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REVIEW ARTICLE

A Systematic Review of Effective Warm-Up Programs to Enhance Fente Performance and Prevent Hip Injuries in Fencing

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KEYWORDS
Fencing,
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ABSTRACT
Background. Fencing is a unilateral sport that uses the same limb, and there are many specific injuries due to the specific characteristics of this sport. **Objectives.** This study aims to prevent fencing-related injuries around the hip joint. Effective warm-ups have been studied to improve fencing performance. **Methods.** Databases including Google Scholar and Web of Science were searched up to April 2024 using keywords such as "fencing," "warm-up," "hip joint," and "fente." Inclusion criteria consisted of peer-reviewed articles addressing warm-up protocols focusing on the hip joint and their effects on performance or injury prevention in fencers. **Results.** The vertical component of the reaction force of the dominant leg and the knee flexor of the nondominant leg are important for improving the performance of fente. Preparing with dynamic active stretching in a short time is necessary for an adequate warm-up to improve fencing performance. To prevent hip joint injuries, which are the most common in fencing, training with eccentric exercises can reduce the risk of re-injury. **Conclusion.** Findings suggest that active warm-ups, eccentric hamstring exercises, and dynamic mobility drills targeting hip extension and control significantly improve fente performance and may reduce injury risk. However, heterogeneity in study designs and a lack of high-quality trials limit definitive conclusions. Further experimental studies are needed to develop evidence-based fencing-specific warm-up programs.

INTRODUCTION

Fencing is an open-skilled combat sport where athletes use their weapons to touch opponents without physical contact to score points. Fencing is divided into foil, sabre, and épée, and each discipline has different rules and allowed parts of the body (1, 2). Since fencing is inherently asymmetrical, requiring coordination, explosive power, speed, and accuracy, and the opponent's actions are fast and unpredictable, translating visual stimuli into movement is crucial (3). The most common attack in fencing is the fente, which is a movement from a basic "En garde" stance to a forward movement with the nondominant leg, extending the stride length to attack the opponent (4). Fente can be categorized into four phases to describe its actions. In the propulsive phase, the hip and knee extensors of the nondominant leg are highly used. This generates an anteroposterior force, propels the body mass forward quickly, and allows maximum speed (5). The hip and knee extensors of the dominant leg are responsible for kicking the dominant leg away (6). The dominant leg's rectus femoris, vastus lateralis, gluteus, and soleus are activated to allow hip flexion and simultaneous knee extension, followed by a plantarflexion to prepare for the ground contact phase. If the anteroposterior acceleration is zero, the final braking phase is mostly dominated by knee extensors, and plantar flexors are used to create the opposite force of the ground reaction force, which creates an eccentric contraction at the last moment of the attack to decelerate (7). In other words, the hip extensor of the nondominant leg plays a major role in the propulsive phase, and the knee extensors of the dominant leg are primarily used in the braking phase (8, 9).

Classification of joints, which is part of the ball and socket joint, hip joint can create movement in three planes, the line of action and the hip's axis of rotation change depending on the position of the hip joint, so it is important to set the angle of the hip joint when creating movement in the lower extremity (10). There are a lot of injuries in the hip joint, especially groin injuries, and it has a lot to do with the angle of internal and external rotation of the hip joint (11). In other words, hip joint restriction causes greater stress on the superior pubic ramus and pubic symphysis, so it is important to have internal and external rotation angles to prevent groin injury (12). A US national fencing team study found that 69% of fencers had at least one injury to the dominant knee, and 31% had at least one injury involving the hip joint. Muscle strains are most common in the dominant hip, while muscle and labral tears are most common in the nondominant hip (13). For fencers, injury affects performance, so it is important to find ways to prevent it. In particular, inadequate warm-ups, poor fencing technique, dangerous tactics, lack of adequate general conditioning, fatigue, overtraining, and repetitive exercises can cause overuse, leading to more severe and lasting damage (14). Therefore, for fencers to increase their fente performance, the hip region must be strengthened to prevent injuries and be prepared with a proper warm-up.

Warm-up increases body temperature and is one way to prevent possible damage during exercise, and can generally be divided into two types, passive and active warm-up (15). Passive warm-up increases core temperature without depletion of energetic substrates, but athletes do not often use it before competition (16). On the other hand, an active warm-up can increase skeletal muscle potentiation through pre-loading stimuli in a way that can be altered to stimulate mechanisms underlying both anaerobic and aerobic metabolism (17). In fencing, like sprinting, performing offensive movements with an adequate warm-up can prevent injuries and improve performance (18). Recent research in 2025 utilizing kettlebell training has demonstrated significant improvements in abdominal and lower limb muscles (19). However, these studies primarily focus on the hip joint and do not provide specific methods for enhancing fente performance. Despite the hip joint's critical role in fencing, especially in executing the fente, a key offensive movement, there is a lack of research on warm-up strategies tailored to its anatomical characteristics. Therefore, developing a fencing-specific warm-up program that targets the hip joint is essential for preventing injuries and improving performance. Therefore, this study aims to investigate a specific warm-up program with anatomical applications to the hip joint to prevent damage and provide a positive program for fencing performance.

MATERIALS AND METHODS

Literature Review and Search Strategy. This review adhered to PRISMA guidelines. A systematic search was conducted in PubMed, Scopus, and Web of Science for studies published from January 2010 to December 2023. Keywords included "fencing," "Fente," "warm-up," "hip joint," "injury prevention," and "performance" (Figure 1).

Inclusion Criteria. Studies involving fencing athletes. Warm-up interventions targeting the hip joint. Reported outcomes related to performance or injury incidence.

Exclusion Criteria. Non-peer-reviewed publications. Studies not involving human participants. Interventions not specifically targeting the hip joint.

Selection Process. A total of 25 peer-reviewed articles were selected based on relevance and quality.

Quality Assessment. Studies were assessed for methodological soundness and relevance to fencing biomechanics and injury prevention.

Data Extraction. Key findings regarding warm-up type, fente characteristics, and hip injury mechanisms were extracted.

Data Synthesis. A narrative synthesis highlighted recurring themes in warm-up efficacy and hip function in fencing.

The research war collected by "Web of science" and "Google scholar". Studies published between 2000~2024 were selected including experimental and review studied about " Fencing athletes"

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Among 482 papers "Fencing warm up" Fencing injury", Fencing performance" "Hip joint muscle", were detailed to these studies

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312 of studies were excluded by first screening
: Not suitable for the purpose of this study

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Studies included by word "Fencing fente" (n =9)
Studies included by word "Fencing injury" (n=8)
Studies included by word "Athletes hip joint injury" (n =8)

↓

25 studies, which is properly qualified about papers were collected

Figure 1. Investigated progress for references of this study.

RESULTS

Characteristics of Fente. A study in 2013 (Table 1) analyzed the movement time and distance of the fente in elite and subelite athletes and found that the average movement time was 601 ms and 583 ms, respectively, and the distance was 1.4 m and 1.13 m (20). Although the movement time of the fente is relatively long, elite athletes had a higher velocity during the flight phase when the dominant leg comes forward and accelerates forward in a fente motion at a speed of 36 ms. In addition, a study of 16 athletes (Table 1) measuring joint torque under isometric conditions showed that the maximum vertical force of ground reaction force was in the dominant leg, and the maximum value of knee flexion in the nondominant leg was significantly exceeded under isometric conditions (21). Also, prior research on epidemiologic analysis of fente (Table 1) has been done to determine which factors are important. 3D motion capture analysis of fente movements in 14 épée athletes showed that knee flexion of the nondominant leg is important for power production (22).

Table 1. Characteristics of fente.

Study	Country	Results
Response timing in the lunge and target change in elite versus medium-level fencers	Spain	The average movement time was 601 vs. 585 ms, respectively, but the former covered a significantly greater distance of 1.4 vs.1.13 m..

Study	Country	Results
Anthropometric, flexibility, strength-power, and sport-specific correlates in elite fencing	Greece	Significant difference in fente time of only 30 ms (measured at 250 Hz) between elite and subelite fencers; has not been detected at 50 Hz
The effect of nonleading foot placement on power and velocity in the fencing lunge	USA	Among those training with a natural forward deviation, the 90° stance still produced higher mean velocity and power than the natural foot placement.
Determinants of olympic fencing performance and implications for strength and conditioning training	UK	Developing reactive strength coupled with deep squats or split squat exercises can help target the gluteal muscles and collectively train a fast recovery from the fente back to on guard. Nordics and stiff-leg deadlifts can help reduce the high incidence of hamstring strains, and increasing adductor flexibility may enhance this.
Physical characteristics underpinning lunging and change of direction speed in fencing	UK	More single-leg work on the weaker leg, such as switching the stance during warm-ups, may address this. Training CODS[1] exercises that develop lower-body power, especially with horizontal propulsion, may be beneficial.
Determination of loading in the lower limb joints during the step-forward lunge in fencing	Russia	The maximal value of hip flexion torque of the lead leg in dynamic conditions significantly exceeds the value for this joint recorded in isometric conditions. The maximal value of knee flexion of the rear leg in dynamic conditions significantly exceeds the value obtained in isometric conditions.
Kinematic determinants of weapon velocity during the fencing lunge in experienced épée fencers	UK	The results indicate that flexion of the rear extremity's knee is an important predictor, suggesting that the Fencer sits low in their stance to produce power during the fente.
Anthropometric and Leg Power Factors Affect Offensive Kinetic Patterns in Fencing	Greece	Significant correlations were observed between fente and step fente velocity and long jump, countermovement jump, drop jump, and reaction strength index.
Effect of uncertainty during the lunge in fencing	Spain	In situations with uncertainty, the fencers had the same target as in the previous situation, but they received the information that they had to change the fente into a defensive move if the target disappeared from the plastron during the action.

[1]: Change of direction.

Athletes' Warm-Up Method. The two types of warm-ups have different effects depending on the physiology of the movement (23). Passive warm-up has the effect of increasing muscle temperature or raising core temperature, while active warm-up has the effect of metabolic change (24). In a research study of 20 fencers (Table 2), the lower limb power and flexibility were examined using two different warm-up methods (25). One group stretched their quadriceps, hamstrings, and triceps surae for 15 seconds using static stretching, and the other group stretched for 43 seconds before measuring limb power. The results showed that power was reduced in the longer stretching group. In a 2008 experiment with soccer players (Table 2), three groups were divided into three different warm-ups to examine how different warm-ups affected vertical jump performance. The results showed that each warm-up group produced different results, with the static stretching group performing lower than the warm-up plus dynamic stretching and warm-up plus dynamic flexibility conditions (26). When performing a warm- up, resting too long after the post warm-up decreased the effectiveness, and the most effective method was a short active warm-up lasting 10-15 minutes and gradually increasing the intensity to 50-90% of maximum heart rate, and resting for more than 15 minutes was not recommended (27).

Table 2. Athletes warm-up method.

Study	Measurement & Method	Results
Acute effects of two different warm-up protocols on flexibility and lower limb explosive performance in male and female high-level athletes	Performed two warm-up protocols that included 5-minute light jogging and short (15s) or long (45s) static stretching exercises for each main leg muscle group, followed by either 3 sets of 3 or 3 sets of 5 tuck jumps.	Lower limb power may be decreased after long periods of stretching, but performance of explosive exercises may reverse this phenomenon.
Acute effect of different warm-up protocols on athletes' performance	Subjects performed a general warm-up for 5 minutes, then pre-tests were measured before each warm-up protocol. All subjects were tested on static balance, vertical jump, 30 m sprint, reaction time, and flexibility performances.	In sports that require speed and jumping, whilst plyometric and suspension warm-up exercises are considered beneficial, in sports that require flexibility, the inclusion of static stretching to these exercises is considered beneficial.
The impact of different warm-up protocols on vertical jump performance in male collegiate athletes	The participants were then randomly assigned to a warm-up only condition, a warm-up plus static stretching condition, a warm-up plus dynamic stretching condition, or a warm-up plus dynamic flexibility condition. VJ[1] performance was tested immediately after the completion of the warm-up.	The results showed a significant difference in VJ[1] performance between the warm-up groups. The mean for the static stretching group was significantly lower than the means for the other three groups. The static stretching negated the benefits gained from a general warm-up when performed immediately before a VJ[1] test.
Effects of warm-up, post-warm-up, and re-warm-up strategies on explosive efforts in team sports: A systematic review	Web of Science, Scopus, PubMed, and ScienceDirect for original research articles published between January 1981 and August 2017. A total of 30 articles met the inclusion criteria, and the Cochrane risk of bias tool was used to assess the risk of bias.	Studies tend to recommend a short active warm-up strategy (10-15 min), gradually increasing intensity, and the use of heated garments soon after the warm-up to maintain muscle temperature. 2 min of active re-warm-up with short-term sprints and jumps should be needed for transitions longer than 15 min.
Rationale and implementation of anterior cruciate ligament injury prevention warm-up programs in female athletes	Analyze the current literature researching possible biomechanical and neuromuscular risk factors in non-contact ACL[2] injury in female athletes and the most effective means of implementing critical elements of a program to decrease ACL[2] injury risk in female athletes while improving athletic performance.	Hip and hamstring training, core stabilization, plyometrics, balance, agility, neuromuscular training with video and verbal feedback to modify technique, and stretching are essential components of these programs.
Effects of drop jumps added to the warm-up of elite sport athletes with a high capacity for explosive force development	After a semi-standardized warm-up, group 1 did five jumps from a height of 60cm, landing with active stabilization in 90± knee flexion. One minute after these modified drop jumps, they performed three single squat jumps (SJ[3]) and three single countermovement jumps (CMJ[4]) on a force platform. The athletes repeated the procedure after 1 hour without the modified drop jumps.	A consistent tendency for improvement with added drop jumps to the warm-up routine was observed compared with warm-up without drop jumps.
Dynamic warm-up protocols, with and without a weighted vest, and fitness performance in high school female athletes	After 5 minutes of jogging, subjects per formed four randomly ordered warm-up protocols: Five static stretches (2~30 seconds), nine moderate-intensity to high-intensity dynamic exercises, the same nine dynamic exercises performed with a vest weighted with 2% of body mass, and the same nine dynamic exercises performed with a vest weighted with 6% of body mass.	A dynamic warm-up with a vest weighted with 2% of body mass may be the most effective warm-up protocol for enhancing jumping performance in high school female athletes.
Effect of Warm-Up and Flexibility Treatments on Vertical Jump Performance	Perform a general warm-up only, a general warm-up and static stretching, and a general warm-up and proprioceptive neuromuscular facilitation (PNF[5]) on three nonconsecutive days. A vertical jump test followed each of the treatments.	A post hoc analysis revealed decreased vertical jump performances for the PNF[5] treatment group. Based on the results of this study, performing PNF[5] before a vertical jump test would be detrimental to performance.

[1]: Vertical jump; [2]: Anterior cruciate ligament; [3]: Squat jump; [4]: Countermovement jump; [5]: Proprioceptive neuromuscular facilitation.

Hip-Related Injury. Hip injuries are common in athletes, especially in sports that involve a lot of quick changes of direction, twisting, turning, and rapid acceleration and deceleration (28). According to the National Collegiate Athletic Association Injury Surveillance Program from

2009-2014 (Table 3), most hip and groin injuries occur in non-contact movements, and most of them do not require surgery, but research on treatment methods is needed (29). A 2001 study in the United States (Table 3), jogging generates a load of 8 times body weight, so hip and groin injuries are common, especially in acute onset, and muscle strain, contusion, avulsion and apophyseal injuries are common, so it is necessary to make accurate judgment and appropriate treatment (30). Hamstrings are one of the muscles most commonly used in fencing, so researchers investigated different exercises to strengthen these muscles. In a study that examined ways to change the architecture and morphology of the hamstring (Table 3), one group performed hamstring eccentric contraction exercises using Nordic curls, and another group performed hip extensions to see how they affected the hamstring biceps femoris long head fascicle, and both were effective. However, hamstring extension was more effective in producing hypertrophy (31). The muscles around the hip joint are one of the most effective ways to prevent knee-related injuries (32). In a study conducted in Australia, the gluteus muscle was tested using a variety of exercises to determine which produced the most force. The results showed that the gluteus maximus was effective in the loaded split squat, loaded single leg romanian deadlift, and loaded single leg hip thrust, while the gluteus medius was effective in the body weight side plank, loaded single leg squat, and loaded single leg romanian deadlift (33).

Table 3. Hip-related injury.

Study	Measurement & Method	Results
Hip and Groin Injuries in Athletes	Muscle strains, Contusions, Avulsions, apophyseal injuries, Hip dislocations, and subluxations, Acetabular labral tears and loose bodies, Proximal femur fractures, Sports hernias and athletic pubalgia, Osteitis pubis Bursitis, Snapping hip syndrome, Stress syndrome, Osteoarthritis, Other disorders, Lumbar spine abnormalities Compression neuropathies	
Epidemiology of hip and groin injuries in collegiate athletes in the United States	Data from the 2009-2010 through 2013-2014 academic years were obtained from the National Collegiate Athletic Association Injury Surveillance Program. The rate of hip/groin injuries, the mechanism of injury, time lost from competition, and the need for surgery were calculated.	Hip/groin injuries are most common in sports that involve kicking or skating, and sudden changes in direction and speed. Most hip/groin injuries in collegiate athletes are non-contact, do not result in time lost from competition, and few require surgery.
Impact of the Nordic hamstring and hip extension exercises on hamstring architecture and morphology: implications for injury prevention	NHE[2] and HE[1] training both stimulate significant increases in BFLH[3] fascicle length; however, HE[1]training may be more effective for promoting hypertrophy in the BFLH[3]. BFLH[3] fascicle length was assessed before, during, and after the intervention with a two-dimensional ultrasound.	NHE[2] and HE[1] training both stimulate significant increases in BFLH[3] fascicle length; however, HE[1] training may be more effective for promoting hypertrophy In the BFLH[3]
ACL injury prevention training results in modification of hip and knee mechanics during a drop-landing task	Kinematics and ground reaction forces were collected while each participant performed a drop landing task before and immediately after participating in a 12-week ACL[4] injury prevention training program.	After ACL[4] injury prevention training, participants demonstrated decreased knee extensor moments, increased energy absorption at the hip, decreased knee-to-hip extensor moment ratios, and decreased knee-to-hip energy absorption ratios.
Gluteal Muscle Forces during Hip-Focused Injury Prevention and Rehabilitation Exercises	Each participant performed eight hip-focused exercises (single-leg squat, split squat, single-leg RDL[5], single-leg hip thrust, banded side step, hip hike, side plank, and side-lying leg raise) with and without 12 RM[6] resistance.	The gluteus maximus was loaded with split squat, single-leg RDL[5], and single-leg hip thrust. Gluteus medius was body weight side plank, loaded single-leg squat, and loaded single-leg RDL[5]. The gluteus minimus was loaded with single-leg RDL[5] and body weight side plank. Peak gluteal muscle forces increased by 28–150 N when exercises were performed with only 12 RM[6] external resistance compared with body weight.

Study	Measurement & Method	Results
Recommendations for hamstring injury prevention in elite football: translating research into practice	Specific risk factor (previous hamstring injury, hamstring eccentric strength, weekly speed exposure, hamstring fatigue resistance), general risk factors (acute chronic workload ratio, lumbopelvic hip stability, functional strength, psychosocial factors)	This approach is not wholly evidence-based, but we believe this represents a judicious approach to HSI[7] prevention, which builds on our shared anecdotal experience and remains evidence-informed.
Hip joint range of motion reduction in sports-related chronic groin injury diagnosed as pubic bone stress injury	Internal and external rotation of the hip motion was measured using a goniometer. Athletes with and without symptoms were compared. Chronic groin injury was diagnosed in 47 athletes, with 37 having public bone stress injury. 13 athletes had previous groin injury.	A reduction of internal and external hip range of motion was demonstrated in athletes with public bone stress injury and in athletes who had current symptoms compared to those who had recovered from their groin pain.
Differential diagnosis of pain around the hip joint. Arthroscopy	The origin of the adductor longus at the pubic symphysis has a relatively smaller tendon area than that of the muscular attachment, which may predispose this area to strain. In addition, there is some evidence that athletes with adductor weakness, abductor–adductor imbalance, or decreased preseason hip ROM[9] are more predisposed to groin strain during the season.	Patients may return to sports or other activities after regaining full strength and ROM[9], with resolution of the pain. Given the predisposition to adductor strain in In the setting of muscle imbalance, attention should be Given to preseason adductor strengthening and hip ROM[9] to prevent in-season groin strain injury

[1]: Hamstring extension; [2]: Nordic hamstring extension; [3]: Biceps femoris long head; [4]: Anterior cruciate ligament; [5]: Romanian deadlift; [6]: Repetition maximum; [7]: Hamstring strain injury; [8]: Magnetic resonance imaging; [9]: Range of motion; N: Newton.

Sixteen studies met the inclusion criteria and were included in the narrative synthesis. The studies included varied population characteristics, intervention protocols, and outcome measures, limiting direct comparisons but allowing for the synthesis of common trends. Dynamic stretching was consistently associated with improvements in hip range of motion, with increases ranging from 8% to 15% in several studies. Proprioceptive neuromuscular facilitation techniques demonstrated enhanced flexibility and improved neuromuscular activation, particularly in the hip flexors and extensors.

Foam rolling reduced myofascial stiffness and improved proprioception, which may enhance movement efficiency during dynamic actions like the fente. Eccentric exercises, especially squats and lunges, produced strength gains up to 20% in knee flexor and hip stabilizer muscles, supporting greater stability and control during lunge-type actions. Across the studies, quality assessment revealed that most were of moderate methodological quality, with common limitations including small sample sizes, heterogeneous protocols, and inconsistent outcome measures. Only a few studies included direct measures relevant to fencing-specific performance.

DISCUSSION

Most fencers use a lot of fente movements, which can lead to musculoskeletal problems due to chronic use of fente. Fente involves many muscles of the hip joint, especially those that attach to the pelvic bone, such as the gluteus and hamstring (34). A 2013 study on the speed and distance of the fente showed that elite athletes go farther than non-elite athletes. This is because elite athletes have greater vertical strength. Moreover, when analyzing the fente with a 3D camera and comparing elite and non-elite athletes, it was found that in elite athletes, the knee flexor muscles of the nondominant leg assist in generating power (35). This suggests that the longer the fente, the more advantageous it is, and that the knee flexors of the nondominant leg muscles are important for using much vertical force. In particular, the hamstring is the muscle that is most used, but also the most damaged in most fencers, so it is important to improve its strength through proper stretching and eccentric exercises. Studies involving hamstring eccentric contraction exercises have shown that the rate of re-injury is not dependent on time, but rather on function, and that exercises that involve eccentric contraction of the muscle, such as the Nordic hamstring curl, result in mechanical transduction, which reduces the rate of re-injury (36). Eccentric contraction occurs when a muscle generates excess force, which causes it to stretch. This process is also known as negative work because the muscle absorbs external force as energy (37). Previous research on the effective intensity of eccentric contraction exercises, such as the Nordic curl, has shown that a total of 128 repetitions of Nordic hamstring exercises performed with extra weight beyond body weight in 30 active males helped to lengthen the biceps femoris long head (38). Therefore, training the knee flexor of the nondominant leg to produce eccentric contraction to improve fente performance in fencers seems to have a positive effect (39). Muscle viscoelastic materials have elastic ability, which means they can store and use energy (40). Therefore, stretching the muscles while maintaining passive stiffness is important, but stretching for a long time can affect passive stiffness, which is not recommended for fencers.

Based on these studies, effective warm-up methods for fencing are described in Figure 2. First, it is important to stretch the muscles attached to the hip joint, which are used a lot in fencing, through dynamic stretching because passive stretching should be avoided as it can affect muscle activity and performance. Also, it is important to use eccentric exercises to stretch the most-used muscles as they are stretched. Use the lower extremity to engage the hamstring, the knee flexor, its antagonist, the quadriceps, and the ankle joint muscles. In addition, plyometric exercises can be used to develop elasticity, which is important in fencing, but be careful not to exceed the limits to affect performance. Future research should focus on randomized controlled trials involving fencers and assess warm-up effects using fencing-specific outcomes, such as fente velocity, joint angle control, or electromyogram activation patterns. Standardization of intervention protocols and longitudinal follow-ups will further clarify the long-term efficacy of each method.

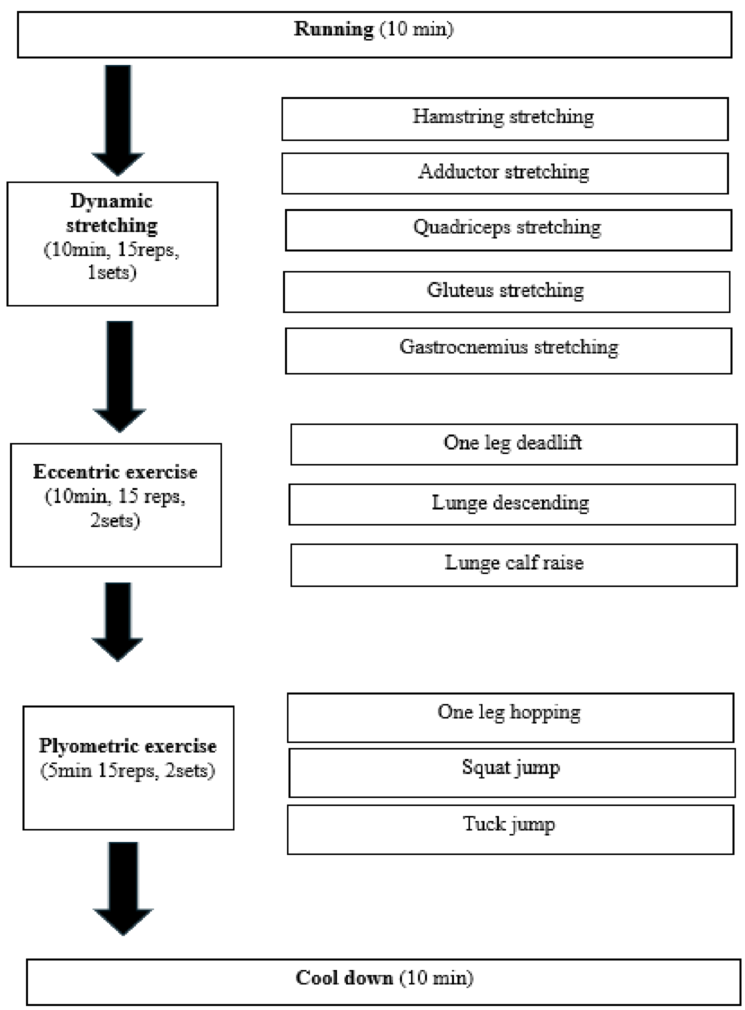

Figure 2. Fencing warm-up program targeted at the hip region of the lower extremity.

CONCLUSION

This review aimed to explore the development of a practical warm-up approach to enhance fente performance in fencing. By analyzing the biomechanics of fente and reviewing related interventions, it was found that improving hip flexibility and strengthening lower limb muscles, particularly through eccentric contraction of the knee flexors, may contribute to improved fente performance by allowing greater movement range. However, the current evidence remains limited. Most studies involved general athletic populations rather than fencers, reducing sport-specific applicability. Protocol variability, small sample sizes, lack of standardized biomechanical outcomes, and limited anatomical justification further constrain the conclusions. The absence of long-term follow-up and potential publication bias also weakens the available evidence. Future research should focus on fencing-specific randomized controlled trials using standardized protocols and objective performance metrics to establish effective and evidence-based warm-up programs tailored to the unique demands of fencing.

APPLICABLE REMARKS

- This study can be compared to previous studies that effectively provided warm-up exercises to perform fente, an attack movement in fencing. Training the knee flexors through extensor contraction improves the performance of fente, and it is important to perform an active warm-up that focuses on the muscles used in fencing rather than a passive warm-up to prevent fencing injuries.

AUTHORS' CONTRIBUTIONS

Study concept and design: Soo-Won Uh, Jung-Hwan Kim. Acquisition of data: Soo-Won Uh, Jung-Hwan Kim, Cheol-Jung Yang. Analysis and interpretation of data: Soo-Won Uh. Drafting the manuscript: Jung-Hwan Kim, Cheol-Jung Yang. Critical revision of the manuscript for intellectual content: Cheol-Jung Yang. Statistical analysis: Jung-Hwan Kim. Administrative, technical, and material support: Soo-Won Uh, Jung-Hwan Kim, Cheol-Jung Yang. Study supervision: Cheol-Jung Yang.

CONFLICT OF INTEREST

There is no conflict of interest.

FINANCIAL DISCLOSURE

This study has no financial interests related to the material in the manuscript.

FUNDING/SUPPORT

This study has no funding or support for the manuscript.

ETHICAL CONSIDERATION

This study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki.

ROLE OF THE SPONSOR

The funding organizations are public institutions and had no role in the design and conduct of the study.

ARTIFICIAL INTELLIGENCE (AI) USE

It did not use AI or AI-assisted tools in the study.

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