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Evaluating the Predictive Power of Pre-Competition Physical Fitness Tests on Fencing Performance in Fencing Tournaments

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AUTHOR BIOGRAPHY

Xilong Lin is a senior at Fairmont Preparatory Academy in California. He is interested in applied mathematics, sports science, and fencing, and hopes to continue research connecting data analysis with athletic performance.

ABSTRACT

This study investigates the relationship between pre-competition physical fitness test results and competitive performance in elite fencing. Using data from the 2025 Chinese National Fencing Tournament, we analyzed standardized physical test scores, including total fitness scores and individual components, to evaluate their predictive power for athletes' national rankings. Multiple linear regression results showed that the full set of fitness measures was not a significant predictor of performance ($R^2 = 0.063$, $p = 0.2165$). However, two individual indicators, lunge depth and firm fork index (a measure of split flexibility and lower body control), were significantly associated with better competitive rankings ($p = 0.025$ and $p = 0.0043$, respectively). Total fitness score and 400 m run performance approached significance, suggesting potential secondary effects of overall conditioning and anaerobic capacity. These findings highlight the importance of lower body flexibility, reach capacity, and explosive control in high-level fencing, suggesting that training programs should prioritize enhancing these attributes alongside technical and tactical development. These results offer practical implications for coaches and trainers by highlighting specific physical attributes that may be prioritized in training and athlete evaluation. More broadly, the findings demonstrate how integrating performance data with sport-specific biomechanics can improve the effectiveness of standardized testing systems in competitive fencing.

Keywords: *Fencing performance; Pre-competition physical fitness tests; Lower body flexibility; Regression analysis; Lunge depth; Firm fork index; Athlete assessment; Sports science.*

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INTRODUCTION

Fencing is a sport that demands a unique combination of agility, endurance, strength, and strategic thinking. While technique and experience are crucial, physical fitness remains a foundational factor that supports high-level performance, especially during long matches and tournaments. In many parts of the world, athletes undergo a standardized pre-competition physical fitness test before major events. However, whether these test results accurately reflect or predict competitive success remains an open question. This study investigates the relationship between the total score of these fitness tests and the athletes' final rankings in the 2025 Chinese National Fencing Tournament.

BACKGROUND

Fencing is a highly dynamic and strategic sport that requires athletes to integrate explosive power, agility, endurance, coordination, and mental acuity, with elite athletes demonstrating distinct physical and neuromuscular profiles compared to non-elite performers (Hekiert et al., 2025). While tactical thinking and technical precision are central to success, an athlete's physical conditioning often determines whether they can execute their strategies effectively, especially under fatigue and pressure in tournament settings. As a result, physical fitness is considered a crucial foundation for competitive success in fencing. Among the various components of physical conditioning, some aspects stand out to be the most critical attributes in high-level fencing.

Explosive Power

Explosive power is critical in fencing, especially for executing lunges and rapid directional changes. The fencing lunge has been identified as a central biomechanical action that largely determines reach, attack timing, and offensive effectiveness in competitive bouts (Chen et al., 2017). Previous research has consistently demonstrated that lower-limb power plays a decisive role in fencing performance. Tsolakis et al. (2010) found that tests like squat jump and drop jump significantly predicted lunge time and distance. Similarly, Turner et al. emphasized that elite fencers need to accelerate their center of mass in a short time, highlighting explosive power and reactive strength as key elements.

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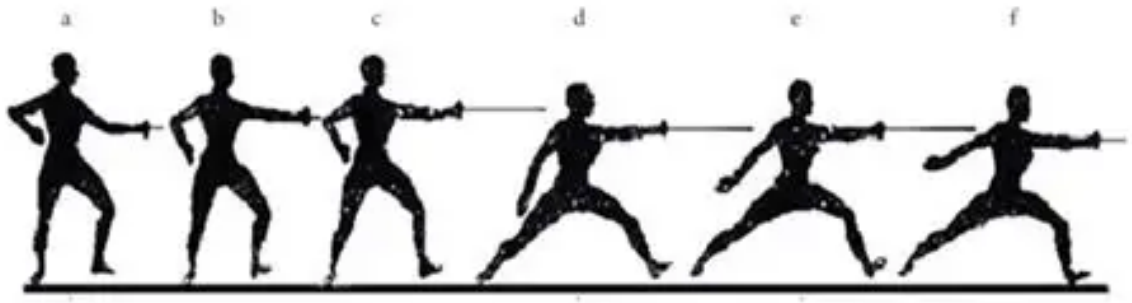
Figure 1 Fencing Lunge



Note. From "Evaluation Algorithm of Fencing Athletes' Strength Distribution Characteristics Based on Gait Tracking," by Z. Fei and C. Zhao, 2022, Mobile Information Systems (https://doi.org/10.1155/2022/3602776). Licensed under CC BY 4.0.

Agility and Coordination

Agility and coordination enable fencers to adapt their footwork and blade movement rapidly in response to opponents. Agility training improves reaction time and directional speed, essential for multiple-action bouts. Research on other sports shows core strength contributes to faster directional changes in agility tests (Horníková, 2024). Additionally, a study on young fencers reported strong correlations among lower-limb power, agility, core stability, and grip strength, highlighting coordination between trunk and limb movements (Prachi Sarvaiya, 2022).

Core Strength and Stability

Core strength and stability play a central role in transferring force from lower to upper limbs and maintaining balance during explosive fencing movements. Core-focused training significantly increases lunge speed and agility, though effects on explosive force may vary depending on the regimen. Core training also indirectly improves fencing-specific techniques by enhancing trunk control and stabilizing posture (Petra Magyar, 2021).

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Figure 2 Back Muscle Endurance

Note. Screenshot from a TikTok(Chinese version) video by @kong2020xw, posted January 31, 2025

Figure 3 Abdominal Muscle Endurance

Note. Screenshot from a TikTok(Chinese version) video by @kong2020xw, posted January 31, 2025

Flexibility

Flexibility enhances range and reduces injury risk, particularly during full-extension lunges and low body positions. Ülkü et al. (2024) identified significant relationships between balance, flexibility (via sit-and-reach tests), and standing long jump in young fencers. Moreover, lunge performance was found to depend on a combination of force production and joint flexibility (Charilaos Tsolakis, 2010).

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Figure 4 Firm Fork

Note. Screenshot from a TikTok(Chinese version) video by @XX181329, posted October 4, 2025

Anthropometry and Body Weight

Anthropometry and body weight influence fencing biomechanics through variables like body composition, limb length, and mass. Tsolakis et al. found that leg muscle cross-sectional area and percent body fat predicted lunge time and shuttle speed, whereas static body measures like height were less significant. Body weight may affect the dynamics of center of gravity during lunges and footwork.

Other Factors

While these physical attributes are important, research by Hui Han (2024) and Giulio Sergio Roi (2008) suggests that fencing performance is also strongly shaped by tactical decision-making, psychological readiness, and strategies specific to matches. Technical mastery, mental adaptability, and strategic control interact closely with physical fitness to determine competitive success, particularly under high-pressure tournament conditions.

Finally, recent work by Luke W. Oates (2023) described fencing as a high-intensity, intermittent sport, requiring repeated bursts of explosive effort combined with strong recovery capacity to sustain performance across multiple bouts within a competition day. These findings highlight the physiological complexity of fencing

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and the need to examine how different aspects of physical fitness influence performance outcomes.

RESEARCH GAP AND PURPOSE

While previous studies have provided valuable insights into specific factors influencing fencing performance, several critical gaps remain. Oates, Price, and Bottoms (2023) highlighted that fencing is a high-intensity sport requiring repeated short bursts of explosive effort combined with recovery capacity, suggesting that future studies should integrate multiple dimensions of performance rather than focusing on isolated metrics. Shen and Wei (2024) analyzed the biomechanics of lunges and demonstrated that flexibility and lower-limb force production are key determinants of reach and reaction efficiency, but their study did not examine how these biomechanical measures translate into actual competitive rankings. Similarly, Roi and Bianchedi (2008) emphasized that fencing performance depends not only on physical conditioning but also on technical skill, tactical adaptability, and psychological resilience. Han and Wang (2024) further showed that psychological readiness and mental adaptability significantly affect outcomes in high-level competitions.

Despite these findings, few studies have quantitatively evaluated the predictive validity of standardized pre-competition physical fitness testing on real world competitive results. In China, athletes experience comprehensive assessments designed to evaluate strength, speed, flexibility, endurance, and coordination, yet there is limited empirical evidence showing whether these test scores, either individually or in total, can reliably predict success in national level fencing tournaments. Addressing this knowledge gap is essential for improving athlete evaluation systems, optimizing training priorities, and informing future research. Our study responds to this need by examining the relationship between pre-competition physical fitness scores and actual fencing performance outcomes, thereby providing empirical evidence to support a more data-driven approach to athlete development.

METHODOLOGY

Research Design

This study adopts a quantitative research design using secondary data analysis to investigate the relationship between pre-competition physical fitness and fencing performance in Chinese national tournaments. Given the numerical nature of the data (e.g., fitness test scores and competition rankings), a quantitative approach is appropriate for identifying statistical patterns and internal associations. The core analytical method employed is linear regression, which allows us to examine how different physical fitness indicators, both individually and in combination, predict fencing performance outcomes. Secondary data analysis is appropriate here because the existing dataset comprehensively covers the relevant variables and participant population needed to address the research questions.

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Data Source

The dataset used in this study was collected for the 2025 Chinese National Fencing Tournament. It includes athletes' results from a standardized pre-competition physical fitness assessment and their official national rankings. The data were originally collected by China's Fencing Association to evaluate athletes' physical readiness and help national team selection processes. This dataset is highly relevant to the study's aims, as it links structured physical fitness testing with real world competition outcomes. However, potential limitations include a lack of diversity (e.g., most participants are elite level athletes), missing values in some indicators, and possible unobserved confounding variables such as psychological readiness or prior injury history.

Variables and Measures

The dependent variable in this study is each athlete's competition performance, measured by their national ranking in the tournament (rank 1 = best). The independent variables include both the total fitness test score and the scores from individual physical fitness components, as shown in Table 1 below.

Table 1
Dataset Sampling

Name	Total_Score	Weight	Back_Muscle_Endurance	Abdominal_Muscle_Endurance	Run_5km	Lunge_Depth	Firm_Fork_Index
Tian Yangqianli	83.5	10	10	10	10	10	8
Zhang Ganggang	80.5	10	10	10	5	10	9
Shi Siyu	80	9.5	10	10	8.5	10	6.5
Chen Jian	80	10	10	10	6	10	7.5
Chen Lizihan	79.5	10	10	10	5.5	10	7.5
Zhang Fengrui	79	10	10	10	8	10	6.5
Zhuang Yan	78	10	10	10	6	10	9
Chang Ganglin	78	10	10	10	5.5	9	9

Double_Unders_Skipping	Run_400m	Run_60m	Standing_Long_Jump	Peak_Power	National_Ranking
8.5	9.5	7.5			#N/A
10	7	9.5			#N/A
8	10	7.5			90
7.5	10	9			91
7.5	10	9			#N/A
7	9.5	8			144
10	6.5	6.5			#N/A
6.5	8.5	9.5			144

All scores were obtained through standardized physical assessments conducted by trained personnel. The variables are numeric and continuous, making them suitable for regression analysis. These variables were selected because they reflect key physical capacities required in fencing, such as strength, agility, and endurance,

and align with the research questions.

Data Preparation

The dataset included multiple athlete categories: youth male, youth female, adult male, and adult female. These groups were first merged into a single dataset for unified analysis. The combined data were then sorted in descending order based on the total fitness test score. Before sorting, rows with missing values in key variables were removed, and data entries were screened for outliers to ensure accuracy.

Data Analysis Procedures

To examine the relationship between physical fitness and fencing performance, this study applied a combination of descriptive and inferential statistical methods. Descriptive statistics (mean, standard deviation, range) were used to summarize the distribution of fitness test scores and competition rankings. ANOVA tests assessed whether specific fitness indicators differed significantly across athlete performance groups (e.g., top vs. lower ranks).

To evaluate predictive relationships, both single variable and multiple linear regression models were built. Single variable regressions identified simple correlations between individual fitness components and ranking, while multiple regression assessed the independent effect of each fitness variable when controlling for others.

All analyses were performed using the R programming language, which provides powerful tools for statistical modeling and visualization. Regression methods were chosen because they quantify the strength and direction of associations between predictors and outcomes, allowing for a nuanced understanding of how fitness components relate to fencing success.

RESULTS

To investigate the relationship between pre-competition physical fitness and fencing performance, both multiple and simple linear regression analyses were conducted using national ranking as the outcome variable.

Multiple Linear Regression

A multiple linear regression model incorporating all eight physical test variables was performed. The model was not statistically significant ($F(8,161) = 1.363$, $p = 0.2165$), with a low coefficient of determination ($R^2 = 0.063$), indicating that only 6.3% of the variance in national ranking could be explained by the full set of

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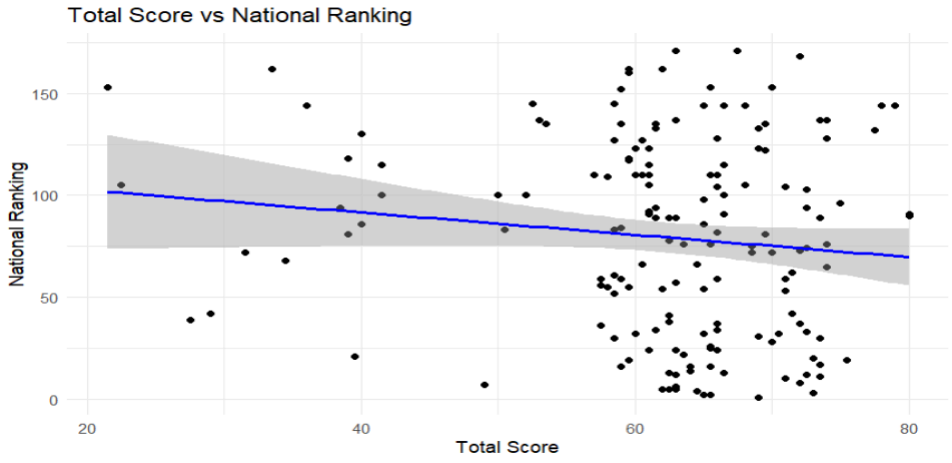
physical fitness variables. No individual predictors in the model reached statistical significance ($p > 0.05$), suggesting limited predictive power when considered jointly.

Figure 5
Total Score vs National Ranking



Single Linear Regressions

Each test indicator was further analyzed individually using simple linear regression:

Lunge depth was significantly negatively associated with national ranking ($\beta = -3.99$, $p = 0.025$), indicating that greater lunge capacity predicted better competitive outcomes.

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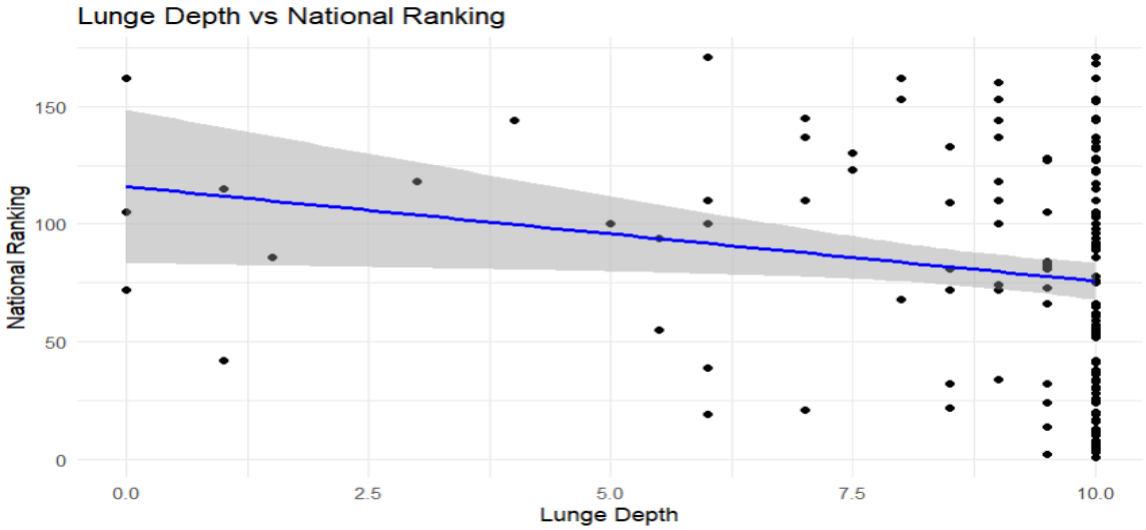
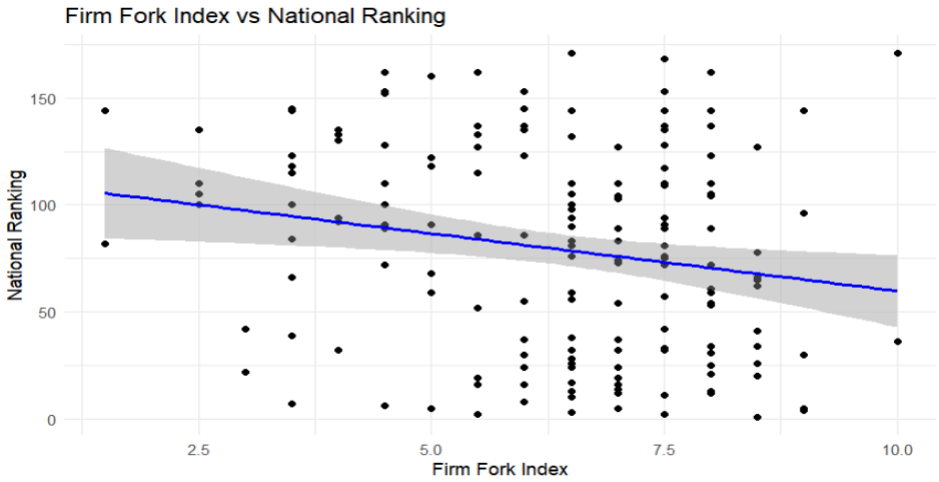
Figure 6
Lunge Depth vs National Ranking



Firm fork index (split flexibility) also showed a significant negative relationship with national ranking ($\beta = -7.04$, $p = 0.0043$), suggesting that superior lower body flexibility and control may enhance competitive performance.

Figure 7
Firm Fork Index vs National Ranking



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Total physical score approached significance ($\beta = -0.57$, $p = 0.0899$), suggesting that overall physical condition may have some influence. Additionally, the 400 m run performance was marginally associated with ranking ($\beta = -2.21$, $p = 0.0514$), indicating a possible trend linking anaerobic endurance in speed with success. Lastly, other variables, including body weight, muscular endurance, 5 km run, and 60 m sprint, did not show statistically significant associations with national ranking (all $p > 0.1$).

DISCUSSION

This study examined the relationship between pre-competition physical fitness test results and national fencing performance rankings. The findings revealed that while the full set of physical tests was not a significant predictor of competitive performance, two specific measures, lunge depth and firm fork index (which are both related to split flexibility), were significantly associated with national ranking.

The lack of significance in the multiple regression model ($R^2 = 0.063$, $p = 0.2165$) suggests that, in elite level fencing, overall performance cannot be explained solely by aggregated physical measurements. This aligns with previous research indicating that technical skill, tactical decision-making, psychological readiness, and strategies specific to matches often contribute more to performance outcomes than general physical condition alone (Hui Han, 2024; Giulio Sergio Roi, 2008). The relatively low explanatory power may also be attributed to collinearity among physical test variables, which could dilute the unique predictive contribution of individual measures in a multivariate context.

The significant association between lunge depth and ranking supports the importance of lower body reach and explosive extension in fencing. A deeper lunge enables athletes to cover greater distance quickly and initiate attacks from a safer distance, potentially reducing exposure to risks of being counter attacked. This result is consistent with prior studies emphasizing the role of lower-limb biomechanics in enhancing offensive reach and reaction efficiency (Shen Wei, 2024).

Similarly, the firm fork index, a measure of lower body flexibility and control, was significantly related to better rankings. Flexibility in the hip and hamstring regions not only allows for more efficient lunging but also facilitates rapid recovery to the “on guard” position, aiding both offensive and defensive transitions. The significant correlation suggests that dynamic flexibility, as opposed to static endurance or maximal strength, may play a critical role in the fluid execution of fencing techniques.

While total physical score and 400 m run performance were not statistically significant, they approached the threshold for significance, suggesting that aerobic-anaerobic transition capacity and overall conditioning may still have an indirect influence on competition outcomes. This aligns with previous findings that fencing demands both repeated short bursts of explosive effort and recovery capacity over the course of multiple bouts in

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a competition day (Luke W Oates, 2023).

However, certain variables, such as back muscle endurance, abdominal muscle endurance, and sprint performance, did not show meaningful relationships with ranking. This may indicate that while core stability and short distance speed are necessary abilities for fencers, they may not differentiate competitive outcomes among elite athletes who already possess high levels of these qualities.

Several limitations occurred. The sample size was relatively small, potentially limiting statistical power. Additionally, competition performance is influenced by numerous non-physical factors, such as tactical adaptability, mental resilience, and opponents' characteristics, that were not captured in this study.

CONCLUSION

This study highlights the critical role of lower body flexibility, reach capacity, and dynamic control, as represented by lunge depth and firm fork index, in determining competitive success among elite fencers. While overall physical fitness contributes to fencing readiness, these specific attributes appear to better cause differences in performance outcomes. Future research should measure biomechanics in live bouts, tracking movement and force in attacks and defenses, and include mental factors like readiness, decision speed, and stress control to better explain performance. Moreover, containing samples from multiple events across athlete levels will increase generalizability.

For coaches and athletes, these findings suggest that enhancing lower body flexibility, optimizing lunge mechanics, and improving explosive power should be prioritized in training. At the same time, balanced development of aerobic and anaerobic conditioning remains essential for sustaining performance throughout competition days. By combining targeted physical preparation with ongoing improvement of technical and tactical skills, fencers may maximize both physical readiness and competitive success.

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