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The Effectiveness of the AMRAP Method in Increasing Strength and Endurance in Adolescent Fencing Athletes

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Abstract: This study aimed to examine the effectiveness of the As Many Rounds As Possible (AMRAP) exercise method on strength (back and leg muscles) and muscle endurance (abdominal, arm, and back muscles). Design of pre-test-posttest control group through experimental method. Participants were 20 male fencing athletes who were selected through purposive sampling and divided into two groups, the AMRAP Group (n=10) and the Control Group (n=20). The instruments used were a foot and back dynamometer and a one-minute push-up, back-up, and sit-up test. Data were analyzed using the Wilcoxon test, the Mann Whitney test, the Kruskal Wallis test, and the Tukey post hoc analysis, with a significance level of 0.005. All statistical analyses were performed using SPSS version 23. Wilcoxon's analysis showed that the AMRAP group experienced significant improvements across all variables, with p values ranging from 0.005 to 0.011 (<0.05), while the control group showed no improvement. The Mann Whitney test showed that the AMRAP group significantly outperformed the control group in posttest results, with a p-value between 0.004 and 0.029 (<0.05). The Kruskal Wallis test further showed significant simultaneous differences in post-strength and muscle endurance outcomes (p = 0.000), although post hoc analysis identified that not all variables improved simultaneously. AMRAP training has been shown to be effective and superior to control conditions in improving muscle strength and endurance in adolescent fencing athletes. AMRAP is recommended as an alternative and time-efficient physical training approach compared to traditional training in improving the physical condition of adolescent athletes to optimize the physical conditioning of athletes needed during fencing matches..

Keywords: AMRAP method, strength and endurance muscles, fencing athletes

1. Introduction

Fencing is a sport that requires a high level of physical readiness [1]. Competitive fencing demands fast reaction speeds, tactical technical execution, and optimal muscle fitness [2]. The match is played on a narrow lane where athletes constantly exchange attacks to score points through precise pushes. In the context of the development of adolescent fencing athletes, intensive and structured training is essential [3]. Adolescence represents a critical developmental period in which physical capacity responds rapidly to training stimuli [4]. Therefore, understanding fundamental movement patterns such as rapid forward and backward actions, sudden changes of direction, and coherent coordination between the lower and upper limbs is essential to designing an effective physical conditioning program.

Muscle fitness is the main component that underlies all movements performed during fencing training and competitions [5]. In the context of fencing, muscle fitness is strongly linked to strength. Strength serves as the basis for developing strength and agility, allowing athletes to perform movements more efficiently. In addition, muscle endurance plays a crucial role in maintaining repetitive technical actions during a high number of repetitions and a longer duration [6]. Without adequate muscle fitness, the accuracy of the thrust tends to decrease as the duration of the match increases, and athletes become more prone to fatigue and injury. Therefore, muscle strength and endurance play an important role in supporting optimal performance in fencing.

One of the training methods that has recently gained widespread attention among sports practitioners is the As Many Rounds As Possible (AMRAP) protocol. AMRAP is a form of circuit-based training that is carried out at maximum intensity, requiring athletes to complete as many laps and repetitions of predetermined exercises within a certain period of time [7]. This approach differs from traditional training methods that rely on fixed sets and repetition; in contrast, AMRAP offers a higher volume of training in a relatively short duration.

The application of AMRAP in training sessions has the potential to greatly improve time efficiency. In about 21 minutes, athletes can achieve a high level of performance aimed at stimulating physiological and cardiovascular adaptation [8]. The characteristics of AMRAP that combine durability and speed are well aligned with the demands of fencing, which involves short, high-intensity actions. The selection of AMRAP as a training method is supported by several considerations: (1) psychologically, adolescent athletes often experience boredom with repetitive and monotonous traditional training structures, while AMRAP provides personal challenges that can increase motivation; and (2) AMRAP simulates a stressful competition environment, requiring athletes to maintain performance even under fatigue.

The application of AMRAP in various sports has been supported by substantial evidence. In petanque, an eight-week AMRAP-based training program has been shown to increase abdominal muscle strength and maximum oxygen consumption [9], Similarly, AMRAP has been reported to effectively improve leg and abdominal strength in basketball athletes [10], Consistent with these findings, other studies have shown that AMRAP training improves lower limb strength, core muscle endurance, and cardiovascular capacity among runners [11], Further research on runners also showed that AMRAP contributes to improved speed, leg strength, and cardiovascular fitness [12]. Collectively, these findings provide a compelling reason for the potential adaptation of AMRAP into physical conditioning programs for fencing athletes.

However, the research that exists has mostly focused on basketball athletes, runners, or teenagers in general. Fencing involves a unique pattern of movement that differs substantially from basketball or running. Previous research has mainly emphasized strengthening the lower limbs and abdominal muscles to reduce the risk of injuries such as ACL tears and jumping knees. In addition, the duration of AMRAP interventions reported in previous studies varied widely, ranging from 16 weeks in basketball, 8 weeks in petanque, and 6 weeks in running. Notably, there is a lack of research that explicitly examines strength and durability of strength during a 10-week intervention period in the context of fencing. It highlights methodological gaps related to the specificity of the exercise, the duration of the intervention, and the age of the athlete.

In line with the gaps identified in previous studies that have been identified in basketball and running, there are still significant gaps related to the implementation of the AMRAP method in fencing which is a sport with a multi-directional movement pattern. The study is novel in that it explicitly evaluated strength and endurance during a 10-week intervention period in adolescent fencing athletes, so it can present stronger physiological adaptation profile data than studies with a relatively short time. The findings of this study are expected to offer a practical contribution to the development of varied and effective physical training programs that improve the physical performance of fencing athletes. Based on the reasons mentioned above, the research questions were formulated as follows:

1. How does the AMRAP method affect strength (leg and back muscles) in fencing athletes?
2. How does the AMRAP method affect strength endurance (abdominal, arm, and back muscles)?
3. How do AMRAP and control groups differ in terms of strength outcomes?
4. How do AMRAP and control groups differ in terms of strength and durability outcomes?

5. How is the strength and durability of the force simultaneously affected in the AMRAP group?

2. Materials and Methods

Study participants

The participants in this study were 20 17-year-old male fencing athletes. This study used an experimental method divided into the AMRAP group (n=10) and the control group (n=10) with a test design *Pretest* and *posttest*. This study used an experimental method with a pretest-posttest control design of one group. Participants were selected using purposive sampling based on the following criteria: (1) male athletes, (2) members of the same fencing club, (3) 17 years old, and (4) not involved in any other external training program. Strength is assessed using a foot and back dynamometer, while strength endurance is measured through push-up, back-up, and one-minute sit-up tests *[13].*

Study organization

The research procedure begins with all participants completing a pretest to assess strength and durability of strength. The first group then received an AMRAP training intervention, while the second group conducted exercises with techniques and tactics on a regular basis without additional conditioning. The intervention was carried out over a 10-week period, with training sessions conducted three times a week. At the end of the intervention, a posttest is given, and the resulting data is further analyzed. The exercise load progressively increases by 5% each week, with the heart rate target maintained between 75% and 90% of the maximum effort. In addition, the number of target sets is increased twice weekly to ensure progressive overload. The AMRAP program consists of three structured sessions: Program 1 (21 minutes) includes a halter squat (2 kg), a kettlebell swing (6 kg), a ladder-and-out squat, and a back-leg raised split squat, each performed for 12 repetitions. Program 2 (21 minutes) involves man maker (2 kg), lunges with knee drive (left and right), plank rows (5 kg), press jacks (2 kg), and ladder Ickey shuffles, also completed for 12 repetitions. Program 3 (10-minute core session) consists of a dead insect (3 kg), a fluttering kick, and a Turkish sit-up (3 kg), each performed for 12 repetitions.

Data Analysis

Data analysis was conducted using descriptive statistics, Wilcoimproving-strengthimproving strengthimproving Effectivenessxon test, and Mann-Whitney test, followed by post hoc analysis, with significance level set at 0.05 [14]. All statistical procedures were performed using SPSS version 23.

3. Results

Table 1. Results of pretest-postest descriptive analysis

Group	Variabel	Prates (M ± SD)	Postest (M ± SD)
AMRAP	Leg strength	67.30 ± 19.832	112.60 ± 32.349
	Back strength	53.90 ± 13.932	91.60 ± 31.792
	Arm Durability Strength	32.40 ± 2.459	33.80 ± 6.303
	Strength endurance core muscle	30.40 ±4.695	35.90 ± 4.149
	Strength endurance back	47.80 ± 15.039	61.80 ± 14.883
Control	Leg strength	94.00 ± 21.738	138.40 ± 203.712
	Back strength	87.60 ± 34.490	77,55 ± 32,887
	Arm Durability Strength	29.00 ± 3..944	29.00 ± 3.162
	Strength endurance core muscle	31.40 ± 3.134	30.50 ± 4.301
	Strength endurance back	60.20 ± 6.909	60.20 ± 6.909

Table 1 shows that the AMRAP group showed an increase in the strength of the lower leg muscles, increasing from 67 to 112, and the strength of the back muscles, increasing from 53 to 91. In addition, muscle endurance results increased, with upper leg endurance increasing from 32 to 33, abdominal muscle endurance from 30 to 35, and back muscle endurance from 47 to 61. In contrast, the control group showed an increase in lower leg muscle strength from 94 to 138, while back muscle strength decreased from 87 to 77. In addition, the endurance of the upper leg muscles remained unchanged (29 to 29), the endurance of the abdomen decreased slightly from 31 to 30, and the endurance of the back muscles showed no change (60 to 60). These findings suggest that AMRAP interventions were effective in improving muscle strength and endurance, while the control group tended to stagnate or decline in some performance indicators.

Table 2. Results of pretest-postest wilcoxon analysis in one group

Group	Pretest – Postest	Means	Tanda
AMRAP	Pretest leg muscle strength	67.30	0.005
	Postest leg muscle strength	112.60	
	Pretest back muscle strength	53.90	0.011
	Postest back muscle strength	138.40	
	Pretest abdominal strength strength	30.40	0.005
	Postest abdominal strength	35.90	
	Strength of pretest arm strength	32.40	0.007
	Post strength arm	33.80	
	Power Return Pretest	47.80	0.005
	Postest strength back empowerment	61.80	
Control	Pretest leg muscle strength	94.00	0.114
	Postest leg muscle strength	138.40	
	Pretest back muscle strength	87.60	0.508
	Postest back muscle strength	91.60	
	Pretest abdominal strength strength	31.40	0.285
	Postest abdominal strength	30.50	
	Strength of pretest arm strength	29.00	1.000
	Post strength arm	29.00	
	Power Return Pretest	60.20	1.000
	Postest strength back empowerment	60.20	

Table 2 presents a comparison in groups between pretest and posttest measurements. The AMRAP group showed a statistically significant improvement across all variables, with a p< value of 0.05, suggesting that the posttest results were significantly better than the pretest results. In contrast, the control group showed no significant difference between pretest and posttest measurements, with a p> value of 0.05.

Table 3. The results of the manwhitney postest analysis of each group

Postest	Means	Differences	Tanda
Leg muscle strength of the AMRAP group	112.60	25.80	0.015
Leg muscle strength control group	138.40		
Back muscle strength of the AMRAP group	138.40	33.70	0.029
Back muscle strength control group	91.60		
Strength of the abdominal muscle endurance of the AMRAP group	35.90	5.40	0.004
Abdominal muscle endurance strength control group	30.50		
Strength of arm muscle endurance group AMRAP	33.80	4.80	0.012
Strength of arm muscle endurance control group	29.00		
Back muscle strength of the AMRAP group	61.80	1.60	0.023
Strength of the back muscle control group	60.20		

Table 3 presents a comparison between the post-outcomes of the AMRAP group and the control group. Overall, the p< value of 0.05 showed a statistically significant difference between groups. Based on the mean scores and differences between groups, the AMRAP group showed superior post-traumatic stress compared to the control group.

Table 4. Kruskal Wallis Test Results

Variabel	Tanda
Strength (leg and back muscles)*endurance strength (rm, abdominal and back muscles)	0.000

Table 4 It showed that simultaneous post-mortem analysis of muscle strength (lower leg and back muscles) and muscle endurance (upper leg, abdominal muscles, and back) resulted in a significance value of p< 0.05, showing a statistically significant difference.

Table 5. Results of the post hoc test tukey

Variabel	Test statistics	Std Error	Statistics tests std	sig	Adj sig
Arm strength, endurance – back strength	-20.770	6.507	-3.181	0.001	0.015*
Arm strength, endurance -back strength	24.800	6.507	4.856	0.000	0.000*
Arm strength endurance – leg strength	31.600	6.507	4.856	0.000	0.000*
Abdominal strength endurance – back strength endurance	-19.300	6.507	-2.966	0.003	0.030*
Abdominal strength, endurance – back strength	23.400	6.507	3.596	0.000	0.003*
Abdominal strength endurance – leg strength	30.200	6.507	4.641	0.000	0.000*
Arm strength - abdominal strength	1.400	6.507	.215	8.30	1.000
Endurance back strength – back strength	4.100	6.507	.630	.529	1.000
Endurance back strength – leg strength	10.900	6.507	1.675	.094	.939
Back strength – leg strength	6.000	8.507	1.045	.296	1.000

Table 6 shows that the adjusted significance value marked with an asterisk (*) < 0.05, indicates a statistically significant simultaneous increase. In contrast, the adjusted significance value without the asterisk > 0.05, indicating the absence of a statistically significant simultaneous improvement.

4. Discussion

The purpose of this study was to examine the effectiveness of the As Many Rounds As Possible (AMRAP) training method in improving muscle strength (lower leg and back muscles) and strength endurance (abdominal muscles, upper legs, and back) in adolescent fencing athletes.These findings directly address the stated research questions and confirm the research hypothesis that AMRAP training results in a significant increase in strength endurance compared to non-AMRAP conditions. The results showed that the 10-week AMRAP training intervention produced a significant effect across all the variables measured. Wilcoxon's analysis in the AMRAP group revealed a statistically significant difference ($p < 0.05$), suggesting that AMRAP training effectively improves the strength of the lower leg and back muscles, as well as the endurance of the abdominal, back, and upper limb muscles. In contrast, no significant differences were observed between pretest and posttest measurements in the control group ($p > 0.05$).

Furthermore, the results of the Mann-Whitney U test comparing post-traumatic outcomes between AMRAP and the control group showed that the AMRAP group performed much better than the control group. These findings suggest that AMRAP training methods are superior to control conditions in improving muscle strength and strength endurance among adolescent fencing athletes. In addition, post-analysis of the strength and strength resistance variables in the AMRAP group using the Kruskal-Wallis test showed a significant simultaneous increase ($p < 0.05$). Post hoc analysis revealed that most combinations of variables showed significant simultaneous increases ($p < 0.05$); However, some combinations namely upper leg muscle endurance strength vs abdominal muscle, back muscle strength vs back muscle strength, lower leg strength vs lower leg muscle strength, and back muscle strength vs lower leg muscle strength did not show a significant simultaneous increase.

The novelty of this research lies in three main aspects. First, it specifically focuses on fencing, a sport characterized by rapid forward and backward movements and coordinated harmonization of the action of the upper and lower limbs. Second, the duration of the 10-week intervention provided a stronger description of physiological adaptation to training. Third, the study simultaneously integrated the analysis of muscle strength and endurance strength to produce a physical performance profile of fencing athletes. The AMRAP method represents a high-intensity circuit-based training approach in which participants are required to perform as many repetitions and laps as possible within a set period of time [15]. The AMRAP method has been shown to be more effective than traditional endurance training, especially for participants who prioritize time-saving training modalities [15], Muscle strength increased by 2.4 kg, muscle endurance increased by 12 repetitions, and in particular, body fat percentage decreased by 4.5% [15], Consistent with the findings of Olivier et al., the AMRAP group showed a higher increase in repetition among experienced participants compared to those with less experience [16]. Together, these studies reinforce current findings, suggesting that the AMRAP method can significantly improve muscle strength and endurance in experienced fencing athletes.

Interestingly, the AMRAP training method has also been applied to football referees, with a 42-day intervention consisting of 24 training sessions and a adjusted session duration of 20-30 minutes. The results showed a reduction in body weight and body fat percentage, an improvement in jumping performance (including a one-step jump and a three-step jump), but a decrease in VO□max [17], Similarly, another study reported that the application of the AMRAP method resulted in decreased return movement jump performance and decreased flexibility in the AMRAP group. [15], [16], These results may be due to fatigue-related factors and inadequate emphasis on stretching before and after training sessions [15,16]. However, other studies have reported improvements after AMRAP training, including a 14-21% increase in lower leg muscle strength, a 6-14% increase in agility, and a 12% increase in cardiovascular endurance among basketball players [18]. Although inconsistent findings have been reported for jumping performance and cardiovascular endurance, increased muscle strength and strength endurance have consistently emerged as the most powerful results in some previous studies. Therefore, the application of the AMRAP method aimed at improving muscle strength and strength endurance continues to be considered an effective training approach.

In addition, post hoc analysis shows that some variables do not show simultaneous improvement. This can be explained by the fact that strength-oriented training mainly emphasizes nerve adaptations that allow for maximum power production over a short period of time, whereas strength endurance relies more on metabolic efficiency and the capacity of muscles to sustain repetitive contractions for long durations, often under conditions of lactate accumulation. Although the AMRAP method is designed to improve performance within a fixed time window by giving rise to both adaptations simultaneously, the body has inherent energetic limitations in accommodating these different physiological demands. As a result, one or more variables may fail to improve simultaneously optimally.

Nevertheless, some limitations must be acknowledged. The relatively small sample size and inclusion of only male athletes limited the generalization. In addition, this study focused exclusively on physical performance variables without assessing technical, tactical, or psychological outcoes that also affected performance in fencing. Core exercises in training programs such as lunges, squats, and push-ups are classified as compound movements and are therefore widely used to develop muscle strength and endurance strength. Consistent with previous research, squat-based exercises, in particular, have been identified as an effective compound movement to optimize increased muscle strength and endurance [19]. This issue is basically related to the regulation of training doses. Training doses, analogous to pharmacological doses, can produce side effects when applied excessively, while insufficient doses may fail to elicit meaningful adaptations [20], [21], Consistent with previous research, physical training interventions should adhere to established programming guidelines, i.e. frequency, intensity, timing, and type, along with volume and progression (FITT-VP)[22].

5. Limitations

Although this study provides promising evidence regarding the effectiveness of AMRAP interventions, some limitations must be acknowledged. First, the sample size was relatively small and limited to male participants. Second, the study mainly focused on physical performance outcomes, while psychological and technical aspects that are also important in athletic performance were not examined. Third, this study used a single comparative design, with comparisons limited to the control group only. Fourth, simultaneous analysis did not produce a uniform improvement across all variables, suggesting limitations in the capacity to induce multiple adaptations under limited energy availability. These aspects require further investigation in future studies.

6. Conclusion

In conclusion, the AMRAP method was effective in improving muscle strength and strength endurance in adolescent fencing athletes compared to the control group. The AMRAP intervention resulted in superior improvement in most of the variables measured, confirming its effectiveness as a structured conditioning approach. Although simultaneous improvement was not uniformly observed across all combinations of variables, the overall findings suggest that AMRAP training effectively improves multiple components of muscle fitness within a single training framework. These findings provide practical implications for trainers, AMRAP can be applied as a time-efficient, progressive, and motivating alternative to traditional resilience training, provided that proper training load management and developmental principles are applied. Future research should expand the sample to include female athletes and different age categories, as well as compare alternative strength training methods to further improve their relative effectiveness.

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Conflict of Interest:

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