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Developing a Specific Training Program to Improve the Lunge Skill of Fencing in University Students

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Abstract

Background and Aims: Fencing is a discipline that requires exceptional agility, quick reaction time, and precise body control, especially when performing essential techniques such as the lunge. As one of the core offensive movements, the lunge enables fencers to swiftly and accurately advance toward their opponent to create scoring opportunities. However, many university students struggle to master this skill, as it demands a combination of refined technical practice and targeted physical training to achieve both power and coordination. Therefore, this research was to develop a specific training program to improve the lunge skill of fencing in university students, and it can be further applied in the club to continue developing the athletes' fencing lunge skill.

Methodology: The population for this research comprises 85 second-year students from the 2024 academic year at Nanfang College, Guangzhou, who have selected fencing as their elective course. All 85 students will participate in a speed test, and 40 students with the lowest scores on the speed test who consent to participate in the research will be chosen as the sample for this study. Using a systematic sampling method, the sample was divided into two groups. 20 students were assigned to the experimental group, and 20 students were assigned to the control group. The training will be conducted for 8 weeks, and 20 students in the experimental group will be trained with a specific training program, while 20 students in the control group will be trained with a traditional training program. Lunge skill tests will be conducted before starting the training, after 4 weeks of training, and at the end of the 8-week training period, to evaluate the effects of the specific training program. Mean, standard deviation, one-way repeated measures ANOVA, Bonferroni post hoc, and independent t-tests were used to analyze the data.

Results: The results showed a statistically significant difference in the post-test lunge skill scores between the experimental and control groups, indicating that the developed specific training program was more effective in improving university students' lunge performance. Furthermore, within the experimental group, significant improvements were observed across all testing intervals, from pre-test to mid-test, pre-test to post-test, and mid-test to post-test, with significant differences at the 0.05 level.

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Conclusion: The specific training program was more effective in improving the lunge skill of fencing in university students.

Keywords: Specific Training Program; Lunge Skill; Fencing; University Student

Introduction

Fencing is a sport with a rich tradition and a long history. Competitions in fencing are categorized into three disciplines: foil, epee, and sabre, each available for both men and women, with individual and team events in each category. The lunge is one of the fundamental movements in fencing, critical to the execution of successful attacks. The effectiveness of a lunge attack is evaluated based on the timing and distance of the lunge itself, as well as the timing, speed, distance, and trajectory of the sword-hand movement. In the correct combat stance, when an opportunity is identified, the distance, speed, angular velocity, and precision of the lunge are essential factors in striking the opponent. Given its importance as a foundational skill, fencing demands a high degree of speed and accuracy in performing the lunge. The ability to master and apply the lunge technique is a key criterion in distinguishing elite athletes in the sport (Peng, D., Guo, L., and Liu, N.L., 2012). Moreover, fencing is a sport that demands a high level of physical agility, speed, and precision, particularly when executing fundamental skills like the lunge. The lunge is a critical offensive technique in fencing, requiring rapid, controlled movement to effectively close the distance between opponents and score points. The ability to execute the lunge quickly is essential for surprising the opponent and scoring points. Sprint training and speed drills are effective in enhancing the overall speed of the lunge (Young, W. et al., 2001). Agility allows fencers to change direction swiftly and maintain balance during the lunge. Agility training, which includes ladder drills and cone drills, helps improve the quickness and fluidity of movement (Sheppard, J. M., and Young, W.B., 2006).

A specific training program that focuses on agility, speed, precision, explosive power, and strength is critical for enhancing the lunge skill in fencing, particularly for university students who are in the process of developing their foundational skills. A specific training program focuses on improving an athlete's ability to perform explosive movements, maintain agility, and react quickly, all of which are essential components of an effective lunge in fencing. The lunge in fencing requires a rapid and forceful extension of the legs to propel the fencer forward. Specific training program includes plyometric exercises that enhance the explosive power of the lower body, enabling fencers to execute faster and more powerful lunges (Miller, M.G. et al., 2006). The ability to react quickly to an opponent’s move is vital in fencing. A training program that improves reaction time by incorporating drills simulating the rapid decision-making required during a bout, enabling fencers to initiate lunges more effectively when an opening is observed (Zemková, E., & Hamar, D., 2013).

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Physical agility, speed, coordination, flexibility, strength, and precision are important to develop lunging skills in fencing. Despite its importance, many university students who participate in fencing struggle to develop the physical fitness required to perform an effective lunge (Ronnestad, B. R., and Mujika, I, 2014). University students often face challenges in developing an effective lunging due to the need for specialized training that integrates both technical drills and physical conditioning. Traditional fencing programs may emphasize the mechanics of the lunge but often lack the structured physical training necessary to enhance the speed, power, and agility required for its execution. This gap in training can lead to suboptimal performance and slower progress in skill acquisition (Bompa & Buzzichelli, 2019).

As mentioned above, current university fencing training still shows several shortcomings that limit the development of an effective lunge. Many programs focus mainly on technique drills while neglecting targeted physical conditioning, resulting in insufficient explosive power, speed, and agility. Training is often generalized rather than fencing-specific, leaving students without the necessary reaction speed and lower-body stability required for high-quality lunges. In addition, feedback tools and individualized training plans are rarely used, causing biomechanical errors to persist and slowing overall skill improvement. These gaps highlight the need for a structured, specific training program designed to enhance lunge performance among university fencers. In conclusion, the lunge skill is considered a fundamental and essential skill in fencing, and the current training still encounters challenges in performing the lunge skill effectively, which affects the university students' overall performance. Therefore, this research seeks to address this gap by developing a specific training program to improve the lunge skill of fencing in university students, and enhancing overall performance in fencing, improving the teaching and learning of fencing at the university level.

Research Objectives

To develop a specific training program to improve the lung skills of fencing in university students.

Literature Review

Fencing

Fencing, a sport with a long and distinguished history, has undergone remarkable development in China in recent decades. Although its origins lie in Europe, the modern disciplines of foil, épée, and sabre were introduced to China in the early 20th century through increased contact with Western countries. In its early years, fencing remained a niche activity practiced mainly by expatriates and students in select academic institutions. After the founding of the People's Republic of China in 1949, the government began promoting a wide range of sports to strengthen public health and enhance China's international image. During this period, fencing started to gain formal recognition through the

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creation of structured training programs and its inclusion in national sporting events, even though its growth was still slower than that of more traditional Chinese sports. China's presence in international fencing gained momentum with its debut at the 1984 Los Angeles Olympic Games. A historic breakthrough occurred in 1992, when Zhang Shanlin won a bronze medal in the men's individual sabre at the Barcelona Olympics, China's first Olympic medal in the sport, which sparked broader national interest and justified increased investment in fencing development (Steffen, K., 2021).

The 2008 Beijing Olympics represented a turning point; Zhong Man's gold medal in men's sabre ended a 24-year wait for an Olympic fencing gold and significantly boosted the sport's visibility across the country. Motivated by this success, China rapidly expanded fencing facilities and established numerous clubs and specialized training centers in major urban areas. Schools and universities also began integrating fencing into physical education programs, providing young athletes with earlier exposure and structured training pathways. To further raise the level of competition, Chinese fencing organizations increasingly sought guidance from leading fencing nations. Partnerships with international coaches, participation in overseas training camps, and exchanges of technical knowledge became integral components of athlete development. This global collaboration has played an important role in modernizing China's training methodologies and strengthening its competitive presence on the world stage (Lu, X., et al, 2022).

Lunge skill

The lunge is a fundamental offensive maneuver in fencing, enabling athletes to swiftly close the distance to their opponent and deliver a decisive attack. Its significance extends beyond mere movement; it encompasses aspects of biomechanics, strategy, and performance optimization. Historically, the lunge has been a cornerstone of fencing technique since the 16th century, evolving into the modern form recognized in contemporary fencing. Its enduring presence in the sport highlights its effectiveness and the necessity for fencers to develop proficiency in this maneuver (Castle, E., 2012).

From a biomechanical standpoint, the lunge is a highly coordinated movement involving multiple joints and muscle groups working in sequence. The action begins with the extension of the weapon arm, which initiates the attack, followed by a powerful push from the rear leg that drives the body forward. Executing this movement effectively requires substantial lower-limb strength and flexibility, particularly in the quadriceps, hamstrings, and hip flexors, to achieve optimal speed, distance, and stability. Research highlights that rapid force production in the legs is a key factor influencing lunge performance; athletes who can generate force quickly can close the distance more rapidly, thereby increasing their offensive efficiency. Targeted conditioning, such as plyometric and resistance training, has been shown to enhance this ability and contribute to more explosive lunges (Chen, TL-W. et al, 2017).

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Tactically, the lunge enables fencers to initiate attacks from a safe distance, reducing the opponent's reaction window and increasing the probability of landing a touch. When executed correctly, the lunge extends reach, improves accuracy, and maximizes the momentum of the attacking action. Fencers frequently adapt the basic lunge to meet specific strategic demands during a bout. For instance, the advance-lunge combines a forward step with the lunge to gain additional ground, while more aggressive techniques such as the fleche use continuous forward momentum to overwhelm an opponent. Mastering these variations allows athletes to respond flexibly to changing tactical situations and enhances their competitiveness (Steward, S.L., and Kopetka, B., 2005).

Due to the explosive and dynamic nature of the lunge, however, fencers face an elevated risk of injuries, particularly in the ankle and knee joints. Proper warm-up routines, mobility training, and strengthening exercises are essential for reducing these risks. Equally important is ensuring that athletes maintain correct technique, as poor form increases the likelihood of strain and decreases overall performance efficiency. Additionally, the ability to recover quickly from the lunge and return to the on-guard stance is crucial for defending against immediate counterattacks. This recovery phase demands agility, balance, and strong neuromuscular control. Psychological readiness also plays a role in executing decisive lunges; repeated practice and successful application in training help build confidence, enabling fencers to employ the movement assertively in competition (Roi, G.S., and Bianchedi, D., 2008).

Explosiveness is critical in fencing lunges. Plyometric exercises such as squat jumps, depth jumps, and resistance band lunges help enhance lower-body power. Research suggests that training programs focusing on eccentric and concentric strength development significantly improve lunge performance in fencers (Turner et al., 2014). Reaction speed and decision-making are vital in fencing. Drills incorporating agility ladders, resistance sprinting, and opponent-driven reaction drills can improve a fencer's ability to execute lunges at the right moment. A study by Guilhem et al. (2014) found that reaction-based training enhanced lunge execution speed by 12% over eight weeks. A well-executed lunge requires excellent balance to avoid counterattacks. Training methods such as single-leg exercises, Bosu ball drills, and core stabilization exercises have been shown to improve postural control, reducing the risk of falls and injuries (Stevens et al., 2017).

A fencer's ability to extend their reach is influenced by their flexibility, particularly in the hip flexors, hamstrings, and ankles. Dynamic stretching, PNF (Proprioceptive Neuromuscular Facilitation) stretching, and mobility drills can increase joint range of motion, leading to greater lunge efficiency (Harmenberg et al., 2019). Since fencing matches involve repeated lunges, endurance training is crucial. Interval training, circuit workouts, and sport-specific drills improve muscular endurance and prevent fatigue, which can compromise lunge performance in prolonged bouts (Baudry et al., 2016). Refining the technique is key to executing an effective lunge. Drills that emphasize controlled movement, foot placement, and synchronized arm-leg coordination improve consistency. Video analysis and motion

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tracking technologies have been used to provide feedback on lunge execution, leading to significant improvements in technique (Williams & Fraser, 2018).

Specific training program

A specific training program refers to a systematically planned set of exercises aimed at improving particular skills, movement patterns, or physical qualities required for a given sport or activity. Unlike general fitness routines, which emphasize overall conditioning, specific training targets the biomechanical and physiological demands of a sport, ensuring that the acquired adaptations directly enhance performance (Bompa & Haff, 2009). In fencing, such programs focus on developing crucial abilities, including lunging technique, footwork efficiency, reaction speed, and muscular endurance through drills that closely reflect actual competitive movements. Guided by the principle of specificity, these training methods replicate the sport's unique demands to optimize skill mastery and performance gains (Verstegen & Williams, 2014).

Moreover, a specific training program emphasizes tailored development rather than broad conditioning. It consists of customized exercises and technical drills designed to enhance the precise physical and skill-based attributes needed for an athlete's role. Unlike general training approaches, which offer wide-ranging but non-specialized improvements, specific training directs effort toward the exact capacities that influence success in a particular discipline. This targeted approach enables athletes to strengthen relevant physiological traits, refine movement mechanics, and build technical proficiency, ultimately leading to more efficient execution of sport-specific tasks (Gjinovci et al., 2017). The design of a specific training program requires careful planning and adherence to fundamental training principles such as specificity, individualization, progression, and periodization. A well-structured program ensures that athletes develop the necessary physical qualities and technical skills while reducing the risk of injury. According to the principle of specificity, training must accurately mirror the muscle actions, energy systems, and coordination patterns utilized in actual performance to yield meaningful and transferable improvements (Haff and Triplett, 2015).

Summary

Fencing in China has grown significantly, especially after Olympic successes and the 2008 Beijing Games, leading to expanded training and international collaboration. The lunge remains a core technique, requiring strength, agility, flexibility, and precision. Research shows that plyometric, agility, flexibility, endurance, and technique-based training improve lunge performance. Specific training programs, built on principles of specificity and progression, are essential for developing fencing skills, enhancing performance, and reducing injury risk.

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Conceptual Framework

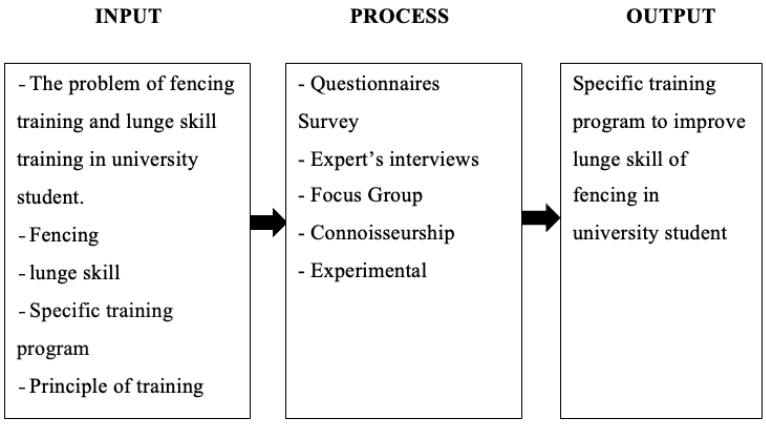


Figure 1 Conceptual framework

Methodology

1. Research Tools

For this study, the following instruments were utilized to conduct the research: (1) Speed test; (2) Questionnaire for students; (3) Interview form; (4) Focus group outline; (5) Connoisseurship outline; (6) Specific training program; (7) Advanced lung test.

2. Population and Sample

The population of this research consists of second-year students of the 2024 academic year at Nanfang College, Guangzhou, who have chosen fencing as an elective course, totaling 85 students. All 85 second-year students of the 2024 academic year at Nanfang College, Guangzhou, who have chosen fencing as an elective course will participate in a speed test. The 40 students who score the lowest on the speed test and agree to participate in the research will be selected as the sample for this research. Using a systematic sampling method, the sample was divided into two groups: 20 students were assigned to the experimental group, and 20 students were assigned to the control group.

3. Data Collection

1. Distribute questionnaires onsite to all 40 university students to investigate the current situation and identify problems related to fencing training and lunge skill development in university students.

2. Invite 7 experts to participate in face-to-face interviews. The experts' interview aims to develop a question framework for the focus group discussions, focusing on elements for developing a specific training program to improve lung skills in university students.

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3. Invite 12 experts to participate in a focus group discussion to develop a specific training program aimed at improving lung skills of fencing in university students.

4. Invite 7 experts to participate in a connoisseurship discussion to confirm and evaluate its appropriateness and effectiveness.

5. Implement the training program over 8 weeks, with sessions scheduled 3 days a week (Monday, Wednesday, and Friday), and 2 hours per day. The experimental group will follow the developed specific training program, while the control group will follow the traditional training program.

6. Both the experimental and control groups will conduct an advanced lunge test before starting the training (pre-test), after 4 weeks of training (mid-test), and at the end of the 8-week training period (post-test).

4. Data Analysis

1. Descriptive statistics, including mean ($\bar{x}$) and standard deviation (S.D.), were used to analyze the data from the questionnaire.

2. Content validity of the questions in the questionnaire for the student and interview form was evaluated using the Indexes of Items of Objective Congruence (IOC). The IOC value of the questionnaire for students = 0.87, and the IOC value of the interview form = 0.90.

3. Experts' interviews, focus group discussions, and connoisseurship discussions were used to conduct content analysis to analyze the data.

4. One-way repeated ANOVA and Post-Hoc were used to analyze the data from the pre-test, the test after 4 weeks of training, and the post-test after 8 weeks of training of the experimental group.

5. An independent t-test was used to compare the test results from pre-test, after 4 weeks of training, and post-test between the experimental group and the control group.

Results

Part 1: Study of the current situation and problems in fencing training and lunge skill performance of university students

The survey involved 85 second-year students from the 2024 academic year at Nanfang College, Guangzhou, who had selected fencing as an elective course. The survey was conducted onsite. The main objective was to identify existing training issues and determine the factors that impact both fencing training and the lunge skill performance of the students. After distributing the questionnaires, the collected data were systematically analyzed to provide insights into the current training conditions and the challenges faced. The following section presents the results of the student survey.

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Table 1 The results of **the** students' questionnaire survey to study the current situation and the problem of fencing training and the lunge skill performance (N=85)

Questionnaire Items	Total Score		Result
	$\bar{x}$	S.D.	
1. The fencing training program adequately covers essential skills (e.g., footwork, blade techniques, and tactics).	2.10	0.60	Poor
2. I receive personalized feedback from my coach during training sessions.	2.20	0.55	Poor
3. The training facilities (e.g., equipment, space) are effective in supporting my fencing development.	3.10	0.58	Moderate
4. I feel confident about my lunge skill in fencing.	1.40	0.52	Very Poor
5. I practice the lunge skill regularly during my fencing training.	2.30	0.50	Poor
6. I find it difficult to execute the lunge skill correctly during training.	4.60	0.45	Highest
7. I have the necessary physical conditioning (strength, flexibility, etc.) to perform the lunge skill effectively.	2.15	0.57	Poor
8. The lunge skill is a key focus of my current training program.	2.00	0.54	Poor
9. I feel that my training sessions are challenging enough to improve my lunge skill.	2.25	0.51	Poor
10. I believe that specific training sessions specifically focused on the lunge skill would improve my performance.	4.70	0.40	Highest
11. I satisfied with the overall quality of my current training sessions.	2.20	0.60	Poor

From Table 1, the results of the students' questionnaire survey to study the current situation and the problem of fencing training and the lunge skill performance, showed that students are not fully satisfied with the current training program and believe that it does not effectively improve their lunge skill. The results of the questionnaire reveal several areas of concern regarding the current fencing training program, particularly in relation to the development of essential skills and the lunge technique. Items such as the adequacy of training in essential skills ($\bar{X}$= 2.10, S.D. = 0.60), receiving personalized feedback ($\bar{X}$= 2.20, S.D. = 0.55), and satisfaction with overall training ($\bar{X}$= 2.20, S.D. = 0.60) were all rated as poor. Additionally, confidence in the lunge skill received a very poor rating ($\bar{X}$= 1.40, S.D. = 0.52), suggesting that many athletes feel underprepared and unsupported in this critical movement. These scores indicate shortcomings in both instructional quality and athlete development support.

In summary, the student questionnaire survey results revealed that students are dissatisfied with the current fencing training program, particularly in relation to the improvement of their lunge skill. They reported that the program does not adequately address key fencing skills,

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provide personalized feedback, or offer sufficient training facilities, with many students rating these aspects as “Poor”.

Part 2: An Expert interview was conducted to gather professional insights into training practices and to identify key components for designing a specific training program to improve the lunges of fencing in university students

From the interview with seven experts, the experts emphasized several key issues regarding fencing training and lunge skill performance. They noted that university training programs often lack individualized attention and structured approaches, particularly in developing fundamental skills like the lunge. Many students struggle with proper technique execution due to insufficient strength, flexibility, and mental focus. The experts recommended a more targeted training approach that isolates the lunge in specific drills, incorporates plyometric exercises for explosive strength, and integrates flexibility training, particularly for the legs and hips. Additionally, they highlighted the importance of personalized feedback and mental conditioning to enhance focus and performance. Overall, a comprehensive, individualized training program focusing on technique, conditioning, and mental preparation was seen as crucial for improving lunge skill in university-level fencing.

Part 3: A Focus group discussion was conducted to develop a specific training program to improve the lunges of fencing in university students, ensuring its relevance and applicability to the needs of university students

The focus group of fencing experts, coaches, and referees provided diverse insights on creating an effective lunge training program. They all emphasized the importance of a balanced approach combining strength, flexibility, and technique. Strength training, particularly for the legs and core, was recommended at the start of each session, followed by flexibility exercises targeting the hips, calves, and hamstrings. Several experts suggested that lunge practice should integrate seamlessly with other fencing movements, like attacks and ripostes, to ensure real-world application. Drills should focus on proper posture, explosive power, and gradual speed development, with some experts stressing the importance of breaking down the movement into phases for better mastery. Consistent practice, with personalized feedback, was also highlighted as crucial for refining technique, especially in addressing common issues such as poor posture, inadequate knee bend, or rushed movements.

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Table 2 The framework of **an** 8-week specific training program to improve the lunge skill of fencing

Week	Details
Weeks 1–2	Foundation Phase – Posture, Flexibility, and Basic Strength Goals: Establish correct posture, basic strength, and joint mobility 1. Warm-up: Dynamic mobility (leg swings, hip circles, arm circles) 2. Strength: Bodyweight squats, lunges, glute bridges, planks 3. Flexibility: Hamstrings, hip flexors, calves (static & dynamic) 4. Technique Drills: - Lunge mechanics without weapon (mirror drills) - Step-lunge transition - Shadow lunging for posture control 5. Cool-down: Static stretching, breathing control
Weeks 3–4	Control & Coordination Phase Goals: Improve control, balance, and lunge initiation 1. Warm-up: Agility ladder + fencing-specific movement 2. Strength: Weighted lunges, single-leg squats, resistance band drills 3. Flexibility: Advanced hip openers, deep lunging positions 4. Technique Drills: - Lunge with target reach - Step-lunge with blade simulation - Lunge and recover (repetitive sets) 5. Footwork Drills: Advance-lunge, retreat-lunge combinations 6. Cool-down: Deep stretching, foam rolling
Weeks 5–6	Power & Speed Phase Goals: Build explosive power and integrate lunge into fencing movement 1. Warm-up: Skipping rope, dynamic stretches, short sprints 2. Strength: - Plyometric lunges, box jumps, medicine ball slams - Core: Russian twists, leg raises 3. Flexibility: Dynamic stretching + yoga flows for hip mobility 4. Technique Drills: - Explosive lunge to marked target - Partner reaction lunge (respond to cue) - Lunge + recovery + parry 5. Cool-down: Hip stretches, breathing recovery
Weeks 7–8	Integration & Application Phase Goals: Integrate lunge with tactical movements under pressure 1. Warm-up: Movement-based warm-up (e.g., fencing footwork patterns) 2. Strength Maintenance: Low-rep, high-intensity sets (e.g., 3x5 box jumps) 3. Flexibility: Maintain full range through dynamic routines 4. Tactical Drills: - Lunge with offensive/defensive blade work (e.g., feint-lunge, parry-riposte-lunge) - Full bout simulations with lunge emphasis 5. Cool-down: Full-body stretch and performance review

A connoisseurship discussion with seven experts was conducted to confirm the appropriateness of the specific training program.

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A connoisseurship discussion was conducted to evaluate the appropriateness and practical applicability of the developed specific training program. The panel included seven experts, who believed that the training program does a good job of addressing the essential physical components of the lunge in fencing, specifically strength, flexibility, and coordination. The program's strength training section effectively targets the legs, core, and hips, which are the most critical muscle groups for a powerful lunge.

Part 4: The effectiveness of the developed specific training program was evaluated through an experimental research design

This research involved an 8-week training period, with sessions held three times a week on Monday, Wednesday, and Friday, each lasting 2 hours. The experimental group participated in the newly developed specific training program, while the control group followed a traditional training program. The evaluation process included administering the advanced lunge test three times: before the training, after four weeks of training, and at the end of the 8-week program. The results from these tests are summarized as follows:

Table 3 Mean and standard deviation of the results of the advanced lunge test of the experimental group

Variables	Experimental Group					
	Pre-test		Mid-test		Post-test	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Lunge distance (cm.)	23.45	3.34	27.40	2.47	30.30	1.49
Formation time (s)	0.64	0.03	0.56	0.04	0.46	0.07

Table 3 shows the results of the advanced lunge test of the experimental group. 1) Lunge distance was pre-test $\bar{X}$= 23.45 and SD = 3.34, mid-test $\bar{X}$= 27.40 and SD = 2.47, and post-test $\bar{X}$= 30.30 and SD = 1.49. 2) Formation time was pre-test $\bar{X}$=0.64 and SD =0.03, mid-test $\bar{X}$= 0.56 and SD = 0.04, and post-test $\bar{X}$= 0.46 and SD = 0.07.

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Table 4 Mean and standard deviation of the results of the advanced lunge test of the control group

Variables	Control Group					
	Pre-test		Mid-test		Post-test	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Lunge distance (cm.)	23.45	3.26	24.60	3.28	25.80	3.66
Formation time (s)	0.65	0.04	0.63	0.05	0.61	0.05

Table 4 shows the results of the advanced lunge test of the control group. 1) Lunge distance was pre-test $\bar{X}$= 23.45 and SD = 3.26, mid-test $\bar{X}$= 24.60 and SD = 3.28, and post-test $\bar{X}$= 25.80 and SD = 3.66. 2) Formation time was pre-test $\bar{X}$=0.65 and SD =0.04, mid-test $\bar{X}$= 0.63 and SD = 0.05, and post-test $\bar{X}$ = 0.61 and SD = 0.05.

Table 5 The comparison between the experiment and control groups with the pre-test results of the advanced lunge test, by t-test independent

Variables	Exp. G		Cont. G		95% Confidence Interval of the Difference		t	p
	$\bar{X}$	SD	$\bar{X}$	SD	Lower	Upper		
Lunge distance (cm.)	23.45	3.34	23.45	3.26	-1.87	1.87	0.89	1.00
Formation time (s)	0.64	0.03	0.65	0.04	-0.02	0.02	0.01	0.83

*P<.05

Table 5 showed that the pre-test results of the advanced lunge test in lunge distance and formation time were not significantly different.

Table 6 The comparison between the experiment and control groups with the mid-test results of the advanced lunge test, by t-test independent.

Variables	Exp. G		Cont. G		95% Confidence Interval of the Difference		t	p
	$\bar{X}$	SD	$\bar{X}$	SD	Lower	Upper		
Lunge distance (cm.)	27.40	2.47	24.60	3.28	25.66	28.01	0.56	0.00
Formation time (s)	0.56	0.04	0.63	0.05	22.42	25.51	0.73	0.00

*P<.05

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Table 6 showed that the mid-test results of the advanced lunge test in lunge distance and formation time pairwise were significantly different, p<.05.

Table 7 The comparison between the experiment and control groups with the post-test results of the advanced lunge test, by t-test independent.

Variables	Exp. G		Cont. G		95% Confidence Interval of the Difference		t	p
	X̄	SD	X̄	SD	Lower	Upper		
Lunge distance (cm.)	30.30	1.49	25.80	3.66	29.11	30.55	0.34	0.00
Formation time (s)	0.46	0.07	0.61	0.05	23.46	26.91	0.82	0.00

*P<.05

Table 7 showed that the post-test results of the advanced lunge test in lunge distance and formation time pairwise were a significant difference, p<.05

Table 8 The comparison of the test results of lunge distance within the experimental group by using one-way ANOVA repeated measurement

Source of Variance (Sov)	df	SS	MS	F	p
Between group	2	43902.150	43902.150	2949.057	0.00*
Within group	17	282.850	14.887		
Total	19	44185			

*P<.05

Table 8 showed that the test results of lunge distance in the experimental group had a significant difference, p<.05, between pre-test, mid-test, and post-test.

Table 9 The comparison of the test results of lunge distance within the experimental group by using the Bonferroni post hoc test

Dependent	Mean	Pre-test	Mid-test	Post-test
		23.45	27.40	30.30
Pre-test	23.45		3.95*	6.85*
Mid-test	27.40			2.90*
Post-test	30.30			

*P<.05

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Table 9 showed that the test results of lunge distance in the experimental group had a significant difference, p<.05, between pre-test and mid-test, pre-test and post-test, and mid-test and post-test.

Table 10 The comparison of the test results of formation time within the experimental group by using one-way ANOVA repeated measurement

Source of Variance (Sov)	df	SS	MS	F	p
Between group	2	0.159	5910.	120.649	0.00*
Within group	17	0.000	0.000		
Total	19	0.159			

*P<.05

Table 10 showed that the test results of formation time in the experimental group had a significant difference, p<.05, between pre-test, mid-test, and post-test.

Table 11 The comparison of the test results of formation time within the experimental group by using the Bonferroni post hoc test

Dependent	Mean	Pre-test	Mid-test	Post-test
		0.64	0.56	0.46
Pre-test	0.64		-0.08*	-0.18*
Mid-test	0.56			-0.10*
Post-test	0.46			

*P<.05

Table 11 showed that the test results of formation time in the experimental group had a significant difference, p<.05, between pre-test and mid-test, pre-test and post-test, and mid-test and post-test.

Summary

This study designed and evaluated a specific training program focusing on agility, speed, precision, explosive power, and strength to enhance the lunge performance of university-level fencing students. Analysis of the pre-test data indicated that there were no significant differences in lunge skill between the experimental and control groups, confirming that both groups had comparable baseline abilities. Following the intervention, post-test results revealed statistically significant improvements ($p < .05$) in the experimental group's lunge distance and formation time, demonstrating that the specific training program was more effective than traditional training methods. In addition, within-group comparisons for the experimental group showed steady and meaningful progress across all assessment points, pre- to mid-test, pre- to post-test, and mid- to

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post-test. These findings provide strong empirical support that the developed program successfully improved lunge skill performance among university fencing students.

Conclusion

The results showed that after 8 weeks of training with the developed specific program, an independent t-test of post-test results confirmed that the experimental group significantly outperformed the control group ($p < .05$). These findings demonstrate that the developed specific training program was more effective than traditional methods in enhancing the lunge skill of university fencing students.

Discussion

The lunge is a fundamental and widely used offensive technique in fencing, allowing fencers to rapidly close the gap between themselves and their opponent while maintaining balance and control. Proper training in lunge execution is vital for improving speed, accuracy, and efficiency, while also minimizing the risk of injury. As a complex movement, the fencing lunge demands a blend of strength, explosive power, coordination, and precision, highlighting the importance of focused training for skill development and performance enhancement.

After completing the 8-week specific training program, students in the experimental group demonstrated a significant improvement in their lunge skill compared to the control group. Post-test results for lunge distance and formation time showed a statistically significant difference ($p < .05$) between the two groups, supporting the conclusion that the specific training program was effective in enhancing the lunge skill of university fencing students. The program focused on developing strength, flexibility, technique, power, speed, and tactical integration. It combined strength training, flexibility exercises, and technical drills to enhance lower-body power, range of motion, and proper lunge mechanics. These findings align with research by Chen, TL-W. et al (2017), which emphasized that the lunge in fencing is a complex movement requiring precise coordination of multiple muscle groups and joints. The movement starts with the extension of the weapon arm, followed by an explosive push from the back leg to propel the body forward. This action requires significant strength and flexibility, particularly in the quadriceps and hamstrings, to achieve the optimal speed and reach. Research has shown that the rate of force development in the lower limbs is a critical factor for effective lunge performance. Fencers who can generate force quickly can execute faster, more powerful lunges. Plyometric and resistance training are key to improving this ability and refining overall lunge technique.

The specific training program incorporated strength training to target lower-body strength and explosive power, which are crucial for enhancing lunge performance. These findings align with Turner

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et al. (2014), who highlighted that lunge skill development in fencing involves a comprehensive approach that integrates strength, speed, balance, flexibility, endurance, coordination, injury prevention, tactical awareness, and mental preparation. An evidence-based, structured training regimen can significantly improve lunge performance and overall competitive success. The lunge movement relies heavily on explosive strength from the quadriceps, hamstrings, glutes, and calves. Studies have shown that lower-limb strength is directly correlated with lunge speed and effectiveness. Key exercises to build this strength include squats (bodyweight, weighted, jump), lunges (stationary, walking, explosive), and plyometric drills (box jumps, depth jumps), all of which enhance power production and movement efficiency. Explosive power is particularly important for executing rapid and powerful lunges. Plyometric exercises such as squat jumps, depth jumps, and resistance band lunges are particularly effective in boosting lower-body power. Research suggests that training programs focused on both eccentric (muscle lengthening) and concentric (muscle shortening) strength development can lead to significant improvements in lunge performance, increasing speed, force, and execution efficiency.

For speed and reaction time aspects, as mentioned above that the specific training program was focused on speed. Therefore, the students also received enough speed training, and after 8 weeks of training, the lunge skill of the students was improved. These findings are consistent with the research conducted by Guilhem et al. (2014), which emphasized that a quick and effective lunge in fencing depends on rapid muscle contraction and efficient neuromuscular coordination. Reaction-based drills are essential for improving a fencer's ability to recognize attack opportunities and execute lunges with precise timing. Research supports that fencing-specific agility training significantly enhances both response time and lunge execution. Key exercises include agility ladder drills, reaction-based lunges (triggered by visual or auditory cues), and sprint intervals, all of which develop explosive acceleration and decision-making speed during bouts.

For flexibility and mobility aspects, because the students are already training in flexibility for 8 weeks, they can improve their lunge skills. These findings are consistent with the research conducted by Harmenberg et al. (2019), which indicated that flexibility in the hip flexors, hamstrings, and ankles is essential for achieving the full range of motion required in an effective fencing lunge. Limited flexibility can restrict movement efficiency and increase the risk of injury. Research shows that dynamic stretching and mobility exercises significantly improve lunging efficiency in fencers. Key exercises include dynamic stretches (e.g., leg swings, lunges with torso twists), PNF (Proprioceptive Neuromuscular Facilitation) stretching, and targeted mobility drills to enhance hip and ankle flexibility, all contributing to smoother and more powerful lunges.

Technical precision and coordination are also critical components for improving lunge skill. These findings align with research by Williams & Fraser (2018), which emphasized that refining the

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lunge technique is key to maximizing efficiency and minimizing unnecessary movement during execution. Drills focused on foot placement, arm-leg coordination, and proper postural alignment help fencers develop more consistent and effective lunges. Motion analysis studies have shown that even minor technical adjustments can lead to significant improvements in lunge performance. Effective exercises for enhancing technique include shadow lunges with a slow-motion focus, video analysis with feedback, and partner drills that emphasize timing and accuracy, all of which promote technical precision and skill refinement.

In conclusion, improving lunge performance in fencing requires a holistic and integrated approach that combines strength, power, speed, flexibility, and technical precision. By incorporating these elements into a specific training program, fencers can significantly enhance their lunge execution, optimize their performance, and gain a competitive edge in match situations.

Recommendation

Recommendation for current research

The research should be conducted across different populations, such as beginner-level or elite university athletes, to validate and refine the program.

Coaches are encouraged to use video analysis and motion capture tools to provide athletes with visual feedback, enabling precise technical adjustments and greater awareness of body mechanics during the lunge.

Recommendation for further research

In addition to physical conditioning, fencing programs should incorporate mental training, including focus drills and decision-making under pressure, to mirror competitive demands and enhance lunge performance in real bout scenarios.

Conduct longitudinal studies to assess the long-term impact of the training program on competition performance, injury rates, and skill retention over multiple semesters or academic years.

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