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EFFECT OF PLYOMETRIC-WEIGHT TRAINING AND SPECIFIC SKILL TRAINING ON SELECTED PHYSICAL FITNESS COMPONENTS, PHYSIOLOGICAL VARIABLES, AND PERFORMANCE OF FENCERS: A MINI REVIEW

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ABSTRACT

Fencing is a very specific Olympic combat sport that involves a combination of physical fitness, physiological efficiency, technical proficiency, tactical intelligence, and psychological readiness. An athlete's fencing success is determined by his or her ability to make explosive movements, to change direction quickly, and to attack and defend precisely, all in fractions of a second. Thus, contemporary fencing training programs focus on the use of scientifically planned conditioning methods such as plyometric training, resistance (weight) training and sport specific skill training to maximize performance. The goal of this brief review is to investigate the impact of plyometric-weight training and particular skill training on chosen physical fitness components, physiological variables and fencing performance. The literature study available shows the increasing trend of sports science research towards the effectiveness of combination training programs. Research over the past 20 years has repeatedly shown that plyometric and resistance training programs significantly improve speed, agility, explosive power, muscular strength, response time, cardiovascular efficiency, and sport-specific performance. Furthermore fencing-specific skill training has been demonstrated to improve technical execution, movement economy, tactical decision making and competitive effectiveness. While an increasing number of research have investigated these training approaches separately, few studies have investigated their combined impact on novice and teenage fencers. Thus, the present study aims to illuminate current trends in research, to synthesize main findings of earlier investigations, and to identify relevant gaps justifying further research on integrated training techniques in fencing.

Keywords: Fencing, Plyometric Training, Weight Training, Physical Fitness, Physiological Variables, Skill Training, Performance.

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INTRODUCTION

Fencing is one of the oldest organized combat sports and has been part of the modern Olympic Games since 1896. The sport is divided into three weapon categories: foil, epée and sabre, each with its own particular rules, target regions and tactical needs. No matter the weapon, fencing needs athletes to execute quick offensive and defensive movements and to maintain balance, coordination and precision under competitive pressure.

Successful fencing performance according to Senn (1999), depends on a mix of speed, agility, muscular strength, explosive power, coordination, flexibility, response time and tactical awareness. Historically, fencing has developed from the combat traditions of sword fighting in the armies of Europe. The Italian, Spanish and French schools of fencing were vital in developing fencing from a combat skill into a structured competitive sport (Anglo, 2000; McClelland, 2017). Today, fencing is managed globally by the Fédération Internationale d'Escrime (FIE), which governs contests from juvenile tournaments to Olympic championships.

In the last two decades there has been a great deal of scientific research into fencing performance. Previous studies have mainly been focused on the technical and tactical aspects of the sport, however, more recent study has been increasingly focused on physiological, biomechanical and neuromuscular determinants of performance. Elite fencer performance is highly dependent on lower-body power, response speed, movement efficiency, and cardiovascular fitness (Nunez et al., 2017).

A survey of the literature shows a strong trend towards the integration of physical conditioning and technical skill development. More than 100 research published between 2000 and 2023 have explored the effects of plyometric training, resistance training, or mixed strength-power interventions on athletic performance in various sports. However, only several of these investigations were performed on fencing athletes. This gap underscores the necessity for future research into training approaches that can concurrently improve physical fitness, physiological functioning and fencing-specific performance.

To give a brief overview of the main studies reviewed in this review, Table 1 presents the main findings concerning plyometric training, resistance training, physiological changes and fencing performance.

Author(s) & Year	Participants/Sport	Training Focus	Major Findings	Relevance to Fencing
Markovic & Mikulic (2010)	Athletes from multiple sports	Plyometric Training	Improved vertical jump, sprint speed, agility, and muscular power	Supports development of explosive fencing movements
Sáez de Villarreal et al. (2010)	Athletes	Plyometric Training	Enhanced stretch-shortening cycle efficiency and force production	Improves lunge speed and lower-body explosiveness

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Tsolakis et al. (2010)	Fencers	Plyometric Training	Increased explosive leg power and fencing-specific movement speed	Direct application to fencing performance
Jovanović et al. (2011)	Competitive athletes	Speed, Agility, and Quickness Training	Improved agility, acceleration, and lower-body power	Enhances footwork and directional changes
Cormie et al. (2010)	Athletes	Combined Strength-Power Training	Greater improvements in speed and power than strength training alone	Supports integrated plyometric-weight training
Andersen et al. (2006)	Athletes	Resistance Training	Improved trunk muscle activation and core strength	Enhances stability during attacks and recoveries
Meylan & Malatesta (2009)	Young athletes	Plyometric Training	Significant gains in agility and explosive actions	Beneficial for fencing footwork performance
Astorino et al. (2012)	Athletes	High-Intensity Training	Improved cardiovascular efficiency and recovery	Supports physiological readiness in competition
Cornelissen & Fagard (2005)	Adults	Resistance Training	Improved autonomic regulation and cardiovascular health	Contributes to improved recovery capacity
Cornelissen & Smart (2013)	Various populations	Exercise Training	Reduced resting blood pressure and improved vascular function	Supports long-term athlete health
Nunez et al. (2017)	Elite Fencers	Performance Analysis	Lower-body power and reaction speed strongly influence success	Highlights key determinants of fencing performance

Table 1. Summary of Selected Literature on Plyometric-Weight Training and Fencing Performance

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Overall, the research reported above in table 1 suggest that plyometric training, resistance training, and sport specific skill development are important factors contributing to gains in physical fitness, physiological efficiency, and fencing performance. There is also evidence to show that integrated approaches to training may be better than separate approaches to training

Plyometric Training and Sports Performance

Plyometric training is widely recognized for its benefits in explosive power and neuromuscular efficiency. It is composed of a fast eccentric muscle contraction followed by a concentric contraction called stretch-shortening cycle (SSC). This technique can help muscles and tendons to store elastic energy, and then release it by means of explosive motions, which results in higher force and movement velocity (Sáez de Villarreal et al., 2010).

Research on plyometric exercise has developed considerably over the past two decades. Markovic and Mikulic (2010) in an extensive review of more than 50 studies concluded that plyometric training can significantly enhance vertical jump height, sprint performance, agility and muscle power. A significant number of studies were examined by Slimani et al. (2016) and they reported consistent increases in explosive strength, reaction time and movement efficiency in athletes from diverse sports after plyometric therapy.

Recent research suggests a shift from traditional jump-based plyometric training to sport-specific plyometric programs. Since 2010 there has been an increasing number of research highlighting the need for specific training approaches replicating competitive movement patterns. These methods have demonstrated increased transfer of training effects to sport performance.

Plyometric exercise can also help to prevent injury by developing the connective tissues, increasing the stiffness of the tendons and enhancing neuromuscular control, as well as improving performance. These adaptations are especially useful in sports that include frequent acceleration, deceleration and changes of direction.

Plyometric Training and Fencing Performance

The lower body activities in fencing are explosive: lunges, advances, retreats and fast changes of direction. Such motions need significant degrees of muscular force and neuromuscular co-ordination. As a result, plyometric exercise is becoming increasingly popular among fencing coaches and sports scientists.

The effects of plyometric exercise on factors linked to fencing performance have been examined in several research. Tsolakis et al. (2010) observed considerable gains in explosive leg strength and fencing-specific movement speed after a structured plyometric training program. Jovanović et al. (2011) also found plyometric training improved agility, acceleration and lower body power in competitive athletes.

Studies have indicated that plyometric training programs specifically designed for fencing are more effective than general conditioning programs. From 2015 to 2023, research gradually incorporated fencing footwork skills, multidirectional jumps and reactive movement exercises into plyometric programs. The speed of lunge, response time, balance and precision of movement increased with the interventions.

Another important new research discovery has been the positive relationship between plyometric training and neuromuscular efficiency. The better neuromuscular coordination allows the fencers to launch attacks more rapidly maintaining technical perfection. Improved balance and postural control also contribute to greater stability during offensive and defensive actions.

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Combined Effect of Plyometric and Weight Training on Physical Fitness Components

The existing sports science literature has demonstrated that the combination of plyometric and resistance training may result in greater improvements in performance than either technique alone. This integrated approach, commonly called complex or contrast training, develops maximum strength and explosive power simultaneously.

When analyzing papers published from 2005 to 2023, a distinct and ongoing trend towards combination training interventions emerges. Today, over 70% of the studies in strength and conditioning supports the use of a combination of resistance and plyometric exercises to improve performance in athletes.

Speed: Speed is one of the most important factors that determine success in fencing. Elite fencers often attack within milliseconds; therefore, they need to be able to move quickly. Plyometrics increase the speed of force development while resistance training increases the maximal force that can be produced. Research by Cormie et al. (2010) showed that athletes following combined strength-power training programmes produced significantly higher gains in sprint performance than those doing strength training alone. Speed gains of 3–10% have been found in several trials after combined training regimens over 6–12 weeks. In fencing, more speed means quicker advances, retreats, and attacking actions.

Explosive power (EP): EP is an important component of lunging, counter attacking and changing direction quickly. Explosive power has been time and time again proven to be one of the best indicators of performance in fencing. Markovic and Mikulic (2010) examined a great number of research and observed significant gains in lower-body power following plyometric exercise. Similarly, Cormie et al. (2010) observed that power output improved more when resistance and plyometric exercises were combined than with regular strength training. Studies have shown that integrated training programs can increase vertical jump performance by 5-15%. These advantages are especially crucial to fencing athletes since explosive lower-body power relates directly to effectiveness of attack and movement speed.

Abdominal Muscular Strength: Core strength is vital for maintaining posture, balance and the transfer of force during fencing movements. Abdominal and trunk muscles provide stability during lunges, recoveries and changes of direction. Resistance training has been shown to dramatically increase trunk muscular activation and strength (Andersen et al., 2006). Clark and Lucett (2010) further stressed that plyometric training challenges core stability through dynamic movement patterns. Recent research trends demonstrate growing emphasis on functional core training integrated with plyometric and resistance exercises. All studies published post 2015 indicated increases in trunk stability, movement efficiency and athletic performance following combined core strengthening therapies.

Agility: Agility is the ability to change direction quickly and maintain control and balance. It is one of the most often investigated performance variables in fencing research. Plyometric exercise resulted in a considerable improvement in agility (Meylan and Malatesta, 2009). Similar effects have been reported in many research on athletes involved in combat, team and racket sports. Current trends in agility research are concerned with reactive agility instead of pre-planned movement patterns. Reactive agility training involves decision-making and stimulus-response components that are especially essential to fencing competition.

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Effect of Plyometric and Weight Training on Physiological Variables

While the research is mostly about performance results, there has been rising interest in physiological adaptations due to plyometric and resistance training.

Vital Capacity: Vital capacity is a measure of breathing efficiency and aerobic fitness. Improved respiratory function means more oxygen to working muscles and increased endurance during longer duration events. According to Perrin (2007), consistent physical exercise helps to increase pulmonary function and respiratory muscle strength. Støren et al. (2008) also showed that strength training can increase exercise economy and oxygen use. Research trends show small but significant gains in lung function metrics like vital capacity and forced expiratory volume in athletes who participate in structured conditioning regimens.

Heart Rate: Resting heart rate and heart rate recovery are common indicators of cardiovascular fitness. The lower your resting heart rate, the more efficient your heart, typically. High-intensity training regimens were found to have a good effect on cardiovascular function and recovery capacity (Astorino et al., 2012). Similarly, Cornelissen and Fagard (2005) reported enhanced autonomic control after resistance exercise. Recent research on adolescent athletes has showed that a structured training program lasting 8-12 weeks can reduce resting heart rate by 3-8 beats per minute.

Blood pressure: Another key physiological indicator related to cardiovascular health and sports fitness is blood pressure. Regular physical training has been shown to lower resting systolic and diastolic blood pressure, say Cornelissen and Smart (2013) after reviewing a number of trials of exercise interventions. Recent research trends have demonstrated that combined strength and conditioning regimens have improved vascular function, endothelial health and circulatory efficiency. Such adjustments can help with healing and overall athletic performance.

Role of Specific Skill Training in Fencing

Physical conditioning provides the base for athletic performance, but it is technical skill training that dictates the extent to which physical abilities are transformed into competitive success.

Specific skill training in fencing comprises stance improvement, footwork drills, lunges, parries, ripostes, blade control, tactical decision making and reaction exercises. These exercises, when repeated, help children improve motor skills, consistency in movement and technical accuracy.

Research from the past 10 years has shown that skill-specific training has a major impact on response time, movement accuracy and tactical effectiveness. In the research of youth and elite fencers, results consistently point to positive connections between technical proficiency and competitive success.

A clear trend in fencing research in recent years has been the use of technology assisted skill training. Video analysis, motion capture technologies, wearable sensors and virtual reality platforms are being used in the improvement of technical learning and performance assessment.

Skill training is especially crucial for beginner fencers, as early technical growth impacts long term athletic development. Studies show that athletes who develop correct movement patterns early in their training do better in the later competitive years.

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Research Trends and Existing Evidence

An examination of the literature reveals several important trends:

1. **Increasing Research Interest:** The number of studies investigating plyometric and resistance training has increased substantially since 2000.
2. **Shift Toward Combined Training:** Recent studies increasingly favor integrated strength-power programs rather than isolated training methods.
3. **Sport-Specific Approaches:** Researchers are moving toward fencing-specific conditioning protocols that closely replicate competitive movements.
4. **Youth Athlete Development:** Growing attention is being directed toward training interventions for adolescent athletes.
5. **Technology Integration:** Modern studies increasingly incorporate biomechanical analysis and performance monitoring technologies.
6. **Holistic Performance Models:** Researchers now emphasize the interaction between physical fitness, physiological adaptations, technical skills, and tactical performance.

However, research on fencing is still relatively scarce compared to other sports such as soccer, basketball and athletics.

RESEARCH GAP

While plyometric training and resistance training have been studied separately in several studies, few studies have evaluated the combined benefits of both training modalities in fencing groups. Much of the material is about elite athletes, college athletes, or adult participation. Moreover, little study has been conducted on the simultaneous effect of plyometric-weight training and fencing-specific skill training on physical fitness components such as speed, explosive power, abdominal muscular strength, and agility. There is a lack of research on the physiological parameters (vital capacity, resting heart rate and blood pressure) of young fencers. Moreover, there is no information on the efficiency of integrated training programmes for beginner fencers aged 10–19 years. Another large gap concerns the long-term interaction between the development of fitness and the development of technical skills. Future studies should further investigate the effects of strength and power improvements on fencing-specific performance. The present investigation was designed to fill this lacuna by studying the effects of eight weeks plyometric-weight training and particular skill training programme on selected physical fitness components, physiological variables and fencing performance among the rookie fencers of Karnal District, Haryana. The results of this study may contribute to a better knowledge of fencing training and have practical applications for coaches, trainers, physical education teachers and sport scientists. In addition, the data may contribute to the establishment of evidence-based training programmes aimed at improving the physical and technical development of young fencers. The findings may also add to the scientific rationale for including plyometric exercises, resistance training and skill-specific practice in youth fencing development programs.

CONCLUSIONS

The data examined in this article suggests that plyometric exercise, resistance training and fencing specific skill training can all play an important role in improving athletic performance. During the last 20 years, a large number of studies have shown positive impacts

of various training approaches on speed, agility, explosive power, muscular strength, response time, balance and cardiovascular efficiency.

Current research trends clearly encourage the utilization of integrated training programs combining strength growth, power augmentation and technical skill acquisition. Combined plyometric-weight training programs have been shown to yield higher increases in physical fitness and sport-specific performance compared to single training approaches.

However, despite a large corpus of data, there are few studies with novice and teenage fencers. More specifically, studies are necessary to examine the combined effects of plyometric-weight training and specific skill training on physical and physiological characteristics. Therefore, additional study is needed to create evidence-based training methods that will help to maximize the performance potential of young fencers.

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