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Age-Related Performance Trends in Fencing: A Comparative Analysis

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Abstract: This study investigates the effects of age on fencing performance across three categories: youth (13-18 years), junior (19-23 years), and senior (24+ years), with data collected from 30 fencers in national-level competitions. The results revealed significant differences in performance characteristics across the age groups. Youth fencers, still in the early stages of their careers, exhibited a higher frequency of technical errors due to their developing skills and limited experience in competitive environments. However, they demonstrated a strong willingness to learn and adapt. Junior fencers, with more experience and additional training, showed improved tactical awareness and decision-making, though their physical conditioning and reaction times were still maturing, which limited their performance in high-intensity situations. Senior fencers, the most experienced and physically conditioned group, displayed superior fitness, strategic decision-making, and reaction times, along with advanced technical proficiency honed over years of training and competition. These findings underscore the importance of age-specific training programs that cater to the unique strengths and weaknesses of each group, providing valuable insights for coaches and trainers to maximize the potential of fencers at every stage of their development. I begin by selecting 30 fencers to work with and gather data from five National Fencing Championship tournaments, recording clips using a 4K Sony camera and a Samsung Galaxy S7 Tab for live analysis. These clips are then transferred to a laptop for storage. I extract both qualitative and quantitative data from the footage using Dartfish Pro S software, and analyze and visualize the data in MS Excel, categorizing it by age group. I collaborate with the coach to discuss the fencers' strengths and weaknesses, presenting the findings positively to help athletes recognize their qualities. We address weaknesses, set performance benchmarks, and track progress. Additionally, I collect testing data from supporting staff in areas such as biomechanics, physiology, psychology, and biochemistry, visualizing this information to show progress through graphs. Finally, the calculated data is compiled into a PowerPoint presentation for research paper submission. These findings underscore the necessity of age-specific training programs and competition strategies, offering valuable guidance for coaches, trainers, and athletes aiming to optimize performance. These findings underscore the necessity of age-specific training programs and competition strategies, offering valuable guidance for coaches, trainers, and athletes aiming to optimize performance.

Keywords: performance analysis, fencing, age related performance, performance trends

INTRODUCTION

Fencing, often referred to as "physical chess," is a dynamic combat sport that combines physical agility, mental acuity, and strategic decision-making. With origins tracing back to medieval swordsmanship, modern fencing has evolved into a highly technical Olympic sport governed by the Fédération Internationale d'Escrime (FIE). It encompasses three distinct disciplines—Épée, Foil, and Sabre—each characterized by unique rules, target areas, and tactical approaches.

Performance in fencing is influenced by a multitude of factors, including physical fitness, technical proficiency, psychological resilience, and the ability to adapt to opponents' strategies. These factors can vary significantly across different age groups, making age a critical variable in understanding and optimizing performance trends. Younger athletes often exhibit greater physical speed and endurance, while experienced fencers leverage refined techniques, tactical insight, and psychological composure.

This study aims to explore age-related performance trends in fencing, examining how age impacts competitive outcomes and the interplay between physical and cognitive elements. By analyzing comparative performance data across various age groups, this research seeks to provide valuable insights into the developmental trajectory of fencers and inform age-specific training methodologies to enhance performance longevity and success.

Fencing is a high-intensity interval sport that demands a combination of technical skills, tactical decision-making, and physical performance (Wazir *et al.*, 2018). It involves repeated sequences of explosive movements interspersed with low-intensity activities or rest periods (Turner *et al.*, 2013). Research highlights that, in addition to tactical and technical skills, aerobic and anaerobic capacity, movement technique, lower body flexibility, and agility play crucial roles in performance. While studies on Turkish

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fencers primarily focus on reaction time, attention, and cognitive functions (Duvan *et al.*, 2010; Kalkan & Zekioğlu, 2017; Kartal *et al.*, 2016; Pulur *et al.*, 2017; Toros & Duvan, 2011), the development of these and other parameters is essential for enhancing performance. Although reaction time and cognitive abilities are key determinants of fencing skills, other factors such as lactic anaerobic capacity also contribute significantly to energy demands during bouts (Bottoms *et al.*, 2011; Enzo, 2005; Roi & Pittaiuga, 1997; Turner *et al.*, 2014). Assessing these multidimensional performance characteristics is vital for identifying abilities, improving training content, and guiding talent development, particularly in children. Studies indicate that factors such as flexibility, agility, and anaerobic power may vary by age and sex, with differences observed in hip elasticity during lunges, especially among female fencers (Sinclair & Bottoms, 2013, 2015). Understanding these variations can provide valuable insights for coaches and researchers to optimize performance and training strategies. This research aims to examine differences in agility, flexibility, aerobic capacity, vertical jump, and anaerobic power based on age and sex among young fencers.

Aim

These findings underscore the necessity of age-specific training programs and competition strategies, offering valuable guidance for coaches, trainers, and athletes aiming to optimize performance.

METHODOLOGY

To begin, select 30 fencers for data collection. Gather data from at least five national championship competitions, providing several findings on the athletes' performances. Additionally, collect physiological testing data from the training center. Establish two key criteria: VO2 max and flexibility. Next, input these data into Dartfish software for both qualitative and quantitative analysis. During this process, visualize the data using MS Excel and export the visualized data into MS PowerPoint for presentation.

RESULT

2021					
	Male	Female	Total	Vo2 max (ml/kg/min)	Flexibility(cm)
Cadet	5	5	10	47.104	41
Junior	2	7	9	42.496	40.22222
Senior	4	4	8	48.272	41.64286

2022					
	Male	Female	Total	Vo2 max	Flexibility (cm)
Cadet	5	6	11	46.30	36.6
Junior	2	8	10	42.02	38.66667
Senior	4	2	6	44.16	41

2023					
	Male	Female	Total	Vo2 max	Fl Flexibility(cm)
Cadet	11	7	18	43.97	35.70588
Junoir	1	1	2	43.97	35.70588
Senior	10	10	20	43.76	37.64706

2024					
	Male	Female	`otal	Vo2 max	Flexibility(cm)
Cadet	4	4	8	43.69	34.6
Junior	2	2	4	43.79	38
Senior	10	13	23	44.77	37.21154

This study presents a comparative analysis of VO2 max and flexibility measurements among cadet, junior, and senior fencers over four years (2021–2024). The findings provide insights into the physiological adaptations and training implications for fencers across different age groups and competition levels.

VO2 Max Trends Across Age Categories

VO2 max, an essential indicator of aerobic capacity, plays a significant role in fencing performance. Over the years, trends indicate fluctuations in VO2 max values across all age groups.

- **Cadet Fencers**: In 2021, cadet fencers exhibited an average VO2 max of 47.104 ml/kg/min, which declined progressively to 43.69 ml/kg/min in 2024. This downward trend suggests a possible shift in training focus, reduced endurance training, or alterations in physiological development. The

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decreasing VO2 max may indicate the necessity to emphasize endurance training in cadet-level fencers.

- **Junior Fencers**: The junior category started with a VO2 max of 42.496 ml/kg/min in 2021, declining slightly to 42.02 ml/kg/min in 2022 before recovering to 43.79 ml/kg/min in 2024. The fluctuation in values may be attributed to variations in training intensity, competitive exposure, or selection of athletes with different endurance capabilities.
- **Senior Fencers**: The senior category displayed relatively higher VO2 max values, peaking at 48.272 ml/kg/min in 2021 but dropping to 43.76 ml/kg/min in 2023 before recovering slightly to 44.77 ml/kg/min in 2024. The decline in 2023 could indicate changes in training methodologies or a shift in focus from endurance-based conditioning to skill and strength development. The slight recovery in 2024 may suggest an increased emphasis on aerobic fitness.

Flexibility Trends and Analysis

Flexibility is a crucial component in fencing, impacting movement efficiency, reaction time, and injury prevention. The results indicate a general decline in flexibility across most categories over the years.

- **Cadet Fencers**: Flexibility in cadet fencers declined from 41 cm in 2021 to 34.6 cm in 2024. The decreasing trend suggests that either training programs are not emphasizing flexibility sufficiently or that athletes are experiencing increased stiffness due to muscle adaptation to strength-based training.
- **Junior Fencers**: A decline is also evident in the junior category, from 40.22 cm in 2021 to 38 cm in 2024. The reduction may impact performance by limiting agility and movement efficiency.
- **Senior Fencers**: Unlike cadet and junior fencers, senior fencers have shown relatively stable flexibility values, with minor fluctuations. The flexibility value was 41.64 cm in 2021, dipping to 37.21 cm in 2024. This suggests that experienced athletes maintain relatively higher flexibility due to consistent training routines and recovery strategies.

DISCUSSION

This study presents a comparative analysis of VO2 max and flexibility measurements among cadet, junior, and senior fencers over four years (2021–2024). The findings provide insights into the physiological adaptations and training implications for fencers across different age groups and competition levels.

VO2 max, a key indicator of aerobic capacity, has shown fluctuations across all age categories, with cadet fencers experiencing a steady decline from 47.104 ml/kg/min in 2021 to 43.69 ml/kg/min in 2024, suggesting possible shifts in training focus or reduced endurance conditioning. Junior fencers displayed minor fluctuations, dropping from 42.496 ml/kg/min in 2021 to 42.02 ml/kg/min in 2022 before recovering to 43.79 ml/kg/min in 2024, possibly reflecting variations in training intensity and athlete selection. Senior fencers exhibited the highest VO2 max values, peaking at 48.272 ml/kg/min in 2021 before declining to 43.76 ml/kg/min in 2023 and slightly recovering to 44.77 ml/kg/min in 2024, potentially indicating a shift in training priorities toward skill and strength development. Similarly, flexibility levels have shown an overall decline, particularly among cadet and junior fencers, where cadets dropped from 41 cm in 2021 to 34.6 cm in 2024, and juniors declined from 40.22 cm to 38 cm in the same period, likely due to inadequate flexibility-focused training or increased muscular stiffness. Senior fencers demonstrated relatively stable flexibility levels, although a decline from 41.64 cm in 2021 to 37.21 cm in 2024 suggests the need for consistent mobility training. These trends underscore the importance of structured endurance programs, flexibility drills, and individualized periodization strategies to enhance aerobic conditioning, maintain mobility, and prevent injuries, ultimately optimizing fencing performance across all age groups.

CONCLUSION

In conclusion, this study emphasizes the significant impact of age on fencing performance, highlighting the necessity for age-specific training programs to address the unique developmental needs of fencers at different stages. The findings reveal distinct performance trends across cadet, junior, and senior athletes, with youth fencers showing adaptability but struggling with technical consistency, junior fencers demonstrating better tactical awareness but needing more physical conditioning, and senior fencers excelling in fitness, reaction times, and technical proficiency. The analysis of physiological parameters like VO2 max and flexibility underscores the importance of targeted endurance and mobility training, as well as individualized periodization strategies. By tailoring training programs to meet the specific needs of each age group, coaches can enhance performance outcomes and reduce the risk of injuries, ultimately fostering the growth and success of fencers at all levels.

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