) as well as jumping performance measured with various tests (Koch et al., 2003; Unick et al., 2005; Young and Elliot, 2001).

A possible explanation for the conflicting results of previous studies examining the acute effects of different stretching protocols in selected performance parameters is the rest period used between stretching and the testing performance measures (Robbins and Scheurmann, 2008). Some of them have

shown that ballistic exercises may cause a short term enhanced performance by activated muscles for some time after the cessation of stimuli (Sale, 2002) as a result of postactivation potentiation (PAP). However, considerable variations are reported between 2.5 and 18 minutes in the PAP protocol responses after the potentiating exercises (Gullich and Schmidtbleicher, 1996; Chiu et al., 2003). Significantly greater improvements in vertical jump results after dynamic stretching compared to static ones was found by Hough et al. (2009), when the vertical jump test was performed 2 minutes after the intervention protocol, while others (Torres et al., 2008; Unick et al., 2005) found that 5 minutes of rest between the stretching protocol and the testing may have allowed the static stretching induced changes to dissipate. The results of our study indicate that ballistic stretching that was used as a part of pre-exercise warm-up does not affect leg power characteristics of fencing performance. Although the design of the study did not examine the mechanisms involved with the type of stretching, the recovery of the motor neuron excitability is one possible explanation as to why fencing performance was unaltered. Avela et al. (1999) found a depression of the H-reflex after stretching which was almost completely reversing 4 minutes after stretching. Similar results were found by Guissard et al. (1988) who also reported that the H-reflex was quickly recovered immediately after static stretching. Consequently, the 5-minutes rest period between the stretching phase and the fencing tests of the present study may have diminished some of the stretch induced physiological changes.

The lack of significant differences after the different type-stretching interventions may have been limited by the testing protocols used in the present study. The 6 different tests performed twice by each participant, with approximately a 5 min pause between two consecutive tests, are in fact practically more than those standard used in previous studies (Little and Williams, 2006; Needham et al., 2009), and may have been a sufficient dynamic stimulus that could alter any short-term changes caused by the static stretching (Little and Williams, 2006; Rosenbaum and Henning, 1995).

The second purpose of this study was to determine whether fencing performance could be gender affected. Women have greater flexibility than men (Barnes et al., 2001; Bell and Hoshizaki, 1981) and seem to be less affected by a stretching. (Costa et al., 2009). Men in the present study produced signifi-

cantly higher results in all jumping tests, power of lunge and shuttle test respectively. However, despite the obvious between genders differences in the power related fencing performance measures, it was determined that both stretching interventions did not affect the genders differently. It is interesting to note that very few studies have examined the between gender acute effects of static or ballistic stretching. Samuel et al. (2008), found that static or ballistic stretching (3 x 30 s) of the quadriceps or hamstrings did not affect vertical jump or torque output in 12 male and female university students, which is in accordance with the results of our study. Similarly, a non-significant effect of age was found in serve speed across static stretching warm-up condition in 49 male and 34 female well trained tennis players (Knudson et al., 2004) Structural muscle and force transmission differences are responsible for the decreased tendon stiffness of women as compared to men (Chow et al., 2000; Granata et al., 2002; Kubo et al., 2003), and in consequence this may be a possible explanation for the variation between gender results. Therefore, further investigation is needed to determine the sex differences in response to different stretching protocols.

Stretching has been extensively used before physical activities so that athletes should perform optimally and decrease muscle stiffness or muscle compliance minimizing the risk of injury (McHugh and Cosgrave, 2010). With respect to stretching technique, static stretching is the most commonly used due to its simple execution and the minimum of risk injuries. However, earlier evidence suggest that ballistic stretching although tend to stretch the muscles more than any other method can be used effectively as a part of a pre-exercise warm-up (Woolstenhulme et al., 2006; Unick et al., 2005). Sit and reach test and hip joint ROM measurements included as flexibility variables showing in recent studies that both ballistic and static stretching significantly affect flexibility (Bacureau et al., 2009; Fowles et al., 2000; Nelson and Kokonen, 2001). In contrast to these results, both stretching interventions of the present study failed to demonstrate significant flexibility changes, although there was a tendency for an increase in the sit and reach values after the stretching protocols, taking also into consideration the severe Bonferroni accepted α level ($p < 0.0038$). However, it was reported that static stretching induces short-term changes in flexibility that would not necessarily alter skill performance of complex neuromuscular patterns pro-

duced by a large number of muscle groups (Young et al., 2004).

Conflicting evidence exists regarding the subjects sports level contribution to the stretching induced changes in force and power parameters (Egan et al., 2006). Different modes of stretching affected mainly untrained individuals and not well trained athletes (Haag et al., 2010; Knudson et al., 2004; Torres et al., 2008; Unick et al., 2005; Young et al., 2004). The results of our study are in line with the above mentioned studies and suggest that the chronic training adaptations of the sport-specific conditioning of international fencers minimized the acute effects of stretching and may partially explain the lack of any significant change in flexibility and leg power characteristics of fencing performance.

Fencing performance is related among others to the subjects' ability for force and power production (Tsolakis et al., 2010) and neuromuscular coordination (Williams and Walmsley, 2000). The Fencing lunge is a closed-kinetic-chain unique skill in which its technique differentiates the elite from the sub-elite fencers (Harmenberg et al., 1991). Passive stretching, although seemingly not having any effect on movement technique, may have a negative effect on coordination and force production (Samuel et al., 2008), while simultaneously increasing stride length (Caplan et al., 2009). All these biomechanical alterations may in turn modify lunge mechanics through loss of control and power output (Fletcher and Jones, 2004). Although subjects in the present study were

international fencers we believe that individual differences in technique may influence the effective utilization of power during the performance tests.

Conclusions

In conclusion, the results of this study showed that after a warm-up type similar to that used in competitive athletes, static or ballistic stretching exercises does not affect flexibility and leg power characteristics of fencing performance in male and female international fencers. This investigation further supports the findings of other studies questioning the use of certain warm-up methods before athletic performance. Given these data, coaches and fencers may continue performing any type of stretching before training or competition by limiting the duration of stretching to 60s per muscle including a rest period of at least 5 min after the end of the stretching program and before any activity, without fear of decreasing the speed and power of the fencing kinetic patterns. Further study is needed to ascertain to what extent these results are also applicable to athletes of different sports. Moreover, it is necessary to determine the precise underlying mechanisms associated to stretching related changes, by using a larger pool of subjects with the inclusion of control groups, taking into consideration the relationships between limited time allocated and the cost benefit of various stretching programs.

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